IWRM

NIUE

FINAL DRAFT

SUSTAINABLE INTEGRATED WATER RESOURCES AND WASTEWATER MANAGEMENT PROJECT IN THE PACIFIC ISLAND COUNTRIES: NIUE

812261

IWRM DIAGNOSTIC REPORT

Prepared by A Levi
VakaiNiue Consultancy Services
&
Andre Siohane,
Manager Water Division,
Public Works Department, Niue

613361

Table of Contents

ACRONYMS

614461

AUsAid	Australia Aid International Development
CBD	Convention Bio Diversity
CBO	Community Base Organisation
DAFF	Department of Agriculture, Forestries & Fisheries
ENSO	El Nino Southern Oscillation
FAO	Food Agriculture Organisation
GIS	Geographical Information 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
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
UN	United Nations
UNFCCD	United Nations
UNFCCC	United Nations Framework Convention to Climate Change
WHO	World Health Organisation

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, since drawing water from underground source adopted a sectoral approach to managing this natural resource.

Niue, over the years have 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 recognized 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 PICs, sharing the same constraints with the assistance of regional organizations such as SOPAC, agreed to approach donor agencies for assistance. For the last 3-4 years a programme of strategies was set in place to mobilize assistance, which is the result of this diagnostic report.

It was through donor assistance in bringing together key personnel from respective PIC's for dialogue and consultation resulting in the formulation of the 6 thematic areas as the baseline to launching the integrated approach to managing water resources in a sustainable manner.

However, before Niue and other PICs mobilize the integrated approach to water management common areas were identified regionally as baseline objectives to facilitate the 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 of which Niue is a signatory to that plan as executed in Sigatoka, Fiji in August 2002:

Niue needs:

(a) to strengthen its capacity to conduct water resources assessment and monitoring as the key component of sustainable water resources management.

(b) to formulate and implement strategies to utilize appropriate methods and technologies for water supply and sanitation systems.

© implement strategies to protect watersheds and the remaining forest from further depletions, which included the identification of critical habitats other than the Huvalu Conservation area.

(d) to strengthen capacity development to enhance the collection and application of climate information to cope with climate variability and change.

(e) to promote the change paradigm for dealing with island Vulnerability from disaster response to hazard assessment and risk management, particularly in IWRM.

(f) to 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 waste water 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 training regional programmes resulting in sustainable levels of skills and knowledgeable people within water and wastewater management.

616661

(l) to work together through a comprehensive consultative process, encompassing good governance, to developed shared national vision for managing water resources in a sustainable manner.

(m) to 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) to identify, promote an appropriate institutional arrangements and resourced sufficiently to enable effective management of water resources and the provisions of appropriate water and wastewater services.

(o) to develop and recognize national leadership in water resources should be encouraged.

(p) to 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) to reduce costs through improved operational efficiency, using benchmarking, development of water-loss reduction programmes, and improved work practices.

WATER RESOURCE MANAGEMENT

GoN is undertaking a restructure of 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 for the last 3-4 decades. This will be the opportunity to integrate the NGOs, Civil Society and all stakeholders in the process of the water and waste water management. The strengthening of the national capacity will enhance efficiency to deliver the require services by the public institutions, but also the awareness of the community on the sustainable use of water as a finite natural resources.

Niue needs:

(i) to implement actions to strengthen national capacity (equipment, training etc).

(ii) to train more technicians in the field of hydrological, water management, quality testing, and other related areas.

(iii) to strengthen and enhance communication and information exchange between national agencies in the field of meteorological, hydrological, water quality, data collection department and the users.

(iv) to 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) to build security fences to protect the reservoirs and bore sites.

(vii) to source funding to import tanks or build concrete tanks here to capture rain water as another source of portable water.

(viii) to encourage users to contribute by way of conserving water so to reduce the related costs.

ISLAND VULNERABILITY

Niue itself is vulnerable to natural disasters such as tropical cyclones given its geographical location in the pacific ocean. Its porous soil formation as indicated by various past investigations, the latest in 2004-

2005, that protection of the under ground fresh water source, is a responsibility of all concern residents as users. Continuous concerted efforts by the GoN and all water users to ensure that surface development activities, regardless of potential economic and financial gains do not contaminate the aquifer thus enforcement of the existing mechanisms and laws are inevitable. In addition the strengthening of human capacity through training to understand the impacts of development projects and to effectively enforce EIAs. This includes strengthening the inspection requirements under the Building code in the designing and installation of septic tanks for house holds and tourist accommodations.

Niue needs:

(i) to 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) to continue quality monitoring practices following WHO standards.

(iii) to continue to work together with climate information services in the region, however the current capacity be strengthen to enable the ongoing development analysis, forecasting and application tools; and including the participation of stakeholders.

(iv) to continue to develop rainfall and drought monitoring and prediction methods, including technology transfer.

(vi) to 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) to develop a drought plan is required,

(vii) to develop safety standards for fishing boats require refueling at the wharf to minimize the associated risks, and

(ix) to undertake EIA as a pre- requisite 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 own by the community. The active participation will actually change the mindset of everyone in the community to actively recognize water resource as a necessity for all forms of life. The driving force of this campaign will be the Community Affairs and Water Division in partnership with NGOs.

The setting up of a participatory framework, community participation as an empowering tool would lead to community ownership and sustainability of water resources. This includes strengthening the capacity of NGOs, CBOs and departments to disseminate information on sustainable water resource and wastewater management effectively. NGOs 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 and radio programmes, schools programmes, women and youth activities.

Niue needs to:

(i) support the establishment of a regional water education fund accessible to by government agencies and NGOs, 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 strengthening of teachers to provide water education.

618861

(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 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 recognize qualification.

TECHNOLOGY

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

Niue needs to:

(i) strengthen the capacity of the institutions responsible for monitoring of demand, quality and collecting data including the inspection role under the Building Code.

(ii) clearly define the responsibilities and roles and to review and activate the waste water management policies.

(iii) to provide continuous support to replace the GIS database at Justice department.

(iv) replace the GPS monitoring system at Justice department.

(v) strengthen gravity system and reduce pumping power cost and explore are sources other sources of renewable energy source suitable for Niue.

(vi) review the Waste Management Action Plan to include new proposals before implementation.

(vii) identify appropriate equipments and technology.

INSTITUTIONAL ARRANGEMENTS

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 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 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 centralize all related functions and resources whether 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; 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 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 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 the existing institutional arrangements of key personnel in Foreign Affairs, Treasury, EPDSU and Environment Department involved on MEAs.

(vii) to 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; continue dependency on government for all related activities rendered 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, 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

The IWRM approach encapsulated 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 generation. 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 does not confine to water resource management but it integrates with other areas that facilitates and contributes to the social, economic, and environment wellbeing of Niue. Under these three pillars are the land use and agriculture, health and hygiene, including ecosystem and habitats, and watershed and coastal management.

Agriculture remains the most important land-use on Niue, and it has over the years went through changes from slash and burn method of cultivation to using the bulldozer now as the means of clearing land for planting various crops for subsistence. Kumara, copra were the export crops in the 1960s; followed by passion fruit and limes in the 1970-1980s; taro was the focus in the 1980s until 2005, but recently reduced due to less volume produced. For the last 3-4 years nonu and vanilla has been seen as the crops for export; growers 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 to continue using is likely to pollute and contaminate the aquifer. Evidently, it does have negative impact on the terrestrial and coastal habitats and ecosystem.

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 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-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.

The impact of human activities are irreversible, hence continuous monitoring through the collection of respective data do assist with the decision making process.

ACKNOWLEDGEMENTS

I would like to acknowledge and thank all people who take time off from their busy schedules to participate in the interviews, the national stakeholder consultations and contributed to the discussions on how they see the existing and current situation in Niue's water and wastewater management regime including suggestions on improvements.

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

SUSTAINABLE INTEGRATED WATER RESOURCES AND WASTEWATER MANAGEMENT PROJECT IN NIUE

1. Introduction

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

Niue adopted a sectoral approach to water resource management which prevails to day. This leads to fragmented and uncoordinated development and management of resources, and having recognized the deficiencies, Niue needs to accept to adopt the integrated approach to managing water as a finite natural resources.

Regional consultations for the last 2 years, guided by SOPAC, agreed to the following themes: Water Resource Management, Island Vulnerability, Awareness, Technology, Institutional Arrangements and Finance. These themes are to guide the introduction of IWRM to Niue

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 such 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 maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital eco-systems including the needs of our future generations.

There will be challenges however, the acceptance of IWRM with the users and stakeholders involvement and participation in the decision making process, decisions will be based on available data and evidences collected. The continuous building and strengthening of capacities will minimize the impacts and the compelling challenges.

IWRM is a process of change, which seeks to systematically shift from the current sectoral approach, has no fixed beginning with no ending. Niue's existing situation, with the assistance from the Regional Institutions through the implementation of the PIC project, Niue stands to gain enormously. And such gain will be seen in the efficient delivery of services, management of the environment given the scarcity of resources, financial and human, it is important to maximise the economic and social welfare not only derived from water resource base but also from other economic development projects in other sectors as determined by Government thus: tourism, agriculture and fisheries.

The promulgation of a National Water Vision focusing on sustainable integrated water resource management and waste water 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 is 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 there had 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"[1]. The Water Resources Act 1996 sets out the policy and guidelines for extraction, supply and use of water the aim is to provide a quality potable water supply to all residents. In the Cyclone Recovery Plan the focus on the water resources is to increase the reliability and quality of water to all sectors.

[1] GoN Integrated Strategic Plan 2003-2008

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, 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; Convention of the Prohibition of Fishing with Long Driftnets in the South Pacific.

Thus 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 manage.

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.

PWD for the last decade has been responsible for all water reticulation programmes hence water related issue falls under its domain: thus the various Water Management related issues are automatically being combined with reticulation and housed at the Water Division at PWD. Understandably, limited human and financial constrains, resources available are being shared, a barrier that affected 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 in national development plan, for the management of water as a natural resource that has cross cutting impact on all and every sectors, with a national plan to embrace all the strategies in a coordinated manner, promoting the water profile at all levels of society, with resulting in strengthening the capacity and awareness of all related institutions including Water Division of PWD.

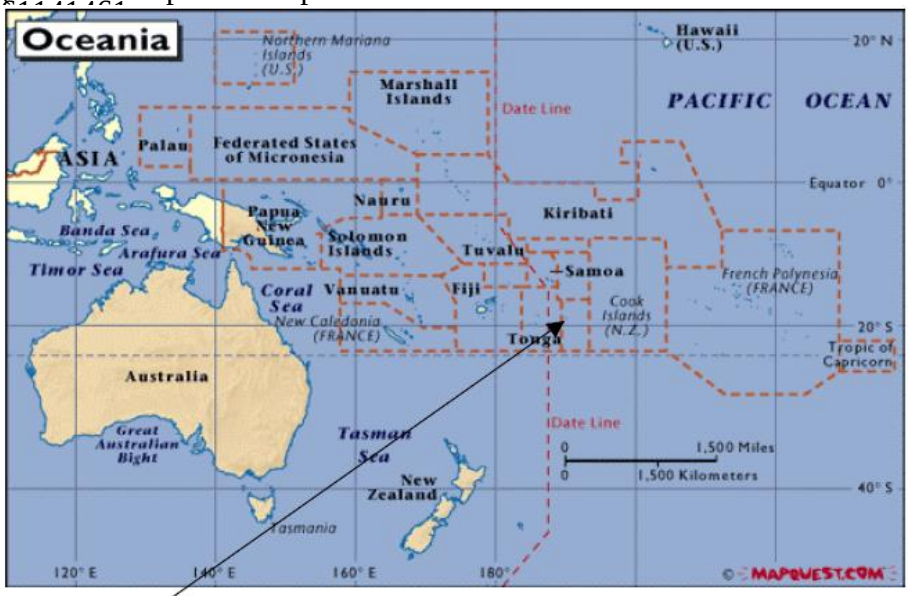
Proposals for capacity building and training of human resources, at various levels, to strengthen monitoring and maintenance of the water infrastructure, though proposal has been submitted, it should have been highlighted as a priority thus, attracting caliber students.

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

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

2. OVERVIEW OF NIUE

(Oceania Map/Niue map



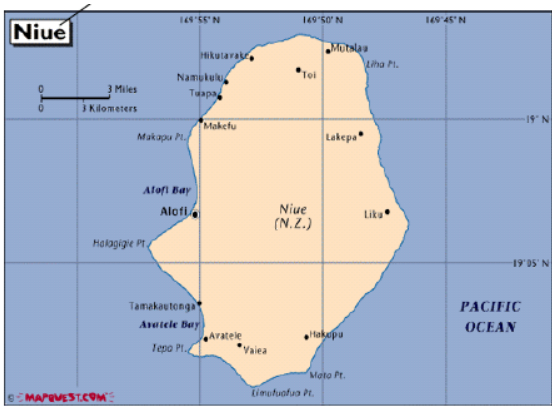


Fig 1 Niue Location in Pacific Ocean

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 radio activity. 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 chasms[2].

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 correctly that Niue is an uplifted high carbonate island with a land area of approximately 259 square km lying at 19° S, 169° W in the Central South-West Pacific (Fig 1). It has a 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 limestone below sea level (Terry and Nunn 2003)[3] underlain by caldera-shaped volcanic structure[4] (Schofield, 1959).

Hydrogeology

[2] 1993, Niue State of Environment Report, SPREP
[3] 2004, Mosley L & Carpenter C; SOPAC Technical Paper; Niue Coastal Water Quality and Groundwater Resources Assessment
[4] ibid.

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 662mm/yr), suggests that over the freshwater lens area (defined at this time as the full island area (259 km2) less a 1km strip around the coastline (50-60km2)) of 200km2, 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 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 2000m3/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 has widely interpreted as an up thrust atoll reef and a former atoll lagoon centre (Schofield, 1959[5])

Chasm existed 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)[6] which has subsequently undergone extensive dissolution. Most contain springs and issues.

Soils

The coral atoll origins of Niue has 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.[7]

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 or wet season from December to March and the cool and 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, which account for 68% of the total annual rainfall. At this time both temperature and humidity are high, with average temperature at 27◦ C. The cool season is characterised by warm sunny days and cool nights, with temperature averaging 24◦C. Annual average temperature does not vary greatly through out 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.[8]

National disasters

Niue is prone to the devastating effects of cyclones. Significant damaging have occurred on average once every 10 years, the most recent being, cyclone Heta, 5 Jnauary 2004, classed as a Category 5 on the Saffir-Simpson scale, with winds up o 300kmh.

[5] ibid
[6] ibid
[7] 2001, Niue National Biodiversity Strategy and Action Plan
[8] 2006, Pacific Adaptation to Climate Change, Niue Island, Report of In-Country Consultations

Vegetation
61161661
Seven types of vegetation are currently recognized comprising fern and cropland and littoral shrub land, littoral forest, coastal forest, matured forest and secondary forest, grouped as natural vegetation.[9]
Agriculture
Agricultural technological advances saw a shift from the traditional landuse practices of slash and burn techniques with and average fallow period between 7 to 10 years, to an increased reliance on agrochemicals. These changes to the land use practice resulted in significant reduction of the fallow period, 3 to 5 years; clearance and use of primary forest and less fertile areas of the island – areas which were inaccessible prior to the mechanized clearance with bulldozers; reliance on fertilizers to increase crop production; increased used of trash burning; and 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 also poses a contamination threat to Niue's water 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 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 with developing countries and 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 1707 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 the 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 2006[10].

Niue's Human Development Index (HDI) of 0.87[11] 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 per cent between 199 and 2003[12]; 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% which 18.3 % are self employed [13].The economy is supplemented by subsistence agriculture, fishing and eco-tourism. Current development policy 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. The Tropical Cyclone Heta in January 2004, significantly impacted Niue's economy with an overall estimated damage of over US $40m[14].

Some 64% of the island is covered in forest. This is estimated to be a decrease from about 86% forest cover in the 1950s[15]. Clearance for agriculture is the main reason for forest loss, especially when the introduction and use the bulldozer is permitted. Government in the 1960s harvested timber for local use, 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

[9] 2001, Niue Biodiversity Strategy and Action Plan
[10] GoN Statistics, EPDSU
[11] 2003, Good L, Poverty in the Pacific, DG Development, European Commission.
[12] GoN Statistics, EPDSU 1999-2003
[13] GoN, Statistics 2005 Employment, EPDSU
[14] 2004, GoN National Impact Assessment of Cyclone Heta.
[15] 2004, GoN National Forest Policy Statement for Niue

side of the island. This 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. As such 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 662mm/yr), suggests that over the freshwater lens area (defined at this time as the full island area (259 km2) less a 1km strip around the coastline (50-60km2)) of 200km2, 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 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 2000m3/d represents less than 2% of the fresh water lens yield and therefore is safely within its capacity to sustain these flows.

Groundwater water monitoring throughout the next year 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.

The analysis of the rainfall and climate data has shown that recharge is limited to six months of the year (between Dec- Apr) with six months of the year being devoid of recharge (Jun –Nov). 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 yet is gathered, preliminary monitoring of the freshwater lens in the middle of the island suggests that the lens may reduce by 3-4m over the dry season period. Given the lens is some 40m 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 a 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 tha 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 (30-60m 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 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. However, as stated earlier in this section, preliminary monitoring of the end of 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 turn suggests the lens is not susceptible to drought (as articulated above).

However 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 however 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;
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.

Currently Niue is implementing monitoring system already in place however there need to be drilling of extra holes specifically for monitoring in order to provide more understanding of the underground water sources. At the stakeholder consultation it was raised that drilling extra holes may lead to some risks in the future especially frequent tremors are being noted, unless these extra holes are strategically located.

It is considered that the amount of the underground water sources will not be exhausted, it is still plenty and the introduction of a desalination system is not yet warranted. However, the fish processing factory has installed a desalination plant but it is inoperable due to cost factor.

There is limited amount of bottled fresh water is imported for sale from New Zealand as alternative source mostly catering for tourists.

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

3.1.2 Types of fresh water uses

Approximately 85% of water pumped from the underground lens is used for domestic purposes, 10% for agricultural use and 5% for commercial and industrial usage[16].

The 2006 figures given by the Water Division, PWD showed that 80% for domestic use, 15% for agricultural use and 5% for commercial and industrial use; an increased in agricultural use is seen.

Niueans in the past were encouraged to build water tanks as catchments to harvest/capture rain water thus to supplement the public system, to cater when there is a cyclones including time when there is

[16] 2004, An overview of IWRM in PIC: A National and Regional, SOPAC.

power failure. All new houses build under the Building Code, water tanks is a compulsory requirement as part of the 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 the supplementary source ought to be vigorously pursue. Rainwater harvesting at the village level and at household level, would provide a back up source, as reserve tanks, with the capacity not only to cater during disasters and when power cuts, but for daily use as well. There are unused reservoirs in villages that structures need assessing for reuse. Harvesting the 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 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, be discused. To monitor and implement this levy process, meters should be installed in all households and level of levy paid is 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, originally initiated due to fish poisoning outbreaks and fish deaths, confirmed a high nitrate and phosphate concentrations. This is believed to be caused by inadequate wastewater treatment primarily from septic tanks draining into the groundwater regime. This 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 Health should be undertaken.

The tourism sector is now pushing to increase the annual number of tourist to 2000 per annum[17], such targeted number is more than the existing population level and would certainly stretched the resources and the providing of services to residents as well.

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

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

The increase in the number of fishing vessels requiring large volumes of ice for fish preservation and drinking whilst at sea free should not continue indefinitely under present arrangements. Although the Fish Process Factory has a desalination plant for its own purposes, there is absent of a monitoring mechanism in place to ascertain the amount of water drawn out of the public water system.

Any logging at commercial level would affect the ability of Niue's watersheds; mining certainly will impact on water source and the environment. The continuous clearance, by bulldozer of the secondary forest, for taro plantations, needs to be re-examined for the contribution of such areas as watershed is vital to the recharging system of the lens including the maintenance of the habitats and the ecosystem, with the survival of future generations not to be compromised.

[17] Niue Tourism Plan 2005-2015

The whole island depends on water pumped from the underground lens for all daily life uses. 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 are- solid waste, septic systems, irrigation, synthetic fertilizers, weed killers, oil spillage and coastal sanitation.

An information exchanging mechanism existed between government institutions but unable to sustain due to costing and labour constraints.

There is very small amount of rainwater harvesting of about 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 2006) have significantly increased the understanding of the hydrogeology of the karstic limestone aquifer in terms of absolute quantification of the thickness of the freshwater lens of the middle of the island, and providing valuable insights into the aquifer bulk transmissivity, hydraulic gradients, and recharge and discharge mechanisms. (Refer Report for details)(Carpenter and Siohane)

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 ground water lens to land use 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 concerns recommended the following ongoing activities as high risks and warrant environmental protection:

- landfilling (both domestic and special waste)
- agrochemical and fertilizer 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.

Some of the concerns raised in this report have been actioned; the batteries kept at the Youth Center needs to be disposed of, the longer they remained there expose to elements, the high the risks.

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 quality data are continued to be collected.

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

Water conservation as a theme and/or an activity should be pursued at all levels of the Community, with the increase in economic development activities formulation of a strategy under the awareness theme is warranted and a priority. Huvalu forests, 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, ecosystem and food security. It acts also 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 also to protect the user, formulation of water conservation policies and include incentives are yet to be organized.

The Persistent Organic Pollutants programme coordinated and undertaken by DAFF in association with UNDP and GEF concluded that Prevention pollution programme, shifting hazardous chemicals abroad for storage; the programme was success and popular to the community and its awareness of the associated dangers.

Land Management and Resource Use Plan Unit, housed under Justice Lands & Survey no longer functioned due to human and financial resources constraints.

During the duration in putting together this report, a joint mission of three professionals from SOPAC and WHO undertook 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 and testing the quality of water including the provisions equipments need strengthening. From this mission, a water safety plan will be formulated.

Niue needs:

(i) to implement actions to strengthen national capacity (equipment, training etc).

(ii) to train more technicians in the field of hydrological, water management, quality testing, and other related areas.

(iii) to strengthen and enhance communication and information exchange between national agencies in the field of meteorological, hydrological, water quality, data collection department and the users.

(iv) to 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) to build security fences for the protection of reservoirs and bore sites,

(vii) to source funding to import tanks or build concrete tanks here to capture rain water as another source of portable water, and

(viii) to encourage users to contribute to reticulation and maintenance costs.

3.2 In 2006, NIUANGO as an umbrella association for NGOs has been reactivated, and its Executive

Island Vulnerability

There 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’ small size, geographical remoteness and exposure to climate variability/instability is noted under the vulnerability definition. This is one major concern facing Niue, and it should receive particular attention, by its decision makers, and it be noted that this 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 hence it can have significant and cumulative effect on the rate and nature of development. It needed to be borne in mind by all levels of the community that Niue’s vulnerability ought to be emphasized, and be prepared for such intervention at all times.

Niue is vulnerable to the effects of ENSO[18] the worst drought from 1950 to 2006 was in 1983 attributed to the El Nino phenomena of 1982/83. The impact of the drought was severe, with people drawing fresh

[18] 2006,Pacific Adaptation to Climate Change Niue Island, Report of In-Country Consultations.

water out of caves[19]. The effect of the subsequent drought of 1997/1998 was not as severe as all 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.

61222261

Tropical cyclones are a serious hazards to Niue; the very high wind speed of tropical cyclones are often accompanied by extremely intense rainfall and storm surge that is likely to be 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.

Non-climate natural hazards/disasters, especially earthquake, although have low frequency for Niue, mindful of Niue's geographical location. Seismic activity which is unpredictable 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 improve prediction may improve in future and require development of risk management strategies.

There is a wide range of human hazards resulted from human activities which are capable of causing considerable harm to water source and infrastructure with negative impacts on water quality. To date Niue is fortunate, perhaps due to population level, though there will always be potential hazards, not to experience situations that may be harmful to water source and infrastructure, such as land disputes, land use and degradation 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 in the IWRM.

3.2.1 Types of disasters

Cyclones and hurricanes are common since the 1830s with severe recorded for 1915, 957, 1959, 1968, 1979, and very severe in 1990 and 2004[20].
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 refueling without safety standards being in place and observed.

The capacity of waste water 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 yet however installation of an instrument to cater for this area is expected to be done in the near future.

The worst drought occurred in 1983, the impact was severe thus Niue had to import taro and bananas (staple food) from Samoa. There may have been an assessment on the economic costs undertaken at

[19] 2004, Nemaia F, National Action Plan, Addressing Land Degradation and Drought
[20] 2000, United Nations Framework Convention on Climate Change, Niue Island Initial National Communication

the time but availability and access to such data is not possible for this exercise. The 1997/98 drought was not severe as all households were connected to the main water system drawn from the water lens. There was no data available to determine the actual impact on the watersheds and coastal management.

There maybe data exist 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 records can be 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 National disaster plan already in existence.

An investigation done in 2005 provided the information that the vulnerability of the fresh water 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 with developments that may be considered 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

Pollution represents the most important challenges in terms of land-based pollution on the quality of underground fresh water. Domestic waste is the major solid waste category produced in Niue. Waste management plan is in place and should be followed.

Although Niue's economic development activities is at a level that does not raise concern with water pollution, nevertheless, regular monitoring and quality testing cannot be relaxed, the mechanism for carrying out this function is already in place. The need to carry out EIA for all development projects is also vital to the protection of habitats, ecosystem, and the general welfare of the community is equally important. Human inactive will always be a concern.

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

Continuous use of paraquats a measure for controlling weeds needs to consider seriously including safe but effective alternatives; there are conflicting information received on its effects, but notably it destroys habitats and ecosystem, human health is somehow also affected. New Zealand has banned the use of paraquat since 1974 yet continues to accept the importation of such toxic chemicals to pacific islands, including Niue.

Intrusion of saltwater due to sea level rise may be an issue for Niue. However Niue do 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 is systematically and strategically placed at the threshold level of 60 meters from the surface (speed drawdown), level considered to be safe, to avoid drawing salt water if the level goes further down. The impacts to Niue on salt water intrusion on the lens, if Niue has no back up system in place will be extreme, compelling people 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 however 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 the internationally accepted practices.

The administration and regulating of EIAs for development projects needs to be strengthen, especially the legislation requirements as a compulsory pre-requisite before any development project takes place, and to follow with 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, as an additional component in the process of making compost after being treated in a proper made and operated facility. Niue soil is thin and poor and the usage of such wastewater would assist to grow quality vanilla and nonu and other fruit crops.

The continuous use of chemicals for weed control such as paraquat has to be totally banned. This is not Niue's problem alone but a regional effort through provisions in the Pacific Plan, given that paraquat has environmental degrading effects. However, the developments of safe and environment friendly alternatives should be identified, since almost all PICs are heading towards producing organically certified agricultural products. Organic tourism and eco-tourism is seeing as the alternative tourist attraction.

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

Niue needs:

(i) to 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) to continue quality monitoring practices following WHO standards.

(iii) to continue to work together with climate information services in the region, however the current capacity be strengthen to enable the ongoing development analysis, forecasting and application tools; and including the participation of stakeholders.

(iv) to continue to develop rainfall and drought monitoring and prediction methods, including technology transfer.

(vi) to 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) to promulgate a drought plan is required,

(viii) to build a proper facilities to treat waste from septic tanks for compost use,

(ix) to develop safety standards for refueling boats at the wharf to minimize the associated risks, and

(x) EIA is required as a pre- requisite 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 in all levels thus: developing a profile on water is required to change the mindset of everyone in the community to actively recognize water resource as a necessity with economic value, and to push water to the fore front of priorities from its current position. Water is a critical component of which 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, 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, 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 sustainable water resource and wastewater management. NGOs 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 and 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 gabs, allowing the change of paradigms process to take place.

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

Access to information on sustainable water and wastewater management by all key stakeholders; improve the communication links and coordination of all stakeholders in sustainable water and waste water 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 source need to be protected from contamination.

Currently there is no awareness programme in existence in the community and schools.

An awareness programme was initiated by the Department of Education approximately 20 years ago for the Primary School level, focusing on water conservation and hygiene; it was build 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, organized and conduct 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 oppose 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 still continues promoting organic farming in its weekly radio sessions, focusing on economic, social and environmental gains.
Committee has included in its activities a water awareness programme amongst other issues. The awareness programme would include the understanding of water rights of an individual, community including respective roles; the role of government is important to ensure that water as a resource with economic value, 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, 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 as a natural resource including conservation, 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, both in theory and practical. The creation of an awareness, through learning, which is absent at the moment, emphasizing on the importance of the hydrological aspects of water and as a natural resources, would motivate students to take up water resource management as a career. The practical aspects in terms of establishing weather station where students are encourage to keeps 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.

Water demand scenario prior to 1997 which exceeded the demand, caused by leakages in homes and management system at that time, should no be repeated. Regular house to house checks for leak taps and toilet cisterns should be carried out at the same time 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 passing the information and to enhance 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 for any sustainable economic development water is an inherent and major component to the success whether social, economic or environmental related. Management instruments must be in place.

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

It is noted that educational institutions in the region has no syllabus/training specifically tailored for water management and engineering with recognized 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 water lens as the only source of potable water, and it is vulnerable to various surface uses including potential contamination from logging and mining if Niue decide to engage in such activities. Most of the impacts from land use activities are irreversible.

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

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

Niue needs to:

(i) support the establishment of a regional water education fund accessible to by government agencies and NGOs, Civil Society groups to ensure effective community participation in sustainable water management' 61272761

(ii) develop a toolbox in association with SOPAC, donors, regional and international organisation 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 strengthening 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 partnership working relationship between all water users.

(viii) inform SOPAC to approach regional education institutions to develop courses in water engineering and management towards a recognize qualification.

3.4 Technology

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

The defining of responsibilities of various stakeholders with effective accountability mechanism put in place, providing enabling environment for dissemination of information culminating in reaching informative decisions resultant in enhance 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 PACTAF project various systems were improved thus: automatic control systems which reduce the replacement costs; minimize leakage. This includes capacity building, on the ground hands on vocational training for employees resulted in improving of skills. The PACTAF project provided a sound platform for the continued operation of the water supply. Much of the equipments were standardized and concerted effort to reduce household leakage reduced domestic water consumption by half. This resulted in saving in excess of $50,000[21] 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 Niue water supply system in the past, from karstic groundwater investigation to infrastructure upgrading and improvement. A 5-year National Water Development Plan was develop by a UN sponsored Civil Engineer under UN Department of Economic and Development auspices in 1992[22], however, during the process of finalizing the report and subsequent implementation, a government initiated reform of the public sector focusing on reducing the number of employees, and as a consequent, those affected migrated causing further decrease in population, unfortunately the report was not implemented.

[21] 2004, Davis S, Evaluation Water Reticulation in Niue

[22] 1992, Nwe NewNyo, 5 Years National Water Development Plan (Draft)

61282861
In 1997-2000, 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 organized 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; installation of automated water pumps providing 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, resulted in effective and easier for the public to obtain when required[23].

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

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 meters or so from each other then GoN is obligated to meet all reticulation costs.

It is uncertain with the actual consumption rate, but estimated in 2005 to be 350L/p/d [24]. This amount identified to have major impact on the total existing storage capacity of the water supply system, including water loss through leakage.

Table 1 Water Demand 2006

Total Population in 2006 (2006 Census)	1679 person
Total Visitors 2006	500person
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 Ltrs***
Total Demand for Agricultural Purposes for 2006	***17,809,499 Ltrs***
Actual Water Production for 2006 in Niue (water meters)	**356,189,978 Ltrs**
Maximum Capacity of Water Production for All Existing Water Pumps	**730,584,000 Ltrs**

Source Water Division PWD

80% of the water production for human consumption and visitors including loss/leakage15% for industrial and 5% for Agriculture purposes in 2006 15% for industrial and 5% for Agriculture purposes in 2006

With the current equipments and new system in place for the island water supply network and also for groundwater monitoring, limited human resource and finance is a constraint in maintaining such infrastructure and operations.

Table 2 Size of Reservoir & PopulationServe

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 Nov 2006	120	174
Vaiea	Irrigation tank relocated to Vaiea. Supply Vaiea and Talamaitoga residences	50	58
Makefu	Needs new roof & tank liner and rubber seals needs replacing. Not	90	25

[23] 2000, Green V, PACTAF Water Supply Project, Niue Island South Pacific.
[24] 2004, Davis S, Evaluation Water Reticulation in Niue, SOPAC

61292961	currently in use but if solar pumps become operational this tank will be needed		
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

Residents on the western are being encouraged to relocate further inland prompted by the devastation caused by tropical cyclone.

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

The defining of responsibilities of various stakeholders with effective accountability mechanism put in place, providing enabling environment for dissemination of information culminating in reaching informative decisions resultant in enhance 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.

Niue has a public water supply system; reservoirs are strategically located in some villages where 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 being connected to the public water system without any levy being charged to all users. During the 1980s the government paid for all connections up to about 20 meters to the household for those living within the recognized village boundaries with the remaining connections to the house and within the house met by the householders themselves. Householders were encouraged to include water tanks as an essential component when new houses are built. Recently, building of water tanks discontinued and not included as part of the building requirements as water is connected directly from the main line to the household, and as well as lack of appropriate equipments

Village reservoirs are not treated however householders and visitors are being encouraged to boil water for drinking at all times. Health department have a water softening system for equipments only to give longer economic life.

There are 30 bore pumps in total, 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, awaiting the appropriate pumps, since most of them are located away from the main power grid, it is envisaged that alternative energy source will be used. (Refer annex for location of bores)

Water demand Management-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 defining respective responsibilities but 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 are being used for waste and waste water storage for each household; when these household tanks are full, a special truck upon request comes and pumped out the septic tank, with $50.00 fee required from the householder; wastewater is disposed on open land. Disposal of wastewater on open land is on the basis of low number of house holds, however in the event of household increase than a proper system is warranted. The management of Waste collection and disposal are covered in the Waste Management Plan.

The Community Affairs department expressed interest to take over the waste management related responsibilities under community development regime.

3.4.3 Major issues and concerns

The current supply of water meets the demand, domestic, industry and agriculture. 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. In order to achieve a non leakage situation, this is subject to both human and financial resources are major concern respectively, this leads to inactivity, which includes performing monitoring and data collection responsibilities. Financial availability is subject to government budget which includes the development of skilful human resources.

The 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 resources both human and financial. 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, as indicated in the Niue Waste Management Plan, including recommendation. The risk associated to human health and to the ecosystem welfare needs immediate addressing.

Assessing of the household septic system whether all systems meet the standards, especially water-sealed latrine needs undertaking urgently, including the strengthening 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 move would be detrimental to and causing conflict with the watershed recharging system. The re-examination of the proposal should include the determination and identification of the actual areas labeled 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 wastewater policies is subject to the political support, including the capacity and/of institutional arrangements.

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

The GIS system, before tropical cyclone Heta, was based at the department of Justice Lands & Survey on the basis of the existing technical expertise including the linkage to the land management system already in place and available. Justice organized training for the users of the information under premise

that the users of the information collect their respective data and transferred to the GIS database. Justice than incorporates 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 collection of information of the critical habitats, the watersheds, and other equally important and useful 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:

(i) to 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) to clearly define the responsibilities and roles and to activate the waste water management policies.

(iii) to provide continuous technical support on GIS database at Justice department.

(iv) to 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 equipments and technology.

(viii) to provide capacity building.

3.5 Institutional Arrangements

A Water Resource Act came into force in August 1996, enabling government to introduce Regulations for the enforcement of the legislation, unfortunately 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 on water reticulation additional coordination responsibilities were automatically absorbed under the water division, stretching its limited resources; it became the focal point for outside donors.

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

The Environment Act 2003 followed, legalizing the establishment of the Department of Environment. One of the requirements under this act is to establish a National Council for Sustainable Development, unfortunately up until now government has not seen the need to create this national body. The creation of National Council apart from its advisory role, will be able to promote 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 centralize 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.

The integrated water resources management (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 recognizes 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 recognized 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 Strategic Plan 2003-2008 to integrate and promote a National Water Vision. The determination of the vision, will articulate to the fore front strategies that would guide the direction that water resource management and waste water management would take, at the same time embracing IWRM approaches, it would also dove tail 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, is yet to be appointed. However, to facilitate the progress of the IWRM, PACC and other water related project to continue to the next stage, Cabinet identified, but not yet formally approved, a National Water Working Committee. The Committee comprised of:

- Director of PWD, Director Meteorology, Director Environment, Director DAFF, Climate Change Coordinator, Water Division Manager, Officer EPDSU, NGO Representative and Senior Health Inspector, with the following roles and functions:
    1. The working group to discuss and to 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 to be submitted to Cabinet Ministers meeting for endorsement.
    5. Discuss water related activities within departments and also 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 depends on urgent matters require to be addressed.
    8. Other staff members from relevant departments can be invited to sit in in 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 Government is in the position to appoint a National 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 premise that the contents needs reviewing before resubmitting to Cabinet for approval and tabling in the Legislative Assembly, subsequently publicise in Niue's official gazette.

Apart from the Environment Act 203 and the Water Act 1996 the following legislations touched on water and waste management:

- Atomic Energy 1945-The mining process covered in the act include 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 o 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 made 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 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;
© 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 ranging from 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 require resources together with the 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.

There is no policy statement formulated however, Niue viewed 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 the lack of resources is the barrier.

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

61343461

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 loose 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 Foreign Affairs division, Treasury, EPDSU, Environment and the implementing agencies. All these institutions have essential roles and responsibilities to effectively administer the MEAs. The harmonization of responsibilities will assist Niue in submitting of 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 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 yet governments 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 the environmental management;
- The coordination of water resources planning with that of the user sectors;
- The coordination of the water resources management with that of land use.

The selection of a Committee under the existing legislation need to be actioned, providing a leading role with the development of water policies, formulation of a strategic plan, 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 coordinated; all sectors compliment each other rather than competing for limited resources.

The gaps and duplication in existing legislation needs to be looked at and to include areas not yet covered and to strengthen areas seen to be weak and repeal areas not appropriate for present day water resource management.

Institutional strengthening through upgrading of skills in related

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 ground water falls under the Crown. However, as ground water 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, captalising on Niue's commitments to MEAs, certainly will assist Niue with its development aspirations.

3.6 Measures to manage impacts and concerns (IWRM approaches)

Niue needs:

(i) to 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) to select Committee under existing legislation

(ii) to 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) to develop 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.

(iv) to 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) to develop national guidelines on wise practice approaches to assessing and managing water and wastewater system requirements that incorporate sound environmental health principles.

(vi) to strengthen and harmonise the existing institutional arrangements, functions and roles of key personnel in Foreign Affairs, Treasury, EPDSU and Environment Department including the implementing agencies, in the administration of MEAs.

(vii) to 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, creating a better understanding on the roles and responsibilities thus identify 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 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, availability of financial and human resources, principles of good governance; continue dependency on government for all related activities 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

Table 3 Niue Annual Water Expenditure

Year	Annual amount	Total Budget	% 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.

Water Division annually competed for funding from governments annual estimates of expenditure; since 2001 the amount approved is always less than 2% of the total budget. This is to cover all water related activities, leakages, including electricity for the bores. There is minimal direct revenue collected (Table 3). It is noted that since the AusAid/PACTAF project cost of the power bill has been fluctuated, this is due mostly to lack of resources to sustain the detection of leakages and undertaking of maintenance work programme. This annual expenditure will increase as more development activities and intensive use are factored into the equation.

Table 4 Donor Assistance

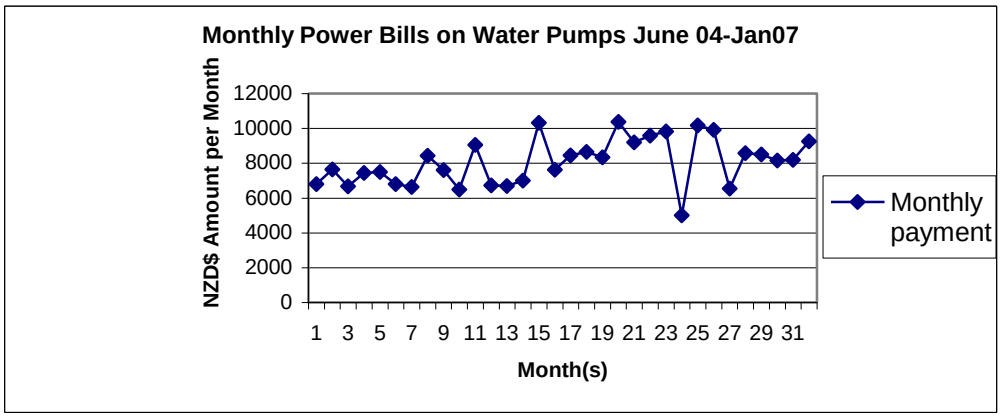
Organisation	Past	Present	Intended	Amount $	Purpose
AusAid/PACTAF/ GoN	1997-2000	-	-	561,186.00 224,300.00	Water supply
NZAid	2005-06	-	-	277,000.00	Bores: 6 irrig 3 moni, 4 consumption
Oxfam	2004-2005			12,000.00	Equ, upgrade tanks Vaipapahi, Namukulu
UNESCO	2005-06			26,000.00	Underground assessment
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

Table 5 Electricity and Power bill

61373761

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

Funding is also sourced from donor agencies either direct or through a regional organization.

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 is currently being considered taking into account Niue's financial situation.

3.6.2 Major issues and concerns

61383861

GoN has identified three industries to focus Niue's development efforts thus: tourism, agriculture and fisheries. All these industries use a lot of water. There is absent of a mechanism to monitor how much water is being use in all sectors; there is no 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 with the balance to meet personnel emoluments leaving insufficient amount for other important activities, such as maintenance of equipments, monitoring and collection of data, human resources development and recruitment, and the development of public awareness programmes etc.

Generally there is a lack of capacity and expertise in the water sector both in public and private sector. The number of trained personnel in the water resource management, water quality monitoring, waste water management etc is very low given the importance of water to all lives. Although the plumbing responsibilities were transferred to the private sector, the public is still requesting Water Division personnel to attend to their household problems.

There is no commercialization in the water sector.

The existing financing arrangements with donors, seems to work well with limited difficulties. The difficulties being envisaged is the process of all stakeholders acceptance to change of paradigm. 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 the reduction of waste through leaking taps etc.

3.6.3 Measures to manage impacts and concerns (IWRM approaches)

Niue needs:

(i) to enforce the Water Act 1996, improve regulatory oversight including sector governance.

(ii) to develop sector master plan to identify funding and cost recovery requirements and benefits, in terms of improving health including poverty alleviation objectives.

(iii) to identify potential benefits of partnerships such as joint ventures.

(iv) to improve demand management.

(v) to develop tariff policies and structures to generate revenues to meet financial and cost recovery policies.

(vi) to establish sound asset management procedures and funding, including operational and management practices.

(vii) to increase consultation and awareness to support cost recovery

4 Linkages to other areas

4.1 Landuse and Agriculture

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

In the mid 1980s all customary lands where bores are located were surveyed and titled so to facilitate leaseholds, ensuring that land owners do not use the lands within 100 meters from the bore site for any purposes, such as residential uses, piggeries, burial grounds and food crops. The aim of surveying is two fold – for leasing the land on the basis of denying landowner access to the land and not water as a resource; and to ensure that the water lens is protected from likely contamination and pollution. The

monitoring of this policy was not well managed however those who are mindful of the consequences acknowledge and accepted the policy. In 1990s with the change of government the 100 meters buffer zone was change to 20 meters and all bore sites are surveyed with ownership determined and registered.

All graves are cemented to ensure that any matters from the decaying human body are not seeped down to the lens. The designing of septic tanks to capture and store wastewater is self treated on site and when pumped into a special truck for transfer to open land, the amount is regarded as low hence the practice.

After tropical cyclone Heta in early 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 “high risks area/zone”, 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 thus proper town planning is required to minimize potential risks to the watershed. There is plan to relocate all government offices to Fonuakula/Kaimiti area.

The DAFF in consultation with farmers recognized that unreliable agricultural water supply is a constraint that limited 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 government’s agriculture support services, to build capacity of Niue farmers and intensify and increase the import substitution agriculture to the island[25].

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

On the management side, including the monitoring protocols, installation of meters would take place with monitoring for water quality being carried out regularly. The basis of how these bores were located in relation to watersheds, were not clear and available other then the understanding that the location has no significant bearing on hydrological system, the deciding factor was on the farmers existing type of use of the land.

The irrigation technology scheme being adopted on the farms is a Drip Irrigation System (DIS), aiming to increase production at the same time save water. The dripping system means that the installation or the creation of a drainage system is not required; understandably the amount of water that drips from the system is adequate, ensuring that the crop/s fully utilized as water drips directly to the root system and limits the water wastage. Due to the porous soil context in Niue, remaining water not used by the crop seeps back to the lens or it is evaporated.

Currently there are only 10 farms registered under the DIS, there is 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 the rainwater for crop growth[26].

[25] 2007, DAFF, Termination Report Develop Irrigation
[26] ibid

The 10 farms selected for the DIS are also being regarded as the demonstration areas, to gauge the success in terms of productivity and the expected gains, the 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 constructions;

Direct and indirect discharge of sewage (septic tanks), grey water, solid waste, oil spillage from motor repair garages and at the wharf/port area, with the increase in number of fishing boats refueling without standards to observe and follow creates a very high risk.

The use of machineries to clear land for cultivation especially secondary forest areas impacts on the watershed, there is no control mechanism exists at the moment, which increases the risk on the abilities of natural watershed system of 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 the reduction cost.

4.2 Habitats and Ecosystems

The Huvalu conservation area, is the only formal recognized area, and included in this conservation area is the Community initiated “tapu/taboo conservation area, purposely set aside for food security more so it is a dedicated area of land/forest as a habitat for lupe, uga and peka, including other forest domicile species.[27]

There were two recognized marine protected areas (MPA) were set up, 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 Namukulu[28].

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 or practices to assist resource recovery; change in fish patterns so that fish are no longer easily available in some inshore area; and natural events-increased predation from other species.

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

Another area MPA is Ana, between Hakupu and Liku on the eastern side of the island, which complimented the traditional practices of placing a “fono/taboo” for duration of 1-2 years, whenever a death occurred in the families who traditionally dedicated this portion of land and sea as their hunting area[29]. Observation and respect of this tradition by all in the community, is always accepted.

The coastal ecosystems play a crucial role in the production and the maintenance of fisheries and other biological resources of primary importance for the human population. Although there are areas where coral reefs are undisturbed, they provide food and shelter for resident and migratory species play a protection role for property tropical storm damage and offers a store house for potential valuable species.

The impact of land use activities on coastal habitats is seen and amplified by what happened to one “Ana Vailahi” (Cave) a coastal area where the old Broadcasting studio was located, adjacent to the south east side of the wharf, this area in particular has zero species, coral, tube-worms, turbine etc is not found

[27] 2003, Tongatule,S; In-Situ and Ex-Situ Conservation Measures Niue, Capacity Assessment Report
[28] 2007, Conversation with Leolahi S, ex Coordinator IWP.
[29] 2001, Togiamana M, Ana Marine Reserve, In-Country Project Report.

there. An asbestos drainage pipe is used to drain water during wet season from the road into the cave, seeping through to the sea. Fuel, oil from roading and silt went through this drainage. After finding the negative results, fish poison in 2005, the drainage pipe is replaced with pvc made pipe and diverted out of the cave through an adjacent soil mount into the sea. The soil mount act as natural a filter hoping to dilute what goes through before it reaches the sea[30].

It is noted that there are springs of about 15 to 30 meters deep, 30-40 meters from the base of the cliff, from the Alofi to Avatele areas; oil has been seen in some of these springs in Alofi areas. The freshwater in these springs and as well as in caves provides drinkable fountain for sea snakes[31].

Another concern is the coral bleached found in Avatele and in Alofi prior to Heta, due to climate change, heat, sea current and the rise in sea level[32].

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 agricultural chemicals and waste,
- Inadequate land use practices,
- Pollution caused by land based sources (solid waste, toxins, siltation, agricultural run offs, oil spillage from refueling of fishing boats)
- Land tenure rights
- Unplanned developments
- Lack of control on forest clearance

Concern has been raised on the continuous use of chemicals as means of controlling weeds, and the irreversible harm it causes to the terrestrial ecosystem and habitats, which includes human health. Farmers noted the changes to the habitats and have talked about the effects but difficult for them to stand up and impressed 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 chemicals[33].

4.3 Health and Hygiene

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

Health department is formulating an Integrated Strategic Plan for 2007-2010 with a vision: “Niue to be the healthiest nation in the Pacific,” with 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, HIV, nutritional and fitness, non-communicatable diseases and other health related areas.

Improving every ones health embraced clean portable water thus regular testing for safety has been done for the last 10 years or so. Unfortunately all testing equipments were destroyed by tropical cyclone Heta in 2004. After the cyclone, testing of the underground water source was a priority whereby the military personnel from Australia upon arrival were requested to perform the testing, and it was found the aquifer remains safe. For precautionary measures a treatment regime was administered.

In 2004, under the 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

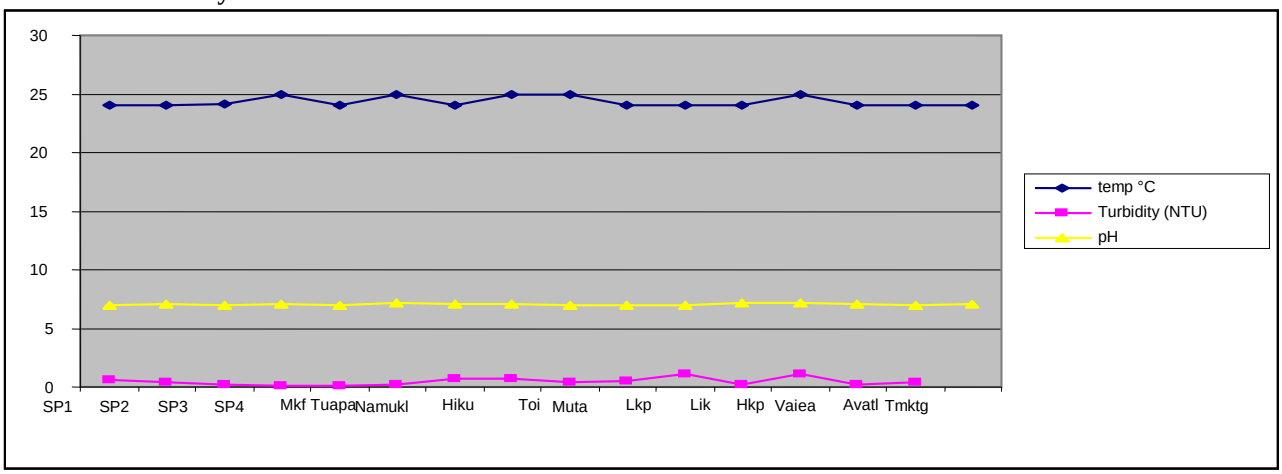
[30] 2007, Conversation with Leolahi S, ex-Coordinator IWP
[31] 2007, Conversation with Niue Dive Proprietors.
[32] ibid
[33] Conversation with local farmers

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."[34]

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 to the health of humans and the protection of the environment.

Water Test Results – October 2006 ***Locations:*** **Niue Bore Holes**

Table 6 Physical Parameters



Source: Niue Foou Hospital Water Lab

Table 7

	temp °C	*Turbidity (NTU)*	*pH*
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	25	1.15	7.2
Vaiea	24	0.25	7.1
Avatl	24	0.36	7.0
Tmktg	24		7.1

	Ammonia (NH3-N)	*Chlorine (Cl2)*	*Iron (Fe)*	*Manganese (Mn)*

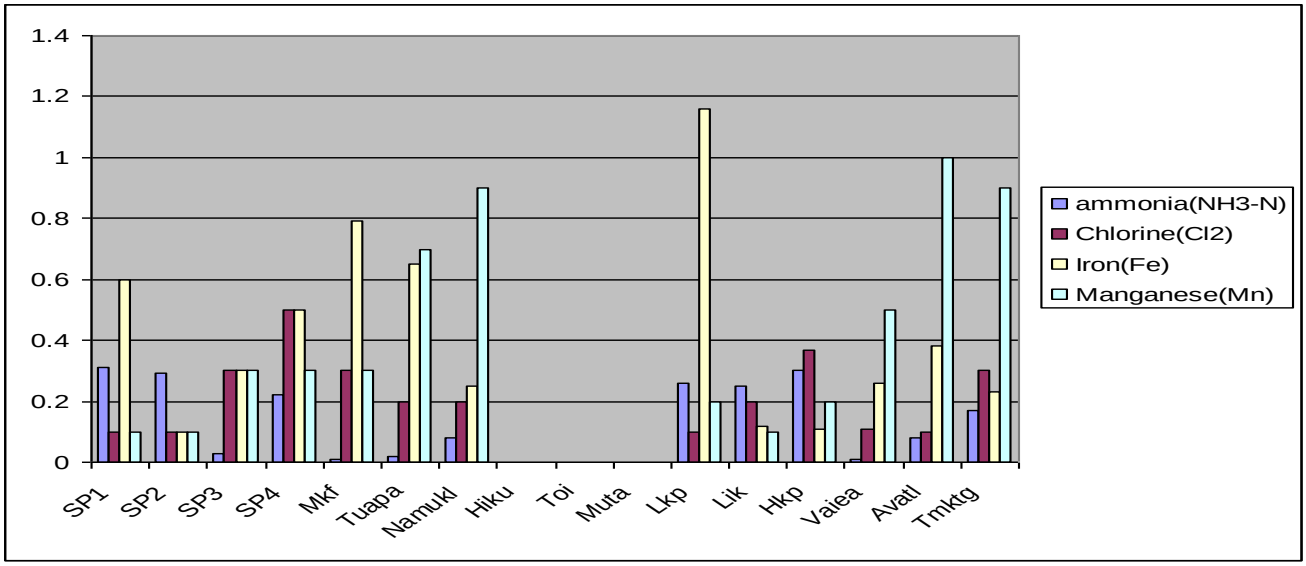
[34] 2004, Tasman Laboratory Report on the Food and Water Sampling Programme, POPs

61434361

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

Table 8 **Chemical Parameters**

Table 9



Source: Niue Foou Hospital Water Lab

Table 10 **Chemical Parameters**

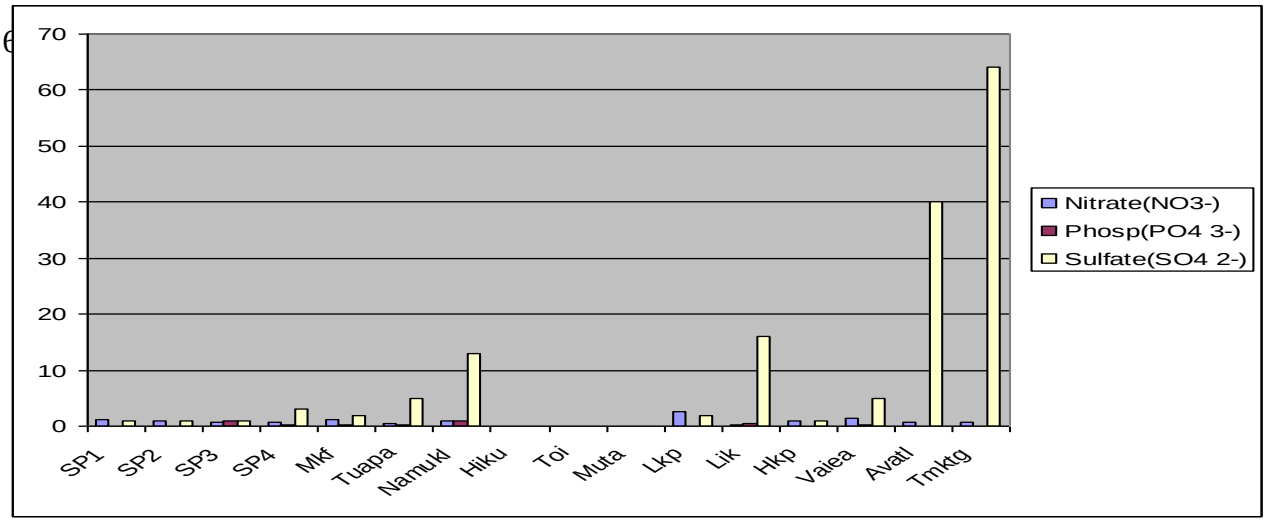


Table 11

	Nitrate (NO3-)	*Phosphorus (PO4 3-)*	*Sulfate (SO4 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*

Water Test Results – October 2006 ***Locations:*** **Niue Bore Holes**
61454561

Table 12 **Summary of Physical, Chemical & Bio Parameters**

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

Source: Niue Foou Hospital Water Lab

The above data indicated that the readings falls within the required WHO standards[35].

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 Environmental Heath Division from Health department is normally the entity responsible for testing water quality on a regular basis. 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 posed potential risks. Niue has in place a solid waste management plan; the private contractor who collects solid waste is required to deposit these wastes at dedicated areas leased from land owners.

Water related diseases do not prevail on Niue however, there are occasions in the past where cases of diarrhea, intestinal infections are reported to Health department, the public are notified urgently to ensure that water for drinking is boiled. Perhaps there were data kept on water borne diseases prior to cyclone Heta, none is available now.

Niue's underground source as fresh portable water is untreated. The storage reservoirs are untreated as well. The only occasion it was treated was after cyclone Heta as precautionary measures.

Wastewater- The practice of dumping wastewater on open land needs to be discontinued under premise that it contributes to the increasing number of flies and other potential environment risks. A small but proper treatment facility needs to be build, and the sludge be utilized 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, the Environment Department, is to have joint and coordinated efforts with the Village Councils and harmonized the intervention targeting:

[35] As verbally indicated by Environment Health Officer, Health Department

- The valorization of the site and environment protection;
- Active involvement and participation of stakeholders and land owners on the site.

61464661

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 increasing numbers. Accordingly, tourism has yet to have significant impact on watershed management yet.

Environment Health division needs capacity upgrading in the areas of human resources and appropriate equipments. An award should be offered specializing 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 setting[36].

In 2004 an investigation was mounted by SOPAC on Coastal quality amongst other important 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 water[37]". .

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.

[36] 2001, National Report Integrating Management of Watersheds & Coastal Areas Carenage, St Georges.
[37] Mosley, L and Carpenter, C; 2004, SOPAC Technical Report, Niue Coastal Water Quality and Groundwater Resources Assessment

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 apriority).

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 suggest 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) Most detailed investigation of the freshwater lens is required and should include topographic leveling of all boreholes, caves and springs to a common datum; monthly dipping flow and EC pressure and conductivity transducers, a datalogged 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 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-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.

The 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:
61484861

- 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

Table 13 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 with 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 harmonization
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 & 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			

Source: National Consultation Friday 09 March 2007 & One to one interviews

6 Other programmes, projects and activities related to IWRM

Table 14 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 15 Regional GEF Projects

Existing Projects						
Project Name (Niue Gov Department	**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	Climate	UNDP	SPREP	Medium	Small/none?	Ending

Energy Programme (PIGGAREP)	Change			Sized Project		
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 organizing the following regional projects, under Community Lifeline water projects, involving Niue as well:

(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:

(i) to implement actions to strengthen national capacity (equipment, training etc).

(ii) to train more technicians in the field of hydrological, water management, quality testing, and other related areas.

(iii) to strengthen and enhance communication and information exchange between national agencies in the field of meteorological, hydrological, water quality, data collection department and the users.

(iv) to 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) to build security fences to protect the reservoirs and bore sites.

(vii) to source funding to import tanks or build concrete tanks here to capture rain water as another source of portable water.

(viii) to encourage users to contribute by way of conserving water so to reduce the related costs.

(ix) to enforce the Water Act 1996, improve regulatory oversight including sector governance.

(x) to develop sector master plan to identify funding and cost recovery requirements and benefits, in terms of improving health including poverty alleviation objectives.

(xi) to identify potential benefits of partnerships such as joint ventures.
61515161

(xii) to improve demand management.

(xiii) to develop tariff policies and structures to generate revenues to meet financial and cost recovery policies.

(xiv) to establish sound asset management procedures and funding, including operational and management practices.

(xv) to increase consultation and awareness to support cost recovery

(xvi) to identify gaps, weakness and areas where not appropriate with current situation in the 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 indeed needs political support, driven by the community themselves through NGOs in partnership with the Community Affairs. The 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 generation has a share in this 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 basically through time, concerted efforts and conscience resulted 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 also require skills to develop and deliver stimulative and persuasive talks at all levels in community gatherings, including various media sources with written pamphlets as information backups.

Existing personnel within the institutions that are involved in various areas and levels requires up-skilling and multi-skilling as well. The multi-skilling approach will assist with the labour shortage of specialized personnel this approach is seen effective in various divisions in Health department except the Health Environment section.

Practical attachments at regional organizations, who specialize in water management, GIS/GPS, environment health, water safety, EIAs and many other water related areas, this includes exchanging personnel within the PICs. The practical attachments may be treated as incentives, it will enhance the performance including increase in productivity.

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

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

Niue needs:

(i) to 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) to continue quality monitoring practices following WHO standards.

61525261

(iii) to continue to work together with climate information services in the region, however the current capacity be strengthen to enable the ongoing development analysis, forecasting and application tools; and including the participation of stakeholders.

(iv) to continue to develop rainfall and drought monitoring and prediction methods, including technology transfer.

(v) to 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 is required,

(vii) to build a proper facilities to treat waste from septic tanks for compost use,

(viii) develop safety standards for refueling boats at the wharf to minimize the associated risks,

(ix) EIA is required as a pre- requisite for all development projects including regular inspections/evaluation of impacts.

(x) support the establishment of a regional water education fund accessible to by government agencies and NGOs, 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 private sector,

.

(xii) adopt water education as part of the curriculum including the strengthening 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 partnership working relationship between all water users.

(xvii) inform SOPAC to approach regional education institutions to develop courses in water engineering and management towards a recognize qualification

(xviii) to 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) to clearly define the responsibilities and roles and to activate the waste water management policies.

(xx) to provide continuous technical support on GIS database at Justice department.

(xxi) to replace GPS

(xxii) Strengthen gravity system and reduce pumping power cost and 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) to provide capacity building.

(xxvi) to 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.

(xxvii) to select Committee under existing legislation

(xxviii) to 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) to develop 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) to 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..

(xxxi) to develop national guidelines on wise practice approaches to assessing and managing water and wastewater system requirements that incorporate sound environmental health principles.

(xxxii) to strengthen and harmonise the existing institutional arrangements, functions and roles of key personnel in Foreign Affairs, Treasury, EPDSU and Environment Department 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, is to be found, it must accept to adopt 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 maximize the resultant economic and social welfare in a 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 resources.

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 on Niue's stagnated/contracting economy, the global economy is dynamic so as society; 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 community oriented, all stakeholders are required to effective contribute in all these areas, including the decision making, participation and consultation 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 that than 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; bring together the existing sectoral visions together to form one whole for Niue, consequently the defining of roles and functions, showing

the direction for Niueans to follow to achieve and harvest sustainable natural resource management to
61545461
us users of to day including those of tomorrow.

Suggest measures to overcome barriers.

Niue needs:

(a) to strengthen its capacity to conduct water resources assessment and monitoring as the key component of sustainable water resources management.

(b) to formulate and implement strategies to utilize appropriate methods and technologies for water supply and sanitation systems.

© implement strategies to protect watersheds and the remaining forest from further depletions, which included the identification of critical habitats other than the Huvalu Conservation area.

(d) to strengthen capacity development to enhance the collection and application of climate information to cope with climate variability and change.

(e) to promote the change paradigm for dealing with island Vulnerability from disaster response to hazard assessment and risk management, particularly in IWRM.

(f) to 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 waste water 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 training regional programmes resulting in sustainable levels of skills and knowledgeable people within water and wastewater management.

(l) to work together through a comprehensive consultative process, encompassing good governance, to developed shared national vision for managing water resources in a sustainable manner.

(m) to 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) to identify, promote an appropriate institutional arrangements and resourced sufficiently to enable effective management of water resources and the provisions of appropriate water and wastewater services.

(o) to develop and recognize national leadership in water resources should encouraged.

(p) to 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) to reduce costs through improved operational efficiency, using benchmarking, development of water-loss reduction programmes, and improved work practices.

61555561

61565661
REFERENCES

Cobb, A; & Other; 2006, Groundwater Resources Investigations on Niue Island, Government of and SOPAC.

_____2006, Capacity Building for Sustainable Land Management in Niue, Government of Niue; United Nations Development Programme

Davis, S; 2004, Evaluation Water Reticulation in Niue (SOPAC)

_____; EPDSU, Government of Niue, National Impact Assessment of Cyclone Heta

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

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

Government of Niue- Niue Integrated Strategic Plan 2003-200

Hekau, S; 2004, Legislative Review of Chemical Management in Niue.

IWP; 2004, Participatory situation analysis: summary report of village consultations, IWP no.12

IWP; 2005, Summary of recommendations for Pilot Project Activities and site selection: report to the Niue IWP national task force, IWP no. 13

Mosley, L and Carpenter, C; 2004, SOPAC Technical Report, Niue Coastal Water Quality and Groundwater Resources Assessment

Nemaia,E; 2002, Combating Land Degradation Niue, Niue's National Report on the Implementation of the UNCCD

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

Niue's Third National Report on the Implementation of the UNCCD, 2006.

Niue Foou-A New Niue, Cyclone Heta Recovery Plan, 2004

Nwe New, Nyo; 1992, Five Years National Water Development Plan, Water Resources Assessment and Development In Niue Island, United Nations Department of Economic and Social Development

_____ 2005; Reducing Vulnerability of Pacific ACP States, Proceedings of Niue 1st Multi-Stakeholder Consultations.

Scott, D, and Others; 2003, Pacific Dialogue on Water and Climate, Synthesis Report,SOPAC

SOPAC; 2004, Water and Sanitation Issues and Strategic Responses in the Pacific, Pacific Brief for the Report of the Secretary-General to CSD 13

SOPAC, 2004; An Overview of Integrated Resource Management in the Pacific Islands Countries: A national and Regional Assessment

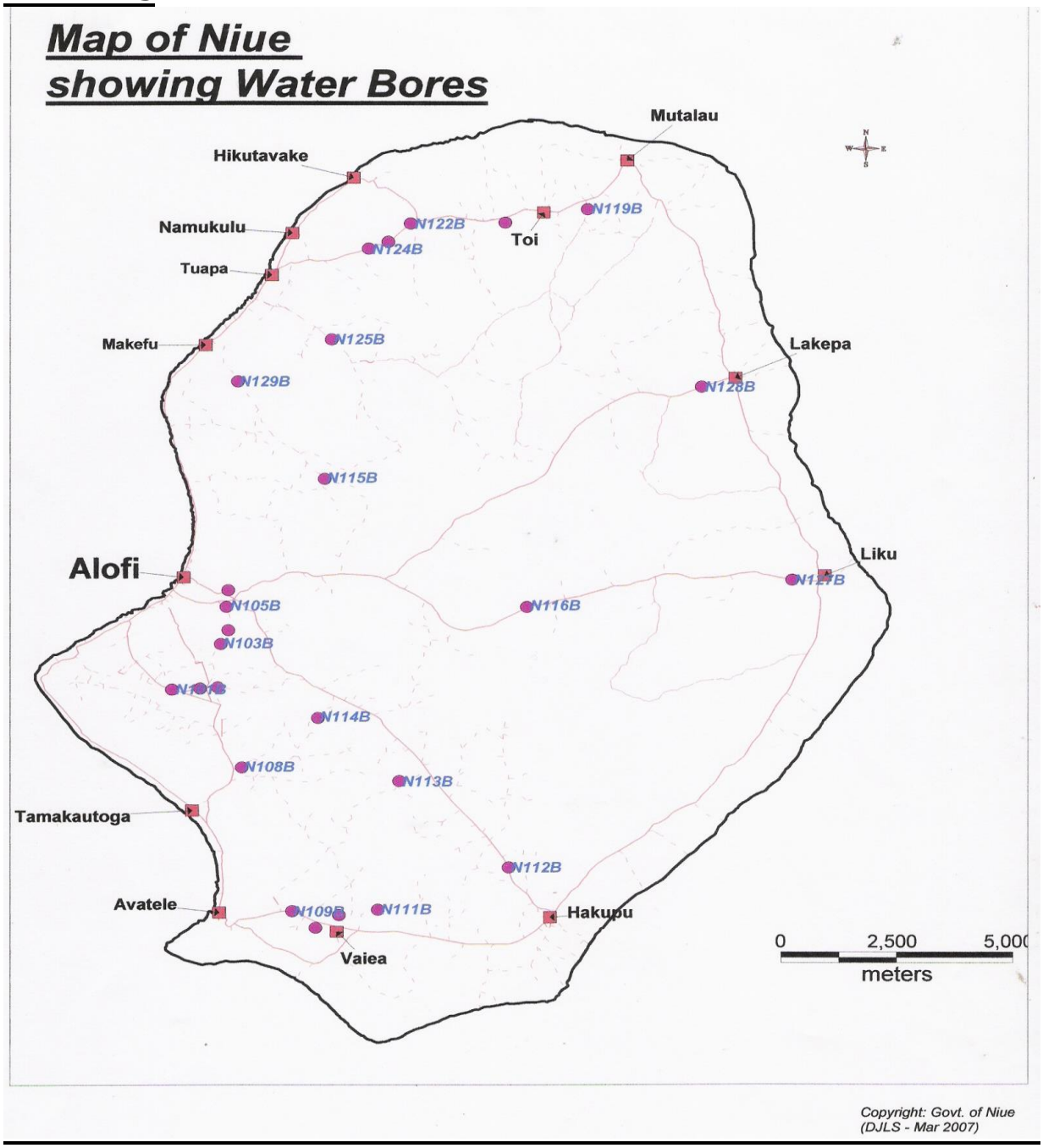
Tasmania, G; 2004, A Report on the Food and Water Sampling Programme, POPs

Tongatule, S; 2003, In-Situ and Ex-Situ Conseravation Measures Niue, Capacity Needs Assessment Report

Togiamana, M; 2001, In-Country Project Report, Ana Marine Reserve, Government of Niue

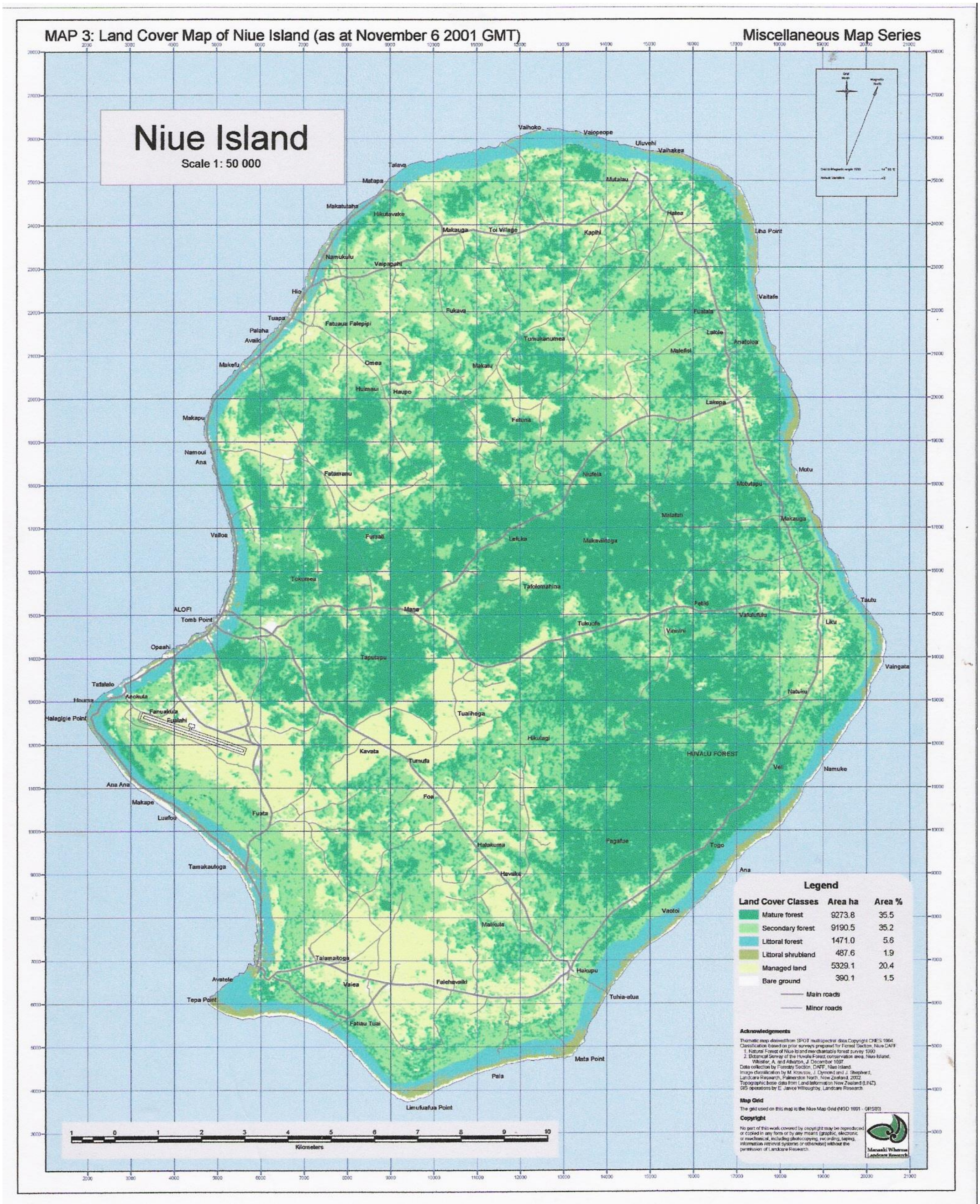
____,2001; Pacific Wastewater Policy Statement (Manjuro)

ANNEXES


Map of Niue
showing Water Bores
Mutalau
Hikutavake
Namukulu
Tuapa
Makefu
Toi
N119B
N122B
N124B
N125B
N129B
Lakepa
N128B
N115B
Alofi
Liku
N105B
N116B
N103B
N114B
N108B
N113B
Tamakautoga
N112B
Avatele
N109B
N111B
Hakupu
Vaiea
0
2,500
5,000
meters
Copyright: Govt. of Niue
(DJLS - Mar 2007)

61585861

MAP OF NIUE SHOWING LAND USE


MAP 3: Land Cover Map of Niue Island (as at November 6 2001 GMT)
Miscellaneous Map Series
Niue Island
Scale 1: 50 000
Vaihoko
Vaiopeope
Uluvehi
Vaihakea
Talava
Matapa
Mutalau
Makatutaha
Hikutavake
Makauga
Toi Village
Kapihi
Halea
Liha Point
Namukulu
Vaipapahi
Hio
Tuapa
Palaha
Avaiki
Fatuaua Falepipi
Fukavu
Tomuilanumea
Vaitafe
Fuatala
Lalole
Anatoloa
Malefisi
Makefu
Omea
Makalu
Huinaui
Haupo
Lakepa
Makapu
Fetuna
Namoui
Ana
Fatamanu
Niufela
Motu
Motutapu
Malalati
Makauga
Vailoa
Fuinali
Leluka
Makavilitoga
Tokumea
Tafolomahina
Tautu
ALOFI
Tomb Point
Mana
Feliki
Tukuofe
Vaiutukulu
Liku
Vaiolini
Opaahi
Taputapu
Vaingata
Tafalalo
Hourna
Aoolula
Natuku
Halagigie Point
Fanuakula
Fualahi
Tualihega
Hikulagi
Kavata
Tumufa
HUVALU FOREST
Vei
Namuke
Ana Ana
Makape
Fos
Luafoo
Fuata
Pagafue
Halakuma
Togo
Tamakautoga
Havaka
Ana
Vaotoi
Malikula
Talamaitoga
Avatele
Hakupu
Vaiea
Falehavaiki
Tepa Point
Tuhia-alua
Fatiau Tuai
Mata Point
Pala
Limufuafua Point
Kilometers
Legend
Land Cover Classes | Area ha | Area %
Mature forest | 9273.8 | 35.5
Secondary forest | 9190.5 | 35.2
Littoral forest | 1471.0 | 5.6
Littoral shrubland | 487.6 | 1.9
Managed land | 5329.1 | 20.4
Bare ground | 390.1 | 1.5
Main roads
Minor roads
Acknowledgements
Thematic map derived from SPOT multispectral data Copyright CNES 1994.
Classification based on prior surveys prepared for Forest Section, Niue DAFF
1. Natural Forest of Niue Island merchantable forest survey 1990
2. Botanical Survey of the Huvalu Forest conservation area, Niue Island. Whistler, A. and Atherton, J. December 1997
Data collection by Forestry Section, DAFF, Niue Island.
Image classification by M. Krausse, J. Dymond and J. Shepherd, Landcare Research, Palmerston North, New Zealand, 2002
Topographic base data from Land Information New Zealand (LINZ)
GIS operations by E. Janice Willoughby, Landcare Research
Map Grid
The grid used on this map is the Niue Map Grid (NGD 1991 - GRS80)
Copyright
No part of this work covered by copyright may be reproduced or copied in any form or by any means (graphic, electronic or mechanical, including photocopying, recording, taping, information retrieval systems or otherwise) without the permission of Landcare Research.
Manaaki Whenua Landcare Research

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**

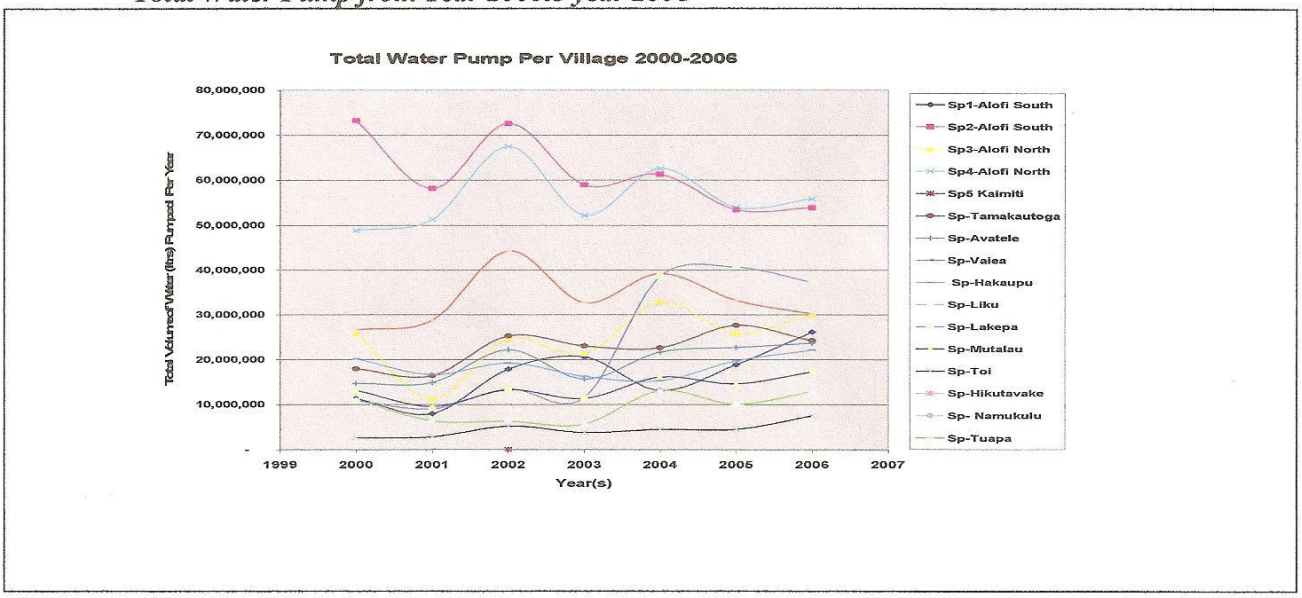
Monthly avearge rainfall from 2000 - 2006

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

WATER USAGE

Total Water Pump from Year 2000to 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-Vaiea		-	-				
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)