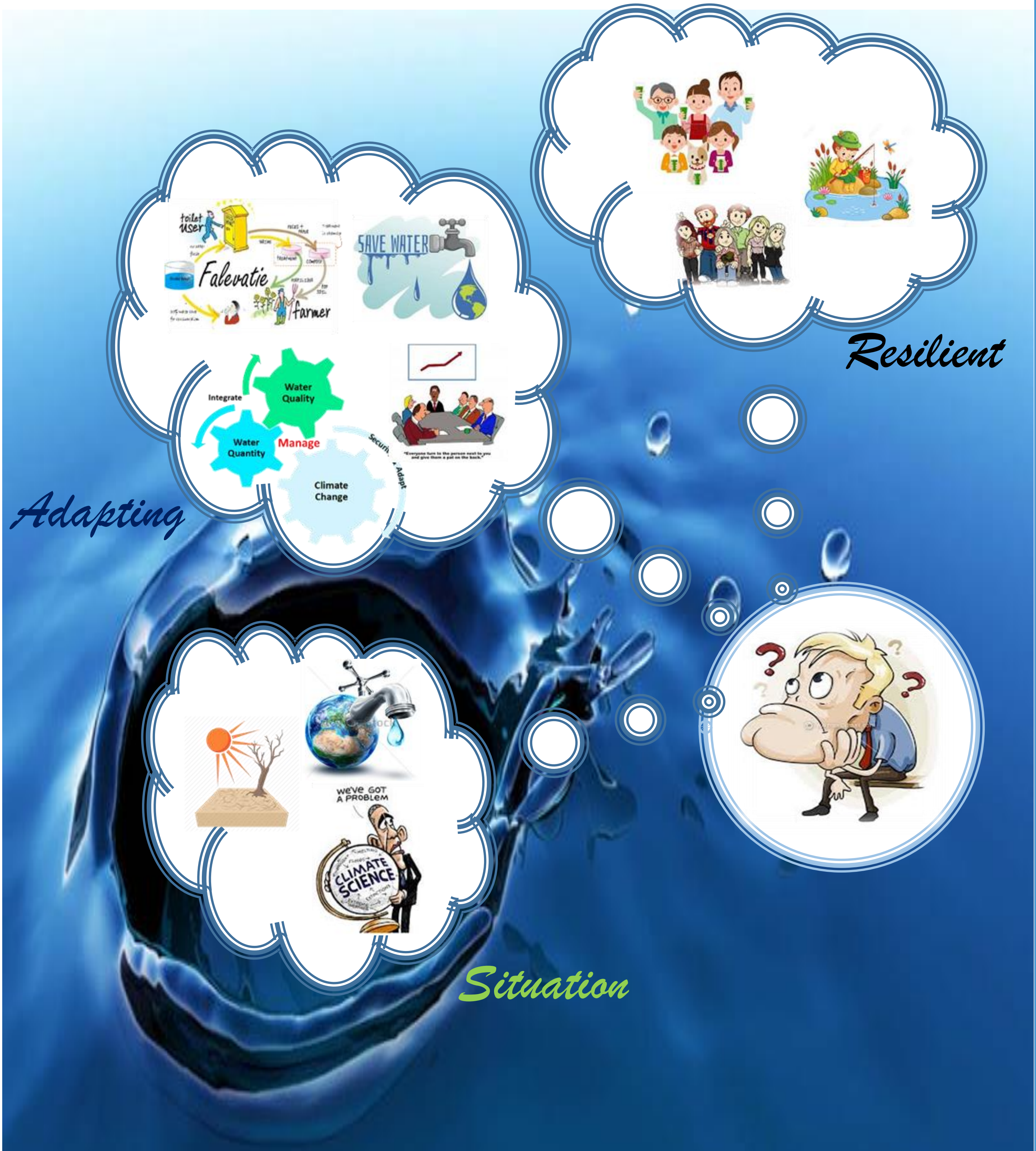
MANUAL GUIDE

Integrated Water Resource Management

(IWRM)



RIDGE TO REEF 2018

Contents

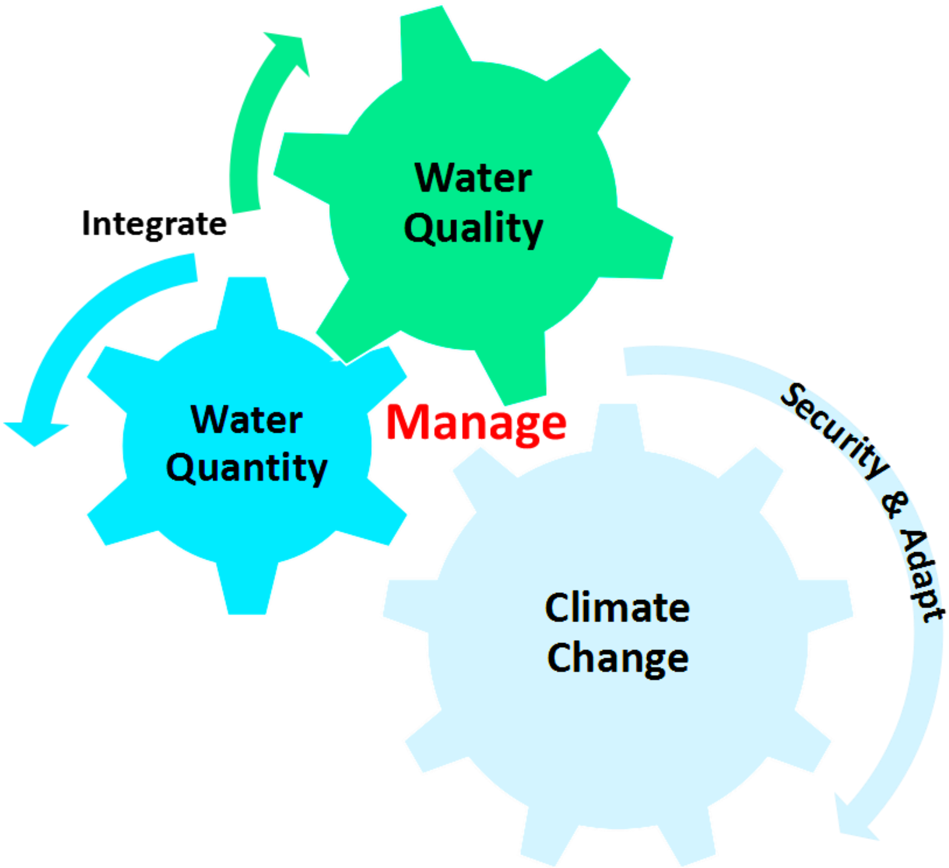
Overview

What is Integrated Water Resource Management (IWRM)?

Integrated Water Resource Management (IWRM) is the process in integrating **Water Quality** Management and **Water Quantity** Management in an equitable manner without compromising the sustainability of vital ecosystem which in other words to provide everyone a secure living by adapting to Climate Change.

Water Quality management is the focus on all characteristics of water quality problems relating to its many valuable uses. It is a reflection or response of water composition to all inputs and processes, whether natural or social. It concerns what water is to be use for (consumption, industrial or agricultural, etc) and criteria's to safeguard those uses.

Water quantity management (or water resources management) in simple is the managing of the amount of available water in a water body/storage to provide for ecosystem health and other in-stream values. It also involves effectively and efficiently managing activities that affect water quantity.



The Purpose (guide).

Water is very important for human survival, health and self-worth and it is a fundamental resource for human development. Tuvalu's water resources are under increasing pressure due to climate change therefore, 'Integrated Water Resource Managing' should be based on a participatory approach, involving all users from all levels, socially, culturally and governmentally.

Therefore, this manual guide is intend and made literacy easy to help each and every one from all levels (household, community, planners and policymakers) understand the importance of IWRM and its processes to enable Tuvalu adapt and resilient to climate change.

Chapter 1; Important Notes – Basic guiding principles

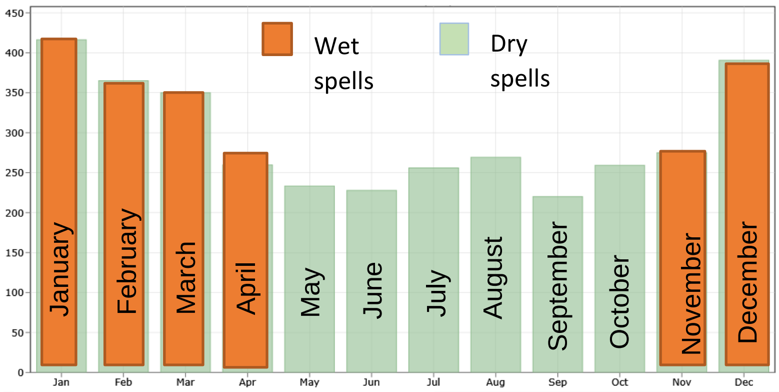
Tuvalu: Country Overview.

Tuvalu is a small island nation in the South Pacific region. Geographically consisting of nine low-lying islands spreading over some 900,000 square kilometres of ocean. It has an estimated land area of 25.4 square kilometres. Of the nine island groups, five are considered true atolls (Nanumea, Nui, Nukufetau, Nukulaelae and Funafuti (capital)), three are table reef islands (Nanumaga, Niutao and Niulakita) while Vaitupu has a composite Characteristics of an atoll and a table reef island.

Tuvalu's geological structure is characterized by coral forming making the soil porous and infertile. The islands elevate at the highest about 4m above sea level. Many habitable islets, including the capital Funafuti, are mostly about 200 metres wide at their widest part. Whereas the groundwater table is generally within 1 – 1.3 meters (m) of the surface, and even lower in some parts of the islands.

Tuvalu's climate is tropical-marine, being influenced by the south-east Pacific trade wind belt with a wet Westerly and a dry Easterly Season. The wet months are November to April and the drier months from May to October. The mean annual rainfall (average) is 3000mm per annum may get to 4000mm in the southern islands. Dry periods are more severe in the northern islands of the group.

Funafuti rainfall Monthly Mean Statistic from 1941 - 2015



Source: Metrological Office Tuvalu (MET)

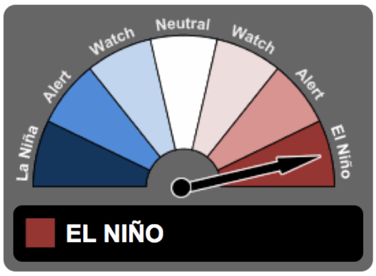
Tuvalu water resources status.

Rainwater harvesting: Primary source of water supply.
Groundwater: Available on all islands, however encourage not to use for consumption (contaminated), but encourage to use for secondary purpose only.
Reverse Osmosis (RO) desalination plant: Supplementary to primary source.

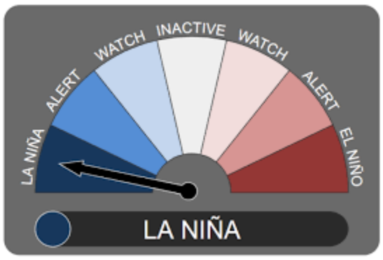
Generally across Tuvalu, drinking water supply is primarily achieved through harvesting and storing of rain, supplementary with RO desalination plant under Government through the Public Works Department (PWD) management. The ground water is not encourage to use due to contamination from household sewage systems, scatted burial grounds and chemical waste from rubbish dumps and other. This is due to the poor soil structure being porous and low-lying, along with the narrow land formation, the water lenses is so shallow and easily contaminated. However to some extent groundwater is used for domestic needs to ease on the pressure of the use of primary source (secondary usage) such as feeding pigs, washing pig pens and flushing toilets. But during extreme events such as droughts its use extends to washing clothes, bathing and even drinking (to some outer islands, however safe practices/measures still applies).

Factors influencing our primary supply – El Niño-Southern Oscillation (ENSO)

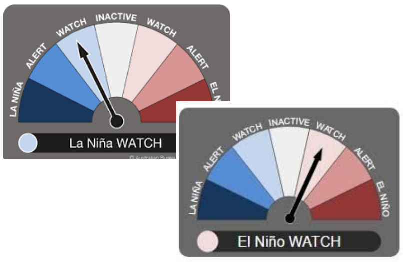
El Niño/La Niña is a major source of climate variability in the Pacific. This phenomena is caused by the changing in trade winds and ocean temperature across the Pacific Ocean. Moving about the main cloud pools (namely the south-pacific convergent zone, inter tropical convergent zone and the west-pacific monsoon) across the Pacific Ocean influencing rainfall patterns, sea surface temperatures and tropical cyclones.



In an ***El Niño condition,*** trade winds weakens and warm water moves to the east bringing the cloud together a little to the centre of the Pacific. This phenomena is in favour to Tuvalu's need of rain supply, it brings more rain (7 to 10 months of rain throughout the year inclusive of more cyclone events) and sometimes high sea level which may cause flooding and inundation to our islands. Whereby to the western countries like PNG and Palau it can cause dry weather and lower sea levels.



The opposite of this ***La Nina condition***, here trade winds increases (stronger than normal) from the east, therefore pushes the warm waters to the west along with the pool of clouds. Here Tuvalu experiences less rain (9 to 11 month dry spell, inclusive less cyclone events) which will lead to drought, this is where Tuvalu needs to be cautious with their water supplies. Also not forgetting our local food sources that may deplete to less rain recharge.

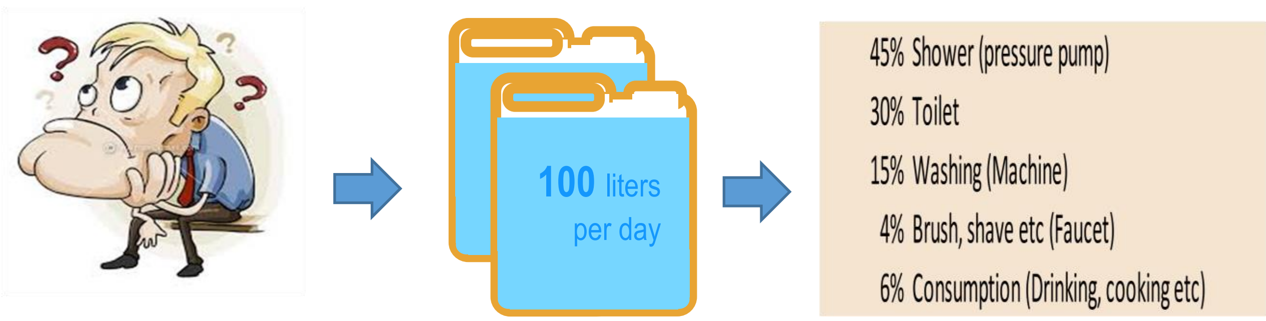


El Niño/La Niña phenomena may in times last for one year or a little longer, than it will all returns to normal. Here Tuvalu returns back to its normal rain pattern (6 months wet spell and 6 dry spell with minimal cyclone events). The cycle than rolls back after 5 to 7 years on average (give or take 2 years).

The ***key message*** here is for the user of this manual to understand that the ENSO is not climate change itself, but it is a natural phenomenon cycle that we need to adapt to in order to survive the extreme condition, La Nina condition (a good example here is the drought Tuvalu experienced in 2011).

Water Consumption per person per day + per household utility appliance (estimate average volume)

A. ***Water consumption per person per day*** *(WcPD)* means the amount (average estimate) of water used / consumed / wasted by each person in a day. This includes all usage like washing, drinking, cooking, bathing/shower, toilet flushing, faucet usage (brushing, shaving, hand washing after toilet, dish washing, etc), livestock support (feeding pig & chicken, etc), garden flourishing (flower, food crops, etc). In two previous studies in Tuvalu (SOPAC - *South Pacific Applied Geoscience Commission* & PACC – *Pacific Adaptation to Climate Change project*) indicates that an average water per person per day consumption averages around 80ltrs (PACC) to 120ltr (SOPAC). Therefore, due to two separate scenarios, this manual will be considering the average value of 100ltr per capita.



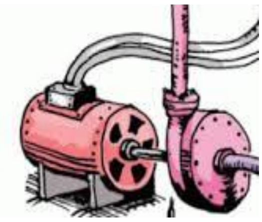
B. + per household utility appliance means the WcPD of occupants in the house in respect to the household water supply.

40% Shower (pressure pump)
30% Toilet
12% Washing (Machine)
3% Manual dishwashing (holding basin)
5% Brush, shave etc (Faucet)
6% Consumption (Drinking, cooking etc)
4% Others (live stock & gardening)

There are 3 common water service supply method practiced in households in Tuvalu, thus each method delivers different water consumption rates per person per day + per household utility appliance. The average water used per household may remain but it's the volume of consumption that differs significantly among these 3 practices. The following is an illustration on each method.

Standpipe supply - water tap stands right / at the side of the water storage. Minimum water consumption and convenient management of water storage, water from the storage is bucket fetched and transported to the household for treatment (boiling).

Gravity supply - water is transferred to an elevated level like an overhead tank and is delivered by gravity into the household. Medium water consumption and convenient management of water supply. Each time overhead tank empties, it acts as regular indication that water is running low.



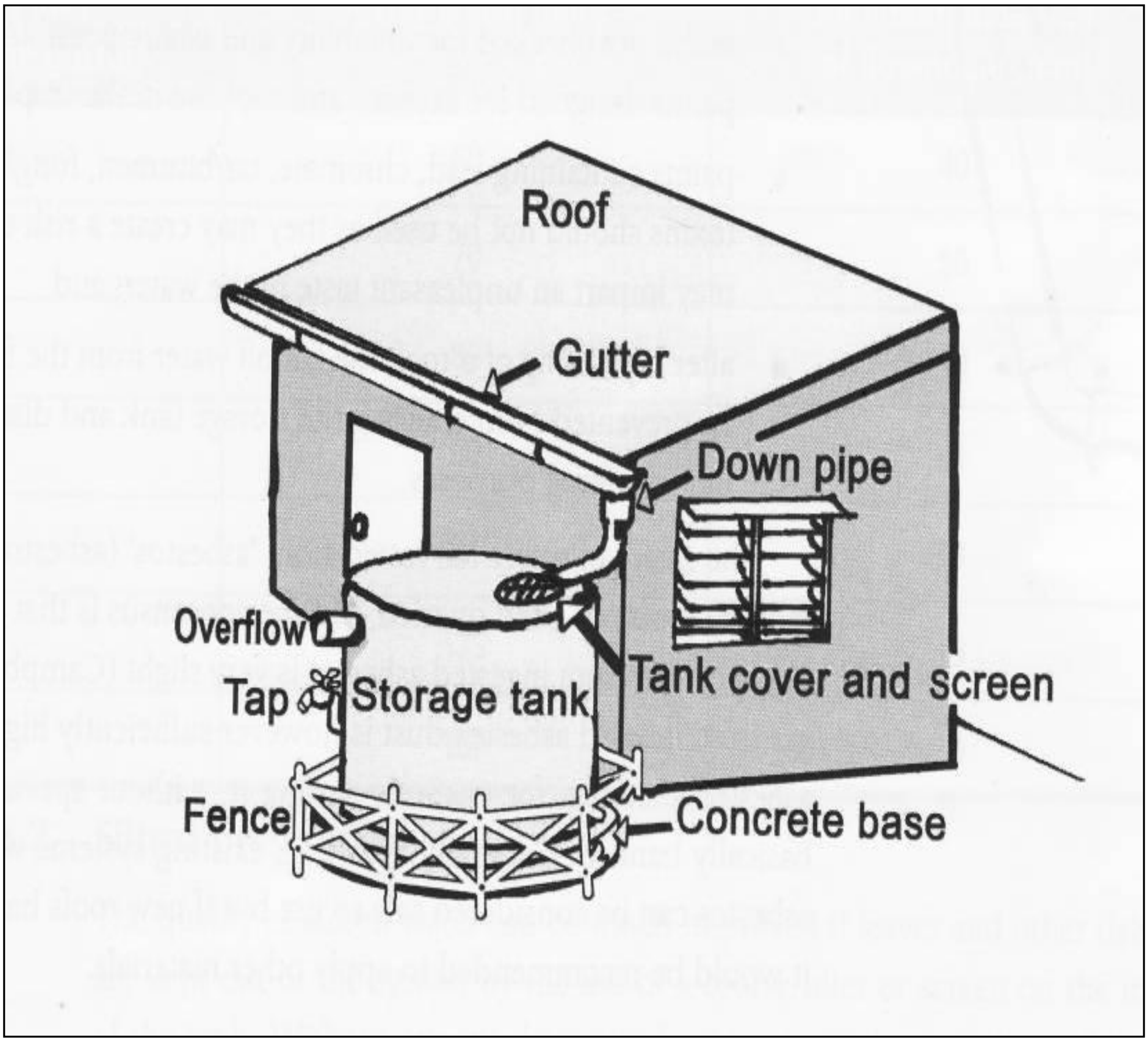
Pressure supply - water storage is connected directly to the domestic water pressure pump. Maximum water consumption, inconvenient management of water storage. Water tank has no indication when it is critical or empty.

The key message is for the reader to understand the rate of consumption per delivery system. Please refer to Chapter 7, "do's & don't" - *Indoor table's* footnotes on page 26 for rate clarification.

Chapter 2 – Water harvesting system

In the previous chapter you have learned about the general information regarding Tuvalu's water resources supplies and most of all the primary supply which is 'Rainwater harvesting'. In this chapter you will be demonstrated the importance of every micro component of the rainwater harvest system and how it is harvested.

System Components



Understanding the purposes of each components

Typical system component (in order of water flow)	What to know, understand, practice, pass on the knowledge to younger generation and most of all adapt to.
Rain	**This is the main source of drinking water**. It is vital to think & understand about climate, weather pattern & drought, its influence to the system. Visit the MET office for monthly bulletin, learn when will be the right time to stock-up and when to conserve water.
Roof	**This is the main catchment of our drinking water**. The larger the roof area + fully covered with guttering is vital to the harvesting. Important to avoid tree cover, it will decrease the catchment volume + add risk of contamination to water.
Guttering	**This is where the harvested water is collected from the roof and channelled to the down pipe.** It is important that the installation is correct, the slope is properly laid, sufficient gutter outlets to avoid water overtopping and gutter breaking, joints well sealed. Visit the PWD for
Downpipes	**This is what connects the guttering to the water storage (Tanks or cistern).** Water is taken from the roof to the storages, outlet connections must be properly fixed, it can easily break from the weight of the water draining down. Length to storage must be short, the weight will bend the pipe and break. Connection to storage must be secure, the water flow vibration will cause the pipe to divert.
First flush (optional)	**This appliance will collect/divert the dirty water (first flow) from the roof away from storage**. Important that its well install/mount fix securely to avoid causing break on downpipe. Check and fix for leaks.
Filter screen	**This is a very fine sieve (nylon proffered) covering the storage mouth.** It's to avoid leaves, large particles, insects, cats and rats entering the storage plus mosquitoes from breeding in the storage. Making sure it is properly secured to the storage mouth is vital.
Storage	**This is where the water is stored, kept safe and protected from contamination.** The storage must be water-tight, leakage free and clean. Occasionally cleaned say 3 tie a year or when the water appears dirty. Can add 'White King' for disinfectant (see chapter 5).
Storage base (main for tanks)	**This is where the tank is to permanent stand or positioned.** It is vital to set the base level, unevenness ground and sharp rocks may cause the tank to crack / puncher. A proper concrete base is advisable. If the tap is directly from the tank (stand tap), it is advisable to fence it to safe guard from animals contamination.
Continue to next page	Continue to next page.

Over flow

This the opening (hole) at the top of a storage to allow the excess water when full to flow out. It is vital to have this opening for it shall avoid the water overflowing out of the mouth causing damage to the filter screen, therefore allowing contamination into the storage. It will also alert the family the storage is full. Screen this opening is advisable to avoid mosquitoes from breeding in the waters.

Storage outlet

This is the lower opening of the storage that is used to/for connecting each other and to the tap. If there are multiple storages connected, making sure the stop valves are open to allow water to flow to fill other storages is vital. Also check that the connecting pipe are water-tight.

Stop valve

This is the valve connected right at the storage outlet. This appliance is vital, it controls the flow from other tanks and to the tap. A good water management tool, can be used to isolate one storage from the others, also when maintenance works is required. Advisable to use pvc ball-valve type, suite well with the atmosphere.

Stand tap or HH tap

This is the point of which water is discharged / collected by users. For stand tap beside the tank it is vital to have it fences properly to avoid animals reaching it, breaking or contaminating it. For HH tap, piping must be water-tight. Preferable 15mm socket size tap.

Collecting container

This is where water is collected and carried / transferred to or for in-house storage. It is vital for the container to be clean and have a proper seal lid / cover, this is to avoid contamination before reaching the household storage.

Household storage

This is where water is to be kept / stored inside the house before consumption. Likewise the collecting container, the storage container must be clean and have a proper seal lid / cover, also heat resistant (should water be boiled), this is to avoid contamination before consumption.

Vital factors

Important factors to be considered to your water system to allow easy management and avoid problems.

Storage level gauge

This is useful to measure and monitor the level of water a family has in their storage. It is vital for management purposed.

Fencing

Important to have your storage and system (pipe lining) fenced properly to avoid animals (dogs and pigs) and intruders accidently break them (stand taps, expose water pipe lining etc).

Chapter 3 - Management & Planning

This chapter will demonstrate methods on how to manage our harvested supply, plus methods on planning to sustain our supply.

But first we need to learn about our supply and demand, the 'How much we can/will collect and how much we will use/waste.

Supply, Consume & conserve

Supply - It is important to know how much water you will collect from every time it rains. Below the standard formula that will / may give you a fair idea of how much water will/ is collected from your roof, this is provided that the roof is fully (100%) cover with guttering also there is very little or no leakage to your guttering, plus very little or no tree coverage.

ROOF AREA X RAINFALL VOL (millimetres) X 85% = HARVEST RAINWATER VOLUME (EST)

- Roof area = length of roof X width of roof
- Rainfall volume in millimetres (this is the rainfall measurement per rainfall event) = this volume you can get from the MET rain gauge.
- 85% = this is the standard estimate (est) run off coefficient (can also be 0.85), it has been calculated that 15% of harvested is lost to 'Overflow, leakage and evaporation' provided the guttering to the building is very good and properly fixed (no leakages etc). However should your guttering condition fall under the following categories below, use the respected related coefficient.

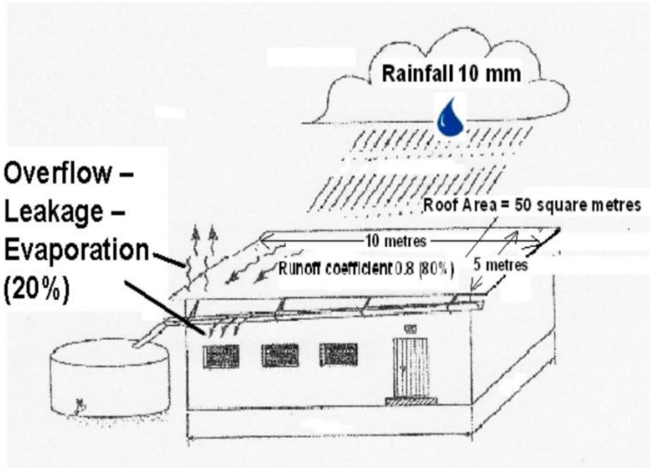
Gutter Condition	Description of condition	Rainfall Coefficient
Good	Totally no leakage	85%
Adequate	Partially leakages (eg minor leaking at connection)	75%
Repair	Some connection to guttering are loose or separated	50%
Replace	Guttering are broken and need urgent replacement	25%
None	Roofing with no guttering.	0%

(Adopt from PWD's Water & Sewage unit '*Water supply Module'* that was produce in close collaboration with the Secretariat of the Pacific community - SPC)

Example,

The diagram above shows the following;

- Rainfall volume from MET = 10 mm (0.01m = 10mm)
- Roof length = 10 m
- Roof width = 5 m



Therefore;

- Roof area; = 5 m x 10 m = 50 m^2
- Rainwater harvested (volume);

Mathematically

- 50 m2 X 0.01 m x 0.85 = **0.4 m3** (0.4m3 = 400 ltr)

(400 litres, equivalent to 35.6 Punjas breakfast cracker bucket (one punjas bucket carries about 10 ltr water).

Below is a table 1S illustrating a fair idea of how much water you or a roof shall collect in various rainfall measurements (MET daily data) verse roof catchment taking in to consideration the 85% coefficient.

Table 1S

Roof Size Square Metres (m2)	RAINFALL IN MILLIMETRES (mm)									
	10	20	30	40	50	60	70	80	90	100
	WATER COLLECTED IN LITRES (L)									
40	320	640	960	1,280	1,600	1,920	2,240	2,560	2,880	3,200
50	400	800	1,200	1,600	2,000	2,400	2,800	3,200	3,600	4,000
60	480	960	1,440	1,920	2,400	2,880	3,360	3,840	4,320	4,800
70	560	1,120	1,680	2,240	2,800	3,360	3,920	4,480	5,040	5,600
100	800	1,600	2,400	3,200	4,000	4,800	5,600	6,400	7,200	8,000
150	1,200	2,400	3,600	4,800	6,000	7,200	8,400	9,600	10,800	12,000
200	1,600	3,200	4,800	6,400	8,000	9,600	11,200	12,800	14,400	16,000
250	2,000	4,000	6,000	8,000	10,000	12,000	14,000	16,000	18,000	20,000

Consume - It is essential to understand how much water you / person will wasting or consuming from your / their storage and how long / many days left will the storage likely last for you / your family to survive. Recalling from chapter 1, several studies were conduction with different scenarios. Therefore find illustrated in tables (1C & 2C) below illustrates a fair idea of how much water is wasted / consumed from your / families storage per day in respect to a range from 200ltr to 40ltr per day per person. Important is to note the grace period or number of days the storage will last for you / family have till it runs out.

Table 1C

WATER IN TANK LITRES (L)	WATER (liter) USE PER DAY - PER ONE PERSON					WATER IN TANK LITRES (L)	WATER (liter) USE PER DAY - PER FAMILY OF 5				
	200	100	80	60	40		200	100	80	60	40
	DAYS WATER WILL LAST						DAYS WATER WILL LAST				
1,000	5	10	13	17	25	1,000	1	2	3	3	5
2,000	10	20	25	33	50	2,000	2	4	5	7	10
3,000	15	30	38	50	75	3,000	3	6	8	10	15
4,000	20	40	50	67	100	4,000	4	8	10	13	20
5,000	25	50	63	83	125	5,000	5	10	13	17	25
6,000	30	60	75	100	150	6,000	6	12	15	20	30
7,000	35	70	88	117	175	7,000	7	14	18	23	35
8,000	40	80	100	133	200	8,000	8	16	20	27	40
9,000	45	90	113	150	225	9,000	9	18	23	30	45
10,000	50	100	125	167	250	10,000	10	20	25	33	50
15,000	75	150	188	250	375	15,000	15	30	38	50	75
20,000	100	200	250	333	500	20,000	20	40	50	67	100
30,000	150	300	375	500	750	30,000	30	60	75	100	150

Table 2C

WATER IN TANK LITRES (L)	WATER (liter) USE PER DAY - PER FAMILY OF 10					WATER IN TANK LITRES (L)	WATER (liter) USE PER DAY - PER FAMILY OF 15				
	200	100	80	60	40		200	100	80	60	40
	DAYS WATER WILL LAST						DAYS WATER WILL LAST				
1,000	1	1	1	2	3	1,000	0	1	1	1	2
2,000	1	2	3	3	5	2,000	1	1	2	2	3
3,000	2	3	4	5	8	3,000	1	2	3	3	5
4,000	2	4	5	7	10	4,000	1	3	3	4	7
5,000	3	5	6	8	13	5,000	2	3	4	6	8
6,000	3	6	8	10	15	6,000	2	4	5	7	10
7,000	4	7	9	12	18	7,000	2	5	6	8	12
8,000	4	8	10	13	20	8,000	3	5	7	9	13
9,000	5	9	11	15	23	9,000	3	6	8	10	15
10,000	5	10	13	17	25	10,000	3	7	8	11	17
15,000	8	15	19	25	38	15,000	5	10	13	17	25
20,000	10	20	25	33	50	20,000	7	13	17	22	33

Conserve – Tuvalu is blessed with a lot of rain in a year, unfortunately it's weathered as learned in chapter 1, minimum of six month plenty and six month little rain. Plus we learned that water is stored in tanks / cistern beside households and community halls. Therefore managing of water is dealt either communally by the leader or representative of the community or household's head of the family. Thus it is encourage for the leaders or heads to understand vividly the philosophies of 'supply and consume' in order to manage wisely their storages. Developing an 'ACTION PLAN' would precisely fit the concept of our context.

Follow's is an example of an ACTION PLAN that the leader / representative or head of family may us to manage their water. The content can be changed to suit the context.

Table 1Co

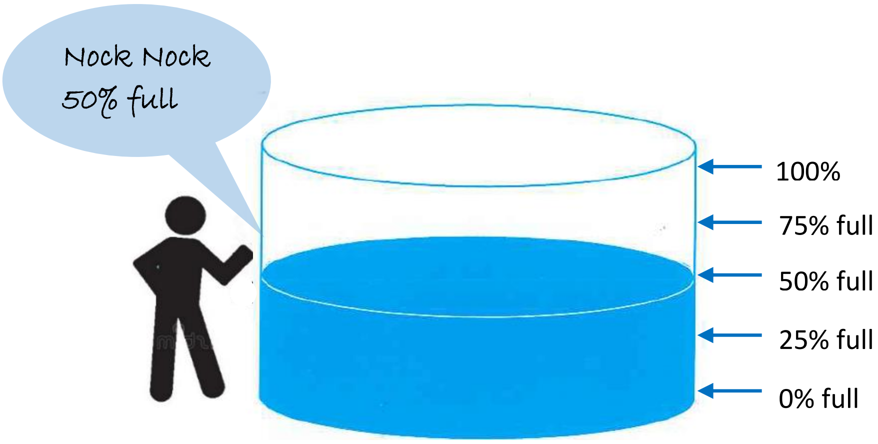
Tank Water Level	Action		Responsibility	
	Communal	Household	Communal	Household
Full	No ration per family, collect as much as needed.	No action	Water storage representative	Head of family
3/4 full	Ration to maximum of 20 bucket per family per day. Make aware the community of water level by annoucing or putting up sign at storage showing water level.	Make aware family members of water level	Water storage representative	Head of family
1/2 full	Ration to maximum of 10 bucket per family per day. Make aware the community of water level by annoucing or putting up sign at storage showing water level. Ask MET office for climate forcast	Make aware family members of water level. Start water conservation practice (see chapter *** to do's and not to do's). Start collecting or purchasing water from community or water authorities bodies (PWD / Kaupule). Ask MET office for climate forcast.	Water storage representative and community leader	Head of family
1/4 full	Ration to maximum of 5 bucket per family per day. Make aware the community of water level by annoucing or putting up sign at storage showing water level. Ask MET office for climate forcast plus alert Disaster office of status to water storage. Update daily office of Disaster on water level.	Make aware family members of water level. Start water conservation practice (see chapter *** to do's and not to do's). Start collecting or purchasing water from community or water authorities bodies (PWD / Kaupule). Ask MET office for climate forcast. Alert community leaders or water authority bodies on water level so that leader shall data base make ready for Disaster alert.	Water storage representative, community leader disaster representative	Head of family & community representative
Empty	Stop ration, update Disiaster office on status of water storage level.	Alert community leaders or water authority bodies on status of water level.	Water storage representative, community leader disaster representative	Head of family, community representative & disaster representative

Monitoring - How to check water level in storage.

Option 1 – Plastic water storage

A. On the side of the storage, stating from the bottom, tap the side of the storage and listen for a sound changing
B. When the sound changes from a solid sounding-like to a hollow sounding-like, that point indicates where the water level is.

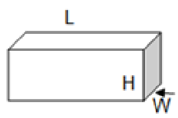
Note: this way of measuring is sometimes not 100% accurate when you are wanting to find the volume, this is for estimation volume reading. For an accurate volume reading you can use option 2 below.



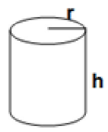
Option 2 – Concrete storage (underground or above)

A. At the mouth / opening of the storage, take a long straight PVC pipe (15mm or 20mm would do) or a clean straight dry stick (cleaned proper).
B. Put the PVC or dry stick through the mouth or opening of the storage until it reaches the bottom of the storage.
C. Quickly pull out the PVC or stick and quickly mark the edge of the wet surface on the PVC or stick.
D. Us a measuring tape to read the measurement from the bottom of the PVC or stick to the wet edge marking, measure in centimetre is encouraging.
E. From the measurement collected from step 4. Calculate the volume available and percentage it out to find the volume you have left available.

<u>Volume formula</u>

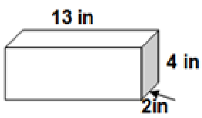


Volume = L • W •H
Volume = Length • Width• Height



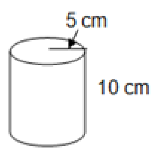
Volume = area of base • height
Volume = $\pi r^2 h$
** The base is a circle, so the area of a circle is πr^2

Example:



Volume = L • W •H
Volume = 13 cm • 2 cm • 4 cm
Volume = 104 cm³

Example:



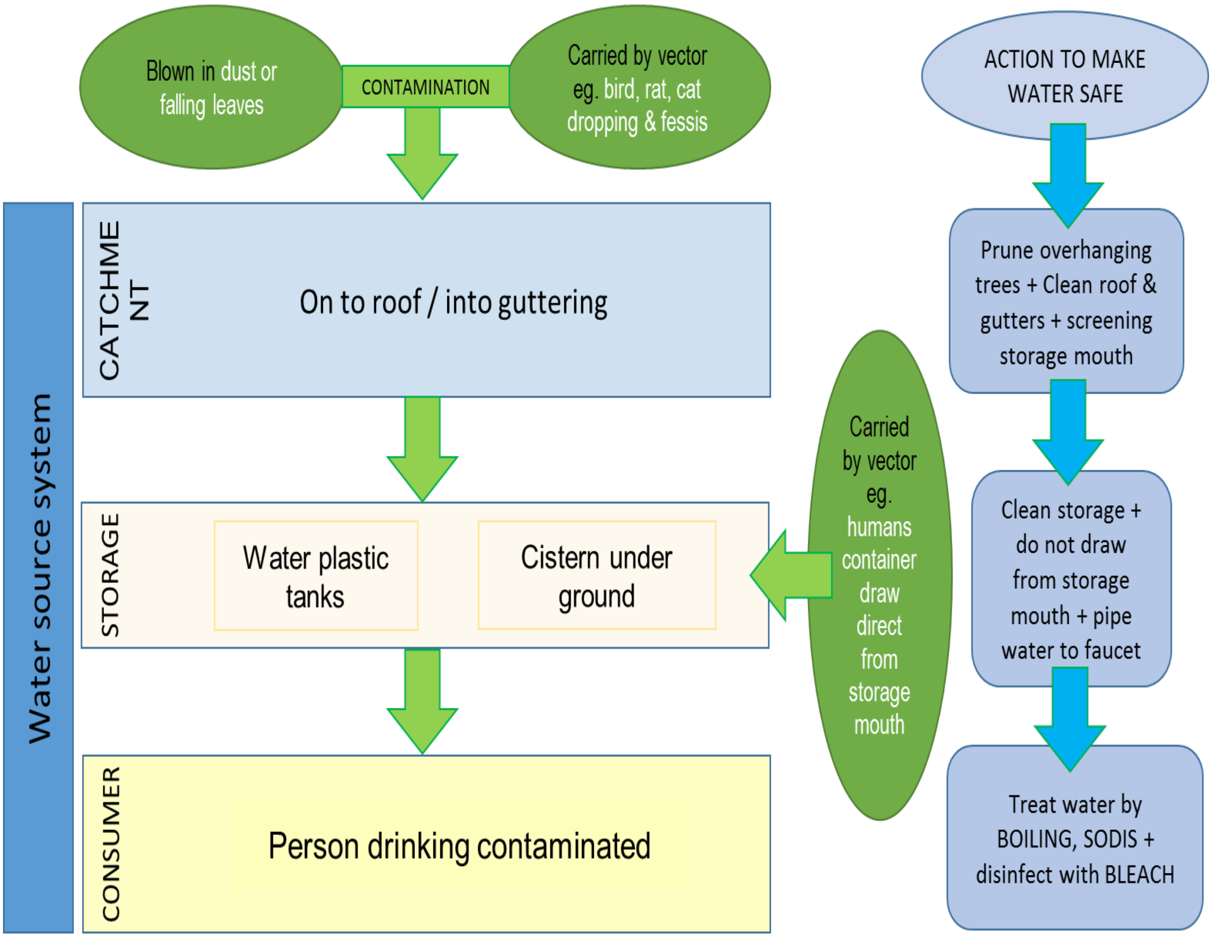
Volume = $\pi r^2 h$
Volume = $(3.14) \cdot (5\ cm)^2 \cdot 10cm$
Volume = 785 cm³

Chapter 4 – Health safety measures

We have learned by now that our primary water source is roof caught / harvested, channel to the gutter then drained into the water storage and most time tapped into a container (cup or bucket) before consuming. A drop of water surely travels a long way and time till it reaches a consumer, exposed and vulnerable to all kind of contamination, therefore this chapter will make you understand how water can be contaminated if the water system is not properly taken care of and most of all household safety practices options of how to disinfect your drinking water.

How can rainwater become contaminated & action to making water safer

The flow chart below will give a snap shot of how your primary water source can be contaminated and actions that can help reduce the hazard.



Simple methods to keeping your drinking water safe

A. Disinfecting water storages using bleach.

If it has been at least 12 months since you last cleaned your storage then you should / must disinfect it. You should / must disinfect your storage when some of the following below have happened.

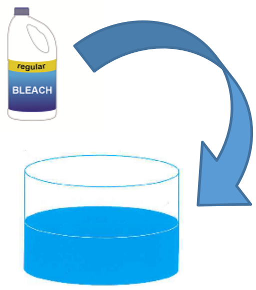
- Animal or human waste, bird droppings has entered the storage.
- A dead animal (eg cat, rat, lizard etc) is found in the storage.
- After tank repairs or cleaning, eg someone has been inside or plastering finish to cistern.
- The water has been tested for bacteria and is known to be present.
- Family members or people a getting sick from consuming (diarrhoea etc)

Steps to follow – Bleaching

STEP 1	Estimate volume of water in storage
STEP 2	Add 125ml of bleach to every 1000ltrs of water in storage. This is base on using bleach with 4% active chlorine. Make sure that bleach is unscented. Mix water and bleach.
STEP 3	Leave storage mouth open to allow chlorine to evaporate. Wait for 24 hours at most before consuming the water.

Bleach comes in 750ml a bottle. Make sure that the bleach used is 'regular' unscented. Below tabulates the appropriate volume (water) required be disinfected with bleach added.

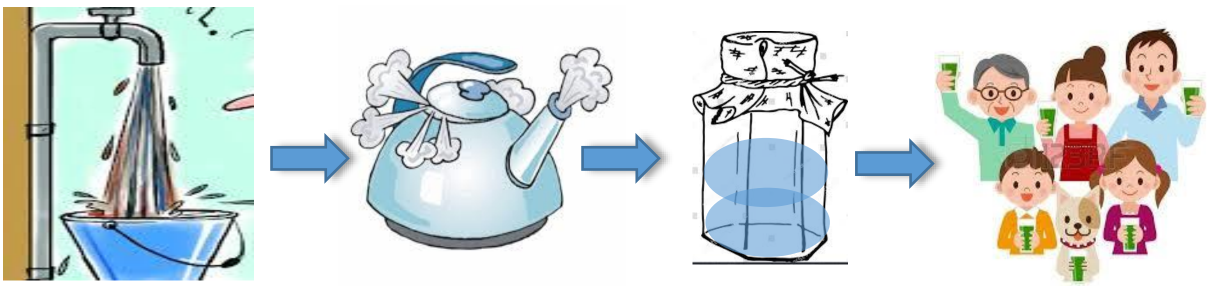
Volume of water in storgae	Amount of bleach need add
1000 liter	125 ml
2000 liter	250 ml
3000 liter	375 ml
4000 liter	500 ml
5000 liter	625 ml
6000 liter	750 ml (1 bottle)



Water storage / tank

B. Before consuming.

Most effective and low-cost solution to keeping your drinking waters safe is simply by **boiling your waters** (let it boil for at least 3 minutes) and storing it in a clean container well close with a tight seal lid (eg punja's breakfast crackers bucket). It is encourage that the ready boiled water in the container must not be left for more than three (3) days, if store longer any bad germs could reproduce and contaminate the water making it unsafe again for consuming.



Water collect from tap — Let boil for at least 3 minute — Store in seal clean container — Consume within 3 days

Chapter 5 – IWRM Intervention.

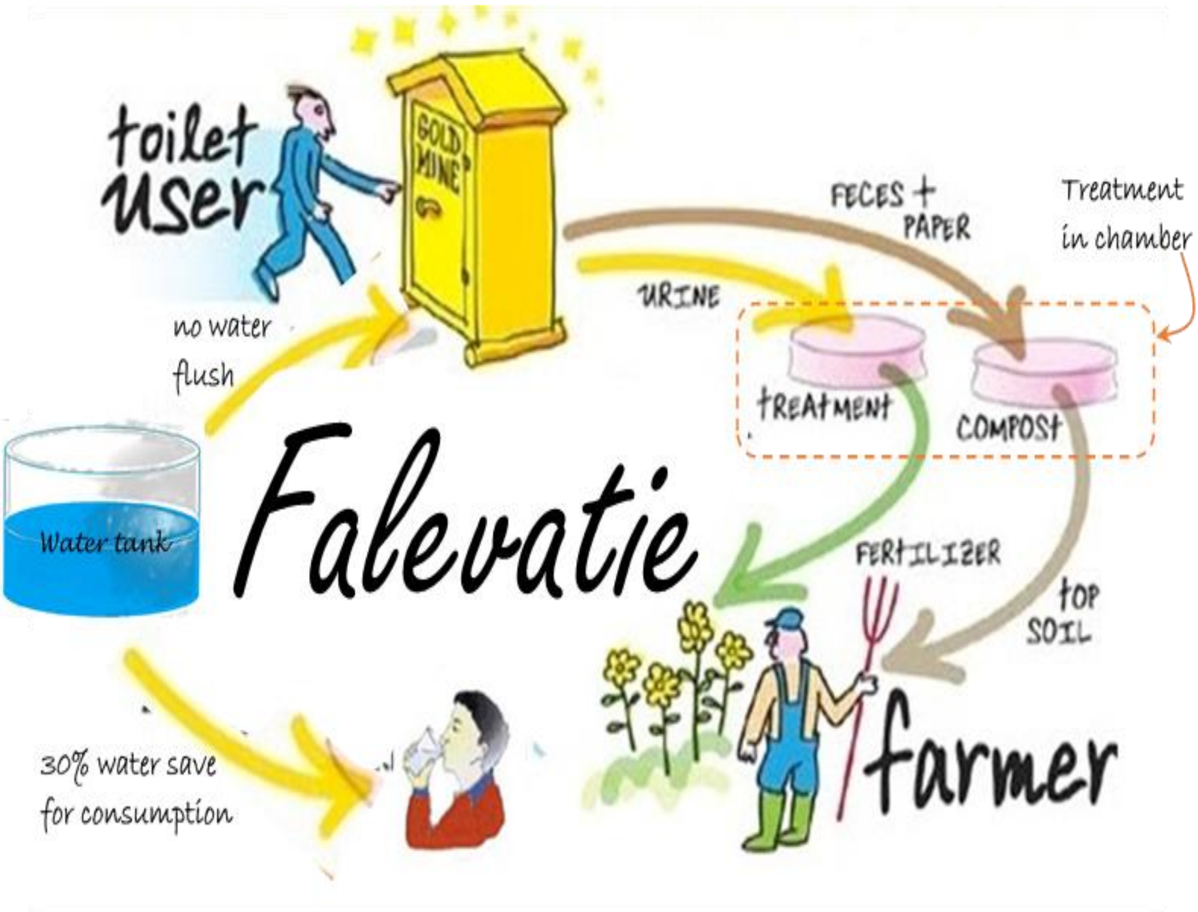
Several measures on water security have already been implemented in Tuvalu in the past years. These interventions merely is for the betterment, safe, healthy and a secure green environment for the people of Tuvalu. This chapter will illustrate the interventions in respect for the readers to understand the importance of;

- What is it and
- How does it work

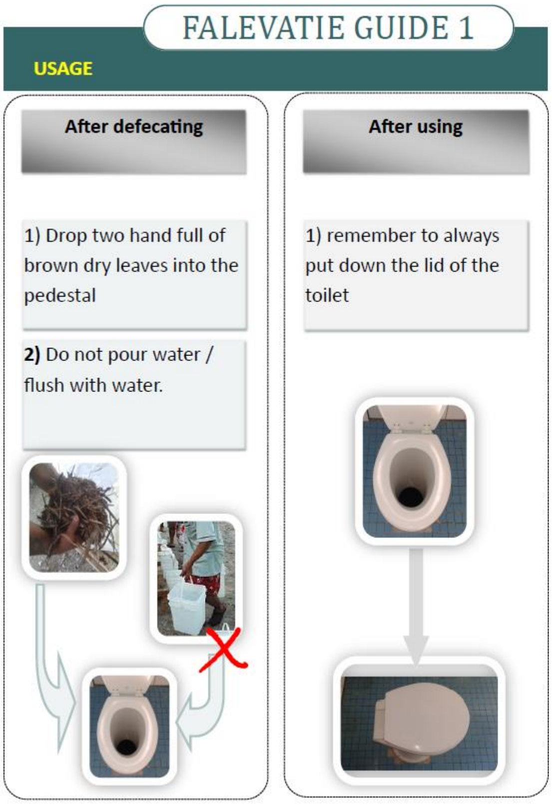
Water Conserving Interventions.

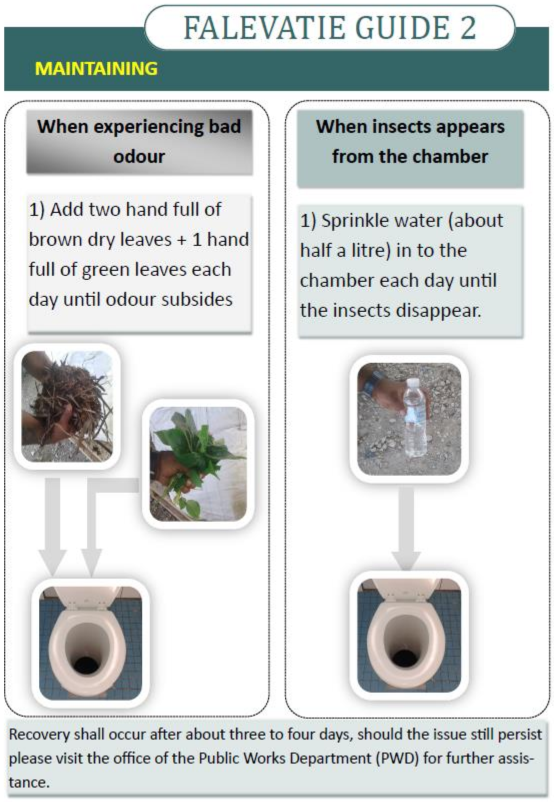
Falevatie (ECO-dry sanitary composting twin chamber toilet).

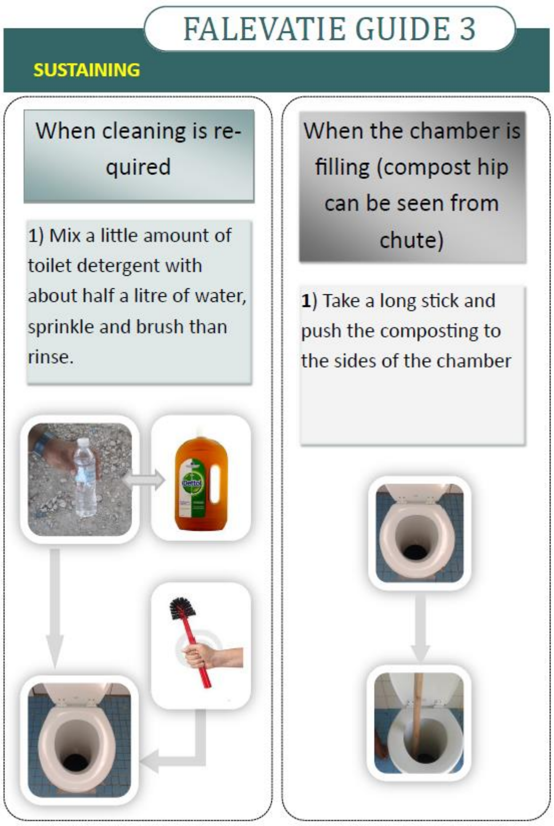
Falevatie is implemented mainly to solve two (2) major issues or problem Tuvalu is facing due to the fast growth of development and population. The issues are, water scarcity and ground water degradation due to intensive septic effluent. Falevatie benefits in saving about 30% of household rainwaters and does not produce effluent however agricultural rich composting materials. How does it works? It's simply by flushing the toilet with brown dry leaves (no water flushing).

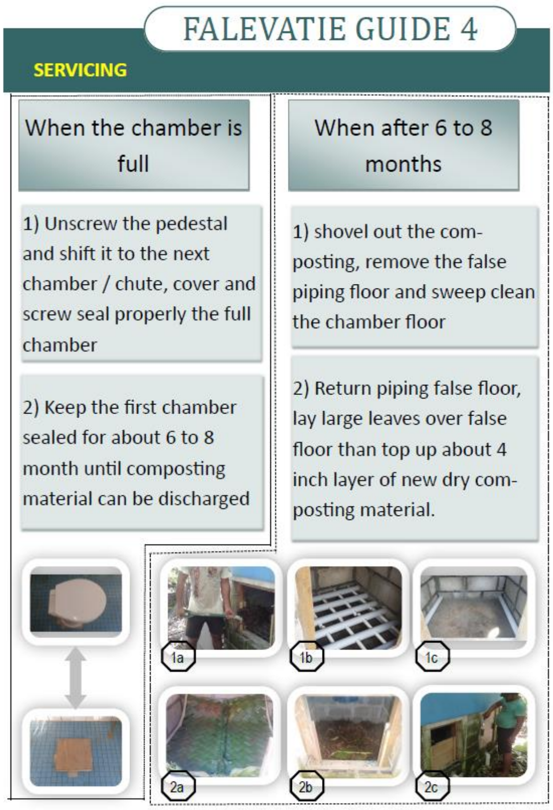


Below is a simple guide of how to use, maintain, sustaining and servicing a Falevatie.







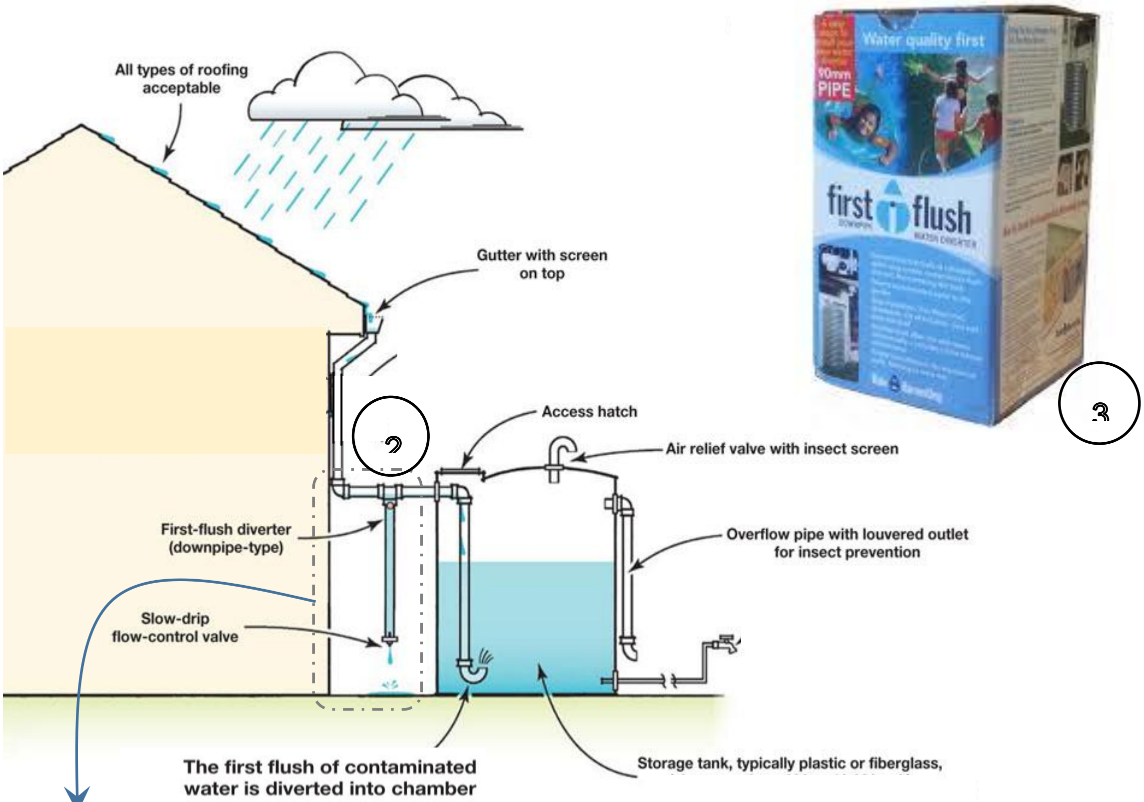


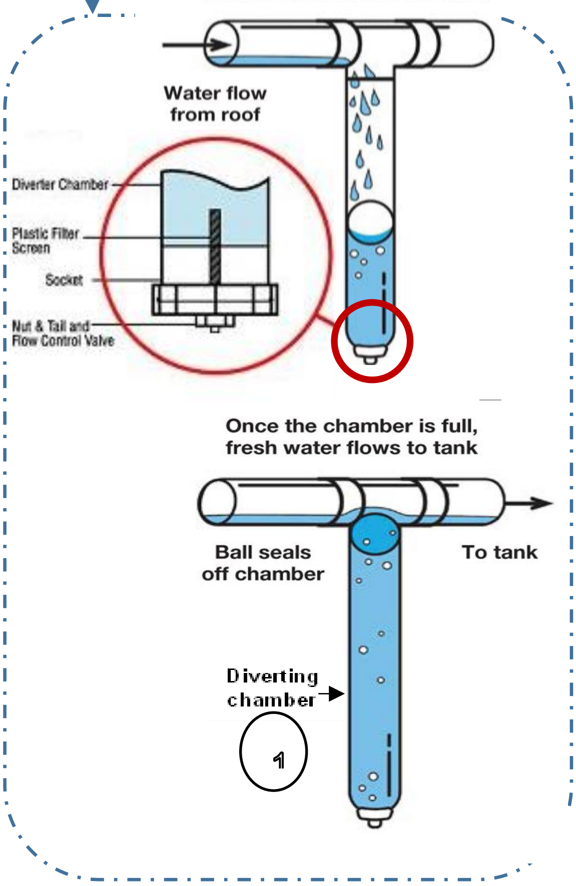
Note: Should you be interested on a Falevatie, refer to the IWRM; '**Falevãtie manual construction; operation & maintenance (version 1) 2013'** document available at the Ministry of Public Utilities & Infrastructure.

Safe & Quality Water Interventions.

1. First flush water diverter technology

First flush water diverter is implemented in to help keep our rainwaters safe from contamination, since roofs plays the most important role in collecting our primary source 'rainwaters'. You should have already understand how rainwater can be contaminated from chapter 4, therefore this technology simply helps / allows divert the contaminated rainwater and preventing it from entering the storage.





Installation guide steps.

1) Check that the roof and the guttering is clean from falling leaves.

2) At the gutter outlet directly at the downpipe connecting to the storage, determine the length of the diverter chamber **(1)** (downpipe to ground) allowing about 1m clearance from ground.

3) Install first flush appliances **(2)** by following the instruction on the *'first flush downpipe water diverter container* **(3)**'

2. Solar Disinfection (SODIS) water treatment.

SODIS (Solar Water Disinfection System) is a simple, Low to No cost solution for preparing healthy and safe drinking water at the household level. This system uses the natural sunlight rays (UV from sunrays) and the sun heat to eliminate at least 99.9% of germs in the water.

Below you can see how this system / practice is done.

Step 1 - Cleaning the bottle

a. Wash the bottle well with dish washing dertergent the first time you are to use it

b. Make sure the bottle is labled PET 1 (it's usually notice molded at the base of the bottle)

¾ full

Step 2 - Filling the bottle

a. Fill the bottle 3/4 full with water from your drinking water source

b. Do not fill the bottle all the way up to the top

Step 3 - Bubbling the water

a. Shake the bottle for at least 15 seconds

Note: Shaking the bottle gets air into the water (through bubbles) Bubble will help kill the germs

SODIS

Solar Water Disinfectant System

(Efficient and sustainable)

1. Untreated water
2. Natural treatment, No Cost (UV sun light)
3) Healthy & Safe for drinking

Step 4 - Topping up the bottle

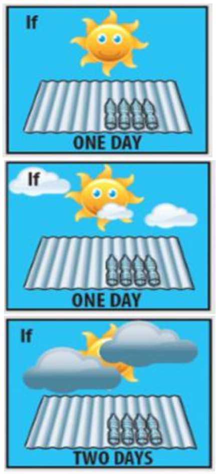
a. Fill the bottle all the way up to the top and close the lid tight

Note: Make sure the bottle is clear of lables or any makings before putting under direct sunlight

Step 5 - Placing bottle under direct sun light

a. Place the bottle on a roofing corrugated iron sheet.

b. Make sure the roofing sheet is placed at an exposed area (roofing top is the best place to put ready bottle)



Step 6 - Exposing periods

a. Expose ready bottle under direct sunlight from morning till evening (one day)

Important:

If sunny day leave bottle for at least 6 hours

If the day is moderate cloudy, leave bottle for more than 6 hrs

If the day is mostly cloudy, leave the bottle for at least 2 days

If rainy day, you will need to boil your waters

Step 7 - Safe for consumption

a. Water is now ready for comsumption, prefered to drink directly from bottle or from a clean cup

If want to stock water, it is advicable to store bottle safe and try to consume it within 3 days. If left longer bacteria may start to grow and contaminate the wate

Chapter 6 – Traditional Knowledge & practises

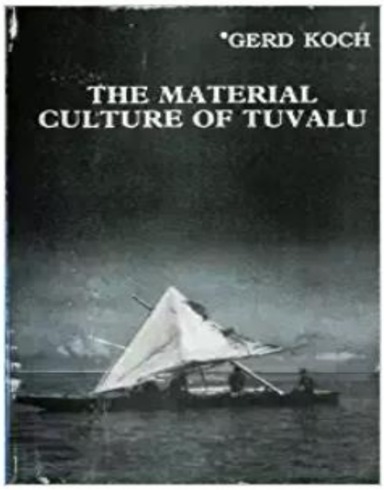
In the very early days before the arrival/first contact of the traders and missionaries it is strongly believed that rainwater was not the primary source of water source. Our ancestors live of the land and sea, ground water was the main source of drinking waters apart from coconut source (toddy and the green nuts). Rain water was merely placed as the secondary source, used mainly for food processing, occasionally drinking and bathing. This is due to the fact of limited large storage equipment's such as tanks and concrete cisterns. Rain water was harvested and collected in a *Tanoa* or *kumete* (consider the largest container at the time). Otherwise *kao kaleve* (bottle-ish container made of ripe coconut shell used to collect little amount of water for easy mobility) was used to collect ground water from *Pulaka pits* after attending the plantation.

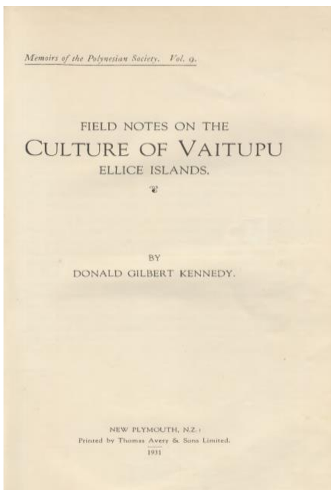

Kao kaleve – ripe coconut shell used normally for toddy collecting

It is strongly believed as well that our ancestor immune system is immune to the ground waters regardless the slight level of hardness and harm present (not confirmed). From that note sanitising practises was believed not practise during those early days.

However after the arrival/first contact, the foreigners were believed not immune to our ancestor ways of living, and with the availability of pots brought along with, they (foreigners) slowly begin introducing sanitation and drinking of rainwater. This practised is one of the many influences brought in by the foreigners. From those newly influences and practises rainwater started to become the primary source of drinking water till today.

Follows are practices that was believed practices by our ancestors before and after the arrival/first contact to our shores.





Water sources

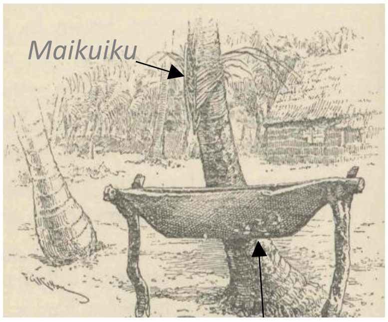
Ground water – ***the search for the right location***. Selecting the right location to dig was not something done for fun. It requires a certain skill of observation by a/some certain people. Here as shared, a good location can be found by one must first look at the reef, where the reef stretch out the most (*te u'tua*), right into inland (distance inland was not identified) a fair distance ground water can be found and is good for drinking.

Ground water – ***sourcing from the Pulaka plantation***. In the early days fetching ground water from the plantation is normally practised by those whom visit the plantation. And is not fetch at any time of the day other than the early morning hours (dawn), this is when the water is undisturbed and it is clear. With the help of the *pu'kao* the very top surface is gently and carefully skimmed/scooped filled into the container (several if required), one maybe used for his refreshing/drink while at work and the remaining will be taken home for the rest of the family.

Pulaka plantation at the early morning hours.

It was also shared that during severe drought (to these days) some families fetch water using this practise, sanitizing (boiling etc.) is required before consuming.

Rainwater Harvesting – ***using the coconut tree.*** To collect a lot of rainwater it is important that the concept is achieved. It is important that the coconut tree has a large sky coverage (lengthy leave with large long fronds), little or no tree coverage from above. The tree must be leaning towards a side and most importantly the gutter component which in the early days was known/called the *maikuiki* and a collecting container (*tanoa* or a *kumete*). The *maikuiku* is the tip of the coconut leaf cut off about a 2 feet length (import to select a leaf with long fronds) the fronds are than wrapped around the coconut trunk and bread/weaved tied to avoid falling, the *maikuiku* must be place close to the collecting container mouth.



Wooden *kumete* & coconut leaf guttering (*maikuiku*) for catching rainwater

Rainwater Harvesting – ***using large surface leave (pulaka plant).*** As shared this practise is not commonly use compared to the above method. This method is only use in critical occasions/situation (when there was/is a prolong dry spell, etc). Here, large pulaka leaves are collected and placed on a slope deck with a collecting container at the collecting end. Another method is just place the collecting container right below the pulaka plant.

Example on how rainwater is collected using pulaka leave

Sanitation methods

Ground water wells – use of ready burnt lime stone (*fatu lase*). One account shared that in the early days burnt lime stone (*fatu lase*) was used to sanities the well waters (ground water) by just placing several stone at the base of the well, it was believed that the reaction of the burnt lime reacts in the hard water will eliminate harmful bacteria's (need confirmation).

Boiling water – using ripe coconut shells (*pu'kao*). Water is filled into the young coconut shell (*pu'kao*) properly cover with pandanus leaf lid and placed it into the ground oven (*te umu*), left there for few minute (depending on the cooks judgement per the heat of the oven). When time is ready the water is sanitised, ready and safe for drinking.

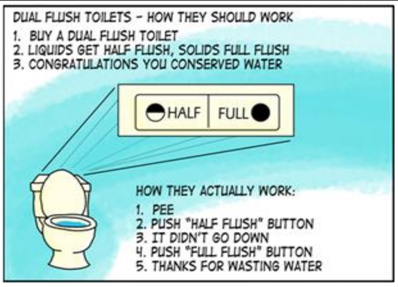
Pu'kao – food container from the young coconut shell (mototo)

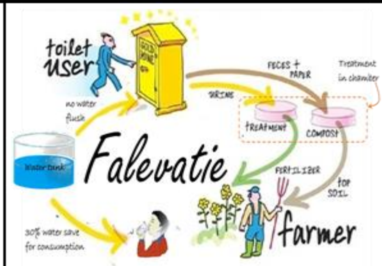
Using the sun heat – exposing the container of water to open sun. This practise is believed to be most resent. Here the container fill with water is place on/at an open area (high grounds) exposed to sun for the whole day or until the water can be felt hot, there than it ready for consumption.

Chapter 7 – Encouragements

By now you should understand the importance of rainwater, how it's harvested, it can get contaminated and ways to improve or keeping it safe for consumption and ways you can improve to conserve. However the main challenge left is encouraging oneself behaviour, for minor water mismanagement is something easily forgotten whereby of high impacted. Follows are some basic behaviour we do every day that waste our precious water thus are so little it easily slips our mind. On the same note, follows are some encouragements that may assist in changing the behaviour by conserving practices. These change in habit do come in handy when we are in our dry spells or heading towards La Nina.

1. Do's & Don'ts

<table>
<tr><th colspan="3">Indoors</th></tr>
<tr><th>Do's</th><th>Don'ts</th><th>Encouragement</th></tr>
<tr>
<td>
Turn off sink tap when brushing, soaping hand or shaving etc.</td>
<td>
Let the water running when brushing, soaping hand or shaving.</td>
<td>
Use a cup for brushing or a bowl for washng hands / shaving</td>
</tr>
<tr>
<td>
Wash dishes in a holding basin (1 for soap wash and the other for rinsing)</td>
<td>
Let the tap run while washing the dishes</td>
<td>
Wipe off remaining food on plate before washing, to avoid rapid water renewing.</td>
</tr>
<tr>
<td>

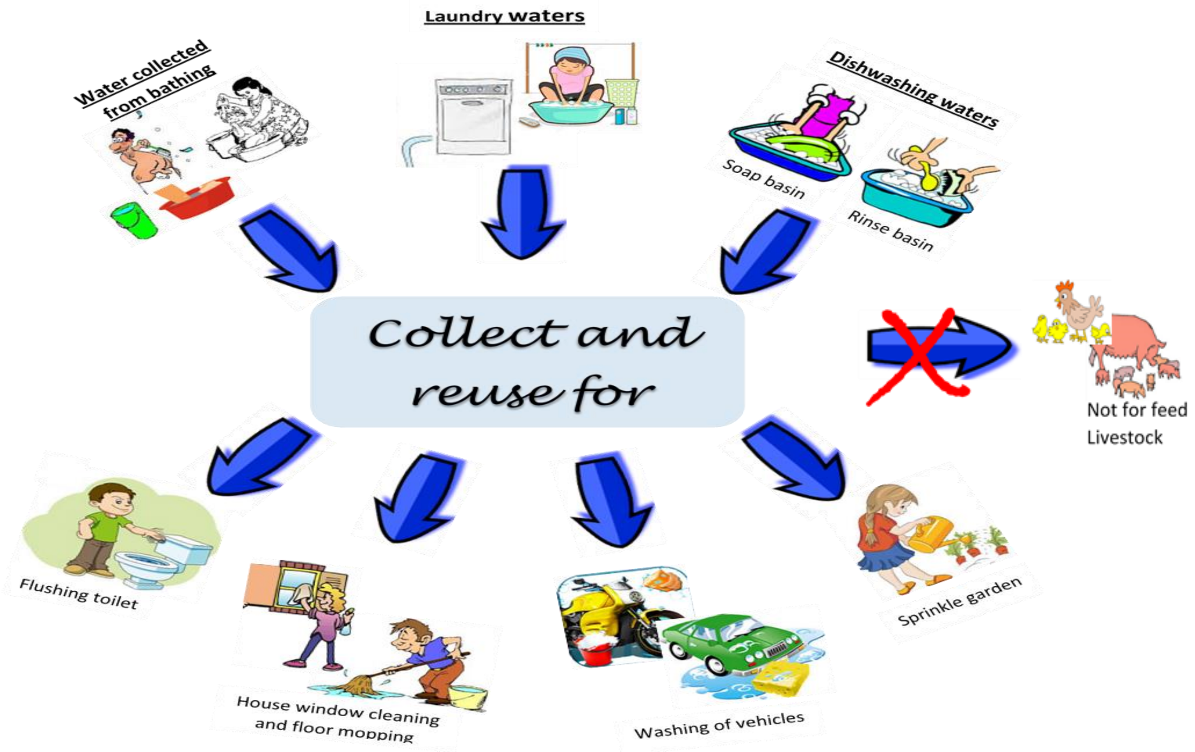
Install dual flushing cistern type and remember to use it accordingly</td>
<td>
</td>
<td>

Try converting or adopting to Falevatie, this technology will save 30% of your drinking waters</td>
</tr>
<tr>
<td>
Take short bathing / shower. Turn off valve when applying soap to body.</td>
<td>
Let water running when putting on soap.</td>
<td>
Taking a bucket bath would be more conserving.</td>
</tr>
<tr>
<td colspan="3">Note:
• Most domestic pressure pumps in 5 minute discharge about 17 gallons, equivalent to at least 6.5 punja biscuit buckets. (punja bucket carries about 2.5 gallons (11.5 ltrs))
• Overhead tanks gravity in 5 minute discharges (15mm faucet) about 6.3 gallons, equivalent to at least 2.5 punja biscuit buckets
• It will take at least 1.5 punja biscuit buckets for an adult to fully bath.</td>
</tr>
</table>

Outdoors		
Do's	**Don'ts**	**Encouragement**
		
Use a springkling can to water food crop / garden around your home	Connect springkling (hose) directly to domestic water pressure pump	Water your garden early morning or late evening to reduce evaporation by sun heat.
		
Wash vechical with a bucket and sponge	Washing vechical with running water hose	To use recycle water for washing / cleaning vechicals (bucket & sponge)
		
Control water for feeding / drinking your livestock	Use rain water (collected at pan site) for cleaning livestock pans keep it for livestock drinking	To limit your live stock to at least 6 pigs, the larger amount will result to more water usage.
		
Wash cloves full load (machine load limit)	Wash a few cloves in full load	Hand washing is less water usage, a more conserving practise.

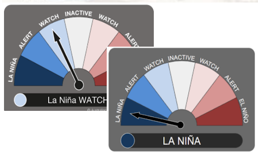
	General	
	Important to fix water leakages at / to	
Indoors	 Bathroom sink and kitchen sink taps	 Toilet flushing cistern
Outdoor	 Roof guttering	 Water storages / standup tap

2. Conserving by reusing water.



Chapter 8 - Closing guidance.

Tuvalu is blessed with sufficient rainfall, however unfortunate not adequate storages to collect all what is receiving. Thus it is up to the household individuals to self-manage and monitor their water system right from the collecting end all through to the usage end. Sufficient roof area plus proper guttering maintenance planning and human behavioural (management) is vital in sustaining one's household chance to survive through dry spells and strong LA Nina.



La Nina to Tuvalu is the time where there is very little rainfall, in history was times Tuvalu experienced serious draughts (e.g. 2011 draught). To know about when or early warning that we are leaning towards a strong La Nina, it is advisable to pay close attention to the Meteorological Office (MET) forecasts advertisement such that you can be prepared before the actual event arrives.

Therefore this is where this document comes in handy, it covers all the basic information an individual needs to learn / know about;

1. When is and How much rainwater you can collect,
2. What to and how to keep the water healthy and safe,
3. How keep the water system sustainable
4. How to manage the available amount you have to survive long dry spells or a strong La Nina.

By practising what is learned from this document to the letter, it will be one's beginning / first step in making Tuvalu safe and resilient to climate change.

Chapter 9 – Credits

This document was developed by the Ridge to Reef project under the Environment Department with value contribution / input and resources from;

- Ministry of Public Utilities & Infrastructures (MPUI)
    - Public Works Department
    - IWRM project; *'Falevãtie manual construction; operation & maintenance (version 1) 2013'*
    - Department of Energy
- Health Department
- Meteorology Department
- Climate Change Department
- South Pacific Commission (SPC)
    - SODIS - Global Climate Change Alliance: Pacific Small Island States (GCCA: PSIS)
- Traditional knowledge & practises accounts from
    - Vete P Sakaio
    - Teleke P Lauti, (sourcing of valuable historical documents)
        - Gerd, Koch, 1961. The material culture of Tuvalu
    - Teagai Esekia
    - Dr. Arthur Webb (sourcing of valuable historical documents)
        - Hedley, Charlse, 1896. General account of the atoll of Funafuti.
        - D. G. Kennedy. Field notes on the culture of Vaitupu.
    - Department of Agriculture.
- Mr Google.