# Demand Management and Conservation Investigations in Funafuti, Tuvalu

**Demand Management Project**

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## EXECUTIVE SUMMARY

Tuvalu is blessed with a high average annual rainfall that is fairly evenly distributed over the entire country. This suits rainwater catchment systems, which is the main source of water supply. However, droughts do occur and there is a need to optimise existing water supply systems.

The following demand management and conservation recommendations are made:

1. Review and update the existing Draft Tuvalu Water and Sanitation Plan including the following specific items:

- Design standards for minimum daily demands (l/c/d) and matching roof areas with storage and demand.
- Water rationing and delivery procedures.
- User-pays system.
- Water saving devices.
- Develop plumbing standards.
- Develop the use of composting toilets to save water use (currently being trialed in Kiribati).
- Adopt building codes and material specifications.
- Develop operation and maintenance procedures for tanks, gutters, down pipes.

2. Seek Government approval for the updated Water and Sanitation Plan along with any legislation and/or regulations recommended in the Plan.

3. All suitable roof areas should collect rainfall.

4. Storage facilities should be optimised depending on rainfall and available or potentially available roof areas.

5. Regular maintenance of roofs, gutters, down pipes and tanks.

6. Construct three additional storage facilities at the Philatelic Bureau, Airport Terminal Building and the Deep Sea Wharf Warehouse to help “drought proof” Funafuti.

## 1. INTRODUCTION

This study was undertaken as part of a Water Demand Management and Conservation Project funded by the Government of Taiwan and was requested by the Government of Tuvalu for the Public Works Department.

Water demand management and conservation practices focus on the development and use of water supplies in such a way to “stretch” available water as far as possible before having to develop new sources.

The principles of demand management and conservation are shown in Attachment 1.

## 2. BACKGROUND

Tuvalu’s dominant source of domestic water is rain captured off roof tops, diverted through gutters and down pipes and stored in various types of tanks. Most islands have wells but their use is insignificant compared to rainwater collection systems. Individual households are responsible for providing their own water. However Government assists by seeking donor funding for projects that provide materials for roofing, gutters, down piping and storage tanks.

Government and community water storage reservoirs are available for public use during drought conditions.

With the people of Tuvalu responsible for providing their own water they have generally become good managers of their water needs.

## 3. WATER RESOURCES

The Tuvalu Group is fortunate that its average annual rainfall is relativity high and more evenly distributed compared to other Pacific areas. Annual average rainfall ranges from a high of about 3550 mm in Funafuti, to a low of about 2670 mm in Nietta, at the northern end of the Group. Figure 1 compares average monthly rainfall for Funafuti, Tarawa, Nadi and Niue. Note that with larger and more evenly distributed rainfall, Tuvalu is better suited for

rainwater collection systems than other Pacific islands. More water is available to collect and

store to overcome periods of dry weather assuming that adequate roof area and storage exists. Figure 2 shows the monthly minimum, average and maximum rainfall for Funafuti.

Being atolls, there are no running streams in the Tuvalu Group. There may be ponded water in old borrow pits and areas of low depression where taro and other crops may be planted.

Groundwater may be found on all atolls. Rainfall infiltrates through the soil forming a lens of water that floats on top of seawater. However the extent and quality of the groundwater depends on the following:

- Size of island
- Soil type and permeability
- Amount of recharge (ie rainfall) and abstractions
- Sources of pollution e.g. latrines, septic tanks, livestock and other forms of waste disposal, specially in high living density areas like on Funafuti

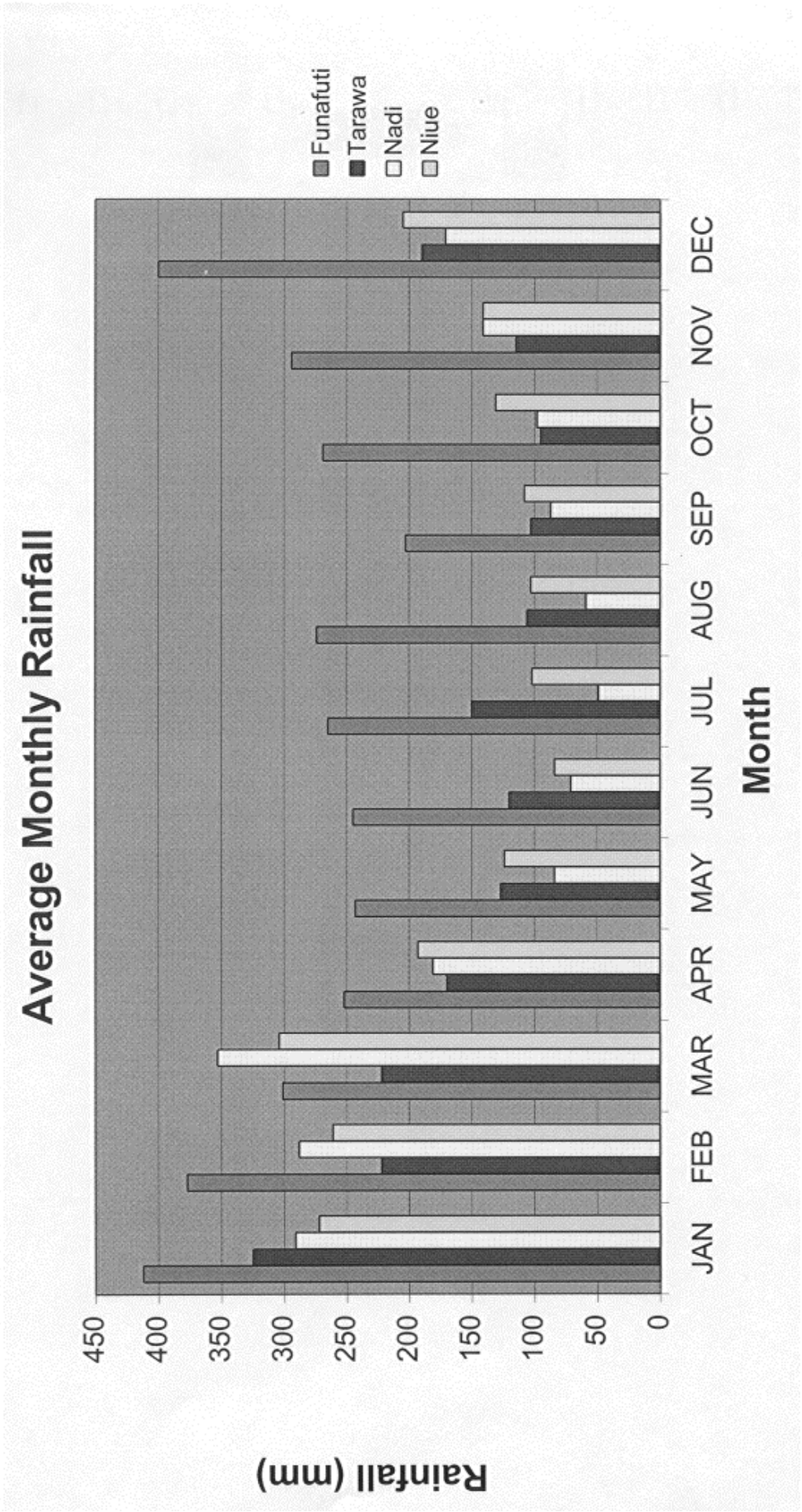
There are existing dug wells throughout Tuvalu, however water use is normally limited to non-domestic activities like for livestock and gardening. Water from wells has been used for domestic needs during droughts. Groundwater lens are fragile, subject to pollution and increased salinities during drought periods by “thinning” of the lens.

The best use of the groundwater resource appears to be in sustaining natural vegetation and crops like coconut trees as coconuts may be drunk to supplement fluid consumption during periods of low rainfall.

## 4. EXISTING WATER SUPPLIES

Collected rainwater is the main source of water supply in Tuvalu. There are dug wells of various standards but the water is of poor quality being subject to many sources of pollution.

[7]


Average Monthly Rainfall
Funafuti
Tarawa
Nadi
Niue
450
400
350
300
250
200
150
100
50
0
Rainfall (mm)
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month

[9]

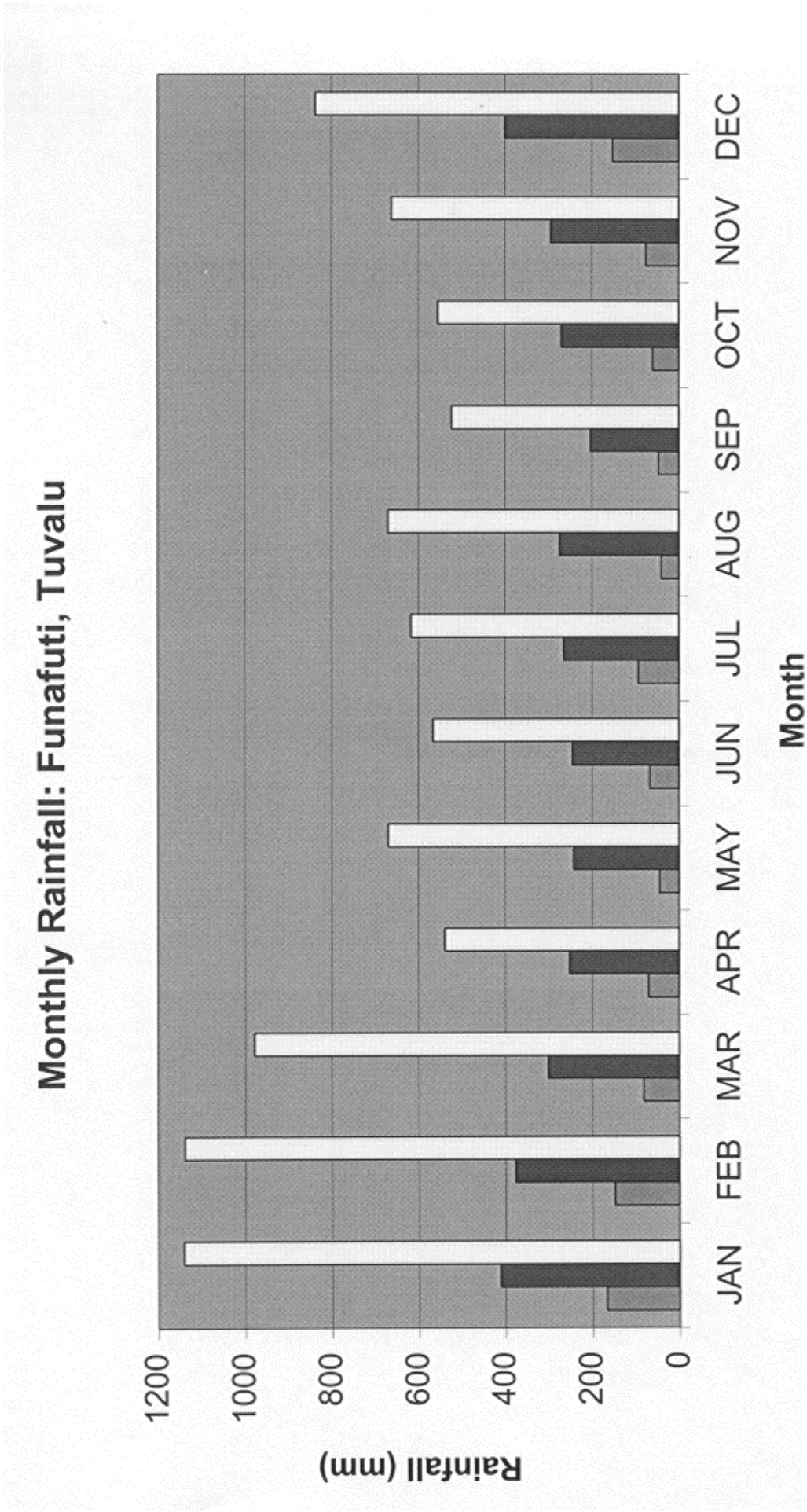

Monthly Rainfall: Funafuti, Tuvalu
Rainfall (mm)
1200
1000
800
600
400
200
0
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
Month

Table 1 below shows Health Department data that was collected during the first quarter of 1997:

| Island | Households | water tanks | Wells | toilets/latrines |
|---|---|---|---|---|
| Nanumea | 178 | 163 | 5 | 127 |
| Nanumaga | 163 | 167 | 0 | 147 |
| Niutao | 183 | 163 | 7 | 150 |
| Nui | 167 | 136 | 5 | 102 |
| Vaitupu | 300 | 233 | 0 | 206 |
| Nukufetau | 151 | 122 | 2 | 107 |
| Funafuti | 540 | 540 | 4 | 500 |
| Nukulaelae | 64 | 65 | 0 | 61 |
| Niulakita | 12 | 16 | 1 | 12 |

From the above data it can be seen that most households have water tanks and that wells are relatively few. Also note that human waste is discharged into the ground through toilets and latrines thus creating potential to pollute the existing wells and groundwater resources. Groundwater has a relatively limited role in providing water for domestic use, except during drought periods.

Individuals are responsible for providing their own water supply in Tuvalu. Government has assisted by securing overseas aid funding for projects that provided materials, training and the expertise to establish and maintain both household and community rain catchment systems throughout Tuvalu. A typical household water supply consists of a roof area (corrugated iron or plastic roofing) to capture rainwater that is collected and conveyed by a system of gutters and downpipes (sheet metal and plastic) to storage tank(s) (ferro-cement, reinforced concrete and concrete block, fibreglass, plastic, corrugated iron). (See photos 1 and 2 for examples of typical systems).

Water is then drawn from the tank for various uses. In some cases water is pumped (using hand, electric or diesel pumps) into an elevated tank for gravity distribution within the building serviced (see photo 3). Some large buildings (government offices and schools) use electric pump and cylinder units to pressurise water reticulation (see photo 4).

During drought periods water is available to individuals from Government and community storage tanks (see photo 5). Water is pumped into individual containers to be taken home or on Funafuti water can be delivered by PWD for $A15 per tank load. The Funafuti Town Council supplies emergency water to the public with the first 2.25 $m^3$ (500 gallons) free and

charge 2 cents per gallon (4.5 l) for additional water. On Funafuti, Government storage facilities are about 400 $m^3$ while the Town Council's available storage is about 800 $m^3$. (taken from a project proposal by PWD 1995). This proposal seeks funding to construct three additional 400 $m^3$ storage reservoirs at the Philatelic Bureau, the Airport Terminal Building and at the Deep Sea Wharf Warehouse at a total cost of $A510,000.

In response to emergency assistance during a very severe drought in 1990, two reverse osmosis desalination plants were supplied to Tuvalu by AIDAB. The desalination plants served their purpose and have not been used since. They proved to be too expensive to operate and difficult to maintain in the Tuvaluan environment. The units are still in place but are inoperative. This reinforces the need to ensure that only appropriate technologies are used for long-term solutions. Desalination units need to be operated on semi-continuous basis if they are to be maintained for emergency purposes only. The high energy cost to run the units usually minimises their operation outside of dry periods.

## 5 WATER DEMAND

Since there is no reticulated water supply in Tuvalu, there are no water meters thus no means to collect data on water usage. Other than rainfall data the only information available was in 1997 where PWD in Funafuti delivered 982 $m^3$ of water from Government storage to various households and other users.

The amount of water available for a household or community system is a function of rainfall, useable roof area, available storage and the maintenance of collection/storage systems. Daily rainfall data are available for most islands and some have rainfall intensity data as well. Roof areas that have the potential to collect and convey water to storage can also be measured. (Note that there are suitable roof areas that are not utilised to collect and convey rainwater.) Rainfall tanks can be measured to assess their available volume. System maintenance is most important for it determines the efficiency of each system, thus minimising water loss between the amount of rain that falls, to the amount that makes its way into storage (see photo 6).

It is ideal to optimise available roof area with storage and rainfall. Thus by doubling the available roof area, twice as much rainfall should be captured. However if the storage tank is too small the extra rain captured overflows to waste. Conversely, if the tank is too big compared to the roof area serving it, the tank may never fill. It is important to optimise roof area and tank size but in reality the availability of funds is a major factor in determining the size and type of rainfall collection/storage system.

Table 2 shows the estimated amount of rainfall storage available in the Tuvalu Group in 1993. The storage data and estimated 1995 population figures shown in Table 2 were taken from the Draft Tuvalu Water and Sanitation Plan for 1993 to 2002. It is believed that these figures are still in the correct order of magnitude. There are no available figures on roof areas.

A quick analyses of the estimated storage values based on the estimated 1995 population figures shows the amount of storage per person. Also assuming an average usage rate of 50 litres per person per day (l/p/d), Table 2 shows the maximum number of days of water available. (Note that the 50 l/p/d design rate has been recommended in the Draft Water and Sanitation Plan). However, on the onset of a dry period it is highly unlikely that the storage tanks would be completely full. As an example, Table 2 suggests that for Funafuti households with an average storage per person of 1.39 $m^3$ and assuming a usage rate of 50 l/p/d, stored water would last for 28 days (assuming that tanks were full to start with). If community storage on Funafuti were included, the average storage per person increases to 2.02 $m^3$ lasting for 40 days. However, again it is stressed that these are potential values and assume that the tanks are full to start with and that the demand rate is 50 l/p/d. Therefore if storage is already at, say 50% of potential and a dry spell begins then water problems may occur.

It is very important to develop all potential roof areas, maintain systems to maximise the rainfall into water stored, and to manage stored water to minimise wastage.

## 6 DEMAND MANAGEMENT AND CONSERVATION PRACTICES

The following are comments on existing and proposed practices that may be developed to utilise the existing rainwater collection system to last longer:

## Table 2: 1993 Estimate of Storage Capacity in the Tuvalu Group (m3)

| Island | 95 Population | HH pre '87 | HH Project | HH Total | m3/person | days @ 50l/p/ | Com pre '87 | Com Project | Com Total | Total Storage | m3/person | days @ 50l/p/d |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Nanumea | 941 | 582 | 1442 | 2024 | 2.15 | **43** | 726 | 400 | 1126 | 3150 | 3.35 | **67** |
| Nanumaga | 800 | 494 | 1131 | 1625 | 2.03 | **41** | 669 | 400 | 1069 | 2694 | 3.37 | **67** |
| Niutao | 971 | 491 | 1344 | 1835 | 1.89 | **38** | 871 | 400 | 1271 | 3106 | 3.20 | **64** |
| Nui | 606 | 313 | 729 | 1042 | 1.72 | **34** | 160 | | 160 | 1202 | 1.98 | **40** |
| Vaitupu | 1487 | ? | 1638 | 1638 | 1.10 | **22** | 285 | | 285 | 1923 | 1.29 | **26** |
| Nukufetau | 824 | 345 | 738 | 1083 | 1.31 | **26** | 200 | | 200 | 1283 | 1.56 | **31** |
| Funafuti | 3952 | 2639 | 2848 | 5487 | 1.39 | **28** | 1283 | 1200 | 2483 | 7970 | 2.02 | **40** |
| Nukulaelae | 268 | 189 | 317 | 506 | 1.89 | **38** | 120 | | 120 | 626 | 2.34 | **47** |
| Niulakita | 92 | ? | 117 | 117 | 1.27 | **25** | 68 | | 68 | 185 | 2.01 | **40** |
| TOTALS | 9941 | 5053 | 10304 | 15357 | 1.54 | **31** | 4382 | 2400 | 6782 | 22139 | 2.23 | **45** |

**KEY**

**95 Population** = estimasted 1995 populastion of each island

**HH pre '87** = total Household storage available before 1987

**HH Project** = total Household storage provide by UN Aid Project

**HH Total** = pre '87 + Project storage available

**m3/person** = total Household storage available per person

**days @ 50l/p/d** = assuming a daily usage of 50l/p/d the number of days of storage available per person

**Com pre '87** = total Community storage available before 1987

**Com Project** = total Community storage provided by UN Aid Project

**Com Total** = pre '87 + Project storage available

**Total Storage** = HH Total storage + Com Total storage

**m3/person** = total Household + total Community storage available per person

**days @ 50l/p/d** = assuming a daily usage of 50l/p/d the number of days of storage available per person

**NOTE:** The data used in the above table was taken from the Draft Tuvalu Water and Sanitation for 1993 to 2002

## 6.1 Legislation

The existing legislation regarding water supply was drafted over 30 years ago and mainly deals with the construction and operation of conventional pipe reticulated water supplies with no specific mention of water sources. However, there is provision to create water reserve for the protection or conservation of any water catchment area and to restrict land use that pollute the source; which can include potential groundwater recharge areas.

Current legislation appoints the Superintendent of Public Works as the water authority for the purpose of the ordinance. It also regulates the delivery of bulk water by the authority.

New legislation would be useful to implement good water demand management and conservation practices including establishment of a water and sanitation agency to regulate the collection and storage of water, the monitoring and distribution of government/community stored water, the monitoring of water quality and the disposal of wastes.

Building regulations should be introduced to ensure that any new house and/or building should have minimum provisions for suitable rainwater roof catchment and storage facilities.

Government could encourage the use of water saving devices such as dual flush toilets through import incentives or regulations.

Any legislation approved should include provisions for monitoring and enforcement of regulations.

## 6.2 Data Collection

Except for limited rainfall figures there is very little existing data to assist in demand management. Rainfall figures are still very important to collect, store and analyse.

Data regarding the amount of government/community water reserves (i.e. in storage tanks) available, water taken from storage and its quality, should be collected to assist in its distribution management. Groundwater levels and water quality (bacteriological and salinity nitrates) should be monitored, where possible, to detect any changes from normal conditions.

Surveys on existing water supplies (i.e. roof areas, available storage, and number of wells)

sanitation facilities and water quality are required periodically to monitor changes.

### 6.3 Policies

As mentioned before, a Draft Tuvalu Water and Sanitation Plan for 1993 to 2002 exists, providing a basis for various legislation, polices and practices for the water sector. It would be most useful for this draft document to be reviewed and updated to include recommendations on the following:

- Design standards for minimum daily demands (l/c/d) and matching roof areas with storage and demand.
- Water rationing and delivery procedures.
- User-pays system.
- Water saving devices (overlaps with legislation).
- Develop plumbing standards.
- Develop the use of composting toilets to save water use (currently being trialed in Kiribati).
- Adopt building codes and material specifications.
- Develop operational and maintenance procedures for tanks, gutters, down pipes.
- Bulk buying of materials.
- New buildings to have storage facilities.
- Continue to seek donor support.

A good water tank management policy, is to monitor water daily and when the level drops to the halfway mark, start to think about reducing use. If the water level continues to drop, start rationing and/or supplementing water from a community or government source.

### 6.4 Planning

Short-and long-term planning is important for the sustainable development of the very limited water resources available to Tuvalu. Again the review and updating of the Draft Water and Sanitation Plan is required.

Short term needs would include optimising existing water supply systems by fixing all leaky plumbing and storage tanks. Roofs, gutters and down pipes should all be in order to ensure that all the rain that falls on roofs enters storage tanks with minimum wastage. Continue preventative maintenance programs at all times.

Long-term planning should include information on future water demands from an increasing population and/or an increase in water usage; monitoring and collection of water-related

data, and the replacement and/or addition of extra individual/community storage facilities. Alternative water sources should also be investigated, such as:

- the use of groundwater;
- collecting of rain runoff from the airport runway (used in Majuro);
- desalination; and
- the use of solar energy to pump water and/or for desalination.

Drought and El Niño prediction and early warning systems should be developed in conjunction with the Meteorological Department. The Water Resources Unit of SOPAC is currently developing indeces using monthly rainfall data that may be used as a tool for drought prediction for Rarotonga and Fiji that could be used in Tuvalu as well.

Budgeting is also an important planning aspect to ensure that current and future funding requirements are identified and provided for.

### 6.5 Resources

Training of water sector personnel at all levels (management, professional, technicians and craftsmen) is essential for the sound planning, implementing, operation and maintenance of Tuvalu's limited water resources.

SOPAC, WHO, ESCAP, SPREP, PWA and UNDP are all sources of technical advice and, in some cases, funding as well.

Financial resources are also under pressure, however monies from Government, town councils, and user-pays systems should be supplemented by bilateral donor funding and lending agencies like the ADB if required.

### 6.6 Public Education and Awareness

For any demand management and conservation practice to succeed, public awareness and education is most important. If the public do not see the value in optimising roof catchment systems through maintenance and the need to conserve and protect limited water resources, then we are wasting our time.

The school system is an ideal way to promote good water and sanitation practice that the children may take home to their parents.

World Water Day is celebrated in March each year and this is a good means to focus on the importance of water to everyday life and the fact that water resources are limited and subject to pollution. World Water Day materials are generally available through SOPAC.

Awareness of the concept of saving water through fixing leaky taps and tanks plus the operation and maintenance of roofs, gutters and down pipes could easily be promoted by Women's Councils, NGOs and church groups. Looking at many of the existing roof catchment from the road side, most systems need some improvements and by securing gutter/pipe/tank connections or by re-aligning/replacing a section of guttering. A few simple maintenance jobs may provide the extra water required to get through a dry period.

Along with conservation of water, safe hygiene and sanitation practices should also be promoted through the Health Department and the same groups mentioned above.

## 7 RECOMMENDATIONS

Tuvalu's high average annual rainfall is fairly evenly distributed over the entire country. This suits rainwater catchment systems - the main source of water supply. However, droughts do occur and there is a need to optimise existing water supply systems.

The following demand management and conservation recommendations are made:

1. Review and update the existing Draft Tuvalu Water and Sanitation Plan to include the following specific items:

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- Adopt building codes and material specifications.
- Develop operational and maintenance procedures for tanks, gutters, down pipes.

2. Seek Government approval for the updated Water and Sanitation Plan along with any legislation and/or regulations recommended in the Plan.

3. All suitable roof areas should collect rainfall.

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5. Regular maintenance of roofs, gutters, down pipes and tanks.

6. Construct three additional storage facilities at the Philatelic Bureau, Airport Terminal Building and the Deep Sea Wharf Warehouse to help make Funafuti “drought proof”.

## 8 REFERENCES

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## 9 ACKNOWLEDGMENTS

I would like to acknowledge the assistance of all the people met during our visit to Funafuti and especially to Mr Saufatu Sopoaga, Secretary to Government and Sir Toaripi Lauti, President of the Funafuti Town Council, for their support.

Also special thanks to Mr Tuisiga Saitala, Acting Director of Public Works, for his assistance and hospitality.

# PHOTOS

Photo 1. Typical individual rainwater collection and storage system.

Photo 2. Typical individual rainwater collection and storage system with an elevated tank for gravity reticulation within the house.

Photo 3. Rainwater is collected off the roofs, stored in a tank and pumped up to the elevated tank for gravity reticulation.

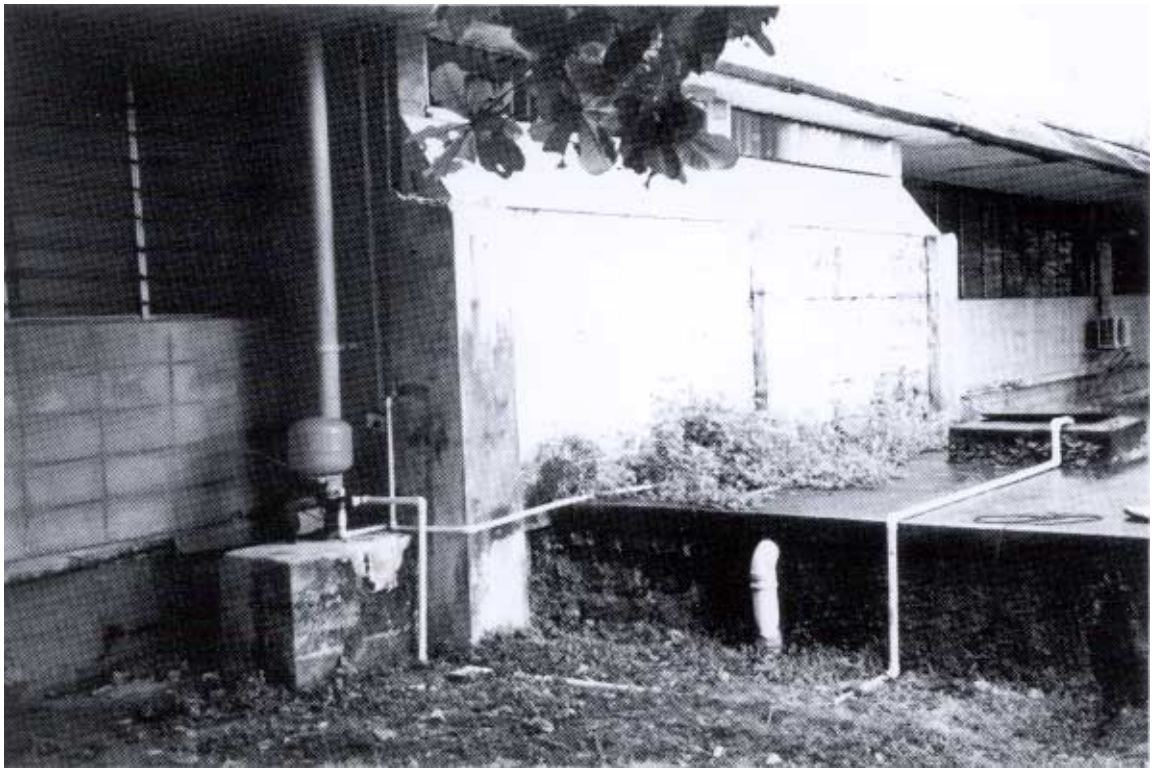

Photo 4. Government storage tank and pressure pump system.

Photo 5. FTC community storage tank and roof collection. Note top of tank used for sporting events.

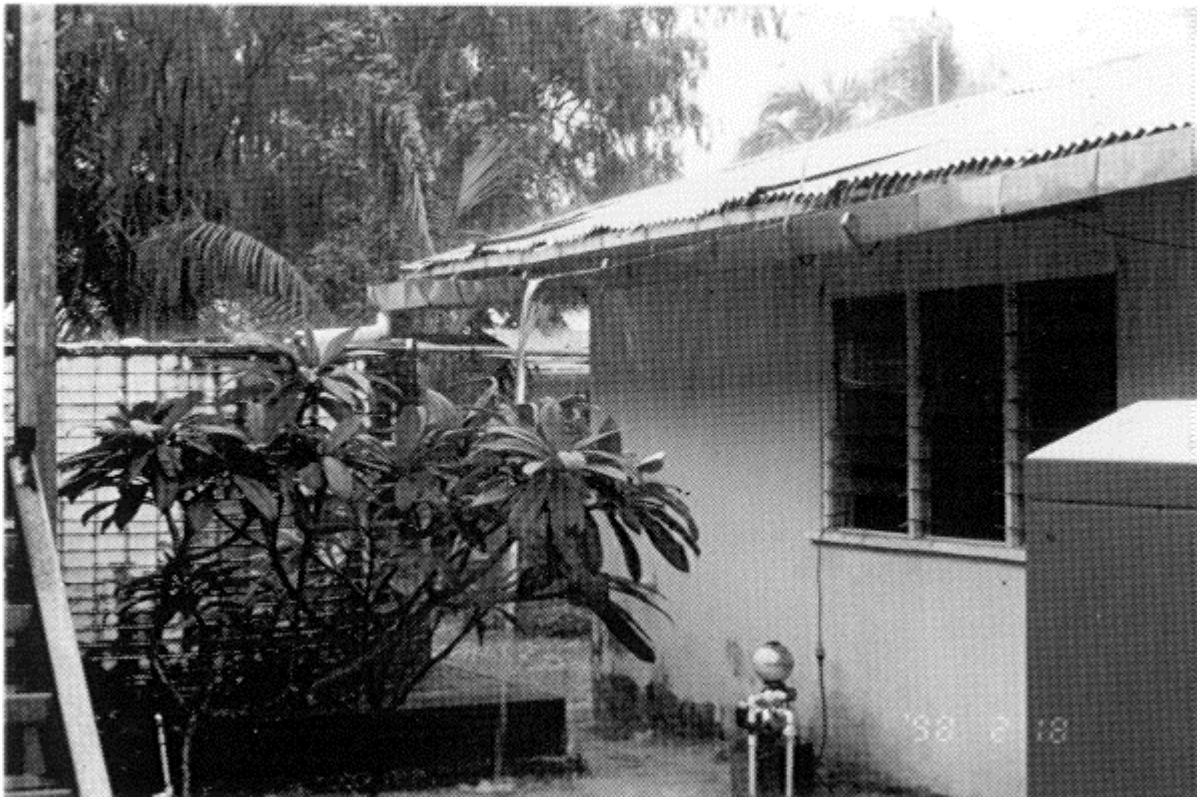

Photo 6. Example of poor maintenance of roof and gutter system resulting in wasted water.

# ATTACHMENT 1

# DEMAND MANAGEMENT AND CONSERVATION

**The Future of Water Resources/Supply Management**
SOPAC 1997 STAR Presentation

**Current Thinking:** *"if we need more water tap another source"*

**Future Thinking:** *"how much water do we have and how best to use it"*

## Demand Management and Conservation

- Legislation
- Data Collection
- Polices
- Planning
- Resources
- Public Education

*SOPAC* - 25 Years of Service

## Legislation

- Regulate water resources and usage
- Catchment protection
- Land use management
- Water quality standards
- Monitoring
- Enforcement

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## Data

- Water resources
  -surface water, groundwater,
- Reticulation system
  -inflows and outflows
- Water Quality
  -bacteriological and chemical

*SOPAC* - 25 Years of Service

## Policies

- Universal metering
  -individual and bulk meters
- User pays system
  -reduces demand and generates revenue
- Leak detection
  -reduces system losses
- Water savings devices

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