Sustainable Integrated Water Resources and Wastewater Management in Pacific Island Countries

National Integrated Water Resource Management Diagnostic Report

Solomon Islands

Published Date: November 2007
Draft SOPAC Miscellaneous Report 645

GLOBAL ENVIRONMENT FACILITY

UNDP

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Acronyms

ACP	African Caribbean Pacific
ADB	Asian Development Bank
AusAID	Australian Aid for International Development
CBSI	Central Bank of Solomon Islands
EDF	European Development Facility
EIA	Environmental Impact Assessment
ENSO	El Niño Southern Oscillation
EU	European Union
FAO	Food Agriculture Organisation
GDP	Gross Domestic Product
GEF	Global Environment Facility
GFS	Gravity Feed System
GIS	Geographical Information System
HSA	Hot Spot Analysis
IOH	Institute of Hydrology
IWP	International Waters Programme
IWRM	Integrated Water Resources and Wastewater Management
JICA	Japan International Cooperation Agency
KG VI	King George VI School
KL	Kilo Litres
KW	Kilo Watts
LPD	Litres per Person per Day
LCD	Litres per Capita per Day
MHMS	Ministry of Health and Medical Services
MME	Ministry of Mines and Energy
NCW	National Council of Women
NDMO	National Disaster Management Office
NEMS	National Environmental Management Strategies
NGO	Non Governmental Organisation
NIWA	National Institute of Atmospheric Research
NMS	National Meteorological Services
PEAR	Pre-environmental Assessment Report
PIC	Pacific Island Country
PPP	Public Private Partnership
RAP	Regional Action Plan
REP-PoR	Regional Environmental Programme
ROC	Republic of China
RWSS	Rural Water Supply and Sanitation
SAP	Strategic Action Programme
SI	Solomon Islands
SIBC	Solomon Islands Broadcasting Corporation
SIDS	Small Islands Development States
SIDT	Solomon Islands Development Trust

SIEA	Solomon Islands Electricity Authority
SIG	Solomon Islands Government
SIMA	Solomon Islands Marine Assessment Report
SISE	Solomon Islands State of the Environment Report
SIWA	Solomon Islands Water Authority
SOPAC	Pacific Islands Applied Geoscience Commission
SPREP	South Pacific Regional Environment Programme
UNDP	United Nations Development Programme
UNEP	United Nation Environmental Programme
UNESCO	United Nations Economic Social Cultural Organisation
VIP	Ventilated Improved Pit
WHO	World Health Organization
WUE	Water Use Efficiency

I Table of Contents

List of Figures

List of Tables

List of Annexes

o Executive Summary

Water resources availability in Solomon Islands ranges from sizeable rivers to small streams, from high mountainous and dense rainforest islands to rainwater harvesting and thin freshwater lens of underground aquifers of the small low-lying atolls and islets.

The increasing demand for water is evident in the country and thus necessitates proper water resources management and development. Urgent and decisive action must begin now to address water resource management issues in the country. Evidence exists that the quality and quantity of fresh water is reducing; although the rate of reduction is not very well understood because of inadequate hydrological data and limited knowledge of local hydrology and water resources.

Although most parts of the Solomon Islands enjoy high average rainfall this does not mean that water resources can be taken for granted. Rainfall and river flows are highly variable in certain areas; drinking water supplies may be short at some stage, yet a few months' later roads and gardens may be threatened by floods. There are special problems in the outlying atolls of the Solomon Islands, where there are only limited supplies of groundwater. Even where water resources are abundant they may not be suitable for a particular use, such as human consumption.

The pollution of drinking water and the resulting health hazards may be one of the biggest watershed issues in the Pacific Island countries. There are no clear-cut regulations applicable to the protection and management of watersheds. Lack of proper coordination of organisations responsible for water has resulted in little emphasis on issues affecting our water resources.

The need to integrate watershed and coastal management in the context of integrated water resources management is based on the understanding that no one system is a separate standalone unit. Any happenings and activities in the upper watershed region, whether it be anthropogenic or natural will certainly have some effect on the coastal environment.

The importance of the integrated approach is fundamental to the protection of the environment with coastal areas, which are defined to include both sea and land and expressly or implicitly aim to achieve an approach to managing human interactions with the coastal environment in a manner that is based on an appreciation that the coast is an integrated ecological whole, and that coastal management must take into account the implication of any action or proposed action for coastal system as a whole rather than merely for any particular sector.

Solomon Islands need an integrated approach to improved land and water management in order to address threats to the water resources. In particular, for projects to emphasise integrated watershed - coastal area management to achieve sustainable water resources management.

Sustainable and reliable water and wastewater service is vital to the country's social and economic development. The recent EU funded Solomon Islands Water Governance Project and the IWRM Project National Analyses have identified various issues/areas to address in relation to water and wastewater management in Solomon Islands. These include:

- Catchment management (protection of water sources)
- Water legislation and policy
- Awareness and education and community participation
- Institutional and capacity building

- Better coordination in the water sector

The IWRM approach to address the key areas identified by this report according to the six thematic areas of the Pacific Regional Action Plan on sustainable water resources management is vital in the proper control and management of water resources in Solomon Islands. The key areas identified for Solomon Islands include:

i) Need for basic information for water resources assessment and protection;

ii) Monitoring, preparedness and disaster management;

iii) Education, awareness and community participation;

iv) Water demand and supply management and provision of water treatment;

v) Policies, legislation, planning and better coordination;

vi) Cost recovery and economic benefits;

vii) Land use planning and management (including forestry);

viii) Environmental monitoring and protection;

ix) Protection of water quality for public health, and

x) Integrated planning and management of watersheds and coastal areas

Acknowledgements

In Solomon Islands the responsibility for water resources is shared amongst three organisations; Ministry of Mines and Energy with provision to provide national coverage on water resource assessment, management and development of groundwater, the Solomon Islands Water Authority for provision of safe water and wastewater services to urban population and the Ministry of Health and Medical Services, Environmental Health Division for provision of safe water and sanitation to rural populations in Solomon Islands.

With responsibility for water resource management in Solomon Islands, the Ministry of Mines and Energy is best placed to coordinate the implementation of the Sustainable Integrated Water Resources and Wastewater Management Project in Solomon Islands through the Country IWRM Focal Point, Director of Water Resources.

On behalf of Solomon Islands Government, IWRM focal point wish to thank SOPAC for providing funding for the preparation of the Country National Analyses for Solomon Islands. On the same note I wish to thank the support of GEF, UNDP, UNEP and EU for their continuous support in the water sector in the region, Solomon Islands especially.

o Introduction

The Solomon Islands is characterised by scattered islands that vary considerably in size, physical and hydrologic characteristics. The types of islands range from high volcanic to tiny low coral atolls. The higher islands have river systems whilst the low coral atolls have no natural surface water systems and are completely dependent upon rainwater catchments and groundwater.

Water resources availability in Solomon Islands ranges from sizeable rivers to small streams from high mountainous and dense rainforest islands to rainwater harvesting and thin freshwater lens of underground aquifers of the small low-lying atolls and islets.

In Solomon Islands there is an increasing demand for water which therefore needs proper management and development. The demand relates to both quality and quantity. For example, in urban areas population has drastically increased over the years with limited expansion in the water supply sector. Similarly, rural populations have experienced deterioration in freshwater quality due to landuse changes (logging and agricultural practices). Urgent and decisive action must begin now to address water resource management issues in the country. The essential, initial tactic is the alteration of attitudes towards water. Water must be generally acknowledged to be a precious resource, one we cannot do without. Water must be the environmental issue at the top of the agenda of governments, institutions and individuals alike.

Solomon Islands is signatory to many regional and international conventions/agreements and has obligations to fulfil. Successive governments have prioritised the water sector, especially provision of safe and reliable water supplies to rural communities and urban centres. However there was little emphasis on water resource management and infrastructure rehabilitation and developments for water and wastewater services.

The national vision in relation to water is to have clean and sustainable water accessible to present and future generations of Solomon Islands, thus promoting the improvement of standard of living and eradicating poverty. To achieve this vision it is important to consider the priorities, obstacles and constraints of each of the issues affecting water resource management. Some of these issues are outlined in the Pacific Regional Action Plan for sustainable water resource management. Each country is expected to undertake programmes and projects that will contribute towards the successful implementation of the Regional Action Plan. Other regional programmes such as the water governance are also contributing towards achieving the national vision.

i) Integrated approach to water resources management

The ability of Pacific Small Islands Developing States (SIDS) to manage their resources and ecosystems in a sustainable manner while sustaining their livelihoods is crucial to their social and economic wellbeing. Within the last two decades, the special needs of SIDS have been recognised through a number of globally significant conferences and high-level international meetings.

For Solomon Islands the common issues relevant for an integrated approach to water resources management are listed below:

- Issues of land use are present – effects on surface and ground water
- Issues of freshwater – water quality due to logging, mining, waste disposal, subsistence farming, livestock, etc

- Issues on coastal marine – effects on coral reefs, fisheries
- Issues on land ownership – landowners vs. investors and government

Solomon Islands need an integrated approach to improved land and water management in order to address threats to the water resources.

Target issues which SIDS have in common, including protection of water supplies, addressing land and marine-based sources of pollution, vulnerability to extreme (particularly climate-related) events, related downstream coastal area management, sustainable management and protection of biodiversity, and tourism development. Regional groups of SIDS often experience common water related environmental problems (for example, inadequate protection of water supplies, coupled with poor wastewater management and saltwater intrusion).

ii) Objectives of the IWRM Project

In 2004, UNDP GEF signed an agreement with SOPAC to develop an innovative programme on Sustainable Integrated Water Resources Management (IWRM) for Pacific Island countries. This programme will support Pacific SIDS in the implementation of the Pacific Regional Action Plan that addresses sustainable water management.

The aim of this regional project is to assist Pacific Island countries to implement applicable and effective Integrated Water Resource Management and Water Use Efficiency (WUE) plans based on best practices and demonstrations of barrier removal. The project will be co-funded by both GEF and the European Union's ACP Water Facility in a partnership of mutual aid and assistance.

iii) Scope of the report

The report has been prepared through national stakeholders consultations. The organisations and institutions that took-part in the national stakeholder consultations include:

- Government organisations;
- Non-governmental organisations;
- Statutory bodies
- Private companies

The sector analyses and reporting have been undertaken by local sector experts identified by the Ministry responsible for water resources in Solomon Islands who coordinated the national analyses preparation as well.

Additionally, resource persons were identified locally to assist in conducting seminars/workshops for the hot spot analysis (HSA) and the demonstration concept in line with the diagnostic report.

The national IWRM diagnostic report, the HSA and the demonstration project design are all part of a logical process, which commences with a review of national water management and its linkages to other sectors (the diagnostic report) and identifies barriers to preventing IWRM and how to overcome them. This reporting and analysis then provides the background information for the HSA.

General Overview

1.1 Country background information

Solomon Islands lie in the southwest Pacific Ocean between latitudes 5° to 12° south and longitudes 155° to 170° east and form a northwest to southeast oriented archipelago approximately 860 km in length (Annex A.1). It consists of about 1000 islands stretched over a distance of more than 1,500 km from Bougainville Islands of Papua New Guinea in the Northwest and Vanuatu in the Southeast. The Solomon Islands encompass more than 800,000 km^2 of sea area with a land area of about 30,000 km^2 (Institute of Hydrology 1993). The islands vary considerably from a small tiny atoll islands to a high mountainous heavily dense rain forested.

The major islands are Guadalcanal, Malaita, Choiseul, Santa Isabel, New Georgia and San Cristobal (see Annex A.1). These vary in length from 145 to 190 km and in width from 35 to 50 km. The largest of the islands, Guadalcanal has a land area of 5,120 km^2 (Gutteridge and Whiteman 1978).

i) Topography

The main islands are rugged and mountainous; the highest named peak Mt Makarakomburu (2447 m) is on Guadalcanal. Most islands are of igneous and metamorphic rocks, overlaid with considerable layers of marine sediments. The only extensively coastal plains are on the north-east coast of Guadalcanal. Many outer islands are coral atolls and raised coral reef.

The islands are mostly of volcanic origin, rugged and mountainous although the group includes some low-lying coral atolls. The country is relatively rich in mineral, hydropower and forest resources but uncontrolled and destructive logging has been a long-standing and serious problem with irreparable damage to the environment, the forests and the country's economic future.

The main islands are high, mountainous and often have sharp ridges with steep-sided valleys in between. Flat land is restricted to coasts and is of limited extent, except in the north-central part of Guadalcanal, referred to as the Guadalcanal Plains. These plains are the largest in the country covering an area of approximately 1,200 km^2 with width varying from 2 to 13 km.

The main islands have numerous hydrological regions while the outlying islands are usually raised coral atolls, only a few metres above sea level with no surface water. Water for domestic consumption is supplied mainly from roof catchments and/or shallow groundwater lens.

ii) Geology

The Solomon Islands lie along the south-western border of the Pacific Ocean, and are predominantly andesite affiliation, being composed largely of lava and volcanically derived sediment. Pleis-tocene, recent and contemporary volcanoes are important features of the landscape of several islands. A substantial part of the sedimentary pile is organogenic, and biohermal limestones are frequent (Manser 1985).

Some of the islands show large exposures of "basement complex" almost certainly pre-Tertiary in age, consisting of older sedimentary rocks, lavas, gabbroic, dioritic and granitic rocks. Some of those older rocks have been lightly metamorphosed. The ultrabasic rocks are a prominent feature of the islands. Apart from serpentinous fragments within the Tertiary sediments, all other ultrabasic rocks are intrusive. All occurrences show extensive intrusion brecciation and some of them have probably suffered semi-continuous plastic

intrusion up to the present. A provisional estimate of the age of initial emplacement is Upper Oligocene – the same for all of the islands on which they have been found (Manser 1985).

The oldest rocks, which apparently extend in age well into the Mesozoic, are the "basement" schists and plutonic rocks. For the most part these consist of metasediments, amphibolites derived from lavas and tuffs, and massive to schistose dioritic and gabbrioc rocks.

The Pliocene period appears to be represented entirely by volcanic rocks where they are the oldest units exposed, ranging from picritic basalt flows through basalts to andesites. The Pleistocene is represented throughout the whole group of major and minor islands by reef limestone and back-reef sediments.

The various islands differ considerably in their broad structural characteristics, though all may fit into a general evolutionary pattern. Some of the islands are intensely faulted, showing no true folding of any importance.

The low-lying islands are predominantly formed of limestone on reefal islets and others compose mainly of atoll islands. On the higher volcanic islands are flatlands which are formed of recent sediments and coral limestone.

iii) Soils

Soils were studied on the islands of Guadalcanal, Kolombangara, Santa Isabel, San Jorge, and Makira Ulawa, mainly under tropical rain forest in mountainous inland regions. In the areas studied soils on stable sites are deep, and intensely weathered and leached. On steep slopes soils are shallow and unstable, with much colluvial rock debris. Most soils are strongly acid to acid (pH 3 to 5) clays and have very low plant nutrient contents.

The Solomon Islands soils are related to similar soils in Hawaii, Western Samoa, New Caledonia, New Zealand, Australia, the West Indies and south-east Asia. In general the most strongly leached Solomon Islands soils have reached a stage of degradation beyond that of similar soils described from other regions. There is apparently an almost closed organic cycle of nutrient turn-over under rain forest, with most of the available plant nutrients concentrated in organic-matter-enriched surface soil horizons and with little contribution to plant growth from underlying mineral horizons.

There is little evidence of close relationships between soils and vegetation, except in soils derived from serpentine which have a forest dominated by Casuarina papuana. Large-scale destruction by fire of Casuarina forest on soils from serpentine has resulted in loss of surface horizons by erosion, failure of the forest to regenerate, and formation of laterite on the bare soil surface.

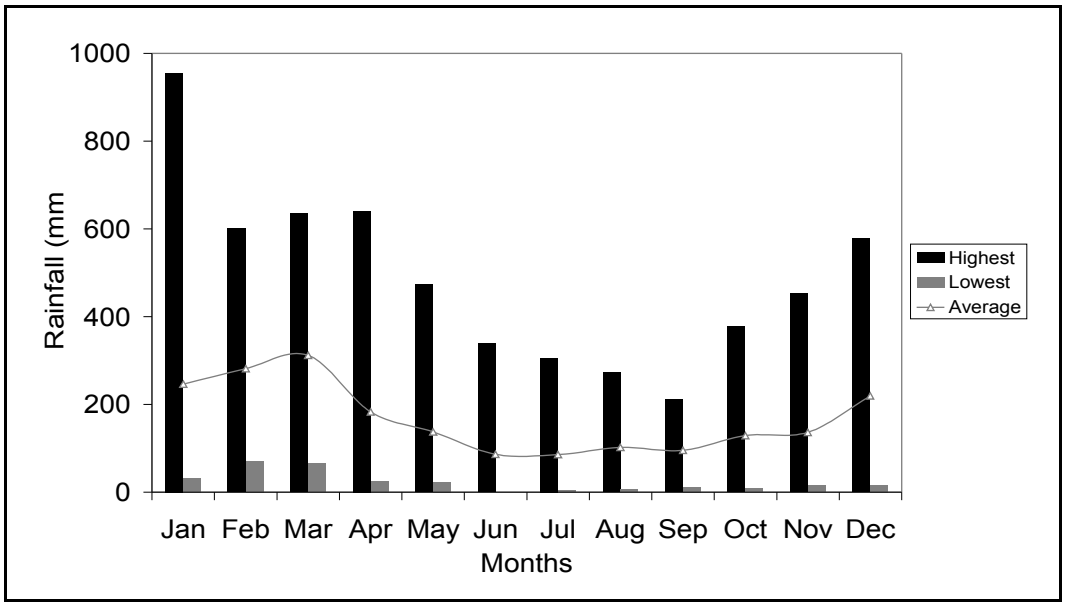
Small-scale destruction of forest for native gardens appears to have little long-term effect on soils or vegetation. 'Soil' animals are usually confined to logs and other above-ground habitats and are rare in the soil, apparently due to the extreme wetness and probably partial anaerobiosis of below-ground habitats.

iv) Climate

Solomon Islands have a tropical climate, hot and humid with an oceanic modification. During the day, a sea breeze blows on shore, and at night a cool breeze flows from mountain areas. The air temperature at the capital Honiara is representative of the island chain as a whole and varies only by a few degrees around a mean of 27ºC (IOH 1993; Solomon Islands Meteorological Service 2003).

Rainfall is generally high, but with distinctive wet and dry seasons during the year associated with the trade winds and orographic effects, i.e. a localised effect imposed by the topography of the islands. The average annual rainfall is mostly within the range 1,500 to 5,000 mm on the larger islands, the total exceeding 8,000 mm on high peaks (IOH 1993). In most of the Solomon Islands, the wettest months are November to April during the North-west monsoon season, with a tendency for reduced rainfall during February when the equatorial trough is normally furthest south (Figure 1). May to October is relatively a dry period (SI Met Service 2003).

Figure 1: Average monthly rainfall for Honiara (1955-2000) representative of Solomon Islands



Source: Solomon Islands Met Service

v) *Natural disasters*

The vulnerability and particular needs of small island countries has been acknowledged by the World Water Council by the inclusion of the "Water in Small Islands Countries" theme in the 3rd World Water Forum (Scott et al. 2002).

In Solomon Islands there are two major types of risk that can be caused by water. Both have occurred in Solomon Islands. They are:

- Too much water (flooding, etc.),
- Too little water (drought, etc.)

In 1986 water completely inundated a major part of Guadalcanal Plain claiming more than 100 lives. In 1995 parts of Solomon Islands experienced too little rain causing severe water food shortages. Cyclone Zoe in 2002 devastated the eastern Solomon Islands. Other natural hazards such as volcanic activity, earthquakes and tsunamis are a threat to the country. In 2007, an earthquake and tsunami devastated the western Solomon Islands clearly highlighting the need for disaster preparedness in the country. These extreme events require an appropriate level of preparedness. Education in the form of awareness is a very important tool to address vulnerability and adaptation by means of preparedness. Disaster preparedness policy is essential to the government in reducing the impact of any manmade and natural disasters to human lives.

In addition to current climatic variability, there is the possibility of climate change and sea level rise due to the enhanced greenhouse effect resulting from

worldwide emissions of greenhouse gases. Climate change scenarios for PICs vary according to location and the models used.

Lastly there are other economic and social issues that can be threat to the as experienced in the last few years when the country went through a dark period as a result of ethnic conflict amongst the different island groups. Social services, infrastructures and economic hardships were experienced as a result of the social crisis.

vi) Vegetation

The Solomon Islands is one of the world's most extensively forested countries (FAO 2000). Much of the country is under lowland rainforest with a small proportion of mainly swamp forest, including mangroves, and upland forests. The under-story of the lowland rainforest contains a variety of short, thick-stemmed, low-stature trees as well as palms, bamboos and shrubs.

The main islands of Choiseul, New Georgia, Santa Isabel, Guadalcanal, Malaita, and Makira have rainforested mountain ranges of mainly volcanic origin, deep narrow valleys, and coastal belts lined with coconut palms and ringed by reefs. More than 90% of the islands traditionally were forested, but this has come under pressure from current logging operations. The coastal strips are sheltered by mangrove and coconut trees. Luxuriant rainforest covers the interiors of the large islands. Soil quality ranges from extremely rich volcanic to relatively infertile limestone. More than 230 varieties of orchids and other tropical flowers brighten the landscape.

Solomon Islands has around 24,000 km^2 of natural forest (approximately 80-85% of the total land area) and almost all is in customary ownership (Sheehan 2000). However, only about 10% is considered suitable for commercial exploitation. The non-commercial areas are situated on steeply sloping land or scattered across many small islands and are presently not economically feasible to log (FAO, 2000). Despite the fact that only 10% of total forest was considered viable for commercial logging, current logging practice is probably extending to areas not strictly suitable for logging, e.g. steep topography. This could imply that logging has probably exploited much greater than 10% of the forest. This generalisation is probably reasonable because the current rate of logging is estimated to be more than twice the sustainable rate.

According to FAO (2001) Solomon Islands natural forest cover was reduced at a rate 2% during the period 1999-2000. CBSI (2003) reported that Solomon Islands recorded its highest logging production during this period. Sheehan (2000) reported that the sustainable timber harvest rate for Solomon Islands was estimated at 250,000 m^3 per year. However, the actual logging rate is approximately 550,000 m^3 per year (more than double the sustainable rate). Such an elevated logging rate could see the depletion of Solomon Island's forests in the next decade (Sevilla n.d).

vii) Agriculture

The Solomon Islands is an agriculturally based society. Agriculture commodities have been the major exports from the Solomon Islands since the country attained its independence. In 2003 the agriculture sector contributed a Gross Domestic Product (GDP) value of SI$39.3 million or 14.5% to the economy and a sectoral growth of 24.2%. Agriculture will continue to form the basis of the economy.

A survey conducted in the 1970s identified 338,100 hectares or 12% of the total land area as having the potential for agriculture development, but only 21,500 ha

or 6.4% have been presently developed based on the Ministry of Agriculture and Livestock records.

The agriculture sub-sector in the Solomon Islands comprises of three distinctive components; the small holder subsistence sector, small holder cash agriculture and the commercial sector which was greatly affected by ethnic unrest recently experienced in the country. While in the context of the agriculture sector the household unit is the predominant economic or production unit whereby individuals or families operate from.

A vast majority of Solomon Islanders are engaged in agriculture activities. The census of 1999 shows 111,905 people participating in some kind of unpaid activity; 78.3% engaged in agriculture activities while fishing accounted for 5.3%. The agriculture industry is the largest single employment sector in the country with 20.6% or 11,859 paid workers employed in the agriculture sector and of these 53.2% were male and 46.8% female (SIG 1999).

The main industries are copra, timber, palm oil, fish, cocoa and to an extent beef cattle. Main exports are timber, fish, copra, cocoa and palm oil/kernel. Agriculture, forestry, livestock and fisheries account for about 70 percent of the GDP (Wahananiu et al. 1993). Ruminant livestock production plays a declining role in the economy of the Solomon Islands, but Government has made plans to increase local production.

viii) Geomorphology

The higher islands are commonly of volcanic origin with mountainous and steep sided characteristics. The lower regions usually have stability while the upper regions become more unstable with outcrops of volcanic rocks. There are usually large drainage systems dissecting the larger islands which become narrower and steep sided in the interior of the islands.

Freshwater is abundant on most islands in the form of flow streams/rivers, springs and groundwater. These streams and rivers are usually flows from upper watersheds through to the oceans.

The low lying atolls rarely have flowing water in the form of stream or rivers. Most of their water comes from rain and thin lens aquifer underlying the islands and usually under threat from contamination from the surface human activities.

ix) Hydro(geo)logy

Water resources availability in Solomon Islands varies considerably. It ranges from sizeable rivers to small streams from high mountainous and dense rainforest islands to rainwater harvesting and thin freshwater lens of underground aquifers of the small low-lying atolls and islets.

Evidence exists in the Solomon Islands that the quality and quantity of fresh water is reducing. The rate of reduction is not very well understood because of inadequate or unreliable hydrological data and limited knowledge of local hydrology and water resources. The essential need is an alteration of attitudes towards water which must be generally acknowledged to be a precious resource. In addition training for hydrologists and other staff dealing with water must be sustained as an on-going activity as part of capacity building for the department to address this issue.

The main source of drinking water in Solomon Islands comes from surface water in the form of streams, springs or rivers. Some small atoll islands collect rainwater for drinking and utilise brackish water from shallow hand dug wells for most of their other domestic needs. Some communities on the higher volcanic

islands also use groundwater for domestic purposes. The major users of groundwater resource are Honiara city and Guadalcanal Plains. The Guadalcanal Plains on the northeast coast of Guadalcanal have abundant potential for groundwater. However, with increasing agricultural developments in the area there is an urgent need for proper planning and management of the resource.

x) Demography

The most recent census (1999) counted 409,042 people residing in the country, of which about 95% were Melanesian, the remaining were Polynesian, Micronesian and others. There are more than 87 dialects spoken in Solomon Islands. Most commonly spoken being Pidgin English, a mixture of English and each dialect. English is the official language (SIG 1999).

The population prediction for 2004 is 460,100. In 1999, about 86% (65,000 households) lived in rural villages leaving only 14% as urban (75% of which were recorded in the Honiara area). Unlike other Pacific Islands, the capital island is not the most densely populated nor does it have the largest population. Guadalcanal, where Honiara is located, had a 1999 population of 62,225 and a population density of 11 people per/km$^{2.}$ Poorly-developed Malaita had 122,620 people and about 29 people per/km^2. Overall, there were 13 people per km^2 in 1999 spread throughout country's nine provinces (REP-PoR Initial Country Review 2006).

xi) *Socio-economic aspects*

The economy consists of a mixed subsistence sector on which over 80% of the population depend, and a small monetised sector dominated by large-scale commercial enterprises. Between 1996 and 2002, Gross Domestic Product declined in real terms by 24%, roughly 35% per capita. Performance was considerably worse for the monetised sector. In 2003, GDP grew by about 3.8%, nearly equalling the 1992 level. The Government of the day then formulated and implemented a National Economic Recovery, Reform and Development Plan (NERRDP) for 2003-2006. It focuses on five areas: 1) normalising law and order; 2) strengthening democracy, human rights and governance; 3) restoring fiscal and financial stability; 4) revitalising the productive sectors; and 5) restoring basic social services (CBSI 2005). The NERRDP was the then government policy with the ultimate objective of economic recovery for Solomon Islands following the negative impact of the ethnic crises experienced by the country.

Cocoa and copra production, the mainstay of rural incomes was resilient. Production of these commodities continued to increase despite inadequacies of transportation and the infrastructure in the rural areas and lack of access to working capital by copra and cocoa exporters and traders.

As law and order was re-established and the world economy flourished, the domestic economy became more active. Export prices for most of Solomon Islands major commodities stabilised during the year. Log exports remain the major foreign exchange earner for the country and continue to increase unabated, although prices contracted for Solomon Islands logs were lower, normally ranging between 30% – 35% of the international prices. Over reliance on one commodity magnifies the country's susceptibility to external shocks.

1. Integrated Water Resources Management Situation for Solomon Islands

2.1 Water Resources Management

2.1.1 Types of freshwater resources

Water resources availability ranges from sizeable rivers to small streams from high mountainous and dense rainforest islands to rainwater harvesting and thin fresh water lens of underground aquifers of the small low-lying atolls and islets.

Although most parts of the Solomon Islands enjoy high annual average rainfall (between 2000-4500 mm) this does not mean that water resources can be taken for granted. Rainfall and river flows are highly variable in certain areas; drinking water supplies may run short one month, yet a few months' later roads and gardens may be threatened by floods. There are special problems in the outlying atolls of the Solomon Islands, where rainfall is low and there are only limited supplies of groundwater. Even where water resources are abundant they may not be suitable for a particular use, such as human consumption.

In the case of atolls where water is scarce, groundwater and rainwater is the option. Dug wells have been used to collect water but due to its relative poor quality (saline) rainwater is used for drinking and cooking. Tanks are used to store rainwater. Groundwater is used only for washing and swimming because of its relatively poor quality. In this way people can manage the use of the water before the next rainy season arrives. These conservation practises in the atoll islands have been passed on through generations as a matter of survival.

On the larger islands the problem of water availability still occurs in particular in areas of high impact activities such as logging. These activities affect the environment and the nearby watersheds. Trees have been cut down and rivers have been polluted with heavy machines used in these areas. As a result people have to walk longer distances to fetch water for cooking and drinking.

In areas where surface water supply is not available for farming, groundwater, if available is the option. Groundwater is very important on the atolls for survival. Similarly surface water is also important on the higher islands. With availability of groundwater on the higher islands there is less stress on the surface water availability compared to groundwater stress on the atolls.

With rural populations accounting for approximately 80% of the country's population, surface water is very important on high islands while atoll islands are heavily dependent on groundwater. With abundant supply of surface water in the rural areas groundwater use is currently limited to atoll islands and some areas on the higher islands including some of the urban centres.

2.1.2 Types of freshwater uses

Development of water resources is primarily for the purpose of human consumption, agricultural, industrial purposes and limited energy generation. Groundwater development is mostly taking place in and around Honiara on the island of Guadalcanal.

In Solomon Islands uses of freshwater can be categorised as follows:

- Drinking and household use: both in villages and in urban centres. The quantities required are relatively small but the quality of the raw water must be high if expensive treatment is not to be required.

Demand for drinking and household use of water is increasing at a fast rate as is the population of Honiara. From this phenomenon usage of water will also increase at a faster rate in the future for urban and rural populations.

- Industrial use: although demands are still relatively small there is considerable potential for future growth. Quality may be an important factor, particularly whether the water contains dissolved salts which will affect equipment such as boilers in industrial processes.
- Agricultural use: whilst most crops are rain fed, agricultural developments on Guadalcanal plains has shown the potential for irrigation. The heavy capital expenditure required for irrigation works makes accurate assessment of the flow from the primary sources very important. Surface water and groundwater will be the main sources used in the farms in the future. This can be seen in Guadalcanal and other high islands in the Solomon Islands.
- Power generation: the nation's rivers are an important source of renewable indigenous energy. Accurate assessment of river flows is needed to determine the technical and economic viability of harnessing this energy potential.

  At the moment there is limited hydropower development in Solomon Islands. There is only a single micro-hydropower (150kW) and about a dozen pico-hydropower installations in the rural areas to date which can sustain a small community.

2.1.3 Major issues and concerns

i) *Extent of exploitation of water resources*

The government recognises that safe drinking water and proper sanitation facilities are basic necessities to better health and is committed to further strengthening and expand the activities of the rural water supply and sanitation programme under the Ministry of Health and Medical Services (MHMS), and also the nation-wide assessment of water resources by the Ministry of Mines and Energy (MME) together with the Solomon Islands Water Authority (SIWA) to achieve national coverage.

With an estimated population of 400,000 in 1999, about 14% live in six urban areas including Honiara and the balance of about 86% of the population live in rural areas while the rest live in urban and peri-urban areas. Information to date revealed that about 50-70% of rural population has access to piped or improved water supply while coverage in urban areas is about 80-90%.

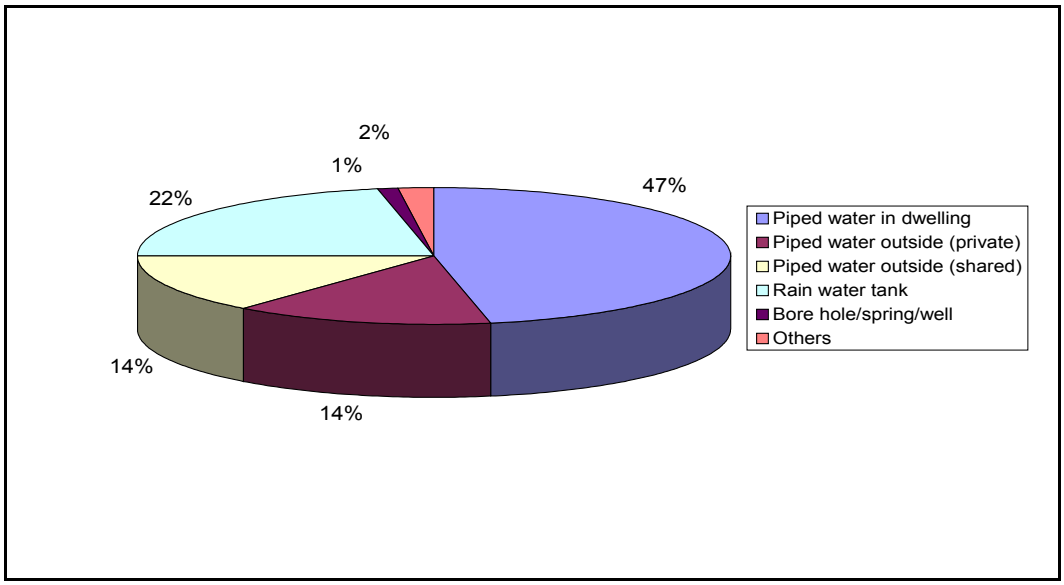
With abundant rivers, streams and springs existing on the larger islands, lack of water supply source is somewhat of a lesser problem although rivers are frequently turbid as a result of activities in the upper catchments which result in poor water quality.

Most water supply systems nationwide are from streams and rivers. Groundwater extraction is common in the Guadalcanal Plains and approximately 20-30% of Honiara water supply is sourced from groundwater. Rainwater harvesting is also a common practice in Solomon Islands, especially for those who can afford water tanks. The low-lying atolls mostly collect rainwater for drinking while shallow groundwater lens is used for other domestic usages.

A survey of urban households in Solomon Islands (JICA 2006) suggested that there are four major types of water supply: piped water, rain tank, bore hole/spring, and river/stream. As shown in Figure 2, piped water and rain water tanks are the main sources of drinking water. Low income households are more dependent

on the piped water than high-income households. The 1999 census noted that piped water is the major source (89%) for the households in Honiara. However, the percentage obtained from this survey was lower (75%) because the higher-income households use rain water tanks for their source of dinking water.

Figure 2: Sources of drinking water in Solomon Islands urban areas



Source: JICA 2006

There is limited desalination for water supply purposes in Solomon Islands except for private resorts and boats mainly for tourists. Approximately 95% of bottled water is imported from overseas.

ii) *Demands on watersheds/water resources*

Drinking and household use in both rural villages and in urban centres is the major use of water resources in the country. Although the quantities required are relatively small the quality of the raw water must be high due to non-presence of expensive treatment for the water supply.

There is limited agricultural water demand because most crops are rain fed or watered direct from groundwater sources. The agricultural developments of Guadalcanal plains have shown the potential for irrigation especially in the small holder rice farming activities.

Industrial water use is seen in the fish processing cannery, palm oil factory, mining operations and some small manufacturing industries. Although the demands are still relatively small there is considerable potential for future growth. Quality may be an important factor, particularly whether the water contains dissolved salts which will affect equipment such as boilers in industrial processes.

Furthermore, with the increase in the population (approximate annual growth rates placed between 2.8 and 3%) there is a need to increase the supply of water in urban and rural areas. In this case better water quality and quantity is needed for the country to meet the increasing population in the near future.

The introduction of mining activities on Guadalcanal creates new threats to the nearby rivers and watersheds. Waste from the mining sites are dumped or washed into the rivers during heavy rains. This can be seen in the river during heavy rain when sediments are washed into the river causing poor water quality as indicated by turbidity of the water. There is the possibility that groundwater may be polluted from chemicals from the mine site during heavy rains.

The commercial palm oil development on Guadalcanal Plains has a high usage of chemicals and fertilisers for the plantation management (farm and factory). These chemicals affect groundwater and nearby surface water sources and are washed into the nearby rivers and pollute the aquatic ecosystems in the rivers. This further affects those who depend on these ecosystems for survival.

In some areas there are signs of water shortage during drought periods. This is true in areas where there is heavy logging and high density traditional farming practices. Rivers in these areas are reduced in size. Tributaries to the watersheds are disturbed by these activities which further affect the supply of water to the watershed. This tends to reduce the amount of water flows into the river. There are some effects of evaporation during dry periods. During wet periods the rivers and streams are back to normal conditions. There are variations that could occur during longer dry seasons. For example, the occurrences of water shortage in Honiara during prolonged dry seasons have been more pronounced during recent years.

iii)

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th relatively low industrial, agricultural and power generation developments in the country, domestic water use has been the most important water use in the country over the years. However, this does not mean other water uses will not impact water resources and watersheds. There are plans and policies in place promoting renewable energy developments and agricultural use which will increase stress on the use of water resources in the country in the not too distant future.

iv) *Sources of pollution of surface water, groundwater, coastal waters*

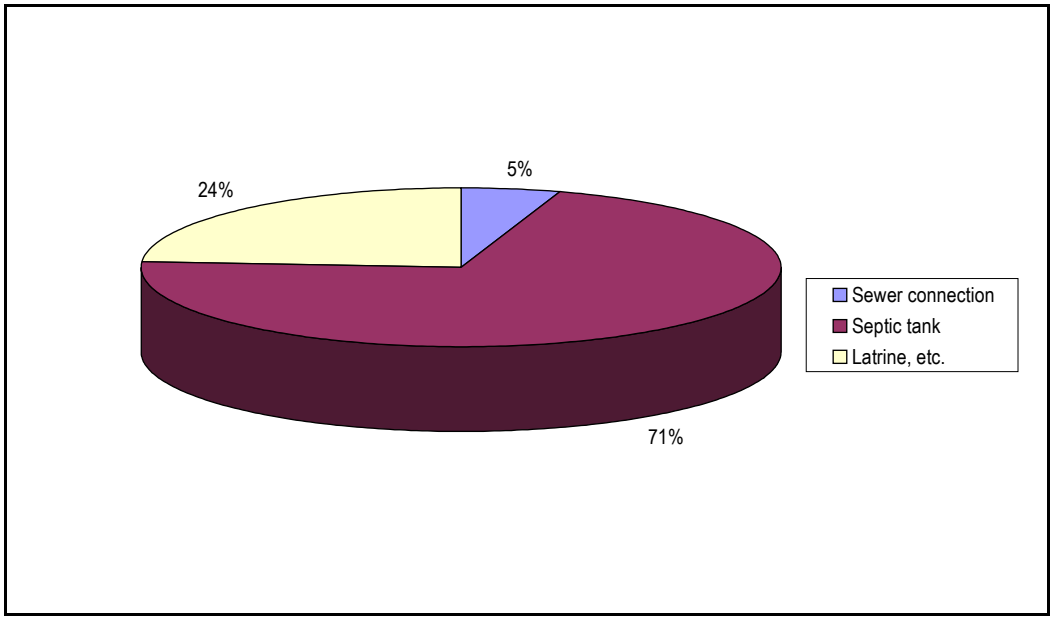
Bad development practices such as unsustainable logging and the traditional slash and burn method of farming have gradually or systematically destroyed the quality and reduced the quantity of rivers and streams, threatening the availability of water to many parts of the country. This is on-going and will become a serious problem for the country if not adequately addressed.

Rapid population growth, poor construction techniques, unsealed roads and unplanned development activities are major sources of water supply system problems. Surface streams and shallow groundwater sources are easily polluted. The pollution of drinking water and the resulting health hazards may be one of the biggest watershed issues in island countries of the Pacific. There are no clear-cut regulations applicable to the protection and management of watersheds. Lack of proper coordination of organisations responsible for water has resulted in little emphasis on issues affecting our water resources.

In Honiara, 70% of toilets are flush type. As shown in Figure 3, major sewage discharge is from septic tanks. It is considered that protection of water sources from contamination is as important as the water supply to the consumer. Direct contamination of water sources includes people's wrong use of streams, rivers, bush and beaches for recreation spots or as toilets.

Prevention of water contamination is the shared responsibility of Honiara residents and the service provider. People should understand the causes of water contamination and some penalties should be applied when people cause water pollution in Honiara. Over 90% of households think that water source should be conserved in order to avoid contamination of water.

Figure 3: Sewerage Discharge System in Honiara



Source:

The most common opinion about water supply expressed by Honiara residents is poor water quality and necessity of water treatment. Most people noted that water was contaminated and not safe for drinking after rain and needs proper treatment.

v) *Information exchange on water resources*

One of the major issues identified by the recently completed Solomon Islands water governance project is the lack of coordination between water related agencies resulting in minimal exchange for information on water related data.

Other issues which are of paramount importance to water resources management include:

- lack of comprehensive water resources assessment (no reliable hydrological data, no representative hydrological network, little understanding of hydrology and water resources);
- lack of appropriate water governance;
- lack of legislative frame work;
- lack of coordinative approach by agencies involve in water resources management;
- River Waters Act inadequate as only few rivers protected under this act;
- Logging (especially uncontrolled) and traditional slash-and-burn agriculture have negative impact on surface water resources quality and quantity;
- Land issues and resources ownership is a major problem for implementation when water catchments are on customary land.

2.1.4 Measures to manage impacts and concerns (IWRM approaches)

i) National Hydrological Network

Water resources assessment can be conducted at a number of levels. In Solomon Islands there are so many streams and rivers in the country that a comprehensive assessment is impracticable. Investigation has to be selective and directed towards areas of important development potential.

The scattered isolation of islands in the country contributes to hardship in executing well programmed hydrological investigations. A more systematic approach to a nation wide assessment of water resources would be helpful in building a data base for quality water resources data.

A hydrological network that is representative of the major island groups and hydrological regions of the country is actively monitored. However, maintaining such a network has been a problem over the years due to on-going limited financial, human resources and other logistic support from the government. Ways to maximise use of limited resources must be sought. Hydrological monitoring on some of the major island groups were established only as early as the 1980s. Currently hydrological monitoring is undertaken on two major islands but the Ministry of Mines and Energy plans to establish at least ten hydrological stations in the coming years in line with the Power Development Master Plan for the Solomon Islands. Under this Plan there are fifteen rivers identified for hydrological monitoring throughout the country over the next 5-10 years for the country's power development.

Using a systematic approach can ensure that the specific information generated has more general application. It will be difficult to anticipate all areas or projects which are likely to develop, but the difficulty of determining priorities accurately should not prevent an expanded programme of systematic investigation during the monitoring period.

In addition to long-term studies carried out under ideal scientific conditions, an ability to respond to immediate demands for information needs will be developed once the water resource data base is expanded. The priority therefore is to establish recording stations on the most likely resources required for development and carry out systematic water resources investigations based on the records collected.

ii) *Water quality and monitoring*

Public Health Ordinances provide some guidelines on water quality requirement for drinking water. Water quality analysis in Solomon Islands is a major problem. Most of the existing laboratories are incapable of analysing required samples as specified in the international standards for water quality.

SIWA Acts provides adequate protection for its water sources. SIWA is currently treating Honiara water supply with chlorine but the level of chlorine doses remains uncontrolled. SIWA is currently implementing the JICA funded project for improvement of water and wastewater systems in Solomon Islands to address both the supply and quality of urban water resources.

The Environmental Health Division at the Ministry of Health and Medical Services has established a National Drinking Water Quality Guideline Committee to review current water quality monitoring practices and to establish a national drinking water quality guideline for Solomon Islands.

In most developing countries untreated sewage finds its way into the nearest watercourse. Over the last 50 years, largely due to public pressure, regulations have been imposed by governments in the developed world to protect their nations' water resources. Such practices have been recognised and applied by the developing countries of the Pacific as well, mainly due to environmental and public health policies and concerns of individual countries. However, the problem of pollution by domestic and industrial waste is still a major problem in the region, not to mention the negative impacts of logging in Solomon Islands.

iii) *Water conservation and reuse practises*

In Solomon Islands rural populations are experiencing water pollution from disturbances to vegetation through human activities such as subsistence farming and logging. There are some areas which are subject to chemical and pesticide pollution from agricultural and industrial activities however, levels of contamination are though to be low.

It is evident nowadays that the water quality of some major water supplies are slowly deteriorating and are subject to complete contamination in the near future.

There is a need for information on water quality and quantity related to different land uses and on industrial impacts, with downstream effects of upstream users particularly important; water balance studies to provide information to aid water resources assessment and planning is vital.

There have been limited activities undertaken in water conservation and reuse in the country. SIWA promotes water conservation practices in line with its water conservation policy for urban water supply. This is done through awareness programmes on local radio and in national newspapers. In addition water conservation practice by the SIWA is reflected in the authority's tariff system whereby limitation on monthly water consumption is charged a lower rate. Above the minimum monthly consumption the charge is at a slightly higher rate to discourage excess use of water.

In addition SIWA also undertook leakage monitoring and control as part of its water conservation practices. The Demand Management Project that SIWA will undertake jointly with SOPAC is a step in the right direction to control water loss through leakage. Additionally the JICA funded project also promotes and implements a leakage detection and control programme as part of water control measures in urban areas.

Currently there are no water conservation and protection policies and incentives in place to promote water use efficiencies. The Government intends to promote water conservation practices especially in the urban areas through awareness on the importance of water conservation in relation to sustainability of limited resources availability within urban centres.

Integrated Water Resource Management is an important tool in conserving the water resource in the country. Different stakeholders including the landowners need to work together in order to achieve this goal. Ideas related to the conservation of the resource need to be shared between the stakeholder groups. Collective ideas will help manage the slim resource that is available in the country. In this way it will help the responsible authorities to conserve the resource for sustainable use

iv) *Pollution prevention measures: buffer zones, water reserves, water safety plans*

There are limited practices in pollution control although legislation exist. Enforcement of such legislation has been the problem which needs immediate attention as there is an urgent need to monitor increased (economic) developments in the country.

The current Logging Code of Practice promotes the control and minimisation of impacts from logging operations while the SIWA and River Waters Acts have provision of declaration for water conservation areas. There is also a monitoring programme in place by Honiara City Council, SIWA and MME in relation to pollution control. In addition the Environment Act and Environmental Health Act

provide for the control of pollution by any development taking place in the country. This includes impacts from development and waste disposal.

The implementation of EIA policy and water safety plans are relatively new initiatives in Solomon Islands which need enforcing to improve pollution control practices in the country. Supporting legislation is in place for provision of control but again, there is a need for enforcement. It is appropriate to have strict regulation on this issue when developments are increasing in the country right now.

Environmental Impact Assessment is an important tool to be used before any development activity can take place. There is need for a feasibility study on the environment for its capacity to accommodate certain developmental activities. This will help the country and the developers to know about the benefits and impacts of developments on the environment. Especially in terms of the effects of pollution that will happen to the area of interest to the developers. Conducting EIAs will help to preserve some of the habitats and ecosystems from pollution threats and aid understanding the relationship that habitats and the ecosystems have to the environment.

2.2 Island vulnerability

2.2.1 Types of disasters

i) *Potential disasters*

Vulnerability refers to the risk of being harmed by unforeseen, or unusual, events. There is a wide range of hazards with the potential to impact upon water resources and human beings in Solomon Islands. In addition the vulnerability of islands is often described in terms of their remoteness, small size and exposure to climatic instability. The significance of the climatic component of vulnerability has drawn particular attention to the impacts of climate variability and change in the region and has been successful in gaining international recognition for those concerns.

Climate (or meteorological) hazards occur over a very wide range of spatial and time scales. Nevertheless, they generally occur frequently enough in human terms to have allowed the development of traditional coping strategies. In addition, the improved scientific capability to observe and describe the interaction of the ocean and atmosphere is now providing for useful forecasts of some of these hazards.

Natural disasters are at best of times unavoidable. However educating the public on its effects on water resources and supplies is important. With climate adaptation, the best that can be done now is to provide relevant adequate information to the general public who may be ignorant on such issues or restricted due to lack of it.

Drought is an unusual hazard as, by its very nature, its onset is gradual. It has the capacity to have a broad range of impacts and as a result it can be defined and quantified in a number of different ways. The nature and severity of any particular drought episode is dependent on the duration and magnitude of the rainfall deficit.

In Solomon Islands there are two major types of risk that can be caused by water. Both have occurred in Solomon Islands. They are: too much water (flooding, etc.) and too little water (drought, etc.).

In 1986 water completely inundated a major part of Guadalcanal Plain claiming more than 100 lives. In 1995 parts of Solomon Islands experienced too little rain

causing severe water and food shortages. In 2002 cyclone Zoe devastated the eastern Solomon Islands. In addition other natural hazards such as volcanic activity, earthquakes and tsunamis are a threat. The 2006 earthquake and tsunami which devastated the western Solomon Islands clearly highlighted the need for disaster preparedness in the country. These extreme events require an appropriate level of preparedness. Education in the form of awareness is a very important tool to address vulnerability and adaptation by means of preparedness. Disaster preparedness policy is essential to the government in reducing the impact of any manmade and natural disasters to human lives.

In addition to current climatic variability, there is the possibility of climate change and sea level rise due to the enhanced greenhouse effect resulting from worldwide emissions of greenhouse gases. Climate change scenarios for PICs vary according to location and the models used.

There has been some dialogue between departments and ministries on the impact of climate changes and variation to water resources. However, there have been very little efforts done to fully understand and realise the impacts. Awareness through Solomon Islands Broadcasting Corporation (SIBC) is an on-going measure to address such issues by the National Disaster Management Office (NDMO) in the country.

The NDMO continues to facilitate awareness programmes through local radio to promote education and awareness of various disasters to the general public and preparedness for such disasters should they occur.

ii) *Sea level rise and /or horizontal land movement (subsidence or isostatic rebound) data*

The Solomon Islands National Meteorological Services (NMS) is responsible for tidal monitoring and prediction while the Seismological Observatory under the Ministry of Mines and Energy is responsible for seismic and volcanology monitoring in the country. Both organisations are vital for disaster preparedness and awareness to the general public. Long-term hydrographic data is available from the NMS and Lands Department while seismic and volcanology data can be obtained from the Ministry of Mines and Energy.

Information on land subsidence which has occurred over the years is also available from the National Disaster Management Office. Such data are vital in disasters awareness and preparedness programmes coordinated by the Disaster Management Office.

Sea level rise is a serious problem for the country in the future, particularly for the small atoll islands with limited landmasses. Once sea level rise occurs the islands will be faced with the possibility of the intrusion of saltwater in the watertable with negative impact on those that depend on the water resource for their livelihood. The horizontal land movement will also change the normal pattern of the land and the position of the watertable on these atoll islands.

The Solomon Islands National Meteorological Services (NMS) is responsible for tidal monitoring and prediction. Daily tidal predictions and weather and climate reports are disseminated through local radio and television news.

iii) *Impact of flood and/or drought on watershed and coastal management*

Flooding usually occurs within and adjacent to major rivers in the country. However, such an event only occurs during prolonged rainfall and usually during the wet season of the year. The major flooding which completely inundated the Guadalcanal Plains in 1986 witnessed the flood plains and coastal area severely

affected by sediment deposit and other debris from the headwaters of the rivers flowing through the Plains.

Farms were under water, root crops were washed away and buildings located near the main rivers were damaged and/or washed away. Bridges and roads were damaged. The devastating impact occurred because of the unexpected strength of tropical cyclone Namu that devastated Solomon Islands in 1986.

Drought on the other hand is common to some areas of the country during prolonged dry seasons. Some parts of the country are usually vulnerable to drought as it impacts them frequently. Drought has been blamed on the ENSO event which is associated with severe droughts or prolonged rainfall in the country.

During drought periods affected areas usually run out of water; rivers and streams dry up and food crops fail affecting people's livelihoods. This is a relatively new experience and cause for concern as alternative water sources need to be identified.

In both cases the impacts on the watershed and coastal zones have been somewhat limited taking into account that flooding usually occurs along flood plains and droughts impacts can severely affect gardening. This is not to assume that these two extreme events have very little impact on the country as they are common events in the country that seemed to re-occur much more frequent.

iv) *Historic data on floods and droughts*

Flood occurrences are recorded and available at the NDMO. Due to the scattered isolation of the islands historic data on floods have been very difficult to maintain by responsible organisations. Historic water flow data are available in the Ministry of Mines and Energy.

Drought information can be obtained from NMS as they are the custodian of rainfall data collected throughout the country. The network of rainfall stations has been operational for sometime and maintained by NMS. The Ministry of Mines and Energy also has rainfall data collected as part of the National Hydrological Monitoring Network in the country. Such data in collaboration with water flow data may be used to do analysis for flood occurrences and drought in the country.

Other organisations (for example, water and power services and education institutions) in the country also collect and store rainfall data for their purposes and they can provide very important historic rainfall data in the country.

v) *Economic costs of water-related disasters*

Cyclone Namu devastated the Solomon Islands in 1986. Major roads and bridges in Honiara and on Guadalcanal were destroyed. Approximately one hundred people were dead and thousands homeless. The cost of the damage was in excess of millions of Solomon Islands dollars and help was received from the international and regional communities.

Other water-related disasters in Solomon Islands over the years are recorded and kept with the Disaster Management Office.

In 2002 cyclone Zoe in 2002 battered the island of Tikopia and destroyed most of the houses and buildings. The repairs of the buildings were done with the help of international donors and regional communities. Luckily there was no human life lost. Only the building and the intrusion of saltwater into the watertable was severe at that time. With the help of communities around the Solomon Islands water was able to be transported on ships to the people of Tikopia.

In April 2007, a destructive earthquake and tsunami devastated the western Province of Solomon Islands. Most of the coastal communities Gizo, Simbo, Ranongga, VellaVella, Shortlands and parts of New Georgia were affected by this natural disaster. People lost their lives, properties were destroyed and drinking water sources were contaminated by the saltwater intrusion. People were traumatised as a result of the unexpected event. There were huge costs associated with the event and the country is now trying its best to help the victims. The international community are donating huge sums of money in helping the victims to recover from the event.

vi) *Threats to life and property from development practices*

Logging is currently taking place in Solomon Islands and there have been wide criticisms on the type of logging practised as environmental damages have been far-reaching.

Development in urban areas is also a threat during heavy rainfall with increased runoff occurring on the surface of the land. Because of the limited percolation of the surface runoff into the soil most of the rain water is washed into the drains and carried to the rivers and coastal areas. These runoffs are from sealed roads and pavements. Domestic and industrial wastes are also washed into the rivers and into the ocean. This further affects the marine resources that live along the coast and affects those that depend on marine resources such as fish.

Other developments in the mining and agricultural sectors are increasing in the country and contribute to threats to life and property. However, with proper regulations and policies in place these developments could be controlled to a certain extent.

vii) *ENSO disasters related*

Extreme climatic events such as flooding and droughts are become increasingly common. This increase in frequency has been connected to the ENSO event as have the changing characteristics of weather in the Solomon Islands.

There are also observed changes to wet and dry seasons in the country which influence cyclonic events. These observed changes are in line with increased ENSO events in the region which have caused droughts and flooding in various parts of the country and the region.

ENSO and EL Nino events impact weather patterns in the tropical Pacific region and affect the availability and distribution of water resources. Increased dry periods result in less availability of water in some areas which can lead to drought affecting farms and gardens that rural communities depend on.. An increased wet period can lead to increased flooding rates, loss of food crops and more intensive and frequent cyclones. This issue must be looked at in order to minimise and manage the impacts.

2.2.2 Major issues and concerns

i) *Lack or inundation of water resources*

Occurrences of flooding and droughts are becoming increasingly common in Solomon Islands and are causing concern to communities in the rural areas especially. The lack of water during drought is not only affecting food crops but human life as well. The general wellbeing of rural people depends very much on availability of water for domestic use. Social and economic developments in the rural areas also depend on good water supply.

Solomon Islands have abundant water resources in the form of surface water, groundwater, springs and other water bodies. However, availability varies for

different islands depending on the physiographic features of the islands. Some islands may have more water than others while others especially the low-lying atolls have only rainwater as source of drinking water.

The health of people especially in the rural areas depends entirely on available water resources. Statistical information available from the health authorities suggest that water related disease increase where water availability is a problem. In other words, there are increased water related diseases in areas where water is a major problem.

ii) *Impacts of pollution on water quality*

In Solomon Islands sources of water pollution comes from many different sources, including untreated sewage, industrial discharges, leakage from oil storage tanks, disturbances to vegetation, mine drainage and leaching from mine waste, and drainage from the residues of agricultural fertilisers and pesticides. Water pollution varies in severity from one region to the next depending on the density of development, agricultural and industrial practices and the presence or absence of systems for collecting and treating the wastewater.

There is a need for information on water quality and quantity related to different land uses and on industrial impacts, with downstream effects of upstream users particularly important; water balance studies to provide information to aid water resources assessment and planning is vital.

iii) *Saltwater intrusion into aquifers*

There is limited knowledge on saltwater intrusion in groundwater systems in the country. On the Guadalcanal Plains there are pockets of land where groundwater development has confirmed the presence of saltwater at certain depths underground. However, the cause of saltwater presence is not known at this stage. The problem was first noticed by US Marines extracting groundwater for domestic use during the Second World War.

It is important to plan and manage the thin lens freshwater aquifer present in the low-lying atolls. To date there is no policy for groundwater development in spite of its importance to many communities. It is vital to develop appropriate policy for proper planning and management of groundwater resource in the small islands of the Solomon Islands.

Groundwater is abundant on the Guadalcanal Plains and numerous drillings have taken place over the years. In order to control salt water intrusion into the groundwater aquifer, boreholes along the coast of the Guadalcanal Plains have been carefully monitored during groundwater development. The communities have been advised to construct shallow boreholes using hand pumps to prevent salt water intrusion.

iv) *Impacts of extreme weather events on watershed*

There is limited information available on the impact of extreme weather occurrences on watersheds in Solomon Islands. Drought especially, can have severe impacts on the watershed.

During recent years the main water catchment for Honiara has been severely affected by drought. In the 1997/98 drought, water flow in the catchment reduced by 30-40% causing water shortages in Honiara.

Flooding also has severe impacts on the watersheds. Food crops die as a result of prolonged rainfall which can lead to waterlogged watersheds. Various commercial crops have been affected by flooding due to prolonged rainfall events.

Logging activities also have severe impacts on the watershed as operations damage ecosystems that provide life for the watershed. Trees that help to sustain the hydrological cycle are destroyed. This can contribute to the global change that affects the hydrological cycle impact watershed catchments. Environmental systems are connected to each other and if one part is affected then the rest will be affected. This principle also applies to the watershed environmental system.

v) *Impacts of sea level rise or storm surges on aquifers or watersheds*

There is limited data available on impacts of sea level rise or storm surges on aquifers or watersheds. This does not mean there is no problem of sea level rise in the low-lying atolls as it is most likely for sea level rise to have severe impacts on the aquifers. Climate information can be useful in monitoring the impact of climate change on water resources. Climate change events in the past have been monitored by the Meteorological Service which provides useful data in assessing future impacts of climate change on water resources in the country.

There is a possibility that sea level rise will affect normal water levels in the atoll islands and higher islands in the country. It has been noticed that there were signs of rise in sea level in some the low-lying atolls. Areas that were once above sea level are now partially submerged under sea water. This indicates that shallow groundwater aquifer for the atoll islands could be affected with saltwater intrusion.

Storm surges are reaching higher on the coastal areas as seen in the new shore levels of high tide water marks, especially during extreme high tides.. During high tides the estuaries are experiencing more saltwater intrusion compared to the past and groundwater is contaminated with saltwater intrusion above its normal level.

2.2.3 Measures to manage impacts and concerns (IWRM approaches)

i) *Disaster preparedness and climate change*

Solomon Islands is now in the process of formulating its Second National Communication and National Adaptation Programme of Action. This should form the basis to address climate change issues in the country.

The National Disaster Management Office is formulating a Disaster Management Policy which focuses on disaster preparedness and management in Solomon Islands. The policy should ensure adequate disaster awareness and institutional capacity to adequately address disaster issues in the country.

There is a coordination mechanism in place which links organisations/institutions having functions necessary to coordinate disaster management during disaster times. The National Disaster Council coordinates activities from the Central Government with Provincial Disaster Management Teams operating from the Provincial Government.

In summary, the following mechanisms are in place with respect to disaster preparedness and climate change issues in the country:

- Inter-governmental climate change team consisting various sector experts;
- Ministerial coordination whose functions relate to climate change and other disasters issues;
- National Disaster Council;
- Provincial Disaster Council;

- Formulation of Second National Communication and National Adaptation Programme

For climate forecasting the Solomon Islands Meteorological Services (NMS) is responsible for monitoring climate change in the country with the help of the AusAID National Tidal Facility Sea Level Rise Programme. This is on-going partnership which really helps the Solomon Islands in forecasting any changes in weather patterns. Climate change events in the past have been monitored by the Meteorological Service and information related to such changes has been disseminated through quarterly weather updates published by the NMS.

Awareness bulletins about the changes have been broadcasted in the media to educate the rural people about possible effects in the future.

Seismic monitoring in Solomon Islands is the responsibility of the Ministry of Mines and Energy. A monitoring programme for earthquakes in Solomon Islands is on-going but is faced with many constraints to effectively provide reliable monitoring and advisory services to the country. Currently there is an increase in earth tremors which have occurred on a daily basis especially after the April 2007 earthquake that devastated the Western Solomon Islands. The Seismology Unit is doing its best in monitoring the current situation with the limited equipment they have.

Awareness activities on the impacts of the natural hazards have been carried out by the Ministry of Mines and Energy through the NDMO, especially to those areas affected. NGOs have also taken part in rehabilitating the affected communities which shows coordination amongst the different stakeholders in addressing disaster issues.

The NDMO is responsible for monitoring the impacts of natural hazards in the country. Early warning systems, drought preparedness strategies and flood forecasting are under the responsibility of the NDMO. The Solomon Islands Water Authority, the Ministry of Mines and Energy and Rural Water Supply and Sanitation Programme are responsible for the water and wastewater services and water resources management. Land use planning is the responsibility of the Ministry of Agriculture and Lands.

2.3 Awareness

2.3.1 Type of awareness campaigns, advocacy initiatives in the area of water resources management

i) *Stakeholder participation in water resource and wastewater management*

Awareness is an integral part of any management strategy to protect water resources and must be carried out in all sectors of society. Lack of information has been a cause of negligence of people to look after this resource. Perhaps a very low literacy rate particularly among the rural populace seems to play a part.

The national stakeholder consultations in 2002 for the preparation of the Pacific Regional Action Plan on Water Resources Management were part of a broad consultative process involving wide sectors of society. The consultation involved both government organisations and non-governmental organisations to ensure decisions made on water resources management drew on a fully representative and participatory approach.

The Pacific Water Governance Project implemented by SOPAC also engaged in a national consultation process to identify major issues that need urgent attention to promote effective and efficient water governance in the country. The identified

issues for urgent attention in Solomon Islands are: formulation of legislation and policy, awareness and community education, and effective coordination of the water sector.

It is important to realise that the main users of water are women. However, their views are often ignored and they must be given the chance to actively participate in the decision making process in water management. Initiatives are been taken by Women Groups who have voiced their concerns on water and wastewater related issues through the local radio and newspaper. This promotes the joint approach to addressing issues that affect the management and protection of water in the country.

Community based initiatives are an important means of national consultation. This is very important to organisations such as SIWA where water sources are customary owned and require community participation in the decision making process.

National stakeholder consultation is very important in the preparation of national reports such as the IWRM national analyses whereby there is a need to get views and experiences from multiple sector groups in the country. The integrated management of water resources necessitates the involvement of stakeholders in national consultations.

There is on-going community participation in the management of water supplies in the rural areas where training for community representatives are conducted to ensure the transfer of knowledge and techniques in the proper management and maintenance of rural water supply infrastructures.

2.3.2 Major issues and concerns

i) *Social or cultural issues associated with water resource and wastewater management*

In Solomon Islands water ownership can cause problems within a community. Although the ownership of water is vested in the State the general understanding or perception by the people towards water ownership is contradictory to the Constitution. This has caused many problems associated with land ownership and water sector development.

The Ministry of Mines and Energy is responsible for the management of water resources in Solomon Islands. Wastewater management is the responsibility of SIWA; although other organisations such as the Environmental Health Division of the Ministry of Health and Medical Services and Honiara City Council also have functions related to the management and control of sanitation in the rural areas and wastewater and refuse collection and management within Honiara.

The supply of water and provision of wastewater services in the country is one of many problems experienced by urban and rural populations. Water is generally accepted as a gift and perceived as free to use. As a result imposing tariffs or a user-pay system is not readily accepted by some people. This has caused enormous problems to the organisations responsible for distribution of water and management of wastewater.

ii) *Community participation and consultation*

The Government undertakes occasional awareness programmes on hydrology on the local radio.. SIWA also conducts public awareness programmes through radio and schools as part of its water conservation programme. There are awareness workshops in the country undertaken by NGOs through donor

assistance. Major issues that impact awareness programmes in the country include:

- Low level of literacy
- Lack of basic water related data to support awareness programmes
- Women are not included in decision making for water

Awareness and public consultation are the key to success of policy implementation as it enables ownership of policies. It is crucial to recognise the different but real needs of the people who are expected to take the policies and legislations on board. There is a need for awareness in schools from the primary level and to include water issues in schools curricular.

There is urgent need to establish a specific unit for public awareness programmes. Young children should be targeted and support from communities for public education programmes actively sought.

The introduction of water metering is good measure for water conservation but people have to first be informed about the reasons for metering water. The message that WATER IS PRECIOUS needs to be convincing and get across to people. Community perception is very important and it is crucial to listen to the real needs of the people, not copy or imitate what other countries are doing. To prevent people misinterpreting assistance and approaches from NGOs, donor organisations and the government, they need to be informed before any work or project is implemented.

iii) *Political will*

Water has not been the main priority in Solomon Islands by successive governments. The Government role is crucial for driving the process to attain sustainable water resources management. There must be a strong political will. To address water issues the Government should take a more concerted approach. Major issues preventing adequate emphasis in water resources management include:

- Inadequate policies and legislation
- Lack of coordination and fragmented water management
- Lack of capacity and human resources
- Low awareness and literacy rate
- Lack of funds for the water sector
- Water a “low priority” for the government
- Limited data collection and information sharing

There have been several workshops and training undertaken regarding water governance and water resources management targeting government and governmental agencies. Nevertheless, it seems that the IWRM approach is not very well known. There is a need for a comprehensive legislation to effectively address water resources management in the country.

iv) *Gender issues*

Women are mostly associated with fetching water for domestic uses in Solomon Islands. They are the ones who are mostly affected by water sector developments especially in the rural areas. Provision of improved water and

wastewater services in the rural areas benefits women as they are able to do other important activities without the constraints of water collection.

As women are closely linked to water in the rural areas their participation in the decision process for water is very important. They should be involved in awareness and community participation to enable them to express themselves and the problems they experience in relation to water.

2.3.3. Measures to manage impacts and concerns (IWRM approaches)

i) *Community based monitoring programmes*

The scattered isolation of islands in the Solomon Islands requires the involvement of community in monitoring programmes. This approach has been proved successful by certain NGO groups operating in the country.

Some NGOs have established Community Base Teams that are able to facilitate programmes in the rural areas. This way the use of available resources are maximised and at the same time involve the community and resource owners to understand issues and challenges in the water sector.

ii) *Targeted campaigns geared towards a certain demographic group.*

There is a need to have target campaigns especially in urban areas where inactive youths are sometimes viewed as a burden to society. Targeted campaigns may involve youths in useful activities as well as promote awareness of water management issues.

In the rural areas campaigns should target water users as part of water conservation practices. Some rural people's perception of running water from piped systems contradicts water conservation practices or measures. They should be able to understand that some water sources gradually reduce flow during dry season and if water use is not controlled the community could face water shortages.

iii) *High level advocacy initiatives*

Advocacy is often taken for granted that it fulfils its planned aims and objectives without actually monitoring its implications on the target area. Sometimes there is advocacy between Government ministries on issues of concern and promotional activities but this often does not reach the upper level policy decision makers to ensure concern for water is appreciated and taken on board.

Advocacy should be undertaken as part of a monitoring programme on water related issues to form the basis for promoting water sector through proper planning and management approach. Initiatives to advocate must come from responsible officers themselves and stakeholders.

We can also go further by including advocacy as part of an overall performance monitoring mechanism for a particular Ministry of Projects. A lot can be passed to the general public and intended target group from proper advocacy.

There are Government Ministries responsible for dissemination of information as part of their awareness campaign on various issues that affect the country.

2.4 Technology

2.4.1 Types of water supply systems

i) Connections and services

Water Supply systems in urban areas

The major urban centres in Solomon Islands are Honiara, Auki, Noro, Tulagi and Gizo. These towns are located on the narrow coastal plains and hills on the inland side.

The Solomon Islands Water Authority (SIWA) was incorporated in 1994 as a result of an Act of the Parliament, SIWA Act 1992. SIWA is responsible for the development and management of urban water and wastewater services. SIWA currently charges its customers for use of water and also charges customers who are connected to the sewage system.

All residents and commercial properties located in urban centres are connected to SIWA for water supply. The average monthly water consumption is more than 410,000 m^3. Domestic usage and commercial usage account for 58% and 42% respectively. Water usage in Honiara, the capital and biggest town in Solomon Islands accounts for more than 90% of total water usage in urban areas.

Most of the spring water sources are located in the mountains while the bores are located in the lowlands and plains within the urban centres. In the urban centres, groundwater sources account for 40% while spring water sources for 60% of the whole production volume. For the supply of water distribution, gravity and pumping systems are both used for urban centres.

The main reservoir tanks are located up in the hills and the tanks are recharged from the gravity systems and the pumped water from the bore fields. Distributions are gravitational from the reservoir tanks. Total length of water distribution in urban towns in Solomon Islands is about 128 km. On the basis of issued bills, there are approximately 7,000 customers connected to the water supply reticulated system.

Water supply systems in urban centres consist of the following:

- Source (Spring or bores)
- Pump facilities
- Disinfection facility
- Water reservoirs
- Water mains
- Water distributions

The current water supply system utilises one source to supply water to many zones or sub-urban centres. This type of system is seen as inadequate and can contribute to the following problems:

- When one water source covers too many areas, the water distribution system suffers from low pressures and water shortage.
- When one water source covers too many areas or districts, any accidents or shortage at the source will affect a large number of users.
- Water reservoirs cannot cope with the function of additional supply in peak demand and emergency cases.

Rural water supply technology applied at present in Solomon Islands is comparative to those adopted in other Pacific Island states. The majority of systems exploit supply under gravity to reach villages and communities. Alternative means of supplying water are making their way forward but have to be measured against their previous non-existence status of application at most locations. Underground water extraction with hand-pumps and improvised

powering sources, particularly with use of solar energy is relatively new. Rainwater harvesting, though it has been in use for a much longer duration remains lacking relevant development to fully realise the technology's potential.

The existing water sources for the current water supply by SIWA to Honiara are classified into springs and boreholes as shown in Table 1 and Table 2

Table 1: Spring Sources for Honiara Water Supply by SIWA

Spring		Water intake volume (m^3/day)	Geology of spring point
Site	Name		
White River	Kongulai spring	12,430	Honiara Beds
Rove	Rove spring	1,780	Honiara coral reef limestone
Kombito	Kombito spring	2,600	Kombito marl

Note: Average volume for June 2005
Source: SIWA

The situation and condition of water supply services for Honiara in 2005 is presented in Table 2. There have been only minor changes in the last two years (JICA 2006) and the problem of reduced flow experienced at Kongulai spring has improved to some extent since early 2007.

Table 2: Groundwater Sources for Water Supply by SIWA in Honiara

Borehole No.		Diameter (inch)	Depth (m)	Yield*1 (m^3/day)	S.W.L*2 (GL-m)	D.W.L*3 (GL-m)	Aquifer	Current use*4
White River	W-I	8	80	(880)	-0.7	9.0	○ Sandstone of Honiara Beds	
	W-2	8	80	(880)	-0.8	8.0		
	W-3	8	80	(880)	-0.5	6.0		
	W-4	8	80	(880)	-0.5	16.0		
Mataniko	M-I	8	100	703	6.0	8.0	○ Sandstone of Honiara Beds ○ Mbonehe Limestone	O
	M-2	8	100	850	7.0	12.0		O
	M-3	8	100	1160	5.2	9.0		O
	M-4	8	100	0	6.1	-		O
	M-5	8	50	1380	4.7	9.0		
	No.I	6	48	720	2.0	24.5	○ Sandstone of Honiara Beds ○ Mbonehe Limestone	O
	No.2	6	90	0		26.7		
	No.3	6	99	0		-		
Kombito	K-I	8	80	1,020	6.5	17.0	Sandstone and limestone of Honiara Beds	O
	K-2	8	80	750	2.3	18.0		O
	No.I	10	20	0	2.8	-		
	No.2	10	60	0	Flowing bore	-		
Panatina	No.I	6	64	2350	5.0	20.5	Sandstone of Honiara Beds	O
	No.2	6	64	680		40.5		O
	No.3	6	48	670		20.2		O
Ndondo Creek	-	5	15	130	2.0	5.9	Alluvial sand	

Note: 1. Water intake volume average value for June 2005
2. S.W.L stands for Static Water Level.

3. D.W.L stands for Dynamic Water Level.
4. O means "in use"

ii) *Rural and urban (reticulated / non-reticulated)*

For rural Solomon Islands excluding provincial towns and development centres that may be classed as urban; various types of water supply systems have been tried. Of them all, the following systems may be considered common sights

- Gravity feed systems
- Rain harvesting systems
- Hand dug wells or natural water holes with the use of hand pumps

Subject to the geographical nature of Solomon Islands; gravity feed systems are common place particularly where rivers, streams and springs are plentiful. Though gravity feed systems may be considered a norm, it is not the rule; since these systems are only practicable on the raised islands (main islands). Gravity feed systems are usually used by individual rural villages and sometimes by community villages. At present most rural communities can access water by stand-alone reticulated systems; however other community villages still rely on un-reticulated natural streams and springs.

Typical water sources for gravity feed systems are rivers, streams and springs. The basic infrastructure components of rural water supply systems operating under gravity are:

- Collection box/Intake dam
- Conveyance main
- Break pressure devices
- Storage structures (tanks)
- Reticulation lines
- Public stand taps

Isolated rural communities including smaller coral island villages are at present drawing water with hand-pumps from hand-dug shallow wells and water holes, or are harvesting rain water from roof structures.

The challenge is to develop a longer serving, if not, sustainable system to supply water for fringe smaller and coral island communities. This may require enhancement of rain water harvesting for better use of frequent tropical high intensity rainfall.

iii) *Water treatment systems*

There is no conventional treatment plant currently used for SIWA operations in urban centres. The only treatment process in use is disinfection using chlorine. The disinfection method mixes calcium hypochlorite in a solution tank and dosed into the mains or reservoir tanks at a certain rate. Normal concentration of free residual chlorine ranges from 8 or 9 ppm at the first house and 3 ppm at the end of the system.

The main quality issue for surface water sources is turbidity and high level of bacterial contamination particularly during and after rainfall. Most of the catchment is on customary land and SIWA has no control over activities taking place in it. Since people are unlikely to move from the catchment, the only alternative is to maintain safe drinking water with proper treatment process before distribution.

Full water treatment to remove turbidity and ensure disinfection is required to meet WHO drinking water standards. In addition to the basic filtration treatment, the dosing of alum in a settling tank to remove high turbidity levels and initial sedimentation of fine particles tank is recommended. After sedimentation, water will still need to be filtered and disinfected. Since the disinfection and alum dosing will reduce the pH level, dosing of soda ash for pH correction will be the final process. The above treatment process is recommended for urban centres and is much cheaper than other processes. It is anticipated that with these proposed treatment steps, water supplied by SIWA will meet the WHO drinking water standard.

Drinking water catchment protection and community education programmes are in place by SIWA because it is very important step in providing safe drinking water to consumers. SIWA realises the fact that providing high level of water treatment to make a contaminated source potable is very expensive in comparison to providing basic disinfection for a clean raw water source. A major set back to SIWA's catchment programme is that all land within the catchment belongs to either traditional landowners or the government. Land in some catchments are given to developers by the government while the landowners are free to do whatever they want on their land within the catchment even under the available catchment protection legislation.

2.4.2 Types of wastewater/sanitation systems

i) Rural and urban (onsite and reticulated)

There are two types of wastewater disposal systems identified in urban centres. These are:

- Conventional gravity sewerage system
- Septic tanks

Flush toilets are used in the urban centres with gravity sewage system or septic tanks system. Only Honiara has a gravity sewerage system and about 30% of the population is connected to it while the rest use onsite treatments in the form of septic tanks. There are 16 sewerage systems and each system is serviced with an outfall in the ocean. Composition of wastes is mostly domestic. Disposal of the waste involves channelling the raw effluent direct from customers' premises and transporting it to the sea where it is disposed by ocean currents at the edge of the continental shelf.

The systems is generally overloaded and in considerable poor condition. Reasons for this being: rapid development and increase in population; lack of maintenance; financial constraints; infiltration and connection of storm water drain to sewer mains; poor technical design and so on. New wastewater connections have continuously been added but whether they have the capacity to cope with increased growth has never been addressed.

ii) *Collection and treatment systems*

Most onsite wastewater treatment systems are conventional type, consisting of septic tank, soak hole and infiltration system. The septic tank system used in Honiara and other urban centres remove most of settleable and floatable material and function as an anaerobic bioreactor that promotes partial digestion of organic matters. Significant pathogens and nutrients are discharged into the soil and in the underlying soils. The topography of urban centres is a major concern because of unsuitable soils for proper filtration and the absence of hydraulic capacities. Many of the septic tanks are old, not properly designed or maintained to ensure long term performances. In addition many septic tanks (including

communal septics) are located near groundwater and surface waters (rivers). Many of these septic tanks are not adequate for minimising nitrate contamination of groundwater, removing phosphorous compounds and attenuating pathogens.

Individual users are responsible for maintenance and operation of septic tanks. Desludging work is usually done by the Town Councils or private companies. In general, individual septic tank owner meet the financial costs for maintenance and desludging. Sludge is either put back into the sewer main or into the ocean.

iii) *Mechanisms for handling and managing wastewater*

Rural communities around Solomon Islands with water supply systems have modest wastewater systems; those that opt for improved sanitation are also provided with sanitation systems. Wastewater systems in rural communities are soak-pits usually located onsite to drain wastewater at household or public stand taps. Improved sanitation systems include pit latrines with various improvements. Sanitation facilities with specialised designations include:

- Long-drop (ventilated improved pits - VIP)
- Squatting systems (basic pit latrine used with water)
- Raiser systems (basic pit with improved seat provision)
- Of lesser occurrence but often seen in private rural homes and at boarding establishments (educational institutions) are reticulated systems with septic provisions for those that can afford it.

For rural systems and settings, any scale of collection and treatment is yet to be realised. Common and current practice in rural communities is shifting from used pits (both soak-away and sanitation) to developing new ones. That of course has the negative impact of disfiguring village environmental surroundings.

The practicable mechanism for handling and managing wastewater used by rural communities is primarily soak-away pits. Of lesser use and not as common is drainage away from point of use to designated locations into natural holes and crevices in the ground, or into rivers and outfalls along the coast.

2.4.3 Major issues and concerns

i) *Water demand and supply*

The population within Honiara's boundary in 1999 was 48,833. However the ethnic tension at the time of the 1999 census resulted in many people leaving Honiara and returning to other provincial centres and villages.

The estimated number of households connected to domestic water services is more than 7,000. Two components of domestic service connection growth are considered. They are:

- Growth in services to match population growth; and
- Growth resulting from connection of existing dwellings without a water supply to the water supply system.

Based on recent JICA study on SIWA water and waste water system, the first component of the growth has been assumed to be equal to the population growth.

The average urban household size is seven and the daily water consumption per person is 150 L/p/d. This gives a daily average water consumption per household at about 1.05 KL. High water users (industrial) consume between 5,000 KL and 6,000 KL per day.

The result of a JICA field survey[1] concluded that the conditions of the water supply system in 2005 were as follows:

- About 50% of the water source depends on Kongulai Spring which is vulnerable to reduction of water intake volume by blockage of the inflow point (or sinkhole) of the source by heavy rain and vandalism.
- About 25% of the population in Honiara water distribution districts suffered from low pressure which resulted in residents not getting sufficient water during the day time.
- Capacity of the existing water reservoir is only about 5 hour-volume of daily maximum water demand.
- Water from spring sources is often contaminated with high turbidity after heavy rain in the catchment area of the sources.
- Un-served ratio is estimated as 30%. There are unserved areas beyond and within Honiara city boundaries. In Kombito area where spring and bore field water sources are located, the residents (estimated at 6,000) are not served. Getting water directly from the spring or river every day is a burden to household wives and children.

Table 3: Data for Water Supply Service for Honiara City in 2005

Code	Item	Unit	Data
A	Population inside town boundary	person	60,365
B	Population outside town boundary	person	6,037
C	Population in water supply service districts [A + B]	person	66,402
D	Served population	person	46,221
E	Served ratio [(D/C) x 100]	%	70
F	Revenue water ratio	%	57
G	Non-revenue water ratio	%	43
H	Leakage ratio	%	40
I	Effective water ratio [100-H]	%	60
J	Effective water consumption (distributed water— leakage)	M^3/day	15,431
	- Domestic	M^3/day	7,596
	- Commercial	M^3/day	4,390
	- Government	M^3/day	1,963
	- Major customers (hotel, school, hospitals, etc.)	M^3/day	1,482
K	Per capita water consumption for domestic customers	LCD	164
L	Per capita water demand for domestic customers	LCD	274
M	Maximum daily water demand	m^3/day	25,719

Note: Revenue water ratio = [(Billed metered consumption + Billed Unmetered consumption)/water distributed] x 100
Non revenue water ratio = [(Water distributed - Billed authorized consumption)/Water distributed] x 100

Urban water demand and usage patterns can only be accurately analysed with good meter reading, availability of metering information and accuracy of the available data. Bulk meter readings at the source and reservoir tanks could be compared with customers meter reading. However, SIWA's recorded readings are not totally reliable due to faulty meters, inaccurate readings and the fact that meter readers sometimes estimate readings for various reasons.

Daily water demand variations in urban centres:

[1] JICA 2006 field surveys as part of the project for Honiara water supply and sewerage systems rehabilitation.

- Unaccounted water loss of 40% is assumed as a constant flow over a 24 hour period.
- High water demands occur around 7.00 am when households are showering and getting ready for work or school.
- Large volume of water is used in the morning when carrying out household chores – laundry in particular.

Coverage by the RWSS Programme of water supply to rural communities is about 70%. This leaves 30% of the rural population still demanding access to water supply. Ensuring maintenance of water supply systems to the 70% that are already served and developing systems for the 30% that is yet to be covered is the primary issue of concern to service providers for rural areas including the RWSS Programme.

NGOs have increasingly played a significant role in assisting the government to address demands for maintenance of existing systems and; meeting requests by those yet to have access to water supply systems.

ii) *Water shortages*

Water shortage is normal in Honiara and other urban centres due to the fact that demand is higher than the supply. Contributing factors could also include; unreliable power supply, pumps not functioning to maximum capacity, not enough water sources, and old infrastructure and leakages.

The JICA 2005 report estimated unaccounted for water[2] at about 40%. This is made up of components including, pipe leaks and bursts, scouring of mains, leaking taps, leaking tanks and illegal connections. It is anticipated that if unaccounted for water is reduced dramatically, there will be increased supply to customers, reducing the high demand curve and thus minimising water shortages.

Water shortage as defined by international standards and definitions, may be applied to most rural local situations; as both quality and quantity of supply are varied for different reasons at different times for different locations. Water shortages have been experienced on numerous occasions, but durations of such events have never extended for longer than those of natural causes such as cyclonic events and natural disasters.

Of particular significance to rural communities at present is the issue of sea level rise, and the subsequent threat of salt water intrusion into thin freshwater lens for coastal communities and coral atoll dwellers. If left unchecked, this would become the major issue to impact on water shortage for fringe communities in the foreseeable future.

iii) *Human/financial resources*

The inter-human and financial resources medium is a more complex issue affecting water shortage that is of concern to providers of water supply to rural communities. Efforts to meet rural demand for water supply resonates obvious unavailability of resources in manpower, and more so finance. With the absence of instigating cost recovery mechanisms in operating rural systems; managing rural systems is a concern exacerbated by the unavailability of financial resources. The RWSS Programme is yet to have in-place any sort of cost recovery mechanism which would pave the way for sustainability in developing water supply systems for rural Solomon Islands.

[2] Unaccounted for water is water from which no revenue is obtained.

iv) *Threats to human health and to ecosystem welfare*

Water pollution due to poor wastewater management is of concern in urban centres, especially Honiara. Increases in development and residential housing in some catchments are threatening the quality of the water. Most bore holes are located in the plains, surrounded by houses along the ridges. Most of the houses are using septic tank systems and are experiencing overflows and the effects are the same for sewered systems. Wastewater leachate in the soil from soak holes could find their way into the aquifer in which bores are tapped from. Faecal coliform and high nutrients detected in the samples taken from bores during heavy rains further prove contamination from the wastewater systems.

In regards to rural areas, the threat of wastewater management to water resources is yet to be an issue of major concern. The sole cause for this positive effect is the absence of wastewater treatment facilities; more so with the non-existence of any such facilities in the interior rural areas.

As mentioned earlier, sewerage infrastructure in Honiara is very old and evidence of systems in need of major improvement occur during heavy rains when blockages and overflows are common as a result of storm water infiltration and reduced capacity to cope with increased urban growth.

System overflows occur at manholes and inspection pits located along the main roads and residential areas. The effluent that spills from such overflows usually remain in the properties, are covered up with soils and flushed out during heavy rains. This poses potential risks to public health. SIWA is currently under-resourced to cope with this situation.

Areas served with septic tank systems, also experience overflows and effects are the same as for sewered systems. With septic tank systems, the situation is more pronounced as they are numerous; and scattered all over Honiara and other urban centres, and could happen at a number of locations each day. Provincial authorities and the Honiara City Council who are responsible for septic systems in urban centres, are under-resourced to cope with the situation. Outbreak occurrences of diarrhoea in some cases could be directly linked to the poor wastewater infrastructure and management system.

The RWSS Programme strives to attain a quality health-wise approach in its execution of functions through promotion of responsible management as relevant to human health. Promoting health to rural population can be challenging at the best of times, particularly when it is linked to managing wastewater. Communities and specifically some rural people at times never think it serious to look at wastewater as their primary concern is water accessibility to their homes, An unintentional ignorance for managing wastewater usually results in human health infections and disease outbreaks. For instance, water related infections and diseases including, but not limited to diarrhoea and the ever present malarial parasite are major concerns with links to wastewater management. In saying this, we have also realised a weakness in the programme capacity to gather, store, manage, and disseminate relevant information that should mitigate the disparity with events of outbreaks to their real causes.

2.4.4 Measures to manage impacts and concerns (IWRM approaches)

i) *Pollution from poorly managed wastewater treatment and/or discharges*

There are Acts of Parliament with provisions, given that they are implemented, that could address with adequacy concerns relevant to preventing pollution from poorly managed wastewater treatment and/or discharges.

Realised and perceived fragmentation to administration and management of water resources and water related services have resulted from causes deeply rooted in organisational structuring. A mitigating measure to address this fragmentation would range from key stakeholder organisation and 'structural adjustments' to refocusing on priority areas to IWRM approaches.

In urban centres, the following administrative and technical measures are important and should be pursued.

- Implementation of relevant legislation; Public Health Act, Environment Act.
- Coordination between utility providers, town planners and developers.
- Having improved wastewater reticulation systems.
- Wastewater treatment via reticulated system.

ii) Water conservation measures.

What is lacking at present for conserving water yield in its natural state may be realised in enforcing readily available provisions under existing Acts. There is adequate provision, certainly with room for improvement for detailing measures and technical methodologies for water conservation. Water conservation in regard to IWRM would require a cross-sectoral multidisciplinary approach. That again would call for refinements to identified stakeholders organisational structures.

Unaccounted for water in urban areas is around 40% which is cause for concern and suggests poor water conservation practices or metering deficiencies. As a general environmental principle, the promotion of water conservation measures, include leakage management and water use awareness. SIWA currently has its own community programme on water conservation, targeting both domestic and commercial customers. The main aim of SIWA's conservation programme is for water users to reduce water consumption, and therefore enable savings and postpone major constructions. As a result of this postponement, ratepayers will not have to carry the cost of infrastructure works in the near future.

iii) *Appropriate technologies and methods*

Appropriate technologies and methods are keys to effective management of water and wastewater services both in urban and rural areas. Water conservation practices are difficult to implement if water supply systems are not maintained. Maintenance and replacement of aging infrastructure are key management tools to ensuring efficiencies in the water services.

Having appropriate and efficient technology is crucial to implementation of plans and programmes to provide effective services to the public. In addition technicians must be able to maintain new technology through proper training to ensure operational procedures are followed for best performance of technologies.

iv) *Existing Geographical Information Systems (GIS) on water resources*

The GIS group in Solomon Islands consists of various organisations that use GIS for data management and other purposes. These organisations include:

- Ministry of Mines and Energy for water catchment data (data input on-going);
- Ministry of Health and Medical Services for water services and sanitation in the rural areas;

- Ministry of Lands and Housing for information relating to topographic maps;
- Ministry of Forests, Environment and Conservation for data relating to forestry including topographic and catchment area maps;
- Ministry of Agriculture and Livestock for irrigation data (limited);
- Stakeholders (e.g. water and power services, industries, mining, agricultural, NGOs and education institutions) for data relevant to their functions.

There has been a marked increase in the use of GIS as a data management tool and database. One of the reasons is the increasing demand for high quality data from public or individuals for their own purposes.

The recent in-country training on GIS by SOPAC for the GIS group provided opportunities for individual organisations to expand their current GIS capability. The Ministry of Mines and Energy recently constructed its own website to maintain information useful to the general public and to other organisations for their own purposes.

2.5 Institutional Arrangements

2.5.1 Types of institutional arrangements

i) National Water Vision

The long-established perception that water is an infinite resource is not consistent with sound stewardship and the need to seriously protect and conserve our environment's precious natural resource for future generations to enjoy is very important.

The national vision in relation to water is to have clean and sustainable water accessible to present and future generations of Solomon Islands, thus improving the standard of living and eradicating poverty. To achieve this vision it is important to consider the priorities, obstacles and constraints of each of the issues affecting the water sector. Some of these issues are outlined in the Pacific Regional Action Plan for sustainable water resource management. Each country is expected to undertake programmes and projects that will contribute towards the successful implementation of the regional action plan. Other regional programmes such as water governance are also contributing towards achieving the national vision.

The government recognises the importance of safe water supply to its population to promote health, social and economic development in Solomon Islands. The implementation of sectoral programmes ensures every Solomon Islander has equal access to sustainable, adequate and good quality water and in partnership with all stakeholders, to ensure the sustainable development, management and supply of water, wastewater services as well as appropriate sanitation for the benefit of current and future generations of Solomon Islanders.

ii) National Water Committee and composition

The Water Resources Steering Committee established in the early 1990s was replaced by the "Core Water Working Group" established to implement the Solomon Islands Water Governance Project which ended in December 2006. The purpose of the committee was to deliberate on matters that affect water resources management and water services in general.

There is a review of the old River Waters Act to replace with a proposed Water Resources Act. Under the proposed Act there is provision for the establishment of a Water Resources Advisory Board, which shall, subject to the provisions of the Act, be responsible for general matters relating to the administration of the Act. The composition of the Board would be as follows:

(a) Chairperson appointed by the Cabinet on the advice of the Minister responsible for the water resources.

(b) Government representative as follows:

i) Permanent Secretary, Ministry of Mines and Energy

ii) Head of Water Resources, Ministry of Mines and Energy

iii) Representative, Ministry of Health

iv) Representative, Ministry of Lands

(c) Community representatives as follows:

i) Representative from NGOs

ii) Representative from Chamber of Commerce

iii) Representative from Women Council

iv) Representative from National Churches

v) Representative from the Provincial Government or Town Council

vi) Representative from Area Council.

vii) Representative from the landowners.

The Board would have the following functions and powers:

(a) to advise the Minister on the issuing of licenses and other matters required under this Act

(b) to steer a process of water reform and make proposals on major water policy issues

(c) to review information on water resources and the water sector in general

(d) to recommend water related investigation programmes and projects

(e) to recommend fees and charges required under the Act

(f) to respond to activities relating to operations of any water utilities

(g) to propose mechanism by which water license fees are paid and collected

(h) to assist in the determination of compensation claims relating to use of water or protection of water catchments or to compensation against commercial use of water

(i) To advise on or approve national or regional water management measures such as plans, special area controls, guidelines for water abstraction and protection

(j) to take any action which it deems necessary or desirable to facilitate the functions of the Board

(k) to inform where appropriate, landowners or land holding groups affected by operations to be carried out, in terms of licenses granted under the Act.

iii) *National Water Resources and National Water Services Policy*

The Solomon Islands currently has no water policy. Realising the urgent need to have one following increased developmental activities, a draft National Water Policy has been prepared as one of the pilot projects under the Solomon Islands Water Governance Project funded by EU Water Facility and implemented by SOPAC.

The policy discusses the current status of Solomon Island's water sector and provides a broad set of strategies, designed to guide the sector's development and focusing on ensuring that the needs and aspirations of the people of Solomon Islands are met. The objectives of the policy will facilitate an enabling environment that encompasses an integrated multi-sectoral approach to sustainable water management.

The policy addresses two main sub-sectors - water resources management and water (and sanitation) services.

iv) *Water related legislation*

The existing legislation in the Solomon Islands that govern and impact on the water resource management include the following:

- River Waters Ordinance 1969: provides measures for watershed control in relation to rivers only and regulates the use of designated river water through permit applications.
- Environment Act 1998: provides for the protection, preservation and conservation of the environment, including the prevention and control of pollution to water.
- Public Health Ordinance 1970: authorises inspections to be conducted for the regulation of water pollution.
- Solomon Islands Water Authority Act 1992: provides for the establishment of Solomon Islands Water Authority for provision of proper management and development of urban water and wastewater services throughout the country.
- Environmental Health Act and Provincial Ordinance: provides for the control and management of water and sanitation services in the rural areas of the country.
- Lands and Titles Act: provides for the allocation and control of registered land.
- Forestry Act: provides for proper development and management of forestry sector in the country.
- Mines and Minerals Act: provides for the promotion and management of mineral development in Solomon Islands.
- Draft Water Resources Act (2006): for provision of water resources management in Solomon Islands.

Under these Acts, each government institution has vested responsibilities to enforce actions against activities likely to have adverse impact on the quality and quantity of water resources. Efforts are made to supplement the existing River Waters Act by drafting the proposed Water Resources Act to cover all water resources in the country. This would then enable the government to draw up a water resources policy.

v) *Mandated legislative and policy documents*

Table 4 provides a summary of legislative and policy documents that provide appropriate mandates for various institutions with water and water related functions in Solomon Islands.

Table 4: Legislative and policy documents

Mandate	Water Functions	Organisations/institutions responsibilities	Formulation
River Waters Act Draft Water Resources Policy	Water resources management	Ministry of Mines and Energy	Act of Parliament Cabinet
Environmental Act National Environmental Management Strategy (NEMS)	Watershed protection Environmental Protection	Ministry of Forests, Environment and Conservation	Act of Parliament Cabinet
SIWA Act Urban water management policy	Urban water and wastewater services	SIWA	Act of Parliament SIWA Board
Environmental Health Act	Rural water supply and sanitation services	Rural area: Ministry of Health (RWSS)	Act of Parliament
Honiara City Council By Laws	Septic tank collection	Honiara City Council and a private company	Act of Parliament
Public Health Ordinance SIWA Act	Water quality monitoring	Ministry of Health Environmental Health SIWA	Act of Parliament
SIEA[3] Act	Hydro power generation	Ministry of Mines and Energy/SIEA: Others – rural electrification	Act of Parliament
Agriculture Act	Irrigation water	Ministry of Agriculture	Act of Parliament

vi) *Monitoring and enforcement*

Where legislation exists and provides for control mechanisms, there is a lack of resources to enforce the law. For example, the Environment Act provides provision for environmental impact assessments (EIA) and pre-environmental assessment reports (PEAR) to be conducted for any development however, this requirement cannot be applied due to the lack of human and financial resources.

The drafting of a new comprehensive Water Resources Act will not solve water issues, if the law is not applied effectively. Therefore this should be considered as part of a global water resources strategy supported by adequate funding and capacity building for implementation.

The fragmented water functions in the water sector further inflict burdens on the effective management of water resources through proper control and monitoring. The government needs to establish clear guidelines of responsibilities to avoid confusion and better cohesion in the administration of this sector.

The ineffectiveness of control and monitoring mechanisms provided under legislation and which are supposed to be effective has its own shortfall due to organisational management inefficiencies. Other major problems that can result in shortfalls in control and monitoring mechanisms of the act include:

- Lack of sufficient financial support to enforce the law;

[3] Solomon Islands Electricity Authority

- Lack of human resources;
- Management inefficiencies;
- Political interference;
- No clear guidelines to enforce regulations, and
- Duplication of responsibilities thus less emphases on the sector

vii) *Commitments to multilateral and environmental agreements (MEAs)*

Solomon Islands is signatory to many regional and international conventions/agreements and has national responsibilities to fulfil their requirements. Successive governments, have prioritised the water sector, especially provision of safe and reliable water supplies to rural communities and urban centres. However there was little emphasis on water resources management and infrastructure rehabilitation to ensure the sustainable water and wastewater services.

In Solomon Islands various institutions/organisations that have responsibilities for water have undertaken programmes and projects which focused on safe and reliable water services to the general population. Studies have also taken place in the areas of water resources to promote the use of the resource for human consumption and power generation.

Evidence exists in Solomon Islands that the quality and quantity of fresh water is reducing. The rate of reduction is not very well understood because of inadequate data and limited understanding of local hydrology and water resources.

There are linkages in water related legislation for the protection of water resources and the natural environment in general. In order to fulfil their statutory obligations as required under various national legislations organisations and institutions must work more closely through a more coordinated approach to address issues affecting the country and to fulfil other obligations as required by the various conventions/agreements that Solomon Islands is signatory.

With fragmented organisations and no clear responsibilities related to water resources the fulfilment of national and international obligations can be somewhat difficult. However, Solomon Islands is continuing to prioritise environmental protection and management issues to ensure adequate emphasis on water and wastewater services in the country.

Solomon Islands is party to the following international environment conventions:

- Convention for the protection of Ozone Layer (1985);
- Convention on Climate Change (1992);
- Convention for the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (1972) [London Dumping Convention];
- Convention for the Prohibition of Fisheries with Long Driftnets in the South Pacific (1989);
- South Pacific Forum Fisheries Agency Convention (1979);
- International Convention for the Prevention of Pollution from Ships (1973) and its 1978 Protocol;
- United Nations Convention on the Law of the Sea (1982) (signed? ratified?);

- South Pacific Nuclear Free Zone Treaty (1985);
- Convention on Biological Diversity;
- The Niue Treaty between Tonga and Tuvalu on Cooperation in Fisheries Surveillance and Law Enforcement (1993);
- Convention for the Protection of Natural Resources and Environment of the South Pacific Region (1986) and related Protocols [SPREP Convention]

2.5.2 Major issues and concerns

i) *Capacity shortfalls*

The effect of little coordination in the water sector is owed largely to fragmentation and unintentional institutional isolationism practices. In addition the impact of government's 'low priority' status given to water provides little incentive to improve administrative and managerial mechanisms in the water sector.

The absence of a comprehensive and encompassing legislation for water resources management is also causing problems in the overall management of water and wastewater services in the country.

Instrumentation is a major problem in the implementation of water resources assessment programme especially for the hydrological monitoring programme which is a prerequisite for effective water resources management. Hydrological recording instruments are too expensive to acquire under current national government funding for the water sector. Further to this support services tend to be poor as services and maintenance for equipment are only available overseas which again is very expensive.

In summary there is urgent action required to seriously address shortfalls to ensure there is sustainable and effective water and wastewater services in the country.

- Capacity building and manpower - limited qualified staff
- Finance - insufficient financial support from government
- Scattered isolation of islands – expensive to maintain hydrological monitoring programme
- Data storage facility - lack of capacity and support services
- Instrumentation/Equipment - very expensive equipment and support services
- Policy and legislation - lack of workable policy and legislation
- Land issues - access to customary lands to carry out assessment

2.5.3 Measures to manage impacts and concerns (IWRM approaches)

i) *Institutional, policy and legislation*

There are acts of parliament with provisions, given their implementation that could address with adequacy concerns relevant to preventing pollution from poorly managed wastewater treatment and/or discharges.

A mitigating measure to address fragmentation to administration of water resources as has been repeatedly experienced would range from key stakeholder organisation, 'structural adjustments' to refocusing on priority areas to IWRM approaches.

Solomon Islands lacks an effective institutional framework to better address the environmental issues that are affecting the country today. This is vital to be able to jointly address the various issues relating to the protection of the environment and water resources. The current fragmented institutions with water related functions has placed water sector in adverse position in relation to government policy. As seen in the past, successive governments have always placed low priority on the water sector.

Solomon Islands warrants comprehensive policies and legislations to manage and control the different stages of social and economic development in the country and to meet requirements for regional and international conventions and agreements.

In addition to legislative requirements the public (resource owners) expectations on monitoring and compliance level must be addressed as well. This necessitates effective legislative framework in place for the sound management and control of activities likely to have adverse impacts on the natural environment which in turn will impact water resources management and sustainability of the resource.

ii) *Capacity building*

The lack of technical capability to undertake applied research and hydrological investigations to better understand the hydrological characteristics of concerned catchments in the country is on-going problem. Worse still is the limited manpower (graduate) available to undertake technical related studies in the field of water resources and hydrology.

In addition the limited basic knowledge on the importance of water resources has been seen as one of the major contributing factors resulting in the poor management of water resources. However, lack of appropriate training is not the only limiting factor in the water sector but it is clear that improved training which is relevant, practical and accessible must be in place before we can achieve sustainability.

Water management must adopt an integrated approach, taking into account a wide range of ecological, economic and social factors and needs. Decision-making should include full public participation with all sectors of society.

Solomon Islands has yet to establish a well practicable system to managing its water resource. Policies and legislation are very old and have been found to be ineffective and inadequate in the proper management and administration of water issues. There should be on-going training for technical personnel to maintain the level of understanding of current day issues in order to fulfil the national requirements of the country.

2.6 Financing

2.6.1 Types of financing arrangements

i) *Funding/revenue sources for water supply and wastewater management.*

In Solomon Islands water supply and wastewater management are controlled by Solomon Islands Water Authority (SIWA) and the Environmental Health Division of the Ministry of Health and Medical Services. SIWA is responsible for urban water and wastewater services while the Environmental Health Division coordinates the Rural Water Supply and Sanitation Programme in the rural areas.

SIWA aims to deliver and levy commercially viable charges for urban water industry services and products within its declared areas of operation in a sustainable and environmentally responsible manner consistent with policies on good governance, transparency and accountability, while observing the cultural and social values of Solomon Islands.

SIWA is a statutory body under the Ministry of Mines and Energy but manages its own financial matters through the SIWA Board of Directors. Funding for all its operations is recovered from costs and tariffs for the water and wastewater services it provides to urban populations; mostly from four urban centres out of the nine provinces.

To date SIWA's financial resources are largely restricted by the energy costs related to all its water pumping stations. SIWA is currently investigating investment possibilities in a conventional water treatment plant to improve the quality of its water supply and to reduce energy costs through gravity feeding systems. Currently there is limited treatment which results in turbid water during rainy periods.

SIWA's aging infrastructure results in excessive leakage which is an added burden to SIWAs already constrained financial capability. As a result re-investment into infrastructure rehabilitation and development is not an option however, through donor assistance from Australia and Japan, SIWA has been able to rehabilitate some of its water supply infrastructures.

The cost of electricity for pumping water is very expensive and this affects SIWA's services in terms of meeting growing water demands of the urban centres. Increasing fuel costs makes it even harder to cope with the maintenance and operation of aging water supply and sewerage systems. At the moment, finance is the main constraint affecting SIWA's developments, and its ability to deliver reliable water and wastewater services.

Rural water supply and sanitation is subsidised through government funding and overseas donors. Most funding is from overseas donors; mainly Australia, New Zealand, EU, Canada, Japan and the Republic of China. While donors fund the projects, the administration and management of disbursement of funds is done through the normal government financial system under the Ministry of Health and Medical Services.

The rural water supply and sanitation services does not involve levy for revenue however, the community themselves set up committees to ensure funds are available through fundraising and donation by community members to maintain the water supply infrastructure.

ii) *Sources of external/ international funding*

Funding support from donor agencies over the years for water and wastewater services have been for infrastructure development, capacity building and equipment.

Most funding in the water sector has been in the form of development projects between the Solomon Islands government and the donor government through mutual agreement and exchange of information and personnel for the design study and construction phase.

The rural water supply and sanitation services funding facility is on-going through Ministry of Health and Medical Services while SIWA currently enjoys on-going support from the Government of Japan for infrastructure rehabilitation for water and wastewater services throughout the urban areas where SIWA is currently operating.

iii) *Tariff structures*

SIWA is a water and wastewater service provider established under an Act of Parliament in 1992 therefore the tariffs for the services it provides must be affordable to all urban people. Similarly the tariff must take into account cost recovery to ensure reliability and sustainability of the services it provides to its customers.

iv) *Economic value of water at the national level*

Water may not have economic value at its natural location, until it is developed and transmitted to demand areas. As soon as there is a demand for water there is economic value placed upon this water which is why there is levy on water supply services in the urban areas.

There is currently a perception by some people that water is gift and everybody has the right to use it without realising that water becomes a resource with economic value when developed and distributed to demand centres. This must be changed if we are to achieve effective water resources management and protect from over-exploitation.

v) *Subsidies*

The only subsidy facility for water supply is for rural water supply and sanitation development. This is only applicable to programmes implemented by the Rural Water Supply and Sanitation Programme in rural areas. This facility provides provision for community participation which promotes community ownership, obligation and maintenance responsibility by community members.

Subsidy in Solomon Islands involves community contribution for up to 25% of the total cost of the project funding which the project community must fulfil before any project material is transported to the project site.

2.6.2 Major issues and concerns

i) *Difficulties with the current financing arrangements*

The Solomon Islands Water Authority relies on the revenue from water and wastewater services levy to maintain its operations. Although there is a proper revenue collection policy in place there is a problem collecting revenue to sustain the operation of the authority especially to maintain its administration and management overheads.

The major problem of revenue collection in Solomon Islands is related to customers refusing to pay their bills on time. This delay in bill payments affects financial resources available to service the administration and management overheads.

2.6.3 Measures to manage impacts and concerns (IWRM approaches)

i) *Regulatory oversight*

Although there is currently a recovery policy for unpaid bills, revenue collection is still causing problems for service providers like SIWA. There have been cases where customers take advantage of weak law enforcement to monitor and control illegal activities that severely affect the effective management of water resources.

ii) *Funding and cost recovery systems*

Currently SIWA's tariff structure incorporates cost recovery systems to ensure revenue collected covers operational and administration costs. The main problem is restricted to unfavourable revenue collection due to unpaid bills.

iii) *Public Private Partnerships*

Public Private Partnerships (PPP) may be an effective tool but Solomon Islands is not yet ready for implementing such a system. The government's control of activities of the private sector is limited compared to public enterprises. The government does not want to see water services tariffs increased to a level that low and average income earners face problems with bill payments.

However, the government is examining ways to involve resource owners to be part of investment opportunities within the catchment.

Linkages to other areas

3.1 Land use and Agriculture

i) Need for land use policy

The Ministry of Agriculture and Livestock currently does not have an existing land-use policy with special emphasis on water resources, wastewater management and water source protection.

With the aim of the current government in the bottom up approach of national development, the Ministry is currently faced with the urgency to facilitate agriculture development in the rural areas, and in the absence of a land-use policy there would be a strain on environmental and water resources as a result of large scale agriculture developments.

Currently there exist conflicts in relation to land use changes within watersheds. There has been intrusions in the watershed areas caused by over pumping of groundwater in and around Honiara as well as in the provincial areas. Also the land use on the watershed areas of most rivers and creeks have been destroyed by logging and mining operations. Severe erosions are observed in parts of deforested watersheds. Logs that were cut down and debris cause damages to infrastructure downstream particularly bridges.

ii) *Impact of land use on source protection*

Land uses within the watershed area greatly affect the velocity of water run-off. When the watershed is densely covered the velocity of run-off toward the low portion is slow and as a result infiltration is great. When water infiltration is great it increases groundwater that sustains the water discharge of a certain creeks or rivers.

While on cleared land the velocity of run-off is fast and erosion is great. Landuse practices in the watershed catchment area determines the quantity and quality of water discharge of rivers or creeks as a source of water use.

iii) *Importance of irrigation with respect to water use at the national level*

Irrigation in agriculture is an important input to increase crop production. Even with adequate supply of other inputs, crop production particularly rice will still remain at low level if there is inadequate water in the area. Planting high yielding variety crops depends heavily on the adequate supply of irrigation water for maximum production.

Drainage will occur through run-off to gullies, creeks or rivers when excess rain water is present on the field. Irrigation systems are regulated according to the water requirement of a certain crop. Water can only be lost through seepage, infiltration and evaporation.

iv) *Distribution of rain-fed agriculture and irrigated agriculture*

Rice is the only crop that is currently farmed using irrigated agriculture, all other crops are rain-fed. There are currently six irrigated rice projects with a total area of 35.4 hectares.

- ROC Farm, King George VI School (3 ha)
- PEFA land King George VI School (15 currently only 4ha is being used)
- Don Bosco Tetere (currently 6.4 ha to be extended to 20 ha)
- Tenaru School (current 3 ha to be expanded to 10 ha)
- Loa farm Malaita province (5 ha currently not in operation due to management conflict)
- Fiu rice farm Malaita province (3 ha)

Table 5: Distribution of rain-fed and irrigated farming in SI

Province	Area (Ha)		Total Area (Ha)
	Rain-fed	Irrigated	
Malaita	185	3	188
Guadalcanal	38	16	54
Western	45		45
Isabel	64		64
Choiseul	65		65
Makira	109		109
Temotu	87		87
Central	10		10
Renbel	1		1
Total	604	19	623

v) *Plans to increase food production through irrigation or rain-fed agriculture*

The majority of the country's food production relies on rain fed agriculture. Solomon Islands Government's (SIG) funded National Rural Rice Development Programme aims to establish a total of 150 hectares of irrigated rice fields throughout the country in five years. The project started in 2006. Plans are also underway to rehabilitate the 200 hectare Metapona Rice Project in the Guadalcanal plain.

vi) *Impact of land based pollution on watershed management*

The need to integrate watershed and coastal management in the context of integrated water management is based on the understanding that no one system is a separate standalone unit. Any activities in the upper watershed region, whether anthropogenic or natural will certainly have some effect on the coastal environment.

Logging and mining activities cause large clearances of land, removing vegetation and exposing soil thus increasing surface runoff and greater erosion in times of heavy rainfall. Greater runoff can lead to increased sedimentation of rivers causing changes to the watershed which will further affect the ecosystems that depend on this area for survival. Most of the debris from the sites will end up in the coastal areas during flooding which will further affect the marine ecosystem. All life depends on each other and if one is affected then the rest will experience similar problems.

Land based pollution will affect receiving water bodies; rivers/streams, lakes and coastal water bodies. The management of watershed takes into account land and coastal management. By controlling land based pollution there should be fewer burdens on the overall integrated watershed and coastal management.

vii) *Main sources of land-based pollution of watersheds*

The excessive use of pesticides/insecticides, weedicide and inorganic/organic fertilisers is the main source of land-based pollution in agricultural development.

For example, commercial and subsistence farming on the Guadalcanal Plains tend to use significant amounts of fertilisers on the crops to help the plants grow well. Through percolation these inorganic/organic will enter the groundwater aquifer, whilst runoff will wash it down to the rivers or nearby tributaries. Not only that but pesticides/insecticides and weedicide will also end up in the same way. All these will affect the watershed if no proper measures are put in place.

viii) *Impacts of deforestation and sedimentation on watershed*

Deforestation denudes the watershed and can cause severe erosion resulting in increased sediment yield of the drainage systems (streams/rivers) significantly decreasing their capacity thereby flooding agricultural areas. The mine tailings or wastes made up of crushed rocks, chemicals and traces of metals when recklessly dumped, leads to siltation as well as poisoning of rivers, rice fields and coastal areas.

An example of this can be seen in Malaita (West Kwaio in the 1990s) where logging is the main income for the landowners. Heavy logging operations removed large tracts of virgin forest causing extensive damage to the environment and the watersheds. Today, most of the rivers have dried up, tributaries are filled with sediment and ecosystems severely effected. All this can be attributed as a result of deforestation of watershed catchment areas.

3.2. Habitats and ecosystems

Biodiversity

Solomon Islands has extraordinary biodiversity. The Islands have a unique flora and fauna retaining complete complex ecosystems and habitats ranging form diverse marine life to terrestrial deep forest dwelling colonies. There is wide range of ecosystems, habitats and faunal and floral species situated in every setting of the islands. Islands with shorelines of coral reefs, rising atolls, mangrove forest and deep green forests inland. Terrestrial rivers and streams in lower contours hold diverse aquatic species wrapping up the uniqueness of Solomon Islands biodiversity.

Ecosystem and habitat types

Solomon Islands have many unique ecosystems which accommodate habitats for different species of floral and faunal organisms. The terrestrial ecosystem encompasses land plants and animals; and the country's marine ecosystem is diverse with onshore coastal-reefs and deep marine organisms.

For this purpose, critical ecosystems and habitats are regarded as economically valuable, nutritionally important, relatively rare, sedentary and easy to exploit and exhaust. They are vulnerable and very fragile and need a lot of attention. Such occurrence of ecosystems and habitats indicates the significance, endemicity, rarity and uncommonness of these species in Solomon Islands.

Commonly known ecosystem (habitat) types and their associate species are briefly discussed. Possible threats to existence of these faunal and floral organisms are also mentioned.

i) *Critical ecosystems and habitats*

Marine ecosystems

Coastal reef ecosystem

Marine reef ecosystems are diverse and display a richness of marine organisms that are important to the marine ecosystem itself and surrounding communities. Solomon Islands have many islands surrounded by various reef ecosystems that consist of various habitats with variety of marine species that can be regarded significant and critical.

Ecosystem and habitat status:

Coastal reef ecosystems are been degraded because of continuous exploitation for food and marine products to serve commercial purposes. This in turn poses uncertainty on the status of many of these marine species. Likewise, the use of unsustainable and destructive harvesting methods also threatens the richness of many reef ecosystems in Solomon Islands (Lam 1997).

Associate species

Documented and studied species associated with marine coastal and coral reef ecosystems are briefly indicated:

a). Turtles

There are about 6-8 species of turtles commonly found in the Indo-Pacific region. In Solomon Islands there are seven species of sea turtles representing two families, *Cheloniidae* and *Dermochelyidae*, and are the only living members of what has been a large and diverse marine radiation of *Crytodirans* turtles. The seven species include the Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*), Kemp's ridley (*Lepidochelys kempii*), Olive ridley (*Lepidochelys olivacea*), Flatback (*Natator depressus*) and the Leatherback (*Dermochelys coriacea*). In Solomon Islands only three species are commonly found feeding or nesting. They are the Hawksbill, Green and Leatherback turtles.

Leatherback turtles are rarely found while the Hawksbill and Green turtles remain endangered and threatened species because of its demand (Leary 1990). This requires urgent attention.

The Arnavon Marine Protected Area on Isabel Province is a turtle conservation area. This is a community based initiative and their plan is to safeguard the endangered green turtle from over harvesting. At the moment there is a ban on harvesting of green turtle enforced by fines/punishment imposed by the community. Fishing on the islands is also controlled to promote conservation practices. Only during certain times of the year that fishing is allowed to the village community. Any other times the island is under conservation.

b). Dugong

Only one observed during a survey Solomon Islands Marine Assessment (SIMA, 2004) indicating a rare and endangered species. This marine organism needs extra protection and conservation (South and Skelton 2000).

c). Cetaceans

10 species sighted by Solomon Islands Cetacean Research Ecological Assessment (SIMA 2004). Cetaceans are vulnerable in the Asia Pacific region according to an IUCN 2003 report. Several species of whales are suspected to have occurred in Solomon Islands, which include Humpback, Sperm, Pacific Blue whales classified by IUCN as vulnerable. The regarded endangered whales are fin whales, Blue and Sei whales.

d) Corals

A remarkably high total number of 494 species of corals were recorded by Solomon Islands Marine Assessment (SIMA 2004). A total of 484 known species and nine unknown species which may be, regarded as new species. This is second highest to Raja Ampat Island anywhere in the world. However, coral death been observed on a few sites due to blast fishing, bleaching and sedimentation.

Coral Reef Fish

SIMA reports Solomon Islands having one of the highest concentrations of reef fish fauna in the world with a recorded 1019 fish species from both survey and museum collection. Apparently, only three other sites in the world could have more species. Although fish diversity is high, over-harvesting and fishing could threaten fish diversity in Solomon Islands.

Some of the large and vulnerable reef fishes surveyed as indicated in SIMA technical report include:

- Sharks (all species)
- Maori wrasse (*Chelius undulates*)
- Humphead parrotfish and steephead parrot fish
- Large groupers
- Giant trevally
- Large and uncommon emperors.

These reef fishes are regarded commercial and can be threatened if there is continuous and massive over-harvesting is practiced and not stopped.

Marine Invertebrates

SIMA reports, following their research survey, which identifies marine invertebrates as: 19 species of sea cucumber, 10 species of bivalves (6 species of giant clamshells and oyster shell), 4 species of gastropods (Trochus and trochus-like species and triton shell) and 3 species of lobster and coral predator crown of thorns starfish (*Acanthaster planci*). Spiny Lobster (several species) and Green Snails are regarded as highly endangered and threatened species (South and Skelton 2000). Gastropods and bivalves can be threatened if unsustainable harvesting continues for commercial purposes.

Seagrass Beds

This can be regarded as an ecosystem of its own as it has different species of seagrass and provides habitats for species of marine organisms.. SIMA reports three species according to Green and Short (2003) while Johnston (1983) and Womersley and Baily (1969) suggest at least seven . A survey by Coles and Long (DATE) predict about 5-10 species.

Associated species

Marine aquatic species confined to seagrass ecosystems have never been classified, however, it is known for providing habitat and shelter for most of the species of organisms as mentioned above.

Mangrove ecosystems

The mangrove area in Solomon Islands is limited due to a lack of suitable intertidal habitats. Hansell and Wall (1976) mapped 642-650 km^2 (64,200 ha) of mangroves which account, approximately, 2.6 percent of total forest area. Mangrove areas are found on almost all islands: Marau Sound (Guadalcanal); Lau, Langa langa, Are Are and Maramasike lagoon (Malaita); Santa Criostobal (Makira), southern shores of New Georgia, Marovo Lagoon (Western Province); and Western Isabel and Arnavon Island. Abundant stands of mangrove in Choiseul occurs on Southeastern, Wagina and Rob Roy Island. Florida islands in passages separating Ngella Sule and Nggela Pile has dense mangrove ecosystems.

Ecosystem and habitat status:

Mangroves are critical ecosystems in Solomon Islands as they nurture vast and diverse marine aquatic organisms and plants. They are found mainly on saline tropical shores and are regarded threatened and endangered because of its current exploitation (agriculture), especially for commercial purposes and increasing demands from rapidly growing populations (Scott 1993).

Associate faunal species

Mangrove species that are harvested daily and could be threatened are mangrove (Mud) crabs and oyster. Associate saltwater crocodile (*Crocodylus porosus)* are threatened in Solomon Islands (Messel and King 1989). Comprehensive research has never been conducted to define the conservation status of many of these mangrove faunal species.

Associate floral species

Mangrove forest

Reports have identified 55 mangrove species belonging to 11 families and 16 genera (Chapman 1970). Others, (Sanger et al. 1983) record 60 species drawn from 16 families and 22 genera recording five more. Further studies show that Solomon Islands have 26 species of mangroves, which belongs to 13 families and 15 genera. This represents 43% of the world's mangroves highlighting Solomon Islands exceptional mangrove richness. *Rhizophera*, *Bruguiera* and *Lumnitzera* dominate Solomon Islands mangrove flora.

Lagoons and beaches

Lagoon and beach ecosystems are associated with coral/reef ecosystems and mangrove areas. It is expected that these ecosystems share the same faunal species and possibly similar flora. The associate species should have the same conservation status as for reef and mangrove ecosystems. Solomon Islands unique and largest lagoon is Marovo which has been proposed to be listed as a World Heritage Site.

Freshwater ecosystems

The many islands have fresh water rivers, streams, swamps and lakes, which holds unique biotic component of the islands biodiversity.

Freshwater (Rivers)/ Lakes and Swamps

There is very little to no information or data on freshwater, swamps and lake ecosystem in Solomon Islands. Knowledge of faunal species in these habitats is lacking at the present.

Associate species

Possible associate organisms are aquatic shrimps, eel fish and other fish species.

Ecosystem and habitat status

There are some freshwater ecosystems under threat because of activities like logging, indiscriminate waste disposal, discharges and agricultural activities. This negatively impacts the biological and environmental status of such ecosystems and its chains of existing species.

Terrestrial ecosystems

Terrestrial ecosystem for the purpose of this report includes only the main land (floral and faunal) components excluding fresh water and mangrove. Each habitats and dwelling inhabitants in different forest ecosystem is not thoroughly discussed though their associated species are briefly indicated.

Forests ecosystem

Solomon Islands forests and woody vegetation cover up to 2.5 million hectares. The forest and vegetation ecosystem is diverse from coastal to montane forest that shelter diverse species of organisms. The variety of faunal and floral species are distributed according to abiotic and biotic setting of each forest ecosystem. There is an unknown number of species of organisms in the different forest ecosystems. There are few studies on the flora of Solomon Islands.

Some identified and common forest ecosystems in Solomon Islands are (Schmid 1978), swamp forest (970 km^2), forest on ultra basic rocks (527 km^2), forest on calcareous terrain (1,150km^2), low and medium altitude forest (20,000 km^2), forest containing *Agathis* (200-300 km^2) and montane forests (600 km^2). Other formations include: Climax shrubs covering 800 km^2, grass savannas (200 km^2), fern communities (50km^2) and crops and bush fallow (2,500-3,000 km^2)

Lowland Forest

The true lower land forest of Solomon Islands is considered to be the most biologically diverse of the country's ecosystem (Whitemore 1976, Henderson and Hancock 1988). This covers 3.8% of Solomon Islands landmass that could be further damaged if extensive commercial timber harvesting continues.

Ecosystem and habitat status:

The forest ecosystems have been providing and supporting Solomon Islands populace for many years. It is possible that impacts imparted on some areas might be excessive while other areas remain untouched. Inventories need to be done in order to identify ecological domains and areas of biological diversity to assist in planning, protecting and conserving important forest (vegetation) ecosystems and habitats.

Vegetation

Floral (Plant) Species

Leary (1991) after Henderson and Hancock (1988) list a total of 3,210 species of vascular plants with 1,077 genera and 205 families. Other components of flora recorded are: Dicots 1,941 species; Monocots 880 species; Gymnosperms 22 species, and Ferns 367 species (Henderson and Hancock 1988). Only three

endemic floral genera of Solomon Islands recorded are: Kajewskiella (Rubiaceous), Allowoodsonia (Apocynaceae) and Homolacladium (Polgonaceae). No endemic families are recorded. Other genus or group that might show endemismare: Climbing pandan (*Freycintia*), gwalifunu (*Boerlagiodendron*), palms, orchids, shrub genus and ferns.

Rare and endangered plants

There is no assessment and record of rare and endangered species. Overview on status of plants species is presently impossible.

Fauna

Associate Faunal species

Reptiles

There are 54 species of terrestrial reptiles observed in Solomon Islands (McCoy 1980). There are three endemic reptile genera making for 25 endemic species. The skinks and small lizards are the most diverse and endemic species although at least 5 species appear to be endangered and already extinct (Brown 1991).

Amphibians (Frogs)

Brown (1952) lists 17 species of indigenous frogs with a total number of seven endemic frog species recorded (41% endemism). This record is known to be the most diverse in the Pacific. Information on status and ecology of Solomon Islands frogs is poor. Approximately 3-4 species are rare and vulnerable (Leary 1989): *Platymantis Solomonis*, *P. aculeodactylus*, *Palmatorappia solomonis* and *Discodeles malakuna*.

Mammals

Research indicates that at least 52 species of native mammals are known. Out of these species, 3 are extinct, 17 are regarded vulnerable and 5 other species remain endangered. About 19-26 of these species are endemic to Solomon Islands (Jones 1998). All of these species are either bats (both flying foxes and insect small eating types), or large forest-dwelling rats. Possum (*kandera*) is an introduced species. Components of mammals according to SISOE Report are: Flying foxes (*Megachiroptera*) 26 species, insectivorous bats (*Microchiroptera*) 18 species and rats (*Muridae*) 8 species. These species will be lost to the world if extinction in Solomon Islands proceeds. (Flannery and Parnaby 2000).

Invertebrates

There is no approximate figure of the total number of species of invertebrates in Solomon Islands. Most studies of insects only include pest species and other snails. Importantly, work needs to be done on this.

Avifaunal Species

Birds

There are approximately 173 species of birds (Leary 1991 and 50 species of sea birds. 40-50% are endemic species, 38% occur elsewhere but are represented in Solomon Islands as unique sub species. 18 % occurs elsewhere.

A draft avifaunal conservation report by SPREP (Sherley 2001) shows Solomon Islands species status as: Four critically endangered species: Becks petrel (*Pterodroma becki*), Thick- billed ground-dove (*Gallicolumda salomoni*), Makira moorhen (*Gallinula silvestrais*) and Ghizo white- eye(*Zosterps luteirosstris*). Three endangered Species: Santa Cruz ground-dove (*Galliolumba sanctaecrucis*), Yellow-legged pigeon (*Columba pallidiceps*) and White-eyed

starling (*Aplonis brunneicapilla*). Information on parrots requires urgent attention (Leary 1990).

About 16 other species are vulnerable, 19 species near threatened and 25 species are threatened by hunting, illegal trade, habitat loss and degradation and introduced predators[4].

Butterflies

There are 130 species of butterflies; 35 species are endemic and rare species (Dahl 1986). Endangered species as identified by the IUCN include: Sword-tail butterflies (*Graphium meeki* and *Graphium mendana*) and the Swallow-tail butterfly (*Papilio toboroi*). A 2002 study of butterflies in Western Solomon (Munda Point and New Georgia) indicated 134 species of butterflies from which three species and 20 subspecies are unique to the island of New Georgia. This figure could also well represent species of butterflies in Solomon Islands.

ii) *Watershed and coastal areas*

There are limited conservation or protected areas/sites in the Solomon Islands. Declaration of such areas are difficult as they are normally located on customary land. Some sites promoted for conservation or protected areas have been identified however they are only proposed sites based on their biodiversity or marine or water resources.

The two marine protected areas are the Arnavon Islands off the eastern end of Choiseul Province and Vainimoturu group of islands in Marovo Lagoon, Western Province. Both areas are currently being monitored by the Ministry of Forest, Environment and Conservation, and Ministry of Fisheries and Marine Resources.

Other sites include Marovo Lagoon in Western Province and Lake Tenggano in Rennel and Bellona Province. These two sites have been identified for World Heritage Sites in Solomon Islands. Another proposed conservation area are the Lungga and Komarindi water catchments for future water sector development (hydro power) for Honiara city.

The Kongulai water catchment is one of the water sources for Honiara city, therefore both the landowners and SIWA have an interest to protect the catchment. There are no legal instruments put in place to declare the areas protected.

iii) *Environmental threats*

There are imminent threats to critical ecosystems (habitats) and species in Solomon Islands.

Threats to marine ecosystems and species

Increasing population and obviously greater demand on marine resources for survival has considerable impact on marine resources in Solomon Islands. The vast majority of the rural populace of Solomon Islands depends entirely on marine resources for food and income. As there is a general regard that all marine resources are consumable there is little to no opportunity to decide on which species should be replenished or untouched. With the current economic difficulty faced by the country, there is daily harvesting of marine resources. Should this exceed sustainable harvests, endemic species will be threatened. The current land tenure system and lack of awareness in most rural communities has aggravated the threat of human influence on marine ecosystems.

[4] Other species can be checked in the Solomon Islands State of Environment Report (1990)

Lack of information contributes to carelessness reckless harvesting leading to destruction of endemic species and habitats. Marine organisms that are rare and unknown may be regarded as useless and escape protection measures. Biologically the diversity of such species will be threatened if it is carelessly destroyed. This can have enormous effects on the biological food chain and will in turn directly and indirectly have impacts on marine ecosystems and critical species.

Overexploitation especially on coastal reefs is exacerbated by destructive fishing methods such as the use of dynamites and explosives. This is common practice in coastal areas around and threatens coral ecosystems and species by chemical impact.

Logging impacts from widespread deforestation has a major impact on catchment areas and reefs. The effect of sedimentation on river mouths and coastal areas is significant. Building up of loose soils and gravel can change and eventually damage marine ecosystems. With increasing logging operations in the country this remains the biggest threat to marine biodiversity.

Subsistence agriculture involves extensive clearing and cultivation of soil, which can have similar impacts as logging operations. Excessive and continuous subsistence agriculture could eventually lead to soil erosion, siltation and leaching which discharges loose soil into marine ecosystems. This can cause marine sedimentation that can kill corals and its mutually depended organisms. This also has a lot of impacts on mangrove ecosystem.

Industrial pollution can be very significant and could cause a lot of damages to its surrounding marine ecosystems. In urban areas like Honiara, it is obviously clear that effects on sewerage and other industrial discharges are having momentous impacts on the marine lives. Usually undiluted and acidic solution can be detrimental to marine lives causing extensive reef bleaching and damages. Industrial discharges can pollute marine environments and contribute to sedimentation.

Threats to terrestrial ecosystem, flora and fauna

Many components of activities that destroy terrestrial ecosystem, fauna and flora are commonly attributed to deforestation of terrestrial ecosystems. The activities of deforestation are in many forms such as:

Commercial forestry (logging) is seen as one of the main threats to our environment. Many commercial timber activities that are in operation are unlikely to be environmentally friendly and generally speaking, do not adhere to the regulations of the Forestry Act. There has been minimal assessment to ensure compliance to regulations. Consequently, most logging activities on many islands are destroying vegetation, fauna and valuable ecosystems at alarmingly fast rates.

Shifting subsistence agriculture and related activities that directly involve removal of vegetation and clearing of native ecosystem is a major issue. Increasing populations and their accumulated demands for survival manifest in unsustainable agricultural practices that threaten biodiversity and contribute to conflicts over land/space.

Urbanisation and development are a direct result of a rapidly increasing population (2.8% per year). Clearing of land for settlement and other activities e.g. shifting agriculture, is seen to have immediate impacts on the environment. Likewise, urbanisation places demands on resource exploitation that can be detrimental to the environment. Lack of proper management and environmental

consideration can result in the loss of many ecosystems, habitats and their existing flora and fauna.

Over harvesting and unsustainable extraction of natural resources are detrimental to the ecosystem. Unsustainable harvesting usually results in exhausting of biodiversity, fragmentation of ecosystems, environmental malfunction and general threats on flora and fauna. As a considerably proportion of communities and individuals involving in such activities, this would destroy our ecosystems at an exponential rate.

3.3 Health and Hygiene

i) *Major health concerns related to watershed and wastewater management*

The quality of water in its natural state is as good as location and specific circumstances permit. Providing water for rural villages is increasingly of major health concern given the invasive landuse practices that are currently developing in-line with the current government's decentralisation policy for agricultural development. These include slash and burn shifting cultivation and destructive logging operations. Information and management are a weak link particularly in regard to ill-timing of obtaining relevant, quality information.

ii) *Water borne and water-related diseases.*

Water related health concerns have been experienced at different times for various locations for different water related disease incidences around the country. The occurrence of water related infections and diseases are already obvious and it is no longer the primary issue. What is at stake is diagnosing the link between health and hygiene for better understanding. It remains an issue to correlate the cause and effect relationship, and disseminate that information on time to relevant stakeholders to help improve planning.

iii) *Impacts of tourism on watershed and wastewater management*

Watershed management in regard to tourism is not a major concern at present as the industry has yet to thrive. Tourism in relation to wastewater management is a potent issue for consideration, though for now it cannot be considered as an isolated and significant issue of major concern. As yet, there is inadequate evidence to suggest tourism to have any appreciable impact on watershed and wastewater management.

3.4 Watershed and coastal management

i) *Need to integrate watershed and coastal management in the context of IWRM*

The need to integrate watershed and coastal management is based on the understanding that no one system is a separate standalone unit. Any activities in the upper watershed region, whether it be anthropogenic or natural will certainly have some effect on the coastal environment

The importance of the integrated approach is fundamentally concerned with the use and protection of the environment - defined to include both sea and land and expressly or implicitly aim to achieve an approach to managing human interactions with the coastal environment in a manner that is based on an appreciation that the coast is an integrated ecological whole, and that coastal management must take into account the implication of any action or proposed action for coastal system as a whole rather than merely for any particular sector.

ii) *Sectoral linkages for more integrated/coordinated management approach in IWRM*

One of the main hindrances to effective water resources and wastewater management in Solomon Islands is the fragmentation of institutional arrangements with functions relating the water sector. However, there have been attempts in the past to promote a more coordinated approach to water issues through:

- Information sharing of data on water resources issues;
- Formation of a Committee that meets on an ad hoc basis to discuss issues concerning water sector and cross sectoral issues; and
- Issue of climate change has also brought together institutions to form a country team to discuss sensitive areas such as water, agriculture, human health and coastal hazards.

In addition there are organisations that have concern for water that communicate through arranged meetings, awareness programmes and other means of communication to discuss and advocate issues relating to water. Such institutional framework includes:

- National government (functions relate to water)
- Provincial government (as above)
- Non-Government Organisations (SIDT[5], tribal committees)
- Women organisations (National Council of Women)
- Educational institutions (tertiary and high Schools)
- Communities (village committees)
- Investors and stakeholders

Stakeholder Engagement

4.1 Consultation process and institutions involved

In 2004, UNDP/GEF signed an agreement with SOPAC to develop the IWRM Project for Pacific Island countries. The project will support Pacific SIDS in the implementation of the Pacific Regional Action Plan that addresses sustainable water management. As a requirement for the project design phase, each country is required to produce national analyses of its water resources. The national analyses include a diagnostic report, Hot Spot Analysis (HSA) and demonstration concepts all part of a logical process, which commences with a review of national water management and its linkages to other sectors and identifies barriers to preventing IWRM and how to overcome them. This reporting and analysis then provides the background information for the HSA.

4.2 IWRM National consultation process in Solomon Islands

The Ministry of Mines and Energy decided that the IWRM Project national analyses in Solomon Islands would be prepared through a national consultation process. The consultation process involved a working group, information gathering and sector analysis reporting, institutional consultations and

[5] Solomon Islands Development Trust

stakeholder seminar consultations. The working group comprised sector experts from various government ministries with functions related to water resources management and conservation and included the following.

- Ministry of Mines and Energy
- Ministry of Agriculture and Livestock
- Ministry of Forest, Environment and Conservation
- Ministry of Health and Medical Services
- Solomon Islands Water Authority
- NGO, Live and Learn
- IWP

The main objective of the working group was to oversee the preparation of the IWRM national analyses in Solomon Islands for submission to SOPAC according to agreed guidelines and templates

4.3 Stakeholder consultation seminar

A consultation seminar was conducted with participants from a wide cross section of the government ministries and NGOs. The seminar was purposely organised to undertake the HSA and demonstration concept for the country. The HSA and demonstration concept were prepared during the seminar and endorsed by the working group for submission to SOPAC as part of the national analyses preparation. The Table below summarises the consultation process.

Table 6: Summary of consultation process

Institution	Stakeholders/Interests and Responsibility	Relevance to IWRM and reason for Inclusion	Role in the consultation process
Environment and Conservation	Habitats and ecosystem	Impacts on the environment	Sectoral analysis
Agriculture	Land use and agriculture	Impacts on water resources	Sectoral analysis
Fisheries	Marine	Impacts on marine resources	Provision of information
Environmental Health	Health and Hygiene	Impacts on health and hygiene	Sectoral analysis
Rural Water Supply and Sanitation Programme	Water/sanitation services - rural technologies	Rural water and sanitation services with provision of available technologies	Sectoral analysis
Solomon Islands Water Authority	Water and wastewater services – urban technologies	Urban water and wastewater management through appropriate technology	Sectoral analysis
Water Resources	Water resources assessment and management	Water resources assessment and management	Coordination of national analyses preparation
International Waters Programme	Watershed and Coastal management	Watershed and coastal management	Sectoral analysis
Live and Learn	Awareness and education	Environmental awareness and education	Environmental awareness and education

The major component of the analyses was information gathering for sector analysis and was allocated to various organisations responsible for the different sectors or with functions related to the sectors.

Table 7: Allocation of information gathering and sector analysis

Sector Analysis	Responsible Organisation
Water Resources Management	Ministry of Mines and Energy Environmental Health SIWA
Disaster and Island Vulnerability	Ministry of Mines and Energy Disaster Management Office SI Meteorological Services
Landuse and Agriculture	Ministry of Agriculture and Livestock
Habitats and Ecosystems	Ministry of Forest, Environment and Conservation
Health and Hygiene Technology	Environmental Health SIWA
Watershed and Coastal Management	Ministry of Mines and Energy IWP Ministry of Fisheries and Resource Management
Awareness	Ministry of Mines and Energy SIWA NGO
Institutional Arrangements	Ministry of Mines and Energy Environmental Health SIWA
Financing	Ministry of Mines and Energy Environmental Health SIWA

Other programmes, projects and activities related to IWRM

5.1 In-country implementation through projects and programmes

Solomon Islands will further its current position on sustainable water resources management through the implementation of programmes and projects through both national government and external donor funding. Listed below are programmes or projects and activities that contribute to the implementation of IWRM in the country. Some of the programmes are at planning stage.

- JICA funded project for Improvement of Water Supply and Wastewater services for all urban centres in Solomon Islands
- As part of the Government's recovery programme, key sectoral policies were identified as priority areas for the responsible Ministry to address. The Ministry of Mines and Energy being responsible for water resources management was expected to address key priority areas as:
  - Develop strategy for improving the efficiency of SIWA: ADB and JICA review of SIWA to improve water and wastewater services
  - Maintenance of hydrological sites and improve national hydrological network to include rivers recommended in the Master Plan Study for Power Development
  - Enhance rural water supplies and sanitation
  - Formulation of new Water Resources Act

- Establishment of National Water Quality Guideline Committee
- GEF-UNESCO funded hydrological equipment for Solomon Islands
- Ministry of Mines and Energy Corporate Plan 2007-2009 and reporting mechanisms
- Ministry of Mines and Energy Annual Work Planning
- Hydrological awareness through SIBC by Water Resources Division
- SIWA public awareness programme through SIBC and Honiara Primary Schools
- On-going training of hydrologist in the Water Resources Division: SOPAC-NIWA Hydrology Training Programme
- International Water Programme
- EDF Project
- Solomon Islands Water Governance Programme
- AusAID funded Kongulai Water Catchment Risk Assessment Study Research

5.2 Water and wastewater management plans or strategies

There are currently no established water or wastewater management plans or practices in Solomon Islands. The JICA funded project for Improvement of Water Supply and Wastewater services for all urban centres in Solomon Islands will formulate a water and wastewater action to year 2015.

Capacity Development Needs for Removing the Barriers

i) *Actions needed on a regional level rather than national level*

There is a possibility to establish linkage mechanisms between countries to share information, problems and to discuss issues of common interest, e.g. results of similar research studies undertaken in similar environments or similar cause for replication in another country.

There was discussion on exchange of information, equipment (technology) and personnel where there is similar interest between countries to maximise the use of available resources in the region.

There have been a number of training programmes developed specifically for the needs of the region and the incorporation of such training needs into a regional training programme with the regional training institutions could benefit PICs as it forms formal training programmes as long-term benefits to the region.

The revolving of managers (as counterparts) within regional countries should provide opportunities to learn new ideas and apply in their own countries with similar environment and problems. Such an approach has been provided on a limited basis through work attachments in the region.

The standardisation of instruments and other procedures can be very important to address servicing and maintenance problems the regional countries are currently facing.

An integrated approach to barrier removal could address common problems experienced by the regional countries. Some common issues to address include:

- Upgrading technical capacity in water resources management through regional approach;
- Better coordination amongst institutions within individual countries;
- Inter-agencies cooperation on issues affecting the region;
- Political advocacy;
- Awareness and community education;
- Sharing of technology and data on common issues;
- Regional approach to addressing issues of concern rather than individual country approach, and
- Regional approach to legislation and policy on common issues.

In Solomon Islands the capacity development needs for the removal of key IWRM barriers identified under the IWRM analyses may be summarised according to the six thematic areas of the Pacific RAP and its linkage to other sectors.

1. Water resources management requires basic water resources information/data and resource protection mechanism as paramount issues to address. The need to gather hydrological information/data through on-going water resources assessment is important to understand the general status of water resources in the country. This can provide the basis to undertake monitoring and control/protection of water resources from pollution or over-exploitation. To ensure effective monitoring and control mechanism it is vital to plan and manage watershed activity through proper land use planning, legislation and policy on water related activities.
2. Island vulnerability requires proper disaster preparedness and management. In Solomon Islands there is need for capacity development in disaster awareness and preparedness. To have an effective disaster management mechanism in place capacity development and support to implement national plans and strategies especially in awareness and education at the national and community level. This leads to the need to establish a monitoring network throughout the country to ensure there is proper and effective disaster preparedness and warning systems in place. Through proper assessment and monitoring mitigation and adaptation to certain issues can be achieved.
3. Awareness is vital for political advocacy and participation from all sectors of the society. It is important to advocate at the national and community level to ensure there is cross sector participation in the country's endeavour to address issues affecting the country. Community participation is key for effective watershed management and protection of water resources and disaster preparedness. Where there is political will and support there is likely to be effective integrated management of land use and watershed activities to protect water resources from natural hazards.
4. Technology is important for water demand and supply management and may lead to proper water treatment for better quality water. The current water service providers require capacity development both for integrated human resources development and integrated infrastructure planning. Human resources and infrastructure development is vital in water demand

management and through proper water treatment facility, resource planning and management, and appropriate technology there is provision to provide efficient services relevant to Solomon Islands situation.

5. Institutional arrangements in Solomon Islands may be improved through proper implementation of policies, legislations and appropriate regulations. This will ensure the existing institutional framework has a coordinated approach in addressing their functions in the water sector. In Solomon Islands there is weak institutional coordination which limits the effectiveness of institutions in the country. There is a need to review existing legislation and regulations available and where appropriate to formulate integrated planning and policy to manage different land use practices, watershed planning and management for control and protection of water resources and the environment. Capacity development is necessary to fulfil the country's obligation towards environmental agreements to promote environment conservation and management. Human and financial support is necessary to implement policies, to enforce regulation and to promote effective assessment and monitoring to ensure there is effectiveness in the activities of institutional establishments in the country especially the national bodies established under various legislations.
6. Finance is vital to the sustainability of service providers to promote customer confidence in service deliveries and promote sustainability and conservation of the resources. It is of the utmost important to ensure there is cost recovery in service deliveries to customers and for economic benefits in the process. There is need in the improvement of metering and billing systems to improve revenue collection. This will result in gaining customer confidence which should help the service provider to improve its service deliveries and reinvest in the control and development of resources. Awareness and education plays a vital role in getting customers to understand their responsibilities in promoting environmental protection and water resources conservation. The country should be able to recognise the realistic value of incorporating environmental and water resources issues into the economic decision making and planning process.
7. Landuse and agriculture can benefit from integrated land use planning and management including forestry activities. This should ensure there is increase in agricultural products (irrigation farming) which the country can benefit from. There is need for integrated land use planning for effective watershed management and monitoring of various pollution sources in the country. Appropriate policies and legislation need review to ensure the current situation is addressed through the effective enforcement and monitoring of existing legislation and policies.
8. Habitats and ecosystems require the proper protection and management of the environment to survive. Solomon Islands remains a virtual biosphere point primarily because of its extraordinary biodiversity. The Islands have a unique flora and fauna retaining complete complex ecosystems and habitats ranging from diverse marine life to terrestrial deep forest dwelling colonies. There are imminent threats identified that could have critical impacts on habitats and ecosystems in Solomon Islands. There is capacity requirement in control and monitoring to ensure there is limited impact on ecosystems. Legislations, policies and planning needs to be put in place.

9. Health and hygiene relates to proper control, maintenance and support to address water quality and public health in the country. In Solomon Islands there is limited capacity to undertake water quality monitoring (surveillance and control) throughout the country. In addition legislation and policy are to be put in place to effectively control pollution threats to water resources as well as integrated management of land uses and watersheds. Information on water quality and pollution threats is vital to proper planning and management for maintenance of water quality in the country. Human resources development and equipment are key areas to address in capacity building to promote health and hygiene in the country.
10. Watershed and coastal management identifies integrated planning and management as key areas to address and effectively promote better management of watershed and coastal areas. Whatever activities occur in the watersheds will impact on coastal areas. Land use planning and better institutional coordination is vital in the overall management of watersheds and coastal areas. Capacity building for human resources, instrumentation, legislation and policies are vital to provide appropriate tools in the integrated management and planning of watershed and the coast.

Activities that are likely to impact on water resources management are likely to be the result of uncontrolled developments in the country. Ergo, having water resources management issues incorporated into the country's decision making process should provide opportunities to implement IWRM approaches to barrier removal. In order to achieve this there is urgent need for proper and effective institutional arrangement in the country for better coordination in addressing the issues that affect the country.

o Introducing an Integrated Approach towards Barrier Removal

i) Measures to overcome impacts and concerns for a coherent IWRM approach (narrative/conceptual)

Table 8: Summary of approaches to overcome barriers to implementation of IWRM

Themes	Existing tools	Limitations	Measures to overcome impacts	IWRM Approach
Water resources management	Legislation: River Water's ordinance 1969 SIWA Act 1992 Environment Act 1998 Public Health ordinance 1970 Forest Act 1998 Draft Water Resources Act.	Lack of: Comprehensive water assessment Appropriate water resources governance Legislative framework Coordinative approach by organisations responsible for water Inadequacy of River Waters Act	UNESCO hydrology equipment SOPAC-NIWA hydrology training Resource Assessment Quality Conservation and reuse Pollution prevention	Coordinated approach Awareness and community education Proper legislation and policy Capacity building Sector-wide participation in the water sector Effective water governance Conservation and re-use practises
Water quality	Public Health ordinance National drinking water guidelines committee (review existing quality monitoring practices)	Lack of capacity to ensure water analyses in-country Threats from logging and mining Lack of enforcement of Environment Act	Project funded by JICA for the improvement of water supply and waste water service in Honiara and 4 other centres. Establishment of a national water quality guideline committee.	Long-term surveillance and compliance monitoring Awareness and community education Water quality guidelines Regulations
Island vulnerability	Dialogue on climatic vulnerability and change related to water between government and NGO attempted	Flooding and droughts No hydrological stations with capability for flood warning	Hydrology awareness radio programme conducted by the NDMO Disaster preparedness	Coordinated approach Instrumentation Awareness and community education Data to enable forecasting Capacity building
Awareness	Radio programme Community participation Education system	Low level of literacy Lack of basic water related data to support awareness programme Women not included in decision making process for water.	Awareness programme on hydrology on radio SIWA conducted public awareness programme through radio and schools Community base monitoring programmes	Sector-wide approach (partnership) in the water sector Awareness and community education NGOs and community involvement Promotion of water sector in formal

			Targeted campaigns High level advocacy	education system
Technology	Changing technology Effectiveness and efficiency of equipment to meet demand Guidelines and expectations (Policy or plan)	Aging infrastructure for water and wastewater services Lack of monitoring and enforcement Lack of appropriate technologies and procedures Lack of training	Pollution from poorly managed wastewater treatment or discharges Water conservation measures Appropriate technologies and methods Information	Effective and efficient technology to deliver service and meet demand Appropriate technology to promote sustainability and reliability Conservation and re-use practises
Institutional arrangements	Government machinery Mandatory functions Political stability	No national water resources policy No comprehensive water resources legislation. Need for effective coordination of various agencies and stakeholders (NGO, private sector, communities) for water management. Training staff is a problem.	Institutional arrangement Policy and legislative framework Capacity building	Coordinated institutional arrangement Clear guidelines and functions Legislation and policies
Finance	National government funding External donors Revenue from service delivery	Lack of financial resources. Only urban areas supplied by SIWA are commercially viable. Provincial governments lack of qualified staff and funds to properly maintain rural water supply systems.	World Bank and JICA, financial restructuring of SIWA to improve revenue and sustainability of service in urban area. Billing system ineffective Cost recovery systems Public private partnership Regulatory oversight	Support from National Government and external donors Re-investment to improve services Effective revenue collection and water use conservation incentives to promote conservation practises Appropriate partnership Legislation and policies

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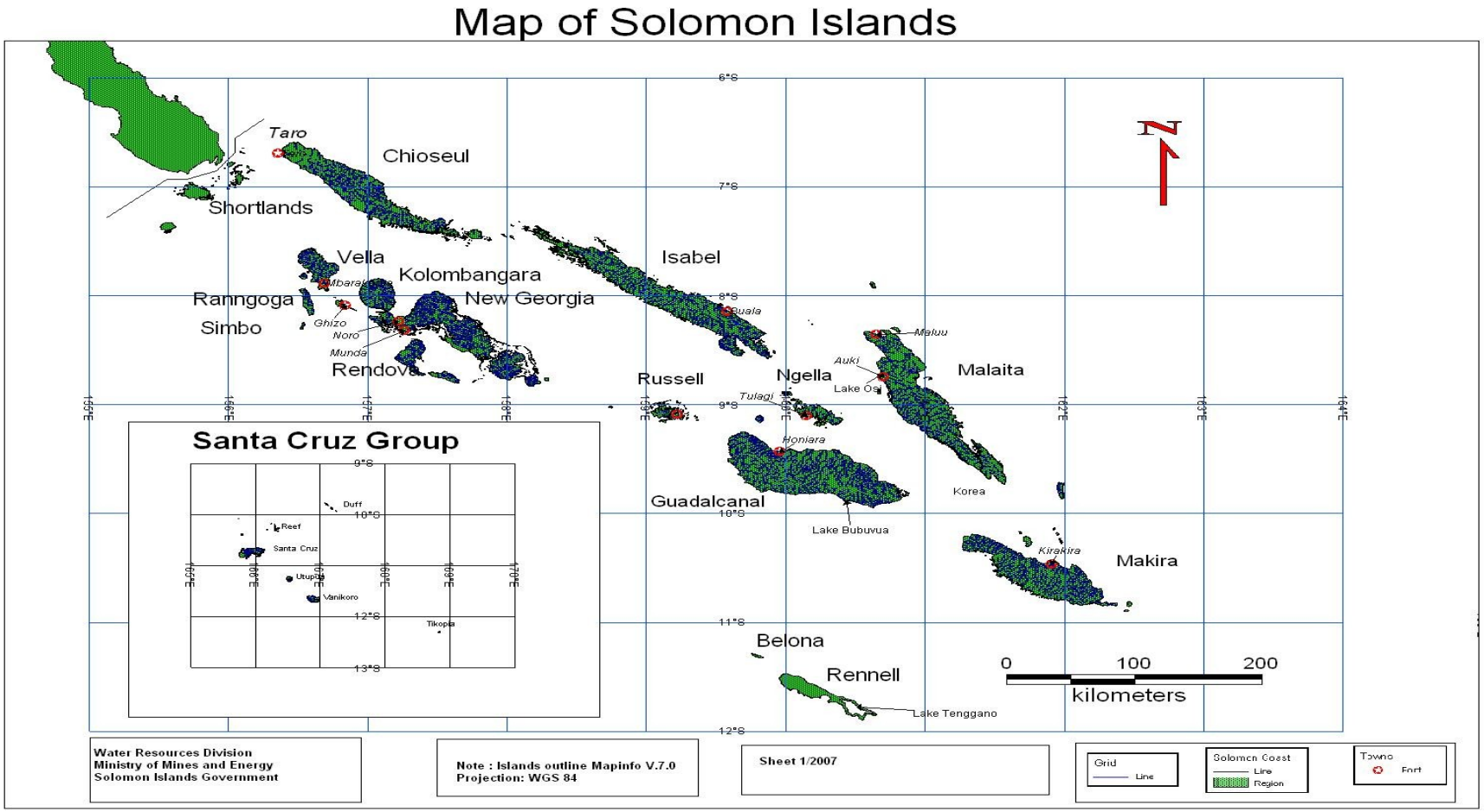
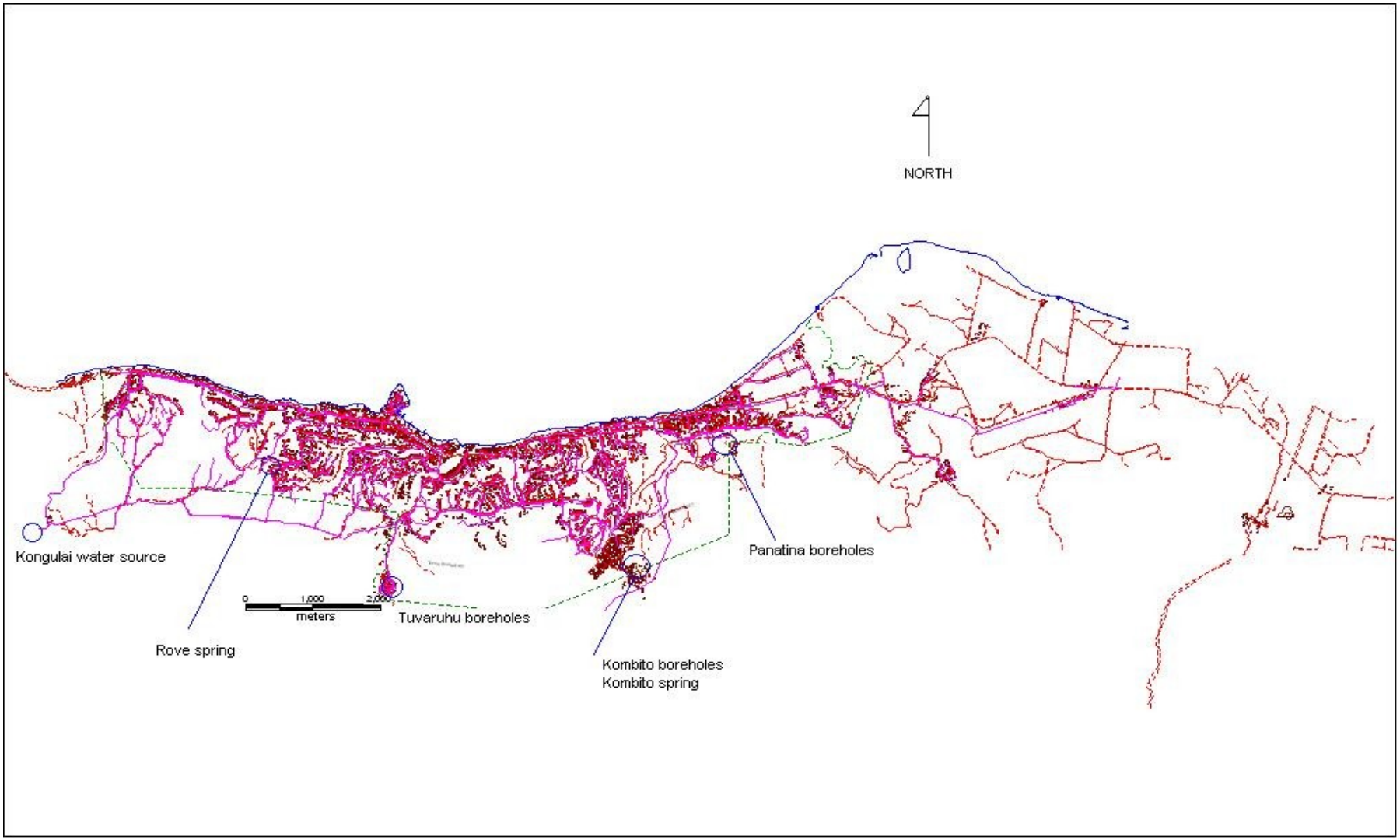
II **Annexes**

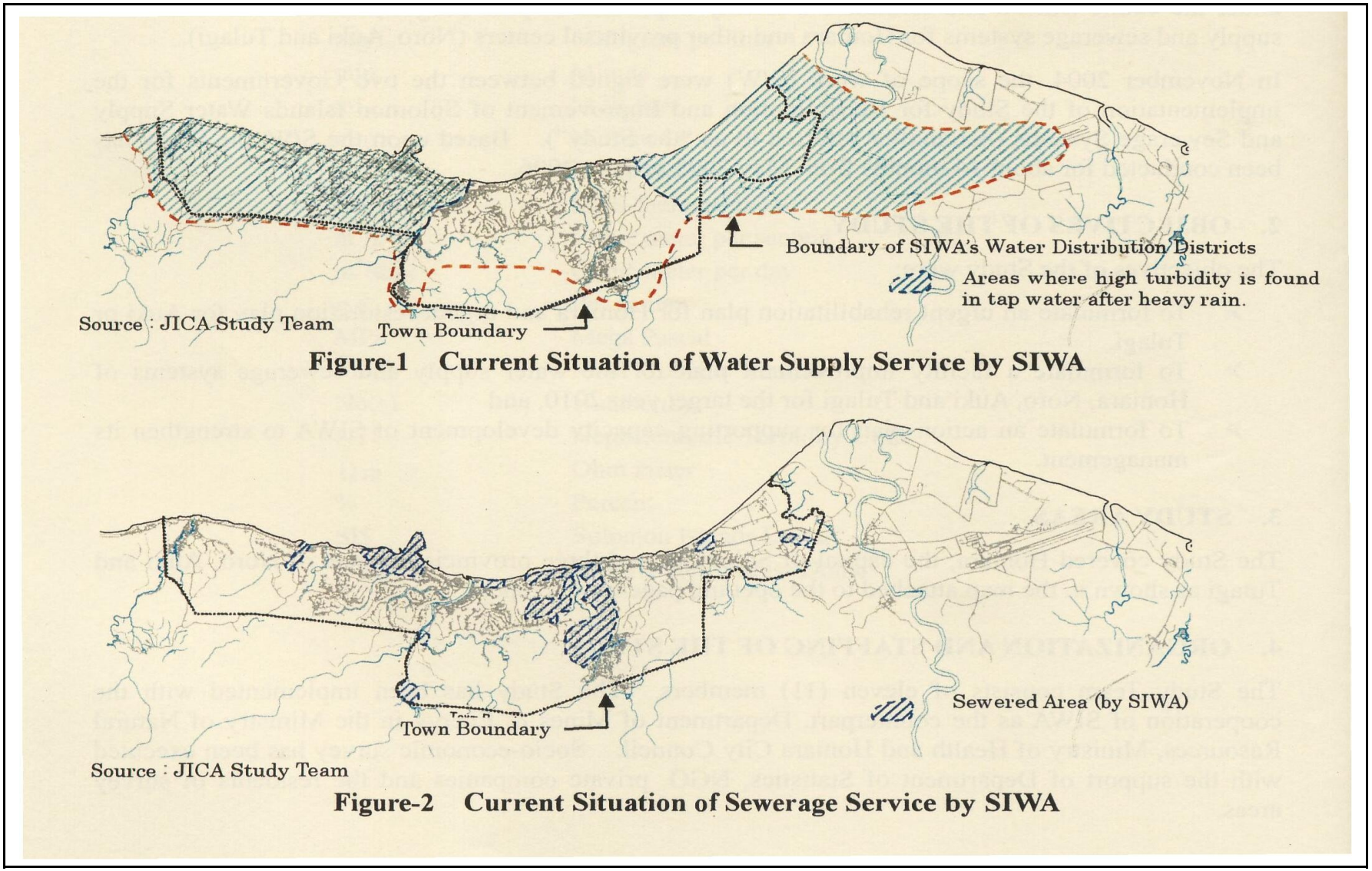
Annex A - Maps



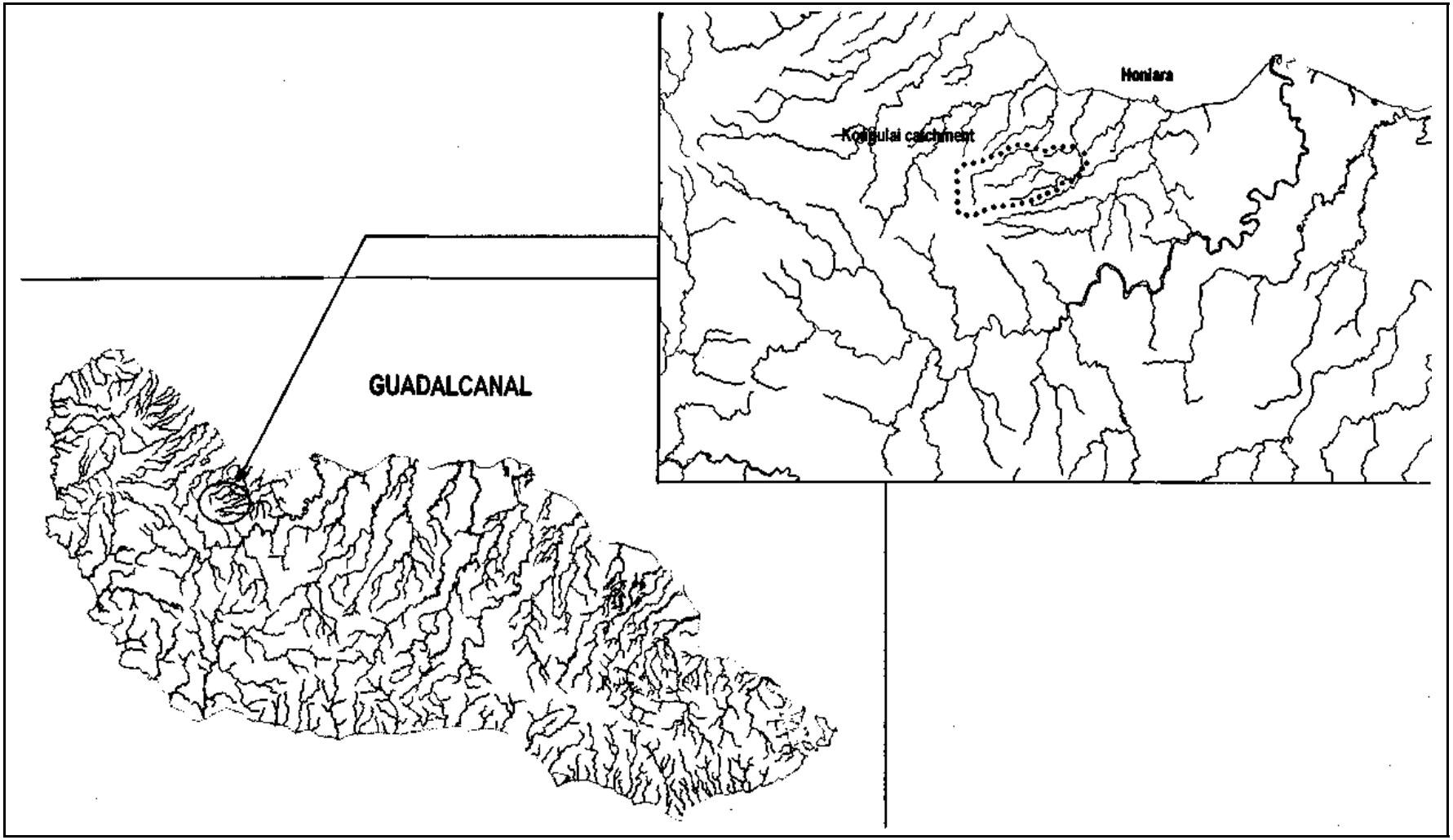
A.1 - Map of Solomon Islands



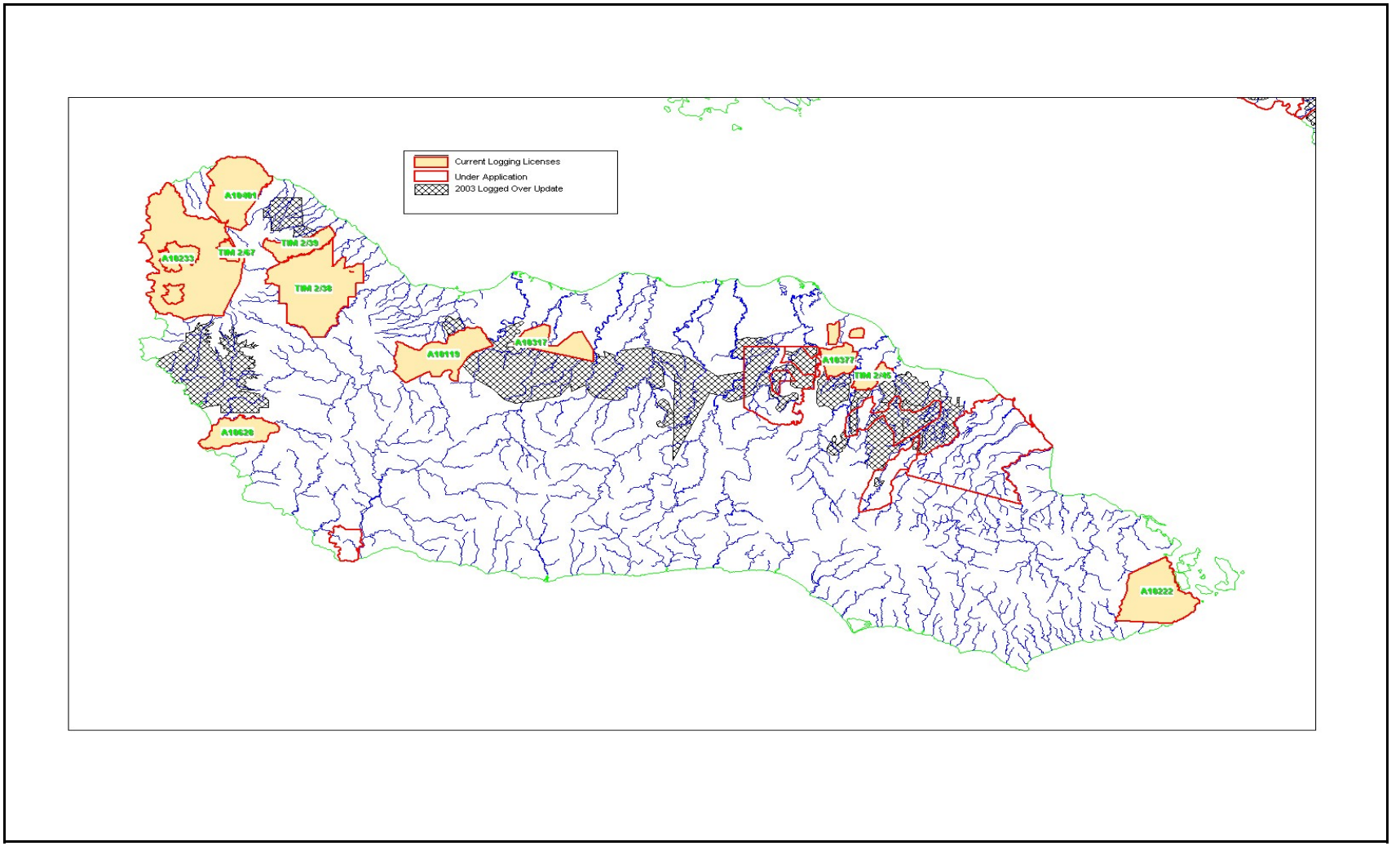
A.2 – Map of Honiara city water supply distribution and sources location



A.3 – Map showing current water supply and sewerage services by Solomon Islands Water Authority for Honiara City



A.4 - Map showing Kongulai water catchment area – Protected area for Honiara water supply source



A.5 – Map showing areas logged over the years

Annex B – Table of Monthly Rainfall for Solomon Islands

B.1 - Taro monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1976	338	481	445	309	386	190	395	563	118	298	118	207
1977	216	234	206	457	162	355	224	448	306			115
1978	249	218	366	189	326	249	182	365	213	241	382	142
1979	146	289	312	361	264	225	483	380	258	213	294	161
1980	244	214	567	148	412	464	415	480	304	261	112	231
1981	333	481	102	206	215	242	403	266	230	357	200	369
1982	238	174	356	403	214	266	444	156	255	365	32	124
1983	102	396	311	291	299	248	352	257	504	237	210	208
1984	131	388	588	385	334	309	671	332	245	177	279	245
1985	345	225	448	584	261	177	373	249	290	227	162	226
1986	322	293	285	522	108	247	291	206	413	270	75	194
1987	98	459	113	293	222	113	345	136	152	318	280	279
1988	263	229	213	351	296	312	394	308	293	451	664	184
1989	247	375	341	371	251	170	148	294	206	251	154	199
1990	335	86	231	214	321	215	270	422	477	245	356	167
1991	303	143	62	232	304	322	224	257	339	135	155	25
1992	227	367	277	149	201	190	241	319	223	366	146	168
1993	408	719	278	411	628	752	643	292	213	230	301	257
1994	202	352	275	306	393	202	281	412	182	210	82	30
1995	382	238	240	237	237	221	233	286	502	373	372	241
1996	207	206	307	286	264							
Average	254	313	301	319	290	273	351	321	286	273	236	192
Lowest	98	86	62	148	108	113	148	136	118	135	32	25
Highest	408	719	588	584	628	752	671	563	504	451	664	369

B.2 - Munda monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1962	203	234	397	319	547	187	454	283	236	185	390	279
1963	166	120	267	123	120	315	563	477	477	232	220	227
1964	239	315	538	264	93	222	440	160	97	243	280	216
1965	481	321	517	289	272	454	932	194	286	245	108	345
1966	346	294	234	122	264	468	463	267	138	261	206	285
1967	670	279	714	254	362	168	302	312	222	311	428	171
1968	751	495	266	260	203	299	253	177	257	189	318	277
1969	508	703	126	226	182	177	342	462	392	206	158	465
1970	291	337	371	367	306	180	246	310	248	252	169	431
1971	380	123	433	288	254	134	296	202	195	205	166	533
1972	687	175	536	415	509	222	394	196	407	161	169	78
1973	282	488	323	336	148	217	273	240	303	209	204	302
1974	185	317	261	249	197	307	192	261	165	247	242	183
1975	413	309	501	296	230	131	174	267	292	261	369	402
1976	645	535	305	553	368	169	358	337	80	210	181	331
1977	885	272	463	309	286	242	421	421	305	208	89	144
1978	416	602	158	233	330	256	140	476	245	85	319	320
1979	733	451	429	235	250	262	358	184	227	271	351	181
1980	381	543	384	72	313	244	349	340	738	135	283	341
1981	353	618	123	214	114	241	532	108	299	185	180	451
1982	267	500	297	622	266	213	651	242	67	509	87	165

1983	370	407	203	197	283	272	176	90	371	222	331	259
1984	136	184	342	210	221	312	232	153	224	286	242	306
1985	347	220	902	215	199	97	172	474	116	195	143	173
1986	333	270	223	433	219	170	203	124	231	155	181	342
1987	125	650	420	109	184	30	139	24	96	222	249	345
1988	468	303	170	560	137	175	241	284	318	360	323	349
1989	161	213	326	403	196	212	212	204	203	219	120	296
1990	699	141	439	159	425	330	294	229	365	225	415	333
1991	417	488	301	252	271	557	328	349	210	236	78	102
1992	283	478	351	353	234	124	194	257	173	224	171	463
1993	221	732	113	422	431	373	255	159	137	82	235	217
1994	369	316	338	270	357	230	467	349	150	309	106	26
1995	445	210	228	329	245	329	427	482	261	315	295	205
1996	317	347	775	184	441	245	186	329	220	169	336	509
Average	399	371	365	290	270	245	333	269	250	229	233	287
Lowest	125	120	113	72	93	30	139	24	67	82	78	26
Highest	885	732	902	622	547	557	932	482	738	509	428	533

B.3 – Buala monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1987			335	203	130	162	167	148	230	262	247	352
1988	370	221	281	340	136	280	277	447	445	527	587	481
1989	484	498	445	304	324	78	269	515	315	386	374	309
1990	398	145	286	408	424	411	325	308	519	557	639	313
1991	266	240	227	335	620	57	256					
Average	380	276	315	318	327	198	259	355	377	433	462	364
Lowest	266	145	227	203	130	57	167	148	230	262	247	309
Highest	484	498	445	408	620	411	325	515	519	557	639	481

B.4 - Auki monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1962	254	535	451	259	206	112	197	191	214	192	264	581
1963	282	159	437	196	107	195	227	266	282	495	260	206
1964	481	482	452	321	97	156	244	180	186	235	223	194
1965	419	286	587	227	246	197	507	319	258	224	111	269
1966	119	339	392	134	248	195	132	166	137	204	350	356
1967	504	478	579	202	363	229	218	419	157	243	383	177
1968	735	519	348	131	158	136	376	149	235	156	197	325
1969	344	406	209	251	246	284	374	361	205	236	80	281
1970	187	538	511	540	257	147	208	170	235	372	245	727
1971	431	394	606	257	238	122	144	292	246	273	201	662
1972	677	179	349	155	432	396	206	117	150	142	145	176
1973	331	428	576	335	126	230	220	219	233	341	143	399
1974	434	361	465	215	110	252	299	97	118	271	233	118
1975	762	328	428	277	235	82	248	243	271	191	401	318
1976	719	517	302	354	150	97	222	181	70	258	166	331
1977	575	201	571	309	177	198	358	381	258	223	327	165
1978	299	396	261	283	184	138	212	153	163	130	279	250
1979	296	273	285	247	322	281	186	142	148	146	294	278
1980	343	522	417	140	112	296	73	332	255	190	281	224
1981	265	517	171	179	128	154	335	121	281	273	139	264

1982	376	248	346	432	192	57	214	317	161	222	26	174
1983	327	517	381	257	165	114	191	201	283	207	201	168
1984	194	183	633	326	224	161	347	233	187	193	273	280
1985	349	425	565	148	223	123	145	285	195	135	169	291
1986	224	392	369	246	625	106	79	149	383	119	204	111
1987	65	407	441	149	157	44	176	17	266	127	152	238
1988	388	398	246	248	117	162	210	334	214	265	169	517
1989	266	463	337	282	251	182	104	125	145	120	163	314
1990	373	98	287	192	232	235	269	111	150	217	228	239
1991	558	420	288	60	215	206	127	383	258	332	133	111
1992	168	496	213	226	60	29	249	199	149	115	272	310
1993	97	357	235	260	261	294	332	123	213	73	183	211
1994	311	312	224	295	191	411	296	267	27	124	90	54
1995	196	230	521	198	252	148	199	245	300	163	175	139
1996	283	211	529	351	267	209	156	233	177	141	285	602
Average	361	372	400	248	216	182	231	221	206	210	213	287
Lowest	65	98	171	60	60	29	73	17	27	73	26	54
Highest	762	538	633	540	625	411	507	419	383	495	401	727

B.5 - Honiara monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1954											116.4	319.8
1955	125.7	131.1	607.6	115.8	174.8	77.8	41.6	6.9	76.0	69.4	136.0	578.8
1956	402.6	489.7	341.3	150.1	51.3	73.4	15.4	26.9	11.6	71.7	119.4	91.1
1957	141.6	369.1	313.1	112.8	186.6	62.2	54.2	87.1	79.9	171.7	97.1	159.0
1958	185.8	88.4	194.7	640.8	123.2	339	23.3	45.9	66.6	185.6	52.7	204.2
1959	371.4	241.3	306	290	129.8	59.2	94.7	194.4	211.2	97.5	158.8	395.2
1960	193.1	307.6	602.8	329	74.3	101.6	152.8	61	133.3	137.0	93.9	130.2
1961	162.5	174.1	316.2	174.4	106.8	63.3	213.3	123.3	142.6	147.6	245.4	121.4
1962	202.1	310.9	117.4	344.2	473	108.9	60.7	68.6	64.2	164.6	98.3	287.0
1963	182.8	206.1	406	187.1	40.8	36.8	95.2	142.2	189.7	274.9	115.1	164.5
1964	238.7	81.4	297.5	157	186.2	42.2	64.5	47.3	37.9	191.7	132.7	109.3
1965	375.2	396.4	373.9	113.7	150.3	108.8	306.2	120.5	67.8	116.6	88.4	168.8
1966	32.3	199.7	248	141.1	57	48	16.3	48.1	26.0	52.8	392.3	285.8
1967	565.3	304.3	635.6	180.6	215	87.7	113.2	138.9	67.2	377.1	167.6	63.9
1968	423.6	318.5	198.1	192.8	23.5	65.1	176.1	97.4	140.9	132.9	137.7	137.9
1969	289.4	362.1	215.3	181.3	135.4	153	96.2	94.6	79.9	95.8	108.1	276.3
1970	168.6	560.8	269.8	332.6	131.6	119.8	52.5	80.9	211.0	197.0	120.2	285.3
1971	236.4	109.7	455.9	328.2	96.3	109.5	88.5	82.2	85.3	157.6	130.3	447.2
1972	955.8	298.3	359.7	204.8	158.2	267.6	103.1	117.9	103.9	76.1	38.7	178.9
1973	82.1	218.7	363.9	107.9	84.4	70.4	90.3	128.1	30.7	245.8	130.1	244.6
1974	232.2	474.4	222.4	139	73	89.2	53	117.4	72.2			
1975												
1976												
1977												
1978												
1979								35.6	75.6	35.8	201.2	200.4
1980	182.2	503.2	407	23.8	58.8	39.8	62.2	95.8	188.2	73.4	189.0	84.4
1981	361	266.2	66	92.6	24	9.8	95.6	89.2	64.0	84.4	27.2	132.2
1982	351.2	179	353.2	352.4	150	40.6	118.2	270.8	123.8	88.8	62.8	155.8
1983	152.8	323.2	211.2	99	127.8	35.8	91.4	72.8	178.0	96.0	83.8	201.2
1984	89.8	210.8	380.4	222.8	125	31.4	37.8	45.4	59.6	172.4	329.8	290.6
1985	304.2	170.6	557.2	143.6	113	53	154.2	270.4	77.8	142.6	340.4	182.2
1986	272.6	182	263	250.6	366.2	40	84.2	115.6	141.0	9.0	207.8	37.2

1987	93.6	231.2	113.8	84.2	60.2	0	66.2	30	62.6	98.4	165.6	299.0
1988	318	409.2	122.6	78.2	32.6	103.6	95.4	139.4	130.4	198.4	453.4	549.4
1989	243.6	483	151.8	247.4	206.8	145.6	34.4	35.8	72.4	65.4	71.2	171.2
1990	230.8	71.4	332.8	160.4	167.8	52.6	111.8	48.2	122.8	41.6	73.6	274.0
1991	273.8	274.8	235.4	151	189.4	139.6	144.2	154	138.8	75.4	35.0	16.4
1992	91.2	423.2	109	117	60.9	46.4	68	34.6	24.2	131.2	100.1	155.2
1993	61.6	232.8	131	187.8	60.2	112.3	97.8	96.1	32.9	41.1	42.5	168.3
1994	258.3	363.9	343.7	140.4	174	201.1	73.4	96.5	19.1	54.8	18.1	97.8
1995	76	98.4	343.7	151.9	151.1	40.1	41.2	70.7	128.6	259.5	15.4	175.2
1996	149	161.5	369.2	153.7	90.6	93	108.8	133.5	70.9	218.4	123.8	517.3
1997	188.4	306.2	582.7	73.8	35.4	60.6	4.6	111.6	150.6	97.6	35.7	45.0
1998	263.6	240.1	395.8	56.3	130.4	45.8	21.6	272.6	115.1	24.7	181.7	350.7
1999	350.1	600.8	179.4	118.8	221.3	78.2	43.3	113.9	99.4	188.8	225.7	364.3
2000	211.8	180.5	304.3		428.9	93.6	44.2	68.1	24.8	50.5		
Mean	246.1	281.8	312.2	183.2	137.7	86.5	85.6	100.7	95.2	127.1	138.1	222.4
Lowest	32.3	71.4	66.0	23.8	23.5	0.0	4.6	6.9	11.6	9.0	15.4	16.4
Highest	955.8	600.8	635.6	640.8	473.0	339.0	306.2	272.6	211.2	377.1	453.4	578.8

B.6 - Henderson Airport monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1974										97	281	119
1975	257	117	345	94	190	41	105	96	52	129	264	245
1976	832	470	426	275	55	95	132	102	91	137	134	95
1977	300	230	331	98	120	139	167	113	254	61	268	52
1978	125	179	68	153	119	25	100	77	114	54	133	125
1979	352	615	54	126	47	142	82	25	43	52	186	171
1980	170	442	405	31	74	87	64	84	114	29	105	90
1981	294	222	68	108	36	16	103	176	75	107	52	189
1982	361	209	334	317	201	79	123	314	146	123	20	118
1983	121	284	159	138	148	51	108	70	163	74	107	251
1984	212	169	280	272	174	49	60	31	69	165	267	279
1985	260	184	462	99	99	52	120	124	44	123	333	330
1986	205	274	342	200	455	22	74	105	138	7	224	79
1987	23	293	137	53	92	1	69	22	50	52	138	264
1988	238	337	166	184	27	37	106	137	101	209	384	712
1989	357	422	206	318	159	72	22	24	63	39	44	102
1990	281	101	181	112	171	35	93	40	117	19	59	333
1991	200	239	201	149	170	126	114	139	162	129	80	43
1992	86	431	101	75	30	26	60	42	42	59	112	109
1993	37	221	125	133	47	98	89	76	41	42	60	225
1994	259	346	244	177	139	238	92	70	24	43	12	28
1995	106	74	312	111	167	26	64	89	73	217	17	67
1996	161	199	321	175	102	91	46	173	69	169	146	517
1997	185	242	564	186	14	27	13	83	148	39	55	37
1998	255	220	333	86	165	46	21	97	195	26	249	410
1999	321	609	133	75	228	60	77	236	248	114	180	206
2000	191	187	331	294		107	53	87	53	83		
Mean	238	281	255	155	129	69	83	101	103	89	150	200
Min	23	74	54	31	14	1	13	22	24	7	12	28
Max	832	615	564	318	455	238	167	314	254	217	384	712

B.7 – Kira Kira monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec

1965	416	345	395	208	396	501	743	515	307	423	130	609
1966	165	437	279	313	363	168	25	155	158	139	393	506
1967	499	297	668	212	367	379	182	708	220	532	236	384
1968	720	380	195	573	169	118	342	157	302	280	228	550
1969	516	389	435	679	260	451	496	462	105	314	116	241
1970	157	185	259	269	356	418	566	695	205	351	200	221
1971	449	289	766	589	170	243	193	343	370	161	240	429
1972	424	259	410	331	457	270	268	130	80	134	141	228
1973	113	120	533	328	105	184	195	299	380	332	247	322
1974	260	771	387	295	157	313	379	122	171	187	285	186
1975	550	342	467	174	218	184	447	252	421	305	534	386
1976	641	617	421	225	206	215	544	448	200	151	185	182
1977	290	327	372	150	204	265	406	413	217	152	266	106
1978	324	359	284	187	422	124	272	349	117	62	159	112
1979	485	371	112	193	198	291	246	107	171	155	325	292
1980	133	549	333	175	434	110	61	192	214	270	330	328
1981	249	278	72	131	138	97	402	313	432	267	154	196
1982	211	405	367	534	350	123	431	586	130	205	71	79
1983	208	173	209	172	229	109	249	176	360	183	269	222
1984	229	259	444	396	237	272	415	153	227	517	186	396
1985	358	211	696	243	489	239	384	706		263	294	172
1986	236	326	274	503	440	137	174	239	451	145	248	130
1987	77		239	234	267	48	250	31	210	153	172	376
1988	290	244	198	305	165	339	361	521	506	309	511	578
1989	528	432	394	586	592	406	291	190	457	111	100	225
1990	400	133	364	588	523	190	157	57	300	170	152	502
1991	297	275	217	213	222	242	187	510	542	478	150	67
1992	152	308	156	271	212	84	219	217	96	42	265	62
1993	197	214	313	188	298	186	107	47	160	150	193	530
1994	195	354	218	341	627	386	239	355	189	58	70	62
1995	135	77	427	106	321	123	339	434	285	507	60	119
1996	295	211	288	269	358	286	402	397	368	303	286	626
Average	319	320	350	312	311	234	312	321	269	244	225	295
Lowest	77	77	72	106	105	48	25	31	80	42	60	62
Highest	720	771	766	679	627	501	743	708	542	532	534	626

B.8 - Lata monthly rainfall data (mm)

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
1970									204	507	288	453
1971	506	434	569	353	158	247	260	479	336	234	282	390
1972	564	309	325	290	653	308	247	296	401	170	253	324
1973	323	330	450	364	306	214	272	337	282	298	279	278
1974	274	390	361	337	148	282	289	404	219	402	460	157
1975	665	287	384	269	231	235	374	346	487	309	496	215
1976	1008	573	657	341	219	269	390	383	334	351	431	523
1977	554	396	420	208	338	347	494	407	376	456	168	167
1978	232	460	300	323	611	338	277	518	325	477	223	341
1979	627	239	361	238	309	516	343	602	297	257	496	324
1980	292	416	385	158	194	525	506	267	562	262	235	397
1981	346	351	135	323	177	107	374	91	422	319	394	610
1982	344	304	766	106	447	408	615	600	299	470	83	123
1983	370	455	206	314	572	95	332	105	469	360	411	375

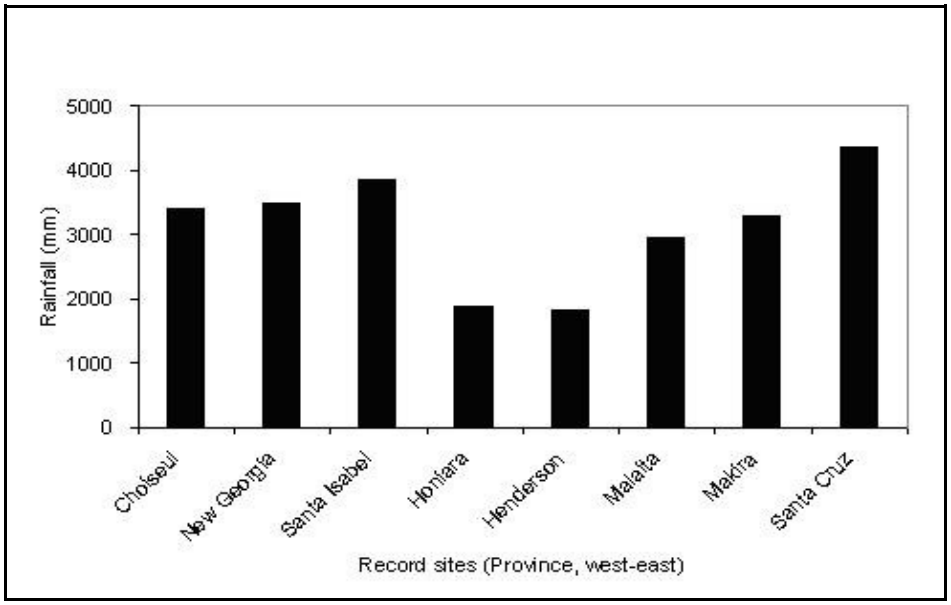
1984	516	313	753	464	414	403	343	130	270	539	594	274
1985	235	353	526	294	364	254	535	702	320	507	473	402
1986	168	312	395	472	661	154	153	177	382	236	378	310
1987	154	620	370	309	388	65	160	96	429	273	135	425
1988	524	497	256	466	275	334	621	416	509	454	581	765
1989	393	626	304	564	494	247	205	144	172	316	363	406
1990	367	312	657	169	329	230	262	236	693	213	308	530
1991	489	430	297	206	531	319	304	732	368	491	179	84
1992	104	471	120	491	339	208	688	308	145	31	112	170
1993	307	636	528	465	595	694	511	422	213	186	375	353
1994	319	362	494	483	390	215	161	182	115	489	236	198
1995	324	240	527	258	368	231	170	665	218	418	252	148
1996	368	286	401	363	417	348	409	398	399	612	271	209
Mean	399	400	421	332	382	292	357	363	342	357	324	331
Lowest	104	239	120	106	148	65	153	91	115	31	83	84
Highest	1008	636	766	564	661	694	688	732	693	539	594	765

B.9 – Average monthly rainfall for Solomon Islands

Islands/Sites	Data period	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave
Choiseul Bay	1976-1995	254	313	301	319	290	273	351	321	286	273	236	192	3410
New Georgia	1962-1996	399	371	365	290	270	245	333	269	250	229	233	287	3541
Santa Isabel*	1989-1990	417	288	337	351	295	256	290	423	426	490	533	368	4474
Honiara	1955-2000	246	282	312	183	138	86	86	101	95	127	138	222	2017
Henderson	1975-2000	238	281	255	155	129	69	83	101	103	89	150	200	1855
Malaita	1962-1996	361	372	400	248	216	182	231	221	206	210	213	287	3147
Makira	1965-1996	319	320	350	312	311	234	312	321	269	244	225	295	3512
Santa Cruz	1971-1996	399	400	421	332	382	292	357	363	342	357	324	331	4301

* JICA (2000) sourced from MME, rest from SI MET Services Data

B.10 – Chart showing rainfall distribution in Solomon Islands



Annex C – Water usage for Honiara city (no data for the whole country)

C.1 – Table of Month Water Usage for Honiara 2006/7 (KL)

	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec
2006	352923	316660	322419	385323	300502	396495	355464	340345	350721	387675	350162	307721
2007	321009	476928	498864	311637								
Ave	336966	396794	410642	348480	300502	396495	355464	340345	350721	387675	350162	307721

C.2 – Chart of Honiara monthly water use 2006/7