Government of Tuvalu and Secretariat of the Pacific Community (SPC)

Rapid Drought Assessment Tuvalu

13 October – 8 November 2011

February 2012

SOPAC TECHNICAL REPORT (PR38)

Peter Sinclair[1], Fereti Atumurirava[2] and Josaia Samuela[3]

[1]Applied Geoscience and Technology Division, [2]Land Resources Division and [3]Public Health Division

This report may also be referred to as SPC-SOPAC Division Published Report 38

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Cataloguing-in-publication data (tbc)

Sinclair, Peter

Rapid drought assessment Tuvalu, 13 October – 8 November 2011/Peter Sinclair. – Suva: SPC, 2012

89 p.: 30 cm
ISSN: tbc

1. Drought, Tuvalu 2. Public health, Tuvalu 3. Water resources management, Tuvalu 4. Food security, Tuvalu

I. Atumurirava, Fereti II. Samuela, Josaia
III. SPC-SOPAC Division Published Report 38

GLOSSARY OF ABBREVIATIONS

AusAID	Australian Agency for International Development
CMR	Consolidated monthly returns
DHS	Demographic and health survey
JICA	Japan International Cooperation Agency
LRD	Land Resources Division of SPC
L/p/d	litres per day
mS	millisiemens (measure of electrical conductivity)
MUAC	mid-upper arm circumference
OCHA	Office for the Coordination of Humanitarian Affairs
PHD	Public Health Division of SPC
PWD	Public Works Department
SOPAC	Applied Geoscience and Technology Division of SPC
SPC	Secretariat of the Pacific Community
UN	United Nations
UNDP	United Nations Development Programme
UNFPA	United Nations Population Fund
UNICEF	United Nations Children's Fund
WHO	World Health Organization

GLOSSARY OF DEFINITIONS (including local Tuvaluan terms)

Desalination	the process that removes salt and other minerals from saline water so that it is potable for human consumption
Fusi	local cooperative stores
Futi	bananas
Kaleve	toddy, a fermented liquid derived from cutting the shoot of the coconut flower and collecting the sap
Kaupule	local island council that administers the affairs of the island
Maneapa	community hall
Mei	breadfruit
millisiemens	a measure of electrical conductivity, used to indicate the salinity of the water
Sounding	measuring the depth of water
Te Mataili	name of the Tuvalu police patrol boat

ACKNOWLEDGEMENTS

This document was prepared by a three-member SPC team from Suva following a rapid assessment mission to Tuvalu. The team consisted of:

Mr Fereti Atumurirava – Plant Health Unit, LRD – SPC
Dr Josaia Samuela – Health Advancement Unit, PHD – SPC
Mr Peter Sinclair – Water Resources Unit, SOPAC – SPC

We would like to thank the Government of Tuvalu for the support and assistance it provided to this assessment.

We would also like to thank several people in Funafuti: Secretary for Home Affairs Mr Pusineli Laafai, National Disaster Management Officer (NDMO) Mr Sumeo Silu, Director for Health Dr Stephen Homasi, Government Statistician Mr Semu Malona from the National Statistics Office of Tuvalu, Mr Pisi Selenganiu and Mr Charles Leepo from the Public Works Department, Mr Tataua Pese of the Tuvalu Red Cross, and Ms Hilia Vavae from the Tuvalu Meteorological Service.

The Commander of the Police Patrol Boat *Te Mataili* Captain Seleganiu Fusi and his crew demonstrated outstanding professionalism and their support made the trip as comfortable as it was. All the members of the assessment team from the government departments including PWD and the departments of environment and agriculture, as well as the Tuvaluan Red Cross, came to together to become a team, supporting each other and achieving a lot in good humour over a short period of time. In particular, Team Leader Mr Elekana Tofinga did an excellent job of managing all the logistics of the trip, including the meetings with all island *kaupule* and ensuring that there was accommodation, food and local support for the team. Finally, we would also like to thank the various families on each of the six atolls who generously cared for us and catered for our needs with all their love and resources.

This mission would not have been possible in the first place without the foresight and wisdom of SPC, and we would like to sincerely thank and express our gratitude to SPC Director-General Dr Jimmy Rodgers, SOPAC Director Dr Russell Howorth, Public Health Division Director Mr Bill Parr and Land Resources Division Acting Director Mr Inoke Ratukalou for their support and guidance in ensuring the success of the mission.

We also acknowledge and express our sincere gratitude to the government missions based in Suva, the New Zealand Aid Programme, AusAID, JICA, the UN Agencies – OCHA, UNDP, WHO, UNICEF, UNFPA and many others for their support and encouragement.

Finally, this trip would was made easier and more pleasant by the constant support and mentoring from Mr Dave Hebblethwaite of SPC's SOPAC Division, who provided the team with all the support anyone could need before heading to a group of atolls with limited water and other resources.

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1. EXECUTIVE SUMMARY

1.1 Introduction

On Wednesday 28 September 2011 the Government of Tuvalu declared a state of emergency due to drought. This followed the declaration of national crisis situations on two atolls (the capital Funafuti and the southern island of Nukulaelae) after a prolonged period with little or no rain and identification by the Government of Tuvalu of the need for emergency measures to provide sufficient safe water for the populations living on these two islands.

Concern by the Government of Tuvalu over the situation on the other main islands of Tuvalu prompted it to request assistance from the Secretariat of the Pacific Community (SPC) with a rapid drought assessment for the six islands to the north of the capital in central and northern Tuvalu: Nukufetau, Vaitupu, Nui, Nanumanga, Nanumea and Niutao.

The purpose of this rapid assessment mission was to ascertain the extent and the severity of the dry weather on these six islands, determine the need for emergency water supplies, identify possible interventions to provide short- and longer-term solutions to ongoing water needs on these islands to reduce the potential for water shortages in the future, and provide information on the impacts of the extended period of reduced rainfall on health and food security.

1.2 Key findings and Recommendations

Agriculture

Agricultural stress for the six atolls surveyed generally looked consistent with a typical dry spell period during the winter months of June to September. Frequent intermittent rains seem to have sustained crop growth on most atolls, so abnormal levels of stress were not observed except in the case of *pulaka*. *Pulaka* is the only crop that consistently demonstrated a high degree of stress; however, some stress was also found in banana crops. Nanumea had the highest level of crop stress found across the six islands.

Recommended responses with respect to the agricultural assessment include:

1.2.1 Increase use of traditional methods of *pulaka* cultivation such as bunding and composting
1.2.2 Erect structures over the plants to provide shade (using coconut leaves) to ease the sun's heat in larger *pulaka* pits, especially on Nanumaga and Niutao
1.2.3 Increase use of mulch and compost including dry coconut and breadfruit leaves as well as green leaves from shrubs surrounding the pit
1.2.4 Use alternative/artificial pits

1.2.5 Consider introducing salt tolerant crop varieties of *pulaka*, breadfruit, banana, sweet potato, taro and rice
1.2.6 Undertake research into other methods of cultivating *pulaka*.

Health

1.2.7 The dry spell did not resulted in any disease outbreaks in children under five years of age or in any other age group.
1.2.8 Normal coping strategies for water shortages and restrictions and positive health behaviours were being practised much earlier and more extensively than expected.
1.2.9 A significant number of families on most of the islands need toilet facilities designed to suit the dry conditions, e.g. composting toilets.
1.2.10 The health situation was similar on all six islands; none of them had any specific health needs.
1.2.11 To reduce the risk of any disease outbreak occurring as a result of water shortages and dry weather conditions, the *kaupule* (local island councils) need to play a more active role in ensuring that positive health measures are enforced and practised.
1.2.12 Disease surveillance must be strengthened to ensure better case definition and reporting to national level, supported and facilitated by better means of communication.
1.2.13 There is no sign of malnutrition amongst children under five years old as measured by mid-upper arm circumference (MUAC).
1.2.14 The abundance of modern and traditional food prepared on each atoll and served for the visiting survey team was evidence that sufficient balanced and nutritious food is available, although this could change for the worse if the current dry weather conditions continue.

Water

Every island in central and northern Tuvalu demonstrated the effects of an extended period of reduced rainfall. Rationing of communal water supplies by the *kaupule* was in place on every island, restricting access to communal supplies to as little as 2.1L/p/d.

Communities and individual households had employed various strategies to cope with the reduced access to their primary water source (rainwater). The most common coping strategy was the increased use of brackish well water, for bathing, washing clothes and flushing toilets. An average of 61% of the households relied upon groundwater to help meet their needs for non-potable water. In most cases this meant utilising brackish water that could be considered marginal for the purposes it was used for.

Recent modest rains which occurred during the period of the assessment have helped alleviate the situation for the communities across most of Tuvalu. As Tuvalu typically receives more rain in the November to March period, it is expected that the situation will continue to improve in the coming months. Rainfall analysis and advice using SCOPIC (Seasonal Climate Outlook for Pacific Island Countries) and other models, however, indicate that below average rainfall can be expected for the next three months or longer whilst under the influence of a La Nina ENSO (El Nino Southern Oscillation) event. After March, when Tuvalu enters the period during which it typically has lower rainfall, there is some potential for a return to dry conditions and increased stress to communities, particularly if the La Nina ENSO event continues into 2012.

General findings and recommendations for improved water access and management include the following:

1.2.15 **Urgent maintenance of guttering** to ensure efficient rainwater harvesting systems must be undertaken at the household level, and for *kaupule* buildings, **across all islands**.

1.2.16 **Issues over guttering ownership and maintenance** should be **addressed via incentive and enforcement schemes**. A national programe incorporating awareness should be a key part of plans to improve outer island water security.

1.2.17 **Regular soundings** (weekly during rationing, quarterly at other times) should be undertaken by the *kaupule* to assist in the management of their **key communal storage facilities**, and act as a **trigger for rationing** or seeking external support from sources such as central government. This is relevant for all islands. Monitoring, reporting and response should be part of a practical and agreed drought management plan.

1.2.18 **Access to groundwater for** communal **non-potable water supplies** should be improved. This would lessen the difficulties we observed associated with reduced access to water, including the time and cost required to access water for non-potable needs.

1.2.19 **Building codes should be developed and enforced** to ensure adequate building standards **for rainwater capture and storage**.

1.2.20 **Linkages** between the existing **National Water and Sanitation Management Committee and the National Disaster Management Committee should be improved** to ensure that recommendations are included and coordinated with the longer-term water and sanitation strategies.

1.2.21 A **drought management plan/strategy should be developed at the island scale.** The plan/strategy would be expected to allow for improved and pragmatic management of the communal water storage facilities, provide advice on expected rainfall conditions, promote coordinated and centralised reporting of storage and rainfall conditions, and include a simple standardised alert mechanism which provides users and communities alike with advice on appropriate water conservation responses.

2. BACKGROUND

This report is the outcome of a needs assessment mission, undertaken by the Secretariat of the Pacific Community (SPC) with the support of the Government of Tuvalu, to the central and northern group of atolls in Tuvalu from 20 October to 5 November 2011. The mission followed a request from the Government of Tuvalu and an appeal to the international community in Suva, Fiji for emergency assistance after national crisis situations were declared on two atolls in Tuvalu (the capital Funafuti and the southern island of Nukulaelae) following a prolonged period with little or no rain and identification by the Government of Tuvalu of the need for emergency measures to provide sufficient safe water for the populations living on these two islands.

On 13 October 2011, a team of three specialists from SPC arrived on Funafuti to work with the Tuvalu National Disaster Committee to assess the situation on Funafuti atoll whilst finalising preparations for an assessment of the six islands to the north of the capital in central and northern Tuvalu: Nukufetau, Vaitupu, Nui, Nanumanga, Nanumea and Niutao. The assessment team left Funafuti on the night of Thursday, 20 October on the *Te Mataili* police patrol boat for Nukufetau.

The purpose of this rapid assessment mission was to ascertain the extent and the severity of the dry weather on these six islands, determine the need for emergency water supply, identify possible interventions that could be acted upon to provide short- and longer-term solutions to ongoing water needs on these islands to reduce the potential for water shortages in the future, and provide information on the impacts of the extended period of reduced rainfall on health and food security.

2.1 Setting

Tuvalu is situated between 5° 38′–10° 47′S and 176° 00′–179° 58′ E and is comprised of nine coral atolls and low lying reef islands with a total area of 26 km2. The highest point is estimated to be about 5 m above sea level.

The soils in Tuvalu are of poor quality; as is typical of atoll soils, they are low in nutrients. The vegetation is limited to scrub, coconut, pandanus and breadfruit. Where the original vegetation exists you could expect to find *Pisonia grandis, Pandanus* spp., *Ochrosia parviflora, Pipturus argenteus, Hibiscustiliaceus, Messerschmidia argentea, Calophyllumin ophyllum, Barringtonia asiatica, Eugenia* and others (Fosberg 1949). Very little original vegetation was observed during the survey.

Throughout most of the islands there is a heavy reliance on rainwater harvesting for potable water. Of the islands visited, groundwater was used to varying degrees for non-potable needs, including washing, cleaning, and toilet flushing, on all islands except Nanumanga, where the groundwater was more than 80% seawater. During this current drought, Funafuti was meeting some of its non-potable needs with groundwater from a number of recently constructed wells where the water was 26–64% seawater.

Tuvalu is fortunate that its ‘average’ annual rainfall is relatively high and more evenly distributed compared to other Pacific areas (Burke 1998). Annual average rainfall ranges from a high of about 3511 mm in Funafuti to a low of about 2827 mm in Nanumea in the north. This relatively evenly distributed rainfall assists the use of rainwater harvesting for water supply. However, as recent experience shows, Tuvalu is vulnerable to droughts, and given its limited alternate water sources, the absence of surface water and the limited amount of fresh groundwater, it is necessary to maximise the collection of rainwater and its subsequent careful management.

Vaitupu 5.63 km sq
Nanumea 3.87 km sq
Nukufetau 2.99 km sq
Nui 2.83 km sq
Funafuti 2.79 km sq
Nanumanga 2.78 km sq
Niutao 2.53 km sq
Nukulaelae 1.82 km sq
Niulakita 0.42 km sq

Areas of atolls and islands

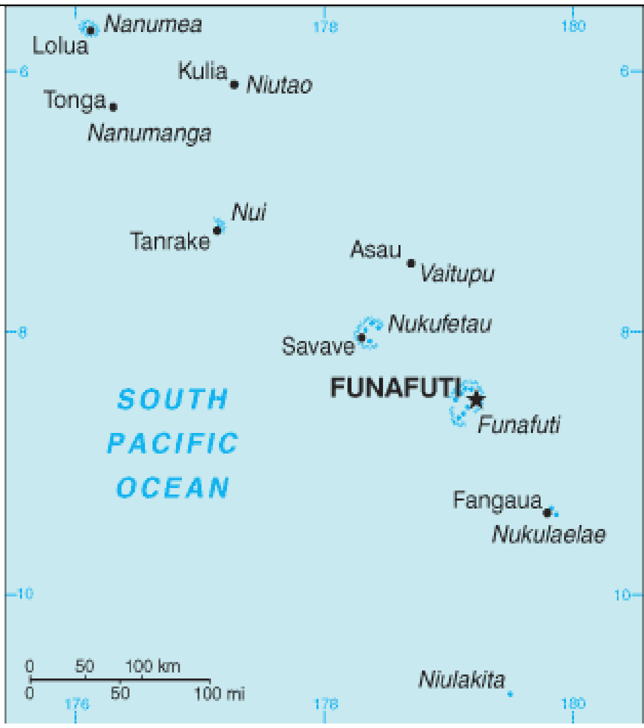

Figure 1. Map of Tuvalu.

2.2 Rainfall

The rainfall graphs in Figure 2 were provided by the United Nations Office for the Coordination of Humanitarian Affairs (OCHA) in September 2011, with data sets from Tuvalu Meteorological Service. They show monthly rainfall and the monthly averages (over 50 years) since January 2008.

Tuvalu has four synoptic stations located across the country, Funafuti, Nui, Nanumea and Nuilakita recording rainfall, barometric pressure, humidity, wind speed and wind direction. The rainfall recorded over the last three years from these stations show alarmingly low monthly totals relative to averages in the last 12 months. The following graphs present rainfall for central and northern Tuvalu, (Funafuti, Nui and Nanumea).

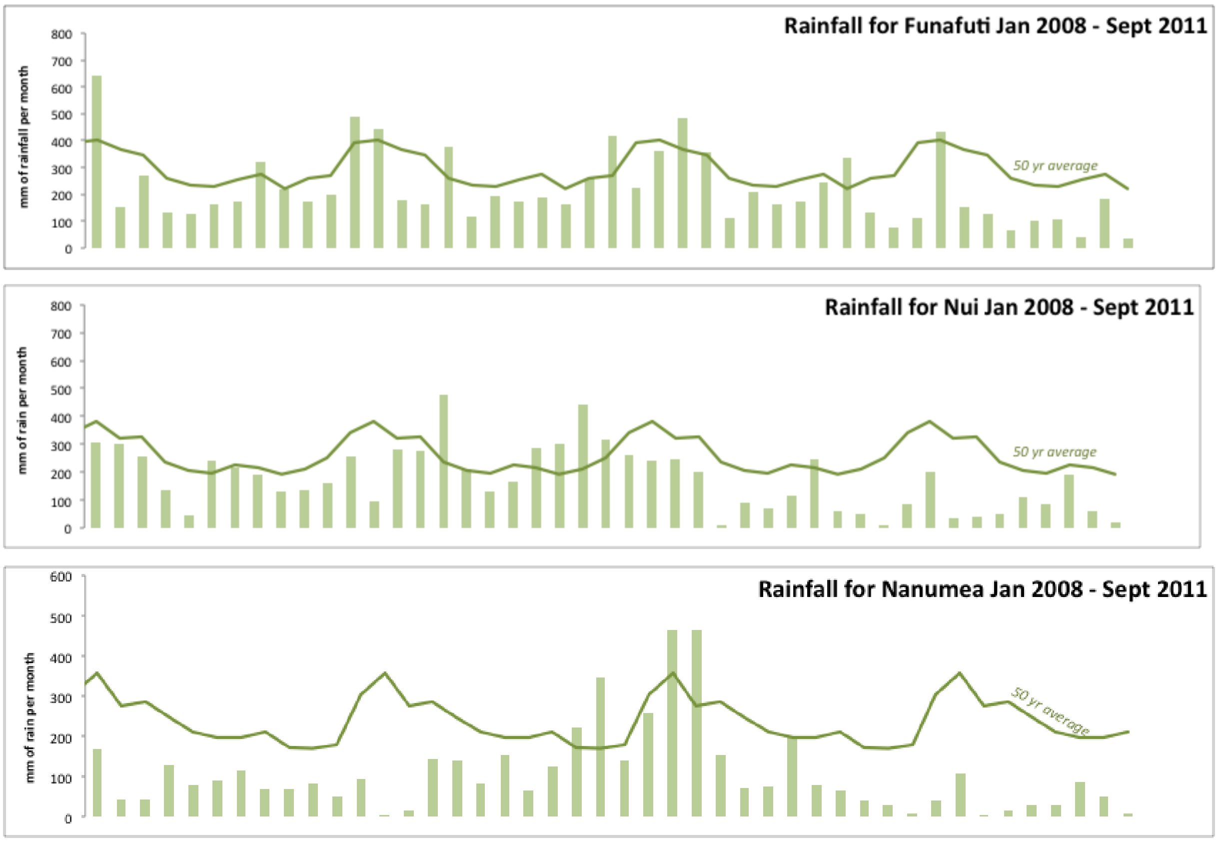

Figure 2. Monthly rainfall graphs for Funafuti, Nui, and Nanumea, Jan. 2008–Sept. 2011, UNOCHA 2011.

2.3 Population

The population is considered to be mainly of Polynesian descent, with a total population of 10,544 (estimated 2011), of which 5300 (2011 estimate) are believed to be residing in Funafuti and the rest are distributed between the eight remaining islands (Table 1). In 1974–1975, ethnic differences within the British colony of the Gilbert and Ellice Islands caused the Polynesians of the Ellice Islands (which became Tuvalu) to vote for separation from the Micronesians of the Gilbert Islands (which became part of Kiribati).

Table 1. Number of households and estimated populations.

Island	Number of households (Government of Tuvalu)	Population (Government of Tuvalu)	Number of Households (estimate from Oct. 2011 survey, source kaupule)	Population (estimate from Oct. 2011 survey, source kaupule)
Nukufetau	**130**	**568**	**130**	
Vaitupu	**321**	**1600**	**260**	
Nui	**203**	**609**	**146**	
Nanumanga	**251**	**674**	**138**	
Nanumea	**205**	**764**	**159**	**537**
Niutao	**169**	**759**	**138**	**702**
Funafuti	**789**	**5300**		

2.4 Mission Team

Mr Fereti Atumurirava	Agriculture, Land Resources Division
Dr Josaia Samuela	Public Health Division
Mr Peter Sinclair	Water, Applied Geoscience and Technology Division

The three specialists worked with a technical team of 11 staff from the Government of Tuvalu who were part of the rapid assessment group for the mission, comprising the Public Works Department (PWD), the Department of Environment, the Department of Agriculture, and the Tuvalu Red Cross. Local counterparts on each of the islands worked with the visiting team specialists and local volunteers upon arrival on each island. A complete list of the assessment team members is provided in Annex 1.

The team travelled aboard the *Te Mataili* police patrol boat, spending 2–3 days at each of the six islands located in the central and northern parts of Tuvalu. A schematic showing the voyage and islands visited and dates of assessment on each island is shown in Figure 3.

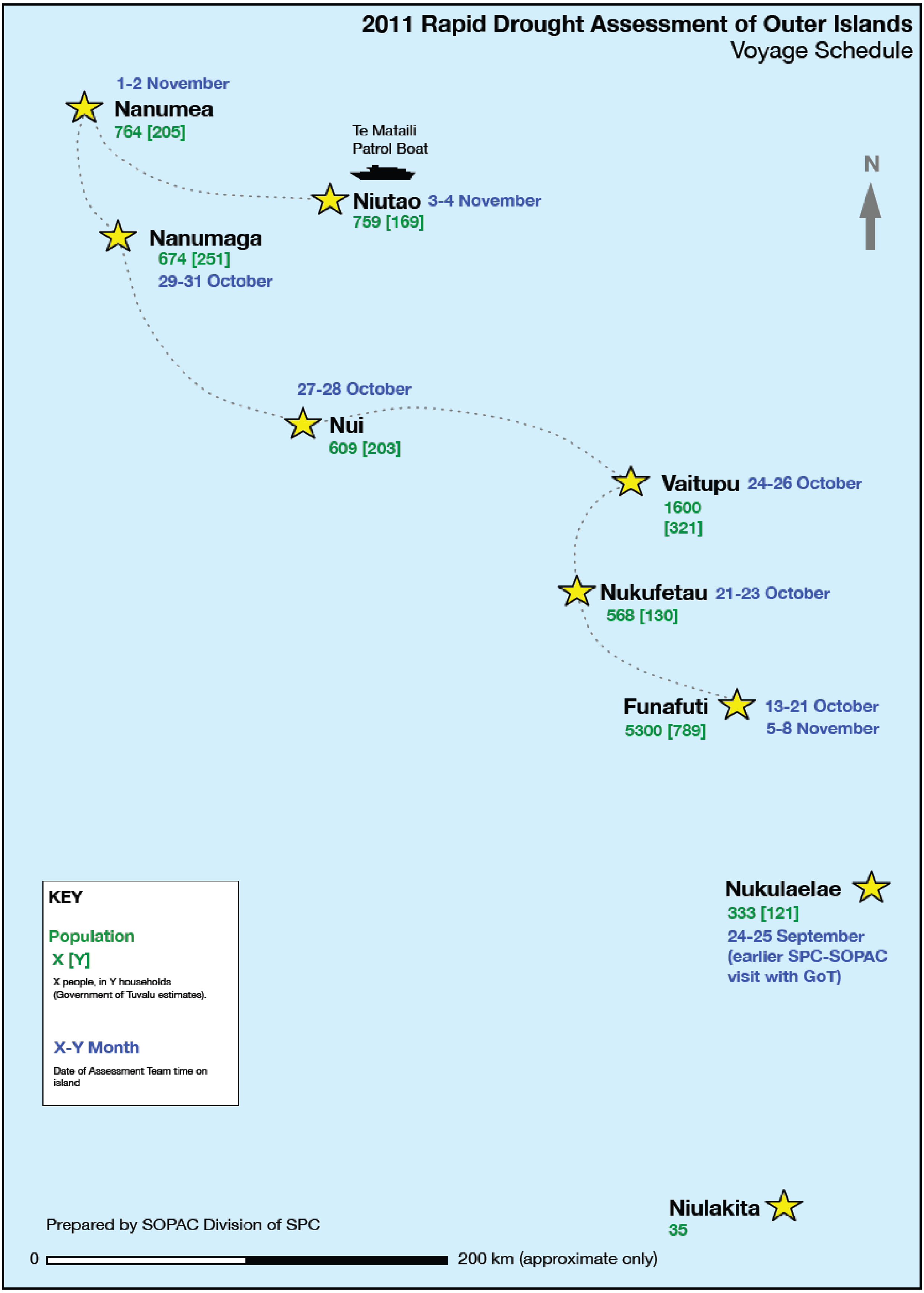

Figure 3. Schematic presentation of the track of the Te Mataili on its assessment voyage and the dates of the visits to the six atolls/islands to the north of Funafuti.

3 METHODOLOGY

3.1 Methodology for the Rapid Assessment

A range of rapid drought assessment tools were employed on each island, including questionnaires, interviews of key personnel in each sector, the review of health records, as well as direct observations and measurements of crop stress, *pulaka* pit water salinity, stored rainwater volumes and guttering conditions, as well as characteristics of groundwater available from wells.

The questionnaire, which was a significant part of the rapid assessment survey, was designed by the SPC team on arrival in Funafuti for use at the household level. The questionnaire was reviewed by the National Disaster Management Committee in Funafuti, the Department of National Statistics and the Ministry of Health of Tuvalu, as well as development partners and UN agencies based in Suva, Fiji. It was designed to provide a rapid appraisal of drought impacts using indicators in each of the three sectors of interest: water, agriculture and human health. A review of the questionnaire and brief training on the assessment methodology was conducted with the National Disaster Committee and assessment team members in Funafuti prior to departure for the outer islands, and modifications were made to both the questionnaire and the tank sounding data collection form. The questionnaire was further revised (albeit with minor changes) after the field trialling in Nukufetau.

As requested by the Government of Tuvalu, a census survey approach (surveying every household) was undertaken using six teams for the questionnaire and six teams for the soundings of rainwater tanks. Local labour provided by the *kaupule* assisted each team. The survey captured information from more than 81% of all households on each of the islands within the available time.

The census-type survey was conducted on each island with the approval of the local *kaupule*. Meetings were held on each of the islands prior to the actual survey in order to brief the locally recruited survey assistants on how to conduct the interviews, including local translations of the questions. Prior to departure from each of the islands, the team conducted briefings with the local *kaupule* with information on the findings obtained by the mission teams' assessment.

A single page radio flash was designed to allow key findings of the assessment on each island to be broadcast by VHF radio from the island upon completion of the team's visit to Funafuti to make information available as quickly as possible to the Government of Tuvalu.

The questionnaire is provided as Annex 2, the radio flash completed for each island as Annex 3, and the forms used for tank soundings and recording of groundwater well data as Annex 6.

3.1.1 Health

In the area of health, questions were designed to assess behaviours related to the safe storage of drinking water, boiling of drinking water, washing of hands with soap and water, and methods of human waste disposal. In addition to the questionnaire, the general outpatient register for the local health centre on each of the islands was reviewed and data were collected for the most common childhood conditions – especially those related to water scarcity. The health specialist worked with the nurse based on each of the islands whenever possible, including visiting preschools to assess children for malnutrition. For children under five years of age, the mid-upper arm circumference (MUAC) was used as the screening tool, with 14.0 cm used as the cut-off point to determine malnutrition. Three preschools were assessed during the course of the mission for childhood conditions including malnutrition.

Qualitative information was gathered as part of the assessment through an in-depth interview using the questionnaires to get details on people's ability to cope with water shortages and food insecurity (if any), and personal hygiene and sanitation through behaviours like boiling drinking water and washing hands with soap and water.

3.1.2 Agriculture and food security

The questions on agriculture focused on peoples' strategies to cope with the risk of food insecurity in the face of any perceived drought; the variety of crops and vegetables grown on the island; the sustainable capacity to produce the traditional main island staple *pulaka*; the types of livestock bred on the islands and the perception of people regarding the effect of possible drought conditions on the sustainable production of *kaleve* (toddy) and *pulaka*.

Pulaka pits on each island were assessed for the severity of stress, and specific measurements were made of the salinity of the water found within all available *pulaka* pits. *Pulaka* pits are considered to be a 'window onto the water table', as *pulaka* are sensitive to the quality of the water in which they grow.

This cross-sectoral aspect, including both an examination of food security and a water assessment, was chosen as SOPAC had previously collected baseline field data from 2006 (Webb 2007), allowing a useful comparison between a normal rainfall year and a drought year.

3.1.3 Water

The household questionnaire included questions on the water sources that were being used at the household level and its reliance. Information was collected on the primary and secondary sources for drinking water as well as the sources for non-potable water for household needs; the number and type of household utilities that use water (e.g. washing machines, type of toilets – flush or pour), to gather information about water use; drinking water storage types; as well as peoples' coping strategies to meet water needs and maintain water security in the face of any perceived drought.

A quantitative survey of the available rainwater storage capacity and the stored volume at the time of the survey was also undertaken for both household and community rain water storage tanks, providing a snapshot of the amount of potable water available at the time of the survey. Information on alternate water sources for potable and non-potable needs was collected, including rapid surveys of groundwater potential utilising existing wells.

3.2 Data Analysis

The raw data from the household survey were entered into an Excel spreadsheet and simple descriptive analyses were obtained using both absolute counts and proportions based on total number of respondents, and the population of the island including number of households.

4 HOUSEHOLD QUESTIONNAIRE ANALYSIS

Table 2 summarises the number of households covered under this rapid assessment. The response rate was 82%. The survey covered a total of 786 households on the six atolls visited, which is about the same as the total number of households on the capital of Funafuti.

4.1 Demography

Table 2. Total number of households surveyed during the mission.

Atolls surveyed	Respondents	Households	Population
Nukufetau	125	130	568
Vaitupu	201	260	1150
Nui	115	146	609
Nanumanga	107	138	597
Nanumea	111	148	537
Niutao	127	141	668
Total	**786**	**963**	**82**

Most of the households had a male family head residing on the atoll at the time of the assessment. Of the total population of 4106 covered in the survey, about 15% were under five years of age and 4% were over 65 years. There was no systematic attempt to assess the level of disability within the communities. Each of the household questionnaires was answered by an adult who verbally consented after a brief introduction of the purpose of the survey. No statistics are available on the gender of the respondents; anecdotally there were more female respondents than male respondents. In cases where both members of a couple were present during the interview, females were most likely to respond to questions.

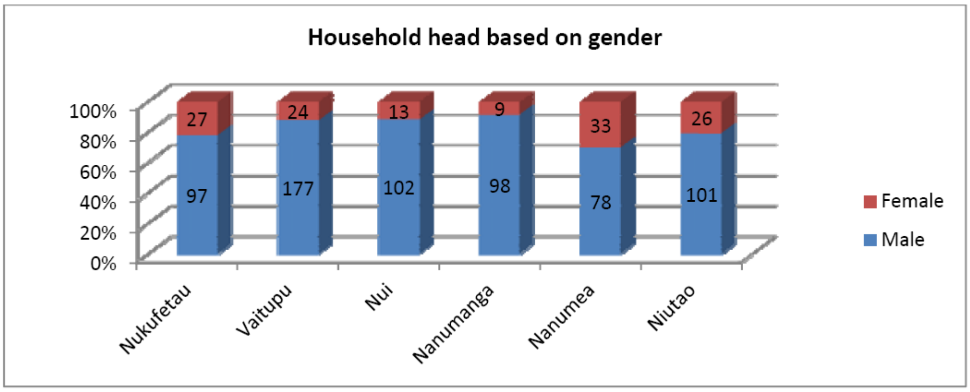

Figure 4. Household heads according to gender.

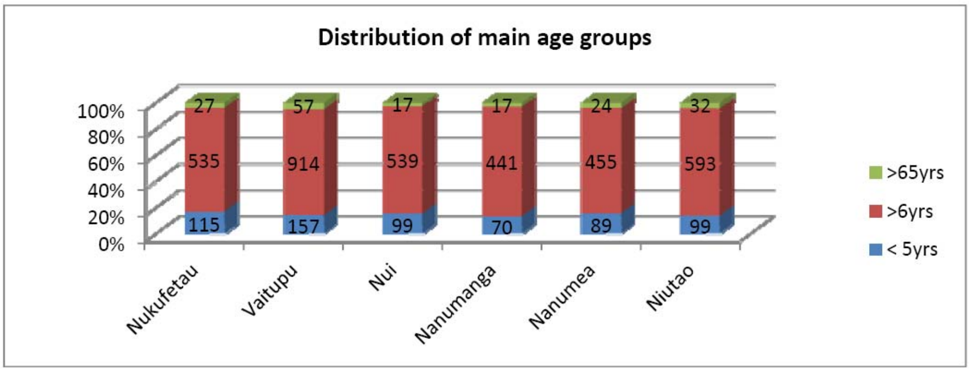

Figure 5. Distribution of major age groups in the islands.

4.2 Water sources and utilisation

The majority of households on the atolls have their own water source, which is either a tank or cistern that collects rain water from the roof catchment (Figure 6). A few households (26/786) have to rely solely on the community supply or someone else's supply for their primary drinking water source. This is surprising given that water shortage has been a chronic and ongoing concern for islanders and the *kaupule*. Ideally, each household should have its own water source.

The main source of drinking water is rain water harvested and stored in tanks or cisterns (Figure 7). This is the only potable water available with the exception of desalinised water from a plant in Nanumanga. The island of Nanumanga does not have any groundwater with acceptable levels of salinity; hence the population is totally reliant on rain water. For Vaitupu, five families were relying on wells as the primary source for drinking water (Figure 8). The majority of households on all islands except Nui stated that currently they did not have any serious problems with water (Figure 10). This is a very interesting finding given that rationing of water has been a permanent way of life for these islanders for many years. All islands except Nanumanga (which has no useable underground water source because of the high salinity) rely, to varying degrees at varying times, on well water for non-potable use (washing, bathing) (Figure 9). Reliance on well water increased during the drier periods.

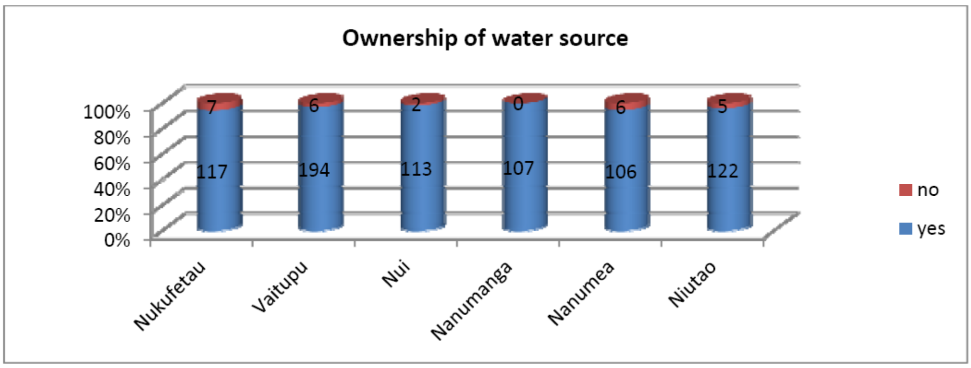

Figure 6. Ownership of water source.

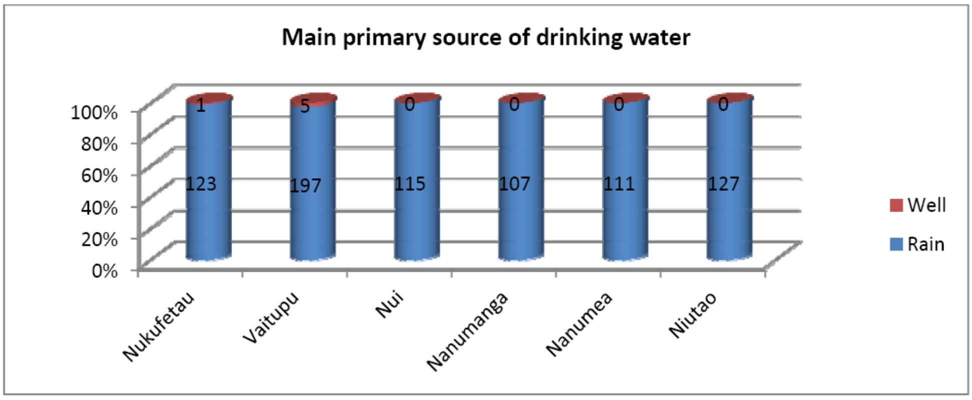

Figure 7. Primary source of drinking water.

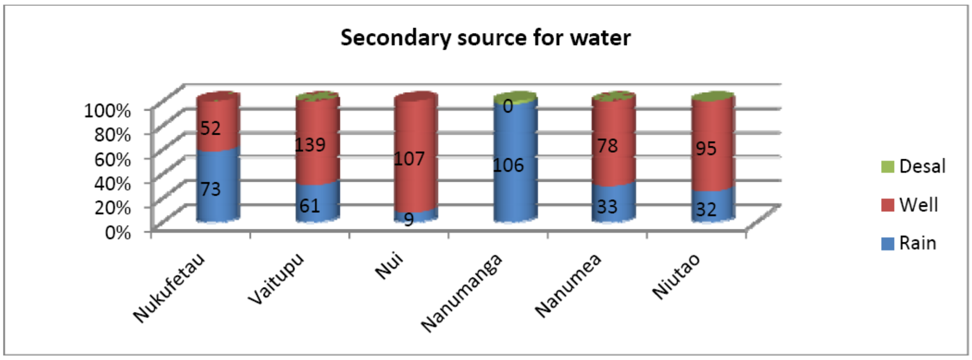

Figure 8. Secondary source of water.

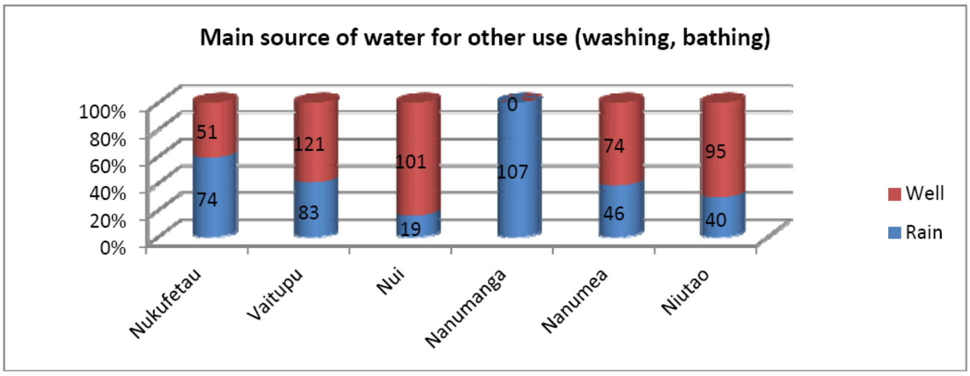

Figure 9. Main sources of water for other household use, e.g. washing and bathing.

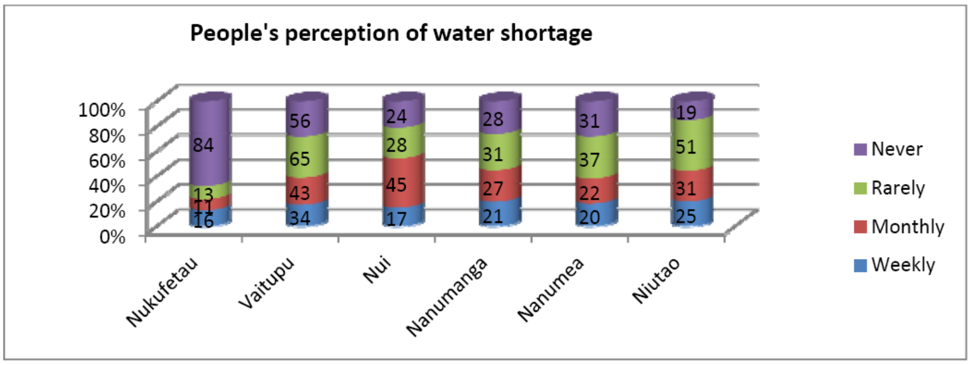

Figure 10. Perception of water shortage -how often people experience a water shortage from their main water source.

4.3 Safe Water for Drinking

Across the six islands, the majority of households safely store drinking water in tanks, cisterns or buckets with lids (Figure 11). The latter are commonly seen in households that regularly access the community supply cisterns; biscuit buckets (15 L) are used to carry water from the source to the house and to store it in the house. Observation of the water supply stations used during rationing indicated that the activity of collecting communal rationed water supplies was shared fairly equally between men and women. Interestingly it appeared that at times women dominated and at other times men dominated the same station. The collection of water which became a routine activity that also provided an opportunity to socialise, with the same people coming around the same time to collect their water ration. Collection of water was always carried out during daylight hours, and most often in the morning from daylight for approximately three hours. To make water safe for drinking, a high proportion of households reported boiling drinking water on a daily basis (Figure 12). The survey did not identify what fuel source was used to boil water. It was observed that wood fires were commonly used for cooking and boiling water.

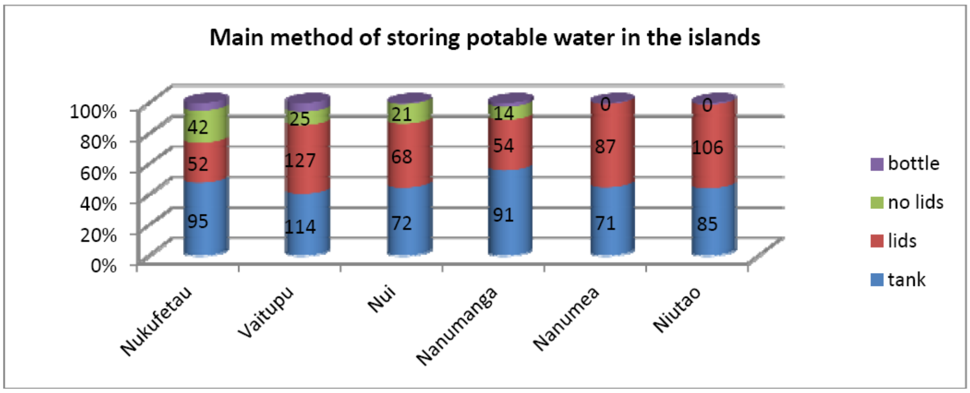

Figure 11. Main methods of storing drinking water.

4.4 Sanitation Level

The sanitation status on all the islands is relatively good, with majority of households having water flush or pour toilets (Figure 13). The majority of these toilets use either rain or well water, with a negligible number ever using sea water. Three of the islands (Nui, Nanumea, and Nuitao) have a significant number of households without any toilets at all – members of those households report that they use either the bush or the beach for such purposes. Almost all of these households have a number of children or women living in them. In a vulnerable environment where water is scarce, a better alternative in terms of conserving water whilst protecting limited underground water sources is to promote compost-type toilets.

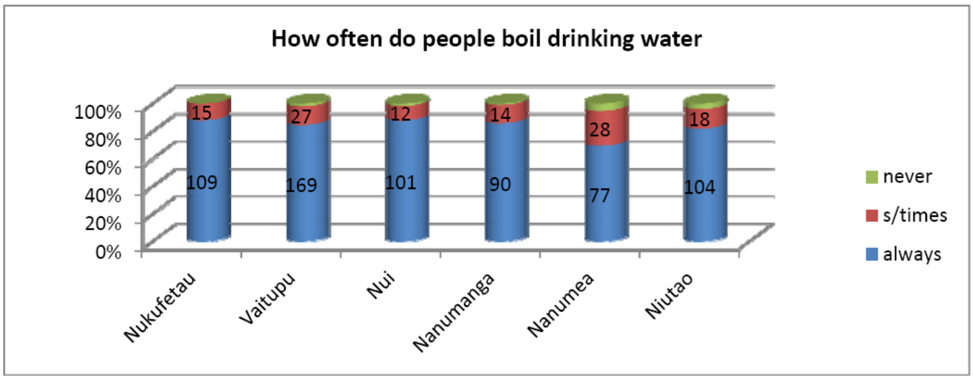

Figure 12. How often people boil their drinking water.

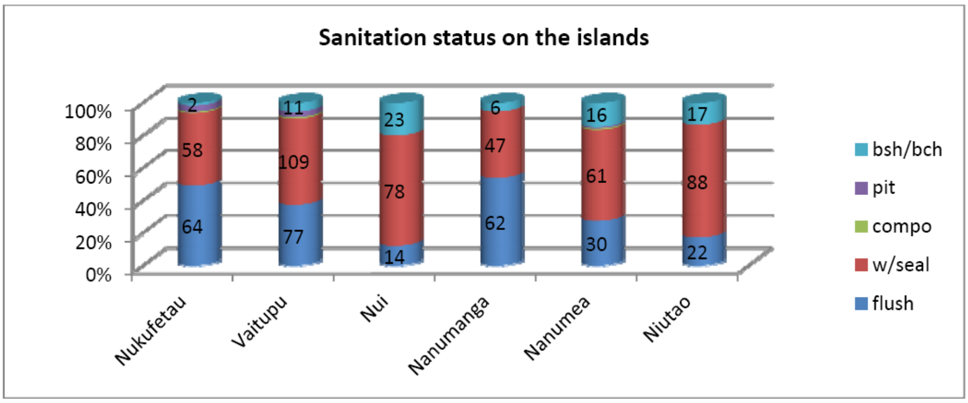

Figure 13. Types of toilets used.

4.5 Personal Hygiene

At a personal level, the majority of houses surveyed reported that they had soap and had used it within the past 24 hours (Figure 14). It should be noted that liquid washing detergent was observed to be commonly used where it would lather more readily in the brackish water. Most responded that they regularly washed their hands before eating and preparing food and also after using the toilet. The survey team did not actively look for evidence of soap within households as it felt that the questions were sensitive enough and further attempts to get objective evidence could be very embarrassing to respondents.

4.6 Strategic Health Communication

In times of crisis, getting vital information to at-risk populations is critical in terms of disease prevention, risk reduction, health protection and promotion. Late in September or early in October when a national state of emergency was declared in Funafuti because of the drought, the Ministry of Health launched the Operation Water Safety campaign, which targeted residents on Funafuti and promoted safe and wise use of water and personal protective measures relating to hand washing with soap. As this campaign was launched through Radio Tuvalu, which is the main means of mass communication on these outer atolls, the survey investigated the dissemination of this message.

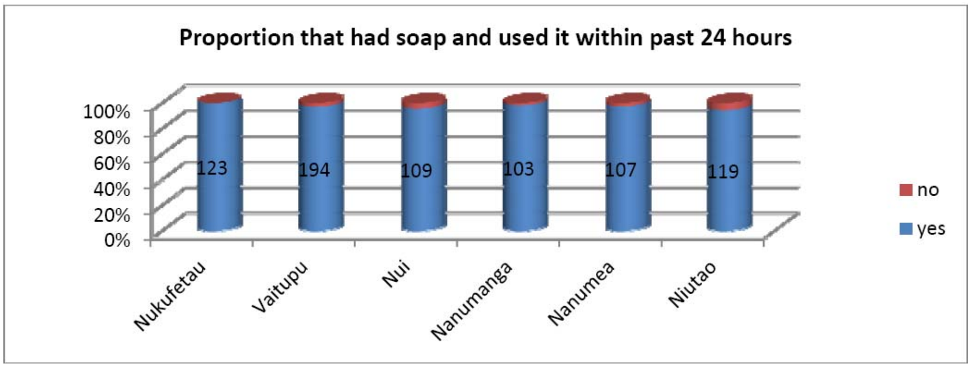

Figure 14. The proportion of respondents (all adults) that had soap and used it to wash their hands in the past 24 hours.

Most of the households surveyed listened to Radio Tuvalu on a regular basis, except on Niutao (Figure 15). Many residents on this atoll informed the team that they prefer to listen to Radio Tarawa, which is based in Kiribati; hence many of them were not aware of the water campaign on

Funafuti (Figure 16). The survey, however, showed that the majority of people who were aware of the campaign had heard about it through Radio Tuvalu. Only a few heard about it through word of mouth. Many residents expressed satisfaction with the way the campaign helped them conserve water and practise good hygiene in the face of water shortages and restrictions.

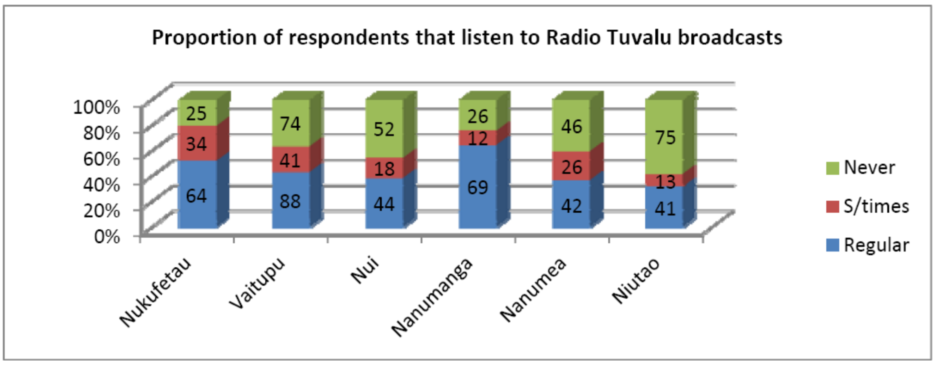

Figure 15. The proportion of respondents who listen to Radio Tuvalu broadcasts.

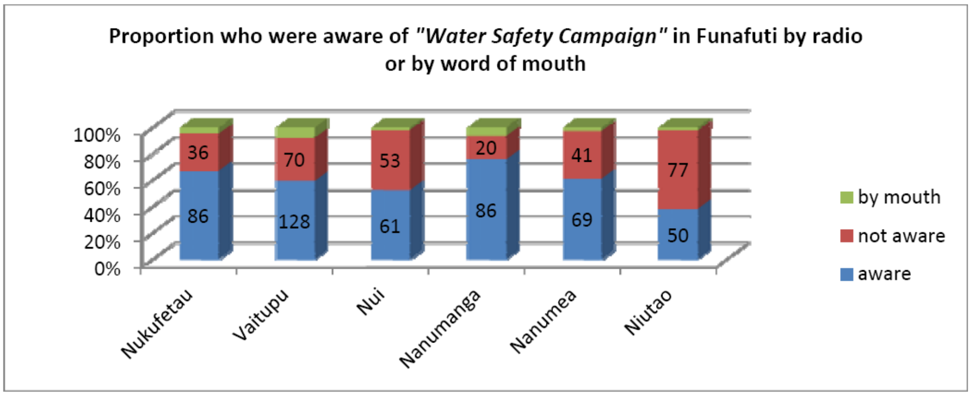

Figure 16. How people heard about the water safety campaign on Funafuti.

4.7 Nutritional Status of Children Under Five Years Old

The health team was able to visit three preschools and take measurements of mid-upper arm circumference (MUAC) of children under five years of age. As shown in Figure 17, none of the assessed children (60 boys and 45 girls) were below the cut-off mark of 14 cm, which is normally used to indicate undernutrition. Although the last demographic and health survey (DHS) in Tuvalu used weight and age to assess the nutritional status of children under five, this part of the rapid assessment used a more pragmatic approach due to time and resource constraints.

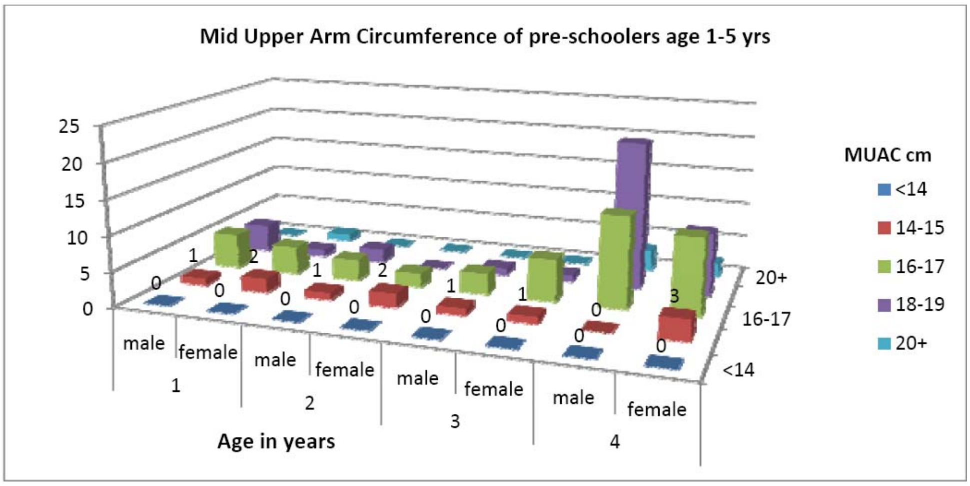

Figure 17. Distribution of mid-upper arm circumference (MUAC) as proxy measure of nutritional status in children under five years. MUAC of 14 or less is considered to indicate undernutrition.

4.8 Childhood Conditions

The second objective of the health team was to review the outpatient records for childhood illnesses and conditions presenting to the local health centre in the previous six months, i.e. May to October 2011. Figures 18 to 21 show the distribution of common childhood illnesses on the six atolls visited. Records were extracted from the consolidated monthly returns (CMR) already submitted to the national government and also validated from the outpatient register. Outpatient attendance on a daily basis remained at usual low numbers in all health centres. There were few patients admitted for care, e.g. chronic wound care. Most of the nurses were carrying out routine duties such as doing home visits and attending to outpatients and also helping the survey team with the questionnaires and the assessment of the nutritional status of preschoolers. Overall, the figures do not provide any evidence of recent or current disease outbreaks related to water scarcity.

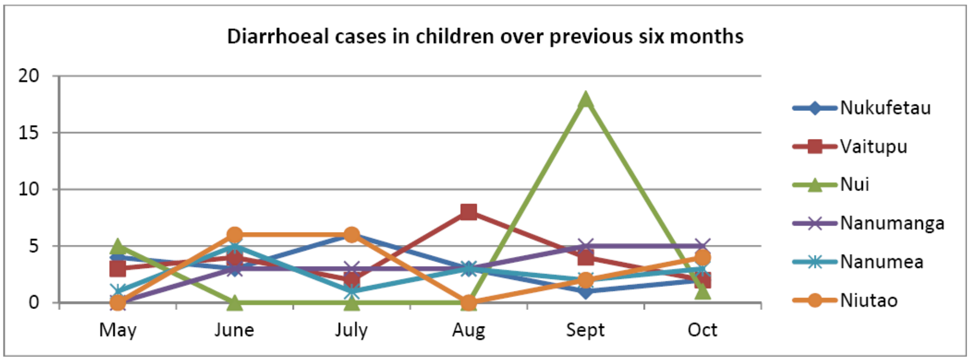

Figure 18. Distribution of diarrhoeal cases in children over past six months.

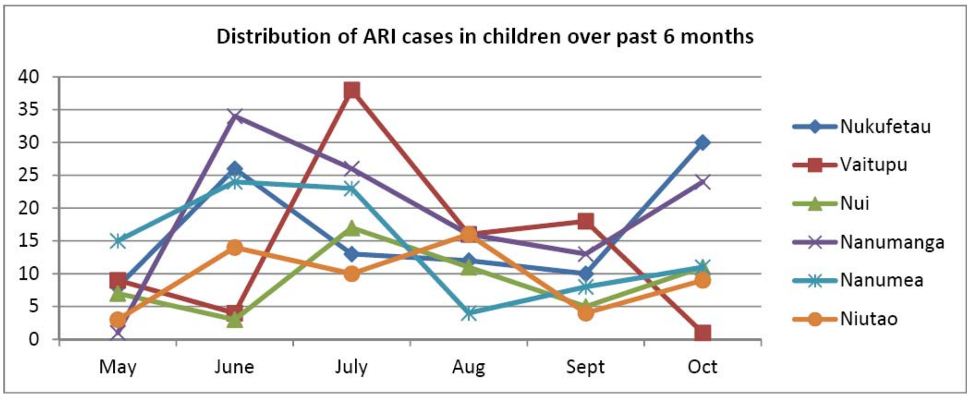

Figure 19. Distribution of acute respiratory infections (ARI) in children over the previous six months.

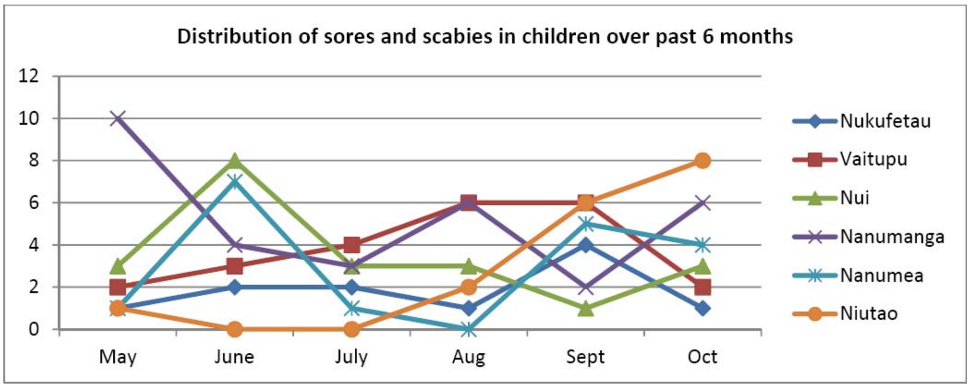

Figure 20 shows the distribution of skin infections (sores and scabies) in children over the previous six months.

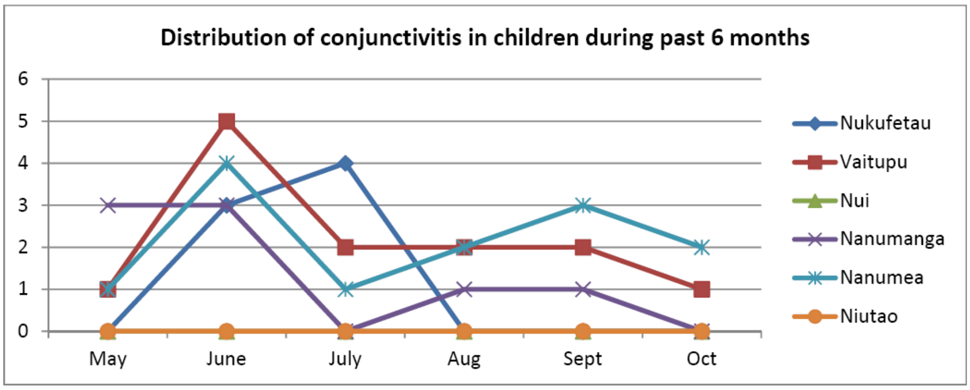

Figure 21. Distribution of conjunctivitis in children over the previous six months.

4.9 Food Security and Coping Strategies

The questions on food availability and coping strategies were developed to get information on any potential impact of the dry weather conditions on food security. Of the six islands visited, only Nukufetau islanders felt that there was no drought and that the dry weather conditions were just seasonal. A significant number of households on Nukufetau were able to cultivate vegetables around their dwellings (Figure 24). This was not the case on the other five atolls, where greens (especially vegetables) were noticeably missing from the main meals, except for the occasional tender fern. Fruit trees like bananas, pandanus and pawpaws are abundant around the homes and are a prominent part of the daily diet – for which the tour team was grateful.

In the area of financial security, Figure 22 shows that 45% of the 454 households that answered this question depended on market earnings as their main source of family income. Most earned money by fishing, selling handicrafts like mats and shells, and selling coconuts. Other sources of household income include salaried work (mainly at the *kaupule*) and remittance from either relatives in Funafuti or overseas-based seafarers.

The prolonged dry weather conditions did not appear to impair the ability of households to earn money. The local cooperative stores (*fusi*) appear to be well stocked with foodstuffs and groceries and residents on all the atolls appear to make use of them.

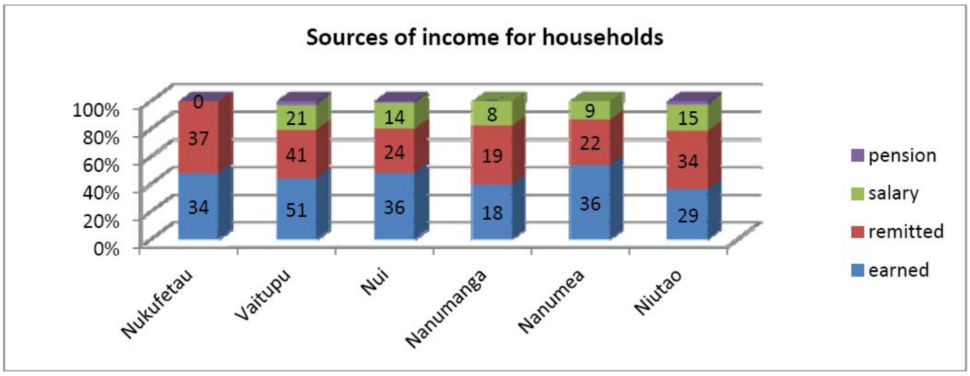

Figure 22. The main sources of family income for the 454 households (58%) that responded to this question.

A stable source of carbohydrates for atoll populations for many generations, *pulaka* (a large taro plant) is cultivated in pits dug out to create swampy conditions. Of the 726 households surveyed, 61% consumed *pulaka* regularly – as frequently as every weekend (the crop is traditionally dug up and prepared for a special Sunday lunch after church). The majority of households depend on rice as the main source of carbohydrates and consume it on a daily basis. The reason for this shift is that, as reported by several family heads, young children prefer rice to *pulaka*. *Mei* (breadfruit) and *futi* (bananas) are alternate staple sources of carbohydrates on these atolls.

At every meal, team members were provided with a generous amount of food by the island communities and families. We were regularly served breadfruit, cooked in many ways, rice, *pulaka*, taro, bananas, fish, chicken, (local and imported) lobsters, octopus and the occasional terns (seabirds) in banquet sized portions for breakfast to dinner and we washed these down with a never-ending supply of green coconut juice and toddy.

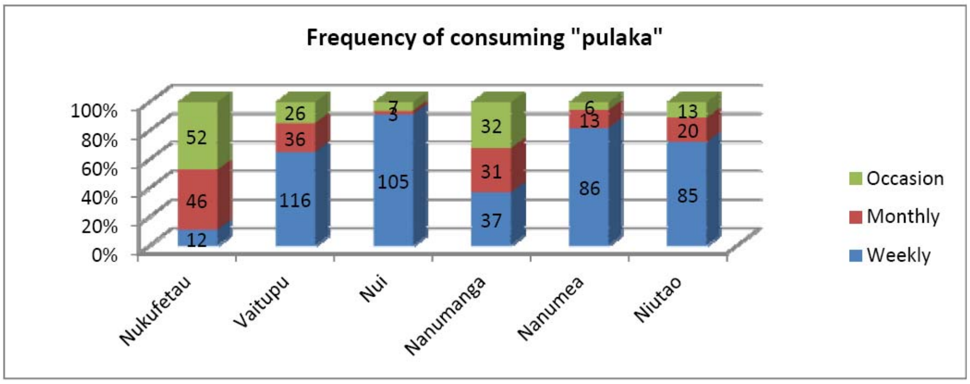

Figure 23. The frequency with which the atoll populations eat pulaka, the staple crop.

Has the prolonged dry weather impacted food security? This question could only be answered by a careful assessment of the atoll vegetation and the quantitative and qualitative findings on the groundwater sources such as wells. The feasts provided for the visitors proved otherwise – food supply is stable for the time being, but many household heads noted that the dry weather conditions were just starting to affect them. Figure 25 shows that the main strategies used to cope with food shortages at the household level are to buy cheaper foods and to prematurely harvest food crops. The third option is to purchase goods from the local cooperative store (*fusi*) on credit. The nutritional assessment of preschool children on two of the six atolls visited did not find any children with malnutrition.

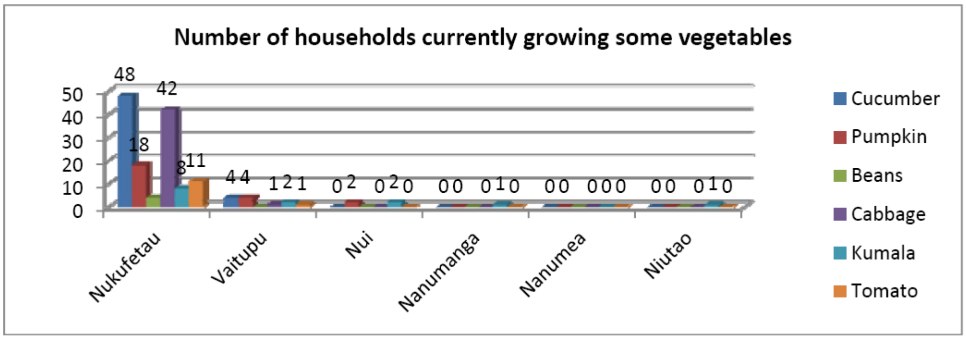

Figure 24. Households with a backyard vegetable garden.

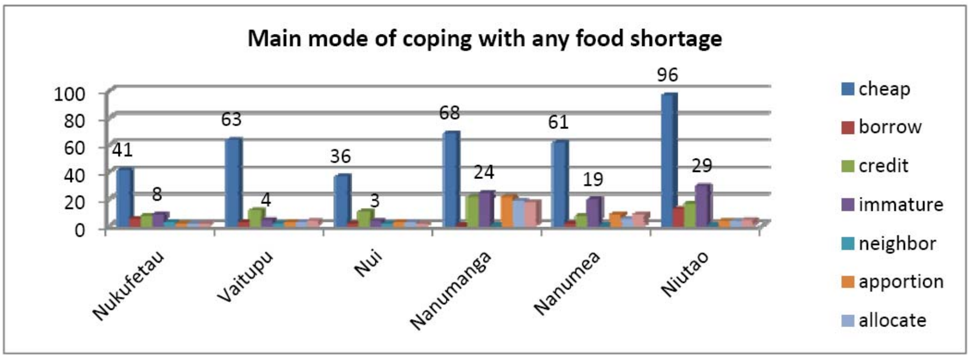

Figure 25. The main coping strategies amongst households experiencing difficulties with food.

5 AGRICULTURAL ASSESSMENT AND FOOD SECURITY

In addition to the specific questions found in the questionnaire on agricultural impacts, a physical assessment or survey on agricultural stress – and in particular *pulaka* pit health – was undertaken on all islands visited.

The results of the agriculture sector rapid assessment for the six atolls surveyed generally looked normal under the circumstances of a typical dry spell period during the winter months of June to September. The crops under review were the common fruit trees (coconut, breadfruit, banana and pawpaw), vegetables and *pulaka*. Intermittent rains seem to sustain crop growth in most atolls, so there is no real stress as yet on the crops under review except for *pulaka.* Throughout the atolls *pulaka* was found to be under a high degree of stress and banana was found to be under some stress. The degree of stress for other crops varied between atolls. Nanumea atoll had the highest percentages of crops under water stress (Table 3).

5.1 Methodology

Rapid assessment was based on visual observation of the vegetation quality executed both on foot and from vehicles using the island main roads and the feeder roads. *Pulaka* pits were physically visited and wells were tested for salinity.

5.2 Results of the Assessment

The result of the assessment is summarised in Table 3. Overall, all the crops reviewed were normal on all the islands, with the exception of *pulaka*, which has been under chronic stress caused by increased salinity present in the groundwater.

Table 3. Rapid assessment summary: percentage of crops under severe water stress.

	Island					
Crop type	Nukufetau	Vaitupu	Nui	Nanumaga	Nanumea	Niutao
pulaka	10	10	5	90	2	50
coconuts	0	5	0	0	5	5
breadfruit	0	0	2	5	5	0
banana	5	5	5	5	10	5
pawpaw	2	2	0	0	2	0
vegetables	0	0	0	0	0	0
pigs	0	0	0	0	0	0
chickens	0	0	0	0	0	0
Assessment ratings	Normal	Normal	Normal	Normal	Normal to moderate	normal

5.2.1 Pulaka pits

Larger *pulaka* pits seemed more vulnerable to dry conditions than smaller pits. Smaller pits benefit from the shade provided by surrounding trees during the day, enabling *pulaka* to grow relatively better under dry conditions.

Pulaka has been the most widely affected crop, although this was not directly associated with water stress, but rather increased groundwater salinity (Table 4). The combination of salinity and the heat of the sun led to adverse effects on the *pulaka* plants. The most common symptom associated with this is drying of the leaves (from the edges moving inwards); stunted growth is another common symptom. Increased use of organic material, which can be obtained through composting, and providing shade by using coconut leaves in larger pits would certainly improve the situation in the short term. In the longer term, it would be appropriate to plant trees to provide shade.

Table 4 also shows the salinity values measured in *pulaka* pits during the 2006 survey. There are significant differences between the readings, with the 2011 data being considerably higher in all cases. Webb (2007) writes that whilst there has not been a great deal of research into *pulaka* sensitivity or crop yield decline with increases in salinity, research indicates that salinities above 3.3–5.0 mS/cm (Mourits 1996) will result in reduced yield and potential crop failure and pit abandonment.

The current survey supports the general relationship between reduced yield and *pulaka* pit abandonment or inactivity associated with increasing water salinity. The survey data indicate a general trend of reduced yield, and pit abandonment or inactivity at salinity levels greater than 11 mS/cm (77%). This would appear to indicate an upper tolerance of salinity at which *pulaka* can sustain productive growth during prolonged dry conditions for Tuvalu soils greater than that identified by Mourits (1996). This suggests that the *pulaka* observed was either more tolerant to higher salinity waters or was able to adapt and better take advantage of the rainfall when available.

However, for reasons that are not clear, 33% of *pulaka* abandonment or inactivity occurred at salinity levels below 11 mS/cm. These abandoned *pulaka* pits were typically smaller ones with less than ten plants; hence these abandonments were most likely due to migration or the crop being less desirable as a staple, and less to do with adverse affects of salinity.

The increase in salinity of the waters found within the *pulaka* pits is considered to be a result of the extended dry period; specifically it is thought to be caused by the increased evaporation in the pits as well as the increased salinity in the groundwater. It should be noted that the amount of standing water in the *pulaka* pits was generally very reduced, limiting our ability to undertake sampling. Additional analysis of the data sets and the sampling methodology is required to validate this initial analysis and hypothesis.

Where possible it would be appropriate for future rapid assessments of the *pulaka* pits to be undertaken by the agricultural staff located on the islands so that they may monitor the recovery of the pits after the drought.

Table 4. Mean salinity levels for surveyed pulaka pits.

Name of atoll	Nukufetau	Vaitupu	Nui	Nanumaga	Nanumea	Niutao
***pulaka* pit**	28	95	11	2	16	5
2011 *pulaka* pit mean salinity (mS/cm)	4.319	8.596	5.814	27.215	2.239	21.100
2006 *pulaka* pit mean (mS/cm)	0.161	1.132	0.296	0.962	0.745	0.619

Plate 1. Effect of salinity and hot sun on newly grown pulaka plants.

Plate 2. Effect of salinity and hot sun on older pulaka plants.

Plate 3. *Effect of salinity and hot sun on larger pulaka pits (approx. 3 ha) Niutao.*

Plate 4. Effect of shade on pulaka growth.

Plate 5. Effect of shade on pulaka growth in the background. an abandoned area in the foreground.

Plate 6. Good agricultural practise such as mulching is important for normal growth of pulaka plants.

Plate 7. Good agricultural practise such as composting is important for normal growth and production in pulaka plants.

Plate 8. Good maintenance of pulaka plants throughout the season contributes to high yield.

Plate 9. Good growth and development contribute to good corm size in a shorter period.

Plate 10. It is highly recommend to provide shade over the pulaka plants during the dry season especially in larger pulaka pits present in Nanumanga and Niutao.

6 HEALTH SURVEY AND ASSESSMENT

A survey using the household questionnaire and a review of the District Nurse's records were undertaken for each island. The following observations have been made in response to these data sets.

At a time of water scarcity and restrictions, the risk of water-borne and water-related conditions is high. In order to reduce these risks, we make the following recommendations, which are based on accepted risk reduction measures.

- Ensure that all households that access the community water supply source transport and store water in clean buckets closed tightly with lids to avoid contamination.

- Ensure that all drinking water is boiled regardless of its source even if a source is considered safe, e.g. rain water from tanks.

- Work continually to raise awareness about the importance of regular hand washing with soap before eating, food preparation and handling, and after using the toilet.

Providing appropriate and simple toilet facilities helps ensure that human waste is disposed of safely. Composting toilets are currently being trialled in Funafuti, under the integrated water resources management (IWRM) demonstration project. Some headway is being made in getting people to accept this toilet system as a viable alternative.

- It is recommended that composting toilets be considered for outer islands because of the real benefits that can be obtained, including significant conservation of potable water, provision of compost for agriculture, and the reduced potential of contamination from septic and soak away systems. However, significant education is required to demonstrate the benefits and viability of composting toilets.

6.1 Health Monitoring

The nurses in the health centres currently work under trying conditions, including limited supply of medicines and medical equipment. However, they compensate for this with their dedication and commitment to serve the people they live with – in most cases those on their own home island. A simple disease surveillance system with only a few syndromic definitions will ensure that potential outbreaks are picked up early and remedial action can be taken. Strict case definition is critical, and appropriate and practical training is recommended for disease surveillance, reporting and data analysis. A consistent and reliable method of transferring or communicating reports from the islands to the national level in Funafuti is required. Internet is available on each island and this service is expected to improve. The Internet and computers obviously have the potential to enable significant advances in communication and education for island communities and should be supported to improve communications and access to information and knowledge. Alternatively, VHF/UHF radio (which is currently used by the meteorological services for daily communications) and similar media can facilitate communication and function as a back up to the Internet for health services.

6.2 Health Assessment Conclusion

A high proportion of the atoll population practices regular hand washing with soap, stores drinking water in covered containers, and regularly boils water for drinking. However, a significant proportion of households do not have proper toilet facilities for human waste disposal and this increases the risk for the spread of water- and food-borne infections.

There were no reported cases of malnutrition in children under five years old and no outbreaks of diseases, either in the health facilities or in the communities visited. This finding was confirmed by reviewing health records at the local centre.

Although all the health facilities keep good records and do regular passive reporting to the national government, this surveillance and reporting system needs to be further strengthened during times of national crisis or public health emergencies.

7 WATER RESOURCES ASSESSMENT

We assessed the available fresh water resources for each island, including rainwater, desalination and groundwater resources. We also estimated the volume of water in all tanks at the time of our visit to each island, through an assessment of rainwater collection efficiency and soundings of all rainwater storage tanks. During the 15 days of survey we completed a total of 1,860 soundings.

In addition, an initial assessment for the suitable location of a desalination plant was undertaken on each island visited with the *kaupule* in preparation for any future deployment as part of an emergency response.

Recommendations for each island with regard to the assessment of the water resources, possible options for potable and non-potable supplies and their improved distribution, and management practises for rationing of communal water supplies were provided to the *kaupule* or the island secretary prior to departure.

It should be noted that this assessment was a rapid assessment and should not be considered exhaustive, particularly with regard to assessment of groundwater resources. The groundwater assessment component concentrated on finding potential groundwater sources that could be easily accessed by the communities and on improving the supplies of groundwater from existing infrastructure.

7.1 Rainwater

The rainwater harvest assessment, which covered more than 80% of all households on the islands visited, provides an assessment of the percentage of roof capture, the general condition of the gutters and downpipes, and the risk to the quality of the water being captured. In general there are a large number of buildings with inefficient rainwater harvesting systems, which could be significantly improved with simple and regular maintenance.

It is unclear why this improvement or maintenance does not regularly occur. During the course of the assessment it was observed that people in some households believe it is not their responsibility to maintain their gutters; or there are insufficient materials, knowledge or concern; or the general construction of the house is inadequate to allow for the construction of a strong and resilient guttering system suitable under tropical downpours. As Tuvalu is blessed with reliable rains most years, an inefficient rainwater collection system probably does not severely limit people's access to water under normal conditions.

A number of aid development projects have supported rainwater harvesting with additional storage either with or without guttering. An efficient guttering and downpipe system leading to the storage tank appears to be the weakest link in rainwater harvesting systems, and improving their efficiency should be considered as important as providing increased storage.

Households on all islands assessed would benefit from improved guttering and down pipes or maintenance of guttering undertaken by the householder. Consideration should be given to implementing an education programme emphasising the fact that responsibility for rainwater harvesting, especially maintaining efficient guttering and downpipes, ultimately rests with the householder. A reward or cash incentive scheme could be set up to provide householders with an incentive to maintain efficient guttering and downpipes to all suitable tanks. Such a system would encourage behaviour change to improve the efficiency of guttering, based on a schedule of rebates according to set criteria, and there is also the potential to enforce fines for continued breaches of basic maintenance requirements.

Table 5 identifies the volume of rainwater available on each of the islands, including community potable water supplies. Communal sources include storage tanks held by schools, church and *maneapas*. They specifically exclude storage tanks at hospitals and agricultural facilities, where rainwater storages are located but not available for general community use.

Table 5. Total available rainwater by island and communal supply storage reserves.

Island	Date and number of soundings	Volume of available rainwater TOTAL (m^3)	% of available rainwater against total rainwater storage	Volume of rainwater in communal storage (m^3)	No. of days supply at ration of 15 L/p/d from communal supplies
Nukufetau	21–23 Oct (167)	723	34%	164	19
Vaitupu (1100 population estimate)	21–23 Oct (485)	1,706	24%	317	19*
(Motufoua school) (485 students + teachers)				(248)	(33)
Nui	27–28 Oct (261)	504	25%	67	7

Nanumanga	29–31 Oct	2,164	60%	505	50

*assumes 1100 population for village of Vaitupu and 485 population for school students + teachers.
Note: Rain fell on the day we left Nui (Friday 28 Oct.) and rain fell on the islands we visited subsequently, on days prior to or during our visits.

Table 6 provides a summary analysis of the storage and guttering coverage with respect to both community supplies and households for each island. As in Table 5, communal sources include storage tanks held by schools, the church and *maneapas*, and exclude storage tanks at hospitals and agricultural facilities, such as fisheries. Households exclude businesses. The analysis refers to houses and tanks that are connected, unless otherwise specified.

Table 6. Summary of household and communal water storage tanks.

Island	Total Storage m^3	No. of tanks	Max. size of tank (L)	Avg. size tank (L)	Median Size Tank (L)	Avg. Gutter Coverage %	No. of Houses with Connected Tank	No. of Houses without Connected Tank	No. of Houses Surveyed	Avg no. of Tanks Per House
Nukufetau communal	523	8	149,477	58,062	54,215	64%	NA	NA	NA	NA
Nukufetau household	1,600	154	67,838	10,391	7,646	67%	100	45	145	1.5
Vaitupu communal	1,006	11	209,633	91,487	82,597	100%	NA	NA	NA	NA
Vaitupu household	4,458	391	61,703	11,402	7,811	85%	253	41	294	1.5
Motufoua school	1,216	13	349,011	93,521	81,760	65%	NA	NA	NA	NA
Nui communal	251	3	108,900	65,707	76,508	84%	NA	NA	NA	NA
Nui household	1,468	208	68,976	7,056	5,753	83%	146	35	181	1.4
Nanumanga communal	900	16	252,280	52,939	25,688	92%	NA	NA	NA	NA
Nanumanga household	2,402	323	52,192	7,940	7,120	93%	149	25	174	2.2
Nanumea communal	967	15	251,658	55,093	9,506	100%	NA	NA	NA	NA
Nanumea household	2,203	256	91,872	8,604	7,069	75%	156	24	180	1.6
Niutao communal	1,752	20	358,577	87,608	46,182	92%	NA	NA	NA	NA
Niutao household	2,208	217	103,946	10,173	7,069	75%	172	24	196	1.3

Rationing by the *kaupule* was in force for communal water storage tanks on every island visited (Tables 7 and 8). It should be noted that even whilst there was stored water available at the household, many households would make use of the ration provided by the *kaupule*.

Table 7. Summary of the current rationing enforced on communal tanks by the kaupule.

Island	Rules for rationing of water
Nukufetau	5 buckets (15L) per household per day
Vaitupu	3 buckets (15 L) per household 4 times a week (Mon. Wed., Fri. Sat.)
Nui	1–2 buckets (15 L) per household per day
Nanumanga	1 bucket (15 L) per 2 people twice a week (Mon. and Fri.) If they require more than 2 additional buckets per household
Nanumea	1 bucket (15 L) per 4 people 4 times a week (Mon. Wed., Fri., Sat.)
Niutao	0.5 bucket/person/day + extra 0.5 bucket for elderly and babies

Table 8. Ration rules for each island in force at time of visit.

Island	Ration per household per day L (where applicable)	Ration per person per day L (where applicable)	Ration of communal water available per day for an example family of 5 (L)	Ration per person per day (L) (based on a family of 5)
Nukufetau	60		60	12
Vaitupu	25		25	5
Nui	15–30		30	6
Nanumanga	8.6	2.14	19.3	3.9
Nanumea		2.14	10.7	2.14
Niutao		7.5 Additional 7.5 L for elderly or babies	37.5	7.5

7.2 Island Summaries of Water Assessment

7.2.1 Nukufetau

Rainwater. General improvements to guttering are recommended; a short heavy rain shower was experienced at the time of the survey and many of the gutters were inadequate or poorly maintained so much of the water was not being collected. Guttering on the school building also was very poor.

Greater management of the communal cisterns and tanks by the *kaupule* is recommended. Whilst the *kaupule* is active in managing the abstraction of the water under rationing, regular weekly soundings of the communal storage tanks would allow the water supplies to be quickly assessed, allowing management of available communal water. The information could then be reported back to Funafuti on a regular basis as a total volume and as a percentage of the total storage capacity to allow ongoing assessment and could be used as a trigger for additional action by both the *kaupule* and the central government.

Groundwater. Nukufetau currently supplements its rainwater harvesting with well water for most non-potable needs. Whilst there are wells located in the village, Savavae, the majority of these appear to be quite brackish (3.6 mS/cm). Fale – the adjoining islet where the majority of the currently functioning *pulaka* pits are located, has three wells, two with fresher groundwater of 0.8 mS/cm or less. Water from one well constructed circa 2004 is carted to the islet of Savave at low tide.

Previously a solar powered floating pump was used to provide water from this well to header tanks. The water was then distributed via a pipeline across the channel to standpipes in Savavae. Prior to the solar pump, a windmill was used. This system is currently in disrepair and if a similar approach could be resurrected then significant security of water supply for non-potable and possibly potable supplies could be maintained.

In discussion with the island secretary it was agreed that this would be an appropriate project in the medium term. To reinstate this water supply from the existing well would require some additional design, to ensure appropriate sized header tanks and pipe dimensions with regard to the proposed number of tap stands and for pumping rates of <0.5 L/s. A preference was indicated by the *kaupule* at the time for a diesel pump as islanders were more familiar with maintenance and operation of this kind of pump.

Immediate improvements could be made when funding is available. Currently, the water is abstracted from the well at Fale via a fire fighting style pump. It is then pumped to a tank and transported across the channel at low tide to provide water to the village. The pump requires replacement and an additional two or three 10 m3 tanks would improve the water supply, allowing villagers to pump from the well on Fale at high tide to one or two header tanks using the existing tank stand on Fale. They could feed the water using gravity to a tank on the flat bed trailer attached to the tractor, which at low tide could then take the water to a central distribution point on Savave and use an additional tank to distribute it to the community.

Desalination. Due to the amount of rainwater currently in storage and the availability of low-salinity groundwater on Fale which can be used for non-potable purposes and potentially for drinking, a desalination plant to provide drinking water for the community is not considered necessary and is not recommended.

However, if this situation were to change and it becomes necessary to deploy a desalination plant for short period of time, the most appropriate site for locating a diesel operated plant of 8–10 KL capacity would be on the existing wharf, which is 11 m x 13 m and is level concrete. This would still allow access to the plant and the wharf for general movement through the channel. Good access to fresh seawater from the channel would be available and disposal of brine could be accommodated. Where housing of the plant is required this would need to be erected.

7.2.2 Vaitupu

Rainwater. As with all islands, we recommend general improvements to guttering. Similarly, we recommend greater management of the communal cisterns and tanks by the *kaupule*. Weekly soundings of the eight communal storage tanks would allow quick assessment of water supplies and improved management of communal water. The data could then be reported back to Funafuti on a regular basis as a total volume and as a percentage of the total storage capacity to allow ongoing assessment. The information on available communal water could be used as a trigger for additional action by both the *kaupule* and the central government.

Motufoua – the secondary boarding school requires improvement to its rainwater harvesting. Last year people at the school had to bring rainwater from the village for drinking as a number of existing cisterns are leaking. Through an AusAID-funded education project a total of 40 tanks of 10KL capacity each (totaling 400,000 L) will be provided to the school, and it is hoped that guttering will also be included. The team observed that 24 of these tanks have already arrived and are waiting to be deployed. The school will require assistance for this. It is believed that those who look after the school grounds and maintenance, including running the desalination plant, are expected to design and install the most efficient tank farm for collecting rainwater. We recommend that AusAID consider extending its support to provide a senior plumber/technician with practical expertise in the design and installation of such a tank farm to assist with the installation of the tanks and the guttering for the proposed tank farm. This would allow the school to complete this work as quickly as possible in preparation for any prolonged extension of the drought in 2012. If all materials were on site in advance of this person's arrival, it is expected that an experienced plumber/technician could undertake this work with the school maintenance staff within the two-week period between scheduled ship visits.

Groundwater. Groundwater resources on Vaitupu are mostly brackish and in the future it is expected that they will be suitable for the same purposes for which they are used now: for non-potable uses or as feed water for the desalination plant(s). There is one well located on the east coast, more than 3 km from the village, with an existing solar pump that was under repair at time of visit but is now operational. This well provides water with a salinity of 2–3 mS/cm that the community can either access directly themselves by travelling to the well or can be delivered to people's houses at a cost of $5/load of 500 L. Bathing as well as water collection can be undertaken at the site, although improvements are required to make the resource accessible to all.

Recommended short-term improvements to the existing well site would include providing spare parts for the pump (two sets of brushes for the motor) and a cut-off float switch on the tank. Additionally, we recommend improving access to and maintenance of to the site with regard to drainage around designated collection points and showering/bathing facilities for both male and females. The facilities currently do not allow people to bathe with privacy.

In the medium to long term, consideration should be given to constructing a header tank and pipe to bring the water closer to the community. Providing greater access to this water source will promote the use of groundwater as an alternate to relying on rainwater for non-potable needs such as washing, bathing and toilet flushing, and reduce the costs of accessing this water, making it more available to the community.

Motufoua uses groundwater both for non-potable purposes and as feed water for the desalination unit. This groundwater, which is used for washing, bathing and toilet flushing, is quite brackish (4.5 – 13 mS/cm) and is abstracted from unlined wells which have silt in the bottom. According to the maintenance staff, the pumps used to abstract the groundwater often only seem to last a year; it is thought that silt and possibly the brackish nature of the water is damaging the pumps and reducing their life.

It is recommended that these wells be cased or an alternate groundwater abstraction point be constructed, such as an infiltration gallery near the playing field. An immediate low-cost response to reduce the silt uptake is to line the wells with geofabrics weighted down by reef stones.

In the short term it is recommended that two replacement pressure pumps be provided to allow people at the school to access this water for their daily non-potable needs. This is a matter of high priority.

Desalination. Two desalination plants with 8 KL capacity were located on Vaitupu, one at Motufoua school and one in the village. Both plants have been moved to Funafuti to respond to the water shortage in the capital and on Nukulaelae. Only one of these units is operational; the other is not functioning and is not considered repairable.

We recommend that a similar sized desalination unit be provided to Motofoua school as a permanent replacement. This would provide the school and the village with increased water security. We also recommend that improvements be made to the well that provides water to the desalination unit. The well is unlined and there is potential for silt to enter the pump inlet, reducing the overall efficiency of the desalination plant. Lining the well with casing or using geofabrics in the well over the short term will minimise the potential for silt to enter the pump inlet.

The desalination plant is run only when it is needed. It is proposed that as in the past the school and the village share the responsibility for running and maintaining this unit depending on the destination of the water and its use. The school is the preferred location for the desalination plant. The feed water at the school is of a lower salinity (10 mS/cm) and the school provides better access and storage options for a desalination plant than the village, where the feed water is from the very brackish lagoon (42–44 mS/cm) and storage is very limited. The school expressed an interest in a solar powered desalination system to provide additional supply at reduced cost. The effectiveness of the plant would need to be investigated keeping in mind the school's needs and its capacity to operate the plant.

In conjunction with the management of the tank farm at the school, and with regular soundings of the village cisterns, a basic management plan could be designed in which low levels of water in the communal storage tanks trigger the operation of the desalination unit.

We recommend that operators be trained to properly maintain the unit so that it can safely be shut down for long periods.

7.2.3 Nui

Rainwater. As on the other islands, we recommend general improvements to guttering.

Similarly, we recommend strengthening management of the communal cisterns and tanks by the *kaupule*. Weekly soundings of the communal storage facilities would allow quicker assessment and better management of available communal water. The data could then be reported back to Funafuti on a regular basis as a total volume and as a percentage of the total storage capacity to allow ongoing assessment and as a trigger for additional action by both the *kaupule* and central government.

Current storage of community supplies seems inadequate. Although there is a total capacity of 331 KL, a 189 KL cistern at the school leaks and cannot be used; therefore, the effective total storage is only 142 KL. When all functioning communal tanks are full there is sufficient storage for only 15 days for the current population at 15 L/p/day.

We recommend that additional communal storage be added at the church, *maneapa* and school. Through the education programme, AusAID has delivered a number of 10 KL tanks; however, it is not known how many tanks will be provided in total and whether guttering will also be provided. We recommend that priority be given to deploying and installing these tanks and their guttering at the school.

The cistern next to the *maneapa* was believed to be inoperable and had either just been cleaned or was to be cleaned before being used for communal storage. Further advice from the *kaupule* on the status of this cistern is required.

Groundwater. The use of groundwater through communal and private wells is high on Nui. The island had the largest number of private and communal wells visited (16). The groundwater is relatively accessible, with an average well depth of less than 2.5 m. Salinity of the wells varied considerably, with some being quite brackish whilst others appeared to be potentially suitable for use as a potable water source. The salinity varied from 1.4 mS/cm to 22 mS/cm, with an average of 6 mS/cm, which suggests that in most cases the well water is suitable for non-potable use only. These results differ from those from the previous surveys of Putten (1988) and Webb (2007), which indicated that the groundwater was fresher at similar locations. The previous surveys were undertaken in wet or normal conditions.

As the current survey took place during an extended dry period, its results are useful to identify which wells maintain lower salinity water and help identify sites that could be used for future development to provide water during dry times. The well at the hospital proved to provide the freshest water found on the island, in contrast to the expectation in the community that Vaimaile would be the best well.

As a result, and in consultation with the Island Planner Papua Ulisese and Island Secretary Tokanikai Selu, a site for a potential infiltration gallery was located on *kaupule* land to provide improved access for the community to low-salinity water. If the water proves to be of sufficient quality for potable use, this gallery will provide additional drinking water security for the island.

It was agreed that design schematics would be provided to the *kaupule* and the Planner by the SPC team with the intention of beginning construction in early 2012. It is recommended that the *kaupule* develop a proposal for construction of the gallery over the coming months. The proposal should be developed in preparation for April 2012, because if the current La Nina conditions continue, potential impacts of reduced rainfall and threats to water security may be felt at that time. It is proposed that the construction include means for distributing the water to the community via standpoints or a centralised distribution point.

Desalination. Currently there is no desalination on island. The high quality and accessibility of groundwater and the community's current reliance on it for non-potable water (83% of non-potable water used on the island comes from groundwater sources) suggest that the island is unlikely to need a desalination plant as long as improved groundwater access can be developed.

Whilst no specific site was identified with the *kaupule* for locating a desalination plant, the lagoon found on the western shores of the islet would provide protected access to feed water from the lagoon or alternatively a purpose built well could be constructed to access lower salinity and better quality feed water.

7.2.4 Nanumanga

Rainwater. As on the other islands, we recommend general improvements to guttering.

Similarly, we recommend greater management of the communal cisterns and tanks by the *kaupule*. Weekly soundings of the communal storage tanks would allow quicker assessment and better management of available communal water. The data could then be reported back to Funafuti on a regular basis as a total volume and as a percentage of the total storage capacity to allow ongoing assessment and as a trigger for additional action by both the *kaupule* and central government.

Groundwater. Groundwater on Nanumanga is very brackish (46 mS/cm) and is considered to be of very limited use for non-potable purposes. It is probably suitable for toilet flushing only. While there may be issues regarding of impact on digestion in septic tanks when this water is used over a long period, there should be no impact when it is used in soak away pits; hence it would be preferable to use groundwater for this purpose.

Currently the only identified use of groundwater was as the raw feed water for the existing desalination plant.

Desalination. Nanumanga has an 8 KL desalination plant constructed in 2000. The existing plant was not operational when the assessment team arrived, but the team's mechanic, in conjunction with the *kaupule* mechanic, got it operating. The plant is old and in need of refurbishment and cannot be expected to run efficiently without some ongoing maintenance. A list of required parts has been identified, and obtaining them is considered to be of high priority to return the plant to fully operational status. This list, along with photos of the parts, is provided in Annexes 4 and 5.

Training on the operation and maintenance of the plant could be provided by PWD staff in Funafuti once they are themselves trained (using a 'train the trainer' approach).

Currently the desalination feed water comes from a well. The water level in the well drops during low tide to the point where raw feed water cannot be pumped to the desalination plant, limiting the production of desalinised water. The well needs to be deepened and lined. A temporary solution for lining it would be use of geofabric with reef stones to weigh the fabric down; this would provide a filter against silt and allow access to the groundwater at low tide.

We also observed that the current distribution of desalinised water is inadequate, and that significant improvement could be made to ensure the quality of the water and access to it. Currently, two 10 KL storage tanks on loan from another project sit directly on the ground, putting the water at risk of being contaminated either directly or when people access it during distribution.

We recommend that two 10 KL storage tanks be supplied for distribution and be raised above ground on a tank stand. Additionally, we recommend that tap trees be provided as used in Funafuti to assist with distribution of the water. Also, the overhanging trees should be cleared to reduce the risk of contamination and gravel should be placed around the collection point to improve drainage and minimise the ponding of water. We recommend that PWD staff be deployed to undertake this work when parts and staff are available to provide hands-on training. This work would require an electrician, a plumber, a mechanic, and a works supervisor for a period of a week.

The *kaupule* expressed concern about the storage of desalinised water in rainwater storage tanks as a longer-term measure for building up water reserves during dry periods. It is important to note that a well maintained and operated desalination unit will provide high quality potable water that can be mixed with rainwater in a communal cistern without any loss of water quality.

The current health message regarding the need to boiling all drinking water should remain in place.

7.2.5 Nanumea

Rainwater. As on the other islands, general improvements to guttering are recommended. The team discussed these with the Island Secretary at the briefing prior to departure.

Similarly, we recommend greater management of the communal cisterns and tanks by the *kaupule*. The possibility of weekly soundings of the communal storage tanks was discussed with the Island Secretary. This would allow quicker assessment and better management of available communal water. The data could then be reported back to Funafuti on a regular basis as a total volume and as a percentage of the total storage capacity to allow ongoing assessment and as a trigger for additional action by both the *kaupule* and central government.

During the surveys one respondent reported that within families water is considered precious, and that whilst he was happy to share well water and food, people only share drinking water when they have enough to share, as their families come first. This respondent went onto say that this was the worst drought that he could remember in his 56 years.

Groundwater. Only a small number of wells could be sampled, and these samples indicate – along with anecdotal evidence provided by the Island Planner, Puatei – that groundwater is brackish. The southern side of the village has no wells as it is believed that the groundwater there is very brackish and unsuitable for most purposes. Average salinity across the 9 wells sampled was 8.8–9.3 mS/cm, suggesting that groundwater potential is limited.

Further to the south of the village, a large diameter well (2 m) has a solar powered floating pump that pumps water to a tank stand with two 6500 L tanks. The pump was not operating at the time of our visit. The water is used for bathing and for pigs. The salinity of the water from the well was tested at 12.8 mS/cm; hence the well water has limited application for most household purposes except toilet flushing. Given the distance of the well from the village and the high salinity if its water, we do not recommend piping water from this well to the village.

The best quality well water in the village was from the private Lilo well, which was measured at an EC salinity reading of 4.3 mS/cm. Whilst this is above the limit for potable water, the water is currently being used by the community for non-potable needs, including washing, toilet flushing and personal bathing. There is a real need to provide additional access close to the community for its non-potable needs to minimise the draw on its potable supplies and the hardship caused by limited access and having to travel more than 2 km to access brackish water. In conjunction with the *kaupule* and the Island Planner, an inspection of the area around the Lilo well was undertaken to see if a non-potable water supply could be provided to assist the community to meet its water needs. Adjoining the Lilo site is a strip of *kaupule* land that is currently not being used. It was proposed that a small infiltration gallery could be constructed in this area with little disruption. This gallery could help meet the community's non-potable water needs. Whilst there is risk of contamination from nearby households and septic/soak away pits, the team felt that these pits could be replaced under the septic tank construction project as a matter of priority to reduce the risk whilst the community is educated regarding the importance of using the water for toilet and washing purposes only.

A backhoe would be needed, and ideally a couple of test pits would be constructed to assess the water quality prior to determining the exact location of the gallery. Schematics for the design of the gallery and potential distribution will be provided to the Planner for use in discussions with the *kaupule* to come to a decision. The depth of the excavation is expected to be 4–5 m.

It is recommended that this concept be presented to the *kaupule* by the Planner with support from SPC and, if appropriate, a proposal be developed to allow funding to be sought before the middle of 2012.

Desalination. A potential site for a desalination plant was discussed with the Island Secretary and the Island Planner. The proposed site is at the main wharf on the lagoon side of the island, near the main cooperative shop or *fusi*. There is sufficient space at the existing site to add a desalination plant without causing too much disruption to wharf activities, and the site allows good access by the community for distribution as well as access to feed water from the lagoon.

If alternative sources of non-potable water cannot be found, it may be necessary to deploy a desalination plant for a short period of time when communal water supplies drop below a certain storage percentage (for example 15% of total storage capacity).

If the deployment of mobile desalination plants is to take place for specified periods from a central location, e.g. Funafuti, then it will be necessary to have in place a generic policy specifying a trigger level.

It is recommended that this operational policy be developed in consultation with the Island Secretaries and Planners and the Office of Home Affairs as a matter of priority, so that once the need for a plant is identified, the necessary logistics are in place to assist with rapid deployment.

7.2.6 Niutao

Rainwater. As on the other islands, general improvements to guttering are recommended and were discussed with the Island Secretary at the briefing prior to departure. It should be noted that heavy rain was experienced by the island on the Tuesday and Wednesday nights prior to our arrival, and this influenced the storage of water in the tanks. Rationing of water was still being undertaken on a daily basis.

Niutao had a surveillance mechanism in place to assist with the distribution of the rationed water. The data, which was collected over a two week period, showed that 3000–5000 L per day were required for the current ration. The possibility of undertaking weekly soundings of the communal storage tanks was discussed with the Island Secretary. This would allow quick assessment of the available water supplies and better management of communal water. This information could then be reported back to Funafuti on a regular basis as a total volume and as a percentage of the total storage capacity to allow ongoing assessment and as a trigger for additional action by both the *kaupule* and central government.

The Secretary and President were also advised of the recommendation to make available one or two government buckets with rope in good condition and treat them with bleach each day prior to use in order to reduce the risk that the communal water supply will be contaminated through people accessing it via containers that are not clean.

Groundwater. The team undertook an assessment of the groundwater potential from existing wells and ponds found within and close to the village. The groundwater potential within the village is limited because it is quite brackish (average salinity of 25 mS/cm).

Fresher groundwater can be found away from the village and closer to the *pulaka* pits. Three communal wells were known to exist and all three were visited. Water from these wells had an average salinity of 3.6–5.8 mS/cm and was used by the community for non-potable needs, including agriculture and pigs. The Malakasi well, which provides water used for washing by the village, had the freshest well water tested (1.4 mS/cm). Its potential for use as potable water source was considered to be marginal as it is located between *pulaka* pits and it is expected that it would draw in organics if any large abstraction of water was undertaken. The Secretary and Island President were advised that it would not be appropriate to develop the Malakasi well to supply water to the village given its distance from the village (estimated at 3 kms) and the high potential for organics to be found in its water. This would affect the aesthetic appearance (colour and smell) of the water and likely reduce its acceptance by the community.

In discussions, the Island Secretary, the *kaupule* President and the assessment team agreed that if there was a need to source additional groundwater supplies for potable water, it would be appropriate for a more thorough groundwater assessment to be undertaken. There is some indication from the rapid assessment that there is potential, albeit limited, for potable groundwater supplies in Niutao.

It was also agreed that it may be appropriate to increase the potential access to water within the village with the construction of a large diameter well. Whilst the water is expected to be quite brackish (estimated salinity of 25mS/cm), the water would be useful and easily accessible by the community to meet non-potable water needs such as flushing toilets. It could also be used as raw feed water for desalination, if required. The well could be constructed on *kaupule* land at a location that was determined with the Secretary and President of the *kaupule* (S 6.0° 6.412' E 177.0° 19.958' – behind the agricultural station and garden of the island). The well is expected to be up to 5 m deep, with final depth determined during construction, to maintain 1 m of depth below the lowest water level encountered at low tide.

Desalination. Consideration to the siting of a desalination plant was undertaken for the island. Access to the island is via a narrow channel through the reef platform. The presence of a relatively wide sandy beach and limited protection for securing a raw seawater pipe to the channel precludes the use of the beach for siting any desalination plant. It is recommended that a well be developed within *kaupule* land, as indicated above, to provide the raw feed water for a desalination plant if one becomes required.

A backhoe or excavator would be needed to undertake this work and it is recommended that 1 m concrete culverts be used in the construction process as the casing to provide some longevity to the infrastructure. A suitable cover should be fitted for security and to prevent rubbish and vegetation from falling into the well, and the well should be back filled around the annulus with coarse sand. A conceptual design is to be provided to the Secretary and planner by SPC.

The New Zealand Aid funded Ship to Shore Project which is looking at improving sea access to the outer islands has employed consultants who are using large excavators in their work to widen and deepen channels from the outer reef to the beach. Advantage could be made of the equipment, in particular the excavator and operator, that will be (is) on the island for this project to assist in digging of the well. The concrete culvert rings should be shipped as a matter of priority to Niutao to allow the well to be cased, ideally during the construction whilst the excavator is on site.

8 CONCLUSIONS AND RECOMMENDATIONS

The main focus of the rapid drought assessment on the outer islands was to identify immediate needs regarding water access and availability, and to identify food security and health issues that require immediate responses. The assessment also identified recommendations for longer-term options to reduce impacts on the people of Tuvalu during extended dry periods and droughts in the future.

It is worth noting that the nature of the rapid assessment precluded the use of focus groups, which could have been useful in canvassing views of particular groups based on gender or age to identify a particular group that may have been more vulnerable. However, the team was mindful to look for any indications suggesting that a particular group was disadvantaged as a result of the dry conditions. Apart from the infirm, some of the elderly with physical restrictions and the very poor, no other group was identified as being particularly disadvantaged with respect to other groups.

The current focus of the reporting limits the detail of analysis that could be undertaken in the available time. Future analysis or revision of the data sets could be useful to further develop our understanding of the impacts of drought conditions on atoll environments.

Each of the islands visited has been impacted by the extended dry period to some extent. Rationing of communal water supplies was in place on each island and groundwater was being relied upon to meet many of the communities' water needs. Health issues across the communities were not considered to be any more significant than under normal conditions. Stress on crops was observed on all islands; however, the current situation did not suggest an impending crisis with regard to food security. It should be noted that whilst stress on all crops was apparent, *pulaka* pits were considered to be the most impacted.

Whilst impacts from the extended dry period were observed and identified on each island, it should be noted that no island community observed was considered to be in a crisis requiring an immediate emergency response (i.e. insufficient potable water for drinking, crop failures resulting in insufficient food for the communities, or evidence of communicable disease outbreaks with concern for public health).

In general, the islands of Vaitupu, Nui, Nanumanga, Nanumea and Nuitao were strongly affected by the extended dry period; the team observed impacts to access and availability of sufficient quantities of fresh water supplies on those islands. Nukufetau in central Tuvalu was less severely affected by the extended dry period; impacts were less strong and groundwater access on Lafaga motu provided resilience for the community's non-potable water supply and *pulaka* pits. The assessment revealed that every island had sufficient potable water supplies and that adaptation strategies were employed at both the household and community scale to ensure that needs were being met, demonstrating resilience on the islands in the face of extended dry periods.

During the household assessments, respondents were asked about whether they felt that the current dry period constituted a drought. The response was varied, reflecting the degree to which respondents had personally had to adapt; however, the majority indicated that they were experiencing drought-like conditions. Respondents were asked to compare the current situation to other droughts they had experienced. It is worth noting that some respondents felt that whilst the current drought was not as memorable as other droughts, such as the 1999 drought, in terms of the shortage of water, it was the length of the current episode that made it most difficult and memorable. This observation is supported by the rainfall records, which indicate the lowest rainfall ever recorded over any 12 month period.

The following recommendations have been identified by both priority and period of response.

Short term = 3 months, medium term = 3–12 months, long term = 1–5 years.

Action	**Response Period**	**Priority**
Agriculture		
• Increase use of traditional **bunding** and **composting** of *pulaka*.	Ongoing	High
• Erect structures over the plants to provide **shade** (using coconut leaves) for larger *pulaka* pits, especially in Nanumanga and Niutao.	Ongoing	High
• Use alternative/**artificial** pits.	Medium to long term	Medium
• Consider introducing **salt tolerant crop varieties** of *pulaka*, breadfruit, banana, sweet potato, taro and rice.	Medium to long term	Medium
• Undertake **research** into other methods of cultivating *pulaka.*	Medium to long term	Medium
• Conduct a **follow-up survey** of *pulaka* pits to determine recovery period of pits.	Medium term	High

Health		
• To reduce the risk of any disease outbreak occurring as a result of water shortages and dry weather conditions, the ***kaupule*** **(local island councils)** need to play a more active role in ensuring that **positive health measures** are **enforced and practised**.	Ongoing	High
• **Disease surveillance** must be **strengthened** to ensure better case definition and reporting to national level, and this must be supported and facilitated by **better means of communication**.	Medium term	High
• A significant number of families on most of the islands need **improved toilet facilities** designed to suit the water-depleted dry conditions, e.g. composting toilets.	Medium to long-term	High
Water		
1. **Urgent maintenance of guttering** to ensure efficient rainwater harvesting collection must be undertaken at the household level, and for *kaupule* buildings, across all islands.	Short term	High
2. Issues of **guttering ownership, incentives and awareness** should be a key consideration of programmes seeking to improve outer island water security.	Medium to long term	Medium
3. **Regular soundings** (weekly during rationing, quarterly at other times) should be undertaken by the *kaupule* to assist in the management of their key communal storage facilities, and act as a trigger for rationing or seeking external support from sources such as central government. This is relevant for all islands.	Short to medium term	High
4. **Monitoring, reporting and response** should be part of a practical and agreed drought management plan.	Medium to long term	Medium to high
5. **Access to groundwater for communal non-potable water supplies** should be improved. This would lessen the difficulties we observed associated with reduced access to water, including the time and cost of accessing water for non-potable needs.	Medium to long term	Medium to high
6. **Building codes** should be developed and enforced to ensure adequate building standards for rainwater capture and storage.	Medium to long term	Medium to high
7. **Linkages** between the existing **National Water and Sanitation Management Committee and the National Drought Management Committee should be improved** to ensure that recommendations are included and coordinated with the longer-term water and sanitation strategies.	Short to medium term	High
8. A **drought management plan/strategy should be developed** at the island scale. The plan/strategy would be expected to allow for improved and pragmatic management of the communal water storage facilities, provide advice on expected rainfall conditions, and promote coordinated and centralised reporting of storage	Medium to long term	High

and rainfall conditions, and include a simple standardised alert mechanism which provides users and communities alike with advice on appropriate water conservation responses.		
Nukufetau		
• Improve access to groundwater from Fale. **Replace the fire fighting pump and 3 x 10 KL tanks.**	Short term	High
Vaitupu		
• **Deploy a desalination plant to Motufoua** to provide water security for school and village.	Short to medium term	High
• **Line all wells in Motofoua with geofabrics** to reduce sediment impacts on pumps.	Short term	High
• **Replace 2 pressure pumps** to allow continued access to well water for non-potable needs	Short term	High
• Investigate **construction of infiltration gallery at playing field** to be used for abstraction of all groundwater needs for Motufoua. This would improve water quality in exchange for a one-time infrastructure set up cost.	Medium to long term	Medium
• **Deploy remaining tanks and guttering under the AusAID programme to Motofoua** accompanied with suitable **experienced plumber/technician** to design and implement tank farm at Motofoua.	Short to medium term	High
• Obtain two sets of **replacement brushes** for existing pump motor at main communal well for village water supplies and install a float switch if possible. Improve conditions for water collection and bathing at communal well site.	Short term	High
• **Construct a pipeline** to bring **well water closer to the village** with distribution at strategic locations.	Medium - long term	Medium
Nui		
• **Deploy remaining tanks and guttering under AusAID programme to school** with suitably **experienced plumber/technician** to connect system and address the lack of communal storage *(high priority)*.	Short term	High
• Increase storage for communal supplies. **Assess *maneapa* cistern and possible replacement** with plastic tanks as short-term measure.	Short term	Medium
• Construct **infiltration gallery for improved access to groundwater** for village. Potential site located with Kaupule.	Medium term	High
Nanumanga		
• **Refurbish or replace the existing 8 KL desalination plant,** which is now 11 years old.	Short term	High
• **Deepen the existing well** used to provide feed water for	Short term	Medium

the plant, improve the site for future distribution of desalinised water where required, including 2 x 10 KL water tanks. Parts required are identified in main report.		
Nanumea		
• Improve access to groundwater in the village for non-potable needs. **Construct an infiltration gallery and header tank on *kaupule* land**. Design concepts to be provided to island planner and secretary, SPC, and *kaupule* to develop proposal with Government of Tuvalu.	Medium term	Medium
Niutao		
• **Construction of a large diameter well on *kaupule* land** to provide feed water for a desalination plant and an additional communal source within the village for non-potable water at other times. Consider utilising excavation on current Ship to Shore project to construct the well. Concrete culvert rings should be shipped as a matter of priority to Niutao.	Short term	Medium
• Details on **well design to be provided to *kaupule*** by SPC, to assist with construction and project design.	Short term	High
• The team recommends the **use of village buckets with ropes** attached to access water rather than allowing individuals to access water with their own buckets. The team also recommends that **ropes and buckets be bleached** after each day.	Short term	High
• The team recommends **weekly soundings** to provide information to the *kaupule* and centralised government on daily takes from tanks and available communal supplies.	Short term	High

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ANNEXES

Annex 1	List of Assessment Team Members
Annex 2	Household Questionnaires inclusive of Health, Water and Agriculture
Annex 3	Radio Flash Messages
Annex 4	Desalination machine and parts in Tuvalu
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Annex 7	Rainfall Data - Tuvalu Sept 2011
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Annex 1: List of Assessment Team Members

Names	Department
1. Mr Elekana Tofinga	PWD Tuvalu.
2. Mr Samuelu Numela	PWD Tuvalu.
3. Mr Jupelii Kamoni	PWD Tuvalu.
4. Mr Pakaia Paepae	PWD Tuvalu.
5. Mr Talesi Temaia	PWD Tuvalu.
6. Mr Tefoto Fegai	PWD Tuvalu.
7. Mr Rurunteiti Kaiarake	Environment – NAPA Tuvalu.
8. Mr Peloti Lotolua	Environment – NAPA Tuvalu.
9. Mr Polikapo Teaukai	Tuvalu Red Cross
10. Ms Paua Vitoli	Tuvalu Red Cross
11. Mr Iosia Siose	Agriculture Tuvalu.
12. Mr Fereti Atumurirava	Agriculture SPC Suva, Fiji.
13. Dr Josaia Samuela	Health SPC Suva, Fiji.
14. Mr Peter Sinclair	Water SPC Suva, Fiji.

Annex 2. Household Questionnaires inclusive of Health, Water and Agriculture

OCTOBER 2011

HOUSEHOLD SURVEY QUESTIONNAIRE

QUESTIONNAIRE

IDENTIFICATION	
ISLAND NAME & CODE NO..	
HOUSEHOLD NAME & CODE NO..	
GENDER OF HEAD OF HOUSEHOLD MALE (1) OR FEMALE (2).	

INTERVIEWER VISITS				FINAL VISIT
	1	2	3	DAY / MONTH / YEAR
DATE				2 0 1 1
TIME				
RESULT CODES: 1 COMPLETED 2 NOT AT HOME 3 PARTLY COMPLETED				

OBSERVATIONS

THANK THE RESPONDENT FOR PARTICIPATING IN THE SURVEY. COMPLETE QUESTIONS 801 – 802 AS APPROPRIATE. BE SURE TO REVIEW THE QUESTIONNIARE FOR COMPLETENESS BEFORE LEAVING THE HOUSEHOLD.

	DEGREE OF COOPERATION.	POOR .... FAIR .... GOOD .... VERY GOOD	1 2 3 4
	INTERVIEWER'S COMMENTS: ____________________ ____________________ ____________________		
	DATA ENTRY COMMENTS: ____________________ ____________________ ____________________		

SECTION 1: GENERAL HEALTH, WATER AND FOOD SECURITY

My name is …………………….. I work with Tuvalu National Disaster Management Team, We are conducting a survey about the potential effect of the drought in Tuvalu to know its impact and we would like you to participate in the survey because it is something very important to the Government and development partners.

Interviewer signature ____________________

Respondent agrees ☐ **Respondent didn't agree** ☐ → End

No.	*QUESTIONS*	CODES	6.,3#2#
101	What is your position or status in this H/Hold?	SPECIFY…………………………………………………	e.g. dad
102	How many people live here?	NO. OF ADULTS & CHILDREN OVER 5 YRS 1 NO. OF CHILDREN UNDER-5 YRS…....... 2 NO. OF ADULTS OVER 65 YRS 3	
103	Do you have your own water source?	YES ………………………………………… 1 NO …………………………………………… 2	
104	What are your first and second sources of drinking water?	RAINWATER……………………………… 1 WELL..… ………...…………………… 2 DESALINATION PLANT………………… 3 BOTTLED WATER………………………… 4 OTHER (SPECIFY)…..…………………… 5	
105	What is your main water source for other purposes? A. Washing clothes B. Shower/bathing C. Cooking D. Gardening E. Livestock	RAINWATER……………………………… 1 WELL..… ………...…………………… 2 DESALINATION PLANT………………… 3 SEA WATER……………………………… 4 OTHER (SPECIFY)…..…………………… 5	
106	Since April this year - how often have you experienced shortage of water from your main source?	WEEKLY…………………………………… 1 FORTNIGHTLY…...…..……………………… 2 MONTHLY……..…………..……………… 3 EVERY 2 MONTHS………….……………… 4 RARELY…………………………………… 5 NEVER…………………………………… 6	
107	Which of these items do you use at home or are connected to your main water source?	WASHING MACHINE…...………………… 1 FLUSH TOILET…………………………… 2 SHOWER/BATH…………………….…... 3 OUTSIDE TAP……………..…………… 4 KITCHEN SINK………............................... 5 OTHER…………..………………………. 6	
108	How do you store your drinking water in your home?	TANKS / CISTERNS……………………… 1 POTS/BUCKETS WITH LIDS…………… 2 POTS/BUCKETS WITHOUT LIDS……… 3 BOTTLES…………………………………… 4 OTHER (SPECIFY)…..…………………… 5	

109	Do you boil your drinking water?	**ALWAYS……………………………………….. 1** **SOMETIMES……………………………... 2** **NEVER ……………………………………… 3**	
110	What type of toilet do you have/use?	**FLUSH...……………………….…………... 1** **WATER SEAL (POUR) …………………….. 2** **COMPOST…………………………………... 3** **PIT…………………………………………… 4** **BUSH/BEACH……………………………… 5** **OTHER(SPECIFY)………………………… 6**	
111	If you use water seal or flush toilet, what type of water do you use?	**RAINWATER...……………….…………….. 1** **WELL WATER.…………………………….. 2** **SEA WATER………………………………... 3** **OTHER(SPECIFY)………………………… 4**	
	COPING STRATEGIES		
112	Number of days out of the past two weeks when you have used the following coping strategies Relied on less preferred and less expensive foods	***(Write numbers 0-14 to answer # days)*** **NUMBER OF DAYS ……………………… 1-14** **NEVER……………………………………….. 0**	
113	Borrowed food from others	**NUMBER OF DAYS ……………………… 1-14** **NEVER……………………………………….. 0**	
114	Purchased food on credit	**NUMBER OF DAYS ……………………… 1-14** **NEVER…………………...………………….. 0**	
115	Harvested immature crops	**NUMBER OF DAYS ……………………… 1-14** **NEVER…………………...………………….. 0**	
116	Sent children or family members to eat with neighbours	**NUMBER OF DAYS ……………………… 1-14** **NEVER…………………...………………….. 0**	
117	Rationed or Limited portion size at mealtimes	**NUMBER OF DAYS ……………………… 1-14** **NEVER……………………………………….. 0**	
118	Restricted consumption by adults in order for small children to eat	**NUMBER OF DAYS ……………………… 1-14** **NEVER…………………...………………….. 0**	
119	Reduced number of meals eaten in a day	**NUMBER OF DAYS ……………………… 1-14** **NEVER……………………………………….. 0**	
	CHILDREN BELOW 5 YRS AGE		
120	Assess every under 5 year old child in this HH both for boys and girls. 1.Age of the child? 2.Height of the child? 3.Weight of the child? 4.MUAC of the child? 5. Child's sex / gender? 6. Does this child appear anaemic or with other micronutrient deficiency? 7. Does this child have any obvious eye or skin infections – conjunctivitis,	**AGE.. ……………………………………… ☐☐** **HEIGHT……………………………………. ☐☐** **WEIGHT ……………………………………. ☐☐** **MUAC ……………………………………… ☐☐** **BOY…………………….................... 1** **GIRL……………………………………… 2** **YES …………………………………….. 1** **NO ………………………………………. 2** **YES …………………………………….. 1** **NO ………………………………………. 2**	

	scabies, sores or tinea? 8. Did this child have any diarrhoea (3 or more loose motions in a day)anytime in the past 4 weeks? 9. Did this child have any cough and fever anytime in the past 4 weeks? 10. Did this child pass any worms in the past 4 weeks?	 **YES …………………………………….. 1** **NO ……………………………………… 2** **YES …………………………………….. 1** **NO ……………………………………… 2** **YES …………………………………….. 1** **NO ……………………………………… 2**	
	BREASTFEEDING BELOW 6 MONTHS OF AGE		
121	Number of infants 0-6 months old who were breastfed in last 24 hrs 1. Do you have any children aged 0-6 months, if so, how many? 2. How many of these children were breastfed in the last 24 hours (last night and yesterday?	 **NO. OF CHILDREN………………………** ☐☐ **NO. OF CHILDREN ………………………** ☐☐	
	INCOME SOURCE		
122	What is the main source of income for your family?	**SUBSISTENCE……………………………….. 1** **REMITTANCE……………………………….. 2** **SALARY……………………………………... 3** **PENSION………………………………………. 4**	
	STRATEGIC HEALTH MESSAGES		
123	Do you listen to the radio Tuvalu regularly, sometimes or never listen?	**REGULARLY……………………………….. 1** **SOMETIMES……………………………….. 2** **NEVER LISTEN……………………………. 3**	
124	Have you heard of the "***Operation Water Safety***" campaign?	**YES ………………………………………… 1** **NO ………………………………………… 2**	
125	What was it about? **PROBE:** What else?	**HOW TO KEEP WATER CLEAN…………… 1** **NEED TO BOIL ALL DRINKING WATER…. 2** **NEED TO HAVE SOAP AVAILABLE………. 3** **IMPORTANCE OF HANDWASHING………… 4** **OTHER ______________________________ 5** **(SPECIFY)**	
	PERSONAL HYGIENE		
126	Do you have any soap for washing or bathing today?	**YES ……………………………………. 1** **NO ……………………………………… 2**	
127	Regarding hand washing, did you use soap today or yesterday in washing your hands?	**YES…………………………………… 1** **NO……………………………………… 2**	
128	Do you wash your hands with water and soap?	**YES**	**NO**

	1.Before eating		1	2
	2.After using the bathroom/toilet		1	2
	3.Before preparing/handling food		1	2
	4.Before feeding young children		1	2

SECTION 2: AGRICULTURE

My name is …………………….. I work with Tuvalu Disaster Management Committee, We are conducting a survey about the status of agriculture here on this island to know the impact of the drought and we would like you to participate in the survey because it is something very important to the Government.

Interviewer signature ____________________

Respondent agrees ☐ **Respondent didn't agree** ☐ → End

No.	*QUESTIONS*	CODES	6.,3#72#
201	What is your status or position in this family or Household?	**HEAD AND HUSBAND………………..… 1** **HEAD AND WIFE.…………………..…. 2** **WIFE……………………………….…. 3** **SON / DAUGHTER……………………... 4** **UNCLE / AUNTY…………………….…. 5** **OTHER (SPECIFY)………………….…. 6**	☐☐
202	What fruit trees do you have? 1.Coconut ☐ 2.Breadfruit ☐ 3.Banana ☐ 4.Pawpaw ☐	**YES NO** **............................ 1 2** **………………….. 1 2** **………………….. 1 2** **………………….. 1 2**	
203	Do you have a home garden? If yes, what are the crops grown? 1.Cucumber 2. Pumpkin 3. Beans 4. Cabbages 5. Tomatoes 6. Sweet potatoes (*kumala*) 7. Others	**………………………………………… 1** **………………..……………………… 2** **………………………………………… 3** **………..……………………………… 4** **……………………..…...…………….. 5** **…………………………………………. 6** **…………………………………………. 7**	

204	Do you have a *pulaka* pit?	**YES** …………………………….…………….. **1** **NO** ……………………………………………. **2**	
205	How many times does your family eat *pulaka*?	**ONCE A WEEK...…………………….……….. 1** **ONCE A MONTH……..…………………….. 2** **OCCASSIONALLY……………………..….. 3** **NEVER……..………………………………. 4**	
206	Has the drought affected your consumption of *pulaka* now? If **YES**, please give reasons: ________________________________ ________________________________	**YES…………….……………………….………... 1** **NO…………………..…………………….. 2**	
207	Has the drought affected your consumption of toddy (*kaleve*) now? If **YES**, please give reasons: ________________________________ ________________________________	**YES…………….……………………….………... 1** **NO…………………..…………………….. 2**	
210	Do you have any livestock? 1. Pigs 2. Chicken 3. Ducks 4.Others (Specify)	**YES** .... **1** …………………………………………… **1** …………………………………………… **1** …………………………………………… **1**	**NO** **2** **2** **2** **2**

Annex 3. Radio Flash Messages

Summary of Radio Flash

		Nukufetau 22/10/11	Vaitupu 24/10/11	Nanumanga 31/10/11	Nui 29/10/2011	Nanumea 3/11/2011	Niutao 5/11/2011
Agriculture	Proportion of pulaka pits stressed	5%	10%	88%	5%	2%	60%
	Proportion of Bananas under severe stress	2%	5%	5%	5%	10%	5%
	Proportion of Breadfruit trees under severe stress	0%	0%	0%	0%	15%	0%
	Proportion of Coconut under severe stress	0%	0%	0%	0%	10%	0%
	Pens with visibly identified stressed pigs	0%	0%	0%	0%	0%	0%
	Respondents with reduced capacity to fish						
Health	Diarrhoeal diseases in < 5yr children (no. cases per 100 population) May - October 2011 No.	0.4	2	0	0	3	3
	Scabies/Sores in < 5 yr children (no. cases per 100 population) May - October 2011	0.2	2	0	0	3	2
	Cough and fever in <5 yr children seen(no. cases per 100 population) May - October 2011	5.0	7	0	0	16	8
	Conjunctivitis in under-5 yr old children seen (no. cases per 100 population) May - October 2011	0.0	1	0	0	2	0
	Malnutrition in under-5 yr old children seen (no. cases per 100 population) May - October 2011	0.0	0	0	0	0	0
	Households that regularly boil drinking water	86%	86%	64%	88%	69%	82%
	Respondents that regularly wash hands with soap	99%	98%	72%	95%	96%	95%
	Volume of rain water storage m3 at time of survey	723	1706	2164	504	1337	1770
Water	Observed use of potable water from ground water	1%	3%	0%	0%	0%	0%
	Observed use of portable water from desalination	0%	0%	3%	0%	0%	0%
	Observed use of potable water from bottled	0%	0%	0%	0%	0%	0%
	Observed use of potable water from other sources	0%	0%	0%	0%	0%	0%
	Observed use of non potable water from ground water	40%	59%	0%	83%	60%	68%
	Observed use of non potable water from desalination	0%	0%	0%	0%	0%	0%
	Observed use of non potable water from seawater	0%	0%	0%	0%	0%	0%
	Observed use of non potable water from other sources	0%	0%	0%	0%	0%	0%

Annex 4 Desalination machine and parts in Nanumanga

Desalination plant in Nanumanga

Plate 11 Generator used for desalination plant - requires new cooling system

Plate 12 Desalination plant in Nanumanga- requiring refurbishment

Plate 13 Flow meter for brine and product water required

Plate 14 Pressure meter for sand filter required

Plate 15 Pressure meters for sand filter required

Plate 16 Main switch in control box

Plate 17 Water quality meter

Plate 18 Fittings for installing pressure gauges for product water and brine water

Plate 19 Pressure gauges for product water and brine water

Annex 5: Parts of the Desalination Plant in Nanumanga required for refurbishment.

Table 9. Parts of the Desalination Plant required for refurbishment.

Parts required for refurbishment of Nanumanga desalination	Prioritisation
Cooling system for generator (PWD mechanic Sam to provide details)	High
2 x 3 fan belts A70=	High
Total time counter for the control panel (ie hours of operation)	Medium
2 pressure gauges and fittings	High
2 pressure gauges for the sand filter	High
1 salinity water quality meter	High
2 flow meters (brine and product water)	High
temperature meter	Medium
chemicals necessary for ensuring the plant can be turned off for an extended period of time without damage	High

There are currently approximately 10 filters in stock for the filters in place after the sand filter. The RO membrane itself was replaced in 2010, its status is unknown.

Annex 6. Findings of the Rapid Assessment of Ground water.

Rapid Assessment Groundwater Survey for Nanumea

Identification						Well Characteristics												Water Quality	
		Well Location		Well Owner	Well Owner	Age of Well	Well water use							Abstraction type	Well			Salinity	Salinity
Date	Time	S	E	NAME	P: private C: communal Unk: Unkown	YEARS OR DATE	Washing laundry, kitchen	personal hygiene, eg showering	Toilet	Cooking	Drinking	Gardening/ outdoor use	Other (e.g. income generated)	A: Pump B: Bucket C: Other	Well Diameter m	Depth to Water m	Total Depth m	Top mS/cm	Bottom mS/cm
2/11/2011	9:50	05^{0} 40.208'	176^{0} 06.676'	HAUMA	C	1942	Y	Y	Y	N	N	PIGS		C	0.95	3.18	3.18	12.3	12.85
2/11/2011	10:07	05^{0} 40.239'	176^{0} 06.684'	SUIA	P	2007	Y	Y	N	N	N	PIGS		C	0.59	2.37	2.37	9.5	9.69
2/11/2011	10:20	05^{0} 40.285'	176^{0} 06.723'	TAUMEHEKE	P	1991	Y	Y	Y	N	N	PIGS		B	0.58	3.11	3.11	7.79	
2/11/2011	10:28	05^{0} 40.400'	176^{0} 06.853'	LILO	P	2002	Y	Y	Y	N	N	PIGS AND CHICKENS		B	0.57	3.51	3.51	4.05	4.38
2/11/2011	10:37	05^{0} 40.400'	176^{0} 06.880'	PATEA	P	1990	Y	Y	Y	N	N	PIGS AND CHICKENS		B	0.58	2.96	2.96	13.52	14.45
2/11/2011	10:51	05^{0} 40.985'	176^{0} 06.600'	TIOTI	C	1992	N	Y	N	N	N	PIGS AND CHICKENS		P (SOLAR)	2.02	2.7	2.7	12.5	12.85
2/11/2011	11:03	05^{0} 40.436'	176^{0} 06.443'	SENTENALI	P	1992	Y	N	N	N	N	PIGS		B	0.56	2.45	2.45	7.43	7.75
2/11/2011	11:12	05^{0} 40.649'	176^{0} 06.565'	SUALIKI	P	2001	Y	Y	Y	N	N	PIGS		B	1.34 X 2.9	2.27	2.27	6.63	6.75
2/11/2011	11:18	05^{0} 40.977'	176^{0} 06.547'	NUISALA	P	2005	N	N	N	N	N	PIGS		C	0.57	2.14	2.14	5.75	5.83

Rapid Assessment Groundwater Survey

Nui

Identification							Well Characteristics												Water Quality
		Well Location		Well Owner	Well Owner	Age of Well	Well water use							Abstraction type	Well			Salinity	Salinity
Date	Time	S	E	NAME	P: private C: communal Unk: Unkown	YEARS OR DATE	Washing laundry, kitchen	personal hygiene, eg showering	Toilet	Cooking	Drinking	Gardening/ outdoor use	Other (e.g. income generated)	A: Pump B: Bucket C: Other	Well Diameter m	Depth to Water m	Total Depth m	Top mS/cm	Bottom mS/cm
27/10/2011	14:27	07^0 14.685'	177^0 08.981'	TANRAKE	C	>40	Y	Y	Y	N	N	Y	N	C	1.9	1.75	2.48	8.9	10.45
27/10/2011	14:42	07^0 14.654'	177^0 08.996'	FANANI	P	>20	Y	Y	Y	N	N	N	N	C	1	1.44	1.8	7.24	7.44
27/10/2011	14:49	07^0 14.604'	177^0 09.014'	KIRITIMATI KAIARAKE	P	10	Y	Y	Y	N	N	N	N	C	2.4	1.5	1.7	4.6	4.6
27/10/2011	15:00	07^0 14.577'	177^0 09.018'	ALOPANOI	P	>10	Y	Y	Y	N	N	Y	N	C				1.778	1.803
27/10/2011	15:04	07^0 14.585'	177^0 09.032'	ALOPANOI	P	1	Y	Y	Y	Y	N	Y	N	C	0.9	1.25	1.65	4.56	4.6
27/10/2011	15:10	07^0 14.559'	177^0 09.012'	OPELOGE	P	>40	Y	Y	Y	Y	N	Y	N	C	1	1	1.5	2.35	2.36
27/10/2011	15:21	07^0 14.450'	177^0 08.985'	SAKALIA	P	<5	Y	Y	Y	N	N	N	N	C	0.53	1.2	1.7	3.99	4.83
27/10/2011	15:27	07^0 14.472'	177^0 08.957'	MAKITI	P	30	Y	Y	Y	N	N	N	N	C	1.55	1.95	2.3	2.09	2.182
27/10/2011	15:38	07^0 14.440'	177^0 08.967'	ISUMU	P	>30	Y	Y	Y	N	N	N	N	C	1	1.7	2.25	3.4	3.54
27/10/2011	15:45	07^0 14.442'	177^0 08.913'	HOSPITAL	C	>30	Y	Y	Y	Y	Y	N	N	C	1.2	2.1	2.65	0.986	1.446
27/10/2011	15:52	07^0 14.462'	177^0 08.854'	MAELI	P	>20	Y	Y	Y	N	N	N	N	C	0.9	2.6	3.2	5.1	5.25
27/10/2011	16:03	07^0 14.584'	177^0 08.893'	TEAPAGA (STANLEY	P	>40	Y	Y	Y	N	N	N	N	C	0.6	2.2	2.95	1.855	6.13
27/10/2011	16:19	07^0 14.634'	177^0 08.892'	VAIMALIE	C	>40	Y	Y	Y	N	N	N	N	C	1.2	2.7	3.6	3.06	4.66
28/10/2011	8:42	07^0 14.736'	177^0 08.951'	IAFETA	P	UNDER CONSTRUCTION										1.9		12.8	
28/10/2011	8:50	07^0 14.807'	177^0 09.032'	TEUTI	P	10	N	Y	Y	N	N	Y			1.8	1.4	1.85	10.92	11.05
28/10/2011	8:55	07^0 14.844'	177^0 09.051'	LIGO	P		N	Y	Y	N	N	Y			1.4	1.4	2	18.1	22.3
28/10/2011	18:00	07^0 14.634'	177^0 08.892'	VAIMALIE	C	>40	Y	Y	Y	N	N	N	N	C	1.2	2.6	3.65	2.89	6.64

Rapid Assessment Groundwater Survey

Niutao

Identification							Well Characteristics												Water Quality	
		Well Location		Well Owner	Well Owner	Age of Well	Well water use							Abstraction type	Well				Salinity	Salinity
Date	Time	S	E	NAME	P: private C: communal Unk: Unkown	YEARS OR DATE	Washing laundry, kitchen	personal hygiene, eg showering	Toilet	Cooking	Drinking	Gardening/ outdoor use	Other (e.g. income generated)	A: Pump B: Bucket C: Other	Well Diameter m	Depth to Water m	Total Depth m	Top mS/cm	Bottom mS/cm
3/11/2011	14:56	06^0 06.754'	177^0 20.657'	VAI-O-IOANE	C	>30	Y	Y	Y	N	N	PIGS			1.8	3.12	3.5	3.94	4.46
3/11/2011	15:04	06^0 06.730'	177^0 20.698'	SALEKA	C	>50	Y	Y	Y	N	N	PIGS		P (SOLAR)	4.8	2.9	3.3	5.57	11.6
3/11/2011	15:22	06^0 06.493'	177^0 21.046'	MATAKASI	C		Y	Y	Y	N	N	PIGS		B	3.3	0.65	1.05	1.406	1.4
3/11/2011	15:37	06^0 06.422'	177^0 20.890'	POND TALIPOIAKA	C		Y	Y	Y	N	N							28.5	28
3/11/2011	15:47	06^0 06.523'	177^0 20.500'	SINKHOLE	C	>20	N	N	N	N	N		FISH AND TURTLE					35.2	35.2
3/11/2011	15:58			LAGOON						N	N							39	
3/11/2011	16:12			CHANNEL						N	N							54.7	
4/11/2011	10:28	06^0 06.380'	177^0 20.048'	KOITI	P	1999	Y	Y	Y	N	N	PIGS		B	1	3.15	3.15		
4/11/2011	10:33	06^0 06.339'	177^0 19.999'	KUI	P	2000	Y	Y	Y	N	N	PIGS		B	1		3.9		
4/11/2011	10:38			FIALIKI	P	1998	Y	N	N	N	N	PIGS		B	0.8	4	4		26
4/11/2011	10:46	06^0 06.298'	177^0 19.983'	LOSA	P	1998	Y	Y	N	N	N	PIGS		B	0.6	3.7	3.72		13.9
4/11/2011	10:53	06^0 06.269'	177^0 20.009'	TELANGI	P	1997	Y	Y	N	N	N	PIGS		B	0.6		3.95		
4/11/2011	11:00	06^0 06.373'	177^0 19.980'	INAKI	P	1993	Y	Y	Y	N	N	PIGS		B	0.7	3.1	3.15		28
4/11/2011	11:08	06^0 06.413'	177^0 20.052'	ULUIBA	P	1981	Y	Y	Y	N	N	PIGS		B	0.5	3	3.05		25.5
4/11/2011	11:14	06^0 06.606'	177^0 20.219'	MISI	P	1990	Y	Y	Y	N	N	CHICKEN AND PIGS		B	0.6	2.5	2.55		32.7
4/11/2011	11:22	06^0 06.373'	177^0 20.124'	SIMEONA	P	1990	Y	Y	Y	N	N	CHICKEN AND PIGS		B	0.7		4.1		

Rapid Assessment Groundwater Survey

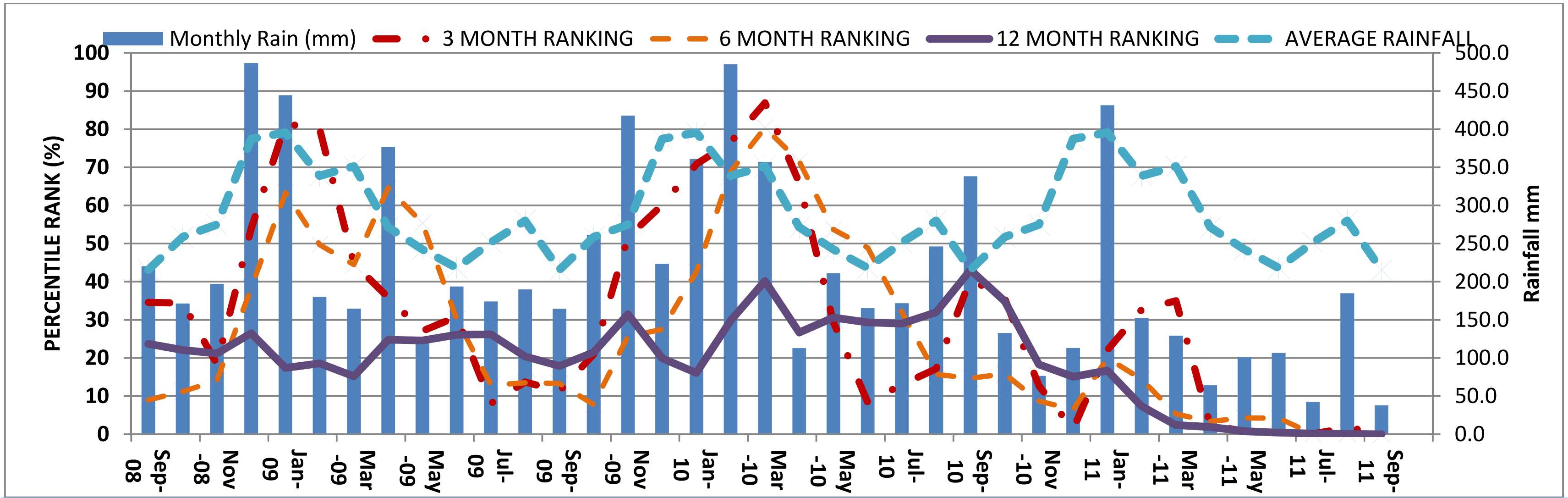
Vaitupu

Identification							***Well Characteristics***											**Water Quality**	
		Well Location		*Well Owner*	*Well Owner*	*Age of Well*	*Well water use*							*Abstraction type*	*Well*			Salinity	Salinity
Date	*Time*	*S*	*E*	*NAME*	*P: private C: communal Unk: Unkown*	*YEARS OR DATE*	*Washing laundry , kitchen*	*personal hygiene, eg showering*	*Toilet*	*Cooking*	*Drinking*	*Gardening / outdoor use*	*Other (e.g. income generated)*	*A: Pump B: Bucket C: Other*	*Well Diameter m*	Depth to Water m	Total Depth m	Top mS/cm	Bottom mS/cm
25/10/2011	*9:57*	*07^0 28.194'*	*178^0 40.056'*		*C*	*>10*	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*N*	*C*	*2.3*	3.4	4	6.67	7.23
25/10/2011	*10:14*	*07^0 27.843'*	*178^0 40.100'*		*C*	*>10*	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*N*	*NA*	*1.5*	3.03	3.14	1.728	1.728
25/10/2011	*10:31*	*07^0 27.893'*	*178^0 40.081'*		*C*	*NA*	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*N*	*NA*	*1.7*	2.9	3.1	0.999	1.031
25/10/2011	*10:43*	*07^0 27.695'*	*178^0 40.107'*	*MAIN WELL FOR VILLAGE*	*C*	*6*	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*N*	*A solar*	*1.28*	1.17	1.64	2.295	3.13
25/10/2011	*11:04*	*07^0 27.782'*	*178^0 40.248'*		*C*	*NA*	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*N*	*C*	*1.7*	3.1	3.4	1.24	1.324
25/10/2011	*11:20*	*07^0 28.303'*	*178^0 40.687'*		*P*	*34*	*Y*	*Y*	*Y*	*N*	*N*	*Y*	*N*	*C*	*1.73*	1.73	2.05	11.69	12.26
25/10/2011	*11:35*	*07^0 28.509'*	*178^0 40.638'*		*P*	*NA*	*N*	*N*	*N*	*N*	*N*	*N*	*N*		*0.75*	2.2	2.25	11.37	11.35
25/10/2011	*12:00*	*07^0 29.017'*	*178^0 40.524'*		*P*	*0.2*	*Y*	*Y*	*Y*	*N*	*N*	*N*	*N*	*C*	*2.75*		2.9	4.47	2.51
25/10/2011	*12:32*	*07^0 29.263'*	*178^0 40.797'*	*WELL INSIDE VILLAGE*	*C*	*>40*	*Y*	*Y*	*Y*	*N*	*N*	*N*	*N*	*C*	*1.1*	2.1	2.37	8.54	9.64
26/10/2011	*9:16*			*DESAL PLANT FOR Vaitupu feed water well next to lagoon*		*5*										1.34	2.24	41.8	43.4
26/10/2011	*10:22*			*MOTOFOUA - OLD WELL IN FRONT OF ADMIN*								*Y*						4.54	7.5
26/10/2011				*MOTO FOUA - GIRLS DORMIOTRY*			*Y*	*Y*	*Y*	*N*	*N*	*N*				3.65	4		12
26/10/2011	*10:57*			*MOTOFOUA - BOYS DORMIOTRY*			*Y*	*Y*	*Y*	*N*	*N*	*N*				3.15	3.45		13.4
26/10/2011	*11:08*			*MOTOFOUA - DESAL FEED WATER*												2.95	3.35	9.8	9.85

Rapid Assessment Groundwater Survey
Nukufetau

Identification							Well Characteristics											Water Quality	
		Well Location		Well Owner	Well Owner	Age of Well	Well water use							Abstraction type	Well			Salinity	Salinity
Date	Time	S	E	NAME	P: private C: communal Unk: Unkown	YEARS OR DATE	Washing laundry, kitchen	personal hygiene, eg showering	Toilet	Cooking	Drinking	Gardening/ outdoor use	Other (e.g. income generated)	A: Pump B: Bucket C: Other	Well Diameter m	Depth to Water m	Total Depth m	Top mS/cm	Bottom mS/cm
22/10/2011		08^{0} 03.694'	177^{0} 22.712'	MOTO LALO	C	>40		NA						NA		1.2	1.6	6.38	6.48
23/10/2011		08^{0} 01.712'	177^{0} 18.868'	SAVAVAE - LAULENESE	P	3	Y	Y	Y	N	N			B	0.565	1.8	2.09	2.016	3.26
23/10/2011		08^{0} 01.720'	178^{0} 18.861'	SAVAVAE - KAUPULE	C	6	N	N	N	N	N	Y		B		1.77	2.31	6.1	2.31
23/10/2011		08^{0} 01.705'	178^{0} 18.856'	SAVAVAE - NEW WELL	P	3	N	Y	Y	N	N	Y		B	1	1.47	2.03	2	2.2
23/10/2011		08^{0} 01.700'	178^{0} 18.860'	SAVAVAE - TUSIUPU	P	0.1	Y	Y	Y	N	N	Y		B					
23/10/2011	16:04	08^{0} 01.693'	178^{0} 18.829'	SAVAVAE - FATIGA	P	>30	Y	Y	Y	N	N	Y		B	2.8	2.04	2.64	6.06	6.57
23/10/2011		08^{0} 01.657'	178^{0} 18.589'	FALE- 1	C	>30	N	Y	Y	N	N	Y		B	2.105	1.52	2.05	8.43	8.45
23/10/2011	16:35	08^{0} 01.723'	178^{0} 18.548'	FALE- 2	C	7	N	Y	Y	N	N	Y		B	2.3	1.88	2.28	0.468	0.447
23/10/2011		08^{0} 01.752'	178^{0} 18.568'	FALE - WINDMILL SITE	C		N	Y	Y	N	N	Y		A	1.1	2.47	3.02	0.764	0.812
22/10/2011		08^{0} 03.694'	177^{0} 22.712'	MOTO LALO	C	>40		NA						NA		1.2	1.6	6.38	6.48

Annex 7. Rainfall Data - Tuvalu Sept 2011
Funafuti



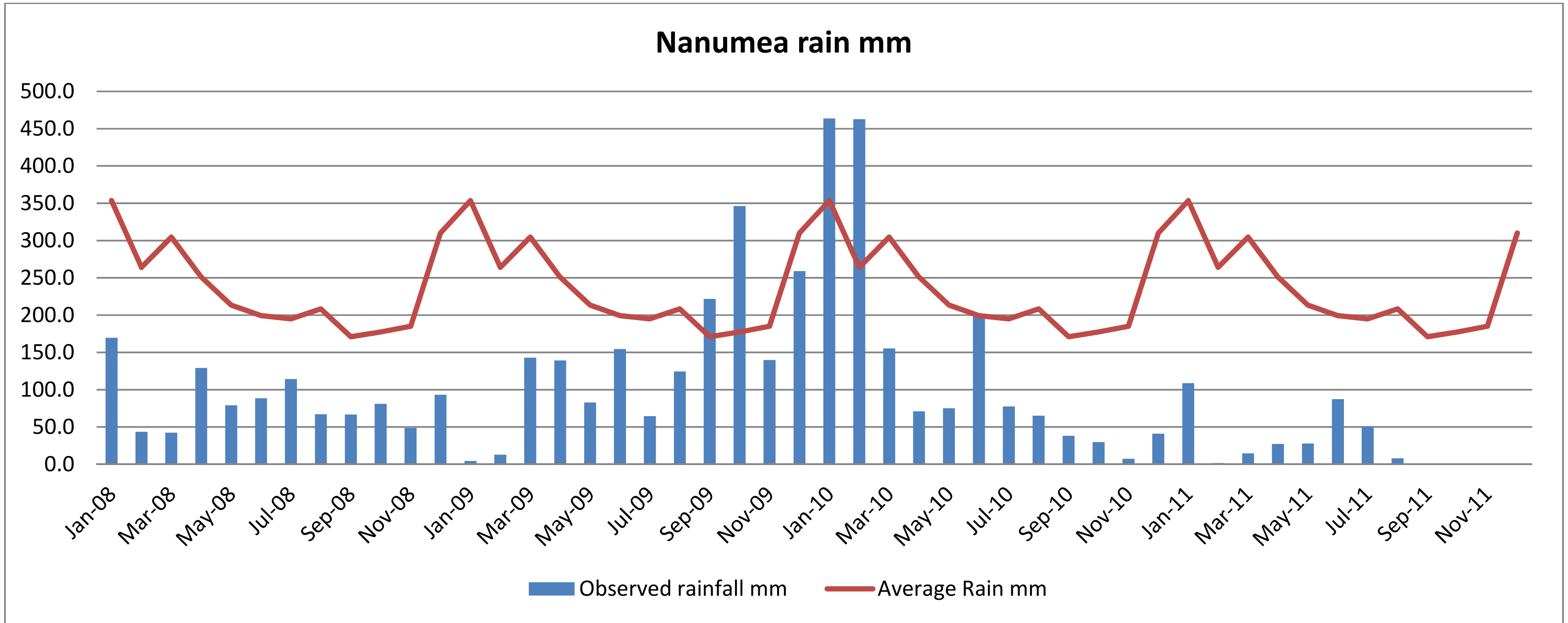
Monthly data (mm) for Funafuti, Tuvalu

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1954	427.0	426.2	299.7	386.1	269.2	137.9	218.9	182.6	235.7	179.1	351.3	353.1	**3,466.8**
1955	1141.5	315.5	596.9	472.2	210.6	67.6	206.8	154.4	178.1	264.4	274.8	299.5	**4,182.3**
1956	217.7	380.7	198.1	92.7	158.8	265.2	262.1	98.8	147.6	244.1	344.9	548.6	**2,959.3**
1957	447.5	1138.9	324.1	378.7	194.1	245.4	219.7	426.0	260.1	301.5	357.6	382.5	**4,676.1**
1958	374.4	210.1	317.8	155.4	343.7	318.8	503.9	549.9	339.9	556.3	524.5	460.8	**4,655.5**
1959	518.2	327.2	241.3	221.0	208.8	374.1	476.8	283.7	275.6	343.7	316.2	442.2	**4,028.8**
1960	425.5	511.6	277.1	322.1	213.4	152.1	210.1	669.5	247.1	260.1	244.1	355.9	**3,888.6**
1961	646.9	378.7	978.2	206.2	266.4	165.1	189.7	96.8	203.7	197.1	303.3	262.9	**3,895.0**
1962	202.2	285.5	148.1	128.3	53.8	137.9	186.4	211.3	115.1	233.9	135.4	636.5	**2,474.4**
1963	276.6	161.5	244.1	258.8	144.8	303.3	248.9	319.3	244.9	59.7	214.6	201.4	**2,677.9**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1964	242.3	552.2	221.7	148.3	253.2	267.5	194.1	99.6	164.1	137.2	516.9	430.3	**3,227.4**
1965	430.5	148.1	347.7	244.6	204.2	181.9	175.5	389.6	522.7	299.0	376.7	404.6	**3,725.1**
1966	411.2	177.5	293.1	211.6	103.4	393.4	254.3	558.8	265.2	381.3	308.4	533.1	**3,891.3**
1967	501.7	382.5	238.8	539.2	378.5	293.6	330.7	226.3	167.1	170.2	661.4	330.7	**4,220.7**
1968	167.4	283.5	223.3	297.2	287.0	179.6	182.1	208.5	298.7	225.3	523.2	252.2	**3,128.0**
1969	276.1	750.1	283.7	302.5	615.2	240.8	272.0	338.1	175.8	144.0	75.4	246.1	**3,719.8**
1970	513.6	418.6	378.7	415.3	196.9	260.6	396.5	401.3	268.2	483.1	262.6	836.9	**4,832.3**
1971	255.0	235.0	226.0	70.0	46.0	132.0	141.0	192.0	193.0	231.0	162.0	343.0	**2,226.0**
1972	433.0	186.0	163.0	121.0	239.0	103.0	167.0	181.0	239.0	262.7	203.0	285.0	**2,582.7**
1973	517.0	426.0	317.0	242.0	233.0	348.0	168.0	195.0	66.0	401.0	457.0	619.0	**3,989.0**
1974	584.5	108.1	340.2	147.7	84.7	112.7	146.1	124.4	93.2	109.2	417.2	574.3	**2,842.3**
1975	521.2	163.2	165	323.1	281.2	94.2	106.8	340.1	162.6	163.2	167	370.5	**2,858.1**
1976	349.5	176.7	312.8	159.6	169.6	138.4	140.5	179.8	101.9	191.6	56.3	495.2	**2,471.9**
1977	283.6	283.4	580.8	353.2	458.7	415.6	293.5	376.1	73.8	242.4	277.4	151.8	**3,790.3**
1978	163.7	334.7	105.7	290.7	257.0	309.0	156.2	257.1	176.3	192.4	250.3	486.8	**2,979.9**
1979	330.5	93.4	323.3	211.7	237.9	132.4	319.6	134.1	162.2	400.1	298.4	438.9	**3,082.5**
1980	190.5	463.4	379.7	97.5	313.3	152.2	227.7	321.0	266.2	319.1	446.3	413.6	**3,590.5**
1981	205.3	673.3	364.6	534.7	151.1	99.7	564.3	128.5	324.9	205.1	211.9	391.9	**3,855.3**
1982	291.2	239.6	222.1	149.4	215.1	289.7	191.3	292.7	513.4	427.4	371.0	229.5	**3,432.4**
1983	656.1	374.3	515.8	109.2	364.2	169.0	252.5	351.9	244.9	202.4	318.6	435.1	**3,994.0**
1984	257.6	273.2	453.8	165.4	224.9	345.5	204.0	417.0	256.0	356.0	201.0	836.0	**3,990.4**
1985	466.0	182.0	574.0	159.0	307.0	97.0	297.0	175.0	136.0	189.0	89.0	220.0	**2,891.0**
1986	542.3	374.7	179.6	497.2	183.4	223.5	397.5	290.5	74.5	241.2	188.3	312.0	**3,504.7**
1987	399.1	487.2	359.5	237.5	509.4	162.3	430.8	206.1	447.9	288.1	147.3	496.8	**4,172.0**
1988	383.8	470.5	280.3	614.2	336.0	298.1	438.7	207.6	133.0	260.6	70.0	239.3	**3,732.1**
1989	428.7	264.4	282.9	232.1	248.0	107.4	145.0	214.6	215.2	143.1	312.0	342.8	**2,936.2**
1990	654.1	494.0	388.2	206.1	127.7	93.7	156.6	326.4	111.8	323.2	373.5	506.4	**3,761.7**
1991	311.6	479.1	435.2	334.0	261.2	298.2	240.2	432.1	225.1	196.4	199.3	476.4	**3,888.8**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1992	280.7	422.0	368.2	466.6	287.7	392.3	191.4	111.8	165.1	293.0	402.0	351.1	**3,731.9**
1993	207.6	330.6	460.4	501.2	535.5	133.4	548.4	125.3	290.8	423.9	186.2	272.0	**4,015.3**
1994	446.5	128.3	351.3	200.3	200.4	417.2	295.0	186.3	253.2	243.1	244.4	325.5	**3,291.5**
1995	564.6	158.9	343.9	447.0	222.5	293.0	222.6	192.7	278.0	468.1	199.2	532.0	**3,922.5**
1996	166.3	226.6	640.9	423.4	177.6	82.8	263.6	167.3	248.2	141.1	136.8	255.4	**2,930.0**
1997	263.6	474.6	1003.4	192.6	321.9	272.8	137.8	1143.0	226.9	379.3	141.0	583.8	**5,140.7**
1998	649.0	500.2	273.0	154.9	239.0	234.3	395.2	380.7	363.5	375.9	229.5	339.8	**4,135.0**
1999	311.6	259.5	313.5	314.5	155.6	221.2	72.2	116.4	93.2	55.1	187.3	308.6	**2,408.7**
2000	199.1	203.6	404.2	154.0	107.0	273.0	242.0	258.0	48.0	222.9	104.8	225.7	**2,442.3**
2001	314.8	257.9	177.4	243.4	157.0	216.3	205.6	176.0	181.6	206.7	249.7	314.8	**2,701.2**
2002	279.8	486.6	502.0	185.7	445.2	220.6	158.8	223.3	272.6	303.7	218.9	282.2	**3,579.4**
2003	480.2	209.9	248.4	397.9	207.4	265.7	229.0	221.9	259.4	317.1	397.7	299.3	**3,533.9**
2004	287.3	296.8	485.3	239.0	162.1	147.9	162.9	159.8	262.8	146.5	211.7	229.4	**2,791.5**
2005	408.9	495.6	257.0	330.8	323.5	157.2	359.9	240.4	93.6	166.1	421.4	334.7	**3,589.1**
2006	380.8	402.7	407.3	58.8	230.5	199.6	317.4	465.5	119.0	281.0	207.4	317.5	**3,387.5**
2007	382.5	199.9	415.6	344.5	198.3	221.6	227.0	449.3	202.5	201.7	232.0	364.3	**3,439.2**
2008	643.5	155.2	271.6	131.3	129.3	162.4	171.8	318.8	220.2	171.5	197.2	486.5	**3,059.3**
2009	444.5	180.0	164.7	376.8	119.1	193.8	174.2	189.9	164.5	261.0	417.7	223.5	**2,909.7**
2010	361.0	485.0	357.1	113.1	211.1	165.3	171.8	246.3	338.3	132.7	76.6	113.2	**2,771.5**
2011	431.4	152.6	129.4	64.3	101.3	106.6	42.5	185.0	38.0				
SUMMARY Using data from 1954-2011 (67 years):													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	395.7	338.9	351.3	271.4	242.3	218.1	251.6	280.1	215.5	258.6	274.9	387.3	**3,473.7**
S.D.	169.7	181.1	171.7	136.6	113.9	93.1	113.1	170.9	102.3	105.4	130.2	147.8	**656**
Cv	0.43	0.53	0.49	0.50	0.47	0.43	0.45	0.61	0.47	0.41	0.47	0.38	**0.19**
Max	1141.5	1138.9	1003.4	614.2	615.2	417.2	564.3	1143.0	522.7	556.3	661.4	836.9	**5,141**
Min	163.7	93.4	105.7	58.8	46.0	67.6	42.5	96.8	38.0	55.1	56.3	113.2	**2,226**

Nanumea Rainfall



Monthly data (mm) for Nanumea, Tuvalu

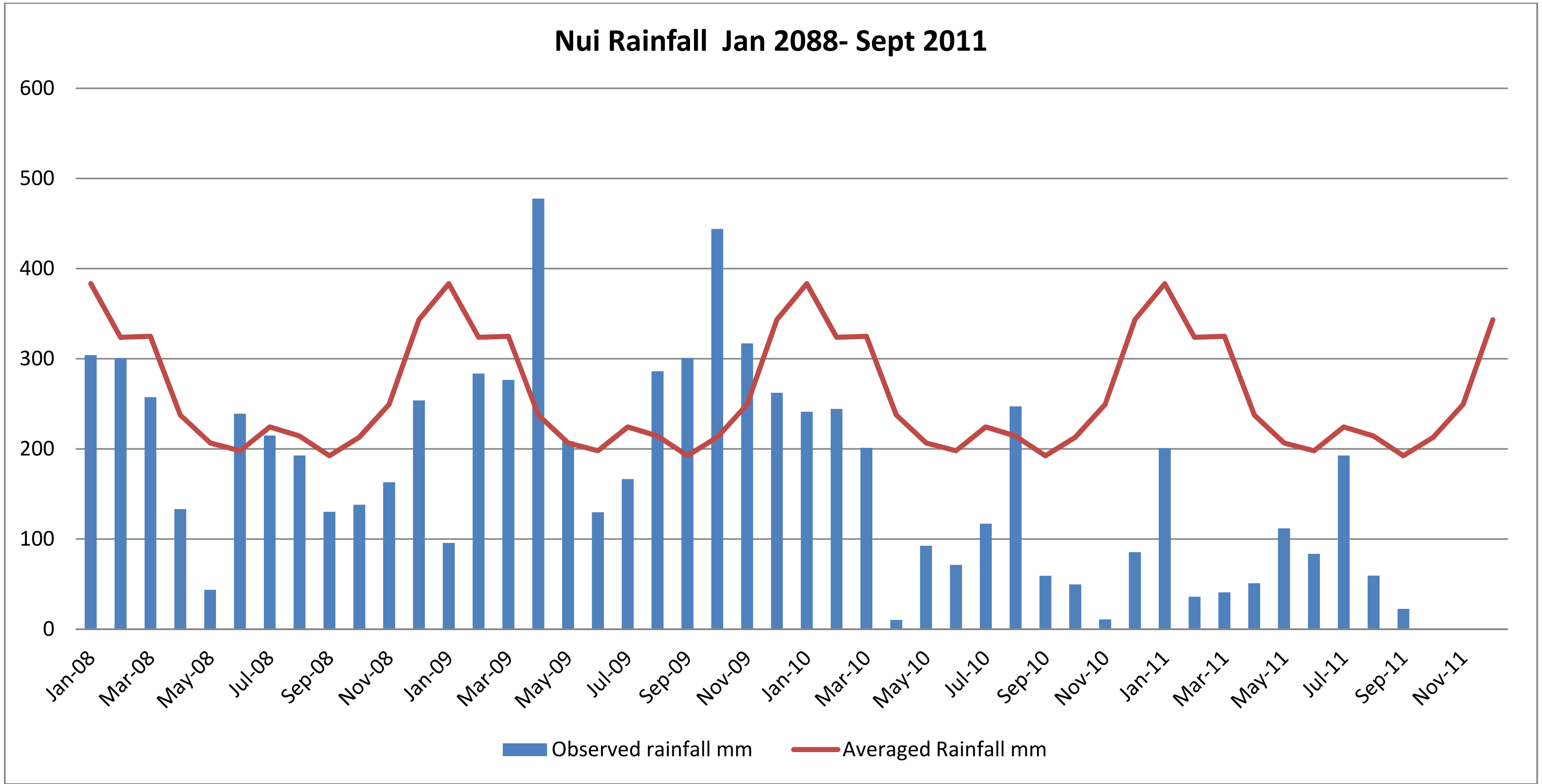
Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1941	369.4	286.2	299.4	251.2	223.6	198.8	210.5	223.2	386.8	140.5	270.3	298.2	3158.2
1942	520.2	719.6	182.6	243.1	182.9	218.7	280.9	195.1	213.4	159.3	114.6	512.1	3542.5
1943	215.9	130.6	111.5	175.5	154.7	198.8	210.5	223.2	175.1	171.0	181.0	320.7	2268.5
1944	428.2	112.5	192.8	174.5	160.5	93.0	210.5	223.2	175.1	171.0	181.0	320.7	2443.0
1945	369.4	286.2	299.4	251.2	223.6	198.8	210.5	223.2	136.1	74.4	94.5	124.2	2491.6
1946	250.4	512.3	299.4	352.6	376.4	122.4	120.4	178.8	103.6	206.2	145.5	389.6	3057.6
1947	468.6	114.3	176.3	149.6	223.6	198.8	210.5	223.2	175.1	171.0	181.0	320.7	2612.7
1948	515.1	386.6	499.4	350.5	206.0	149.6	253.7	295.7	139.7	103.9	182.1	340.1	3422.4
1949	415.5	241.8	278.1	328.7	160.3	395.0	219.7	250.2	139.4	111.8	127.5	141.5	2809.5
1950	324.9	494.5	43.9	179.6	217.2	127.5	125.0	121.7	8.1	8.1	155.4	181.6	1987.5
1951	125.2	92.2	232.2	258.6	198.4	137.4	339.6	221.7	178.1	215.4	144.0	396.2	2539.0
1952	333.2	381.0	252.0	401.3	227.3	300.2	214.9	105.7	62.5	87.4	131.8	333.2	2830.5

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1953	427.2	370.1	278.9	229.4	329.4	249.4	355.3	662.7	418.6	299.5	352.3	223.8	4196.6
1954	369.4	286.2	299.4	489.2	215.9	153.2	210.5	211.6	91.2	97.8	166.6	264.9	2855.9
1955	582.9	130.3	145.8	342.1	74.9	153.7	94.5	78.0	54.6	90.7	35.8	105.4	1888.7
1956	196.9	71.9	154.2	126.7	104.6	144.0	38.4	71.6	47.8	67.6	58.2	412.5	1494.4
1957	101.9	698.0	101.6	224.3	75.4	169.9	297.2	283.0	309.1	336.8	152.7	408.2	3158.1
1958	653.8	164.6	419.9	212.1	313.9	384.0	125.7	278.4	196.6	170.4	494.0	419.9	3833.3
1959	432.6	396.0	178.3	118.1	118.4	94.0	409.2	257.8	163.8	496.1	166.1	176.5	3006.9
1960	437.9	265.7	320.8	243.8	412.2	92.2	273.3	283.0	192.3	271.0	288.5	106.4	3187.1
1961	351.5	328.4	908.6	197.1	366.8	103.4	112.8	167.9	99.6	126.5	127.0	107.4	2997.0
1962	243.1	71.4	48.8	197.6	131.1	93.5	28.2	88.1	18.8	100.8	68.1	76.2	1165.7
1963	65.5	95.8	187.5	344.4	327.2	337.3	192.8	198.4	239.0	132.6	357.6	527.3	3005.4
1964	674.6	352.3	116.1	200.4	200.9	87.9	155.4	76.7	25.1	44.2	64.5	311.9	2310.0
1965	268.7	297.2	315.7	218.9	170.9	142.2	294.1	386.8	356.9	421.1	371.3	251.7	3495.5
1966	757.4	158.5	263.9	270.3	268.7	301.8	146.1	189.0	129.8	187.7	269.5	94.0	3036.7
1967	104.4	167.1	316.2	340.6	227.8	200.7	92.2	214.9	171.7	79.0	235.2	304.3	2454.1
1968	480.8	74.2	151.9	116.3	257.8	227.3	356.9	89.4	144.0	207.3	206.8	196.9	2509.6
1969	267.0	254.8	170.9	438.7	270.8	347.7	229.9	212.3	414.8	219.2	133.1	469.6	3428.8
1970	347.2	391.9	554.2	379.7	208.8	256.3	248.4	192.0	228.3	155.2	83.6	321.1	3366.7
1971	76.0	22.0	142.0	124.0	81.0	29.0	21.0	543.0	59.0	44.0	113.0	174.0	1428.0
1972	289.0	127.0	199.0	75.0	75.0	92.0	145.0	211.0	446.0	289.0	250.0	351.0	2549.0
1973	457.0	353.0	517.0	289.0	329.0	357.0	173.0	246.0	35.0	50.0	240.0	257.0	3303.0
1974	236.0	184.0	6.0	292.0	174.0	158.0	107.0	35.0	27.0	61.0	43.0	468.0	1791.0
1975	485.0	156.0	121.0	167.0	110.0	40.0	75.0	82.0	17.0	10.0	40.0	131.0	1434.0
1976	371.0	254.0	139.0	102.0	84.0	40.0	77.0	61.0	74.0	68.0	116.0	571.0	1957.0
1977	374.0	281.0	766.0	228.0	275.0	324.0	307.0	189.0	260.0	110.0	426.0	310.0	3850.0
1978	364.0	519.0	437.0	315.0	174.0	117.0	153.0	354.0	73.0	141.0	61.0	398.0	3106.0
1979	557.0	303.0	469.0	220.0	221.0	133.0	152.0	125.0	203.0	277.0	203.0	406.0	3269.0
1980	388.0	260.0	569.0	308.0	154.0	169.0	297.0	255.0	149.0	82.0	206.0	207.0	3044.0
1981	312.0	490.0	348.0	475.0	234.0	366.0	411.0	185.0	317.0	47.0	79.0	496.0	3760.0
1982	254.0	298.0	482.0	227.0	101.0	228.0	549.0	705.0	218.0	647.0	162.0	687.0	4558.0
1983	1143.0	573.0	488.0	230.0	247.0	506.0	478.0	358.0	429.0	309.0	87.0	320.7	5168.7
1984	144.0	101.0	231.0	212.0	475.0	318.0	302.0	311.0	99.0	204.0	341.0	636.0	3374.0
1985	324.0	122.0	624.0	172.0	82.0	121.0	119.0	170.0	116.0	135.0	233.0	320.7	2538.7

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1986	373.0	161.0	117.0	303.0	355.0	81.0	119.0	181.0	105.0	146.0	218.0	578.0	2737.0
1987	360.0	561.0	506.0	284.0	324.0	399.0	386.0	447.0	357.0	509.0	180.0	587.0	4900.0
1988	534.0	492.0	257.0	240.0	222.0	171.0	99.0	167.0	38.0	121.0	28.0	53.0	2422.0
1989	103.5	286.2	74.2	156.2	80.8	125.9	25.1	81.2	105.0	56.0	316.5	294.2	1704.8
1990	334.5	377.1	435.5	170.2	98.6	134.3	47.7	174.4	42.9	69.1	184.7	265.4	2334.4
1991	174.2	286.2	202.3	255.1	107.9	87.5	122.6	139.9	158.2	205.3	270.8	294.6	2304.6
1992	650.0	259.0	559.9	241.4	314.8	227.6	235.0	176.7	218.5	220.6	119.9	621.8	3845.2
1993	175.7	472.2	288.0	386.4	377.2	206.9	320.6	286.4	325.4	257.1	295.5	291.4	3682.8
1994	328.8	183.2	284.4	171.7	256.7	198.8	167.3	123.1	88.8	94.7	170.3	364.0	2431.8
1995	399.3	291.9	251.5	331.3	257.1	121.5	145.8	195.1	142.0	140.4	136.7	427.5	2840.1
1996	125.7	151.4	114.0	273.6	407.8	198.8	155.1	187.8	260.2	194.6	319.6	251.5	2640.1
1997	572.6	207.5	705.8	233.7	295.8	383.4	322.1	323.2	455.6	171.0	127.1	533.6	4331.4
1998	763.1	683.6	218.2	396.4	439.3	237.9	413.3	412.2	162.3	234.2	75.9	101.6	4138.0
1999	27.5	99.3	315.1	134.3	208.3	281.6	226.6	19.4	156.7	72.1	96.3	65.8	1703.0
2000	26.0	20.6	122.7	146.6	179.8	153.6	82.3	136.2	93.9	16.4	41.3	71.2	1090.6
2001	85.0	102.8	606.0	301.1	72.5	224.8	145.1	100.9	118.1	121.2	250.5	632.3	2760.3
2002	271.0	494.9	360.0	268.9	185.3	204.9	169.7	340.9	386.1	248.0	447.5	300.1	3677.3
2003	566.9	265.1	274.2	565.0	300.1	176.7	214.1	61.9	168.2	327.2	209.2	205.3	3333.9
2004	754.4	168.7	451.7	489.7	168.3	334.5	208.2	175.8	212.0	244.6	493.2	486.1	4187.2
2005	420.6	496.9	135.9	211.0	332.1	189.5	180.0	137.1	81.0	86.2	62.8	26.3	2359.4
2006	64.1	263.4	203.3	112.7	114.8	328.8	118.4	344.1	166.3	188.4	199.2	194.8	2298.3
2007	541.9	224.3	204.1	215.4	130.7	167.9	169	160.1	49.4	103.6	56.2	83.8	2106.4
2008	169.7	43.5	42.4	129.2	79.1	88.5	114.2	67.1	66.6	81.0	48.7	93.2	1023.2
2009	4.4	13	143.0	139.3	82.9	154.5	64.5	124.5	221.8	346.2	139.9	259	1693.0
2010	463.7	462.8	155.4	71.1	75.3	199.0	77.5	65.1	38.2	29.8	7.4	41.1	1686.4
2011	108.8	1.8	14.8	27.3	28.0	87.4	50.7	8.1					

SUMMARY Using data from 1941- 2011 (70 years):													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	353.6	264.1	304.7	250.9	213.4	199.4	195.0	208.4	171.2	177.4	185.1	310.2	**2,816.8**
S.D.	226.1	169.9	199.4	113.0	111.6	105.7	120.7	131.3	119.4	130.3	121.7	178.4	**957**
Cv	0.64	0.64	0.65	0.45	0.52	0.53	0.62	0.63	0.70	0.73	0.66	0.58	**0.34**
Max	1143.0	698.0	908.6	565.0	475.0	506.0	549.0	705.0	455.6	647.0	494.0	687.0	**5,168.67**
Min	4.4	1.8	6.0	27.3	28.0	29.0	21.0	8.1	17.0	10.0	7.4	26.3	**1,023.20**

Nui Rainfall



Monthly data (mm) for Nui, Tuvalu

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1946	272.3	281.4	339.9	271.3	86.4	214.6	176	141.5	166.9	476.3	225.8	220.7	**2873.1**
1947	535.7	239.5	302.8	141	210.8	172.7	79.2	70.9	128.8	365.3	155.4	190.2	**2592.3**
1948	579.4	244.9	253.2	319	211.3	173.7	320.5	397	317.2	325.4	355.1	494.8	**3991.5**
1949	694.2	288.3	200.9	243.3	71.9	275.6	180.3	197.9	247.7	182.4	402.1	400.3	**3384.9**
1950	296.4	352.8	184.9	188.2	159.8	232.2	210.6	63.5	18.8	71.1	201.2	530.1	**2509.6**
1951	567.4	223	251	154.4	185.4	132.3	491.7	79.2	127.3	300.5	252.7	420.1	**3185**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1952	323.1	397	263.9	443	226.6	514.6	244.3	202.9	141.2	202.7	247.9	415.8	**3623**
1953	490.2	576.3	320.5	174.8	433.6	188.5	322.8	580.1	578.9	395	277.4	283.2	**4621.3**
1954	316	274.1	866.6	257.6	115.1	141.2	209.3	130	87.6	140.5	311.7	265.9	**3115.6**
1955	660.9	299.7	357.4	219.2	67.6	54.4	197.9	76.7	109.5	105.2	133.6	272.3	**2554.4**
1956	429	300	232.4	148.3	144.5	236.2	138.7	91.4	98.3	144.8	122.7	265.9	**2352.2**
1957	197.9	963.2	188.7	267.2	270.5	138.7	164.3	404.4	219.7	253	205.7	423.2	**3696.5**
1958	464.3	180.6	465.8	137.9	196.9	280.4	279.7	327.2	236.2	177	268.2	307.6	**3321.8**
1959	543.1	210.1	256.3	108.5	154.7	110.7	341.1	282.2	188.5	540	215.1	288	**3238.3**
1960	603.5	233.4	270.3	164.3	218.4	165.6	250.7	367.5	192.8	376.9	235.2	144.8	**3223.4**
1961	481.6	521.2	1392.7	342.4	187.2	57.4	123.2	93.7	199.4	205.2	390.4	288.8	**4283.2**
1962	199.6	235.7	71.1	130	150.6	141	59.9	74.7	83.8	181.1	227.1	306.6	**1861.2**
1963	188.7	145.5	291.8	178.6	140.2	214.9	188.2	141.2	246.9	109.7	223.3	447.3	**2516.3**
1964	226.6	447.3	308.6	118.9	97.8	169.4	101.6	68.1	6.9	80.8	257.6	354.3	**2237.9**
1965	317.5	330.2	261.6	330.2	106.7	139.7	231.1	436.9	248.9	264.2	320	391.2	**3378.2**
1966	449.6	236.2	375.9	149.9	129.5	416.6	160	315	213.4	221	381	317.5	**3365.6**
1967	175.3	226.1	203.2	414	213.4	127	200.7	180.3	188	182.9	269.2	500.4	**2880.5**
1968	243.8	348.0	254.0	223.5	152.4	177.8	205.7	127.0	269.2	335.3	454.7	116.8	**2908.2**
1969	119.4	335.3	149.9	309.9	594.4	147.3	170.2	254.0	172.7	162.6	198.1	551.2	**3165**
1970	449.6	523.2	383.5	408.9	388.6	218.4	266.7	205.7	528.3	188.0	137.2	515.6	**4213.7**
1971	362.0	110.0	126.0	88.0	73.0	60.0	71.0	115.0	137.0	100.0	158.0	297.0	**1697**
1972	273.0	157.0	388.0	170.0	115.0	82.0	145.0	77.0	316.0	352.0	338.0	507.0	**2920**
1973	646.0	535.0	272.0	173.0	290.0	413.0	118.0	198.0	61.0	101.0	432.0	617.0	**3856**
1974	474.0	156.0	92.0	225.0	179.0	148.0	137.0	82.0	104.0	136.0	278.0	680.0	**2691**
1975	457.0	109.0	177.0	140.0	175.0	52.0	82.0	243.0	69.0	89.0	205.0	159.0	**1957**
1976	446.0	263.0	257.0	125.0	70.0	91.0	96.0	43.0	34.0	141.0	135.0	685.0	**2386**
1977	478.0	315.0	757.0	191.0	543.0	464.0	262.0	321.0	198.0	232.0	584.0	245.0	**4590**
1978	353.0	670.0	510.0	366.0	134.0	227.0	181.0	339.0	188.0	215.0	340.0	552.0	**4075**
1979	455.0	299.0	344.0	244.0	186.0	162.0	228.0	145.0	172.0	185.0	308.0	762.0	**3490**
1980	217.0	430.0	431.0	124.0	419.0	177.0	397.0	444.0	277.0	144.0	628.0	275.0	**3963**
1981	275.0	625.0	236.0	445.0	177.0	212.0	240.0	257.0	234.0	197.0	295.0	665.0	**3858**
1982	267.0	366.0	464.0	144.0	210.0	131.0	221.0	376.0	432.0	231.0	259.0	264.0	**3365**
1983	890.0	781.0	574.0	290.0	218.0	248.0	710.0	479.0	226.0	330.0	273.0		**5019**
1984	238.0	158.0	667.0	221.0	290.0	379.0	377.0	413.0	186.0	188.0	227.0	350.0	**3694**
1985	689.0	205.0	691.0	261.0	279.0	118.0	182.0	346.0	83.0	174.0	255.0		**3283**
1986	463.0	260.0	192.0	340.0	294.0	205.0	433.0	137.0	158.0	166.0	296.0	500.0	**3444**

Year	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
1987	464.0	633.0	420.0	355.0	431.0	310.0	506.0	154.0	588.0	477.0	398.0	353.0	**5089**
1988	647.0	397.0	240.0	386.0	326.0	163.0	319.0	147.0	144.0	276.0	59.0	94.0	**3198**
1989	319.5	26.4	339.3	155.6	114.5	121.2	129.4	180.0	224.1	162.3	298.1	448.3	**2518.7**
1990	584.1	492.9	620.1	104.4	85.1	285.2	208.0	263.1	121.4	128.4	429.5	323.3	**3645.5**
1991	493.1	563.2	356.9	392.2	167.7	243.9	191.9	269.5	152.3	145.6	203.8	348.0	**3528.1**
1992	406.2	261.1	253.0	201.4	257.1	265.5	235.6	222.5	230.6	139.3	180.7	202.3	**2855.3**
1993	224.1	215.6	408.8	486.6	358.8	295.6	374.4	207.6	299.8	274.2	257.7	333.4	**3736.6**
1994	401.9	330.2	272.2	198.8	212.5	204.8	155.3	293.6	60.2	258.1	168.0	448.9	**3004.5**
1995	860.3	370.4	359.0	430.5	256.3	131.6	199.7	147.9	185.0	206.4	219.9	517.4	**3884.4**
1996	224.3	363.5	330.6	165.0	202.1	169.8	229.7	136.3	153.8	114.4	164.9	309.6	**2564**
1997	225.6	185.6	125.9	108.1	152.0	186.8	337.1	160.9	189.0	265.4	166.1	460.5	**2563**
1998	258.9	123.3	100.8	108.1	152.0	186.8	337.1	160.9	189.0	265.4	166.1	460.5	**2508.9**
1999	61.5	172.9	132.0	137.8	189.5	170.6	118.8	71.4	50.7	11.0	84.6	164.9	**1365.7**
2000	148.1	160.3	150.7	244.7	143.9	163.0	163.0	132.1	61.4	198.1	31.4	145.5	**1742.2**
2001	112.2	127.0	305.5	279.6	241.8	247.4	119.7	58.8	180.3	322.5	235.5	552.4	**2782.7**
2002	210.9	540.7	188.7	171.1	162.0	229.2	246.0	263.9	366.8	185.2	278.9	289.3	**3132.7**
2003	521.3	278.9	257.5	325.3	351.9	358.6	243.1	368.9	271.9	294.5	160.2	256.2	**3688.3**
2004	393.9	168.3	651.1	583.4	153.3	257.8	143.6	82.1	393.5	129.1	246.7	427.6	**3630.4**
2005	360.8	679.0	181.3	375.7	297.1	50.1	403.5	146.2	70.3	218.4	182.0	130.1	**3094.5**
2006	78.4	290.0	172.5	45.2	119.6	155.4	95.5	169.2	232.1	51.6	191.6	196.1	**1797.2**
2007	651.6	263.3	176.8	362.3	233.8	327.4	159.0	398.1	128.7	115.6	116.7	178.2	**3111.5**
2008	303.9	300.7	257.4	133.3	43.7	239.1	214.8	192.6	130.1	138.0	163.0	253.7	**2370.3**
2009	95.7	283.6	276.5	477.7	208.5	129.7	166.5	286.1	300.8	444.1	317.1	262.3	**3248.6**
2010	241.1	244.4	201.2	10.2	92.4	71.4	117.1	247.1	59.1	49.7	10.9	85.4	**1430**
2011	200.9	36	40.9	50.9	111.8	83.6	192.6	59.3	22.6				

SUMMARY Using data from 1946-2011 (65 years):													
	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**Annual**
Mean	383.3	323.6	324.9	237.6	206.5	197.8	224.3	214.3	192.4	212.9	249.4	357.3	**3136.5**
S.D.	186.6	180.4	213.4	123.0	111.4	98.8	116.8	124.6	122.3	110.0	113.9	157.8	**807.3**
Cv	0.49	0.56	0.66	0.52	0.54	0.50	0.52	0.58	0.64	0.52	0.46	0.44	**0.26**
Max	890.0	963.2	1392.7	583.4	594.4	514.6	710.0	580.1	588.0	540.0	628.0	762.0	**5089.0**
Min	61.5	26.4	40.9	10.2	43.7	50.1	59.9	43.0	6.9	11.0	10.9	85.4	**1365.7**

Annex 8. Photographs - Rapid Drought Assessment Tuvalu October 2011

Plate 20. Nukufetau

Plate 21. Vaitupu

Agriculture

Plate 22 *Kaleve* (toddy) production

Plate23. *Pulaka* pit bunds

Questionnaire and Health

Plate 24. Vaitupu Island Nurse measuring the Mid Upper Arm Circumference (MUAC) of preschool girl.

Plate 25 Undertaking Household Surveys - Nuitao

Plate 26 Undertaking Household Surveys - Nuitao

Plate 27. Undertaking Household Surveys - Vaitupu

Plate 28. Undertaking Household Surveys - Nanumea

Water Resources Assessment

Plate 25. Water Rationing Niutao

Plate 26. Pumping from communal cistern for water distribution - Vaitupu

Plate 27. Traditional well - Vaitupu used for washing and watering pigs (note corn beef tin on pole as means of abstracting water).

Plate 28. Measuring Rainwater Cistern - Motufoua High School - Vaitupu Island

Plate 29. Washing machine moved to be close to well water source, alternate water source coping strategy

Plate 30. Hand washing of clothes with well water

Plate 31. Domestic well, 44 gallon drums for casing, with corned beef tin used as a bucket for extracting water - Nanumea

Plate 32. Well under construction in response to shortage of water - Vaitupu

Plate33. Solar pump and water storage - from main well water supply for Vaitupu

Plate 34.2 Communal Well - Nanumea with floating solar pump, not operating at time of survey. Salinity mS/cm approximately 1.5 km from village centre

Plate 35. Unused well in Vaitupu

Plate 36. Undertaking household survey Nanumea

Plate 37. Transporting water from community supply - Niutao

Plate 38. Drawing water from well at Hospital - Nui

Plate 39. Rainwater harvesting - Niutao. Note the 200L containers to collect the water from an inefficient gutter.

Plate 40. Rainwater harvesting - Niutao. Note the two concrete tanks, unconnected. When one tank is full the guttering is manually shifted to fill the other tank.

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