Sustainable Integrated Water Resources and Wastewater Management in Pacific Island Countries

National Integrated Water Resource Management Diagnostic Report

REPUBLIC OF THE MARSHALL ISLANDS

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SOPAC

Acronyms

ADB	Asian Development Bank
CMI	College of the Marshall Islands
DUD	Djarrit Uliga Delap (urban town area of Majuro)
ENSO	El Nino/Southern Oscillation
EPA	Environmental Protection Authority
EPPSO	Economic Policy, Planning and Statistics Office
EU	European Union
EVI	Environmental Vulnerability Index
FEMA	Federal Emergency Management Agency
GIS	Geographic Information System
KADA	Kwajalein Atoll Development Authority
MIMRA	Marshall Islands Marine Resources Authority
MWSC	Majuro Water and Sewer Company
MG	million gallons
NGO	Non-governmental organization
ODM	Office of Disaster Management
OEPPC	Office of Environmental Policy, Planning and Coordination
PPP	Public Private Partnerships
RMI	Republic of the Marshall Islands
RWH	Rain Water Harvesting
SOPAC	Pacific Islands Applied Geoscience Commission
UN	United Nations
UNFCCC	United Nations Framework Convention on Climate Change
USAID	United States Agency for International Development
WB	World Bank
WHO	World Health Organization
WUTMI	Women United Together Marshall Islands

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TABLE OF CONTENTS

EXECUTIVE SUMMARY 5
ACKNOWLEDGEMENTS 2

1. INTRODUCTION
   1.1 Integrated water resources management 6
   1.2 Scope of report 6

2. GENERAL OVERVIEW 7

3. INTEGRATED WATER RESOURCES MANAGEMENT SITUATION FOR RMI
   3.1 Water resources management 9
      3.1.1 Types of freshwater resources 9
      3.1.2 Types of freshwater uses 13
      3.1.3 Major issues and concerns 13
      3.1.4 Measures to manage impacts and concerns (IWRM approaches) 16
   3.2 Island vulnerability
      3.2.1 Types of disasters 18
      3.2.2 Major issues and concerns 19
      3.2.3 Measures to manage impacts and concerns (IWRM approaches) 23
   3.3 Awareness
      3.3.1 Type of awareness campaigns and advocacy initiatives undertaken 23
      3.3.2 Major issues and concerns 25
      3.3.3 Measures to manage impacts and concerns (IWRM approaches) 25
   3.4 Technology
      3.4.1 Types of water supply systems 26
      3.4.2 Types of wastewater /sanitation systems 27
      3.4.3 Majors Issues and Concerns 27
      3.4.4 Measures to manage impacts and concerns (IWRM approaches) 28
   3.5 Institutional Arrangements
      3.5.1 Types of Institutional Arrangements 30
      3.5.2 Majors issues and concerns 32
      3.5.3 Measures to manage impacts and concerns (IWRM approaches) 32
   3.6 Financing
      3.6.1 Types of Financing Arrangements 33
      3.6.2 Major issues and concerns 36
      3.6.3 Measures to manage impacts and concerns (IWRM approaches) 36

4. LINKAGES TO OTHER AREAS
   4.1 Landuse and agriculture 37
   4.2 Habitats and ecosystems 37
   4.3 Health and hygiene 39
   4.4 Watershed and coastal management 40

5. STAKEHOLDER ENGAGEMENT 41

6. OTHER IWRM RELATED PROGRAMMES, PROJECTS AND ACTIVITIES
   6.1 Water related projects and activities 42

7. CAPACITY DEVELOPMENT NEEDS FOR REMOVING THE BARRIERS....43

8. INTRODUCING AN INTEGRATED APPROACH TOWARDS BARRIER REMOVAL
8.1 Three "Big Picture" requirements for IWRM in the RMI....44
8.2 Summary Matrix IWRM Actions for the RMI....44

9. REFERENCES....50

ANNEX 1: Monthly Rainfall....51

List of Table and Figures

Page

Table

1 Types of Freshwater Resources: Majuro, Ebeye, Outer Islands 10
2 Water Pumped by MWSC: 2003 to 2005.... 11
3 RMI Rainfall Summary: 4th Quarter 2006.... 13
4 Results of EPA Outer Islands Water Catchment Bacterial Tests: 2002 to 2006.... 15
5 RMI Major Disasters with FEMA Assistance: 1980s and 1990s.... 18
6 Typhoons in the RMI: 1970s to early 1990s 19
7 Key Organisations in water/wastewater related issues.... 30
8 MWSC operating revenues, expenses and balance: FY2003 to FY2005.... 33
9 MWSC Tariffs 34
10 Majuro and Ebeye Hospital Gastrointestinal Outpatient Cases: 2001 to 2005 39
11 Organisations, relevance, roles 42

Figure

1 Map of RMI 7
2 Mean Monthly Rainfall (inches), Majuro Atoll: 1959 to 2001.... 8
3 Mean, Upper and Lower Bands for Majuro Rainfall (inches) 1959 to 2001 9
4 Coefficient of Variation for Majuro Rainfall: Based on 1959 to 2001 Monthly Rainfall Data 9
5 Aerial View of Ebeye 12
6 Results of EPA Outer Islands Water Catchment Bacterial Tests: 2002 to 2006.... 15
7 Relative Mean Sea Level, Majuro Atoll: 1968–2005.... 20
8 Exposed home on Oceanside of DUD area of Majuro Atoll.... 21
9 Schematic of Majuro reticulated water supply 26
10 Stagnant water on Ebeye 28
11 Public Health Spending by Type: FY1999 to FY2003 35
12 Gastroenteritis Outpatient Cases and Costs, Majuro and Ebeye: 2001 to 2004.... 40

EXECUTIVE SUMMARY

Water resources are finite and fragile, and yet they are under increasing pressure from population growth, urbanisation, economic development and other forces. This is especially true even in the small islands of the Pacific. Different uses of water are interlinked and interdependent. It is important therefore to take a holistic approach to the management of water resources. These are the underlying principles of Integrated Water Resources Management (IWRM).

Water continues to be a scarce and vital resource for the people of the RMI. As a coral atoll nation,water and wastewater issues are perennial concerns. This report diagnoses and analyses water resource issues in the RMI and is part of a wider regional analysis of water resources in the Pacific being conducted by SOPAC. The main objective of this report is to help the RMI develop a sustainable integrated water resource management system. Time and experience has shown that adopting an integrated approach is the only way to ensure that water resources are used effectively for the wellbeing and development of the nation and that they will be safeguarded for future generations.

Overall, water resource management in the RMI is more non-integrated than it is integrated. While there is some cooperation among water related agencies, overall collective management remains weak. All organisations with direct and indirect responsibilities for water and wastewater management and the network that connects them need development. The absence of a formal national water committee (or equivalent entity) and no current water strategy result in a relatively unclear future in this regard.

Majuro, Ebeye and the Outer Islands of the RMI face both water quantity and quality challenges. The two main water utilities continue to face financial and operational challenges. Conservation and demand management remain weak. Water resources assessment and monitoring remains limited (although this is slowly improving).

The RMI faces increasing vulnerability from floods and other natural and man-made disasters and yet its disaster preparedness capacity remains fundamentally weak. This becomes especially problematic with unsustainable development practices and the potential threats posed by climate change.

There is, therefore, much room for improvement across the board. A more integrated water resource management system can be built if a number of measures are taken. Overall coordination and collaboration must improve and be institutionalised. Better education campaigns focusing on behaviour change can help. Traditional leaders and women should be better utilised and included in decisions and dialogue. More public-private partnerships should be considered.

These are just a few of the ideas that must be considered – sooner rather than later – to help break down the barriers that currently prevent better integration in water management – and better overall access to and quality of water resources for the Marshallese people.

1. INTRODUCTION

1.1 Integrated water resources management

Water resources are finite and fragile, and yet they are under increasing pressure from population growth, urbanisation, and economic development. This is true even in the small islands of the Pacific. Different uses of water are interlinked and interdependent. It is important therefore to take a holistic approach to the management of water resources. These are the underlying principles of Integrated Water Resources Management (IWRM).

IWRM is common sense, but it is not commonly practiced. It is hoped, therefore, that this analysis and the subsequent initiatives that will stem from it will strengthen and improve the way water resources management is perceived and practiced.

1.2 Scope of report

Water continues to be a scarce and vital resource for the people of the RMI. As a coral atoll nation, water and wastewater issues are perennial concerns. A sampling of recent news headlines from the weekly newspaper (Marshall Islands Journal) highlights the ongoing water concerns:

“Stand By For Some Weird, Wild Weather” (December 8, 2006)
“It’s Time To Pray For Rain” (January 12, 2007)
“Reservoir Levels Getting Low” (January 19, 2007)
“RMI on Drought Alert” (February 23, 2007)
“Water Situation Really Bad” (March 2, 2007)

This report diagnoses and analyses water resource issues in the RMI and is part of a wider regional analysis of water resources in the Pacific being conducted by SOPAC. The main objective of this report is to help the RMI develop a sustainable integrated water resource management system. Time and experience has shown that adopting an integrated approach is the only way to ensure that water resources are used effectively for the wellbeing and development of the nation and that they will be safeguarded for future generations.

This report covers a wide scope. It begins with a general overview of the RMI, discusses the major integrated water resource management issues (under the six themes of water resources management, island vulnerability, awareness, technology, institutional arrangements, and financing), analyses linkages to other areas (such as landuse and agriculture, habitats and ecosystems, health and hygiene, watershed and coastal management), and describes stakeholder engagement, other related IWRM programs, and projects activities. The report then concludes with a discussion on capacity development needs and introduces an integrated approach towards barrier removal.

Most of the sections of this report analyse the RMI’s three major settlement areas: Majuro (the capital and urban centre where half the population currently resides), Ebeye (the second urban centre) and the Outer Islands (a general grouping of the rest of the country, mostly consisting of small scattered rural communities living on single coral islands and atolls). This analysis does not cover islands in Kwajalein Atoll occupied by the US missile base, including Kwajalein and Roi-Namur.

2. GENERAL OVERVIEW

Geography. The Republic of the Marshall Islands (RMI) consists of two roughly parallel chains of 29 coral atolls and 5 single coral islands located between 160 and 173 degrees east longitude and between 4 and 14 degrees north latitude. The RMI's total land mass measures about 180 square kilometres; and its exclusive economic zone measures about 2 million square kilometres. The highest elevation is only 10 metres above sea level, and average elevation is 2 metres. The southern atolls and islands are characterised by more lush vegetation relative to the northern atolls and islands.

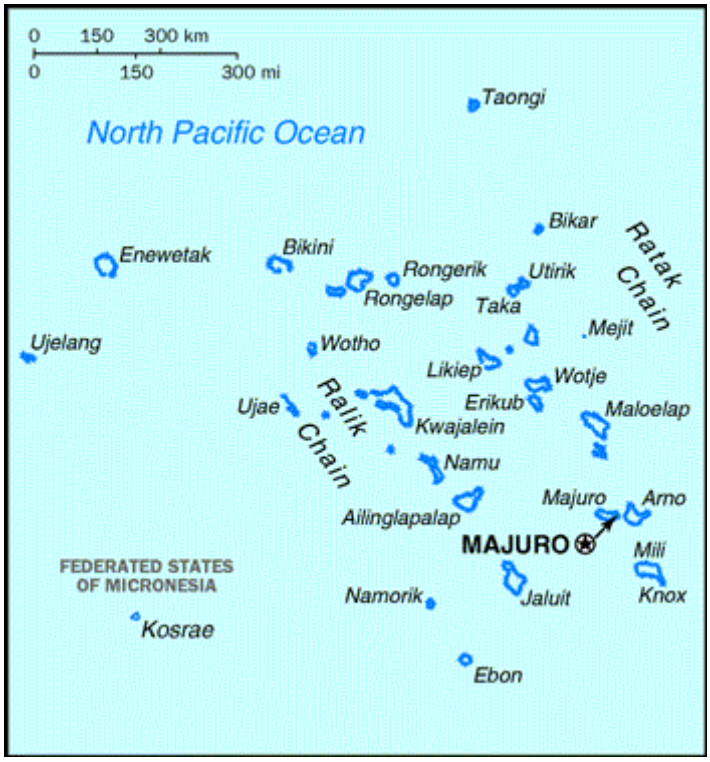

Figure 1: Map of RMI. (Source: Economic Policy, Planning and Statistics Office)

Geology. The RMI consists entirely of atolls and raised coralline islands. Soils consist mainly of poor and overlying coral sand. The atolls enclose a lagoon with depths up to 300 feet. The base of the atolls and islands are basaltic volcanoes that were active more than 150 million years ago. Reef growth during subsidence of the volcanoes results in a cap of calcium carbonate minerals that spans the distance from the top of the now-submerged volcano to the surface (USGS 1997).

Population. The last census in 1999 enumerated 50,840 persons, nearly 70 percent of whom reside in the two urban centres of Majuro and Kwajalein atolls (with the majority of Kwajalein residents living on Ebeye Island).

Social and economic issues. The RMI continues to face many social and economic challenges. The economy remains heavily dependent on foreign assistance and public sector expenditures. Economic stagnation has encouraged rising social problems, including high unemployment and increasing poverty and hardship. Education, health and overall human development indicators remain relatively poor, despite high amounts of aid per capita.

Agriculture. The bulk of agricultural activity in the RMI remains at the subsistence level. However, in recent years small scale commercial agriculture has grown in Laura Village in Majuro Atoll. Moreover, the RMI has long produced and exported coconut oil (from copra) and coconut feed and the copra industry remains heavily subsidised by the Government.

Disasters. High risk natural and environmental disasters include cyclones and storm surges. Droughts are considered medium risk and earthquakes and tsunamis and their impacts are considered low risk. Human-induced disasters considered high risk include fires, marine oils spills, water supply pollution, hazardous chemicals and disease outbreaks (EPPSO 2006). The climate is tropical and characterised by mild to warm temperatures, high humidity, and persistent winds.

Water resources. Sources of water in the urban centres include rainwater, groundwater, desalination and importation. In the rural atolls and islands, primary water resources are rainwater and groundwater.

Climate. The climate is moist and tropical with temperatures averaging about 27 degrees Celsius with little variation throughout the year. Rainfall varies from an annual mean of about 4,000 mm in the southern atolls to only 2,000 mm in the northern atolls (ADB 2005). A dry season runs from January to mid-April and a wet season from mid-April to December (see chart below).

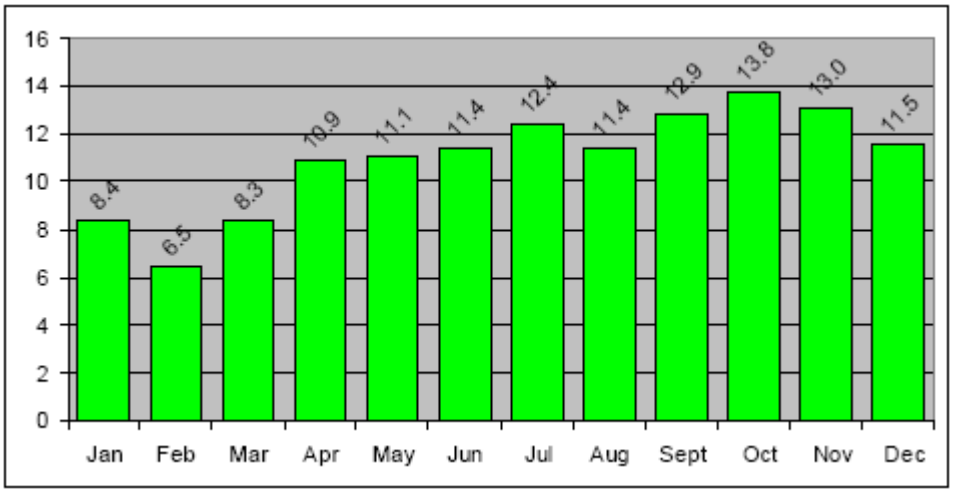

Figure 2: Mean Monthly Rainfall (inches), Majuro Atoll: 1959 to 2001. (Source: RMI Statistical Yearbook and Majuro Weather Station)

The following two charts illustrate rainfall variability based on data from 1959 to 2001. What the historic data clearly suggest is that variability is highest during the January through April period.

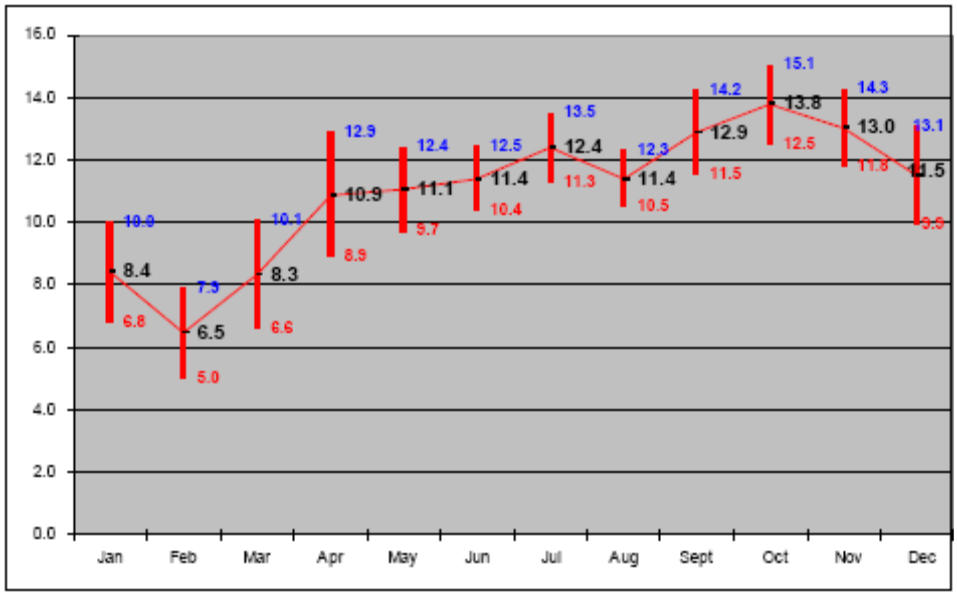

Figure 3: Mean, Upper and Lower Bands for Majuro Rainfall (inches), 95% Confidence Level: Based on 1959 to 2001 Monthly Rainfall Data. (Source: RMI Statistical Yearbook and Majuro Weather Station 2002)

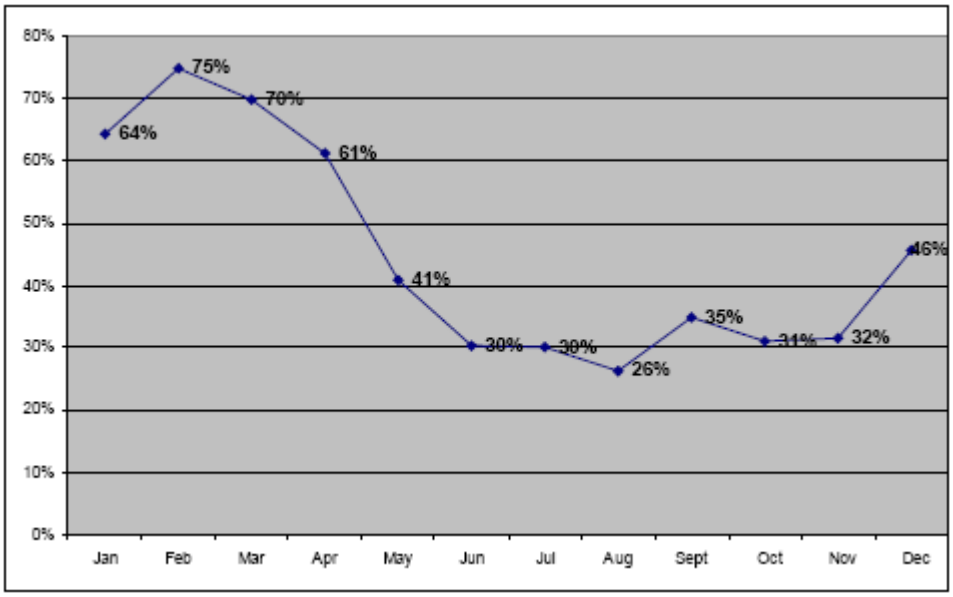

Figure 4: Coefficient of Variation for Majuro Rainfall: Based on 1959 to 2001 Monthly Rainfall Data. (Source: RMI Statistical Yearbook and Majuro Weather Station 2002)

3. INTEGRATED WATER RESOURCES MANAGEMENT SITUATION FOR RMI

3.1 Water resources management

3.1.1 Types of freshwater resources

For the RMI as a whole, the supply of natural freshwater is severely limited. The primary source of freshwater is rain which (due to the low elevation of the atolls and islands) soaks directly into the soil and disperses into saltwater which permeates atoll subsoils. In some favourable locations some of the freshwater may accumulate in a Ghyben-Herzberg lens which floats on the saltwater below and can be accessed with wells (SOPAC 1996).

There is a rainfall gradient, with heavier rainfall in the southern atolls and islands (typically in excess of 100 inches per annum) and less rainfall in the northern atolls and islands (typically less than 100 inches per annum).

The table below summarises the different types of conventional and non-conventional freshwater resources available in Majuro, Ebeye and the Outer Islands.

Table 1.Types of Freshwater Resources: Majuro, Ebeye, Outer Islands.

	Rainwater	Groundwater	Desalination	Importation
Majuro	• Annual average rainfall 131 inches per year (95% confidence interval of 125 to 137 inches per year based on 1959 to 2006 data) • Municipal water supply (RWH airport catchment and reservoirs with 36.5 mg storage, supplemented by Laura wells). 1,100 households on water line (about one-third). Household RWH also heavy, 71% of households have catchments in 2006	• Laura wells currently producing about 100,000 gallons daily • Small percentage of households still rely on groundwater wells for drinking (35 households or 1% of Majuro households in 1999 census)	• Occasional use of desalination units for public water (during droughts and emergencies) • Commercial use of desalination (for bottled water) by private companies	• Increasing imports and sale of bottled drinking water
Ebeye	• Annual average rainfall 100 inches per year • Household RWH (22% of households have catchments in 2006)	• Very few households still rely on groundwater wells for drinking (1 in 1999 census and 1 in 2006 survey)	• Municipal water system uses desalination system with a maximum production capacity of 200,000 gallons per day (or roughly 200 gallons per household)	• Many household s reliant on public water stands on US base at Kwajalein for drinking water • Increasing imports and sale of bottled drinking water
Outer Islands	• Rainfall gradient: southern atolls annual average rainfall over 100 inches and northern atolls as little as half this amount • Household RWH heavily used	• Household wells heavily used, especially in dry periods	• n/a	• Some imports of bottled drinking water from urban centres

Note: RWH = rain water harvesting mg = million gallons

Majuro. Majuro freshwater resources include both conventional (rain and ground water sources) and non-conventional (desalination and importation). Majuro has an average of 131 inches of rainfall a year, with a 95 percent confidence interval of between 125 to 137 inches based on rainfall data from 1959 to 2006[1]. During ENSO years, however, rainfall is notably less. For

[1] Author's calculations.

example, rainfall in 2006 (due to mild ENSO conditions) was only 104.6 inches (see table 2.3 below) and during the last major ENSO year, 1998, rainfall was only 102.1 inches.

Rainwater is harvested using the airport runway as a catchment area (with approximately 80 acres of area). The airport catchment area yields about 223 million gallons annually but the potential dependable yield is about 170 million gallon annually (Beca 2003). Water from the airport catchment is pumped to a series of reservoirs that currently hold 36.5 million gallons. Airport catchment water is supplemented by groundwater pumped from seven wells in Laura Village to the reservoirs. The Laura wells are estimated to have a maximum yield of up to 400,000 gallons daily (USGS 2005) but the current rate is only around 100,000 gallons daily (theft and leakage are noted as key problems by the Majuro Water and Sewer Company). The dependable yield of the Laura wells is at least 52 million gallons annually (Beca 2003). The reservoirs feed a reticulated distribution throughout Majuro.

Majuro Water and Sewer Company's (MWSC) reticulated system delivered the following quantities (in millions of gallons) from 2003 to 2005. As the data in Table 2 indicate, the amount of water delivered through the system varies significantly from year to year. In 2005 about 341 million gallons were pumped through the reticulated system. Data on the distribution of water demand (between residential, commercial, government, etc.) is not currently available from MWSC. It is known that approximately 1,100 residential households are subscribed to the water line (or roughly one-third of all Majuro households).

Table 2 Water Pumped by MWSC: 2003 to 2005. (Source: EPPSO and MWSC)

Year	Total Gallons (millions)
2005	340.7
2004	200.9
2003	232.8

Household rainwater harvesting is also practiced heavily on Majuro and a survey[2] in 2006 found that 71 percent of households had their own catchments. This closely matches results of the 1999 census which showed that on Majuro 75 percent of households used catchments. A small number of households also continue to rely on groundwater as their primary source of freshwater (only 35 households in 1999 used wells as their primary source of drinking water).

Majuro's non-conventional water sources include desalination and importation. Several reverse osmosis units have been made available from the US Government (FEMA[3]) and Japan and these are used during dry periods. At least two Majuro companies also use desalination to produce and sell bottled drinking water. The importation, sale and consumption of bottled drinking water is also on the rise in Majuro but no hard data exists due to poor import data systems.

Ebeye. Ebeye's freshwater resources include rainfall, desalination, and importation (with almost no use of groundwater resources). Ebeye receives roughly 100 inches of rainfall annually (rainfall in 2006 recorded on nearby Kwajalein was 103.62 inches). Like Majuro, Ebeye also has a reticulated water line. This is operated by the utility Kajur. Kajur previously harvested rainfall using a .44 acre catchment basin at the southern tip of the island (see Figure 5 with catchment area shown at bottom end of island), but this is no longer in service and suffers from leakage and deterioration. Kajur now operates two desalination units that provide some 100,000 gallons of

[2] RMI 2006 Community Survey, covering 544 households (18 percent sample).

[3] Federal Emergency Management Agency

water daily (with a maximum capacity of 200,000 gallons). However, recent news indicates that only one of the units is now in operation. Moreover, the 2006 Community Survey found that only about one third (32 percent) of Ebeye households (which total just over 1,000) depend on the main water line for drinking water.

Many Ebeye households rely on importation of water from neighbouring Kwajalein Island, home to the US military base. Public standpipes at the Kwajalein dock provide potable water to Ebeye residents, many of whom transport water back to Ebeye daily in small water containers. Importation of bottled water from outside the RMI is also on the rise on Ebeye but no data are available on this. Rainwater harvesting at the household level exists but is not as common as it is on Majuro. Only 22 percent of households recently surveyed in Ebeye (2006 Community Survey[4]) were found to have their own water catchments to catch roof runoff. This low prevalence of home water catchments may be due to the limited space available on Ebeye.

Figure 5: Aerial View of Ebeye.

Outer Islands. Rainfall in the Outer Islands varies widely, with atolls and islands in the southern regions typically receiving in excess of 100 inches of rainfall annually (e.g. see Mili, Arno, Ailinlaplap in Table 3) while those in the northern regions receiving usually less than 100 inches annually (e.g. see Wotje below). Outer Islands rely almost entirely on rainfall (using roof runoff and catchments) as well as groundwater wells.

[4] [4] Conducted by the EPPSO

Table 3: RMI Rainfall Summary: 4th Quarter 2006. (Source: Pacific ENSO Update 1st Quarter, 2007 Vol. 13 No. 1.)

Station		Oct.	Nov.	Dec.	4th Qtr	2006 Total
Wotje*	Rainfall (inches)	9.59	7.91	9.02	26.52	78.38
Kwajalein	Rainfall (inches)	19.91	13.01	6.57	39.49	103.62
	% of Normal	174%	121%	83%	126%	105%
Majuro WSO	Rainfall (inches)	10.75	8.05	7.65	26.45	104.63
	% of Normal	77%	68%	67%	71%	80%
Laura*	Rainfall (inches)	4.3	9.58	12.52	26.1	88.37
Alinglaplap*	Rainfall (inches)	5.93	11.97	9.26	27.16	114.97
Arno*	Rainfall (inches)	12.34	9.01	7.81	29.16	100.95**
Mili*	Rainfall (inches)	13.41	12.85	7.78	34.04	141.16

* Long term normal is not established for these sites
** Estimated

3.1.2 Types of freshwater uses

Majuro. On Majuro, rapid population growth, urbanisation, and increasing private and public sector development are all contributing to dramatic growth in both the demand for and various uses of freshwater. Recent growth in public infrastructure, commercial fisheries operations, retail businesses, hotels, and small-scale agriculture have increased overall demand and competing demands for freshwater on Majuro.

Ebeye. Overall, growth on Ebeye is nowhere near what it is on Majuro (in terms of both population growth and overall development). As a "bedroom community" for the Kwajalein military base, Ebeye's demand for freshwater is mostly residential and non-commercial. The national and local governments do have a footprint on Ebeye (including a large government hospital), and this does put some pressure on water supply. The current reverse-osmosis system in operation by Kajur, for example, was put into place in 2001 in part to ensure that the new hospital (which opened in 2002) would have a more reliable water service.

Outer Islands. Virtually all freshwater use in the Outer Islands is residential. There are several exceptions, namely in Jaluit, Wotje, Bikini, Rongelap, and Arno where some government and commercial facilities exist. These facilities provide their own freshwater, primarily through rainwater harvesting.

3.1.3 Major issues and concerns

The major issues and concerns related to overall water management in the RMI are as follows:

Insufficient quantity. Throughout the RMI water supply is not meeting demand. On Majuro, MWSC continues to operate on a water rationing basis with water available at most for several hours a day for several days a week (this schedule is drastically reduced during dry months). Water delivery orders are backlogged and anecdotal evidence suggests strongly that sales of domestically produced and imported bottled water are growing quickly (in response to overall weak supply). As an example from the commercial sector on Majuro, a large fish processing plant that will open in late 2007 will require such a large quantity of fresh water on a daily basis that it will have to provide its own desalination facility. As another example (and one from this current dry period), in February of 2007, a large Japanese tour group visited Majuro for four days and hotels hosting the tourists had to request special deliveries of water from MWSC during their stay. Despite a long backlog of water delivery orders ahead of the hotels, MWSC and the Government granted the special request to the hotels due to the unique circumstances.

Various studies have identified that Majuro's current 36.5 million gallon reservoir capacity as insufficient and should be doubled in order to help meet growing demand. Moreover, in the Majuro water reticulated supply system there is significant leakage and theft which may be contributing to up to 50 percent wastage of water.

The Laura wells present another area of concern with respect to insufficient quantity. As stated in the previous section, the USGS estimates that Laura's maximum sustainable yield is up to 400,000 gallons daily. However, MWSC estimates that it only draws on average 100,000 gallons daily. If these estimates are accurate, then much more can be extracted sustainably from Laura. Also, if the MWSC estimate for daily extraction from Laura is accurate (100,000 gallons), then this would provide an annual extraction level of some 36.5 mg. As shown in Table 2, MWSC supplied a total of 340.7 mg in all of 2005. Therefore, a rough estimate would place the proportion of supply reliance on Laura at around 11 percent. The impression drawn from these estimates is that much more can be drawn on a sustainable basis from the Laura wells. More analysis needs to be conducted on this issue.

On Ebeye the public water supply is so inconsistent (stemming from power and maintenance problems) that households have to resort to hand carrying jugs of water from the Kwajalein base dock across the lagoon (where a public water stand is available).

Ongoing preliminary analysis of Majuro, Ebeye and Outer Island rainwater harvesting data (incorporating rainfall, household roof size and runoff estimates, and estimates on guttering and water catchment size) suggests that even with 100 percent guttering and adequate catchment volume, a typical household will almost always run the risk of running dry during normal rainfall years and will certainly run dry for at least several weeks during periods of extended dryness (two or three months).

What all of this suggests is that while improvements to home rainwater harvesting can and should be made (e.g. better guttering and larger tanks) to reduce the risk of going dry during normal years, improvements to back up water sources (including the main water systems and community sources) are also necessary.

Challenged public utilities. As discussed in more detail in the section on finance, the two main water utilities, MWSC on Majuro and Kajur on Ebeye, continue to face great challenges in delivering quality water and services on a consistent and reliable basis. On Ebeye an added complication stems from the fact that power problems (power is also run by Kajur) directly create water supply problems (as the desalination unit requires power to operate). On both Majuro and Ebeye, capacity development and training remain critical for the improvement of financial and operational management.

Contamination. Contamination and pollution are real and present threats to water resources everywhere, including in the water systems, in the groundwater (especially in urban areas), in household catchments, and in coastal areas. For Outer Island households, the Environmental Protection Authority (EPA) has dramatically increased its water quality testing in recent years (see table and chart below). Increased testing has revealed that a high percentage of home water catchments are contaminated. This also is the case in the urban centres where sampling of water catchments has shown that most households are using contaminated catchment water. This, in turn, supports the data that show a high and increasing prevalence of water-borne diseases (see section on Health and hygiene). Sources of pollution at the household level include unsanitary roofs, guttering and catchments. For homes using wells, pollution sources include human and solid waste.

In Laura, there is increasing concern over the use of chemicals for agriculture and the effects these may have on the Laura water lens. Moreover, in Laura, there is no sewage system so households use septic tanks and these often leak and threaten to contaminate the water lens. At

the airport catchment, fuel spills, residue from asphalt, salt spray and inundation are all sources of pollution.

The main water line is also regularly quality tested and sometimes found to be contaminated. This is caused by insufficient chlorine dosing and occasionally because of illegal connections that backflow into the line when pumping is stopped.

Sources of coastal waters pollution include human and animal waste, solid waste, and runoff.

Table 4: Results of EPA Outer Islands Water Catchment Bacterial Tests: 2002 to 2006. (Source: EPA)

Year	# Tests	# Safe	% Safe	% Not Safe
2002-2003	232	58	25%	75%
2004	947	239	25%	75%
2005	586	170	29%	71%
2006	342	132	39%	61%

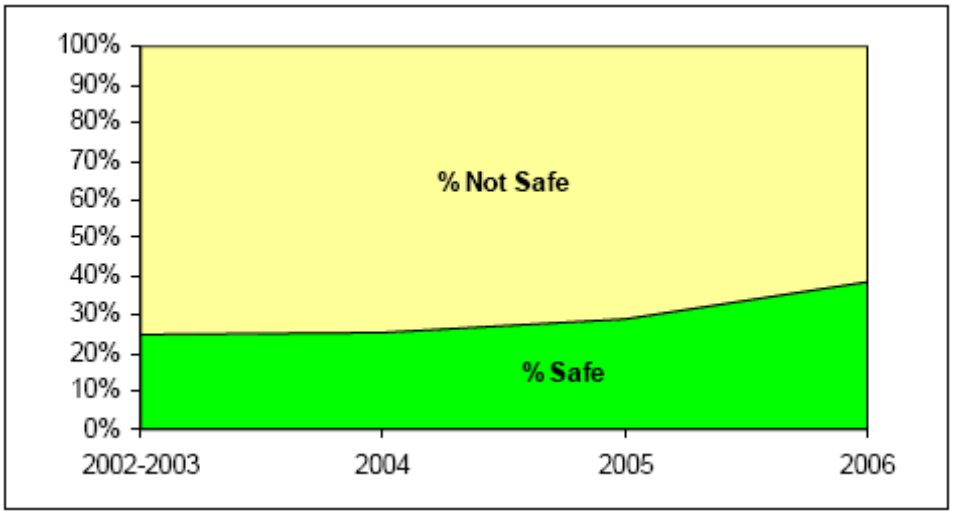

Figure 6: Results of EPA Outer Islands Water Catchment Bacterial Tests: 2002 to 2006 (Source: EPA).

In terms of prevention measures of contamination, there are only a few hard examples available. At the household level, the EPA has stepped up its distribution of home catchment cleaning kits as well as its advice on how to clean water catchments using basic measures (like using household bleach). In 2002, the Government erected a higher perimeter wall around the airport runway to protect the catchment area from saltwater intrusion during high wave action. MWSC is currently stepping up its theft and leakage detection efforts via closer inspections of household and business connections and ensuring that all hookups are legitimate. Other common prevention measures such as water reserves and water safety plans have yet to be developed.

Weak conservation and demand management. Public attitude and awareness on water conservation, reuse, and related issues is poor. Campaigns for water conservation are few and far between, even during the dry season (as described in the section on awareness). Moreover, there is virtually no promotion of water efficient appliances. The EPA's community water monitoring programme has proven to be an effective face-to-face way of educating various communities and this presents an opportunity for further improvement.

Non-integrated management. There is fragmentation of authority and responsibility over water issues, with no single organisation or entity serving to pull together information and harmonise efforts. There exists no national level water committee (or similar entity) and community level coordination is just starting. The RMI has no information exchange system on water resources.

There has been improved collaboration on certain initiatives and projects. For example, the National Government, in conjunction with EPPSO and local governments, has successfully run a water catchment distribution project that has seen 2,187 water catchments distributed to Outer Island homes (along with guttering and other material). As another example of national-local collaboration, over the past several years EPA has stepped up its community water monitoring activities, engaging local governments and community members to help carry out water testing and reporting.

However, overall, vertical and lateral collaboration between and among government and other organisations remains weak. As a result, it is fairly safe to say that water resource management in the RMI remains quite non-integrated.

In addition to insufficient quantity, challenged public utilities, contamination, weak conservation and demand management, and non-integrated management, the following major water resource management issues and concerns also exist:

- Water resources assessment and monitoring remains limited.
- As discussed in more detail in the section on island vulnerability; disaster and emergency planning and preparedness is a key weakness.
- The incorporation and enforcement of rainwater harvesting specifications into building design remains weak.
- Training and capacity building needs are high across the board.
- No overall water sector strategy.

3.1.4 Measures to manage impacts and concerns (IWRM approaches)

Addressing these serious issues and concerns requires a number of actions:

- Much better water resources assessment and monitoring needs to take place within and between the relevant agencies. The RMI does not have a formal National Hydrological Network that coordinates assessment and monitoring and overall knowledge management on water issues remains weak. Entities such as EPA, MWSC, Kajur, Public Health, and local governments should address these issues.

- To address the supply issue, simultaneous interventions must be made at both the household level and at the public infrastructure level, as well as in both the urban and rural areas. At the household level, targeted assistance, beginning with the most at-risk households (i.e. those in the driest regions and those in the urban areas that cannot afford water line service), is required. At the public level on Majuro, efforts must be made to expand the Majuro water reservoirs, eliminate leakage and theft, and improve overall efficiency. On Ebeye, power and maintenance problems contributing to inconsistent overall supply and service must be immediately addressed.

- Laura presents another area of concern that needs to be analysed more closely. It appears from the estimates on dependable yield and extraction rates that much more can

be drawn from Laura wells at sustainable levels – this needs to be analysed more closely by MWSC and other relevant entities.

- Assistance to atolls and islands that are still currently facing drought conditions (including Wotho, Ailuk, Lae, Utrik and others) must be expedited by the appropriate authorities.

- In relation to the supply issue, the RMI must also pay more attention to emerging and alternative technology, including such non-conventional sources as large scale desalination and the possible use of oceanic thermal energy conversion (which produces potable water as a byproduct).

- The contamination issue can only be more effectively addressed beginning with more monitoring and sanitation measures. Of course some contamination sources will be easier to detect and eradicate, including home water catchment contamination sources. Development and implementation of a comprehensive water safety plan that addresses all contamination issues would help greatly in this regard. Related to this, the Laura groundwater resources need to be more effectively protected against rising sources of potential contamination.

- The two water utilities require continued and consistent technical assistance, training, and capacity building. A number of organisational challenges continue to prevent the utilities from living up to their full potential in terms of providing quality, consistent water and wastewater services.

- More and more effective demand management measures must be implemented, including stronger conservation campaigns and mechanisms to induce use of more efficient appliances.

- The overall water resource management universe consists of many national, local, and community entities that all share some aspect of responsibility for water resources. In order for water resource management to be truly integrated, two things must happen: (1) a new multi-sector water committee needs to be formed and needs to collaborate and share information and knowledge more effectively; (2) a medium term water sector strategy needs to be established to address all water resource issues in all RMI regions (urban and rural), identify a common vision and lay out simple, agreed-to objectives on how to move forward. Without this collaboration and without a sound plan to guide the RMI, water resource management will continue to be fragmented, ad hoc, and non-integrated.

- As discussed in more detail in the section on island vulnerability, efforts must be made immediately to strengthen the RMI's Office of Disaster Management (ODM). Emergency planning and preparedness is key weakness that needs urgent attention.

- The incorporation and enforcement of rainwater harvesting specifications into building design should be considered by entities such as Public Works and local governments.

- More technical assistance, training and capacity building activities are required, especially in the utilities and especially for community level groups.

3.2. Island vulnerability

3.2.1 Types of disasters

The RMI is vulnerable to a number of natural and man-made types of disasters including: typhoons, tropical depressions, storm surge, flooding, sea level rise (and other climate change effects), droughts, fires, marine oil spills, water supply pollution, hazardous chemicals and disease outbreaks.

The Environmental Vulnerability Index profile review of 2003 identified areas of most environmental vulnerability to include: country fragmentation, coastal settlements, isolation, population density, relief, oil spills, endangered species and fertilisers. Areas of good environmental resilience, on the other hand, include: volcanoes, natural vegetation, earthquakes, ecological overfishing, tsunamis, (SO2), endemics, mining, introductions, conflicts, extinctions, sanitation and genetically modified organisms (SOPAC 2003).

Historical data on typhoons and droughts. There are some data gaps in historical records on typhoons, droughts and other types of disasters. The US Federal Emergency Management Agency (FEMA), which provides assistance to the RMI, provides the following list of major declared disasters for which US emergency assistance was provided during the 1980s and 1990s. This list excludes smaller events that were not declared national disasters, including a number of high wave action events (the latest one occurring in Majuro in October of 2006).

Table 5: RMI Major Disasters with FEMA Assistance: 1980s and 1990s.

Source: US Federal Emergency Management Agency
URL: http://www.fema.gov/news/disasters_state.fema?id=68#diz

Year	Date	Disaster Types
1998	20-Mar	Severe Drought
1994	6-Oct	High Surf, Wave Action
1992	16-Dec	Typhoon Gay
1992	7-Feb	Tropical Storm Axel
1991	6-Dec	Typhoon Zelda
1988	16-Jan	Tropical Storm Roy
1987	27-Apr	Fire

An historical compilation of typhoons that have occurred in the RMI over the past 150 years is also available[5]. This historical compilation is the best inventory of typhoons available today. The following table lists a subset of this compilation (only those typhoons that occurred from the 1970s through the early 1990s).

[5] [5] http://marshall.csu.edu.au/Marshalls/html/typhoon/Stormy_Years.html

Table 6: Typhoons in the RMI: 1970s to early 1990s. (Source: Spennemann and Marschner 2000)

Year	Dates	Typhoon Name
1992	7-9 January	Axel
1992	5-7 February	Ekeka (*)
1992	5-8 August	Kent (*)
1992	21-22 September	Val (*)
1992	6-12 October	Zack (*)
1992	15-16 October	Brian (*)
1992	17-20 November	Gay
1991	4-5 November	Verne (*)
1991	17-24 November	Yuri (*)
1991	28 November - 2 December	Zelda (**)
1990	5-9 November	Page (*)
1990	14-24 November	Owen
1988	8-9 January	Roy
1987	20-22 August	Ed
1987	4-5 September	Holly
1986	11-13 August	Georget
1986	21-23 December	Norris
1982	25-28 November	Pamela
1981	11-15 March	Freda
1979	2-6 January	Alice
1978	19-20 October	Rita
1977	23-27 December	Mary
1972	4-7 October	Marie
1972	12-19 December	Violet

* Severe tropical storms
** Severe tropical storm, developed into a typhoon after leaving the RMI

The US Geological Survey lists droughts in the RMI over the past several decades during the years 1970, 1977, 1983, 1992, and 1998. The droughts occurred between 6 and 9 years apart and are characterised by a one to four month period of monthly rainfall less than 2 inches per month, within a 3 to 7 month period of lower than average rainfall (USGS 2005).

ENSO related events. The historical records demonstrate a fairly strong link between the occurrence of the ENSO phenomenon and typhoons and droughts. Records show that during ENSO years the RMI has a 71 percent chance of experiencing a typhoon while during non-ENSO years the probability falls to just 26 percent (Spennemann and Marschner 2000).

Like typhoons, droughts correlate with the ENSO phenomenon with the most extreme droughts occurring in very strong ENSO years, during 1983 and 1998.

3.2.2 Major issues and concerns

High impacts of floods and droughts. Due to the low-lying elevation of the atolls and islands, when typhoons (and their accompanying effects) do occur, they've proven to be extremely damaging, including to water resources. During ENSO-associated droughts, access to water is extremely difficult because of both very low rainfall as well as because of lowered sea levels which lower the watertable, thus making access to ground water very difficult (US Climate Change Science Program 2001). Flooding damage from typhoons and other events causes losses in subsistence food crops, contamination of potable water supplies (and associated diarrhoea and conjunctivitis), losses in homes, and saltwater intrusion of public water supplies, including the airport catchment area and home wells (ADB 2006).

Estimates of the economic costs of floods, droughts and other disasters have yet to be quantified, but are considered to be very significant. The high wave action do 1979, for instance, displaced over 5,000 people in the Djarrit Uliga Delap (DUD) area of Majuro, many of whom were unable to rebuild their homes for several years. If the same high wave action were to occur today, the equivalent affected population would now be 20,000.

Global warming and sea level rise. As the RMI comprises entirely of low-lying coral atolls and islands (with a mean elevation of just several feet above sea-level), the very existence of the nation is directly threatened by global warming and sea level rise. Changing weather patterns due to atmospheric warming related to climactic changes are already considered to have caused recent droughts and typhoons. Rising sea levels in the RMI will mean increased flooding and coastal erosion and will introduce salinity into the fragile freshwater lenses. Moreover, warmer sea temperatures directly harm atoll and reef ecosystems which protect the islands (ADB 2006).

Analysis of tidal data in a recent ADB risk assessment for sea level rise in the RMI shows a long-term trend toward a higher relative sea level. The rise is about two centimetres per decade, slightly more than the global rate of sea level rise during the 20th century of 0.9–1.8 centimetres per decade (ADB 2006).

A real and growing threat is posed by global climate change and sea level rise. However, there remains very little discussion and awareness on this issue in the RMI. Moreover, there does not appear to be any type of contingency in place in case the worst-case sea level rise scenarios materialise.

High-risk development practices. Development practices also raise risk levels for both life and property damage in the RMI. The two most densely populated settlements in the RMI, the DUD area of Majuro Atoll and Ebeye island, expose roughly 30,000 Marshallese and their property to a number of risks as they are located on the eastern (windward) sides of their atolls, where vulnerability to storm surge and flooding is relatively higher. Moreover, homes in these areas are often constructed very close to the shoreline and are virtually unprotected from high waves, surge, and subsidence (see picture below).

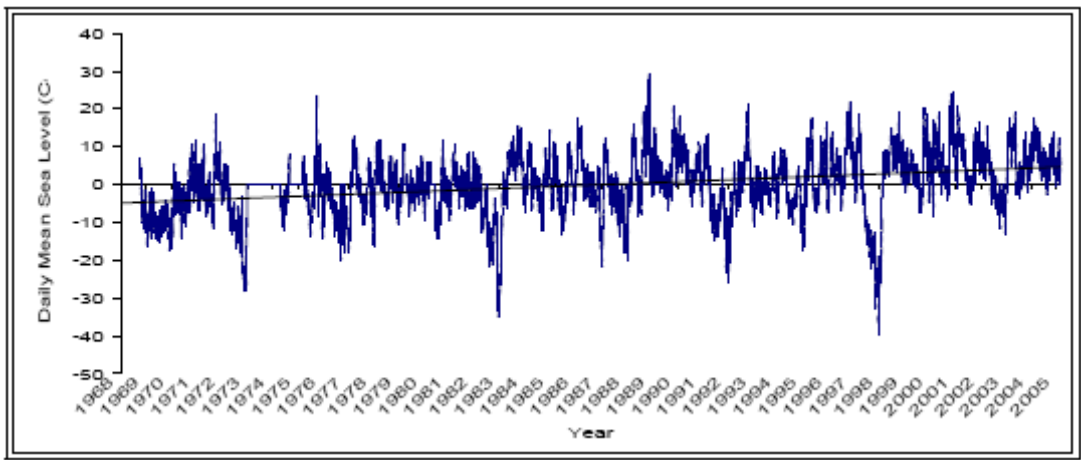

Figure 7: Relative Mean Sea Level, Majuro Atoll: 1968–2005. (Source: Asian Development Bank. 2005. Country Environmental Analysis of RMI. Manila.)

Figure 8: Exposed home on Oceanside of DUD area of Majuro Atoll. (Source: Satish Chand 2005)

Traditionally, windward areas of atolls were only used for temporary settlement or saw very small and scattered populations residing there. The larger islands on the leeward sides of atolls were more preferable for settlements because they ensured protection from extreme climatic events such as typhoons and storm surges. The two main urban settlements of Majuro and Ebeye, therefore, go against long-established traditional practices (Spennemann 1998).

Rapid population growth in DUD and Ebeye has resulted in overcrowding (with population densities of over 2,500 per square kilometre) and poorly constructed houses packed together, most of which are without adequate sanitation and solid waste disposal.

Other high risk development practices include construction of inappropriately designed sea walls and landfills, dredging, reef blasting, land clearance, and blockage of natural channels (via landbridges). All of these practices contribute to accelerated shoreline erosion.

Disaster un-preparedness. The RMI's disaster and emergency planning, preparedness, and response capabilities are extremely weak. The Office of Disaster Management (ODM, managed by the RMI's Chief Secretary) remains perhaps the weakest link in the entire disaster preparedness chain – despite the fact that its very existence is to serve as the strongest link in the chain. The ODM remains understaffed, under-budgeted, and does not appear to be a very high priority of the RMI government. There is just one full time person devoted to disaster and emergency issues and the ODM in general has limited interaction with other offices and very limited interaction with the community at large.

RMI access to US FEMA assistance will end in 2007 and a new program of US assistance from the US Agency for International Development (USAID) will commence. It is unknown, however, if the level of support and assistance under the new USAID program will match that of FEMA.

The text box below contains a recent Marshall Islands Journal article entitled "Total Lack of Action," that provides a fresh reminder of how poor disaster preparedness is in the RMI today.

Total Lack of Action

It is quite likely that the word "proactive" is not in the vocabulary of the majority of our government workers.

While hoping for it to be may be wishful thinking, there are some offices where this is a must, a prerequisite to everything they are supposed to be doing. In this case, we're referring to the government's so-called disaster preparedness office. All Majuro residents received a glimpse at this office's lack of effort when high tides combined with high winds to flood much of Majuro. Advance warnings to the public? Coordination of cleanup efforts? No such luck.

And last week we learned that despite the fact that the Marshall Islands is now two months into an extended drought, the disaster office is still just "thinking" about whether or not to call a meeting of key people to talk things over. Everyone and his brother who reads newspapers (even our modest publication) or checks the Internet once or twice a week could tell you that weather forecasters started predicting the current moderate El Niño way back in early 2006.

The impact of El Niño in our part of the world is well known: It dries up the rain clouds, causing extended periods with no rain.

In line with "accountability" and "serviceability" wouldn't it make more sense just to get rid of the so-called disaster preparedness office? If its staff is unable or unwilling to do the job, find someone who is able to in another ministry, or better yet, just disband the whole charade. At least then there won't be any illusion or expectation of preparing for disasters.

We'll just know that, like now, we're all on our own.

Source: Marshall Islands Journal, February 23, 2007

While the tone of this article is highly negative and cynical about the current disaster preparedness situation, it should also be acknowledged that the ODM does recognise these weaknesses and is taking some measures to address them. In May of 2005 it submitted its standard mitigation plan for approval by the US FEMA with the aim of securing technical assistance and funding following disasters. The plan was based on the revisions of the 1998 National Hazard Mitigation Plan and the 2003 Disaster Preparedness and Mitigation Act and addresses the need to strengthen and improve emergency communication and early warning systems throughout the nation. It notes that while communication and early warning systems exist, users need to be trained to maintain the equipment and ensure its proper application. The plan also recognises the need to raise awareness in communities to help prepare for disasters and so minimise risks (ADB 2005). Anecdotal evidence suggests, however, that there remains much room for improvement.

Furthermore, with respect to global climate change and sea level rise, the RMI is only beginning to clarify what potential measures it may deploy to mitigate risks and manage impacts. However, what the RMI has not yet done is clarify its plans for dealing with the potential worst-case scenarios of sea-level rise (which would render the entire RMI uninhabitable). The ADB funded 2005 Social and Economic Report recommended strongly that "The Cabinet should immediately begin researching, developing, and seeking public consultation on a long-term plan to adapt to climate change and sea level rise." By all indications this has yet to occur.

Far better coordination and collaboration among the different government offices, including the Disaster Office, the Office of Environmental Policy, Planning and Coordination (OEPPC) and the EPA, and far stronger direction and leadership on this issue from the highest levels of Government must occur sooner rather than later if disaster and climate change preparedness are to improve.

3.2.3 Measures to manage impacts and concerns (IWRM approaches)

There are limits to what the RMI can do in terms of reducing its vulnerability to exogenous events such as droughts, typhoons, and sea level rise. Nevertheless, the RMI can do far more in terms of planning, preparation and risk mitigation. So far, it has proven to be ineffective in most of these areas. Reversing this will require the following actions:

- The ODM, which is supposed to serve as the strongest link in the disaster planning, preparedness, and risk mitigation chain, needs immediate attention. Technical assistance, training, capacity building are all required and as soon as possible. It is simply unacceptable to have a weak, under-resourced disaster management office in the face of mounting natural and man-made threats and vulnerabilities. Urgent attention from the highest levels of RMI government is needed. A strong and effective ODM will ensure that immediate disasters and emergencies are adequately planned for and addressed and will also help the RMI begin the long road to planning for the potentially devastating effects of sea level rise.
- High risk development practices must be examined more closely by the appropriate authorities. Majuro's DUD area and Ebeye face higher risk of high wave action and storm surge because of their eastern atoll locations and some form of preventative measures and plans need to be in place to account for this. This would require close collaboration between a number of parties, including the ODM, local governments, and others. Landowners are also key in this regard and need more involvement on this issue.
- Water resources and assets (at both the household and public levels) are vulnerable to different types of disasters, most notably saltwater intrusion. Protective measures need to be put into place to hedge against these disasters. Better water reservoirs, stronger protection of groundwater lenses, more drought-sensitive design of water storage facilities and better reticulation systems are among some of the measures that can be taken to safeguard water resources. All of this can be addressed in a water safety plan.
- A quick glance at the historical data on droughts, typhoons and high wave action generally suggest that the October through March period can be considered the "high risk" season in the RMI. Figures 2, 3 and 4 in the previous section show that rainfall volatility is highest from January to March. Climate forecasting may be difficult, but at least there is some general predictability in these events based on history. RMI's planners need to really take this into account and better prepare themselves and the country prior to and during this "high risk" season. The poor preparation and planning demonstrated during the late 2006/early 2007 El Nino season (as described in the text box "Total Lack of Action") suggests strongly that RMI's planners are not taking this knowledge into account.

3.3 Awareness

3.3.1 Type of awareness campaigns and advocacy initiatives undertaken

Awareness programmes and activities. Not much is currently taking place in terms of ongoing public awareness programs and activities related to water resources. EPA is the only public agency that provides regularly scheduled activities. EPA's most consistent and widest-reaching education activity is its weekly radio show, which is broadcast on the national government radio station and which reaches all of the Marshall Islands. EPA has also developed an environmental education guide, pamphlets on specific environmental issues (including one on how to treat water catchments), and conducts community and school visitations.

OEPPC also provides some project-specific awareness activities (e.g. through its International Waters Programme). Other public and non-governmental entities including the Ministry of Health, MWSC, EPPSO, Kajur, the Office of Disaster Management and several NGOs have tangential and occasional water related awareness activities. For example, many of these entities are involved in the annual World Water Day activities.

A lot more can be done. More effective programmes need to be developed – programmes that move beyond just basic information dissemination and awareness building. Innovative social marketing campaigns can be developed which are more targeted and which focus on behaviour change (and not just awareness). Moreover, resources can be pooled between the various entities to leverage up the awareness and education activities.

Community outreach and participation. A group of concerned farmers in Laura have recently formed a community group to address the issue of water lens protection. The Laura groundwater lens is a valuable asset not only for the farmers and community but also to the greater water supply system (which it supplements). EPA recognises this as a good first step in terms of a community initiative and hopes that other communities can form similar groups to address water related issues specific to their areas. As mentioned, EPA has already established a network of community and local government persons who are involved in the ongoing water monitoring program – this can be used as a vehicle to further promote community groups.

Political will and public understanding. There remains room for improvement in terms of both political will and public understanding on water issues and environmental issues in general. Several recent events have demonstrated that political will does exist. As mentioned earlier the RMI Government, with strong support from Cabinet, has funded an ongoing water catchment distribution program that has seen 2,187 catchments distributed to households on the Outer Islands along with guttering and other material. Moreover, organisations like the OEPPC and the EPA have in recent years been taken up into the portfolio of the Office of the President, which indicates a stronger, high-level political backing of these agencies and their initiatives. EPPSO has also emerged as a strong, high-level backer of water related initiatives.

On the other hand, there also exist examples of lack of political will. For instance, Government funding for EPA's community water quality monitoring program (about US$40,000 annually) was recently cut and EPA must now rely on US federal funding through a partnership with the College of the Marshall Islands (CMI) Land Grant program – funding that may eventually dry up.

Both supply (government) and demand (community) side perspectives must both be addressed in any public awareness activities. Advocacy efforts by EPA and its partner entities must take this into consideration.

Cultural issues related to water/wastewater management. All land in the RMI remains under the traditional matrilineal land tenure system. In fact, the RMI is one of the few countries in the world wherein the Government owns virtually no land. This sometimes complicates environmental management and overall development. Because all land in the RMI is privately held, there have been instances where landowners' interests and greater public interest have not agreed. While this is an obvious challenge, it also presents an opportunity for better working partnerships.

Landowners and traditional leaders are very likely to be the "untapped resource" that entities like EPA can mobilise to champion their cause. A stronger policy of landowner inclusion and consultation would go a long way to help strengthen water resource awareness and management.

3.3.2 Major issues and concerns

Limited awareness and limited awareness efforts. Public awareness and education on water related issues remains quite low, while at the same time awareness and education activities and outreach remains relatively weak. This holds true for the general public as well as among the RMI leadership (Government). Current awareness activities are too limited; they focus too much attention on simple awareness and broad information dissemination, and should try to utilise more innovative approaches that promote behaviour change. Awareness activities are not very targeted (e.g. to different audiences and demographic groups and market segments). Moreover, there is little environmental education taking place within the formal school system (environmental education is supposed to be in the curriculum, but it is not known to what extent it is actually taught and whether this is very effective) and the Ministry of Health has limited (but improving) public health and environmental education activities related specifically to water.

No targeting of government and traditional leaders. There is virtually no targeting of politicians, who can more effectively serve as water resource champions. Political understanding and will can go a long way to securing more resources for and providing more support to water resource management. Activities also do not address traditional leaders very effectively.

Limited funding. Funding for carrying out public awareness and education activities remains limited. EPA has resorted to decentralisation of some of its monitoring and awareness activities, which is proving to be an effective low-cost approach to getting the word out (especially to remote communities), but the current programmes still have very limited funds and limited reach. The decentralisation of these activities is happening, but it is slow and insufficient.

Women largely untapped. Women are also an untapped resource. Women in the RMI typically run the household and are likely to be more keen on and affected by water resource issues. They could be more ideal targets for such awareness programs as water conservation and effective water sanitation.

Few PPPs. Public-private partnerships (PPP) are not commonly seen in the RMI and could present an opportunity for improved awareness and education building on water related issues.

3.3.3 Measures to manage impacts and concerns (IWRM approaches)

The following actions and measures can help address these issues and concerns:

- Far more effective campaigns need to be developed, preferably jointly between different entities that focus less on simple awareness building and more on behaviour change. Such campaigns need to address multiple market segments.
- Public-private partnerships are one way to improve effectiveness of awareness and education campaigns. Just as the Ministry of Health currently works with the Youth to Youth in Health (NGO) to carry out prevention activities, so too can the EPA, OEPPC and other public entities engage in similar relationships with other non-state actors to more make awareness activities more effective.
- Entities responsible for water resources should consider pooling their awareness resources to leverage up the market reach of their campaigns.
- Politicians and traditional leaders must also be targeted so as to improve political will and community support for water resource management efforts.
- Campaigns should also target more women, the keepers of the households, and existing NGOs such as WUTMI can provide strong on-the-ground support for grassroots level social marketing and awareness campaigns.

- Improvements must be made with respect to information sharing and availability. This includes more information sharing and collaboration between responsible entities as well as better information flows to the public.
- Consideration should be given to some "upstream" interventions, including incorporation of water related education into school curriculum or (at the very least) more school targeted campaigns and activities.

3.4 Technology

3.4.1 Types of water supply systems

Majuro. As detailed in Section 1, Majuro has a reticulated water supply system that is operated by MWSC and which uses a combination of airport runway rainfall catchment and groundwater wells as its source. Treatment includes sand filtration and chlorination. Approximately 1,100 residential households are currently subscribed to the main water system (about one third of total households on Majuro). Figure 9 illustrates the water system on Majuro. All other households who are not on this system rely on rainwater harvesting (roof runoff and catchments) or other means.

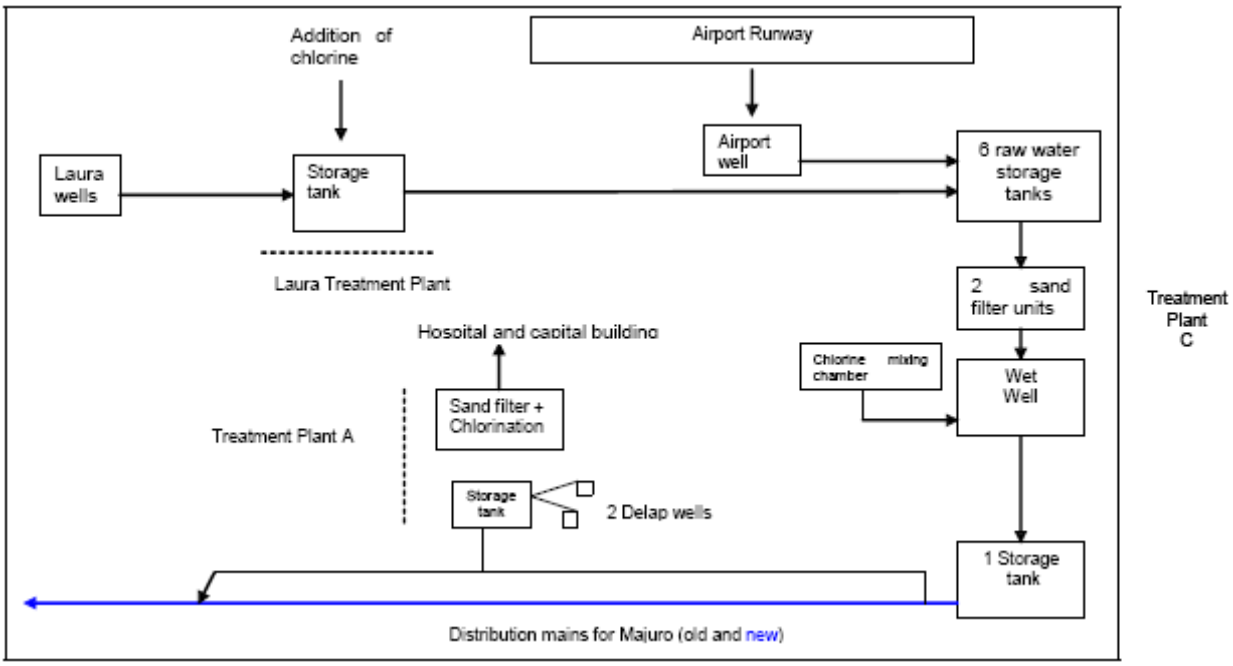

Figure 9 Schematic of Majuro reticulated water supply. (Source: SOPAC RMI Mission 2005)

Ebeye. Ebeye's water supply uses two reverse-osmosis units with a maximum production capacity of 200,000 gallons per day (100,000 each). However, as of early 2007 only one of these units was in operation. Water is distributed via a reticulated water system with chlorination treatment. A survey in 2006 found that only one in three households rely on this system as their primary source of drinking water. All other households who are not on this system must rely on rainwater harvesting or other means, including transport of potable water from the Kwajalein base.

Outer Islands. The Outer Islands use very limited technology and rely solely on rainwater harvesting and groundwater sources.

3.4.2 Types of wastewater /sanitation systems

Majuro. Majuro utilises a saltwater reticulated wastewater system operated by MWSC that consists of a saltwater flush line and a sewerage line. Both the saltwater and sewer system cover the main DUD area of Majuro, from Rita (the eastern end of the atoll) to the Bridge. From the Bridge to Laura (on the western end) only the saltwater line is available (no sewer system). The system currently has some 1,300 households subscribed, which is just over one-third of households on Majuro (although some of these households only use the saltwater line and dispose of wastewater in their own septic tanks). Households who do not have a connection to the sewer use septic tanks (if they have sanitation facilities), and this leads to the issue of septic tank emptying and potential overview. Untreated sewerage water is disposed of through an 80 foot ocean outfall behind the MWSC office in Delap Village.

Ebeye. Ebeye also utilises a saltwater reticulated wastewater system (saltwater line and sewer line) operated by Kajur. The system was first developed in the 1960s as a gravity sewer system and this still forms the bulk of the reticulation. The system includes an extended aeration loading treatment plant; however this plant is currently non-operational. Instead, untreated sewage is redirected into the lagoon via a 660 foot, 10 inch diameter outfall pipe (Beca 2003).

Outer Islands. There are no wastewater or sanitation systems in the Outer Islands. Households utilise various forms of sanitation facilities from indoor flush toilets to open pit latrines. A number of households have no facilities whatsoever.

3.4.3 Majors Issues and Concerns

The major issues and concerns with respect to technology are as follows:

Majuro Water Systems: Quantity and Quality Problems. The Majuro water system has both quantity and quality problems: including insufficient storage capacity, leakage, theft, well contamination, saltwater infiltration, unsanitary wells, insufficient chlorination, and lack of cleaning and maintenance (airport runway surface). All of this contributes to lower and poorer quality of water supply. Moreover, only one third of all households on Majuro are currently hooked up to the main water line. The current water supply system and technology simply cannot keep up with the rapid population growth and development of the atoll (whose population is fast approaching 30,000). This has become especially evident during the dry season and in droughts. During extended droughts (e.g. in 1998) emergency desalination units are used.

Theft and leakage in Majuro's reticulated water system is very critical. It is estimated that upwards of 50 percent of water is lost because of illegal connections and leaks. MWSC has recently stepped up its detection efforts, but much more needs to be done, including stiffer penalties for illegal water hookups.

Limited Majuro wastewater system. On the wastewater side, Majuro's biggest concerns involve the wastewater reticulation system which collects and disposes of untreated sewage into the ocean. Only 1,300 households are estimated to be currently subscribed to this system, meaning the remaining nearly 2,000 households on Majuro must use septic tanks (or other means) and this presents other risks. Many households that use septic tanks fail to periodically empty them and this leads to seepage into the water lens. The entire village of Laura, whose groundwater provides supplementary water to the main system, is not connected to the wastewater system and this is leading to E-coli contamination of the water wells (SOPAC RMI Mission Report 2005). As most households are not connected to the wastewater system, the assumption is that most of them utilise septic tanks. There is no consistent septic tank emptying program and anecdotal evidence suggests that very little is done to monitor this problem. This issue becomes especially

problematic in Laura, where septic tank overflow poses a direct threat to the groundwater resources.

Ebeye water system unreliable. On Ebeye the current water supply system has the potential to provide adequate supply but it suffers from frequent break down (caused by poor maintenance as well as power supply issues) and like Majuro it appears that only one in three households uses the water main as their primary source of drinking water. This means that most households on Ebeye simply do not rely on the current system and technology, even though the system could potentially produce enough water daily for all Ebeye residents (200,000 gallons daily for the 10,000 residents' yields 20 gallons per person per day). Many Ebeye residents continue to rely on water transported from Kwajalein. Moreover, unlike Majuro and the Outer Islands, many households on Ebeye simply cannot install their own catchments due to space limitations and this prevents them from harvesting rainwater.

Ebeye sanitation system unsafe. On sanitation side, many problems currently plague the Ebeye wastewater system. The reticulated saltwater system suffers from saltwater infiltration during high tides which causes raw sewage to backflow into the streets (see picture below). The sewage pump stations are in need of urgent repair and whereas the treatment plant used to use oxidation ponds to treat wastewater prior to discharge into the lagoon, now the treatment plant is inoperable and raw untreated sewage is dumped directly into the lagoon.

Utilities remain weak. The technologies used in Majuro and Ebeye's water and wastewater systems are only as good as the organisations that manage them. In the case of both Majuro and Ebeye, there is much room for improvement. Both Kajur and MWSC utilities continue to face serious managerial, financial, operational and other challenges that must be addressed.

Figure 10 Stagnant water on Ebeye. (Source: SOPAC)

Poor/lack of facilities create urban sanitation 'hot spots'. Majuro and Ebeye islands have a few sanitation "hot spots" that warrant urgent attention. These are areas in which poor sanitation technology, systems or facilities pose a direct threat to health, human welfare, and ecosystems. On Majuro, this includes congested urban settlements such as Jenrok Village, where most households do not currently have access to either the water line or the wastewater system. On Ebeye this includes the North Camp area where at least several hundred people live in group housing facilities with very poor and unsanitary group sanitation facilities.

3.4.4 Measures to manage impacts and concerns (IWRM approaches)

The above issues and concerns can be addressed by the following measures:

- MWSC needs to make improvements to its supply capacity by expanding reservoir resources (a longer term and costlier initiative) and by reducing or eliminating leakage and

illegal hookups (a more immediately attainable initiative). By maximising efficiency of current water resources, MWSC can raise its supply level and in turn grow revenue.

- MWSC also needs to improve its capacity to detect and deter theft and leakage in its main water line. It has made efforts to improve in this area, but more is needed.
- The Majuro water system also requires better monitoring and management of pollutants. This can be done through better detection of illegal hookups, improving the sanitation of the Laura wells, better chlorination practices, and more effective leaning and maintenance of the airport runway surface. All of this will contribute to higher quality of water supply.
- More data on residential rainwater harvesting effectiveness is needed. For example, there is insufficient data on the level and types of home water utilisation, on roof sizes, roof guttering, and the extent of use of ground water. More research and analysis needs to be done in these areas and this knowledge should be fed into future plans and programmes.
- On the wastewater side, options need to be reviewed for establishing treatment facilities on Majuro and re-establishing the treatment plant on Ebeye. The situation on Ebeye is far more dangerous as its outfall is on the lagoon side where there is little water circulation.
- More aggressive monitoring of household septic tanks, especially on Majuro, needs to take place to ensure that seepage is not occurring. Consideration needs to be given to stepping up septic tank emptying programmes.
- In relation to the above, an investigation needs to take place into why more Majuro and Ebeye households are currently not subscribed to both the water supply and wastewater lines. Factors such as costs, location, and others need to be analysed and every effort should be made to expand users of these systems. This will simultaneously improve revenues for the utilities, ensure that households have backup water supply systems in place, and (in the case of wastewater subscriptions) help ensure that sewage is consolidated and is not accumulating in individual septic tanks.
- As many households on Ebeye cannot install their own catchments, they are all the more vulnerable to water shortages during dry months and droughts. This heightens the need for Kajur to establish more consistent and accessible water supply. This is especially true for residents of the highly congested Mid-Corridor residence areas.
- As recommended in an earlier section, the RMI must also pay more attention to emerging and alternative technology, including such non-conventional sources as large scale desalination and the potential use of oceanic thermal energy conversion (which produces potable water as a byproduct).
- Engineering and other reports prepared by Beca in 2003, SOPAC in 2005 and USGS in 2005 document many detailed, technical problems associated with Majuro's and Ebeye's water supply and wastewater systems. These detailed technical recommendations must be addressed by appropriate authorities and a plan for improvements should be put into place. This could be part of the water sector strategy that has been recommended. For Ebeye specifically, various options are provided:
    - Consider converting the current extended aeration loading treatment plant to a conventional activated sludge loading system.
    - Consider upgrading the capacity of the current system via installation of additional 20KW of aeration capacity, installation of 54 foot diameter clarifier and sludge handling and disposal facilities.
    - Upgrade pump stations.
    - Add screening mechanism.
    - Consider disinfection also required to reduce health risk (chlorination could be used).

- Improve the lagoon outfall or move it to the ocean side.
- Rehabilitate the sewers.
- Establish a whole new wastewater treatment plant.

- A final technological measure that can help in the monitoring and management of water resources is GIS. GIS has recently been introduced and is being used by the Marshalls Energy Company, EPA, and the Majuro Weather Station. More GIS technology could be encouraged via additional training and resources.

3.5 Institutional Arrangements

3.5.1 Types of Institutional Arrangements

The institutional environment related to water resources management can be described in terms of its key organisations, the legislative/policy/regulatory framework (or legal framework), monitoring/enforcement/compliance arrangements, and the multilateral environmental agreements (MEAs) to which the RMI is a party.

Key Organisations. The universe of public organisations that hold authority and responsibility over water, wastewater and related issues or which are indirectly involved and included in Table 7.

Table 7: Key Organisations in water/wastewater related issues.

Key public organisations	Other organisations
EPA	Donors and development partners
OEPPC	NGOs
Majuro Weather Station	Community groups
MWSC	Traditional leaders and landowners
Kajur	
EPPSO	
Office of Disaster Management	
Ministry of Health	
Ministry of Public Works (Project Mgt Unit)	
Ministry of Foreign Affairs	
Ministry of Internal Affairs	
Ministry of Finance	
College of Marshall Islands	
MIMRA	
Local Governments	

Running alongside the formal public institutions are donors and development partners, NGOs, community groups and traditional leaders and landowners. Donors and development partners include the ADB, WHO, UN, US, Japan, Taiwan, EU, Australia and others.

The institution of traditional authority is composed of landowners and the traditional land tenure customs, rights and practices in the RMI. This traditional institution often wields as much (if not more) authority and influence as the formal institutions of government, and as would be expected, government authority and traditional authority do not always agree. For instance, the RMI is currently experiencing a clash between Delap Village landowners who oppose a government approved multi-million dollar dry dock facility.

Moreover, several non-governmental organisations have become increasingly involved in water, wastewater, environmental and related issues (including the recently established Marshall Islands Conservation Society). NGO involvement in water resource issues remains relatively weak, however.

Legal framework: legislation, policy, regulations. The legal framework that gives authority to the key organisations and which underpins water resource management consists of legislation, policies, and regulations that have been introduced and adopted over the past several decades. Specifically, this includes:

- Enabling legislation for each of the key organisations (e.g. the Environmental Protection Authority Act, the Office of Environmental Planning and Policy Coordination Act, etc.)
- Strategic plans and specific policies of each of the key organisations
- Public Health and Sanitation Act
- Coast Conservation Act
- EPA Public Water Supply Regulations
- EPA Marine Water Quality Regulations
- RMI Water and Sanitation Sector Strategy (including water policy)
- Local Government ordinances

A detailed review of these different parts of the legal framework for water resources management has yet to be conducted, but some overlap does exist and better clarification and delineation of roles and responsibilities should be sought. For example, there remains some confusion and overlap between the work programmes of the EPA and OEPPC (see section below on Multilateral Environmental Agreements).

Moreover, some of the policies in place need to be updated and made more relevant. For instance, the EPA Water Supply Regulations (first developed in 1994) were written for a 24-hour water supply system.

Monitoring, enforcement and compliance arrangements. Monitoring of water resources is primarily shared among EPA and the two utilities (MWSC and Kajur) but it is also expanding to include local governments and communities in the Outer Islands. This partnership is proving thus far to be effective in expanding the coverage of monitoring. Further technical assistance and funding can help in this regard.

Nevertheless, overall enforcement of and compliance with general rules and regulations related to water resources remains weak. For instance, local government ordinances on Majuro that relate to littering, solid waste, animal waste (e.g. pig pens), and animal containment (e.g. not letting pigs roam freely), are very weakly enforced. As another example, illegal hookups to the main water line exist but MWSC lacks the tools and capacity to effectively detect and deter these illegal hookups.

Multilateral Environmental Agreements (MEAs). The RMI is party to numerous multi-lateral environmental agreements (MEAs) that relate directly or indirectly to water resources. Some MEAs are administered by the EPA while others are administered the OEPPC (including the UNFCCC, Biosafety Project, Biodiversity Convention and International Waters Programme). In fact, one of the key arguments for the establishment of the OEPPC in 2003 was for it to take responsibility for the RMI's MEAs and to handle international and multilateral environmental issues, thus allowing the EPA to concentrate on enforcement and its core programs. However,

the EPA still retains responsibility over some MEAs and still participates in some regional, international and multi-lateral projects and initiatives.

3.5.2 Majors issues and concerns

The major concerns and issues with respect to institutional arrangements include the following:

Organisational weakness. There are weaknesses within each of the key organisations – weaknesses that prevent them from fully and effectively carrying out their legal mandates and which, in turn, lead to weaker collective management of water resources. These include both capacity weaknesses as well as financial limitations.

Overlapping authority and outdated policies. There exist some areas of overlap and confusion with respect to the roles and responsibilities of the various organisations (e.g. EPA and OEPPC) and some of the legislation, policies, and regulations are in need of updating (e.g. EPA's water supply regulations).

Institutional weaknesses. In addition to the weaknesses *within* organisations, there are clear weaknesses in the institutional network that binds together these different entities – in other words, weaknesses *between* organisations (with the exception of the effective partnerships that are emerging to help improve community level water quality monitoring). There is a Water and Sanitation Sector Strategy and National Water Policy, but these are outdated (developed in the early 1990s) are rarely referred to. There is no national water committee (or related entity) – an ad hoc grouping of entities and individuals does meet annually to organise World Water Day events, but nothing beyond this. There is no multi-party water safety plan (or similar document) in place for Majuro, Ebeye or the Outer Islands. There is no currently followed national water vision or equivalent statement of an overall strategy for water resources management.

Traditional authority often left out. The institution of traditional authority is often left out of the decision making process and this often leads to conflicts.

Weak compliance. Overall enforcement of and compliance with general rules and regulations related to water resources remains weak.

Civil society can do more. While non-state actors (non-government and civil society organisations) have stepped up their involvement in water and environmental related issues, this involvement remains relatively weak. Greater participation from the civil society sector in water resource management will only help the RMI.

Non-integrated institutions. In short, the "integrated" aspect of integrated water resources management remains a monumental challenge in the RMI. Effective resource management requires that the RMI has in place organisations that: (1) possess effective and relevant mandates; (2) have the resources, capability and political support to carry out these mandates; and (3) are effectively collaborating (both vertically and laterally) to ensure that resource management really is integrated and seamless. Arguably, the RMI faces real and serious challenges in all three of these areas. This is perhaps the major reason why the RMI continues to rank poorly in international governance evaluations and ratings.

3.5.3 Measures to manage impacts and concerns (IWRM approaches)

The RMI needs to pursue a number of measures to address these major issues and concerns.

- A new water resources strategy should be considered; one that ties together all of these issues, addressing all water resources in all RMI regions (urban and rural), identifies a common vision and lays out simple, agreed-to objectives on how to move forward.
- Strengthening water resources management requires continued strengthening of the key organisations that are tasked with this responsibility. Across the board capacity building and institutional strengthening is required.
- Clarification of roles and responsibilities is another must to ensure that overlap, duplication and confusion are minimised.
- More effective vertical (from high levels of government all the way to community groups) as well as lateral (between agencies and ministries and civil society organisations) collaboration is required to champion water issues. This, however, requires one entity to serve as the catalyst and champion of integration.
- A legislative and policy review of laws and regulations governing water resources should be conducted so as to clarify the rules of the game and minimise conflicts.
- A multi-party water safety plan (or similar document) should be considered to help protect water assets and resources.
- A policy of inclusion must be taken with respect to the institute of traditional authority. More involvement and buy in from traditional leaders and landowners will only help establish integrated processes.
- Stronger emphasis must be placed on enforcement of and compliance with general rules and regulations related to water resources. This requires more involvement of local police forces. NGOs and civil society groups can sometimes add immense value to public initiatives and programmes, as they are often more in tune with communities than are government organisations. As such, these groups should also be utilised more effectively, especially for outreach and awareness type activities.

3.6 Financing

3.6.1 Types of Financing Arrangements

Financial overview of utilities. MWSC averages about US$1.1 million in annual operating revenue, with utility water billings making up some 80 to 90 percent of this. The remaining roughly 10 percent of revenue comes from hookups and deliveries and other sources. MWSC's expenses continue to exceed revenue and in FY2005 operating losses totalled US$211,702.

Table 8: MWSC operating revenues, expenses and balance: FY2003 to FY2005.
(Source: MWSC Annual Audit reports)

Item	2005	2004	2003
Revenues	1,037,480	1,116,213	1,160,596
Expenses	1,249,182	1,170,755	1,167,262
Operating Surplus (Loss)	(211,702)	(54,542)	(6,666)

Kajur operates as both a power and water utility. Its water-related revenue was US$280,843 and US$261,152 in fiscal years 2003 and 2002 from total revenue of about US$2.2 million in each year (meaning roughly 12 percent of revenue comes from its water business). In total the company made operating losses of US$2.6 and US$1.6 million in fiscal years 2003 and 2002, respectively.Both MWSC and Kajur continue to carry large receivables balances, with gross

receivables for MWSC averaging US$1.5 million in the recent two years and for Kajur about US$3 million in recent years. Improvements to billing and collection can dramatically improve the cash flow and overall financial position of both companies.

MWSC's tariffs are presented in Table 9. It is not clear whether tariffs were originally derived based on actual costs (cost recovery). MWSC continues to offer more favourable rates to government entities compared to non-government clients and this continues to affect its overall profitability.

Table 9: MWSC Tariffs. (Source: MWSC)

A. Unmetered Connections (US$ monthly)	8
B. Metered Connections (US$ monthly per 1,000 gallons)	
Supply from Airport Waterworks to Laura	5
Supply from Airport Waterworks to Delap-Uliga-Darrit/Rita	6
Supply to Government	5
Supply to Commercial and Industrial	10
C. Tanker Supplies: (US$ per 1,000 gallon delivery)	
Airport to Rita	20
Airport to Woja	40
Woja to Laura	50
Commercial and Government	30

All costs are in US$ per 1,000 gallons unless otherwise stated. Table excludes connection costs.

Subsidies and viability of utilities. MWSC has recently "graduated" from being a subsidised to an unsubsidised state owned enterprise, with no subsidies from RMI received in the last two fiscal years (2004 and 2005). However, MWSC receives support from the electric utility (Marshalls Energy Company) which provides managerial and other support. This support has helped sustain MWSC through its losses. Meanwhile, Kajur received operating subsidies in FY2003 and FY2002 of approximately US$200,000 and US$500,000 (respectively). These subsidies to Kajur were for the American Samoa Power Association (ASPA) management contract. With respect to Kajur's overall financial health, the last audit report (FY2003) stated the following (excerpt):

> KAJUR has incurred significant net operating losses since inception. KAJUR depends on KADA and RepMar for cash and noncash funding to continue its operations. Although KADA and RepMar have provided funding in the past, no formal agreement exists to provide funds in the future, except as described in note 5. The continuation of KAJUR's operations is dependent upon future financial support from KADA and RepMar and/or significant improvements in operations.

A very similar assessment of MWSC's overall status is made in its most recent (FY2005) audit report: "Management believes that the continuation of MWSC's operations is dependent upon future financial support of RepMar[6], compensation by RepMar for the cost of actual utility service provided, the collection of long outstanding utility receivables, and/or significant improvements in operations."

Donor and outside funding. Donor and other funding, including both technical assistance (grants) and loan funding from the Asian Development Bank, for water, wastewater and related investments and activities have been significant[7]. In addition to the ADB, funding has come from the US (via Compact grants, FEMA emergency assistance, and other federal programmes), Japan, and other development partners.

[6] Republic of the Marshall Islands

[7] As an example, in the mid 1990s ADB funded a two phase Majuro Water Supply Project worth US$9.2 million

Donor and outside funding has gone into both public infrastructure investments (water reservoirs, reticulation systems, etc.) as well as household-level investments (home rainfall harvesting equipment, etc.). Donors and outside entities not only fund infrastructure but also fund ongoing programmes and activities. EPA's ongoing community water quality monitoring program utilises funding through a US federal land grant (which it access via the College of the Marshall Islands). US Compact funding also provides annual funding to the EPA (totalling some US$400,000 in FY2005) for the purposes of:

(i) improving environmental protection;

(ii) establishing and managing conservation areas;

(iii) planning, designing, constructing, and operating environmental infrastructure; and

(iv) involving citizens in conserving their country's natural resources.

US Compact related grants are also used for ongoing education and awareness activities in the Ministry of Health. While outside funding for water related projects and activities has been significant, the allocation of these funds has not always been clear. This stems partly from the fact that the RMI currently has no comprehensive water sector strategy that identifies, prioritises and costs public water and related investments.

Preventative versus curative funding allocations. A recent analysis conducted by EPPSO on amounts spent in the areas of water quality monitoring and awareness concluded that far too little is currently being invested in these preventative types of activities and this is contributing directly to increases in gastroenteritis and other water borne illnesses. This, in turn, raises the amount the RMI spends on treatment and curative health care for these conditions.

EPPSO estimates that the RMI currently spends just US$60,000 to US$70,000 total annually on preventative water monitoring and awareness building activities (this is essentially the budget used by EPA for its community water quality monitoring programme), while outpatient costs alone for treatment of water borne illnesses is now fast approaching half a million dollars annually. In short, EPPSO argues that investing more in preventative measures would constitute a far more economical allocation of resources than what is currently practiced. Other analyses have highlighted this misallocation of public resources in the RMI, including the 2005 RMI Social and Economic Report (see Figure 11), which argued that overall the health care system is allocating too little into prevention and too much on secondary and tertiary care.

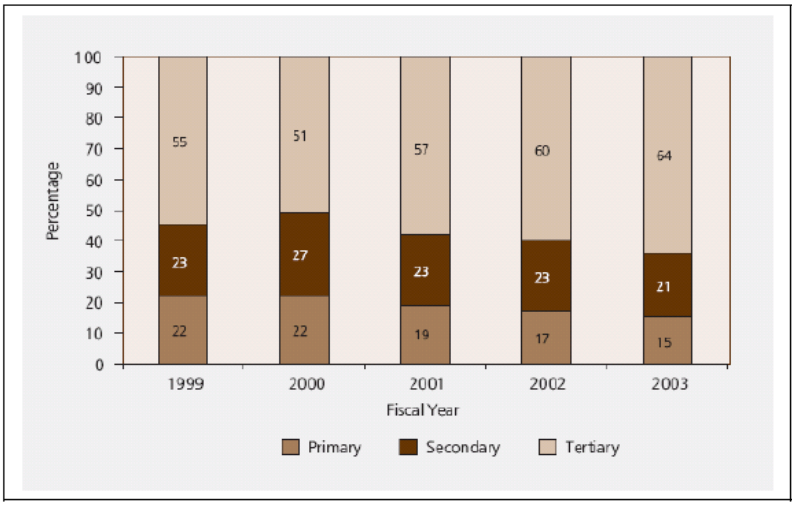

Figure 11. Public Health Spending by Type: FY1999 to FY2003. (Source: RMI 2005 Social and Economic Report)

3.6.2 Major issues and concerns

The major concerns with respect to financing including the following:

Financial performance of utilities poor. The overall financial performance of the RMI's two water utilities remains precarious and subsidies are likely to be required for at least the near to medium term. The MWSC and Kajur client base is far below what it could be (e.g. only 1,100 households are subscribed to the MWSC water line) and it is not entirely clear why this is so. It is quite possible that households cannot afford current tariffs but no formal investigation has confirmed this. Moreover, as stated earlier, the utilities continue to offer discounted tariffs to government entities and this affects their overall revenues and profitability.

Leakage and theft hurting business. Leakage and theft, especially in MWSC, are significant and lead to significant loss of potential revenue. Estimates that up to 50 percent of water supply is lost through leakage and theft suggests that hundreds of thousands of dollars worth of revenue is lost each year.

Allocation of donor funds not clear. Donor and other outside funding (including from the ADB) has been significant for both infrastructure projects, home rainwater harvesting equipment, and actual operations and activities of public entities (such as EPA), but allocation of these funds has not always been clear and in line with any sort of water sector strategy.

Imbalanced allocations. The current allocation of public funds appears to be imbalanced, with too little going into preventative measures and too much going into treatment and curative activities.

3.6.3 Measures to manage impacts and concerns (IWRM approaches)

The RMI can consider a number of measures to address these issues and concerns. These include the following:

- Immediate attention must be put towards the two water utilities to ensure that their financial and operational performance is set on a better and more sustainable path. This requires reconsideration of tariffs (with due consideration of both profitability and poverty and accessibility issues), improvements in billing and collections, and continued targeted technical assistance and training (addressing key issues specific to each utility).
- Especially in Majuro, much more effort needs to be put towards minimising non-revenue water losses due to leakage and theft.
- Domestic and donor funded investment into water infrastructure and activities could be clarified with a comprehensive water sector strategy, complete with identification and prioritisation of water related projects and activities.
- EPA, Ministry of Health and other entities need to reconsider resource allocations with a view towards shifting more emphasis towards preventative programs and less towards more expensive curative activities.
- Public private partnerships (PPPs) present one way to develop more collaborative approaches to preventative programs. EPA, Ministry of Health, MWSC and related entities should consider PPPs in future plans.
- As recommended earlier, an investigation into why MWSC and Kajur's client base remains limited should be conducted. Cost considerations should be analysed, along with other barriers to entry for households. Expanding accessibility to these services will help the households as well as expand the utilities client base (and potential revenue).

4. LINKAGES TO OTHER AREAS

4.1 Landuse and agriculture

Land-use policy. While zoning laws and regulations governing land use exist, common practice and development do not conform closely to these laws and regulations. Moreover, because virtually all land in the RMI is privately held, there are often conflicts between development interests and land owners' interests. To date, there are only a handful of incidents where these differences have significantly affected water related resources and management. In one recent example on Majuro (currently ongoing), landowner resistance to a public reservoir extension near the airport has created delays and uncertainty over the project. Majuro's reservoir capacity has long been identified as a key weakness.

In general, land use policy in the RMI remains a complex and critical issue for not only water resource management but development in general.

Land-based pollution. Typical land-based pollutants that contaminate the groundwater and coastal water resources include solid waste, human and animal faecal waste, runoff, and graves. In urban centres such as Ebeye and Majuro's DUD area, there is significant contamination and degradation of water resources, so much that all coastal waters in DUD are unsafe for recreation or harvesting seafood. Moreover, a number of wells in Majuro are considered unsafe for use, especially in the urban areas.

In recent years, with the increase in small scale commercial agriculture in Laura Village, (Majuro Atoll), chemical pollutants are becoming more of an issue. Fertilisers and other chemicals used in the growing agriculture sector are generating concerns among some in the Laura area about the impacts of these substances on the valuable groundwater lens. Laura's groundwater serves both the local community and also supplements the larger MWSC water supply system and is therefore crucial strategic asset that must be managed sustainably. A group of Laura farmers, in conjunction with EPA and other agencies, has begun meeting to discuss this issue and to explore safe and sustainable farming methods.

Furthermore, in some atolls in the RMI, agriculture, ground water resources, and other natural resources have been greatly affected by the direct and lingering results of the US' nuclear testing program which took place after World War II.

4.2 Habitats and ecosystems

Critical ecosystems and species. The RMI has identified number of critical habitats and ecosystems, including the following major categories and subcategories[8]:

Mixed forest communities:

Scaevola-Guettarda, "kõnnat"-"utilomar" community
Pisonia grandis, "kañal" forest
Tournefortia argentea, "kiden" forest
Pisonia-Tournefortia "kañal"-"kiden" community
Suriana "kalañe" society
Neisosperma oppositifolia "kõjbar" forest
Pandanus "bõb" forest
Scaevola servicea "kõnnat" forest
Sida fallax "kio" scrub or scrub forest

[8] Office of Environmental Policy, Planning and Coordination (OEPPC) website, accessed February 25, 2007 (www.biormi.org)

Pemphis acidula "kõñe" scrub or scrub forest
Cordia subcordata, "kõno" community
Barringtonia asiatica, "wõp" forest
Dodonea viscosa "kamen" stands
Sandy beach, high tide area
Coconut "ni" groves and plantations
Breadfruit "mã" forest and community
Lepturus, "ujoij" grasslands and savannahs
Urban forests and environments

Freshwater and brackish water bodies:
Inland lakes
Tree holes and other small freshwater reservoirs
Taro, "iaraj" pits
Large artificial reservoirs
Bruguiera "joñ" community and basins
Sonneratia "bulabol" community

Marine areas:
Seagrass community and meadows
Supratidal and intertidal
Sandy areas of the intertidal and subtidal zones
Coral reefs
Reef holes, artificially quarried and bombed
Sea surface; lagoon water column, open water
Deep water

These habitats are home to a wide range of endemic species and subspecies of plants and animals (cnidarians, mollusks, arthropods, bryozoans, brachiopods, echinoderms, fishes and birds)[9]. Endangered species found in the RMI include: blue whale, sperm whale, Micronesian pigeon, leatherback turtle, and the hawksbill turtle.

Coral reefs, coastal beaches and coastal mangrove areas are particularly critical as they help prevent erosion. These critical areas are under increasing pressures stemming from urban development, sea walls, pollution, and other threats.

Protective areas. Currently, the only formally protective area in the RMI is the Jaluit Atoll Conservation Area. However, in late 2005, the RMI submitted the RMI World Heritage Tentative List to the World Heritage Commission. A number of areas were recognised for protection based on their exceptional natural heritage, including Bikini Atoll, the Northern Uninhabited Atolls (Bikar, Bokak, Ailinginae, Rongedrik, Taka, Jemo, and Erikub), and Mili Atoll.

Primary threats. The primary threats to these habitats are both human and natural:

- human population growth, urbanisation, pollution, over-exploitation, loss of traditional environmental management practices, etc.;
- natural disasters and phenomenon (floods, droughts, coral bleaching, etc.), invasive species, etc.

[9] A comprehensive list of endemic species can be found at http://www.biormi.org/index_navmap.shtml?en/endemic_micronesia.shtml

4.3 Health and hygiene

Major health concerns. The RMI faces a number of water-related health concerns. A number of reports, articles and analyses have highlighted the increasing health risks posed by contaminated and polluted home water catchments, wells, and coastal areas. As recently as February 23, 2007, the EPA reported that all lagoon and ocean areas tested on Majuro Island (excluding the northern islands) showed averages of bacterial contamination well above safe levels (MI Journal Feb 23, 2007). “The situation has not changed over the last several years,” reported EPA’s Abraham Hicking.

While these problems are especially critical in the urban areas of Majuro and on Ebeye, ongoing drinking water testing by the EPA confirms that risk factors for Outer Islands are also high, stemming mostly from unsanitary home water catchment and collection systems. In all of 2006, EPA’s water quality monitoring program conducted 342 tests throughout the Outer Islands and found that 61 percent of sources tested had unsafe bacterial levels.

Water borne illnesses. A January 2007 EPPSO Policy Discussion Paper on water borne illnesses stated very clearly that water quality is becoming an increasingly critical health issue because of increased urbanisation, population growth and mounting economic challenges faced by many households and families. The rising number of gastrointestinal outpatient cases in the two main hospitals provides clear and direct evidence of mounting water borne health problems and their associated economic costs to the RMI. As shown in Table 10, for both Majuro and Ebeye the number of cases has climbed sharply from under 2,000 cases in 2001 to over 3,000 by 2004. This translated into nearly US$400,000 in outpatient costs in 2004 (based on an average outpatient cost estimate of US$119).

Table 10: Majuro and Ebeye Hospital Gastrointestinal Outpatient Cases: 2001 to 2005. (Source: EPPSO)

Item	2001	2002	2003	2004	2005
Majuro OP cases	864	999	1,078	1,770	1,750
Cost at $119/case	102,816	118,881	128,282	210,630	208,250
Ebeye OP cases	1,125	1,235	1,348	1,241	na
Cost at $119/case	133,875	146,965	160,412	147,679	na
Total OP cases	1,989	2,234	2,426	3,011	na
Total costs	236,691	265,846	288,694	358,309	na

Moreover, in late 2000 and early 2001, an outbreak of cholera (toxigenic V. cholerae O1) infections occurred on Ebeye and Lae Islands. This generated great concern as cholera had not been previously detected in the RMI. An official investigation into the outbreak concluded that contamination of water likely occurred during transport from the Kwajalein base to Ebeye using loosely sealed vessels from which water was removed by opening the vessel (Beatty 2004).

Also on Ebeye, an estimated 1,000 to 3,000 residents of Ebeye reside in group housing facilities that have shared sanitation facilities. These areas present serious health risks and certain disease outbreaks in the past have been linked to these areas.

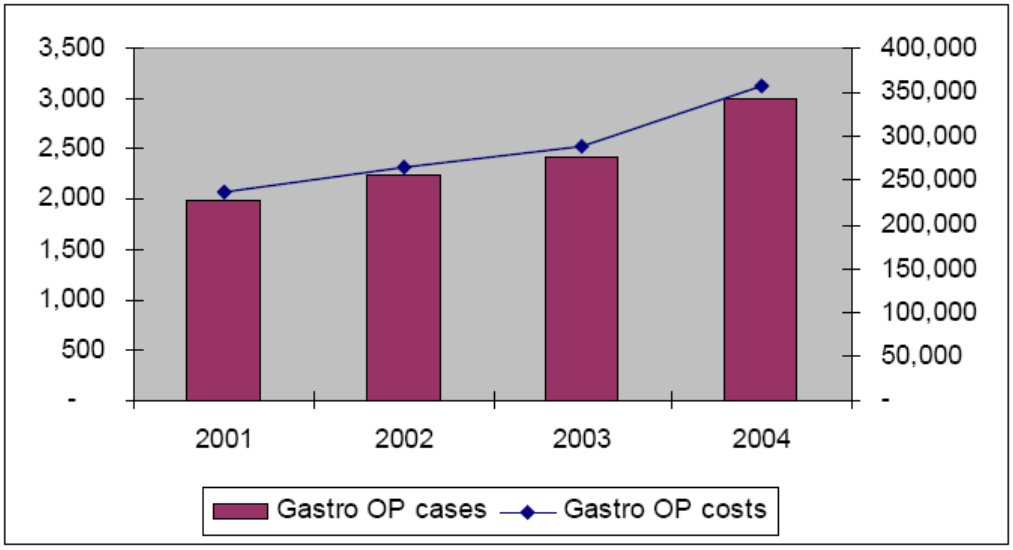

Figure 12 Gastroenteritis Outpatient Cases and Costs, Majuro and Ebeye: 2001 to 2004. (Source: EPPSO)
Note: Outpatient cases shown by line and left axis, costs shown by bars and right axis.

Tourism. Water related health issues not only affect the local population, but also directly affect the RMI's tourism potential. While tourism remains in its early stages of development, a number of new hotel and resort investments are currently underway, commercial and private cruising tourism is growing, and in 2007 Majuro Atoll received its first direct charter flights from Japan. However, local operators are increasingly concerned over rising lagoon pollution and other environmental threats as these will directly constrain if not prevent sustainable tourism development.

Abraham Hicking for the EPA commented specifically in the 23 February Marshall Islands Journal that, "If people will stop using the lagoon as our waste disposal site, people from outside (tourists) can simply enjoy our water without fear of getting infectious diseases from the water."

Tourism is also affected by water quantity constraints. During the first 2007 charter flight, hotels hosting some 200 Japanese visitors had to request special deliveries of water from MWSC in order to cater to their guests. These hotels were given preferential treatment for water delivery due to the special circumstances. Tourism, therefore, is also placing pressure on local water resources even thought the industry remains quite small.

4.4 Watershed and coastal management

Degradation of land-based water resources ultimately affects coastal waters and resources. This statement rings more true in the RMI than it does in most other countries. The need to integrate land and sea based water resource management is high but this remains a key weakness. Local governments have legal jurisdiction over land (up to the mean high water mark) while national government has jurisdiction over lagoons and oceans. Landowners and traditional leaders also share authority over land and near-shore resources.

In order to better link land and coastal management, all relevant parties must work closer together. Land based pollutants that directly affect coastal areas are well known, but measures to better address this problem remain weak.

5. STAKEHOLDER ENGAGEMENT

Consultative process. This report was developed in late February and early March 2007 through a consultative process that gathered knowledge from various sources including: people, prior analyses, online resources, databases, and other sources. Information was gathered via interviews, meetings, and desk research. In addition, additional feedback and input was provided during the RMI Hot Spot Analysis (which took place on March 9, 2007).

Key persons and organisations. Key persons and organisations consulted, including participants in the Hot Spot Analysis (shown by asterisk*), were:

John Bungitak*	EPA
Abraham Hicking*	EPA
Julian Alik*	EPA
Rodney Arelong*	EPA
Carl Hacker*	EPPSO
Terry Mellan	MWSC
Arlington Robert*	MWSC
Reginald White*	Majuro Weather Station
Nallo Samson*	Ministry of Internal Affairs
Antonio Eliu*	Office of Disaster Management
Amlet Kaleman*	College of Marshall Islands Land Grant Program
Thompson Keju*	Ministry of Health
Elbia Rusin	Women United Together Marshall Islands
Deborah Lorennij*	Ministry of Transportation and Communication
Ben Chutaro	Private consultant
Caleb McClennon	Private consultant (former EPA advisor)
Yumi Crisostomo	OEPPC

Table 11 summarises the key organisations, their relevance to IWRM and their role in the consultation process.

Table 11: Organisations, relevance, roles.

Organisation	Relevance to IWRM	Role in Consultative Process
EPA	Responsible for all environmental management, host agency for IWRM project	Major source of data, information, knowledge, participated in HSA
OEPPC	Responsible for environmental policy, planning, coordination	Provided data and information
Majuro Weather Station	Collects all weather data	Provided data and information, participated in HSA
MWSC	Majuro water and sewer utility	Provided data and information, participated in HSA
Kajur	Ebeye water and sewer utility	Government provided data and information
EPPSO	National policy and planning, including water issues and infrastructure	Provided data and information
ODM	Responsible for disaster management, including droughts and other water related issues	Provided data and information
Ministry of Health	Responsible for water related health issues	Provided data and information, participated in HSA
Ministry of Public Works (Project Management Unit)	Responsible for public infrastructure development and maintenance, including some water facilities	Provided data and information
Ministry of Internal Affairs	Responsible for outer island affairs	Participated in HSA
Ministry of T and C	Responsible for some inter-island transport	Participated in HSA
College of Marshall Islands	Land Grant program provides funds for EPA community water monitoring	Participated in HSA
WUTMI	Largest NGO in RMI with extensive network of chapters throughout RMI	Participated in HAS

6. OTHER IWRM RELATED PROGRAMMES, PROJECTS AND ACTIVITIES

6.1 Water related projects and activities

There are several ongoing and recently concluded projects, activities and initiatives related to water resources and management. This includes the recently concluded International Waters Project, a UNDP and SPREP initiative that included community level water resource and solid waste monitoring in Jenrok Village in Majuro. The RMI Government also has ongoing plans to expand MWSC infrastructure, including a major plan to expand the Majuro reservoir system. Moreover, SOPAC has a few water and wastewater related initiatives that are ongoing.

Furthermore, the RMI is in its final stages of negotiating the use of nearly 1 million euros from the EU European Development Fund (EDF) to carry out the following water related initiatives (EPPSO 2006):

- Mitigation of the effects of droughts on Outer Islands;
- Reduction in the incidence of water borne diseases, including the improvement in the management of water resources and related health issues through application of the Guidelines and Manual on Rainwater Harvesting;
- Improvement of Water Quality Monitoring on the Outer Islands.

This plan has yet to be finalised but should greatly enhance and support IWRM efforts.

7. CAPACITY DEVELOPMENT NEEDS FOR REMOVING THE BARRIERS

Effective capacity development must consider issues at the institutional, organisational, and individual levels, as well as the networks that connect these together. This is especially if the ultimate goal is to develop truly integrated and collaborative management of water resources.

Capacity development is needed throughout the entire RMI water resource management landscape. All organisations with direct or indirect responsibility or authority for water resources have weaknesses that contribute to the poor state of water resource management in the RMI.

At the institutional level, capacity development efforts must focus on the overarching strategies and policies of water resource management. Challenges at this level include the already mentioned absence of a comprehensive national water vision and the lack of an active national water committee. Water related legislation and policies must also be revisited and reconsidered. Bodies like the Chief Secretary's Office and the ODM could play a far more effective role in improving the institutional framework for IWRM and in better coordinating the other related entities.

At the organisational level, a great deal of improvement can be made within the key water resource entities, including the EPA, the two water utilities, and again the ODM. The weaknesses of these organisations span from poor operational effectiveness to weak financial performance to ineffective communication and collaboration.

Finally, the need for individual level capacity development is perpetual, both at the management and staff or technical levels. Technical level training is typically the only type of capacity development that the RMI's organisations receive, but there remains a general shortage of this type of training. For example, the EPA's laboratory staff could benefit from additional and ongoing technical training programs. More could also be done to provide other stakeholders with water quality testing and monitoring capability, especially in the Outer Islands.

Moreover, a key area of weakness across all organisations (including in the highest offices of Government) remains the basic understanding and practice of the fundamentals of governance and management. Most managers and supervisors have never taken any type of basic management or related course and fail to exercise even the most basic and well-established organisational and financial management principles.

As a result, most organisations fail to manage resources effectively, fail to adequately plan and execute their plans, and generally underperform year in and year out. The sum of all this is ineffective resources management.

Regional organisations that currently provide technical assistance, training and capacity building can help improve capacity by helping first to assess where exactly capacity development is needed and what type of development is needed (technical, managerial, etc.). Regional organisations can also help bridge together the different countries in order to help them share

information and experiences and to collaborate better on a regional or sub-regional scale. Islander-to-Islander capacity development, attachment programmes, and other proven capacity development schemes should be used more by regional organisations.

8. INTRODUCING AN INTEGRATED APPROACH TOWARDS BARRIER REMOVAL

8.1 Three "Big Picture" requirements for IWRM in the RMI

First and foremost, it is imperative that the various organisations and stakeholders that are tasked (in whatever capacity) with managing water resources must have clear and relevant mandates, strategies and objectives. This is especially important for those entities that are directly responsible for water resource protection, monitoring, and supply.

Second, these organisations must have the capacity and resources to effectively carry out their mandates, strategies and objectives. For the RMI this directly necessitates ongoing (over a longer period than just one or two years) and customised capacity building, technical assistance and training. Capacity building and training must take into account the special circumstances of the RMI and must simultaneously sharpen technical and specific functional skills as well as overarching organisational management and support skills and must also consider institutional interventions.

Third, organisations not only have to carry out their own relevant mandates, strategies and objectives, but they also have to collaborate and communicate effectively with each other to ensure that there is congruence in their overall goals. Most of the organisations tasked with water resource management and other stakeholder groups with an interest in water resources share the same broad goals (and often face the same set of problems), but they very often work in isolation and do not collaboratively endeavour to meet their common goals. This collaboration needs to occur both vertically and laterally (or across sectors).

In short, the RMI must have organisations that are effectively executing sound and relevant mandates, strategies and objectives and that are working together to realise their common, collective water resource management goals.

Existing sectoral linkages. Despite the absence of a national water committee or an overarching water strategy, there is some collaboration between sectors that is taking place. EPA, the Weather Station, ODM, MWSC and other entities do collaborate on occasion and as needed (e.g. during crises). There are also linkages between national and local governments on some water related issues (e.g. the ongoing water quality monitoring activities between EPA and local communities). The key message of this analysis, however, is that these linkages (and the greater network) must be strengthened and that collaborative water resources management needs to be institutionalised – or at least made more regular and recurring.

8.2 Summary Matrix IWRM Actions for the RMI

The following table summarises the various issues and concerns raised throughout this report and the corresponding measures and actions recommended for addressing these issues and concerns. This summary is organised by the six major thematic areas.

1. Water Resources Management	
Issues and Concerns	*Measures and Actions*
• Insufficient quantity • Challenged Public Utilities • Contamination • Weak conservation and demand management • Non-integrated management • Water resources assessment and monitoring remains limited • Weak disaster and emergency planning and preparedness • Incorporation and enforcement of rainwater • harvesting specifications into building design remains weak • Training and capacity building needs are high across the board • No overall water sector strategy	• Much better water resources assessment and monitoring needs to take place within and between the relevant agencies. The RMI does not have a formal National Hydrological Network that coordinates assessment and monitoring and overall knowledge management on water issues remains weak. Entities such as EPA, MWSC, Kajur, Public Health, and local governments should address these issues. • To address the supply issue, simultaneous interventions must be made at both the household level and at the public infrastructure level, as well as in both the urban and rural areas. At the household level, targeted assistance, beginning with the most at-risk households (i.e. those in the driest regions and those in the urban areas that cannot afford water line service), is required. At the public level on Majuro, efforts must be made to expand the Majuro water reservoirs, eliminate leakage and theft, and improve overall efficiency. On Ebeye, power and maintenance problems contributing to inconsistent overall supply and service must be immediately addressed. • Laura presents another area of concern that needs to be analysed more closely. It appears from the estimates on dependable yield and extraction rates that much more can be drawn from Laura wells at sustainable levels – this needs to be analysed more closely by MWSC and other relevant entities. • Assistance to atolls and islands that are still currently facing drought conditions (including Wotho, Ailuk, Lae, Utrik and others) must be expedited by the appropriate authorities. • In relation to the supply issue, the RMI must also pay more attention to emerging and alternative technology, including such non-conventional sources as large scale desalination and the possible use of oceanic thermal energy conversion (which produces potable water as a byproduct). • The contamination issue can only be more effectively addressed beginning with more monitoring and sanitation measures. Of course some contamination sources will be easier to detect and eradicate, including home water catchment contamination sources. Development and implementation of a comprehensive water safety plan that addresses all contamination issues would help greatly in this regard. Related to this, the Laura groundwater resources need to be more effectively protected against rising sources of potential contamination. • The two water utilities require continued and consistent technical assistance, training, and capacity building. A number of organisational challenges continue to prevent the utilities from living up to their full potential in terms of providing quality, consistent water and wastewater services. • More and more effective demand management measures must be implemented, including stronger conservation campaigns and mechanism to induce use of more efficient appliances. • The overall water resource management universe consists of many national, local, and community entities that all share some aspect of responsibility for water resources. In order for water resource management to be truly integrated, two things must happen: (1) a new multi-sector water committee needs to be formed and needs to collaborate and share information and knowledge more effectively; (2) a medium term water sector strategy needs to be established to address all water resource issues in all RMI regions (urban and rural), identify a common vision and lay out simple, agreed-to objectives on how to move forward. Without this collaboration and without a sound plan to guide the RMI, water resource management will continue to be fragmented, ad hoc, and non-integrated. • As discussed in more detail in the section on island vulnerability, efforts must be made immediately to strengthen the RMI's Office of Disaster Management (ODM). Emergency planning and preparedness is key weakness that needs urgent attention.

	• The incorporation and enforcement of rainwater harvesting specifications into building design should be considered by entities such as Public Works and local governments. • More technical assistance, training and capacity building activities are required, especially in the utilities and especially for community level groups.
2. Island Vulnerability	
Issues and Concerns	*Measures and Actions*
• High Impacts of floods and droughts – Global warming and sea-level rise • High-risk development Practices • Disaster unpreparedness	• The ODM, which is supposed to serve as the strongest link in the disaster planning, preparedness, and risk mitigation chain, needs immediate attention. Technical assistance, training, capacity building are all required and as soon as possible. It is simply unacceptable to have a weak, under-resourced disaster management office in the face of mounting natural and man-made threats and vulnerabilities. Urgent attention from the highest levels of RMI government is needed. A strong and effective ODM will ensure that immediate disasters and emergencies are adequately planned for and addressed and will also help the RMI begin the long road to planning for the potentially devastating effects of sea level rise. • High risk development practices must be examined more closely by the appropriate authorities. Majuro's DUD area and Ebeye face higher risk of high wave action and storm surge because of their eastern atoll locations and some form of preventative measures and plans need to be in place to account for this. This would require close collaboration between a number of parties, including the ODM, local governments, and others. Landowners are also key in this regard and need more involvement on this issue. • Water resources and assets (at both the household and public levels) are vulnerable to different types of disasters, most notably saltwater intrusion. Protective measures need to be put into place to hedge against these disasters. Better water reservoirs, stronger protection of groundwater lenses, more drought-sensitive design of water storage facilities and better reticulation systems are among some of the measures that can be taken to safeguard water resources. All of this can be addressed in a water safety plan. • Historical data on droughts, typhoons and high wave action generally suggest that the October through March period can be considered the "high risk" season in the RMI. Climate forecasting may be difficult, but there is some general predictability in these events based on history. RMI's planners need to really take this into account and better prepare themselves and the country prior to and during this "high risk" season. The poor preparation and planning demonstrated during the late 2006/early 2007 El Nino season suggests strongly that RMI's planners are not taking this knowledge into account.
3. Awareness	
Issues and Concerns	*Measures and Actions*
• Limited awareness and limited awareness efforts • No targeting of Government and Traditional leaders • Limited funding • Women largely untapped • Few PPPs	• Far more effective campaigns need to be developed, preferably jointly between different entities that focus less on simple awareness building and more on behaviour change. Such campaigns need to address multiple market segments. • Public-private partnerships are one way to improve effectiveness of awareness and education campaigns. Just as the Ministry of Health currently works with the Youth to Youth in Health (NGO) to carry out prevention activities, so too can the EPA, OEPPC and other public entities engage in similar relationships with other non-state actors to more make awareness activities more effective. • Entities responsible for water resources should consider pooling their awareness resources to leverage up the market reach of their campaigns. • Politicians and traditional leaders must also be targeted so as to improve political will and community support for water resource management efforts.

	• Campaigns should also target more women, the keepers of the households, and existing NGOs such as WUTMI can provide strong on-the-ground support for grassroots level social marketing and awareness campaigns. • Improvements must be made with respect to information sharing and availability. This includes more information sharing and collaboration between responsible entities as well as better information flows to the public. • Consideration should be given to some "upstream" interventions, including incorporation of water related education into school curriculum or (at the very least) more school targeted campaigns and activities.
4. Technology	
Issues and Concerns	*Measures and Actions*
• Majuro water systems: quantity and quality problems • Limited Majuro wastewater system • Ebeye water system unreliable • Ebeye sanitation system unsafe • Utilities remain weak • Poor/lack of facilities create urban sanitation Hot Spots	• MWSC needs to make improvements to its supply capacity by expanding reservoir resources (a longer term and costlier initiative) and by reducing or eliminating leakage and illegal hookups (a more immediately attainable initiative). By maximising efficiency of current water resources, MWSC can raise its supply level and in turn grow revenue. • MWSC also needs to improve its capacity to detect and deter theft and leakage in its main water line. It has made efforts to improve in this area, but more is needed. • The Majuro water system also requires better monitoring and management of pollutants. This can be done through better detection of illegal hookups, improving the sanitation of the Laura wells, better chlorination practices, and more effective leaning and maintenance of the airport runway surface. All of this will contribute to higher quality of water supply. • More data on residential rainwater harvesting effectiveness is needed. For example, there is insufficient data on the level and types of home water utilisation, on roof sizes, roof guttering, and the extent of use of ground water. More research and analysis needs to be done in these areas and this knowledge should be fed into future plans and programmes. • On the wastewater side, options need to be reviewed for establishing treatment facilities on Majuro and re-establishing the treatment plant on Ebeye. The situation on Ebeye is far more dangerous as its outfall is on the lagoon side where there is little water circulation. · More aggressive monitoring of household septic tanks, especially on Majuro, needs to take place to ensure that seepage is not occurring. Consideration needs to be given to stepping up septic tank emptying programmes. • In relation to the above, an investigation needs to take place into why more Majuro and Ebeye households are currently not subscribed to both the water supply and wastewater lines. Factors such as costs, location, and others need to be analysed and every effort should be made to expand users of these systems. This will simultaneously improve revenues for the utilities, ensure that households have backup water supply systems in place, and (in the case of wastewater subscriptions) help ensure that sewage is consolidated and is not accumulating in individual septic tanks. • As many households on Ebeye cannot install their own catchments, they are all the more vulnerable to water shortages during dry months and droughts. This heightens the need for Kajur to establish more consistent and accessible water supply. This is especially true for residents of the highly congested Mid-Corridor residence areas. • As recommended in an earlier section, the RMI must also pay more attention to emerging and alternative technology, including such nonconventional sources as large scale desalination and the potential use of oceanic thermal energy conversion (which produces potable water as a by-product). • Engineering and other reports prepared by Beca in 2003, SOPAC in 2005 and USGS in 2005 document many detailed, technical problems associated with Majuro's and Ebeye's water supply and wastewater systems. These detailed technical recommendations must be addressed by appropriate authorities and a plan for improvements should be put into place.

	This could be part of the water sector strategy that has been recommended. For Ebeye specifically, various options are provided: o Consider converting the current extended aeration loading treatment plant to a conventional activated sludge loading system o Consider upgrading the capacity of the current system via installation of additional 20KW of aeration capacity, installation of 54 foot diameter clarifier and sludge handling and disposal facilities o Upgrade pump stations o Add screening mechanism o Consider disinfection also required to reduce health risk (chlorination could be used) o Improve the lagoon outfall or move it to the ocean side o Rehabilitate the sewers o Establish a whole new wastewater treatment plant • A final technological measure that can help in the monitoring and management of water resources is GIS. GIS has recently been introduced and is being used by the Marshalls Energy Company, EPA, and the Majuro Weather Station. More GIS technology could be encouraged via additional training and resources.
5. Institutional Arrangements	
Issues and Concerns	*Measures and Actions*
• Organisational weakness • Overlapping authority and outdated policies • Institutional weaknesses • Traditional authority often left out • Weak compliance • Civil Society can do more • Non-integrated institutions	• A new water resources strategy should be considered; one that ties together all of these issues, addressing all water resources in all RMI regions (urban and rural), identifies a common vision and lays out simple, agreed-to objectives on how to move forward. • Strengthening water resources management requires continued strengthening of the key organisations that are tasked with this responsibility. Across the board capacity building and institutional strengthening is required. • Clarification of roles and responsibilities is another must to ensure that overlap, duplication and confusion are minimised. • More effective vertical (from high levels of government all the way to community groups) as well as lateral (between agencies and ministries and civil society organisations) collaboration is required to champion water issues. This, however, requires one entity to serve as the catalyst and champion of integration. • A legislative and policy review of laws and regulations governing water resources should be conducted so as to clarify the rules of the game and minimise conflicts. • A multi-party water safety plan (or similar document) should be considered to help protect water assets and resources. • A policy of inclusion must be taken with respect to the institute of traditional authority. More involvement and buy in from traditional leaders and landowners will only help establish integrated processes. • Stronger emphasis must be placed on enforcement of and compliance with general rules and regulations related to water resources. This requires more involvement of local police forces. • NGOs and civil society groups can sometimes add immense value to public initiatives and programmes, as they are often more in tune with communities than are government organisations. As such, these groups should also be utilised more effectively, especially for outreach and awareness type activities.

6. Financing	
Issues and Concerns	*Measures and Actions*
• Financial performance of utilities poor • Leakage and theft hurting business • Allocation of donor funds not clear • Imbalanced allocations	• Immediate attention must be put towards the two water utilities to ensure that their financial and operational performance is set on a better and more sustainable path. This requires reconsideration of tariffs (with due consideration of both profitability and poverty and accessibility issues), improvements in billing and collections, and continued targeted technical assistance and training (addressing key issues specific to each utility). • Especially in Majuro, much more effort needs to be put towards minimising non-revenue water losses due to leakage and theft. • Domestic and donor funded investment into water infrastructure and activities could be clarified with a comprehensive water sector strategy, complete with identification and prioritisation of water related projects and activities. • EPA, Ministry of Health and other entities need to reconsider resource allocations with a view towards shifting more emphasis towards preventative programs and less towards more expensive curative activities. • Public private partnerships (PPPs) present one way to develop more collaborative approaches to preventative programs. EPA, Ministry of Health, MWSC and related entities should consider PPPs in future plans. • As recommended earlier, an investigation into why MWSC and Kajur's client base remains limited should be conducted. Cost considerations should be analysed, along with other barriers to entry for households. Expanding accessibility to these services will help the households as well as expand the utilities client base (and potential revenue).

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ANNEX 1: MONTHLY RAINFALL

MONTHLY RAINFALL IN MAJURO (inches), 1959 to 2001

Year	Annual	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Coefficient of variation	16%	64%	75%	70%	61%	41%	30%	30%	26%	35%	31%	32%	46%
LOWER	125.5	6.8	5.0	6.6	8.9	9.7	10.4	11.3	10.5	11.5	12.5	11.8	9.9
UPPER	137.7	10.0	7.9	10.1	12.9	12.4	12.5	13.5	12.3	14.2	15.1	14.3	13.1
Confidence Interval 95%	6.11	1.62	1.44	1.73	1.99	1.35	1.03	1.12	0.90	1.34	1.28	1.23	1.57
stdev	20.4	5.4	4.8	5.8	6.7	4.5	3.5	3.7	3.0	4.5	4.3	4.1	5.2
mean	**131.6**	**8.4**	**6.5**	**8.3**	**10.9**	**11.1**	**11.4**	**12.4**	**11.4**	**12.9**	**13.8**	**13.0**	**11.5**
2001	124.3	5.7	5.1	0.5	4.1	7.1	15.1	10.0	11.7	20.9	20.2	14.9	9.0
2000	135.4	23.8	20.9	6.6	8.8	4.0	5.3	11.3	11.1	7.0	12.3	15.0	9.2
1999	120.0	7.2	3.8	10.2	5.3	8.2	13.1	8.9	11.0	11.4	17.9	13.3	9.9
1998	102.1	1.6	0.3	0.3	0.6	6.6	10.5	16.3	12.1	9.3	19.5	13.6	11.5
1997	125.2	5.4	7.0	6.6	14.5	21.3	8.2	4.9	11.7	19.1	10.9	7.9	7.6
1996	152.6	14.1	16.7	8.3	19.5	10.6	13.0	7.4	7.5	15.7	9.7	13.2	16.9
1995	131.4	8.2	4.4	4.6	22.0	7.9	12.2	10.6	11.9	15.8	10.6	11.2	12.1
1994	127.7	9.4	1.7	9.5	14.1	15.7	5.7	8.3	11.7	13.2	10.4	11.3	16.7
1993	152.6	5.8	8.5	13.5	14.1	11.3	8.2	13.9	13.3	9.8	20.5	14.4	19.2
1992	87.1	7.7	0.2	0.2	0.4	14.2	8.4	10.4	12.6	5.9	13.6	10.1	3.5
1991	177.8	9.9	11.7	29.5	20.5	13.2	16.6	16.4	11.0	19.7	10.4	15.4	3.5
1990	118.3	7.0	4.2	10.4	9.4	16.6	7.3	9.1	14.4	7.6	6.2	15.9	10.4
1989	134.8	7.8	8.3	4.8	8.5	11.2	7.2	17.4	10.3	14.6	16.4	19.8	8.5
1988	122.3	14.7	1.5	6.8	5.9	6.9	9.1	14.3	10.6	13.9	17.9	7.2	13.7
1987	122.5	6.2	10.4	4.9	2.1	9.2	14.8	21.2	8.4	11.1	11.3	15.5	7.5
1986	148.6	10.5	3.9	14.8	12.2	14.9	15.9	12.1	20.0	10.5	7.3	9.4	17.1
1985	149.7	8.7	16.6	4.6	15.4	9.7	14.7	13.2	16.8	8.0	18.1	12.8	11.3
1984	115.7	16.1	16.8	1.3	3.9	4.2	5.4	9.4	9.2	6.4	14.8	13.3	15.0
1983	86.3	0.8	1.0	0.7	2.0	1.5	14.5	12.6	6.1	11.3	13.5	9.8	12.7
1982	144.5	12.6	9.7	13.3	4.7	11.5	17.0	14.7	11.7	18.9	8.2	19.1	3.2
1981	119.2	0.9	4.3	17.4	10.2	9.0	5.4	16.5	12.2	6.7	7.3	14.6	14.5
1980	108.3	8.1	9.7	5.1	7.0	11.3	6.7	8.5	13.9	12.9	9.3	5.4	10.6
1979	109.3	6.8	2.8	7.1	11.8	7.9	13.2	6.7	13.0	6.5	15.0	11.3	7.1
1978	142.8	3.6	5.3	3.4	12.7	13.9	10.7	16.3	8.9	9.7	20.6	23.6	14.4
1977	122.0	2.4	0.8	2.6	10.6	17.2	8.4	10.9	11.2	9.7	17.6	11.9	18.9
1976	145.0	8.6	9.4	15.7	19.4	15.3	9.4	16.8	8.4	17.7	9.0	12.7	2.8
1975	151.8	5.2	3.2	7.8	12.8	10.6	17.6	14.2	16.4	16.5	18.3	15.3	14.0
1974	148.8	11.1	8.1	7.2	15.7	12.8	13.7	12.5	13.7	10.4	19.9	9.3	14.5
1973	124.0	0.8	1.8	11.1	14.6	14.3	12.2	7.3	13.9	12.8	13.8	14.2	7.2
1972	157.7	9.6	7.1	15.5	9.2	15.0	14.9	14.8	10.8	19.0	14.1	4.5	23.4
1971	162.4	8.2	5.7	9.8	31.1	19.9	13.4	15.5	14.9	7.9	18.1	9.5	8.4
1970	89.0	5.6	0.4	1.7	2.9	9.2	10.7	7.7	11.2	11.8	12.6	6.7	8.4
1969	134.3	8.2	2.4	16.2	17.2	8.8	13.0	16.7	10.2	15.7	7.1	11.7	7.2
1968	135.7	5.4	3.5	11.1	8.9	9.3	16.1	11.4	11.5	9.8	12.1	12.0	24.8
1967	126.1	11.9	9.7	12.5	7.6	4.9	11.0	13.9	8.0	13.8	15.2	11.2	6.5
1966	128.7	3.8	4.4	5.8	16.0	8.6	9.4	14.9	6.5	14.0	13.5	12.2	19.4
1965	114.8	9.9	5.3	2.0	4.7	7.9	11.5	14.9	6.9	15.5	14.7	12.1	9.6
1964	162.7	1.4	7.0	7.2	11.5	22.0	11.2	18.7	15.6	21.1	22.8	16.9	7.4
1963	131.5	17.5	9.6	12.4	6.2	11.3	12.0	11.7	10.8	6.8	13.1	11.6	8.6
1962	151.4	17.6	5.2	11.5	6.0	12.0	7.5	11.0	8.9	21.0	16.4	22.7	11.7
1961	131.7	22.0	6.5	4.2	8.5	8.3	13.9	5.3	11.3	11.1	11.5	12.0	16.9
1960	153.0	9.2	3.6	11.2	23.4	14.3	13.2	14.1	14.6	16.9	9.7	16.3	6.5
1959	130.6	1.1	9.5	8.7	12.7	6.4	14.2	11.0	5.3	16.4	11.5	19.9	14.0

Source: Majuro Weather Station