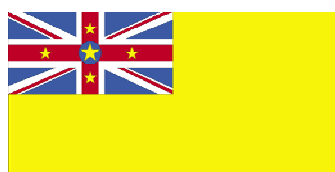




Sustainable Integrated Water Resources and Wastewater
Management in Pacific Island Countries

National Integrated Water Resource Management Diagnostic Report

Niue



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SOPAC



ACRONYMS

AusAID	Australia Aid International Development
CBD	Convention on Biodiversity
CBO	Community Based Organisation
DAFF	Department of Agriculture, Forestry and Fisheries
ENSO	El Nino Southern Oscillation
EPDSU	Economic Planning Development Statistics Unit
FAO	Food Agriculture Organisation
GIS	Geographical Information System
GPS	Global Positioning System
GoN	Government of Niue
GPS	Global Position System
HDI	Human Development Index
HYCOS	Hydrological Observation System
IFOAM	International Federation of Agriculture Movement
IWP	International Waters Project
IWRM	Integrated Water Resource Management
MEAs	Multi Environment Agreements
NIOFA	Niue Island Organic Farmers Association
NIUANGO	Niue Island United Association of Non-Government Organisations
NGO	Non Government Organisations
NZAID	New Zealand Aid
PACC	Pacific Adaptation to Climate Change
PACTAF	Pacific Technical Assistance Facility
PICs	Pacific Island Countries
POPs	Persistent Organic Pollutants
PWD	Public Works Department
SOPAC	Pacific Islands Applied Geoscience Commission
UNESCO	United Nations Educational, Scientific and Cultural Organization
UN	United Nations
UNFCCD	United Nations Forum on Climate Change and Desertification
UNFCCC	United Nations Framework Convention to Climate Change
WHO	World Health Organisation

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EXECUTIVE SUMMARY

Water is essential for life and livelihood, and is an essential commodity for all sectors of the economy. Water is regarded as a public property, a finite natural resource, with economic value. Niue draws water from underground sources and has adopted a sectoral approach to managing this natural resource.

Over the years Niue has noted significant deficiencies in its capacity to conduct essential water resources assessment and monitoring which prevented Niue from formulating proper planning, development, and sustainable management of its limited and vulnerable water resources. Although Niue has recognised the need for a systematic, coordinated approach to addressing these deficiencies, it lacks the baseline data and the appropriate technical ability to facilitate appropriate remedial actions. In this respect, together with other Pacific Island countries (PICs), sharing the same constraints with the assistance of regional organisations such as SOPAC, Niue agreed to approach donor agencies for assistance. For the last 3-4 years a programme of strategies was set in place to mobilise assistance, which is the result of this diagnostic report.

It was through donor assistance that brought together key personnel from respective PICs for dialogue and consultation resulting in the formulation of the six thematic areas as the baseline to launching the integrated approach to managing water resources in a sustainable manner.

However, before Niue and other PICs mobilise the integrated approach to water management common areas were identified regionally as baseline objectives to facilitate integrated water resource management (IWRM) at national levels thus: Niue shared the following key areas and strategies aligning them with the Pacific Regional Action Plan on Sustainable Water Management (Sigatoka, Fiji August 2002) of which Niue is a signatory.

Niue needs to:

- (a) strengthen its capacity to conduct water resources assessment and monitoring as the key component of sustainable water resources management.
- (b) formulate and implement strategies to utilise appropriate methods and technologies for water supply and sanitation systems.
- (c) implement strategies to protect watersheds and the remaining forest from further depletions, which have included the identification of critical habitats other than the Huvalu Conservation Area.
- (d) strengthen capacity development to enhance the collection and application of climate information to cope with climate variability and change.
- (e) promote the change paradigm for dealing with island vulnerability from disaster response to hazard assessment and risk management, particularly in IWRM.
- (f) set up a high quality participatory framework to allow for open participation of stakeholders in sustainable water and wastewater management.
- (g) include water and sanitation in the formal education system.
- (h) improve the communication and coordination of all stakeholders in sustainable water and wastewater management including government, NGOs, civil society and private sector.
- (i) identify appropriate institutions, infrastructure, and information to support sustainable water and waste water management.
- (j) continue collaboration with regional and international partnerships to facilitate appropriate assistance in all areas relating to water resource and wastewater management.

- (k) support regional training programmes resulting in sustainable levels of skills and knowledgeable people within water and wastewater management.
- (l) work together through a comprehensive consultative process, encompassing good governance, to develop a shared national vision for managing water resources in a sustainable manner.
- (m) work together towards developing and strengthening national instruments, vision, policies, plans and legislation taking into account social, economic and environmental and cultural needs of its citizens.
- (n) identify and promote appropriate institutional arrangements and resources sufficiently to enable effective management of water resources and the provisions of appropriate water and wastewater services.
- (o) develop, encourage and recognise national leadership in water resources.
- (p) create a better and sustainable environment for investment by public and private sector, by developing and implementing national, sector, and strategic plans that identify the economic, environmental and social costs of different services and develop pricing policies, which ensure the proper allocation of resources for the water sector.
- (q) reduce costs through improved operational efficiency, using benchmarking, development of water-loss reduction programmes, and improved work practices.

Water resource management

The Government of Niue (GoN) is restructuring its Public Service which is a timely opportunity to integrate water management functions adopting the IWRM approach and principles in lieu of the current sectoral approach adopted over the last 3-4 decades. This will be an opportunity to integrate NGOs, civil society and all stakeholders in the process of water and wastewater management. The strengthening of the national capacity will enhance efficiency to deliver the required services by the public institutions, but also the awareness of the community on the sustainable use of water as a finite natural resource.

Niue needs to:

- (i) implement actions to strengthen national capacity (equipment, training etc).
- (ii) train more technicians in the field of hydrology, water management, quality testing, and other related areas.
- (iii) strengthen and enhance communication and information exchange between national agencies in the field of meteorology, hydrology, water quality, data collection department and the users.
- (iv) implement a holistic approach and IWRM principles and practices through the systematic coordination between related agencies, with the long term commitment for the implementation of IRWM and provide appropriate support and training sourced from regional and international institutions.
- (v) build security fences to protect the reservoirs and bore sites.
- (vii) source funding to import tanks or build concrete tanks on-site to capture rain water as another source of potable water.
- (viii) to encourage users to contribute by way of conserving water to reduce related costs.

Island vulnerability

Niue is vulnerable to natural disasters such as tropical cyclones given its geographical location in the Pacific Ocean. Its porous soil formation (various investigations, the latest in 2004-2005), suggests that the protection of the underground fresh water source, is a responsibility of all resource users.

Continuous concerted efforts by the GoN and all water users to ensure that all surface development activities, regardless of potential economic and financial gains from these activities, do not contaminate the aquifer thus the enforcement of the existing protection mechanism and laws are essential. The strengthening of human capacity through training and to improve the understanding of the impacts of development projects and to effectively enforce the protection mechanism requirements and the importance of conducting of EIAs is required. This includes strengthening the inspection requirements as mandated under the Building Code in the designing and installation of septic tanks for new houses and tourist accommodations.

Niue needs to:

- (i) action the recommendations in the national Waste Management Plan¹, to ensure the water lens are protected from any form of contamination and pollution. Institutional capacity requires strengthening.
- (ii) continue quality monitoring practices following WHO standards.
- (iii) continue to work together with climate information services in the region, strengthen current capacity to enable the ongoing development analysis, forecasting and application tools; and include the participation of stakeholders.
- (iv) continue to develop rainfall and drought monitoring and prediction methods, including technology transfer.
- (vi) implement actions to strengthen national capacity to carry out hazard assessment and risk management using existing tools and other vulnerability assessment and risk management tools.
- (vii) develop a drought plan.
- (vii) develop fuelling safety standards for fishing boats
- (ix) undertake environmental impact assessments (EIA) as a prerequisite for all development projects including regular inspections and the continuous evaluation of impacts.

Awareness

The promoting of fresh water as a finite resource as well as an economic good, rests with all members of the community, all users and stakeholders thus ensuring that water profile is always at the forefront, a resource owned by the community. The active participation will actually change the mindset of everyone in the community to actively recognise water resources as a necessity for all forms of life. The driving force of this campaign will be the Department of Community Affairs and the Water Division of the Public Works Department in partnership with NGOs.

The setting up of a participatory framework must include community participation as an empowering tool to lead to community ownership and sustainability of water resources. This includes strengthening the capacity of NGOs, community based organisations (CBOs) and government departments to effectively disseminate information on sustainable water resources and wastewater management. NGO involvement plays a significant role at the grass root level through encouraging a water oriented civil society. Information is a powerful tool for changing behaviour in the water world, through television, radio programmes, schools programmes, women and youth activities.

¹ Implemented by the Department of Health but in early 2007, responsibility was transferred to the Department of Environment.

Niue needs to:

- (i) support the establishment of a regional water education fund accessible by government agencies, NGOs and civil society groups to ensure effective community participation in sustainable water management'
- (ii) develop a toolbox in association with SOPAC, donors, regional and international organisations to support water education for all levels of society, including politicians, government personnel, civil society and private sector.
- (iii) adopt water education as part of the school curriculum including the training of teachers to provide water education.
- (iv) define roles and responsibilities of government, civil society groups, private sector and communities in the sustainable management of water.
- (v) share information between all stakeholders.
- (vi) improve awareness of policy and legislation through education and community based learning.
- (vii) adopt a partnership working relationship between all water users.
- viii) request SOPAC to approach regional education institutions to develop courses in water engineering and management towards a recognised qualification.

Technology

Involvement of various institutions needs to be coordinated effectively from a focal point with the appropriate authorisation mechanism, thus by legislation, regulation or a Cabinet instrument. The formalising of the authority enables defined roles and responsibilities preventing fragmentation, uncoordinated plans, and enabling strategic actions to improve linkages with other sectors.

Niue needs to:

- (i) strengthen the capacity of the institutions responsible for monitoring demand, quality and collecting data including the inspection role under the Building Code.
- (ii) clearly define the responsibilities and roles of relevant institutions and to review and activate the wastewater management policies.
- (iii) provide continuous support to replace the GIS database at Department of Justice.
- (iv) replace the GPS monitoring system at Department of Justice.
- (v) strengthen gravity system and reduce pumping power cost and explore alternative sources of renewable energy suitable for Niue.
- (vi) review the Waste Management Action Plan to include new proposals before implementation.
- (vii) identify appropriate equipment and technology.

Institutional Arrangements

The GoN is committed "to provide a quality potable water supply to all residents" (Niue Strategic Plan 2005-2008). However there is a need of a national "vision" focusing on sustainable integrated water management, to indicate the priority, the direction and the level of understanding as to the governance requirement related to water as a finite natural resource, a necessity to all forms of life.

The Niue Public Service is under review focusing on performance, and increasing productivity. The review is the opportunity for GoN to adopt the IWRM approach and principles, by deciding where to locate water resource management functions, and whether to maintain the status quo or to

centralise all related functions and resources (technical or administrative) under one institution/roof.

Niue needs to:

- (i) determine a National Water Vision focusing on sustainable integrated water resource management, raising the water profile, empowering people to account for the use of water; and provide an impetus with strategic direction that would sustain water as a resource with economic and social value.
- (ii) include all parts of the water and service delivery sector in the national vision for sustainable water resource management – including water, wastewater, sanitation and drainage – and give particular regard to cultural and/or traditional rights and practices.
- (iii) articulate the national vision for sustainable resources management through a process of full inclusion of, and consultation with, all stakeholders. This process should be confirmed with stakeholders before the formal development of IWRM stage commences.
- (iv) create and implement an awareness programme adopting IWRM principles to educate people at all levels of the community to use water wisely and view it as a finite economic and social good, and that the protection from contamination and pollution is the responsibility of all users.
- (v) develop national guidelines on wise practice approaches to assessing and managing water and wastewater system requirements that incorporate sound environmental health principles.
- (vi) strengthen and harmonise the existing institutional arrangements of key personnel in Foreign Affairs, Treasury, EPDSU and the Department of Environment involved in multi-environment agreements (MEAs).
- (vii) identify gaps, weakness and areas where not appropriate with current situation, in the existing legislation and recommend for appropriate action.

Financing

The efficiency to delivery water to all users, for different use and purposes in a sustainable way rests with the basic understanding that water has economic value and should be treated as a commodity. To continue dependency on government for all related activities renders water management ineffective. It is imperative that all users must contribute to the formulation of policies and share the reticulation costs.

Niue needs to:

- (i) enforce the Water Act (1996), and improve regulatory oversight including sector governance.
- (ii) develop sector master plan to identify funding and cost recovery requirements and benefits, in terms of improving health including poverty alleviation objectives.
- (iii) identify potential benefits of partnerships such as joint ventures.
- (iv) improve demand management.
- (v) develop tariff policies and structures to generate revenues to meet financial and cost recovery policies.
- (vi) establish sound asset management procedures and funding, including operational and management practices.
- (vii) increase consultation and awareness to support cost recovery

Integrated Water Resource Management

The IWRM approach encapsulates the process of change that will bring about positive impacts, effective long lasting solutions with political support and user participation culminating in sustainable natural resources for future generations. Niue needs to act now and to capitalise on regional and international assistance.

IWRM challenges conventional water development and management systems. The traditional top-down, supply led, technically based, sectoral approaches to water management are imposing unsustainably high economic, social and ecological costs on human societies and on the natural environment. Niue's current economical situation will not improve if it continues with the traditional approach to water and wastewater management.

IWRM is not confined to water resource management but integrates with other areas that facilitate and contribute to the social, economic, and environment wellbeing of Niue. Under these three pillars are; landuse and agriculture; health and hygiene, including ecosystem and habitats; and watershed and coastal management.

Agriculture remains the most important landuse on Niue, and it has evolved over the years from slash and burn methods of cultivation to using bulldozers as a means of clearing land for planting various subsistence crops. Kumara and copra were the main export crops in the 1960s; followed by passion fruit and limes in the 1970-1980s. Taro was the export focus in the 1980s until 2005, but has declined in significance due to less volume produced. For the last 3-4 years Nonu (*Morinda citrifolia*) and vanilla have grown as export crops and planters are encouraged to add value to their crops by adopting the organic agricultural principles.

The introduction of agrichemicals to increase productivity and to control weeds has been seen as unsafe and continued use is likely to pollute and contaminate the aquifer. A SOPAC survey on coastal quality in 2003 highlighted the vulnerability of the water sources to any land surface development activities and the link between land and watersheds activities and coastal zone impacts.²

The small size of Niue, its geography and location is of particular importance to the intimacy, which exists between the watersheds and the coastal area. The drainage pattern of the island, poor landuse practices, lack of landuse plans, lack of human and financial resources, dependence on underground water lens, coastal resources and the marine environment, make integrated management of coastal areas and watersheds of critical importance to survival. These issues are cross-sectoral in nature wherein the activity of one sector can adversely affect the development of the other and poses a threat to economic sustainability and environmental quality.

² SOPAC 2004. Miscellaneous Report 554. An overview of Integrated Water Resources Management in the Pacific Countries; National and regional Assessment.

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Of special fakaue lahi to the Manager of Water Division (PWD) for advice, direction and the supplying of resource materials; Niue Met Office, Department of Environment, Department of Justice Lands and Survey, and the International Waters Programme (2001-2006) Coordinator for the releasing of appropriate data.

1. Introduction

Water is vital for human survival, health and dignity and a fundamental resource for human and economic development.

Niue has practised a sectoral approach to water resource management which prevails today. This leads to fragmented and uncoordinated development and management of resources. Having recognised the deficiencies, Niue needs to accept to adopt an integrated approach to managing water as a finite natural resource.

Regional water consultations in recent years have been guided by SOPAC, and six themes have been identified to guide the introduction of IWRM to Pacific Island countries, including Niue. The themes are: water resource management, island vulnerability, awareness, technology, institutional arrangements and finance.

In particular, if effective, long lasting solutions to water problems are to be found, a new water governance and management paradigm is required. It is believe that the new paradigm is encapsulated in the IWRM concept as a process which promotes the coordinated development and management of water, land and related resources in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems including the needs of our future generations.

There will be challenges. These include the acceptance of IWRM by resource users, ensuring stakeholder involvement and participation in the decision making process, and basing decisions on available data and evidences collected. The continuous building and strengthening of capacities will minimise the impacts and the compelling challenges.

IWRM is a process of change, which seeks to systematically shift from the current sectoral approach, and has no fixed beginning or ending. Niue stands to gain enormously from the assistance of regional institutions through the implementation of the Pacific regional IWRM project. It is anticipated that gains will be seen in the efficient delivery of services and management of the environment given the scarcity of financial and human resources. It is important to maximise the economic and social welfare benefits not only derived from water resource base but also from other economic development projects in other sectors as determined by Government that is, tourism, agriculture and fisheries.

The promulgation of a National Water Vision focusing on sustainable integrated water resource management and wastewater management provides Niue with a strategic direction it would take in implementing the IWRM.

As with many small islands developing States, water resource management poses a serious sustainable development challenge for Niue. The water resources and supply comes from underground sources and rain catchments. The rainfall infiltrates the porous coral until it reaches the saline water that lies under the island where its lowest density allows it to form a pool over the salt water. This lens provides the freshwater used for human consumption, agriculture and industry. The aquifer strata are porous and vulnerable to contamination from activities carried out on the surface, and any large scale contamination of the freshwater lens will pose a risk to the population. However, to date, there has been no outbreak of diseases attributable to untreated water.

Water resources management is part of an overall strategic objective of the GoN on environment which allows for “sustainable management of Niue’s natural resources for future generations”³. The Water Resources Act of 1996 sets out the policy and guidelines for extraction, supply and use of water with the aim to provide a quality potable water supply to all residents. In the Cyclone

Comment: Confirm correct title of strategic plan diff from exec summary in footnote

³ GoN Integrated Strategic Plan 2003-2008

Recovery Plan the focus on the water resources is to increase the reliability and quality of water to all sectors.

Niue has noted the deficiencies in its capacity to efficiently adopt and embrace IWRM principles to conduct proper planning, development, and sustainable management of its limited and vulnerable water resources. Its lack of capacity – institutional and human, coupled with geographical isolation and financial dependence are major obstacles which is further compounded by the continued decline in population due to emigration. However, in spite of these difficulties, Niue is committed and has demonstrated its commitment to environmental sustainable development through the adoption of international legal instruments, which are strengthened by regional agreements and include UNFCCC and Kyoto Protocol; CBD and Biosafety Protocol; UNCCD; Stockholm Convention and POPs, World Heritage Convention; Convention of International Trade in Endangered Species of Wild Fauna and Flora; UN Convention of the Law of the Sea; South Pacific Nuclear Free Zone Treaty; Convention of the Protection of the Natural Resources and Environment of the South Pacific Region; and the Convention of the Prohibition of Fishing with Long Driftnets in the South Pacific.

Niue is progressing further with its continuing commitment, to accept, adopt and implement IWRM strategies with assurance that the uses of its water resources are systematically coordinated and sustainably managed.

Water as a natural resource, an endowment, has no formal written policy to govern its various uses, control the demand and protection from potential contamination and pollution render it vulnerable to various disasters, natural and or man made.

The Public Works Department (PWD) for the last decade has been responsible for all water reticulation programmes and water related issues fall under its domain. The various water management issues are automatically combined with reticulation and housed in the Water Division of PWD. Understandably, limited human and financial constraints and the sharing of limited resources is a barrier that affects the efficiency, monitoring and effectiveness of the Division in performing the functions as determined in the PWD mandate. Resources are stretched to meet the demand from users including the implementation of policies set by government.

Niue needs to define a national vision, and include it in the national development plan; water resource management has cross cutting impacts on all sectors. A national plan to embrace all the strategies in a coordinated manner, may promote the water profile at all levels of society, and result in strengthening the capacity and awareness of all related institutions including the Water Division of PWD.

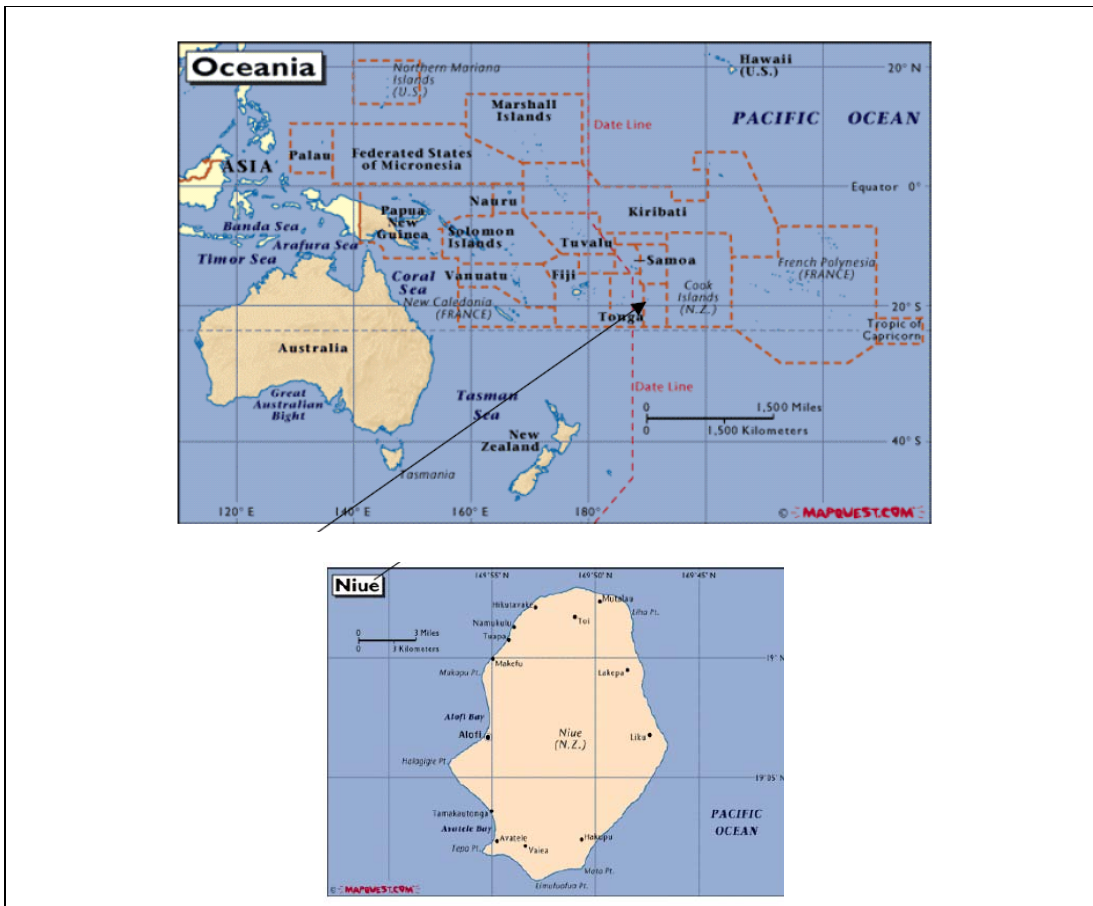
Proposals for capacity building and training of human resources should be treated as priority for all levels, to strengthen monitoring and maintenance of the water infrastructure.

The Water Division recognises the usefulness as well as the complexity and enormity of an IWRM approach as the way forward for Niue and has to date, effectively coordinated various components, with assistance from regional programmes, to drive this forward addressing the challenges endeavouring to optimise water's contribution towards Niue's sustainable development efforts.

The methods employed to prepare this report included the review of existing literature; personal interviews and national stakeholder consultations. The limitations of the report included inadequate data and time. The report follows the guidelines provided by SOPAC.

2. OVERVIEW OF NIUE

Figure 1: Niue Location in Pacific Ocean



Geomorphology/topography

Niue is the world's largest and highest single raised coral atoll, which emerged in stages out of the ocean. Two theories have been put forward explaining how Niue was formed. One being that Niue was formed due to forces from internal volcanic activity, as in some areas there is a thin layer of ash that is the cause of locally high radioactivity. The other theory is that the uplifting was due to the buckling of the Pacific tectonic plate prior to its subduction into the Tongan trench, evidence being Niue's characteristic chasms⁴. Niue rests on a seamount with the surrounding ocean depths reaching up to 4000m.

Geology

Niue geology and hydrogeology has been investigated periodically since 1957. Schofield (1959) carried out magnetic surveys identifying Niue as an uplifted high carbonate island with a land area of approximately 259 sq. km lying at 19°S, 169 W in the central Southwest Pacific. It has a

⁴ Niue: State of Environment Report. 1993. SPREP

maximum thickness of limestone 68m above sea level with a series of wave-cut terraces and platforms associated with periods of uplift. The island consists of more than 500m of limestone below sea level (Terry and Nunn 2003)⁵ underlain by caldera-shaped volcanic structure⁶ (Schofield 1959).

Hydrogeology

The estimate of recharge is fundamental to determining the yield of the fresh water lens. The investigations and monitoring to date have confirmed that recharge to the lens can be exceptionally rapid, and more monitoring is required to determine to what extent this rapid recharge is lost from the aquifer and does not remain within the fresh water lens.

Best estimates of recharge (using a unit area recharge rate of 662 mm/yr), suggests that over the freshwater lens area (defined at this time as the full island area of 259 sq. km) less a 1 km strip around the coastline (50-60 sq. km) of 200 sq. km, that 132 million m³/yr of recharge enters the aquifer.

Assuming 30% of this is available as sustainable yield, this provides an initial estimate of the sustainable yield of 39.7 million m³/yr, or as a daily pro-rated yield this equates to 108,820 m³/d or 1,260 litres/second (l/s). Whilst the future groundwater demand from the addition production and irrigation boreholes remains to be determined, it appears the existing groundwater abstraction from the PWD public water supply wells of typically 2000 m³/d represents less than 2% of the fresh water lens yield and therefore is safely within its capacity to sustain these flows.

Topography

Niue topography shows the highest ground to be around the edge of the island with lower plateau in the centre. This is widely interpreted as an upthrust atoll reef and a former atoll lagoon centre (Schofield 1959⁷).

Chasms exist around the coast, most notably at Vailoa, Matapa, Togo, Vaikona, with smaller structures and pools at Limu and elsewhere. Most of these appear to be sub-parallel to the general coast line and are presumably associated with faulting (Schofield 1959)⁸ which has subsequently undergone extensive dissolution.

Soils

The coral atoll origins of Niue have made soil conditions marginal for intensive agriculture and long term monoculture. Much of the land is covered with fern growth, which again indicates the poor structure and nutrient contents of the soil and rainfall is expected to infiltrate rapidly through the extensive secondary porosity within the limestone rock. Thus up to 40% of land is unsuitable for agriculture while those areas under cultivation are only at subsistence level.⁹

Climate

Niue lies on the edge of the southern tropical cyclone belt and in the zone of the southeast trade winds, and is subject to strong gale force winds during the hot season. There are two distinct seasons: the hot/wet season from December to March and the cool/dry season from April to November. The average annual rainfall is approximately 2,180 mm, but it can vary from 810 to 3,300 mm. This bulk of rainfall is concentrated in the hot season delivered in torrential downpours, and account for 68% of the total annual rainfall. At this time both temperature and humidity are high, with average temperatures of 27°C. The cool season is characterised by warm sunny days and cool nights, with temperatures averaging 24°C. Annual average temperature does not vary

⁵ Mosley, L. and Carpenter C. 2004. Niue Coastal Water Quality and Groundwater Resources Assessment. [SOPAC Technical Paper](#);

⁶ *ibid.*

⁷ *ibid.*

⁸ *ibid.*

⁹ 2001, Niue National Biodiversity Strategy and Action Plan

greatly throughout the year due to the influence of the sea on a small low-lying island. The annual rain pattern is erratic, with very dry or very wet months possible at any time of the year.¹⁰

National disasters

Niue is prone to the devastating effects of cyclones. Significant damages have occurred on average, once every 10 years, the most recent been, cyclone Heta, which struck on 5 January 2004, classed as a Category 5 on the Saffir-Simpson scale with winds of up to 300 km/h.

Vegetation

Seven types of vegetation are recognised: fern and cropland and littoral shrub land, littoral forest, coastal forest, matured forest and secondary forest, grouped as natural vegetation.¹¹

Agriculture

Agricultural technological advances have seen a shift from the traditional landuse practices of slash and burn techniques with average fallow periods between 7 to 10 years, to an increased reliance on agrochemicals. These changes to the land use practice have resulted in a significant reduction of the fallow period, 3 to 5 years, the use of less fertile areas with mechanized bulldozers for clearing, an increased reliance on fertilisers for crop production; increased used of trash burning; and the use of Gramoxone for weed control, and herbicide in lieu of manual clearing and mulching techniques. Excessive use and reliance of agrochemicals in the absence of monitoring and evaluation poses a contamination threat to Niue's aquifers, which are recharged by rainfall filtering through the thin topsoil layer as porous base rock.

Nearly 5 years now a group of concern farmers formed Niue Island Organic Farmers Association (NIOFA) to promote and advocate the traditional organic farming methods of not using chemicals. The adoption of organic standards has been used to certify vanilla and Nonu plantations following International Federation of Agriculture Movement (IFOAM) sanctioned standards. NIOFA in association with Government of Niue is working towards declaring Niue as the first organically certified nation by 2010.

Demography and socio economic aspects

The indigenous Niuean people are of Polynesian descent. In contrast to developing countries and its Pacific island neighbours, Niue has a declining population mainly due to emigration mostly to New Zealand, given that Niueans are New Zealand citizens under constitutional arrangements. The population has steadily declined from 5,296 in 1969 to 1,707 in 2002. Prior to 1969 the population was relatively stable fluctuating from 4,000 and 5,000. A number of measures were introduced by government to counteract this trend, with limited success. A recent monthly statistical bulletin issued by Government Statistics showed a total population 1,625 for 2006, with an annual growth of -1.9%, the % increase from the 2001 census of -9.1; average person per household for 2001 of 3.4 persons and 3.2 persons for 2006¹².

Comment: Conflicts with table 2 figure of 1805

Niue's Human Development Index of 0.87¹³ is ranked third in the Pacific region, and is reflective of the high life expectancy of approximately 67 years, low infant mortality and universal rates of adult literacy of 99%.

The GDP in current prices per head of population increased by 16 percent between 1999 and 2003¹⁴; although from 2003 to 2006 there are no formal regular estimates of GDP. Niue's economy is dominated by the public sector accounting for approximately 59% of the total local employment where as the private sector accounts for 41% of which 18.3% are self employed¹⁵. The economy is supplemented by subsistence agriculture, fishing and eco-tourism. Current development policy

¹⁰ 2006, Pacific Adaptation to Climate Change, Niue Island, Report of In-Country Consultations

¹¹ GoN 2001, Niue Biodiversity Strategy and Action Plan

¹² GoN Statistics, EPDSU 2006 Census results

¹³ Good L. 2003. Poverty in the Pacific, DG Development, European Commission.

¹⁴ GoN. Statistics, EPDSU 1999-2003

¹⁵ GoN. Statistics EPDSU 2005 Employment

focuses on eco-tourism and private sector development through increase of employment opportunities and agricultural production, such as vanilla and Nonu (*morinda citrifolia*) for export, to reduce aid dependency. Tropical Cyclone Heta in January 2004, significantly impacted Niue's economy with an overall estimated damage of over US\$40m¹⁶.

Some 64% of the island is covered in forest. This is an estimated decrease from about 86% forest cover in the 1950s¹⁷. Clearance for agriculture is the main reason for forest loss, especially with the use of bulldozers for land clearance is permitted. The Government in the 1960s harvested timber for local use and the operation was transferred to the private sector in the 1980s. Significant concerns about the negative impacts of deforestation gave rise to the Huvalu Forest Conservation Area located on the south-eastern side of the island. This is a community based initiative in partnership with the South Pacific Biodiversity Conservation Programme involving Hakupu and Liku villages. The site contains approximately 75% of the remaining forest on Niue, complementing and strengthening the traditional conservation methods, activities and sustainable use.

3. Integrated Water Resources Management Situation for Niue

3.1 Water resources management

Niue has a long history of water management. Each village under community regime, build concrete water tanks with catchments to harvest the rainwater; these water tanks are managed by the village constable.

3.1.1 Types of fresh water resources

There is no surface runoff in the form of streams, rivers and lakes. Water for residential and commercial consumption can only be drawn from the underground water lens supplemented by the collection of rainwater at the village and household level.

The estimate of recharge is fundamental to determining the yield of the fresh water lens. The investigations and monitoring to date have confirmed that recharge to the lens can be exceptionally rapid, and more monitoring is required to determine to what extent this rapid recharge is lost from the aquifer and does not remain within the fresh water lens.

Best estimates of recharge (using a unit area recharge rate of 662 mm/yr) suggest that over the freshwater lens area (defined at this time as the full island area (259 sq. km) less a 1 km strip around the coastline (50-60 sq. km) of 200 sq. km, that 132 million m³/yr of recharge enters the aquifer.

Assuming 30% of this is available as sustainable yield, this provides an initial estimate of the sustainable yield of 39.7 million m³/yr, or as a daily pro-rated yield this equates to 108,820 m³/day or 1,260 l/s.

Whilst the future groundwater demand from the addition production and irrigation boreholes remains to be determined, it appears the existing ground water abstraction from the PWD public water supply wells of typically 2000 m³/d represents less than 2% of the freshwater lens yield and therefore is safely within its capacity to sustain these flows. Groundwater water monitoring throughout the next 12 months should help to improve this estimate of recharge and therefore the sustainable yield.

The vulnerability of the freshwater lens to drought is a function of the lens size, the rock storage and the recharge entering it (or lack of it) with time.

¹⁶ GoN. National Impact Assessment of Cyclone Heta. 2004

¹⁷ GoN. National Forest Policy Statement for Niue. 2004

The analysis of the rainfall and climate data has shown that recharge is limited to six months of the year (between December and May) with the remaining six months (June to November) devoid of recharge. The significance of this dry season depends on the storage in the lens and how much it reduces during the dry period. Whilst a full set of dry season data is being gathered, preliminary monitoring of the freshwater lens in the middle of the island suggests that the lens may reduce by 3-4 metres over the dry season period. Given the lens is some 40 metres thick at this location, this suggests the lens is relatively robust to dry season and even dry year drought periods. However these findings are preliminary and should be treated as such.

The active storage within the karst aquifer remains unclear at this point in time. The active karst conduits are likely to have storage of 1-2 % of the rock mass. However previous investigations on Niue and other karst islands (as well as tertiary carbonates elsewhere in the world) have identified a more diffuse storage within that rock mass of typically 20-25 %.

Whilst the karst storage alone would indicate that the freshwater lens as a whole retains only six to twelve months storage (30-60 metres lens thickness per year), the more diffuse storage would suggest more like 10-12 years of storage (3-4m lens thickness per year).

Clearly the significance of the aquifer having only 1-2% storage is of concern (as highlighted by Carpenter, 2004) as it suggests the aquifer is highly vulnerable to the annual dry season let alone a more serious and lengthy drought period. As stated earlier in this section, preliminary monitoring of the end of the 2005 dry seasons suggests that a 3-4m reduction in the freshwater lens might be typical. This gives more confidence that the larger storage figure is more indicative of the actual storage in the aquifer and this in turn suggests the lens is not susceptible to drought (as articulated above).

These findings are based on limited monitoring of part of a dry season, and extrapolated thereafter. These conclusions should be treated as preliminary only.

There does not seem therefore to be any specific need at this time to consider recharge augmentation or other means to improve the drought yield. However consideration should be given to the temporary loss of some or all of the production bores, perhaps due to temporary sea water inundation or island wide power loss, such as during and after cyclone Heta.

It would be prudent to introduce low cost storage facilities on the island to enable gravity fed water supply to be maintained on the island during power outages. Examples of such systems include:

1. household rainwater harvesting; and
2. strategic storage water reserve tanks served by generator powered abstraction boreholes and located in the middle of the island, from which water tankers would serve and refill the village tanks.

Of these 2 examples, rainwater harvesting should arguably be practiced as it would reduce pumping costs and maintenance for PWD, and reduce the abstraction demand on the freshwater lens.

Niue is implementing an existing monitoring system although there is a need to drill extra holes specifically for monitoring in order to provide better understanding of the underground water sources. At the stakeholder consultation concern was raised that the drilling of extra holes may lead to some risks in the future in the light of frequent tremors and careful consideration should be given to the holes strategic location.

It is considered that there are sufficient underground water sources and the introduction of a desalination system is not yet warranted. The fish processing factory has installed a desalination plant but it is inoperable due to cost factor.

There is a limited amount of imported drinking water from New Zealand as an alternative source mostly catering for tourists.

Wastewater reuse is not yet considered as another source of water, especially as the current capacity may not be sufficient to warrant purchasing such technology, and the underground water capacity seems to be at safe level.

3.1.2. Types of fresh water uses

In 2003, approximately 85% of water pumped from the underground lens was used for domestic purposes, 10% for agricultural use and 5% for commercial and industrial usage¹⁸. 2006 figures (provided by the Water Division, PWD) showed 80% for domestic use, 15% for agricultural use and 5% for commercial and industrial use; an increase for agricultural purposes is noted.

Niueans in the past were encouraged to build water tanks as catchments to harvest rainwater to supplement the public system, to cater to demand during cyclones and in periods of power failure. All newly constructed houses are subject to Building Code standards, and water tanks are now a compulsory requirement of a house.

3.1.3 Major issues and concerns

Niue cannot continue to depend entirely on its underground water lens as the only source of fresh water; with the planned increase in economic development activities, rainwater harvesting as a supplementary source ought to be vigorously pursued. Rainwater harvesting at the village level and at household level, would provide a back up source. There should be reserve tanks, with the capacity not only to cater during disasters and power failures, but for daily use as well. There are unused reservoirs in villages that need assessing for reuse. Harvesting rainwater using roofs of school, church buildings and community halls to facilitate the catching of rainwater connecting through down pipes to the reservoirs will require minimum costs. The significant costs involves houses that are without water tanks, it may be cost less to import plastic tanks in bulk from overseas rather than building the concrete tanks here. This was the view unequivocally expressed by majority of the participants at the National Water Management Stakeholder Consultation in March 2007.

The cost of the infrastructure and maintenance is absorbed by the government from its annual budget and with the planned increase in the economic development activities, consideration for users to contribute to the maintenance through a modest level of an annual levy, is being discussed. To monitor and implement this levy process, meters could be installed in households and level of levy paid subject to amount of water and type of use.

The increase in land surface activities may compromise the quality of the water lens. A study carried out by SOPAC on coastal water quality in 2003, was initiated due to fish poisoning outbreaks and fish deaths. The study confirmed a high nitrate and phosphate concentration believed to be caused by inadequate wastewater treatment primarily from septic tanks draining into the groundwater regime. The survey highlights the vulnerability of Niue's water resources to any land surface activities and the close link between land and catchments activities and coastal zone impacts. Regular quality checks by the Department of Health should be undertaken.

The tourism office is pushing to increase the annual number of tourists to 2000 visitors per annum¹⁹, such targeted number is more than the existing population level and would certainly stretch resources and the provision of services to residents.

The government is exploring the potential economic gains in bottling underground water for export, under the premise that such commercial use would not affect the quantity of the underground aquifer, as it would bring in much needed foreign revenue.

Increase in agricultural use for irrigation, cleaning of piggeries, cash cropping of vanilla and Nonu, including the fish waste effluent disposal at the fish processing factory will impact on water quality and quantity.

¹⁸ SOPAC 2004. An overview of IWRM in PICs: A National and Regional Assessment

¹⁹ Niue Tourism Plan 2005-2015

The increase in the number of fishing vessels requiring large volumes of ice for fish preservation and drinking whilst at sea free or at no cost should not continue indefinitely under present arrangements. Although the fish processing factory has a desalination plant for its own purposes, there is no monitoring mechanism to ascertain the amount of water drawn out of the public water system.

Any commercial logging or mining would affect Niue's watersheds and significantly impact water sources and the environment. The continuous clearance, by bulldozers of the secondary forest, for taro plantations, needs to be re-examined as the watershed is vital to the recharging system of the lens. There is concern that the maintenance of habitats and the ecosystem, for future generations should not to be compromised.

The whole island depends on water pumped from the underground lens. Currently the domestic use of 80% of the water pumped from underground is the priority use followed by agriculture, and commercial and industry. With the expected increase in tourist accommodations, agriculture and fishing industries the level of different uses will progressively change.

Pollution sources include: solid waste, septic systems, irrigation, synthetic fertilisers, weed killers, oil spillage and coastal sanitation.

An information exchanging mechanism existed between government institutions but has not been sustained due to costing and labour constraints.

There is no surface runoff in Niue in the form of rivers, streams and lakes. As such water for all uses can only be sourced from the underground water lens supplemented by the collection of village or household level.

There is very small amount of rainwater harvesting and an approximate 66% annual rainfall evaporates.

3.1.4 Measures to manage impacts and concerns (IWRM approaches)

The latest field investigations undertaken in Niue (October 2005 to February 2006²⁰) have significantly increased understanding of the hydrogeology of the karstic limestone aquifer in terms of absolute quantification of the thickness of the freshwater lens in the middle of the island, and provided valuable insights into the aquifer bulk transmissivity, hydraulic gradients, and recharge and discharge mechanisms.

According to the report, the existence of very rapid recharge mechanisms as demonstrated by the immediate ground water response to the 12-13 February 2006 tropical storm, confirms the vulnerability of the groundwater lens to landuse activities. Whilst the storm recharge represents an extreme (but annual) event, it confirms that substances on the ground can reach the freshwater lens within 1-2 days (refer actual report for details).

The groundwater resources investigations on Niue Island report raised a number of concerns and it recommended the following ongoing activities as high risks that warrant environmental protection:

- landfilling (both domestic and special waste)
- agrochemical and fertiliser application (including fish waste spreading)
- trade affluent disposal (especially the processing and vehicle workshops)
- hospital liquid and solid waste disposal (especially hazardous waste)
- batteries and petrol stations

²⁰ Carpenter, C. and Siohane, A. 2006. Groundwater Resources Investigation on Niue Island

Some of the concerns have been actioned; the batteries kept at the Youth Centre have yet to be disposed of carefully as the longer they remain exposed to elements, the higher the risks of leakage.

PWD in association with SOPAC carried out a hydrological assessment in 2005 including the setting up of monitoring stations at various bore sites. PWD has been tasked to continue with the monitoring and recording of related data. This areas needs strengthening to ensure continuous quality data are collected.

Quality monitoring and safety checks are carried out by the Health Department under the Public Health Act.

Water conservation as a theme and/or an activity should be pursued at all levels of the community. The increase in economic development activities suggest that a formulation of a strategy under the awareness theme is warranted and a priority. Huvalu forest, has been zoned and declared a conservation area, not only to protect it from commercial logging but maintain it as a national catalyst for terrestrial habitats, ecosystems and food security. It also acts as the watershed for the aquifer.

The increase in piggery farms and agricultural irrigation requiring use of substantial amount of water would justify protection policies. Policies are required to protect both the water source and the user. Formulation of water conservation policies that include incentives are yet to be organised.

The Persistent Organic Pollutants (POPs) programme coordinated and undertaken by the Department of Agriculture (DAFF) in association with UNDP and GEF concluded that a prevention pollution programme be implemented. This saw the shifting of hazardous chemicals abroad for storage. The programme was successful and popular in the community and it highlighted an awareness of the associated dangers.

The Land Management and Resource Use Planning Unit, housed under the Department of Justice Lands and Survey no longer functions due to human and financial resources constraints.

During the report writing period, a joint mission of three professionals from SOPAC and WHO undertook a study on assessing the water quality monitoring in Niue and to identify the opportunities for education awareness on issues relating to unsafe drinking water quality and effects on health. The findings concluded that monitoring, water quality testing and equipment needed strengthening. From this mission, a water safety plan will be formulated.

Niue needs to:

- (i) implement actions to strengthen national capacity (equipment, training etc).
- (ii) train more technicians in the field of hydrological, water management, quality testing, and related areas.
- (iii) strengthen and enhance communication and information exchange between national agencies in the field of meteorology, hydrology, water quality, data collection department and the users.
- (iv) implement a holistic approach and IWRM principles and practices through the systematic coordination between related agencies, with the long term commitment for the implementation of IRWM and provide appropriate support and training sourced from regional and international institutions.
- (v) build security fences for the protection of reservoirs and bore sites,
- (vii) source funding to import tanks or build concrete tanks on-site to capture rain water as another source of potable water, and
- (viii) encourage users to contribute to reticulation and maintenance costs.

3.2 Island vulnerability

The GoN in its Niue Strategic Plan 2003-2008, is committed “to provide a quality potable water supply to all residents”. However there is a need of a national “vision” focusing on sustainable water management to indicate the priority, the direction and the level of understanding as to the governance requirement related to water as a finite natural resource, a necessity to all forms of life.

Niue’s small size, geographical remoteness and exposure to climate variability/instability are noted under the vulnerability definition. This is a major concern facing Niue, and it should receive particular attention, by its decision makers. Preparations and discussions should encompass disaster preparedness, hazard management as well as the vulnerabilities associated with climate changes and climate variability. It ought to be noted from past experiences that disasters are recurrent and can have a significant and cumulative effect on the rate and nature of development. Niue’s vulnerability needs to be borne in mind by all levels of the community who should be prepared for such events at all times.

Niue is vulnerable to the effects of ENSO²¹. The worst drought from 1950 to 2006 was in 1983 and was attributed to the El Nino phenomena of 1982/83. The impact of the drought was severe, with people drawing fresh water out of caves²². The effect of the subsequent drought of 1997/98 was not as severe as households had reticulated water, drawn from the water lens. It is the understanding that the nature and severity of any drought is dependent on the duration and magnitude of rainfall deficit. The understanding of the indications as to the type of drought would assist with the allocation of water quantity for various types of water uses.

Tropical cyclones are a serious hazard to Niue; the very high wind speed of tropical cyclones are often accompanied by intense rainfall and storm surges that are amplified by the association of low atmospheric pressures. The severe devastation caused by Cyclone Heta in 2004, damaging properties and infrastructure is a manifestation of Niue’s vulnerability to natural disasters.

Earthquakes, although low in frequency in Niue are a non-climate natural hazards/disaster. Seismic activity is unpredictable and can result in severe damages. For Niue, seismic activity has the potential to affect water supply catchments including extensive damages to water supply infrastructure. Continuous monitoring and improved predictions would greatly assist in the development of risk management strategies.

There is a wide range of human hazards resulting from human activities which are capable of causing considerable harm to water sources, water quality and infrastructure. To date Niue is fortunate, perhaps due to its low population numbers, to avoid human hazards. There will always be potential hazards however and authorities need to be mindful of situations that can be harmful to water sources and infrastructure such as land disputes, land degradation, loss of water quality through the use of agricultural chemicals, inadequate sanitation and waste disposal methods.

Niue’s current situation, though not yet extreme, falls under what may be called “human inactivity” caused by inadequate human resources and technical capacity, inadequate information, budgetary limitations and institutional structure and arrangements. Niue cannot afford to be complacent and become inactive.

There is always an ongoing need for capacity development to enhance the collection and the application of climate information to adequately cope with the climate variability and changes. The change includes the current approach for dealing with island vulnerability from disaster response to hazard assessment and risk management, particularly with IWRM.

3.2.1 Types of disasters

²¹2006, Pacific Adaptation to Climate Change, Niue Island, Report of In-Country Consultations

²² Nemaia, F. 2004, National Action Plan, Addressing Land Degradation and Drought

Cyclones and hurricanes are common with severe systems recorded for 1915, 1957, 1959, 1968, 1979, and very severe in 1990 and 2004²³.

There is always potential human induced disaster caused by continuous use of agrichemicals seeping through the porous soils, oil spillage from tanks carrying petrol and diesel from the port through the main street of Alofi to the main storage depot has potential risks.

There is a potential risk at the wharf, associated with fishing boats refuelling without safety standards being in place and observed.

The capacity for negative impacts of wastewater is currently insufficient to cause any alarm nevertheless the institution responsible for the disposal should always be aware of the associated risks.

There is no data available on sea level rise. The installation of a recording instrument to cater for this area is expected to be done in the near future.

The worst recorded drought occurred in 1983, the impact was severe enough for Niue to import taro and bananas (staple food) from Samoa. There may have been an assessment on the economic costs undertaken at the time but availability and access to such data is not possible for this exercise. The 1997/98 drought was not as severe as all households were connected to the main water system drawn from the water lens. There are no data available to determine the actual impact on the watersheds and coastal management.

There may be existing data on the economic costs pertaining to water related issues, such as the droughts in 1983, 1997/1998, but unfortunately this exercise cannot truthfully determine where these records are located. There was a financial assessment for Cyclone Heta in 2004 valued at US\$40 million.

A plan on drought management is required which will supplement the existing National Disaster Plan.

A 2005 investigation provided the information that the vulnerability of the freshwater lens to drought is the function of the size of the lens, the rock storage and the recharge entering it (or lack of it) with time. The investigation report provides a detailed analysis of the underground water resources.

Niue has yet to confront developments that may be considered a threat to life and property, however it is noted with some considerable concern the devastation caused by tropical cyclone Heta in January 2004 as evidence of ENSO.

3.2.2 Major issues and concerns

Land-based pollution represents the most important challenges on the quality of underground fresh water. Domestic waste is the major solid waste category produced in Niue. A Waste Management Plan is in place and should be followed.

Niue's economic development activities are at a level that does not raise great concern for water pollution, nevertheless, regular monitoring and quality testing (mechanisms are in place) cannot be relaxed. The need to carry out an EIA for all development projects is vital to the protection of habitats, ecosystems, and the general welfare of the community. Human inactivity will always be a concern for implementing protective measures.

Waste being pumped from septic tanks and consequently pumped to open land should not continue indefinitely. Proper facilities need to be identified and installed, and the final product be used for soil revitalisation, given that Niue has adopted organic agriculture practices.

The continued use of the controversial herbicide Paraquat needs to be considered seriously and safe and effective alternatives should be sought. There is conflicting information on the effects of

²³ United Nations Framework Convention on Climate Change. 2000. Niue Island Initial National Communication

Paraquat but notably it destroys habitats and ecosystems, and human health can also be affected. New Zealand has banned the herbicides use since 1974 yet continues to accept its importation to Pacific islands, including Niue.

Intrusion of saltwater due to sea level rise may be an issue for Niue. Niue does not have physical measures to combat or arrest the sea level rise other than to encourage representatives to be vocal when attending global forums. On the technical side the installation of pumps are systematically and strategically placed at the threshold level of 60 metres from the surface (speed drawdown), a level considered to be safe, to avoid drawing salt water if the level drops. If salt water intrusion did occur, there is no back up system in place. Residents would be compelled to draw water from tanks catchments as alternative source.

Niue's porous soil context has positive contribution when intense rainfall occurs as it will transport surface based pollution to the water lens. Consistent regular monitoring and collection of data is important to ascertain more information to assist with the drawing of contingency plans for Niue's water sustainability and welfare.

3.2.3 Measures to manage impacts and concerns

Niue has in place a disaster management plan, which includes provision for water management. The solid waste regime needs reassessing to be in line with internationally accepted practices.

The administration and regulating of EIAs for development projects needs to be strengthened, especially the legislation requirements as it should be a compulsory prerequisite before any development project takes place. There needs to be the inclusion of periodical monitoring and evaluation of impacts, which will be easier and quicker for the application of remedies and perhaps when needed declare such development unsafe and close it.

The wastewater from septic tanks is useful to the revitalisation of the soil nutrients, and as an additional component in the process of making compost after being treated in a properly constructed and operated facility. Niue soil is thin and poor and the usage of wastewater would assist the growth of quality vanilla, Nonu and other fruit crops.

The use of chemicals for weed control such as Paraquat has to be totally banned to decrease negative environmental impacts. This is not Niue's problem alone but a regional effort through provisions in the Pacific Plan. The development of safe and environment friendly alternatives should be identified, as many Pacific Island countries are heading towards producing organically certified agricultural products. Organic tourism and eco-tourism is seen as an alternative tourist attraction.

A drought plan should be developed and incorporated with the National Disaster Plan already in place.

Niue needs:

- (i) action the recommendations in the Waste Management Plan, to ensure the water lens are protected from any form of contamination and pollution. Institutional capacity requires strengthening;
- (ii) continue water quality monitoring practices following WHO standards.
- (iii) continue to work together with climate information services in the region, strengthening current capacity to enable the ongoing development analysis, forecasting and application tools; and including the participation of stakeholders.
- (iv) continue to develop rainfall and drought monitoring and prediction methods, including technology transfer;

- (vi) implement actions strengthening the national capacity to carry out hazard assessment and risk management using existing and other vulnerability assessment and risk management tools;
- (vii) promulgating a drought plan is required;
- (viii) build proper facilities to treat waste from septic tanks for compost use;
- (ix) develop safety standards for refuelling boats at the wharf to minimise the associated risks; and
- (x) ensure an EIA is a prerequisite for all development projects including regular inspections/evaluation of impacts.

3.3 Awareness

The promotion of fresh water as finite natural resource and as well as an economic good is lacking at all levels thus: developing a profile on water is required to change the mindset of everyone in the community to actively recognise water resource as a necessity with economic value, and to push water to the forefront of priorities. Water is a critical component of life but Niue largely depends on donor assistance in this area in its sustainable developments efforts.

The creation of a high quality participatory framework would allow users, decision makers at government and community levels, NGOs, and the private sector to come together in partnership to dialogue on the numerous issues pertaining to water and sanitation conditions. The setting up of a participatory framework is essential and community participation as an empowering tool would lead to community ownership and sustainability. This includes the strengthening the capacity of CBOs, NGOs and departments to disseminate information on the sustainable use of water resources and wastewater management. NGO involvement plays a significant role at grass root level through encouraging a water oriented civil society. Information is a powerful tool for changing behaviour in the water world, through television, radio programmes, schools programmes, women and youth activities.

Generating of appropriate knowledge on water resource management and wastewater at all levels of community to enhance and fill knowledge gaps, allowing the change of paradigms process to take place.

School children are effective advocates and schools should be encouraged and financially equipped to devise and engage in driving educational awareness programme, focusing on various components of water management, within the schools. This includes building IWRM into school curriculum as both teaching and practical subjects. This will also encourage students to see water management/engineering as an attractive career prospect.

Improve access to information on sustainable water and wastewater management to all key stakeholders. Improve the communication links and coordination of all stakeholders in sustainable water and wastewater management, including government, civil society and the private sector.

3.3.1 Types of awareness campaigns, advocacy Initiatives

The promoting of fresh water as a finite resource as well as an economic good is lacking at all levels; support and active participation by political leadership to drive the awareness would be seen as conviction and commitment with assurance that water sources need to be protected from contamination.

Currently there are no awareness programmes in the community and schools.

An awareness programme was initiated by the Department of Education approximately 20 years ago for primary school level, focusing on water conservation and hygiene; it was built into the curriculum in the subjects of science, health and social studies. This includes the process of change in the minds of school children to view water as an important element in their social life as

individuals, families and community. At the secondary level, awareness was only through teaching in the science subject.

In 2003-2004 NIOFA organised and conducted a workshop, using local experts as resource people presenting papers on the benefits of organic farming to the human life including the environment, and the water lens, as opposed to the conventional farming methods where agrichemicals are used to improve productivity. It was difficult to convince conventional farmers of the vulnerability of the water lens as well as the impact to human health, the biodiversity and ecosystem, however awareness was raised. NIOFA continues promoting organic farming in its weekly radio sessions, focusing on economic, social and environmental gains.

In 2006, NIUANGO as an umbrella association for NGOs has been reactivated, and its Executive Committee has included in its activities a water awareness programme amongst other issues. The awareness programme will include the understanding of water rights of an individual, the community and including respective roles. The role of government is important to ensure that water as a resource with economic, spiritual and medicinal values requires sustainability for the future generations; the advocacy of "rights to water" would follow UN guidelines.

Although Niuean people are mindful of water as a necessity in life, without a specific programme mounted at village level targeting the users, there seems to be a general thinking that water is infinite without consideration of the environmental changes and climate variability, which impacts on the water lens and the related cost associated with the drawing of water from the underground source.

3.3.2 Major issues and concerns

Identification of an institution whether within government or an NGO to be duly responsible for the creation of and to drive the awareness programme on water conservation and quality; and the need to ensure that the community participates in all aspects of water management. The awareness programme requires the involvement and participation of all users including the support of political leadership.

All water users should be well aware as to the ownership of the underground water as a resource including the provisions of individual, and community rights as to its access and usage.

Water resource management should be included as a teaching and practical subject in the school curriculum. The creation of an awareness, through learning, which is absent at the moment, emphasising the importance of the hydrological aspects of water would motivate students to take up water resource management as a career. The practical aspects in terms of establishing a weather station where students are encouraged to keep daily records with visits to other weather stations on the island including bore sites and to take readings on water quality during the school year. This awareness includes the learning of the fundamental cultural, medicinal and spiritual context of water. Reading materials on water management for schools are required.

Prior to 1997, water demand exceeded supply caused by leakages in homes and coupled with a weak management system gave rise to a water demand scenario that should not be repeated. Regular house to house checks for leaking taps and toilet cisterns should be carried out simultaneously with village health inspections. Village councils are expected to be involved by way of notifying households after each inspection on the leakages and issue warning notices prompting households to repair leaking taps.

Community participation in the decision making process needs to be strengthened. Community participation provides continuity of the information flow and enhances an active partnership culminating with an intellectual community on water management.

Political support and drive seems to be lacking considering the importance of water to daily life and sustainable economic development. Water is an inherent and major component to any social, economic or environment success and management instruments must be in place.

Gender issues such as access to water resources or conflict of usage is a non-issue in Niue. Everyone has equal access to water.

It is noted that educational institutions in the region have no syllabus/training specifically tailored for water management and engineering with recognised qualifications.

3.3.3 Measures to manage impacts and concerns

Community involvement in the awareness and monitoring programmes needs to be encouraged.

All water users must understand that the water lens is the only source of potable water, and it is vulnerable to various surface uses including potential contamination from logging and mining if Niue decided to engage in such activities. Most of the impacts from land use activities are irreversible.

The management of the only officially recognised conservation area, at Huvalu as the only watershed, needs reactivation and policing.

Water is a fundamental necessity of life, affecting all levels of the community, participation in the decision making process by all users provides transparency.

Niue needs to:

- (i) support the establishment of a regional water education fund accessible to government agencies, NGOs and civil society groups to ensure effective community participation in sustainable water management'
- (ii) develop a toolbox in association with SOPAC, donors, regional and international organisations to support water education for all levels of society, including politicians, government personnel, civil society and private sector.
- (iii) adopt water education as part of the curriculum including the training of teachers to provide water education.
- (iv) define roles and responsibilities of government, civil society groups, private sector and communities in the sustainable management of water.
- (v) share information between project stakeholders.
- (vi) improve awareness of policy and legislation through education and community based learning.
- (vii) adopt a working partnership relationship between all water users.
- (viii) inform SOPAC to approach regional education institutions to develop courses in water engineering and management towards a recognised qualification.

3.4 Technology

Involvement of various institutions needs to be coordinated effectively from a focal point with the appropriate authorisation mechanism, by legislation, regulation or a Cabinet instrument. The formalising of the authority enables defined roles and responsibilities preventing fragmentation, uncoordinated plans, and enables strategic actions to improve linkages with other sectors.

The defining of responsibilities of various stakeholders with an effective accountability mechanism put in place, providing enabled environments for dissemination of information culminating in reaching informed decisions resultant in enhanced performances. Strengthening of institutional capacities will support appropriate technology selections, increase system performance, increase the understanding of subsequent environment and health impacts and demonstrate the need for water conservation and natural disaster preparedness.

Under the Pacific Technical Assistance Facility (PACTAF) project various systems were improved: automatic control systems which reduce the replacement costs; minimise leakage. This included

capacity building, on the ground, hands-on vocational training for employees resulted in improved skills. The PACTAF project provided a sound platform for the continued operation of the water supply. Much of the equipment was standardised and concerted efforts to reduce household leakage reduced domestic water consumption by half. This resulted in saving in excess of NZ\$50,000²⁴ per annum in annual power costs from borehole pumping and provided consumers with continuous and reliable water supply.

3.4.1 Types of water supply systems

Several works have been undertaken in the water supply system in the past, from karstic groundwater investigation to infrastructure upgrading and improvement. A 5-year National Water Development Plan was developed by a UN sponsored civil engineer under the UN Department of Economic and Development auspices in 1992²⁵. However, during the process of finalising the report and subsequent implementation, a government initiated reform of the public sector focusing on reducing the number of employees, resulting in the emigration of workers and the report was not implemented.

From 1997 to 2000, AusAID in association with GoN funded a project with the aim to improve the health status of the people of Niue by upgrading the standards of water supplies and waste management including capacity building. To achieve the aim of the project, AusAID recruited an overseas Water Supply Adviser organised under PACTAF protocols, for three years to provide capacity building and on the ground vocational hands-on training to the local staff. The island water supply system was improved, with significant reduction of water wastage and water shortage. The installation of automated water pumps provided an effective and efficient system. At the conclusion of the project, in 2000 significant improvements were observed. Before the completion of the project, a septic pre-casting facility to strengthen the design of the sanitation system was implemented, resulting in effective and easier access for the public to obtain when required²⁶.

SOPAC also provided much needed assistance in undertaking assessment of the island reticulation and groundwater works, undertaking GIS network for the reticulation work (Dawe 2001). It conducted a GIS-Map Information workshop including demand management assessment as well as establishing the groundwater monitoring regime in 2005.

Comment: Not in references. Is this in a SOPAC Technical paper?

Water for all purposes is free, however if a house located well away from the main public pipe line the owner is required to meet the reticulation costs. When there are five or more houses located within 30 metres or so from each other then the GoN is obligated to meet all reticulation costs.

In 2005, the consumption rate was estimated to be 350 L/p/d²⁷. This amount was identified as having a major impact on the total existing storage capacity of the water supply system, including water loss through leakage.

Table 1: Water Demand in Niue, 2006

Total Population in 2006 (2006 Census)	1679 persons
Total Visitors 2006	500 persons
Water Consumption per Capita per day	350 L/c/d
Water Demand for Total Population + Visitors Per Year 2006	278,367,250 L/c/year
Total Demand for Industrial for 2006	53,428,496 Litres
Total Demand for Agricultural Purposes for 2006	17,809,499 Litres
Actual Water Production for 2006 in Niue (water	356,189,978 Litres

²⁴ Davis, S. 2004. Evaluation Water Reticulation in Niue. SOPAC

²⁵ Nwe N.. 1992. Five Year National Water Development Plan (Draft)

²⁶ Green, V. 2000. PACTAF Water Supply Project, Niue Island South Pacific.

²⁷ Davis, S. 2004.

meters)	
Maximum Capacity of Water Production for All Existing Water Pumps	730,584,000 Litres
Water production for human consumption (inc. visitors, losses/leakages)	80%
Water production for industrial use	15%
Water production for agricultural use	5%

Source: Water Division PWD

With the current equipment and new system in place for the island water supply network and for groundwater monitoring, limited human and financial resources are a constraint in maintaining infrastructure and operations.

Table 2: Size of Reservoir and Population Served

Tank/District	Remarks	Capacity m3	Pop. Served
Alofi South	Leaking badly	460	427
Paliati (Alofi Nth)	Needs to have sediments cleaned out and joints painted with sealant	195	205
Tamakautoga	Badly leaking, requires new seals and bolts, link with Avatele	80	146
Avatele	New tank installed November 2006	120	174
Vaiea	Irrigation tank relocated to Vaiea. Supply Vaiea and Talamaitoga residences	50	58
Makefu	Needs new roof and tank liner; rubber seals need replacing. Not currently in use but if solar pumps become operational this tank will be needed	90	25
Tuapa	In good condition, roof was repaired in 2001, Meter no longer working	195	188
Namukulu	by Tuapa tank Damaged by cyclone Heta, repaired roof structure in 2005. Village can be supplied which has ample storage capacity	50	22
Vaipapahi farm	Tank put back into service since cyclone Heta but it is in poor condition, badly leakage on the sides	50	12
Hikutavake	In good condition, roof repaired in 2001	80	68
Toi	In good condition	80	33
Lakepa	In good condition , upgraded in 2001	80	86
Liku	In good condition	80	76
Hakupu	In good condition	120	229
Mutalau	In good condition	120	103
		Total	1805

Source: Water Division, PWD. Note: Figures based on 2001 Census.

Involvement of various institutions needs to be coordinated effectively from a focal point with the appropriate authorisation mechanism, by legislation, regulation or a Cabinet instrument. The formalising of the authority enables defined roles and responsibilities preventing fragmentation, uncoordinated plans, and enables strategic actions to improve linkages with other sectors.

The defining of responsibilities of various stakeholders with effective accountability mechanisms put in place, providing enabling environments for dissemination of information culminating in reaching informative decisions resulting in enhanced performances. Strengthening of institutional capacities will support appropriate technology selections, increase system performance and the understanding of subsequent environment and health impacts and demonstrate the need for water conservation and natural disaster preparedness.

Niue's public water supply system is supported by strategically located reservoirs where it is appropriate to use gravity to transfer water to households; however in most villages electrical

automatic pressure pumps are used. Currently about 99% of all households are connected to the public water system without any levy being charged to users. During the 1980s the government paid for all household connections up to about 20 metres for those living within the recognised village boundaries. For households beyond this distance, connections to the supply has to be met by the householders themselves. Householders are actively encouraged to include water tanks as an essential component to their home. Recently, building of water tanks has discontinued and not included as part of the building requirements as water is connected directly from the main line to the household. The shortage of building materials has contributed to the discontinuation of construction.

Village reservoirs are not treated and users are encouraged to boil water for drinking at all times. The Health Department has a water softening system for equipment only to give longer economic life.

There are a total of 30 bore pumps, strategically located, 6 for irrigation purposes 3 for monitoring and 20 being part of the of the public supply system. The irrigation bores are yet to be used, and are awaiting the appropriate pumps. As most of them are located away from the main power grid, it is envisaged that alternative energy source will be used (See annex 1 for location of bores). The electricity consumption by boreholes and pressure pumps has been monitored for the past seven years and is used as an indicator for water consumption. During this period the population is steadily decreased.

There is a local operator selling bottled water.

The effective implementation of the IWRM is subject to each involving institutions, clearly defining respective responsibilities and to work in partnership, including users and stakeholders.

3.4.2 Types of wastewater/sanitation systems

Niue has no public sewage system. Septic tanks purchased from PWD used for waste and wastewater storage for each household. When these household tanks are full, a special truck upon request comes and pumps out the septic tank, for a NZ\$50 fee required from the householder. Wastewater is disposed on open land. Disposal of wastewater on open land is made on the basis of the low number of house holds, however in the event of household increase then a proper system is warranted. The management of waste collection and disposal are covered in the Waste Management Plan.

The Department of Community Affairs has expressed interest in assuming waste management related responsibilities under the community development regime.

3.4.3 Major issues and concerns

The current supply of water meets the demand for domestic, industry and agriculture uses. The only times when shortage is experience is when the electrical power is turned off, or when pumps are up for maintenance or breakdown, and cyclones.

Although leakage has been reduced significantly, it will continue to be a problem. To achieve a non leakage situation requires adequate human and financial resources. These in turn are of concern as they are limited and so can give rise to inactivity in regards to performing monitoring and data collection responsibilities. Financial availability is subject to government budget which includes the development of skilful human resources.

Data collection as highlighted in the Underground Water Resources Investigation Report, is required at regular intervals, including reliability and accuracy is subject to the availability of human and financial resources. The experience after tropical cyclone Heta where personnel were engaged on urgent, unavoidable recovery work, highlighted this concern, hence the collection of data was withheld but not neglected.

The potential for pollution of the water lens from household sewage is a concern and is noted as such in the Niue Waste Management Plan. The risks associated to human health and to the ecosystem welfare needs to be immediately addressed.

Assessing of the household septic system whether all systems meet the standards, especially water-sealed latrine needs undertaking urgently, including the strengthening/enforcing of the Building Code.

The proposal to relocate villages on the western side of the island inland or the upper terrace needs to be re-examined as such a move would be detrimental to and cause conflict with the watershed recharging system. The re-examination of the proposal should include the determination and identification of the actual areas labelled as “high risks” rather than condemning the whole western side of the island; the relocation will be requiring substantial funding not only for water reticulation but for other essential services.

3.4.4 Measures to manage impacts and concerns (IWRM approaches)

The defining of responsibilities and roles with the expected results will be to reactivate the wastewater policies. The reactivation and implementation of the policies is subject to political support, including the capacity of institutional arrangements.

Contamination of water sources from human activities is always a risk, however these risks can be minimised through awareness programmes and the introduction of safety mechanisms.

The GIS system, before tropical cyclone Heta, was based at the Department of Justice Lands and Survey on the basis of the existing technical expertise including the linkage to the land management system already in place and available. The Department of Justice organised training for the users of the information under the premise that the users of the information would collect their respective data and transfer it to the GIS database. Justice would then incorporate the data to the land management system to facilitate proper location of infrastructure and for town planning purposes. A continuous technical support for the database management is required.

Information on location of bore sites has been added as another information layer and the replacement of the respective technology would improve and enhance the collection of information of critical habitats, watersheds, and other equally important areas. The information will be stored and available to all users for planning purposes and for informative decision making process. The collection of data, collating and interpretation requires information technology hardware including GPS and related technology systems.

Niue needs to:

- (i) strengthen the capacity of the institutions responsible for monitoring and collecting data including the inspection role under the Building Code covering the design of septic tanks.
- (ii) clearly define the responsibilities and roles and to activate the waste water management policies.
- (iii) provide continuous technical support on GIS database at Department of Justice.
- (iv) replace GPS
- (v) Strengthen gravity system and reduce pumping power cost and explore renewable energy source suitable to Niue.
- (vi) review the Waste Management Action Plan to include new proposals.
- (vii) identify appropriate equipment and technology.
- (viii) provide capacity building.

3.5 Institutional Arrangements

The Water Resource Act came into force in August 1996, enabling government to introduce regulations for the enforcement of the legislation. Unfortunately the government decided not to sanction the regulations leaving the gaps to continue indefinitely. This legislation is administered by PWD, empowering the Director and the Manager of Water Division to perform the reticulation functions. As a result of PWD involvement in water reticulation, additional coordination responsibilities were automatically absorbed by the Water Division, stretching its limited resources. It has become the focal point for outside donors.

Comment: Need to include new government scenario diagram, have pdf scan copy but unclear.

The Health Department under the Public Health Ordinance of 1965, although unclear of the functions, absorbs the hygiene and sanitation and wastewater management regime, under the premise that these are health related responsibilities. Health also assumes the quality control functions under the broad WHO standards and governance.

The Environment Act 2003 followed, legalising the establishment of the Department of Environment. One of the requirements under this act is to establish a National Council for Sustainable Development (NCSA). Until now the government has not seen the need to create this national body. The creation of a NCSA, apart from its advisory role, would be able to promote the water management profile at all levels of society including the formulation of a vision.

The Niue Public Service is under review focusing on performance, and increase productivity. The review is the opportunity for GoN to adopt the IWRM approach and principles, by deciding where to locate the Water Resource Management functions, whether to maintain the status quo or to centralise all related functions and resources whether technical or administrative under one institution/ roof.

The decision making process is currently confined within the government domain without the participation of stake holders and various users.

IWRM calls for an informed participation of different users and stakeholders concerned with sustainable development. Timely, accurate and comprehensive information about water resources derived from hydrological information systems forms the basis for effective water resources and wastewater management. For sustainable development recognises the monitoring and assessment of water resources, in terms of quantity and quality, requiring adequate meteorological, hydrological and other related data.

3.5.1 Types of institutional arrangements

Niue is committed to sustainable use of its natural resources including fresh water sourced from the underground lens. This commitment is recognised by Niue's signatory to at least 29 global and regional MEAs. As a signatory, it unequivocally shows to the international community that Niue is concerned about the environment problems and is a good citizen in regional and global politics.

Niue needs to revise the strategic objective under the National Integrated Strategic Plan 2005-2008 to integrate and promote a National Water Vision. The determination of the vision, will articulate the priority strategies that would guide the direction that water resource and wastewater management would take, at the same time embracing IWRM approaches, it would also dovetail with strategic objectives of other water related sectors to ensure all stakeholders progress along the same direction.

The Environment Act 2003 mandated the selection of a National Sustainable Development Committee which has not yet been appointed. However, to facilitate the progress of the IWRM, Pacific Adaptation to Climate Change (PACC) and other water related projects, Cabinet has identified, but not yet formally approved, a National Water Working Committee. The Committee is comprised of:

- The Director of PWD, the Director Meteorology, the Director of Environment, the Director of DAFF, Climate Change Coordinator, Water Division Manager, an officer from EPDSU, a NGO Representative and the Senior Health Inspector.

The Committee will have the following roles and functions:

1. A working group to discuss and address all water related issues and projects nationally.
2. Provide information related to each department that is relevant to be undertaken by PACC and IWRM.
3. Identify and discuss relevant outputs and activities to be undertaken by PACC, IWRM and other water related projects.
4. Report activities to the Secretary to Government so that in turn, they can be submitted to Cabinet Ministers meeting for endorsement.
5. Discuss water related activities within departments and from regional organisations; and discuss potential activities that should be supported by regional organisations.
6. All members of the working group to communicate using email services.
7. Working group to meet quarterly or as required, for example, on urgent matters that need to be immediately addressed.
8. Other staff members from relevant departments can be invited to sit in on meetings if the above members are not available.

It is noted as expressed at the national consultation on Friday 9th March 2007, that an action oriented Committee is preferred, to drive the project forward to the next phase, until the government is in a position to appoint a National Sustainable Development Committee as mandated by legislation.

The Water Act 1996 has not been fully enforced. Attempts to process the regulations as required under this enabling act ceased to progress under the premise that the contents need reviewing before resubmitting to Cabinet for approval and tabling in the Legislative Assembly, and subsequently publicised in Niue's official gazette.

Apart from the Environment Act 2003 and the Water Act 1996 the following legislations touch on water and waste management:

- Atomic Energy 1945- The mining process covered in the act includes the removal of overburden by mechanical or other means and the stacking, stoppage storage and treatment of any substance considered to contain any mineral, deposit or discharge of any mineral, material, debris, tailings, refuse or waste water produced from, or consequent on, any such operations or purposes, the lawful use of land, water, pools, and natural depositories or water (whether containing water or not) and the doing of all lawful acts incident or of any such operations.
- Niue Public Health Act 1965- It provides provisions for the protection and control of water supply and for domestic purposes.
- Niue Act 1966- It makes reference to the laying of poison and polluting water; it is an offence for a person to place any poison in any place or throw any offensive matter into or pollute any water course, cistern, well or any supply of water.
- Land Act 1969- It makes provisions for the establishment of reservations for communal purposes, it provides complete protection on land areas considered reservations - ensures against unlawful use of any substance or chemicals that may pollute the area.
- Mining Act 1977- similar to that of the Atomic Energy Act.
- Public Emergency Act 1979- Covers emergencies caused by natural hazards or man made, the likely accidents arising from improper storage and transportation of hazardous substances and waste.

The Environment Act 2003 provides the Environment Department with an over-riding mandate and powers of which the following are the significant issues pertaining to the adoption of IWRM approach as per section 4: Matters to be taken into account-

- (1) All persons exercising functions and powers under this Act shall take into account the following matters:
 - (a) the maintenance and enhancement of the quality of the environment;
 - (b) the efficient use and the development of natural and physical resources;
 - (c) the concept of sustainable development;
 - (d) the protection of the water lens from contamination;
 - (e) the protection of indigenous fauna and their habitats;
 - (f) the protection of the coastal zone from inappropriate use and development;
 - (g) the relationship of Niueans and their culture and traditions to their lands and historic areas;
 - (h) the compliance to multilateral environment agreements Niue is party to.

In addition, Section 6 provides the overall functions of the department including the formulation of environmental and resource management objectives, monitoring, enforcement, and awareness to facilitate compliance to and implementation of multilateral environment agreement relating to the environment.

The establishment of the department is timely and appropriate. However to implement the mandated functions requires resources together with political support; without the political support the department will only scratch the surface of its legal mandate. The implementation begins with the formulation of a corporate plan that would link and integrate with the national vision, followed with strategies and actions.

A policy statement has not been formulated as Niue views the enactment of the Water Act and the Environment Act as the instruments covering all aspects related to water and the environment.

The translation of the requirements under the legislations into practical plans involving the monitoring, enforcement and compliances mechanisms are in place but not yet implemented. In this regard a lack of resources is the barrier.

It is very clear from Section 4 (1) (h) of the Environment Act that the Environment Department is empowered by legislation to facilitate compliance and implementation of MEAs Niue is party to.

Although the responsibility is empowered by legislation, there is present confusion as to the channel that Niue should adopt to ascertain the highest use of MEAs. Use it or lose it is the inherent message that governs the benefits of MEAs. GoN urgently needs to harmonise and strengthen the existing institutional arrangement of key personnel in External Affairs, Treasury Department, EPDSU, Department of Environment and the implementing agencies. All these institutions have essential roles and responsibilities to effectively administer the MEAs. The harmonisation of responsibilities will assist Niue in submitting respective project proposals in a timely manner.

The likely departments that will be involved are Public Works, Health, Environment, Agriculture, Foreign Affairs, Treasury, Community Affairs, Village Councils, NIUANGO, NIOFA, and the private sector.

3.5.2 Major issues and concerns

The promulgation of a National Water vision is subject to political support and how GoN sees water as a resource that has cross cutting interest, effects and concern amongst all residents of Niue.

The articulation of the vision within the community would raise the profile of water, reminding people that water is life and to be used sustainably. It is generally agreed that the economic value of water is not well appreciated by the end users.

Water is essential for life and livelihood and is an essential commodity for the productive sector of the economy. Water production and conservation is not a government priority hence the absence of a water management policy. To develop a water policy the following criteria may be used:

- Systematic management of water resources with equal regard to quantity and quality;
- The integration of water resources with environmental management;
- The coordination of water resources planning with that of the user sectors;
- The coordination of water resources management with that of land use.

The selection of a committee under the existing legislation needs to be actioned, providing a leading role with the development of water policies, formulation of a strategic plan, and adopting a holistic approach to sustainable development issues. Importantly, the coordinating functions between various agencies within government including the linkages with NGOs has to be established in order to ensure a smooth, effective and continuous active working partnership towards a water oriented society. Inter-sectoral planning, aligning with the national plan needs strengthening and coordination; all sectors should compliment each other rather than competing for limited resources.

The gaps and duplication in existing legislation needs to be reviewed and should; identify areas not yet covered; strengthen areas seen to be weak and; repeal areas not appropriate for present day water resource management.

The Water Act 1996 Section 7 stipulated that water is vested in the Crown thus: the right to use, sale, store, pipe and control to all groundwater falls under the Crown. However, as groundwater falls under the natural resources domain, of which the management responsibilities come under that of the Environment Department, the reticulation area rests with PWD. For efficiency, equity, and transparency it is inevitable that the integration of the inherent responsibilities requires dialogue between the PWD and Environment Department, to identify areas within the respective legislations that requires both institutions to perform, and to agree as to whom should continue such responsibilities.

The integrated approach to capturing global funds and capitalising on Niue's commitments to MEAs, will certainly assist the country's development aspirations.

3.5.3 *Measures to manage impacts and concerns (IWRM approaches)*

Niue needs to:

- (i) determine a National Water Vision: raising the water profile empowers people to account for the use of water; provide an impetus with strategic direction that would sustain water as a resource with economic and social value.
- (ii) select a national committee under existing legislation.
- (ii) include all parts of the water and service delivery sector in the national vision for sustainable water resource management – including water, wastewater, sanitation and drainage – and give particular regard to cultural and/or traditional rights and practices.
- (iii) develop national vision for sustainable resources management through a process of full inclusion of, and consultation with, all stakeholders. This process to be confirmed with stakeholders before the formal development stage commences.
- (iv) create and implement an awareness programme adopting IWRM principles to educate people at all levels of the community not only to use water wisely but to view it as a finite

economic and social good; and protection from contamination and pollution is the responsibility of all users and decision makers.

- (v) develop national guidelines on wise practice approaches to assessing and managing water and wastewater system requirements that incorporate sound environmental health principles.
- (vi) strengthen and harmonise existing institutional arrangements, functions and roles of key personnel in External Affairs, Treasury Department, EPDSU and Department of Environment including the implementing agencies, in the administration of MEAs.
- (vii) identify gaps, weakness and areas where not appropriate with current situation in the existing legislation and recommend for appropriate action.

3.6 Financing

Consultation and participation by all users and stakeholders is promoted, creating a better understanding of the roles and responsibilities thus identifying the direction the water resource management would take to enable its sustainability and facilitate equal access. The establishment of strategies objectives that identify the economic, environmental and social costs of different services and develop related policies which ensure the appropriate resources for the water sector would be a priority.

The efficiency of water delivery to all users, for different uses and purposes in a sustainable way rests with the basic understanding that water has economic value and should be treated as a commodity. Factors such as the availability of financial and human resources, principles of good governance; continued dependency on government for all related activities have rendered water management ineffective. It is imperative that all users must contribute to the formulation of policies and share the reticulation costs.

3.6.1 Types of financing arrangements

The Water Division competes annually for funding from government. Since 2001, the annual estimates of expenditure have not been received. The approved amounts have been less than 2% of the total budget. The approved funds are meant to cover all water related activities, leakages, including electricity for the bores. There is minimal direct revenue collected.

Table 3: Niue Annual Water Expenditure 2000-2007

Year	Annual amount (NZ\$)	Total Budget (NZ\$)	% against Total Budget
2000 – 2001		20,604,709	
2001 – 2002	242,251.00	21,600,753	1.12
2002 – 2003	211,254.00	16,629,084	1.27
2003 – 2004	227,251.00	17,696,587	1.28
2004 – 2005	222,982.00	24,352,343	0.91
2005 – 2006	235,889.00	21,698,005	1.87
2006 – 2007	245,566.00	23,414,292	1.04

Source: Niue Government Annual Budget of Estimates.

It is noted that since the inception of the AusAID/PACTAF project, power bill costs have fluctuated (see Table 5), due mostly to lack of resources to sustain the detection of leakages and maintenance work programme. This annual expenditure will increase as more development activities and intensive use are factored into the equation.

Funding is also sourced from donor agencies either directly through bilateral agreement or through a regional organisation.

The intention to introduce tariffs/water rates were proposed 5 years ago, but implementation was deferred indefinitely due to political reasons. Measures for cost recovery are currently being considered taking into account Niue's financial situation.

Table 4: Donor assistance

Organisation	Past	Present	Intended	Amount \$	Purpose
AusAID/PACTAF/ GoN	1997-2000	-	-	561,186.00 224,300.00	Water supply
NZAID	2005-06	-	-	277,000.00	Bores: 6 irrigate 3 monitor, 4 consumption
Oxfam	2004-2005			12,000.00	Equ, upgrade tanks Vaipapahi, Namukulu
UNESCO	2005-06			26,000.00	Underground assessment
AusAID	2005-2006			67,000.00	Tanks-Avatele, Paliati
NZAID/SOPAC	2006	2007-2009		40- 45,000.00	W/Demand
NZAID/SOPAC/ WHO	2006	2007-2009		40- 45,000.00	W/Quality-Lb
HYCOS		2006-2009			W/Facility
FAO	2004-2006		*2008- 2012	159,000.00	Irrigation, *expansion Phase
POPs	2003-006		*	250,000.00	Enabling *NIPs

Source: Water Division, PWD

3.6.2 Major issues and concerns

GoN has identified three industries to focus Niue's development efforts: tourism, agriculture and fisheries. All these industries use a lot of water. There is no mechanism to monitor how much water is being used in each sector nor is there is any differentiation of type of use.

The cost of electricity to pump water from the bores to consumers for 2006 absorbed 50% of the total financial allocation from government for water related activities. The remaining balance was used for personnel emoluments leaving an insufficient amount for other important activities, such as maintenance of equipment, monitoring and collection of data, human resource development and recruitment, the development of public awareness programmes etc.

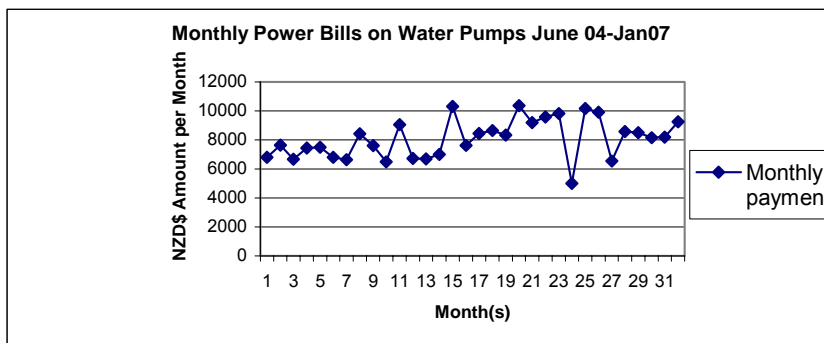
Generally there is a lack of capacity and expertise in the water sector both in the public and private sector.

The number of trained personnel in the water resource management and monitoring fields are very low. Although plumbing responsibilities were transferred to the private sector, the public continue to request Water Division personnel to attend to their household problems.

There is no commercialisation in the water sector.

Table 5: Electricity and Power Bill

MONTH	Amount Paid	04/05 FY	05/06FY
June	\$ 6,791.70		
Jul-04	\$ 7,635.00		
August	\$ 6,668.70		
September	\$ 7,431.80		
October	\$ 7,484.40		
November	\$ 6,804.60		
December	\$ 6,631.80		
Jan-05	\$ 8,425.80		
February	\$ 7,605.60		
March	\$ 6,493.00		
April	\$ 9,049.50		
May	\$ 6,719.70		
Jun-05	\$ 6,679.50	\$ 87,629.40	
July	\$ 7,000.80		
August	\$ 10,313.10		
September	\$ 7,614.44		
October	\$ 8,452.02		
November	\$ 8,653.74		
December	\$ 8,343.34		
Jan-06	\$ 10,371.30		
February	\$ 9,190.36		
March	\$ 9,574.16		
April	\$ 9,811.66		
May	\$ 5,008.08		
Jun-06	\$ 10,169.30	\$ 104,502.30	\$ 104,502.30
July	\$ 9,903.94		
August	\$ 6,548.92		
September	\$ 8,578.62		
October	\$ 8,505.16		
November	\$ 8,152.96		
December	\$ 8,197.74		
Jan-07	\$ 9,245.08	\$ 59,132.42	



Source: Water Division PWD

The existing financing arrangements with donors, seems to work well. The difficulties are in the process of all stakeholders accepting changes. In order to facilitate this process, public awareness is considered the approach in persuading all users to contribute to sustainable water management, not only through financial means but through practical means such as the reduction of waste through leaking taps etc.

3.6.3 Measures to manage impacts and concerns (IWRM approaches)

Niue needs to:

- (i) enforce the Water Act 1996; improve regulatory oversight including sector governance.
- (ii) develop sector master plan to identify funding and cost recovery requirements and benefits, in terms of improving health including poverty alleviation objectives.
- (iii) identify potential benefits of partnerships such as joint ventures.
- (iv) improve demand management.
- (v) develop tariff policies and structures to generate revenues to meet financial and cost recovery policies.
- (vi) establish sound asset management procedures and funding, including operational and management practices.
- (vii) increase consultation and awareness to support cost recovery.

4 Linkages to other areas

4.1 Landuse and agriculture

Agriculture remains the most important landuse on Niue and is a major economic activity, with the majority of households dependent on agriculture for subsistence.

In the mid 1980s the bores on customary lands were surveyed and titled to facilitate leaseholds. This was done to ensure that landowners were restricted from using land within 100 metres from the bore site for any purpose, such as residential uses, piggeries, burial grounds and farming. The aim of surveying was two fold – for leasing land to control landowner access to the land; and to ensure the protection of the water lens. The monitoring of this policy was not well managed and only a few landowners acknowledged and accepted the policy. In 1990s with the change of government the 100 metre buffer zone was reduced to 20 metres and all bore sites were surveyed with ownership determined and registered.

All graves are cemented to ensure that any matter does not seep into the lens. The designing of septic tanks to capture and store wastewater is self treated on-site and pumped into a special truck for transfer and disposal to open land. The amounts are regarded as low hence the open land disposal practice.

After tropical cyclone Heta in 2004, residents living on the western side of the island, especially Alofi to Hikutavake, were encouraged to relocate inland on the upper terrace. The relocation was on the basis that the western side of the island is regarded as a “high risks area/zone”, and no new buildings will be permitted. If the relocation takes place, such residential usage will definitely have conflict with the watershed including reticulation costs.

The Kaimiti area in Alofi has been noted as one area with more new buildings, and Alofi residents will continue to relocate from the coastal area. Proper town planning is required to minimise potential risks to the watershed. There is plan to relocate all government offices to the Fonuakula/Kaimiti area.

The DAFF in consultation with farmers recognised that unreliable agricultural water supply is a constraint that limits agriculture production activities; water supply to agriculture production is neither sufficient nor convenient. Rainwater harvesting techniques are yielding insufficient water to fully meet the crop-water requirements given the variability of rainfall, while the capacity of village bores is very limited for agriculture use. It is deemed important and necessary to develop sustainable and appropriate water development and irrigation technologies to strengthen the government's agriculture support services, to build capacity of Niue farmers and intensify and increase the import substitution agriculture to the island²⁸.

Irrigation is believed to have both positive and negative impacts. Recently 6 water bores were specifically drilled for agricultural irrigation purposes. The obvious positive impact would be the increase in vegetable production, and the reduction of imports. However, a continuous use of agrichemicals and the increase in landuse, if policies are not in place, could lead to potential contamination to the water sources over time. Policies should consider including transfer of waters rights to farmers, including other inherent responsibilities. There is also the likelihood that landowners within close proximity of the bores may opt to build living quarters to be near their crops; and the location of these bores are likely to attract further development.

In terms of management and monitoring protocols, installation of meters would take place with regular monitoring of water quality. The basis of how these bores were located in relation to watersheds, are not clear or available other than the understanding that the location has no significant bearing on the hydrological system. It appears that the deciding factor was based on the existing type of agricultural landuse.

The irrigation technology scheme being adopted on the farms is a Drip Irrigation System (DIS), aiming to increase production and at the same time save water. The DIS does not require the installation of a drainage system as an adequate amount of water drips directly to the root system and limits water wastage. Due to the porous soil context in Niue, unused water seeps back to the lens or evaporates.

There are only 10 farms currently registered under the DIS, although there is a likelihood that more farmers will be attracted to use the system subject to tangible results and economic gain. Niue's subsistence approach to farming usually relies heavy on rainwater for crop growth²⁹.

The ten farms selected for the DIS are regarded as demonstration areas to gauge the success in terms of productivity. An increase in food production has been considered vital and future expansion is subject to results of these selected farms, and securing of additional funding including what is seen by government as priority areas.

Land based pollution derived from development activities affect watershed management when standards are not being effectively adhered to during construction. Direct and indirect discharge of sewage (septic tanks), greywater, solid waste, oil spillage from garages and port areas, and the increase in number of fishing boats refuelling without safety standards creates a very high risk.

The use of machineries to clear land for cultivation, particularly secondary forest areas has negative impacts on the watershed. There is no existing control mechanism which increases pressure on the natural watershed system for recharging the lens.

Alternative energy for pumping water from the underground source needs to be explored as wind power or other source of energy may assist with cost reduction.

4.2 Habitats and ecosystems

The Huvalu Conservation Area, is the only formally recognised area, and lies under a community initiated "tapu/taboo. The conservation area has been purposely set aside for food security and is a

²⁸ DAFF. 2007. Termination Report Develop Irrigation

²⁹ Ibid.

dedicated area of forest as a habitat for lupe (pigeon), uga (coconut crab) and peka (flying fox), including other forest domicile species.³⁰

There were two recognised marine protected areas (MPA), both on the north-western side of the island under the IWP: Anono to Namoui and Alofi North to Makefu. Only one Temporary Closed Area (TCA) from December 1st to December 31st 2005, Tongalupo to Vaila. The are two replicated areas, Tomb Point to Utuko (Alofi) and Hio to Namukulu³¹.

The aims are to protect the bio-ecosystem, geo-ecosystem, fishing grounds, cultural resources in terms of food security; unsustainable harvesting; habitat degradation; lack of management activities to assist resource recovery; change in fish patterns so that fish are no longer easily available in some inshore areas; and natural events-increased predation from other species.

Although the boundaries for these areas were established and recognised in written records, there is spill-over, in terms of fish migration, to adjacent areas. The management licenses were granted under the Domestic Fisheries Act 1997.

Another MPA is Ana, between Hakupu and Liku on the eastern side of the island, which uses the traditional practices of placing a “fono/taboo” for a period of 1-2 years, whenever a death occurs in the families who traditionally dedicated this portion of land and sea as their hunting area³². Observation and respect of this tradition by all in the community, is always accepted.

Coastal ecosystems play a crucial role in the production and maintenance of fisheries and other biological resources of primary importance for human population. Undisturbed coral reef areas provide food and shelter for resident and migratory species, play a protection role from tropical storm damage and are considered a store house for potential valuable species.

The impact of land use activities on coastal habitats is seen in the case of “Ana Vailahi” cave, located to the south east side of the wharf. This area is marked by an absence of marine species, there are no corals, tube-worms, turbine etc. Previously, an asbestos drainage pipe was used to drain water during wet season from the road (containing fuels, oils, chemicals, silt, etc) into the cave, seeping through to the sea. The extent of the pollution was discovered in 2005 when fish were poisoned. Action was taken to replace the asbestos pipe with a PVC one and diverted out of the cave through an adjacent soil mount into the sea. The soil mount acts as a natural filter and hopefully dilutes what goes through before it reaches the sea³³.

There are springs of about 15 to 30 meters deep, some 30 to 40 meters from the base of the cliff from the Alofi to Avatele areas. Oil has been seen in some of these springs in Alofi which is of environmental concern. The freshwater in these springs and caves provides drinkable fountain for sea snakes³⁴.

Another concern is the coral bleaching found in Avatele and in Alofi prior to cyclone Heta, due to climate change, heat, sea current and the rise in sea level³⁵.

Niue needs to locate and identify more areas of watersheds and coastal springs for protection. The threats to habitats and ecosystems relate to lack of information, education and public awareness and include the following:

- pollution from land based sources (agricultural chemicals, solid waste, oil spillage etc.)
- inadequate land use practices/controls
- land tenure rights

³⁰ Tongatule, S. 2003. In-Situ and Ex-Situ Conservation Measures Niue, Capacity Assessment Report

³¹ S. Leolahi oral comm.2007

³² Togiama, M. 2001. Ana Marine Reserve, In-Country Project Report.

³³ S. Leolahi oral comm. 2007

³⁴ Conversation with Niue Dive Proprietors. 2007

³⁵ Ibid.

- unplanned developments
- lack of control of forest clearance

Concern has been raised over the use of agrichemicals and the irreversible harm it causes to the terrestrial ecosystem and habitats. Farmers have noted the changes to the habitats and have talked about the effects but find it difficult to stand up and impress upon the leadership of Niue to ban the importation of chemicals. Farmers talked about the many earth worms in the soil before, and the different types of fruits from edible creepers in the past but they hardly see them today since the introduction of weed control chemicals³⁶.

4.3 Health and hygiene

Good quality drinking water is essential for the wellbeing of all people prompting the UN to declare access to clean water as a basic human right. Niue is fortunate that its underground water source is still free from pollution and contamination.

The Health Department is formulating an Integrated Strategic Plan for 2007-2010 with the vision: "Niue to be the healthiest nation in the Pacific," and a mission: "to improve the health of everyone in Niue." Although the plan is not completed, implementation has began, with the Public Health Division as the driving force focusing on public awareness programmes, educating people in the areas of water safety, nutrition and fitness, non-communicable diseases and other health related areas.

Regular testing for water safety had occurred for 10 years until all testing equipment were destroyed by cyclone Heta in 2004. After the cyclone, testing of the underground water source was a priority and military personnel from Australia were requested to perform the testing. Fortunately it was found that the aquifer remained safe. For precautionary measures a treatment regime was administered.

In 2004, under POPs, food and water samples were tested and found that- "for all organochlorine, organonitrogen and organophosphorous pesticides tested for, there were no definite levels detected in any of the samples. The results for Paraquat are also encouraging in that no levels were detected in any of the samples. This can be used as initial finding, but further monitoring is needed."³⁷

The routine monitoring and assessment of water quality is a priority for the Health Department who is the responsible institution in this area. The data collected needs proper assessment to enable proper management for the health of humans and the protection of the environment.

The data shown in Tables 6 to 9 show water test results from Niue's bore holes. The data indicates that the readings falls within the required WHO standards³⁸.

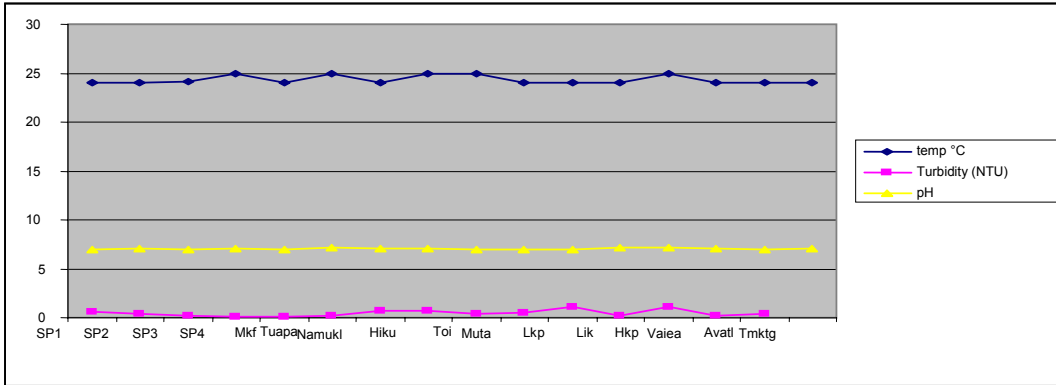
³⁶ Conversation with local farmers

³⁷ Tasmania, G. 2004. A report on the Food and Water Sampling Programme, POPs

³⁸ Environment Health Officer, oral comm. 2007

Water Test Results – October 2006, Niue Bore Holes

Figure 2: Water test results: physical parameters



Source: Niue Fooou Hospital Water Lab

Table 6: Water Tests Results October 2006: Turbidity

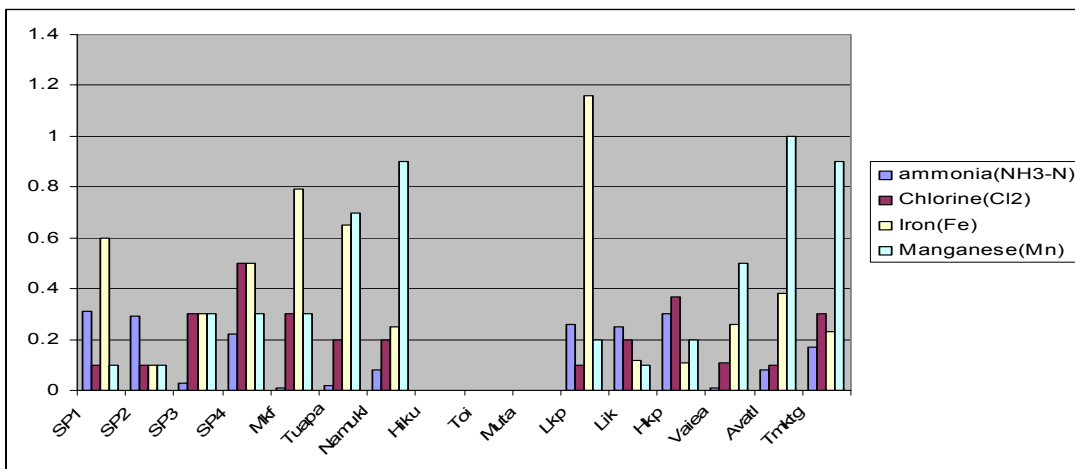
	<i>Temp. °C</i>	<i>Turbidity (NTU)</i>	<i>pH</i>
SP1	24	0.64	7.0
SP2	24	0.36	7.1
SP3	24.1	0.2	7.0
SP4	25	0.15	7.1
Mkf	24	0.12	7.0
Tuapa	25	0.21	7.2
Namukl	24	0.69	7.1
Hiku	25	0.73	7.1
Toi	25	0.36	7.0
Muta	24	0.52	7.0
Lkp	24	1.1	7.0
Lik	24	0.25	7.2
Hkp	24	1.15	7.2
Vaiea	24	0.25	7.1
Avatl	24	0.36	7.0
Tmktg	24		7.1

Water Test Results – October 2006, Niue Bore Holes

Table 7: Water Test Results October 2006: Chemical Parameters

	Ammonia (NH3-N)	Chlorine (Cl2)	Iron (Fe)	Manganese (Mn)
SP1	0.31	0.10	0.60	0.1
SP2	0.29	0.10	0.10	0.1
SP3	0.03	0.30	0.30	0.3
SP4	0.22	0.50	0.50	0.3
Mkf	0.01	0.30	0.79	0.3
Tuapa	0.02	0.20	0.65	0.7
Namukl	0.08	0.20	0.25	0.9
Hiku	-	-	-	-
Toi	-	-	-	-
Muta	-	-	-	-
Lkp	0.26	0.10	1.16	0.2
Lik	0.25	0.20	0.12	0.1
Hkp	0.30	0.37	0.11	0.2
Vaiea	0.01	0.11	0.26	0.5
Avatl	0.08	0.10	0.38	1.0
Tmktg	0.17	0.30	0.23	0.9

Figure 3: Water Tests Results October 2006: Chemical Parameters



Source: Niue Fou Hospital Water Lab

Water Test Results – October 2006, Niue Bore Holes

Figure 4: Niue Bore Holes Chemical Parameters

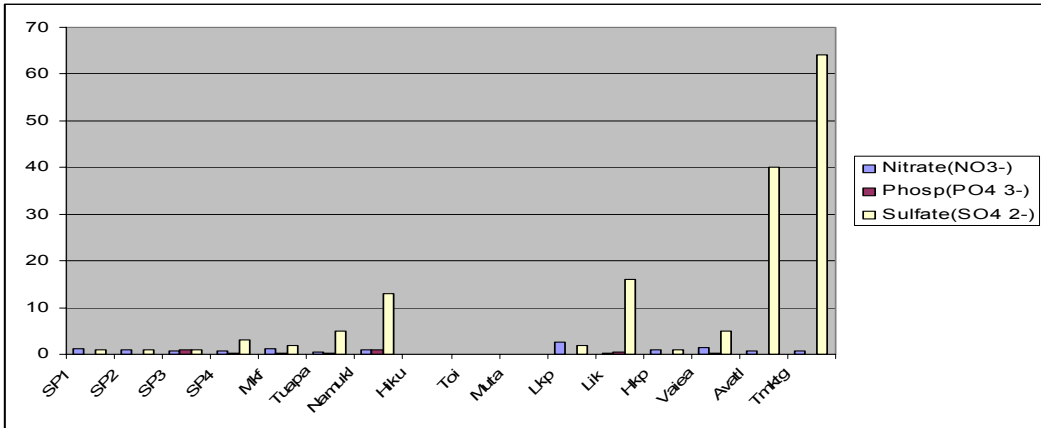


Table 8: Water Tests Results October 2006: Village Pumps/Bores

	Nitrate (NO ₃ ⁻)	Phosphorus (PO ₄ ³⁻)	Sulphate (SO ₄ ²⁻)
SP1	1.2	0.05	1
SP2	1.0	0.08	1
SP3	0.7	0.83	1
SP4	0.8	0.13	3
Mkf	1.2	0.25	2
Tuapa	0.4	0.14	5
Namukl	0.9	0.83	13
Hiku			
Toi			
Muta			
Lkp	2.6		2
Lik	0.3	0.40	16
Hkp	0.9	0.08	1
Vaiea	1.5	0.17	5
Avatl	0.8	0.09	40
Tmktg	0.7	0.10	64

Table 9: Summary of Physical, Chemical and Bio Parameters

	temp °C	Turbidity (NTU)	pH	Ammonia (NH3-N)	Chlorine (Cl2)	Iron (Fe)	Manganese (Mn)	Nitrate (NO3-)	Phosphorus (PO4 3-)	Sulphate (SO4 2-)	Total Coli	Faec Coli
<i>P1</i>	24	0.64	7.0	0.31	0.10	0.60	0.1	1.2	0.05	1	0	0
<i>SP2</i>	24	0.36	7.1	0.29	0.10	0.10	0.1	1	0.08	1	0	0
<i>SP3</i>	24.1	0.2	7.0	0.03	0.30	0.30	0.3	0.7	0.83	1	0	0
<i>SP4</i>	25	0.15	7.1	0.22	0.50	0.50	0.3	0.8	0.13	3	0	0
<i>Mkf</i>	24	0.12	7.0	0.01	0.30	0.79	0.3	1.2	0.25	2	0	0
<i>Tuapa</i>	25	0.21	7.2	0.02	0.20	0.65	0.7	0.4	0.14	5	0	0
<i>Namukl</i>	24	0.69	7.1	0.08	0.20	0.25	0.9	0.9	0.83	13	0	0
<i>Hiku</i>	25	0.73	7.1								0	0
<i>Toi</i>	25	0.36	7.0								0	0
<i>Muta</i>	24	0.52	7.0								0	0
<i>Lkp</i>	24	1.1	7.0	0.26	0.10	1.16	0.2	2.6		2	0	0
<i>Lik</i>	24	0.25	7.2	0.25	0.20	0.12	0.1	0.3	0.4	16	0	0
<i>Hkp</i>	25	1.15	7.2	0.30	0.37	0.11	0.2	0.9	0.08	1	0	0
<i>Vaiea</i>	24	0.25	7.1	0.01	0.11	0.26	0.5	1.5	0.17	5	0	0
<i>Avatl</i>	24	0.36	7.0	0.08	0.10	0.38	1.0	0.8	0.09	40	0	0
<i>Tmktg</i>	24		7.1	0.17	0.30	0.23	0.9	0.7	0.1	64	0	0

Source: Niue Fooou Hospital Water Lab

The major concerns are:

(i) Water quality. Niue is yet to determine its water quality standards however authorities of Health department are using standards recommended by WHO. The Department of Health's, Environmental Health Division is normally the entity responsible for regular water quality testing. The Division needs to fully equipped with the appropriate technology and human skills to effectively administer the WHO required standards.

(ii) Sanitation. Solid waste disposal poses potential risks. Niue has a solid waste management plan; the private contractor who collects solid waste is required to deposit waste in dedicated areas leased from land owners.

Water related diseases do not prevail on Niue however, there are occasions when cases of diarrhoea and intestinal infections are reported to the Health Department. If there is a public health concern, the public are notified urgently to ensure that drinking water is boiled. Following the loss of records in cyclone Heta, it is not known if any data on water borne diseases exist.

Niue's underground source of fresh potable water and storage reservoirs are untreated. The only occasion for treatment was after cyclone Heta as a precautionary measure.

The practice of dumping wastewater on open land needs to be discontinued as it contributes to the increasing number of flies and other environmental health risks. A small but proper treatment facility needs to be built, and the sludge be utilised for growing plants and other uses.

The main tourism concern related to watersheds management is to prevent attractive natural or historical sites from degradation. Accordingly, the challenge for the Tourism Authority and the Environment Department is to have joint and coordinated efforts with the Village Councils and target:

- the valorisation of the site and environment protection;
- active involvement and participation of stakeholders and landowners on the site.

Niue has yet to experience mass tourism activities, however with the push towards increasing tourist numbers to 2,000 per annum, appropriate mechanism should be put in place to cater for the

projected increase. Accordingly, tourism has yet to have significant impact on watershed management.

The Environmental Health Division needs capacity upgrading in the areas of human resources and appropriate equipment. An award should be offered specialising in Public and Environment Health which fits well with the departments' vision.

4.4 Watershed and coastal management

A clear simple definition of watershed and coastal areas is warranted, especially for the Niue stakeholders to understand the terms:

- (i) a watershed area is a hydrologically defined area bounded by topographical features and drained in the central location to a common destination. The area stores, filters and releases water to the catchment area.
- (ii) refers to the ecosystems within a contiguous watershed divide from the hinterland to coastline and drained by one major water system.
- (iii) sometimes referred to as a catchment or drainage basin and constitute an independent hydrological unit.
- (iv) coastal area is a geographic entity of land and water affected by the biological and physical processes of both the terrestrial and the marine environments. The area affected by its proximity to the sea and that is unavoidable within the small island system setting³⁹.

In 2004 an investigation was mounted by SOPAC on coastal quality and highlighted the following:

"The major sources of the elevated nutrients in Niue's near shore coastal waters are likely to be from human waste discharges from septic tanks and other household or agricultural chemicals...The focus of relevant authorities should be to reduce the input of nutrients to the coastal water⁴⁰".

The following conclusions were made:

1. The coastal survey whilst of limited extent, shows that land based activities are impacting upon the coastal water quality.
2. The link between the land based pollution and the fish toxicity has not been proved or disproved, but the coastal water contamination will contribute to the stressing and deterioration of the coastal fishery environment per se.
3. Hydrochemical assessment of the karstic limestone aquifer confirms a freshwater lens to exist across the entire island, but thickness requires further investigation.
4. The aquifer is dominated by karstic flow and nitrate concentrations around Alofi confirm it is highly vulnerable to surficial land use activities, including storm wave over-topping.
5. Conventional sustainable yield assessments suggest annual ground water abstraction is less than 1% of annual recharge, and therefore the aquifer remains sustainable. Nearly all groundwater discharge to coastal and possibly submarine springs.
6. However a more detailed yield assessment suggest that the aquifer can store 3 months of recharge, and given the perceived rapidity of its response to recharge events and subsequent immediate spring discharge, the freshwater lens is likely to reduce considerably during the annual dry period of 3 or more months.

³⁹ Carenage, S. (?) 2001. National Report Integrating Management of Watersheds

⁴⁰ Mosley and Carpenter 2004.

7. Ground water storage should be adequate to provide at least a minimum of 5 months water supply through these dry months and therefore in an average year the island should have adequate water resources.
8. In the drought years, 8-9 months of no recharge have been estimated, and the lens would be expected to shrink in size accordingly.
9. Historical data indicates individual borehole yields of 0.75 l/s should prevent saline up-coning, but boreholes with larger yield might create saline up-coning if drawdowns exceed 0.5m.
10. Finally the lack of data on freshwater lens geometry and responses to recharge events means the lens is not adequately understood. (Groundwater monitoring have commenced as a priority).

In addition the study has the following recommendations:

- (a) Further work is required to examine sources of contamination around the Port of Alofi and to confirm results of the initial coastal survey.
- (b) Local personnel should be trained to conduct on-going water quality monitoring.
- (c) A land and coastal management plan should be developed for the Alofi port area.
- (d) A full water resource investigation needs to be carried out. A submission for funding for this has already gone through the Niue National Council and now being assessed by UNESCO.
- (e) It is highly recommended that a full EIA is carried out at the cost of the proposed developer to investigate the potential of the proposed fish cannery effluent disposal on the groundwater lens.
- (f) It is recommended that land use zoning be introduced as part of the planning process, which considers the likelihood of the proposed activity affecting the aquifer. Protecting zones around the public water supply abstraction could be introduced and enforced.
- (g) It would be prudent to have a "standby" emergency abstraction wells located in the middle of the island that could be activated by PWD should the wells on the western coast becomes temporarily salinised after tropical storm and cyclonic events.
- (h) There is an immediate need to introduce a freshwater lens monitoring network to the island as a major priority, given the study suggests large sub-annual variations in the lens size and therefore yield occur.
- (i) Specific capacity yield test should be carried out on all boreholes as a matter of operational design and planning, to determine drawdown therefore the potential saline up-coning.
- (j) Conductivity monitoring of each abstraction should be carried out routinely (at least monthly) to provide advance warning of increasingly saline wells, and enable abstraction rate reduction.
- (k) More detailed investigation of the freshwater lens is required and should include topographic levelling of all boreholes, caves and springs to a common datum; monthly dipping flow and EC pressure and conductivity transducers, a data logger installed, and if adequate financing can be secured the drilling of purpose designed monitoring wells, geophysically downhole logged and fitted with multi-level samplers/probe.

The small size of Niue its geography and location is of particular importance to the intimacy, which exists between the watersheds and the coastal area. The drainage pattern of the island, poor land use practices, lack of a land use plan, lack of human and financial resources, dependence on underground water lens, coastal resources and the marine environment, make integrated management of coastal areas and watersheds of critical importance to survival. These are cross-

Comment: This para has been repeated twice now in the report

sectoral in nature wherein the activity of one sector adversely affects the development of the other and poses a threat to economic sustainability and environmental quality.

Integration is an essential aspect of the management system, which ensures linkages between the process of planning and implementation in attaining sustainable development goals. This will allow relevant management issues arising from the physical, social and economic linkages to be adequately addressed; ensure programs are consistent with the national development goals; facilitate stakeholder participation; provide consistency in policy deliver; develop and implement cost recovery measures etc.

Integrated management will allow for policy and management strategies to respond to the challenges of changes in the watershed and coastal areas and to be consistent with national and sustainable development goals.

The existing sectoral linkages have significant roles:

- Agriculture – land clearing for plantations, degradation, irrigation, agrochemicals
- Health – quality, sanitation, waste management
- Tourism – water quantity, waste water
- Education – curriculum development
- Environment – natural resource management, MEAs
- Lands – land use planning, zoning, GIS, GPS

5 Stakeholder Engagement

This involved a national stakeholder consultation held 9 March 2007 and through individual interviews and one-on-one conversations. Table 10 outlines stakeholder involvement and relevance to IWRM.

Table 10: Stakeholder Involvement Matrix

Institution	Stakeholder/Interests and Responsibility	Relevance to IWRM and reason to inclusion	Role in the consultation process
Secretary to Government	Head of the Public Service/Chief Advisor to Cabinet/Focal Point Foreign Affairs/MEAs	Policies, Development Plan Institutional arrangement, Capacity building	Advise on Government policies, and strategic directions, Donor relationship
NPSC	Employing Authority	Institutional Arrangements, capacity building	Advise career and human resource development
PWD Water Reticulation	Focal point -SOPAC Government agency on Water reticulation	Implementing agency Water Act 1996, Bore sites Building Code	Water reticulation, monitoring and data collection, coordinating role with other institutions, technical matters on underground water systems, Building code, designing septic systems
Education department	School curriculum	Awareness, advocacy	Career development
Environment Department	Empowered by law	Manage natural resources	EIAs, MEAs, monitoring
Health Department	Water quality	Testing Equipments Capacity building	Water Safety, solid waste, waste water

			management
Justice, Lands & Survey	Land use planning	GIS data, mapping, survey, GPS database	Surveys, data collection, land rights, Land Information System harmonisation
Met Office	Climate Change	Adaptation, vulnerability	Monitoring and Data collection, sea level rise, rainfall, drought, weather forecast, land degradation, ground water/hydrology
EPDSU	National Planning	Statistical data and interpretation	Coordination monitoring, evaluation, projects
Community Affairs	Community Development	Community focal point, c	Awareness, NGOs, women, youth
DAFF	Agricultural use, agrichemicals	Land use management,	Irrigation use, land management, forestry
NIOFA	Organic Farming	Traditional land use, organic	Water quality awareness
NIUANGO	NGOs, CBOs, Civil Society	Rights of use and access, traditional knowledge, community participation. Awareness	Community use and advocacy, awareness, human rights, gender, disables, women, youth, awareness, civil society
Police	National Disaster	Risk and hazards management	Risk assessments, disaster management.
Tourism	Accommodation	Water safety, environment	Users, policies
IWP			

6 Other programmes, projects and activities related to IWRM

Table 11: Single Country GEF Projects in Niue

Existing projects					
Project name (Niue Gov Department)	GEF focal area	GEF Agency	Project type	Grant US\$	Status
National Biodiversity Strategy, and Action plan and reports to COP (Environment)	Biodiversity	UNDP	Enabling activity	135,000	Completed
Additional Enabling Activity for Participation in the Clearing House Mechanism of the CBD (Environment)	Biodiversity	UNDP	Enabling Activity	14,000	Completed
Biodiversity Enabling Activity Add on Components for Niue (Environment)	Biodiversity	UNDP	Enabling Activity	280,000	Completed
Enabling Activities for the Preparation of Initial National Communication Related to the UNFCCC (Meteorology)	Climate Change	UNEP	Enabling Activity	296,000	Completed
Climate Change Enabling Activity (Additional Finance for Capacity Building in Priority Areas (Meteorology)	Climate Change	UNEP	Enabling Activity	100,000	Completed
Enabling Activities for the Preparation of Second National Communication Relating to the UNFCCC (Meteorology)	Climate Change	UNEP	Enabling Activity	405,000	Ongoing
National Capacity Self Assessment Exercise (Environment)	Multi-Focal Areas	UNDP	Enabling Activity	225,000	Ongoing

Initial Assistance to Niue to Meet Its Obligation under the Stockholm Convention on POPs (DAFF)	Persistent Organic Pollutants	UNDP	Enabling Activity	250,000	Completed
Enabling Activities for Desertification (Various Sources not GEF) (DAFF)	Desertification and Land Degradation	UNDP and Other	Enabling Activities (Various)	-50,000	Completed
Enabling Activities to Prepare National Biosafety Framework (DAFF)	Biodiversity and Cartagena Protocol	UNEP	Enabling Activity	250,000	Ongoing
FUTURE PROJECTS					
Capacity Building for Sustainable Land Management in Niue (DAFF)	Desertification/ Land Degradation	UNDP	Medium Sized Project	499,545	Approved
				-2,000,000	

Source: MEA Project Documents

Table 12: Regional GEF Projects

Existing Projects	GEF Focal Area	GEF Implementing Agency	CROP Agency	Project Type	Approx Amount to Niue US\$	Status
South Pacific Biodiversity Conservation Programme (Environment/Community Affairs)	Biodiversity	UNDP	SPREP	Full sized project	???	Completed
Implementation of Strategic Action Programme (SAP) of the Pacific Small Island Developing States (DAFF)	International Waters	UNDP	SPREP	Full sized project	410,000	Ends 2006
Pacific Renewable Energy Programme (PIREP) ??	Climate Change	UNDP	SPREP	Medium Sized Project	Small/none?	Ending
Pacific Islands Oceanic Fisheries Management Project (DAFF)	International Waters	UNDP	FFA/SPC	Full Sized Project	Negligible	Endorsed
Implementation Sustainable Integrated Water Management Project (PWD-Water)	International Waters	UNDP/UNEP)	SOPAC	Full Sized Project	-700,000.00	Project Development Phase PDF B
Pacific Greenhouse Gas Abatement Through Energy Project (PIGGAREP) (??)	Climate Change	UNDP	SPREP	Full Sized Project	???	Approved
Pacific Invasive Species Management (DAFF)	Biodiversity	UNDP	SPREP	Full Size Project	???	Waiting Approval
Pacific Islands Adaptation Project (Meteorology/PWD)	Climate Change(Special Climate Change Fund)	UNDP	SPREP	Full Sized Project	-500,00.00	Project Development Phase PDF B

Source: MEA Project Documents

SOPAC is organising the following regional projects, involving Niue, under its Community Lifeline water projects:

- (i) Water Safety Plan covering monitoring and inspection, emergency contingent plan, and operation procedures.
- (ii) Water Quality Management focusing on identifying training needs.

- (iii) HYCOS focusing on capacity building, climate resource centre.
- (iv) Water Demand management focusing on usage, needs analysis and capacity building.

Niue needs to:

- (i) implement actions to strengthen national capacity (equipment, training etc).
- (ii) train more technicians in the field of hydrological, water management, quality testing, and other related areas.
- (iii) strengthen and enhance communication and information exchange between national agencies in the field of meteorology, hydrology, water quality, data collection department and users.
- (iv) implement a holistic approach and IWRM principles and practices through the systematic coordination between related agencies, with the long term commitment for the implementation of IRWM and provide appropriate support and training sourced from regional and international institutions.
- (v) build security fences to protect the reservoirs and bore sites.
- (vii) source funding to import or build concrete tanks to capture rain water as another source of potable water.
- (viii) encourage users to contribute to conserving water to reduce related costs.
- (ix) enforce the Water Act 1996, improve regulatory oversight including sector governance.
- (x) develop sector master plan to identify funding and cost recovery requirements and benefits, in terms of improving health including poverty alleviation objectives.
- (xi) identify potential benefits of partnerships such as joint ventures.
- (xii) improve demand management.
- (xiii) develop tariff policies and structures to generate revenues to meet financial and cost recovery policies.
- (xiv) establish sound asset management procedures and funding, including operational and management practices.
- (xv) increase consultation and awareness to support cost recovery
- (xvi) identify gaps, weakness and areas not appropriate with current situation in existing legislation and recommend for appropriate action.

7 Capacity Development Needs to Removing the Barriers

Awareness at all levels of the community, including stakeholders, users and policy makers is not only vital to the success of IWRM but it is an ingredient to a win-win situation, which is important to the mix. This ingredient needs political support, and to be driven by the community through NGOs in partnership with the Community Affairs. Awareness as a tool builds the capacity of the community, providing knowledge, empowering them to use water resources sustainably with the succinct understanding that future generations have a share in these natural resources. Of equal importance is the insurance by stakeholders of today that the aquifer remains free of contamination and pollution. The empowering through knowledge and time, concerted efforts and conscience can result in change of paradigm, to a water safety oriented community. The total output will be the creation of an enabling environment.

The selected personnel to spearhead and effectively drive the awareness programme require skills to develop and deliver stimulating and persuasive talks at all levels in community gatherings, including various media sources with written pamphlets as information backup.

Existing personnel within the responsible institutions require up-skilling and multi-skilling. The multi-skilling approach will assist with the labour shortage of specialised personnel. This approach is effective within the Health Department but not in its Environmental Health Division.

Practical attachments at regional organisations, who specialise in water management, GIS/GPS, environment health, water safety, EIAs and other water related areas is recommended. This includes exchanging personnel within Pacific Island countries. The practical attachments may be treated as incentives and will enhance the performance including an increase in local productivity.

Long-term training awards should be offered in the areas of resource management, hydrology and other areas related to underground water.

It is noted that the region does not offer specific training in water engineering it is generally a component of a civil engineering degree.

Niue needs:

- (i) action the recommendations in the Waste Management Plan, to ensure the water lens are protected from any form of contamination and pollution. Institutional capacity required strengthening.
- (ii) continue quality monitoring practices following WHO standards.
- (iii) continue to work together with climate information services in the region, strengthen current capacity to enable ongoing development analysis, forecasting and application tools; and including the participation of stakeholders.
- (iv) continue to develop rainfall and drought monitoring and prediction methods, including technology transfer.
- (v) implement actions to strengthen national capacity to carry out hazard assessment and risk management using existing tools and other vulnerability assessment and risk management tools.
- (vi) promulgation of a drought plan.
- (vii) build proper facilities to treat waste from septic tanks for compost use.
- (viii) develop safety standards for refuelling boats at the wharf to minimise the associated risks.
- (ix) ensure an EIA is a prerequisite for all development projects including regular inspections/evaluation of impacts.
- (x) support the establishment of a regional water education fund accessible by government agencies, NGOs and civil society groups to ensure effective community participation in sustainable water management.
- (xi) develop a toolbox in association with SOPAC, donors, regional and international organisations to support water education for all levels of society, including politicians, government personnel, civil society and the private sector.
- (xii) adopt water education as part of the curriculum including the training of teachers to provide water education.
- (xiii) define roles and responsibilities of government, civil society groups, private sector and communities in the sustainable management of water.
- (xiv) share information between project stakeholders.

- (xv) improve awareness of policy and legislation through education and community based learning.
- (xvi) adopt a working partnership relationship between all water users.
- (xvii) inform SOPAC to approach regional education institutions to develop courses in water engineering and management towards a recognised qualification
- (xviii) strengthen the capacity of the institutions responsible for monitoring and collecting data including the inspection role under the Building Code covering the design of septic tanks.
- (ix) clearly define the responsibilities and roles and to activate the wastewater management policies.
- (xx) provide continuous technical support on GIS database at Department of Justice.
- (xxi) replace GPS
- (xxii) strengthen gravity system and reduce pumping power cost; explore renewable energy source suitable to Niue.
- (xxiii) review the Waste Management Action Plan to include new proposals.
- (xxiv) identify appropriate equipments and technology.
- (xxv) provide capacity building.
- (xxvi) determine a National Water Vision.
- (xxvii) select Committee under existing legislation.
- (xxviii) include all parts of the water and service delivery sector in the national vision for sustainable water resource management – including water, wastewater, sanitation and drainage – and give particular regard to cultural and/or traditional rights and practices.
- (xxix) develop a national vision for sustainable resources management through a process of full inclusion of, and consultation with all stakeholders. This process be confirmed with stakeholders before the formal development stage commences.
- (xxx) create and implement an awareness programme adopting IWRM principles to educate people at all levels of the community on sustainable water use, protection of water resources and encourage concepts of water as a finite economic and social good as the responsibility of all users and decision makers.
- (xxxi) develop national guidelines on wise practice approaches to assessing and managing water and wastewater system requirements that incorporate sound environmental health principles.
- (xxxii) strengthen and harmonise the existing institutional arrangements, functions and roles of key personnel in External Affairs, Treasury Department, EPDSU and the Department of Environment including the implementing agencies, in the administration of MEAs.

8 Introducing an Integrated Approach towards Barrier Removal

If effective, long term solutions for water problems in Niue, are to be found, it must accept to adopt a new water governance and management paradigm which is encapsulated in the IRWM concept and principles.

IWRM is a process of change which promotes the coordinated development and systematic management of water, land, costal and related resources, in order to maximise the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital

ecosystems, including the wellbeing of the future generations. All stakeholders must be aware that water is a natural finite and vulnerable resource.

As a process of change seeking to shift water development and management systems from their current sectoral unsustainable forms, the IRWM is believed to have no fixed beginning. In spite of Niue's stagnated/contracting economy, the global economy is dynamic and the natural environment is also subject to change. IWRM needs to be responsive to respective changes and capable of adapting to new economic, social and environmental conditions equally with changes in human value.

The themes being adopted are community oriented. All stakeholders are required to effectively contribute in all these areas, including the decision making, participation and consultation which require political support as the driving force to ensure efficiency, equity and transparency across all local fronts. Of equal importance is that if one theme is ignored then a wide gap will be opened inviting the sectoral approach to slowly return, hence it is vital to ensure that this IWRM principles are fully implemented.

The driving force needs a simple vision, achievable and measurable; bringing together the existing sectoral visions to form one whole for Niue. Consequently the defining of roles and functions, showing the direction for Niueans to achieve and harvest sustainable natural resource management to users of today including those of tomorrow is important.

Suggest measures to overcome barriers

Niue needs to:

- (a) strengthen its capacity to conduct water resources assessment and monitoring as the key component of sustainable water resources management.
- (b) formulate and implement strategies to utilise appropriate methods and technologies for water supply and sanitation systems.
- (c) implement strategies to protect watersheds and the remaining forest from further depletion, including the identification of critical habitats other than the Huvalu Conservation Area.
- (d) strengthen capacity development to enhance the collection and application of climate information to cope with climate variability and change.
- (e) promote the change paradigm for dealing with island vulnerability from disaster response to hazard assessment and risk management, particularly in IWRM.
- (f) set up a high quality participatory framework to allow for open participation of stakeholders in sustainable water and wastewater management.
- (g) include water and sanitation in the formal education system.
- (h) improve the communication and coordination of all stakeholders in sustainable water and wastewater management including government, NGOs, civil society and private sector.
- (i) identify appropriate institution, infrastructure, and information to support sustainable water and wastewater management.
- (j) continue collaboration with regional and international partnership to facilitate appropriate assistance in all areas relating to water resource and wastewater management.
- (k) support regional training programmes resulting in sustainable levels of skills and knowledgeable people within water and wastewater management.
- (l) work together through a comprehensive consultative process, encompassing good governance, to develop a shared national vision for managing water resources in a sustainable manner.

- (m) work together towards developing and strengthening national instruments, national vision, policies, plans and legislation taking into account social, economic and environmental and cultural needs of its citizens.
- (n) identify and promote appropriate institutional arrangements resourced sufficiently to enable effective management of water resources and the provisions of appropriate water and wastewater services.
- (o) develop, encourage and recognise national leadership in water resources.
- (p) create a better and sustainable environment for investment by public and private sector, by developing and implementing national, sector, and strategic plans that identify the economic, environmental and social costs of different services and develop pricing policies, which ensure the proper allocation of resources for the water sector.
- (q) reduce costs through improved operational efficiency, using benchmarking, development of water-loss reduction programmes, and improved work practices.

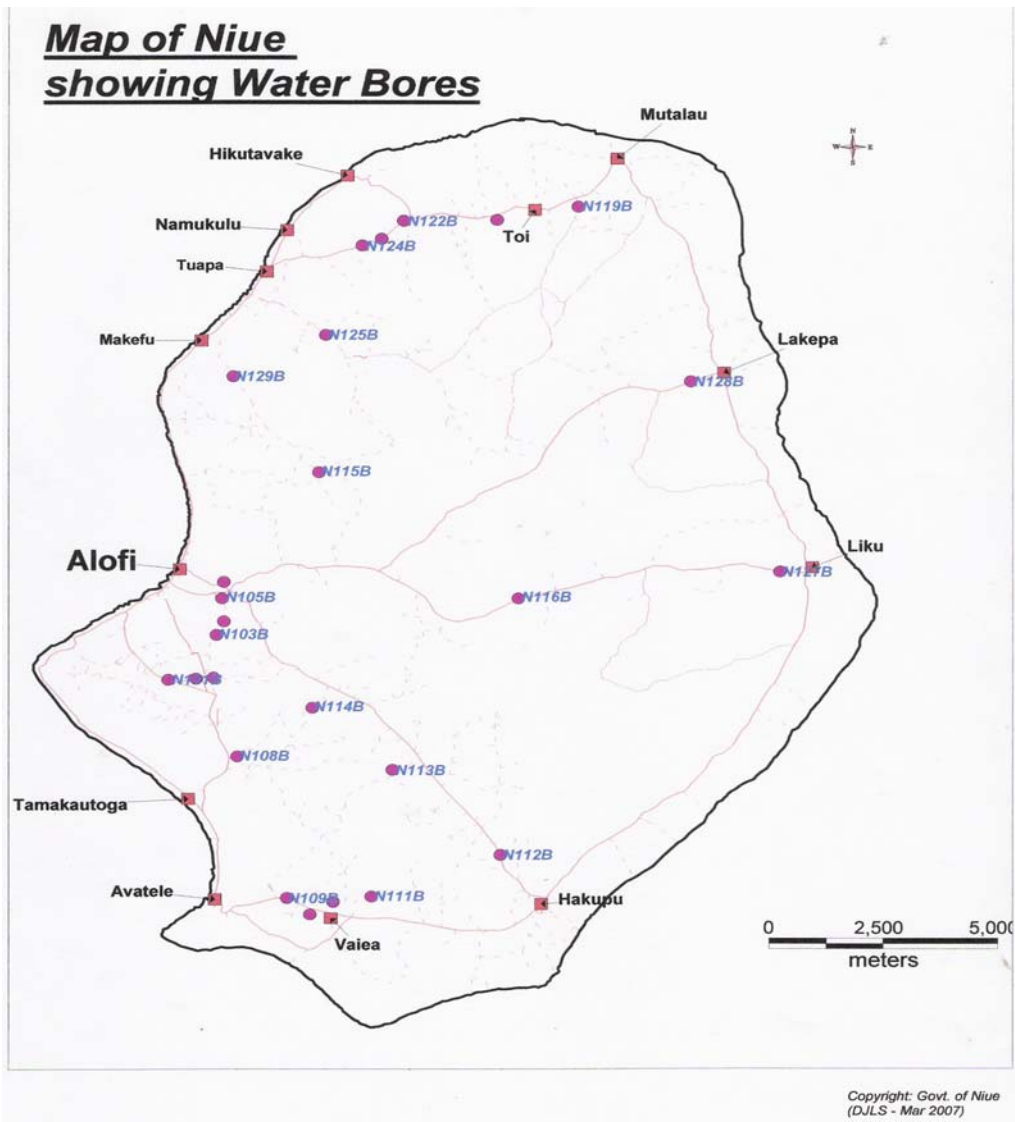
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ANNEXES

Annex 1: Map of Niue showing water bores



Annex 2: Map of Niue Showing Landuse



Annex 3: Monthly Rainfall on Niue: 2000 - 2006

Monthly total rainfall from Year 2000 - 2006

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Yearly total (mm)
2000	389	281	291	282	129	38	160	179	90	311	158	157	2465.0
2001	251	273	299	346	126	203	172	47	53	43	105	179	2097.0
2002	392	149	314	146	145	19	192	99	51	80	131	141	1859.0
2003	433	256	182	124	23	15	107	126	114	183	42	245	1850.0
2004	313	80	194	197	160	90	67	212	160	228	265	243	2209.0
2005	178	236	168	444	104	65	187	148	348	279	173	124	2454.0
2006	536	281	234	373	180	201	117	185	48	32	69	127	2383.0

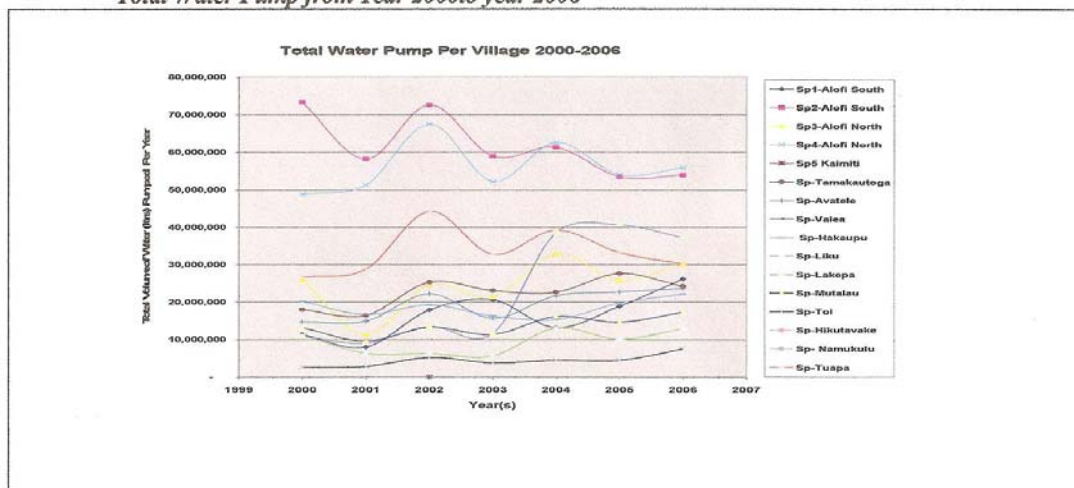
Monthly average rainfall from 2000 - 2006

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Yearly Average
2000	12.5	9.6	9.3	9.4	4.1	1.2	5.1	5.7	3.0	10.0	5.2	5.0	80.1
2001	8.0	9.7	9.6	11.5	4.0	6.7	5.5	1.5	1.7	1.3	3.5	5.7	68.7
2002	12.6	5.3	10.1	4.8	4.6	0.6	6.1	3.1	1.7	2.5	4.3	4.5	60.2
2003	13.9	9.1	5.8	4.1	0.7	0.5	3.4	4.0	3.8	5.9	1.3	7.9	60.4
2004	10.0	2.7	6.2	6.5	5.1	3.0	2.1	6.8	5.3	7.3	8.8	7.7	71.5
2005	5.7	8.4	5.4	14.8	3.3	2.1	6.0	4.7	11.6	9.0	5.7	4.0	80.7
2006	17.2	10.0	7.5	12.4	5.8	6.7	3.7	5.9	1.6	1.0	2.3	4.0	78.1

Source: Niue Meteorological Service

Annex 4: Water Usage

Total Water Pump from Year 2000 to year 2006



Village Bore Pump	2000	2001	2002	2003	2004	2005	2006
Sp1-Alofi South	11,318,000	7,947,000	17,832,000	20,542,000	13,078,000	18,826,000	26,105,000
Sp2-Alofi South	73,203,000	58,081,000	72,518,000	58,840,000	61,245,000	53,387,000	53,811,000
Sp3-Alofi North	25,942,000	11,186,000	24,616,000	21,225,000	32,788,000	25,794,000	30,000,000
Sp4-Alofi North	48,802,000	51,241,000	67,418,000	52,154,000	62,528,000	53,909,000	55,846,000
Sp-Tamakautoga	17,900,000	16,360,000	25,210,000	22,970,000	22,550,000	27,600,000	24,190,000
Sp-Avatele	14,670,000	14,834,000	22,121,000	15,617,000	21,570,000	22,630,000	23,590,000
*-Sp-Valea							
Sp-Hakaupu	20,120,000	16,610,000	19,160,000	16,220,000	15,223,000	19,667,000	22,089,000
Sp-Liku	10,996,000	6,366,000	6,293,000	5,645,000	13,030,000	10,058,000	12,839,000
Sp-Lakepa	10,857,000	8,983,000	13,384,000	11,521,000	38,482,000	40,615,000	37,179,000
Sp-Mutalau	13,140,000	9,521,000	13,196,000	11,299,000	16,044,000	14,544,000	17,239,000
Sp-Toi	2,640,000	2,870,000	5,255,000	3,852,000	4,569,000	4,540,000	7,511,000
*Sp-Hikutavake							
*Sp-Namukulu							
Sp-Tuapa	26,550,000	28,720,000	44,170,000	32,630,000	39,150,000	33,170,000	30,110,000
Sp-Makefu							
Total	276,138,000	232,719,000	331,173,000	272,515,000	340,257,000	324,740,000	340,509,000

Table of water pump in Litres per year. (* village pump without meter)