



# Water for Life



## THE SAMOA WATER AND SANITATION JOURNAL



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Front Cover Caption: No Water – No Life: Save Every Drop Now. By Elisara Elisara, Vaoala College

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# **WATER FOR LIFE**

**THE SAMOA WATER AND SANITATION JOURNAL**

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## PREFACE

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It is with great pleasure that I present this first issue of the Samoa Water and Sanitation Journal 2014. It is my hope that the annual publication of this Journal will strengthen existing clearing house mechanisms for sector funded research, assessments and studies.

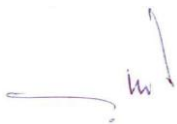
The Sector Research Initiative was established in 2012 with the aim to promote and encourage evidence based research as a crucial element of the Sector's policy, planning, monitoring and evaluation processes. I hope that policy makers and planners alike make use of this Research Initiative to gauge critical feedback from the community on whether we are making an impact, a positive change from the work that we are doing. Are we making an impact? If we are, how are we making an impact? Are we able to sustain positive changes in the communities? Are we targeting the right communities? Are our efforts in tandem with community priorities? Are we being practical with our strategies? Do we really know what the communities think? These are just some of the key questions that I hope will be answered, justified and verified through implementation of evidence based research.

I am pleased to note that this Journal has been registered with an International Standard Serial Number from the ISSN International Centre in Paris, France. The publication of the Samoa Water and Sanitation Journal is therefore internationally recognised and catalogued. I would like to acknowledge and thank the National University of Samoa for facilitating our request to the Centre in France.

I would also like to acknowledge the hard work of the Peer Review Committee, their guidance and technical support in the implementation of the Sector Research Initiative which has led us to the launching of this first edition of the Journal.

Last but not least I would like to acknowledge our Development Partners in particular the European Union for their continuous support in the development of the Sector

I encourage everyone in the Public and Private Sectors, NGOs, Civil Society, Schools and Tertiary Institution etc to make good use of this Journal. It is my utmost hope that you will find it very useful.



Seumanutafa Malaki Iakopo

**CHAIRMAN**

**JOINT WATER SECTOR STEERING COMMITTEE**

*This First Edition of the Samoa Water and Sanitation Journal is dedicated to the Memory of the late Chief Executive Officer of the Ministry of Natural Resources and Environment, Tofa Taule'ale'ausumai La'avasa Tuifuisa'a Malua and the late Managing Director of Samoa Water Authority, Afioga Ta'inau Vui Moefa'auo Titimaea.*

# Water Attitudes, Consumption and Waste at the household level

Tuiloma Susana Tauaa

## **ABSTRACT:**

*This is a pilot study of household water attitudes towards the use and / or abuse of water among geography students at the National University of Samoa. Each respondent will be given a questionnaire of 30 questions based on individual water use in the home, individual and household response to water pricing and general practices considered as positive water conservation attitudes. A snapshot of water attitudes at the individual and household levels can be gauged from this sample of one hundred and fifty students upon which meaningful water policy-solutions can be based on. The study is an effort to collect, quantify, document, design and advocate for water use efficiency in the home as part of a nationwide effort to sustainably manage our water resources.*

*Key Words: Household water attitudes, water conservation, water use efficiency.*

## **INTRODUCTION**

There are currently more than 800 million people facing water scarcity and the United Nations project that about 2 to 7 billion people will go without water by 2050 (United Nations 2006). Closer to home, Tuvalu (population of 11,000) in the later part of 2011 ran out of water, fortunately for them, Australia and New Zealand intervened to prevent a major catastrophe in our backyard. Given these frightening statistics, we in the Pacific, Samoa in particular, should rethink of how we deal with water, recognize how valuable and fragile this resource is and modulate demand as well as protecting supply.

Decreasing availability coupled with deteriorating quality and escalating demand for water are important water challenges for Samoa. Extreme weather patterns and climate change will worsen our situation. Rather than wait for a ‘Tuvalu experience’ to hit us, it is imperative that measures are put in place to avert such gloomy situation from happening.

A more practical starting point therefore, is to begin with the individual in their comfort zone-the household (bottoms up approach). Anecdotal evidence suggest a huge waste of water through poor, complacent-and-water-is-a-gift-from-God-therefore-its-free-and-I’m-paying-for-it-none-of-your-business-attitude. A SOPAC technical report in 2011 presented the estimated and reported water use for 14 Pacific island states, and the figures for Samoa are:

- 308 l/capita/day Estimated compared to 500 l/capita/day Reported. (SOPAC 2011:3).

This piece of data is indicative of a general belief that there is a significant wastage of water at the individual-household level. As such, this presents a problem when the state is pushing for water conservation awareness, and investing in very expensive hardware to deliver clean water into the homes and businesses but the community at large do not share this idea. Given this understanding, determining water use efficiency in the household is indeed a positive step towards a policy response with a technical solution. Having said all that, this study hopes to quantify the temporal and spatial nature of household water attitudes that will guide future household water pricing policies and practical water conservation ideas in the future.

Furthermore, studying the water attitudes of household members is an essential input to water planning. Understanding how people use water in their homes, is necessary for determining likely future demands on water supply and designing demand management programs.

## **RESEARCH OBJECTIVES:**

*General:* To determine whether current water pricing is reflective of water abundance in Samoa. How does cheap water pricing impact on the costs of production and supply of water to households in particular? Conversely, does the price of water affect consumer attitudes. And how do households react to potential increases to water pricing?



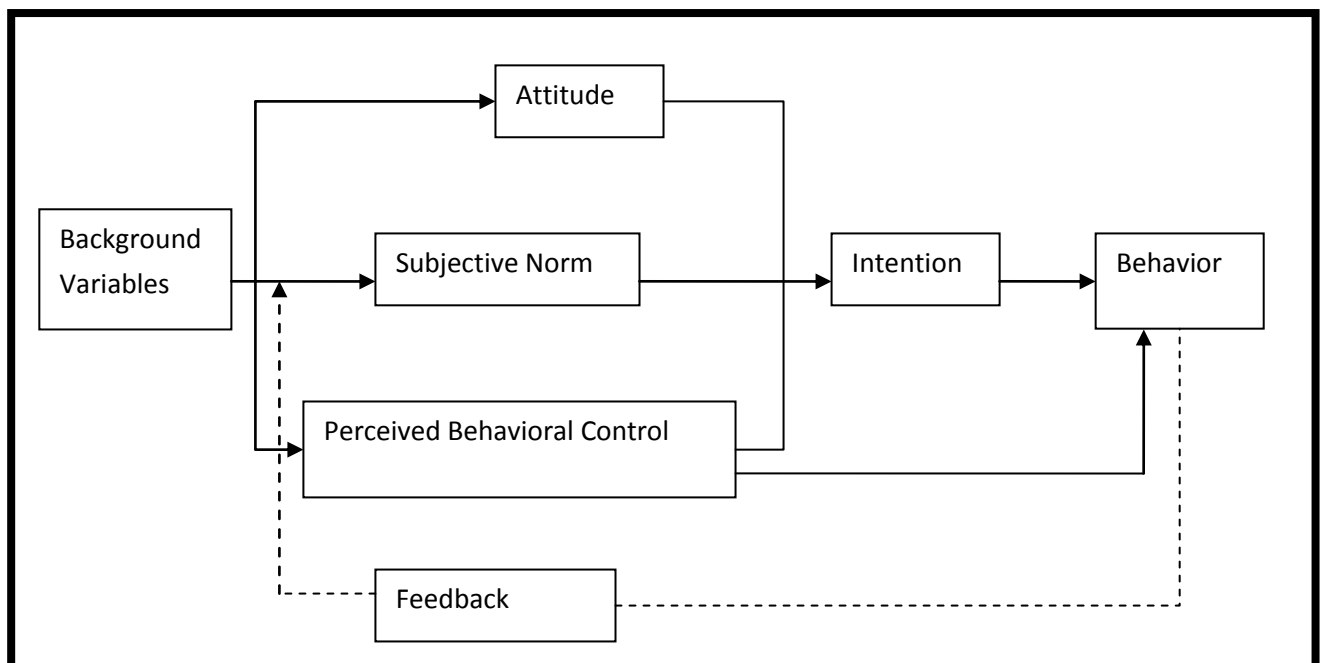
Specific: To profile individual household member’s daily (24 hours) water consumption habits-patterns among young people aged between 17 to 21 years old.

To ascertain a correlation between water price, household responsiveness to price change and household water attitudes as in the consumption and conservation of water among the geography student population in the Faculty of Arts.

### CONCEPTUAL FRAMEWORK:

Explaining human behavior is a complex and difficult task. Given this study focuses on explaining water attitudes of households, it is essential to set a framework to help explain and predict people’s behavioral dispositions, such as social attitude and personality trait towards the water issue. The Theory of Planned Behavior (TPB; Ajzen 1985) and the Value-belief-norm theory (VBN; Stern 2000) are proposed as two frameworks that serve the purpose of this study. The TPB suggests that a person’s behavior is determined by his/her intention to perform the behavior and that this intention is, in turn a function of his/her attitude toward the behavior and his/her subjective norm as diagrammatically represented in Figure 1(Ajzen 1991:180). The three variables that predict behavior namely attitudes, subjective norms, and perceived behavioral control are particularly relevant to this study.

Figure 1. Theory of Planned Behaviour Model.



Source: Ajzen,I (1991) p.180.

Attitudes refer to the extent to which a person has a favourable or unfavourable assessment of the behaviour in question an example from the study is the daily practice of water conservation habits in the home. The extent to which students are aware of the need to save water and whether this awareness translates into the action of saving water illustrates the intention-behaviour relationship as suggested by Ajzen. Subjective norms are social factors that refer to the perceived social pressures to perform or not to perform the behaviour including the opinions of others about the behaviour. Evidence from previous studies indicates a strong correlation between conserving water, price of water and household income (Taua'a 2010). Households with less than two income earners and a combined income of \$400:00 per week are compelled to perform the behaviour of conserving water such as immediate fixing of leaking/dripping taps. Perceived behavioural control refers to the perceived ease or difficulty of performing the behaviour. Among the study sample, given that they are not yet earning an income, and therefore are not directly responsible for meeting household water prices, the degree of difficulty in performing the behaviour of conserving water is much higher compared to those household members who are responsible for paying water prices. Evidence from the study point towards longer and frequent showers irrespective of whether the water supply is metered or not. Having a shower is one of the highly ranked priorities on the list of 'things to do' by the respondents alongside brushing, drinking and food preparation.

The background variables that are of particular relevance to this study include and not limited to the age group of the respondents, water supply and demand, number of people living in the household, willingness of the respondents to adopt water-saving behaviours and awareness of water-saving practices as publicized by the responsible ministry on national television.

The value-belief-norm theory, was designed to explain environmental behaviour (Stern 2000). It postulated a series of causal factors that begin from basic, general values and beliefs to behaviour-specific beliefs and norms to actual behaviour-actions. At the start of the postulated series are general values, which are perceived as guiding principles in people's lives (Rokeach 1973). Schwartz (1994) categorizes values into two dimensions, self transcendence (concern for others) and self enhancement (concern for self). Self transcendence values relate to pro-environmental intentions and behaviours. In relation to the study, self transcendence is adopting and practicing water-saving attitudes on a daily basis, and performing individual role/part in the household, or community that amount to collective efforts to reduce water waste in the homes and promote water-saving habits. Self enhancement, on the other hand, can be negatively related to water-saving measures, given the emphasis is placed on the individual rather than the collective good.

## **LITERATURE REVIEW:**

Although 71% of the earth's surface is covered by water, only 1% or less of the world's fresh water is accessible for human uses (Marsh and Grossa: 2005). As such, water is one of our most critical resource, even more important than oil. In most developed societies, clean water is taken for granted, rarely questioning the source, quality and reliability. Perhaps, habit dictates that there will always be more water to support agriculture, industries, our food chain and household demands. However, in the developing economies such as the Pacific islands, their economic and social well being is largely determined by the quality and quantity of water available, which is often constrained by the small size of many of these islands, climate variability, increasing storm water runoff and increasing competition for water resources.

The literature documenting household water use elsewhere reported massive use and waste. The average American family of four can use 400 gallons of water every day, where 70% of this water is used indoors ([www.epa.gov/watersense](http://www.epa.gov/watersense)). Home living and all activities related to the daily routine of washing, brushing, cooking, flushing use a large quantity of water. Despite efficiency measures advocated to conserve water, there seems to be a general sense of reluctance on the part of the household members to adopt simple behavioural changes towards a collective effort to reduce household water waste.

Elsewhere in the developing world, water consumption is as low as 20 litres a day for the average person. Previous studies on Samoa show a figure comparable to American water consumption rates per person of 300 litres per day (Tauaa 2010:10). Perhaps our growing water use [or abuse and misuse?] is a sign of our developing affluence. However, our increased water consumption is putting a strain on our water resources. This study will contribute to the water data base from the household angle in the interest of proactive policy design that actually work and make sense to the average water consumer.

The Dublin conference on water and the environment in particular the Four Principles (see Table1) highlights the global significance of the water issue. Principle 2 is particularly relevant to this study where the participatory approach of stakeholders, in this case the young people and their attitudes towards the use of water in the household is of particular interest. When the views of a section of the population are overlooked, action-policies become biased and the success of future water policies may be hampered. This study is a response to the Dublin conference call for fundamental approaches to develop and manage water resources from the highest levels of government to the smallest communities (Dublin Statement 1992).

Table 1: The Four Dublin Principles

1. Water is finite, vulnerable and essential resource which should be managed in an integrated manner.
  2. Water resources development and management should be based on a participatory approach, involving all relevant stakeholders.
  3. Women play a central role in the provision, management and safe guarding of water.
  4. Water has an economic value and should be recognized as an economic good, taking into account affordability and equity criteria.
- 

Source: ICWE: 1992

Principle 1 emphasizes the indivisible nature of water. For instance, water may be rainfall in the water cycle, then soil water, ground water and surface water at a later stage, but it all remains the same water. Extracting groundwater depletes the availability of surface water and any use or diversion of water affects the entire water cycle. On the other hand, water is different from other resources and ‘economic’ goods. If society need energy, they can select between fossil fuel, solar, wind and hydropower. A need for vitamins can be provided for from a variety of fruits. With water, one cannot simply choose another type of water. Since water is a resource that has no other substitute, the only choice to make therefore is to find the most efficient way to allocate and manage water use and the best place to start is in the home.

## **INTEGRATED WATER RESOURCES MANAGEMENT**

The four principles that emerged out of the Dublin conference provided the foundation for the integrated water resources management framework (IWRM). Integration, decentralization, participation and economic sustainability are the key concepts re-emphasized in the latter framework (Xie 2006). According to the Global Water Partnership, IWRM is “ a process that promotes the coordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems” (Global Water Partnership 2000). As such, IWRM can be distilled as a coordinated process, incorporating all interest groups with a common interest in society’s social and economic well being through protecting ecosystems. This is achieved through the application of scientific tools underpinned by good governance practices and participation of all stakeholders as reemphasized in the concepts of integration, decentralization, participation and economic sustainability.

Integration promotes both a horizontal and vertical connectivity among all sectors mainly people (households), agriculture, ecosystems, industries and others that depend on water resources. To integrate all sectors is to recognize the multifaceted value of water and the need to coordinate management of water resources from the watershed into people's homes and industries.

Decentralization acknowledges the need to strike a balance between top-down and bottom-up management. So, the responsibility for water resource management is devolved from national governing bodies to independent local authorities, private sector, water basin or sub-basin levels which ever the case may be within the country.

Participation is the third concept that is most relevant to this study where all water users, community based, individuals, households are called to play a greater role in water management decisions. Participation allows all user groups particularly the vulnerable to voice their concerns on water issues that impact on their social welfare.

Economic sustainability stipulates the economic value attached to water particularly with the rising costs of supply throughout the less developing world. This concept advocates for the pricing of water to include all costs from withdrawing, treating, delivery and all environmental externalities pertaining to using water. Pricing water allows water providers to continue servicing the public and at the same time recover costs involved in this particular service.

## **WATER AND DEVELOPMENT**

The United Nations Human Development Report for 2006 provides a grim statistical view of the water problems in the Third World. Some 1.1 billion have inadequate access to water which is directly related to poverty and water-related diseases where 1.8 million children die each year from diarrhea. A further 1.8 billion have to travel 1km or more to collect water (UNDP 2006: 6). The Millennium Development Goals of 2015 for measuring progress towards the human right to water is a dismal prospect in that there will still be 1.1 billion people in the developing world without water while Europeans and Americans are using more water than is available to millions of individuals living in urban slums of the developing world (UNDP 2006: 5). This raises the issue on the distribution of access to adequate water where it closely reflects the distribution of wealth in many countries. According to the UNDP estimates, household access to piped water averages 85% for the wealthiest 20% of the population compared with 25% for the poorest 20%. To further compound the issue, the poorest people not only get access to less water, and to less clean water, they also pay some of the world's highest prices. For instance, slum dwellers in Jakarta, Manila and Nairobi pay 5-10 times more for water per unit than those in high-income areas of their own cities and more than the average consumers in London or New York.

In the Pacific, the priority for water investment is improving access to clean water where it is only marginally above 50 percent across the region (SOPAC/UNDP/UNEP/GEF Water Use Efficiency Report 2011:10). As such, improving water use efficiency is an integral dimension of water resources management that addresses principles 1,3 and 4 of the Dublin statement. Water use efficiency is defined by SOPAC as the maximum value (social, economic and environmental) obtained from the use of limited water resources. For instance, the most simple and direct measure to demonstrate water use efficiency in agriculture is by considering the yield a crop has produced per unit of available water.

## **METHODOLOGY:**

The study employs a pragmatic approach that is both quantitative and qualitative. A basic quantitative approach is used in the collection of primary data through structured and semi-structured questionnaires. Participatory appraisal methodologies such as focus group discussions and key informant interviews are qualitative methods used to verify the data that will be collected. These social research methods are supported by an emerging Pacific research approach of Talanoa defined as a ‘personal encounter where people story their issues, their realities and aspirations’ (Vaioloti 2006:21). Talanoa belongs to the phenomenological research family where the emphasis is on understanding the meaning that events have for participants (Patton 1991). As such, it is deemed relevant to engage the interviews and focus group discussions in the subject’s vernacular to enable participants to challenge or legitimize each other’s statements, stories or information about water attitudes.

### **Focus Group Method:**

The focus group session will allow for a wider cross section of individuals to discuss their views and attitudes towards water consumption and conservation in the household. It can stimulate debate and generate more analysis and description of reality and explanations of causality (Waldegrave 2003). The advantage of focus group sessions for this research is that it is less time consuming, flexible and data rich and elaborative over and above individual responses. The focus group is a group interview that produces trustworthy naturalistic data about important insights into human behaviour (Fern 2001).

Application software packages Microsoft excel and access will be used in the quantitative analysis. For example, after inputting data, an overall view of the data can be determined to assess the range of answers given by the respondents. From this assessment, unusual cases and extreme values and obvious errors can be identified.

### **Study Population:**

A purposive sample of one hundred and fifty respondents randomly selected from the geography student population of two hundred and thirty three at the National University of Samoa is the total study population. The age spread in the proposed study population is from 17 to 21 years old. This age group is a sub-set of the youth population of 15-24 as defined in the Samoa Bureau of Statistics Population and Housing Census Report 2011. The total population of 17-21 year olds as of 2011 is 17,304 where 150 were selected based on their enrolment in the geography programme. Each student respondent is assumed to belong to a 'household' and for the purpose of this study, the student's water needs and behavioural patterns is an exercise in understanding and documenting a selected cohort of young people's attitudes, behaviour and perceptions of household water use to inform demand management strategies.

### **Expected Results and Dissemination**

Findings from this study will be presented during the Environment week forum in November. The findings from this study contribute to informing policy makers to address the challenges posed by household consumer behaviour and one of its off shoots – water waste.

Profiling household member's water use on a 24 hour basis provides a snapshot of:

- Young people's water behaviour.
- Collective consumer attitudes to the idea of 'water conservation'
- Realistic do-able actions to alleviate water waste at the household level upon which 'household water conservation' campaigns can be based on.
- Estimated water waste at the individual-household level
- A correlation between price of water, user-pay, and user water attitude.

## **DISCUSSION OF RESULTS**

The student water use survey consisted of 30 questions which were designed to elicit information from participants about various aspects of individual [household] water use, conservation and standard demographic and household composition data. The study is subject to sampling errors and biases. For instance, non respondents may have been generally less interested about the issue that may have introduced a bias into the results. Leading questions may influence the results where respondents were encouraged to give answers they thought were expected of them. All efforts to minimize such problems have been exhausted. The questionnaire design used a mixture of the Likert scale response format, open ended and multi-choice questions.

**Response Rate:**

This is a study of water attitudes among geography students aged between 17 and 21 in the Faculty of Arts. There are 233 geography students of which 150 were selected for the sample study. Out of the 150 questionnaires distributed in the period from June 11th to July 12th, only one hundred and thirty were returned yielding a response rate of 86.7% which was comprised of 76 females and 54 males. Not all questions were fully answered by all respondents, hence, some analysis were conducted with smaller sample sizes as noted. Fifteen respondents (11.5%) are considered as outliers aged 22 and above, so they were excluded from the analysis. Thus, the total number of respondents was 115 (71 females and 44 males). The average age for the male respondents was 18.4 and 18.6 for females.

**Water Attitudes:**

Samoans are aware of the importance of water in their daily lives, yet do not seem to think about the source of their water until there is an interruption. There is a general belief that water is abundant in the country and that it is a gift from God, therefore it is within their rights to use it freely. The particular age group in this study manifest this general belief as is evident in many of their responses discussed in this study. There is a tendency among respondents to take water for granted, especially when they are students and are not yet burdened by the responsibility of paying for the monthly water bill.

**Behavioural Questions:**

The questions were divided into two categories. The first line of questions was designed to collect user specific data related to individual habitual behaviour/actions. Habitual behavior is a form of automatic and routine behaviour. Such behaviour is repetitive because it is easy, it must be done, it is rewarding and does not require constant reasoning with oneself about what is the best thing to do. For example, washing, showering, brushing, cooking and flushing. Almost all behaviour (individual and household water behaviour) is a form of habitual behaviour (Stern 2000). The second category looked at the respondents' water saving behaviours and levels of awareness / perceptions about water conservation and their role as future paying customers given 89.6% (103/115) of the respondents are from households with metered water supply.

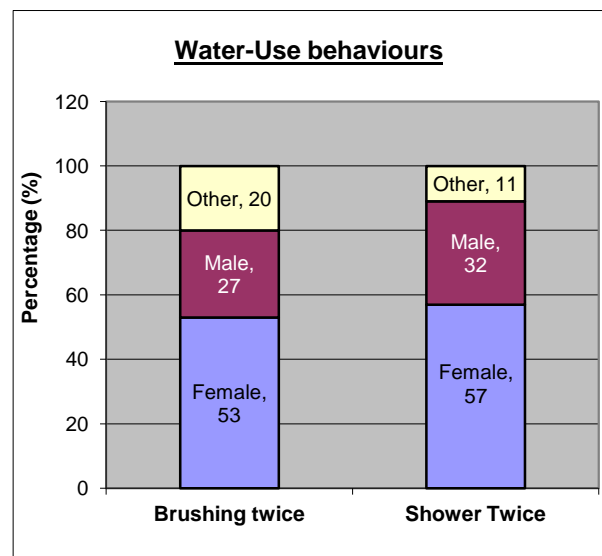
**Metered and Non-metered water supply:**

89.6 % of respondents [males (41) and females (62)] reside in households with metered water supply. The remaining 10.4% are from households that are non-metered [government] or under the independent water supply scheme [community]. There was no significant correlation between the respondents' water behaviour and the metered or non-metered state of water supply in the households. Fifty-seven percent of females from households with metered water supply and all females from non-metered households [66/115] reported taking two



showers per day. Similar behaviour was reported by the male respondents [37/115 or 32%] from both metered and non-metered households (see Figure 2). Having two showers per day is a common behaviour among males and females independent of whether the household water supply is metered or otherwise. There are no statistically significant differences between the sexes in how frequent they shower. But there are some areas where some statistically significant differences between the sexes may occur. For instance, females are more likely to say that they shower twice in a day than males. Also, females are more likely to insist on two showers per day compared to males. It is important to note, that there are other factors to justify this particular behaviour as indicated by the young female respondents. Hot and humid weather conditions, personal hygiene and comfort encourages daily and lengthy showers, twice in a 24 hour period. Similarly, with the male respondents, it is a normal routine habit. The price of water and reliability of supply does not deter young women (or men) from habitual showers. Likewise with brushing teeth, an overwhelming majority of the respondents were engaged in habitual brushing twice on a daily basis (see Figure 2). The ‘other’ category of respondents consisted of those who did not respond to the question or indicated that they showered and brushed once per day.

Figure 2: Water-use behaviours



**Water use Behaviour:**

One of the important questions asked of the respondents is related to the length of time spent in the shower. The purpose of asking this question was to gauge actual - current behaviour and to determine the degree of willingness to engage in a future behavioural change towards suggested water saving behaviour. Table 2 and Figure 3(a) summarises the responses to the question on shower duration. The same information is combined in graph form to show total proportion by both sexes (see Figure 3(b)).

Table 2: How much time do you spend in the shower?

	≤ 5 minutes	5 – 10 minutes	More than 10 minutes	N=115
Males	6 (5.22%)	28 (24.35%)	10 (8.61%)	44
Females	2 (1.74%)	52 (45.22%)	17 (14.78%)	71
Total	8 (6.96%)	80 (69.57%)	27 (23.48%)	115 (100%)

Figure 3(a): Time spent in the shower by sex.

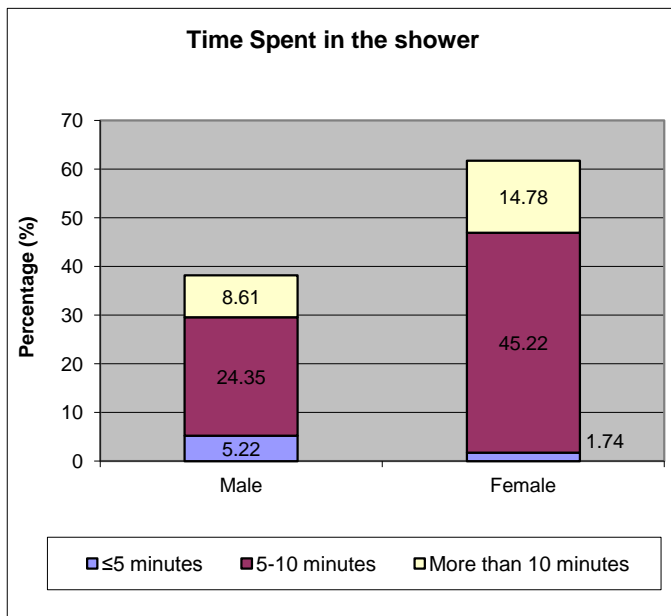
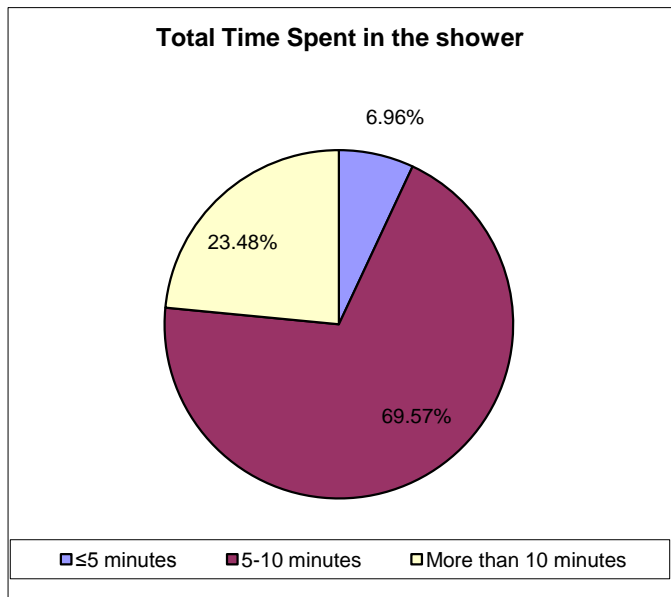


Figure 3(b): Time Spent in the shower by both Males and Females.



The majority of respondents (69.57%) spend 5 to 10 minutes showering. These were suggested estimated shower duration that may vary from actual time spent showering.

Nevertheless, 5-10 minutes is quite high by developed world standards that tend to support the SOPAC/UNDP/UNEP/GEF findings about the very high water use among Pacific islands such as in Palau [700L/capita/day], Solomon islands[721L/capita/day], and Samoa[500L/capita/day]. When the respondents were queried about engaging in a ‘water-saving’ action while showering, there was no response forthcoming, which was interpreted as non-understanding of the question or assumed that there was actually no effort to save water such as turning off the tap while soaping/lathering. Factors that determine shower duration and frequency of showers tend to vary between the sexes. Young females attribute longer showers to ‘shampooing and conditioning’ hair or ‘shaving’ legs. For both genders, the amount of dirt, sweat (sports, home chores), and the time of the day also dictate shower duration, so 5-10 minutes is a conservative estimate, otherwise showers could be longer or brief. Those respondents who spend more than 10 minutes in the shower, reported bathing younger siblings and doing laundry as reasons for lengthy showers. Otherwise shower duration varies between 5 to 10 minutes.

Directly related to the question on shower frequency and duration is the question to test ‘awareness’ and ‘familiarity’ of the respondents with water-saving ideas/practices. Table 3 and Figure 4 (a) and (b) summarizes their responses.

*Table 3: Do you know of any ‘water-saving ideas and practices’?*

	Yes	No	Other responses	N=115
Males	18(15.65%)	15(13.04%)	11(9.57%)	44
Females	30 (26.09%)	14 (12.17%)	27 (23.48%)	71
Total	48(41.74%)	29(25.21%)	38(33.05%)	115

*Figure 4 (a): Knowledge of Water-Saving ideas & practices.*

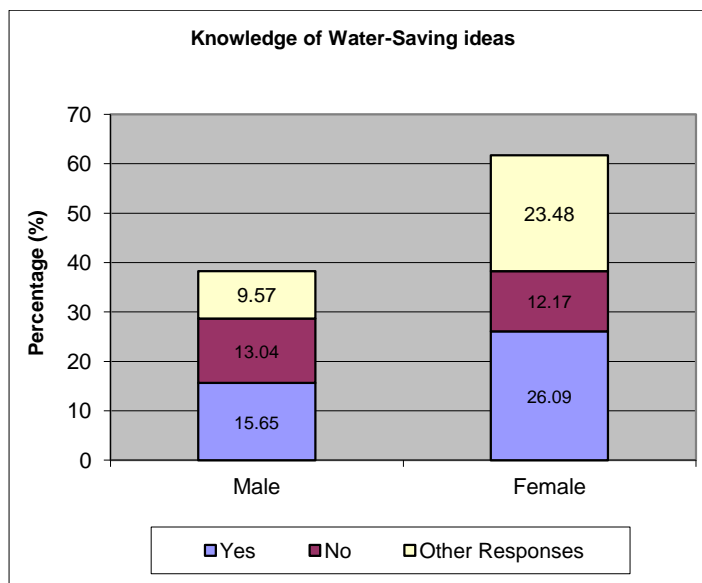
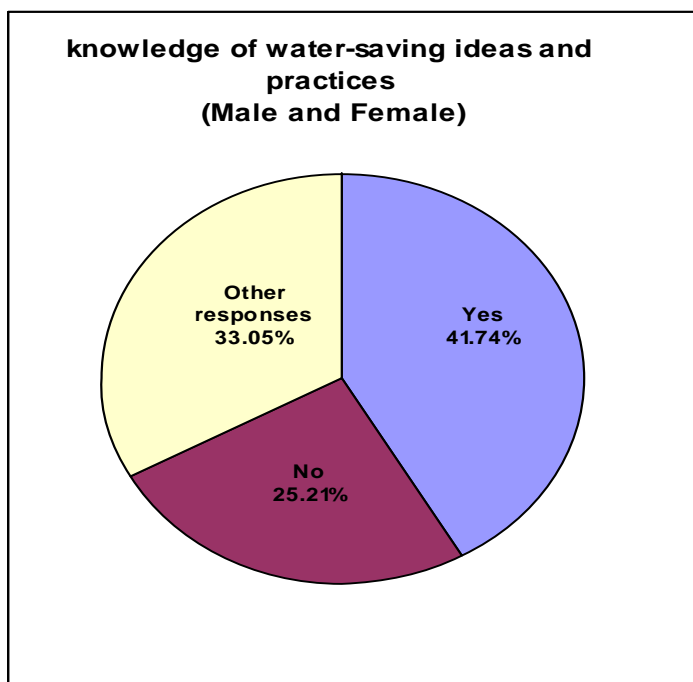


Figure 4 (b): Knowledge of Water Saving Ideas and Practices by total



Less than half (41.74%) of the respondents indicated a positive response to the question. Prompted further to indicate precisely the water-saving behaviour/action that supports their positive response to the question, the most common responses by both genders were as follows:

- use water wisely, because water is life
- use buckets, barrels, water tanks to store water
- plug sinks or basins when washing dishes
- turn off the taps properly
- turn off water meters after using taps
- do not waste it on useless things
- shower only when you need to

From the responses, it seems that there is some degree of water-saving 'knowledge' and 'awareness' of the importance of water as reflected in the suggested 'action-behaviour'. Beyond this, the study cannot prove whether these are habitual behaviours the respondents automatically engage in on a daily basis. The 25% who indicated that they do not know of any 'water-saving' ideas/practices can be classified as either genuinely unaware of water-saving methods, or did not fully understand the question. Other responses (33%) consisted of those who did not indicate an affirmative or negative response, but provided lengthy explanations about the significance of water and why we should all perform our part as individuals and responsible members of the community to protect our water resources. A closer analysis of their responses strongly indicates a higher level of awareness and

understanding of the bigger issues pertaining to water supply and demand. Some of the more common responses were as follows:

- water is a finite resource, it cannot reproduce itself...
- if we don't get our act together now and preserve the headwaters, I don't see any future for us...
- I'm sure that I don't want to drink from recycled water like the Australians...
- water is another bill for my parents to pay, I think I am expected to help pay for our water when I finish school, I suppose we all have to reduce our water use in our family...
- protecting water resources is a community responsibility, we need to play our part at home

The respondents were also asked to indicate how much time they spend on brushing their teeth (Table 4). An overwhelming majority of females (50.5%) spend 5-10 minutes on brushing their teeth which corresponds to similar behaviours towards showering. Such behaviours are common and expected from females especially those within the age cohort of this study. One of the common reasons to explain lengthy brushing sessions was attributed to smoking where a sizable number of females have indicated smoking in secrecy. On the other hand, males (20%) spend less time on brushing, and the reasons for these marked differences in both sexes behaviour towards brushing relates to gender differences in opinion. Females believe showering and brushing are equally important habits, whereas males are of the opinion that brushing only requires a small fraction of the human anatomy [mouth], therefore the amount of time spent on brushing should not be too great. The focus group discussion session alluded to the Ministry of Health public awareness campaigns on oral hygiene where 1-2 minutes is the recommended duration for brushing teeth. It is possible to take the Ministry of Health medical advice as the benchmark to standardize brushing time and at the same time promote water-saving behaviour for all household members.

*Table 4: How much time do you spend on brushing your teeth?*

	≤ 5 minutes	5 – 10 minutes	Other responses	N=115
Males	23(20%)	15 (13%)	6 (5.2%)	44
Females	8 (7%)	58 (50.5%)	5 (4.3%)	71
Total	31 (27%)	73 (63.5%)	11(9.5%)	115(100%)

Figure 5 (a): Time Spent on Brushing Teeth

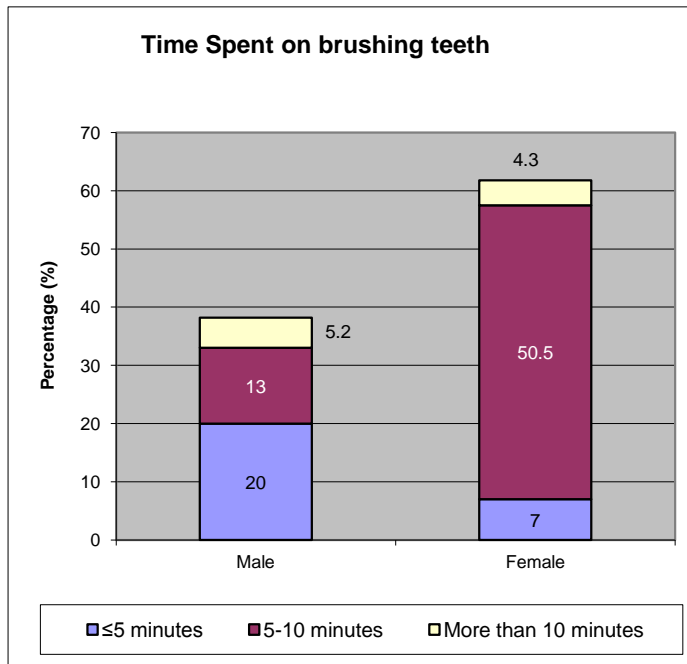
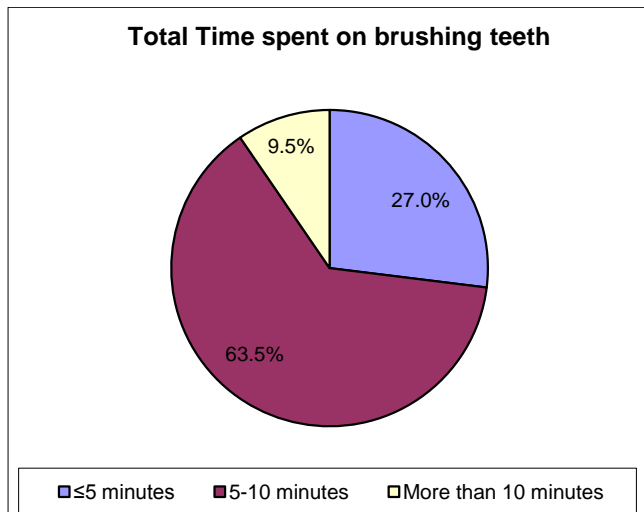


Figure 5(b) Time Spent on brushing teeth for both Males and Females



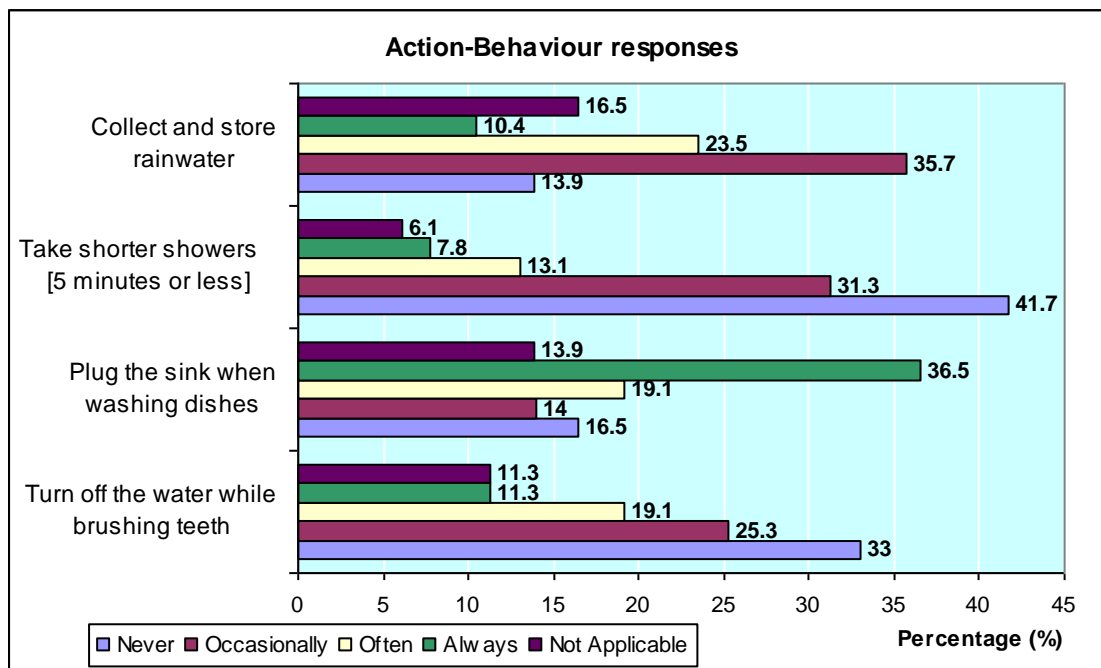
To gauge a closer representation of the responses and the daily practices, the respondents were asked to indicate how often they engaged in selected behavioural actions (Table 5 & Figure 6).

Table 5: How often do you do the following in your daily life?

(Select one answer per row)

Action-behaviour	Never	Occasionally	Often	Always	Not Applicable
Turn off the water while brushing teeth	38 [33%]	29 [25.3%]	22 [19.1%]	13 [11.3%]	13 [11.3%]
Plug the sink when washing dishes	19 [16.5%]	16 [14%]	22 [19.1%]	42 [36.5%]	16 [13.9%]
Take shorter showers [ $\leq$ 5 minutes]	48 [41.7%]	36 [31.3%]	15 [13.1%]	9 [7.8%]	7 [6.1%]
Collect and store rainwater	16 [13.9%]	41 [35.7%]	27 [23.5%]	12 [10.4%]	19 [16.5%]

Figure 6: How often do you do the following in your daily life?



An alarming proportion (58.3 percent) of respondents either ‘never’ or ‘occasionally’ turn off the water while brushing teeth compared to 11.3% of those who claim to ‘always’ engage in the practise of turning off the water while brushing. When queried about this particular habit during the focus group sessions, 50% of the group said that it does not cross their minds to turn off the water at that specific time while performing the actions of brushing teeth, in other words, it is not an automatic behaviour whereas brushing teeth is a habitual behaviour. According to the Theory of Planned Behaviour, failure to turn off the water while brushing teeth is subject to the lack of social pressures to perform or not to perform this particular

behaviour that is to turn off or not to turn off the water while brushing teeth. Social pressures, such as constant or strict reminders by parents can induce young people to adopt water saving behaviours.

More than half (55.6%) of the respondents indicated that they ‘often’ and ‘always’ plug the sink when washing dishes. This is a very encouraging habit, but further probing revealed that the extensive use of liquid dish washing detergent in the households requires plugging the sink, whereas soap and paste-like types of dish washing agents demand alternative dish washing practices.

A sizable number of respondents (41.7%) indicated that they ‘never’ take shorter showers (less than 5 minutes) which comes as no surprise given that 69.57% of respondents spend 5 - 10 minutes showering (see Table 2). Personal hygiene cannot be compromised or so it seems from the focus group sessions. At this age-stage (17 to 21) in life, it is quite normal to expect young people to possess a very high level of self awareness in their appearance and presentation, and showers apparently, is one other contributing variable to an overall trendy appearance. On the other hand, long, leisurely showers are considered as a form of personal freedom. 31.3% of respondents stated that they occasionally take shorter showers when under pressure from other household members who are waiting to take their own showers particularly in the mornings before work and school rush. A very small percentage of the respondents (13.1% and 7.8% respectively) indicated that they ‘often’ and ‘always’ take shorter showers. While the respondents did not state the reasons for taking shorter showers, there is a strong correlation between being a male and taking shorter showers (see Table 2).

On collecting and storing rainwater, the 13.9% who reported to ‘never’ engage in the practice were presumed to have other household members such as domestic helpers and younger siblings responsible for this task. It is important to note that, collecting and storing rainwater is dependent upon the following:

- household ownership of a rainwater tank
- reliability of piped water supply in the area
- seasonal variation between the wet and dry months of the year

For those respondents who reported occasionally (35.7%) and often (23.5%) collecting and storing rainwater, the practice depended on the time of the year (wet season) where most households engage in this practice particularly when the community water supply is most unreliable during the wet season. The 10.4% of respondents who ‘always’ collect and store rainwater do so because they ‘own’ a rainwater tank and are dependent on rainwater as their main source of drinking water.



## Household Outdoor Taps

The number of outdoor taps is another important indicator of household water usage. More than half (53.04% or 61/115) of the respondents have 1-2 taps located outside the main living house compared to 41.74% (48/115) who reported 2 or more taps. Only 5.22% do not have outdoor taps (figure 7). An overwhelming number of households have one, or more than one outdoor tap which is a common feature of most Samoan families outdoor landscape primarily for convenience purposes as shown in figure 8. Washing the car and general cleaning of household items such as pots, pans and watering the garden are the three most common uses for outdoor taps as identified by the respondents. These are household chores frequently performed by young people as in this study. The actual execution of many household chores as stated in figure 8, is a behaviour that demands a high level of water use. According to the theory of Planned Behaviour, household expectations on young people to play their part in the daily routine of household responsibilities are described as ‘subjective norms’ or social factors that put pressure on individual members of the household including young people to perform the behaviour, in this case washing the car, BBQ and large cooking utensils, and watering the garden.

*Figure 7: Number of Households with Outdoor taps by percentage*

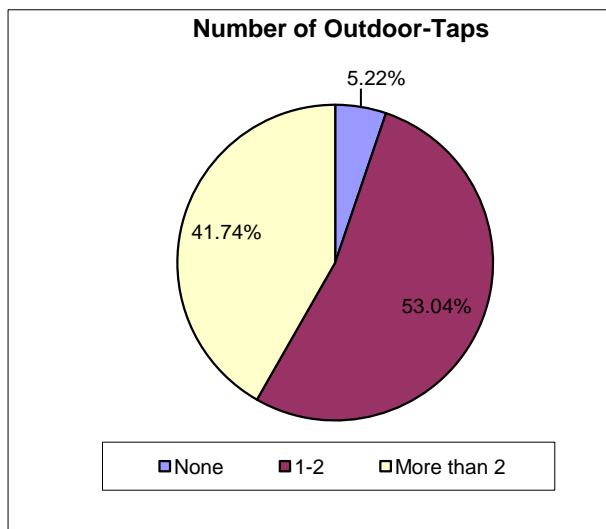
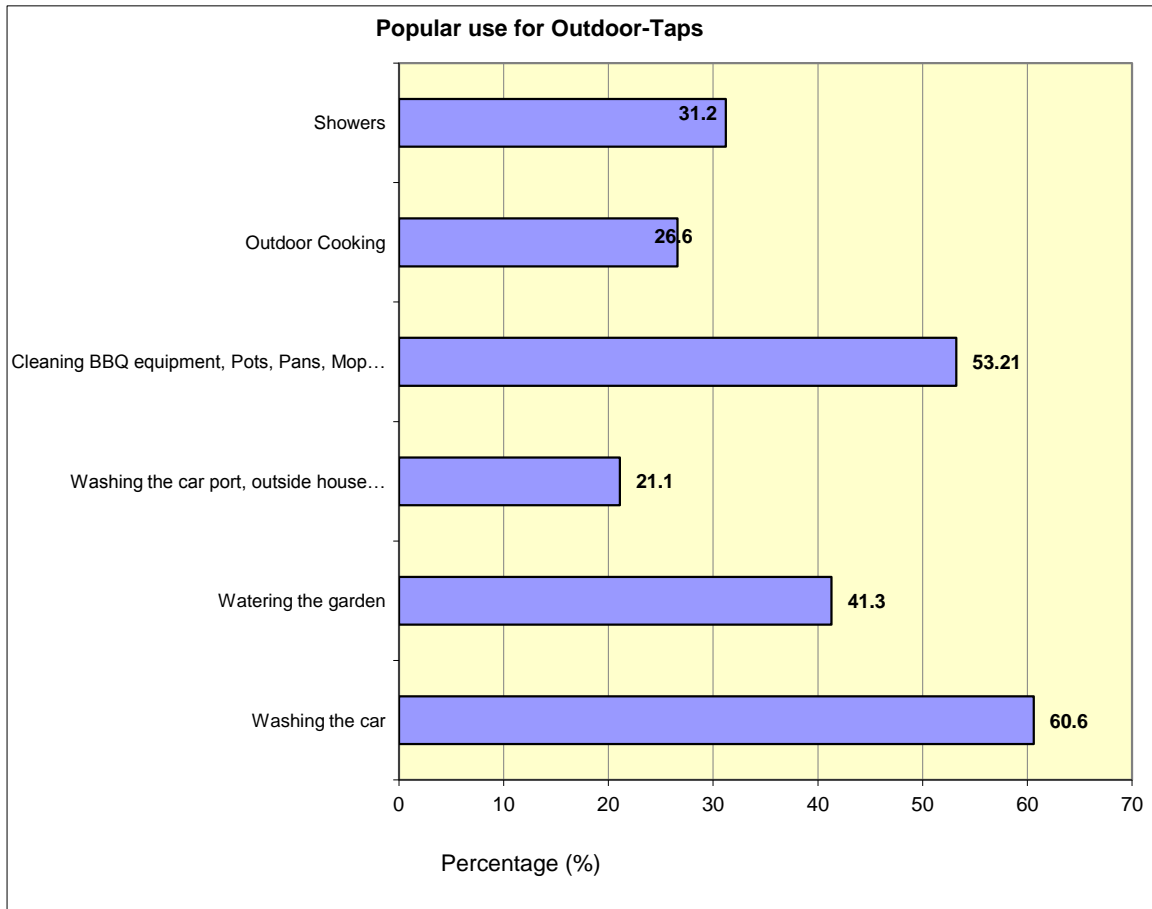


Figure 8: Common Uses for Outdoor taps



### Focus group discussion

Two focus group sessions were conducted primarily for three reasons: Firstly, was to follow up on perceived and actual water attitudes/practices of the respondents. Secondly, to gauge the respondents awareness levels of water-saving practices and thirdly, to identify water challenges common to young people which may have a bearing on future water policies. Group 1 of 11 males and 14 females [25] were asked to identify water-saving products used in their homes. Group 2 consisted of 12 males and 16 females [28], they were asked to explore water-saving actions in the home. After being introduced to the purpose of the focus groups and the topics for discussion, the participants were then split into two groups to maximize interactive group discussion. Each focus group ran for two hours (see Table 6).

Table 6: Focus Group Key Questions

Topic	Summary of Group Discussion	Comments
<p><b>Group 1:</b> Identify any water-saving products used in your homes.</p>	<ul style="list-style-type: none"> <li>-monitor young children from playing with the outdoor tap(s), hose...</li> <li>-fancy looking shower head that sprays water..</li> <li>-use of buckets, water tank, large plastic containers &amp; large pots to store water for cooking.</li> <li>-turning off the water meter to safe guard against unknown leakages</li> </ul>	<ul style="list-style-type: none"> <li>-Water-saving <i>products</i> has an extended meaning to people. From the responses, these products include all kinds of containers for water storage.</li> <li>-Storing water is synonymous with water-saving products.</li> <li>-<i>Fancy looking shower head:</i> is a water efficient shower head, obviously a modern type fitting for the purpose of water conservation in the home.</li> <li>-Dual flush toilets: very common but respondents do not think of them as water saving products in the home.</li> </ul>
<p><b>Group 2:</b> Discuss all forms of water-saving actions practiced in your household.</p>	<ul style="list-style-type: none"> <li>-Use water meters to control water consumption.</li> <li>-Collect &amp; use as much rain water as possible during the wet season to reduce reliance on tap water&amp; minimize water loss through overland flow.</li> <li>-recycle water</li> <li>-water rationing</li> <li>-take shorter showers</li> <li>-males were more likely than females to feel a moral commitment to adopt a positive attitude towards water-saving actions.</li> </ul>	<ul style="list-style-type: none"> <li>-Water meters are used as a form of control on water usage to allow households to manage their water consumption.</li> <li>-Taking shorter showers was an idea flagged during the discussion, but in terms of willingness to take shorter showers on a daily basis, the participants were not quite sure if this action can be consistently adhered to.</li> <li>-Recycling water was a common water-saving behaviour, but substantial evidence on how much water was recycled and how water was recycled in the homes</li> </ul>

		<p>was insufficient to draw any conclusions. This particular water-saving action is attributed to widely published information used by students in their studies.</p>
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Several conclusions can be drawn from the focus group discussion. Firstly, water-saving products such as dual flush toilets and water efficient shower heads are quite common bathroom devices in most households, but, household members do not fully comprehend how these devices function apart from perhaps the male occupants and the heads of the household. Secondly, water-saving products extend to include large containers [pots, buckets] and water tanks for storing water in case of a major water supply interruption particularly during the wet season. According to the respondents, these are products to be used for storing and saving water on a daily basis to support one-off installations such as dual flush toilets and water efficient shower heads. Thirdly, the water meter is perceived as a water-saving product in terms of controlling the use of water and preventing unknown leakages. Sixty-four percent [16/25] of the group reported turning off the water meter (night time) in their households as a precaution against the above. Similarly with group 2, water meters function both as an indicator of the amount of water used and the cost of water to the household. Total household water consumption can be monitored to ensure it does not exceed the household's capacity to pay for their water price. Fourthly, a strong sense of personal moral commitment to engage in water-saving actions was evident in the focus group discussion. While both genders identified taking shorter showers as the best immediate water-saving action, males were more likely than females to adopt this particular water curtailment action. Recycling water was also suggested as a water-saving action but examples of how water was being recycled in the homes were not forthcoming. According to the group, water recycling is one of many messages that come across in the literature that is yet to be fully realized across households in Samoa.

### **Price of Water**

In the past 20-30 years water conservation was seen as an engineering problem, rather than a social-economic one. Water providers were often disinclined to use price increases as a form of water conservation tool, instead relying on non-price efforts such as education and awareness campaigns and low-flow technologies (shower-heads, toilets). Other forms of non-price water management tools such as mandatory water-use restrictions on particular household activities such as car washing and garden-watering were also adopted to control water use in some parts of the American mid-west. Studies conducted in these parts of the country reported no statistically significant water-savings in the residential sector (Renzetti

1992). Elsewhere in Pasadena and Santa Barbara in California, mandatory water use restrictions induced a demand reduction of 29 percent (Renwick and Green 2000). So, in effect, household responses to non-price water conservation methods yielded mixed results. On the other hand, pricing is an obvious mechanism for water utilities to strategically manipulate customer (household) behaviour. Studies elsewhere have confirmed that raising prices does reduce demand, albeit only modestly (Gaudin 2006 and Kenney et al 2008). For Samoa, can price be used as a water management tool, or should there be a politically acceptable mix of price and non-price mechanisms to address water-savings in the household?

### **Water pricing as a conservation tool:**

According to the Dublin principles and the IWRM framework, water is an economic good and like any economic good, it is governed by the laws of supply and demand. And, given that water is almost a scarce resource in some parts of the world, price is used to allocate such resources. Studies conducted in the United States provide quantitative evidence to support the merits of a price based water conservation approach (Olmstead and Stavins 2007). For instance, raising the marginal price of water can effect a reduced demand in household water consumption. Using price as a tool for water conservation allows the households to respond voluntarily to water-saving attitudes as opposed to mandatory water rationing means prescribed by non-price approaches. In addition, the impact of a price increase on demand for water depends upon income and the substitute effect. When the price of water rises, households may start to use more water-saving technology and or more frugal in the use of water. Given water has no close substitutes, households therefore would pay any price for water. The challenge for Samoa rests with selecting the best form of price and non-price approach to our water conservation efforts.

One of the questions asked of the respondents related to the price of water paid by the household on a monthly basis. Table 7 and Figure 9 summarizes the feedback from the respondents. Slightly less than one-third of the respondents indicated that their households pay between \$50:00 to \$100:00 per month for water in a household of seven to eight people. Water consumption by a household [both price and quantity] depends on the demographics (age) of the household and the social – economic obligations of the household (funerals, weddings, visitors) from time to time. The respondents confirm that young people consume more water than older people primarily for reasons as outlined in the previous section of this report. Similar behavioral trends were reported in studies conducted elsewhere (Lyman 1992, Renwick and Green 2000). Other factors such as income, type of dwelling (e.g., open European house with extension, closed European house), age of house, size of house and the water-fitting technologies featured in the house (s) are helpful in explaining household water demand and price. As expected, quite a large number of respondents seem to be unaware of

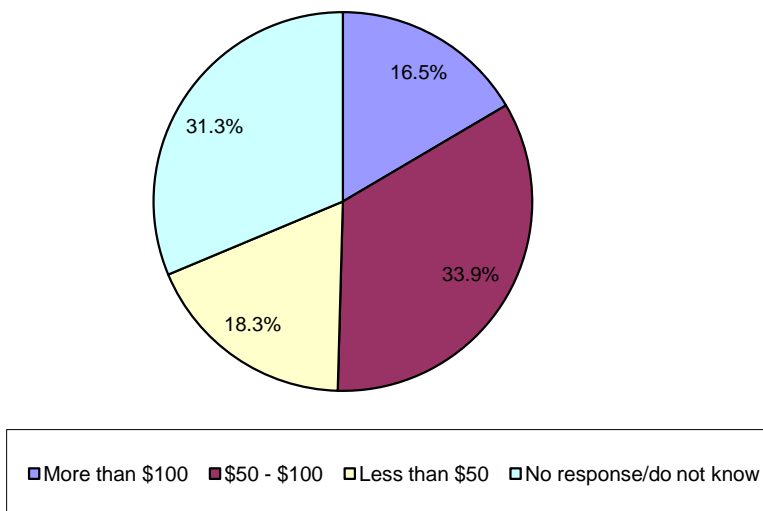
the price of water as they are not earning an income where they are expected to contribute to paying for certain household expenses.

*Table 7: How much does your household pay on a monthly basis for your water supply?*

Amount	N=115
Less than \$50:00	21 (18.3%)
\$50:00 - \$100:00	39 (33.9%)
More than \$100:00	19 (16.5%)
No Response/Do not know	36 (31.3%)

*Figure 9: Monthly price for Water*

**How much does your household pay for your water supply per month**



The respondents were asked a follow up question related to their views about the price of water in Samoa. The question was designed to elicit the respondents' views and values related to the water debate in general and to establish any link between the price of water and water-saving attitudes of the household. The following were the more common responses:

- water is cheap compared to electricity
- there is plenty of water, so price could be cheaper...
- expect a reliable supply since we are paying for it
- secure supply of water for use in the home and protection against natural disasters
- feelings of shame or guilt about wasting water
- dislike for those who waste water

- water conservation is a shared responsibility between individuals, household and government
- discourage excessive use through higher water prices
- balanced water needs between agriculture, industry and home.
- Water should be affordable

Certainly, the responses provided for some mixed reactions. On the one hand, there is some qualitative evidence to suggest a direct link between individual-household water values and intentions to think and /or adopt water-saving behaviour that is beneficial to society. On the other, was a more liberal and economically inclined mindset. For example, if water price is considered cheaper than electricity, and that there is a general belief about the abundance of water, does this imply a lesser inclination towards water-saving behaviour? Given the abundance of water resources, less than one-third [32/115 or 27.8%] of the respondents felt that the price of water could be cheaper.

### **Water conservation**

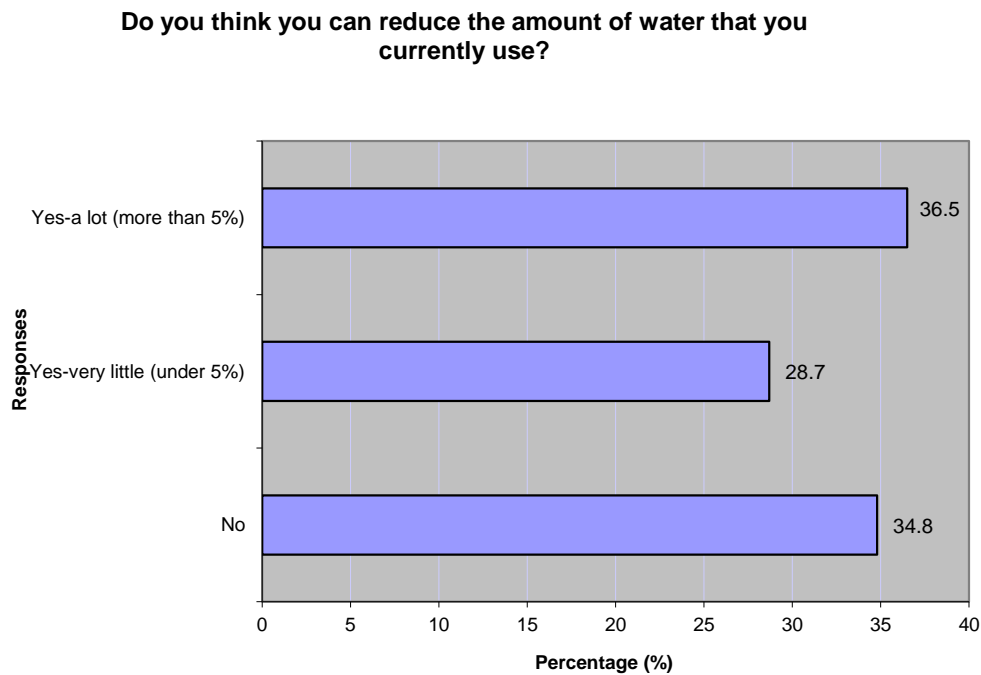
Respondents were asked an open ended question on what they know about water conservation. The most common responses were as follows:

- My quality of life will decrease when I reduce my water use
- Water conservation means reducing water waste
- We have to live less comfortably
- Water conservation is too much of a hassle
- Water conservation should be compulsory for everyone
- If water is life, therefore water must be conserved and used wisely
- It is about conserving water catchment areas and fixing old leaking pipes
- Making the right choices about the sustainable uses of water to benefit society

From the above responses, two clusters of individuals can be identified: 1) committed water conservationists and 2) non-committed water conservationists. The committed water conservationists have a strong sense of obligation to water saving behaviour, while the non-committed water conservationists are more inclined towards self enhancement as depicted in the value-belief-norm theory (Stern 2000). Comments such as, a reduced quality of life, difficult and too much of an inconvenience can only confirm the perceptions and probable behaviour of the latter group.

To confirm the respondents' level of commitment to water conservation behaviour, a question to deduce how willing they were to reduce their water usage was included in the questionnaire (see Figure 10).

Figure 10: Do you think you can reduce the amount of water that you currently use?



Despite generally favourable views towards water conservation issues in general, slightly more than one-third (34.8%) of the respondents do not think they can reduce the amount of water they are currently using. Less than one-third (28.7%), stated that it is possible to reduce water usage by as little as under 5%. As many as 36.5% said they thought that they could reduce their water consumption a lot more. These responses suggest that further household water savings may be limited by prevailing attitudes and patterns of behaviour. So, what are these attitudinal and behavioural obstacles to water conservation in the household?

#### **Obstacles to water saving behaviour:**

Respondents were asked to identify obstacles that may prevent them from using water efficiently in their homes. Several themes emerged from the responses that may assist in explaining the relatively high water use among the age group in this study and why more than half of them are unwilling to change their water behaviour. Firstly, it is difficult to have low water consumption in a large family, as such it is difficult to control other family member's water behaviour. Secondly, water is readily available with the simple act of turning the tap, anything that threatens this convenience particularly with our demanding lifestyles is considered an obstacle to water saving. Thirdly, our warm and humid weather generates a lot of dust and dirt around the homes that demands a lot of regular cleaning inside and outside the house including washing the car, hosing the garage, and watering the gardens. These are 'chores' very much performed by young people as in this study population which somehow require more use of water. Some respondents identified inconveniently placed water meters (compared to the cash power meter) that make it difficult to monitor water usage. Similarly,



children and young people who use a lot of water are inadequately advised and monitored, so they tend to use more than their fair share of total household water.

Similar views on obstacles to water saving behaviour were expressed in the focus group session. According to the group, water is an abundant resource, so the need for water conservation was not a priority. Comments such as, ‘don’t think about’, ‘too many things to do’ and ‘hard to change a habit’ reflect the individuals’ personal knowledge, motivation and circumstances. Some respondents are of the belief that Samoa receives adequate rainfall during the wet season, therefore there is no urgent need to engage in water saving behaviour. This study raised the issue about the lack of quantitative evidence available to the public to indicate how much water is actually being used up by urban households that would help inform individuals on future water saving behaviour. Table 8 provides a summary of common responses to the question about obstacles to water saving behaviour as indicated in the questionnaires and the focus group discussion.

*Table 8: Obstacles to water saving behavior.*

<b>Common Responses</b>	<b>Focus Group</b>
Plenty and reliable supply	Need time to change habit
Don’t think about it	Abundant water supply.
Large Family, difficult to monitor other household members	Reluctance to change behavior-hygienic purposes
Water is cheap	Do not know about usage level so do not feel need to conserve
Poor placement of water meter	Easy conservation system that you do not have to think about
Home chores require the use of water	Hot weather means more washing, laundry for the household
Individuals are not doing their part to reduce water waste in the home	

### **Influencing Water Attitudes and Behavioural Change**

Information dissemination particularly through advertising campaigns is important in informing individual and household decision making and behaviour. But, the provision of information alone does little to change behaviour. Studies on the impact of awareness campaigns on water use indicated a very minimal impact of 2-5% (Inman and Jeffrey 2006). According to Inman and Jeffrey, there are three reasons to explain this lack of impact:

- a. People ignore information if it is too difficult, or if the suggested behaviour change is too burdensome.

- b. People are strongly influenced by habit.
- c. People tend to overlook information that is incongruous with their current attitudes, values and behaviour

Irrespective of the above, information is nevertheless a necessary condition for behaviour change (Darnton 2008). Information is necessary for people to explain why they need to change their behaviour and to show them how they could change. Information needs to be relevant, clear, simple, concise and credible. To effect behaviour change in young people, water use advertising campaigns need to consider these variables. Consumers need to be informed and convinced about actions they can do to save water at home.

Providing economic incentives motivate consumers to take up water saving actions. Such incentives can be in the form of threats such as fines to induce households to adopt environmentally responsible actions or money saving opportunities linked to reduced water usage (MacKenzie-Mohr et. al 1995). In this study, behaviour change is more likely to occur in the form of savings accrued to households through pricing structures that favour households with reduced water usage monthly and annually.

Mandatory water restrictions as widely practiced elsewhere is one way of inducing households to use water wisely (Ferrara 2008). For example, restrictions on certain types of water usage such as car washing and mandatory installation of water-efficient technologies can be more effective at reducing water use than voluntary measures derived from public advertisement campaigns alone.

### **Policy Implications:**

There is more that needs to be done in terms of a water policy framework for sustainable water management based on reducing household water consumption. The study has indicated evidence of a high incidence of water use and waste among young people aged 17 to 21, justified on the basis of an abundance supply of water that is cheap and reliable. Direct policy measures can take the form of mandatory water efficient technology on all newly constructed homes, strengthen community information and education programs together with reformed price setting that encourage water saving habits.

Also, the demand for residential water use will be determined by various socio-demographic factors such as age, household income, type and size of house and the attitudinal characteristics of household members in particular the young people. As such, any form of policy response, be it price or non-price should consider these characteristics. According to a study by Gilg and Barr (2006), any policy designed to encourage water saving attitudes should be tailor-made to meet the needs of the various behavioural groupings and lifestyle types in the population.

Addressing consumer behaviour requires a multiplicity of policy intervention to influence people's moral norms, self-efficacy and community support for water conservation. The public need to feel a sense of moral obligation to save water that would translate into water efficiency attitudes such as turning off the tap while brushing. Messages that advocate the close links between individual actions, water conservation and benefits to the wider community may assist to develop this sense of moral obligation. An assurance of benefits to consumers encourages household practices and desire to engage in water saving behavior. This in itself is a step towards creating a culture of water conservation beginning in the household and spreading to the wider community.

## **CONCLUDING STATEMENTS**

This study was an attempt to quantify the water-attitudes of households through studying the water attitudes of young person's to improve on policy interventions aimed at influencing the water behaviour of households and consumers in a pro-water direction. Several conclusions can be drawn from this study. Firstly, an individual's behaviour is a complex phenomenon (Ajzen 1985) that is influenced by internal and external factors. There is no single approach to explain why individuals behave in a certain manner. Evidence from the study suggest young people generally do not think nor engage in water saving actions on a daily basis. To promote water saving habits require behavioural change that involves the undoing of old habits and forming new ones. A good starting point is within the household, where prompts or reminders can be placed at the point of water use to remind householders of acceptable and do-able water saving actions.

Secondly, despite some favourable views towards water conservation in the home, relatively few respondents are committed to go much further in engaging in simple water saving behaviour such as taking shorter showers and turning off the tap while brushing teeth. Any further household water savings may be restricted by prevailing attitudes and behaviour. It takes more than awareness and education campaigns to convince people to change their behaviour. There has to be some practical and rewarding incentives to induce behavioural change. According to the literature, water pricing can be a tool for water service providers to influence consumer behaviour (Brookshire et al 2002). For a small, rapidly modernizing island state such as Samoa, raising the price of water [as it is with electricity] does in fact reduce the demand, albeit only modestly, in that householders are inclined to become more careful in their water consumption habits.

A mandatory retro-fitting of all newly constructed houses with water efficient technologies subsidized by the water utilities providers can make it easy for households to manage their water use. One of the obstacles to water saving behaviour identified in the focus group sessions refer to the need for an easy water conservation system that residential water users

do not need to think about when they turn the tap on. Evidently, installing water efficient technologies can go a long way in meeting this demand for simple and hassle free means of water conservation.

Directly related to the need for easy water conservation methods is the prevailing mentality that water use is a personal matter. Any infringement or directive to watch how they use water or avoid unnecessary water waste is considered an invasion of one's privacy. Such attitudes reinforce the need for mandatory installation of low-flow technologies to avoid water service providers from having to deal with issues of this nature.

The fourth general conclusion concerns the need for a substantial and sustained educational-awareness campaign to show how we can address water conservation in a manner that is practical and attainable. The responsible ministries need to take a more active engagement with the community rather than leaving public moral consciousness to short-lived media campaigns during environment week or when there is a potential threat to water supply particularly during the dry season. Moral consciousness and awareness levels vary across the population and subject to one's level of education. For the respondents in this study, having a tertiary education can impact strongly on raising awareness and concern about water usage in the household. The challenge for these young people is to translate this awareness and concern into practical behavioural habits in their homes.

Finally, to encourage young people to adopt a positive attitude towards water consumption requires putting into place certain elements to support pro water behaviour. Water pricing and consistent pricing policies induce an emotional reaction to perform a positive water behaviour that yields a favourable outcome for the entire household. Getting water providers to initiate pro water actions such as subsidizing water saving devices will assist in building individual capacity to reduce water consumption and sustain a positive attitude to water conservation.

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Appendix 1.

Final Questionnaire:

1. Name: \_\_\_\_\_

2. Gender: \_\_\_\_\_

3. Village/usual place of residence: \_\_\_\_\_

4. Age: \_\_\_\_\_

5. Number of people residing in your household?

1 -3

4 -6

7 -9

9 or more

6. Number of taps/faucets inside your home-house?

1 – 3

3 or more

7. Number of taps/faucets outside the home-house?

None

1-2

More than 2



8. Is your water supply metered?

Yes

No

9. How much does your household pay in a month for your water supply?

Less than \$50:00

Between \$50:00 and \$100:00

More than \$100:00

10. What do think about the price your household is paying for your water?

11. Should the price of water be increased?

12. Why/Why not?

**User specific questions:**

13. Based on a 24 hour time line, can you identify and estimate a temporal quantification of your water usage in the home?

14. How often do you brush you teeth?

Once a day

Twice a day

Other

15. How often do you shower-wash?

Once a day

Twice a day

Other

16. How much time do you spend showering-washing?

$\leq 5$  minutes

5 – 10 minutes

More than 10 minutes

17. How much time do you spend on brushing your teeth?

$\leq 5$  minutes

5 – 10 minutes

other

18. While in the shower, do you wash clothes and / or bathe younger children/siblings?

Yes  No

19. If yes, how long will you be in the shower?

More than 5 minutes , 5 to 10 minutes , 10 minutes or more

20. How often do you do the following in your daily life? [Select one answer per row]

Action-behaviour	Never	Occasionally	Often	Always	Not Applicable
Turn off the water while brushing teeth					
Plug the sink when washing dishes					
Take shorter showers [ $\leq 5$ minutes]					
Collect and store rainwater					

**Water Conservation:**

21. What do you know about water conservation in the home?

23. What do you think about the price of water?

24. Do you get a reliable supply of water into your home?

25. If yes, are you satisfied with the overall water services provided by the supplier?

26. If not, what do you think needs to be done to address this issue of unreliable water supply into the people's homes?

27. Do you practice water conservation methods in the home?

28. If yes, what are they?

29. Do you think you can reduce the amount of water that you currently use?

No

Yes, very little [under 5%]

Yes, a lot [more than 5%]

30. List all obstacles to water conservation you encounter in your household-home environment.



ARTIST: RUMIKO SASA SCHOOL: Seven Day Adventist School

# **The impacts of climate change and development in water catchment areas on water resources**

**Aurora Elisaia-Vaai  
Muliagatele Siatua Lautua  
Mafutaga Leiofi**

## **EXECUTIVE SUMMARY**

The Vaipouli and Palauli Catchment in Savaii, Alaoa, Fuluasou and Togitogiga Catchments in Upolu Island are large estate catchments making it vital for regional biodiversity, water quality protection and landscape linkages to ensure water supply. Water Resources Division in its aim to ensure the sustainable management and development of Water Resources in Samoa through the appropriate policy and legal frameworks, effective monitoring and assessment of water resources and sustainable management and protection of watersheds, has its management practices subject and guided by the Water Resources Act 2008 for a quality controlled environmental management system which includes protecting biodiversity and stream (river) health. As part of conserving biodiversity, maintaining wildlife corridors, stands of native vegetations and linkages between native habitats is crucial. Water Resources Division through their Watershed Section fosters wider community involvement in the management of the rehabilitated forest estate including wildlife corridors referred to as buffer zones. Our project aim was to contribute to an increased understanding of the impacts of climate change and development in water catchment areas on water resources. We sought to achieve this by examining the landscape linkages corridors as habitat, assessing the native vegetation in the corridors within the 5 catchment sites concentrating on stream health by conducting a habitat survey along the streams.

Data was sought from field observation and methodology designed from overseas studies of catchment areas by the analysis of stream health. Field data was collected from 5 segments of the major river on each catchment as this was the achievable field data collection with the time span of five months (June – Oct 2012)

## INTRODUCTION

Our area of study is located in both islands; two in Savaii and three in Upolu. MNRE-WRD is also very involved with the wider community. Fostering wider community input to forest management planning are being implemented through annual action plans in each of the Ministry's plans. .

Our study will be looking at corridors along the stream as habitat watershed survey in the five catchment sites. For this we need to understand corridors and what value they are to fauna and survival of species and biodiversity conservation. To achieve this we shall be seeking to answer questions such as; does width dictate tree species composition? Does stand strata and cover abundances effect the usage of the corridor by species? Does width of the corridor affect usage by fauna? Does the tree species composition affect the usage of the corridor by fauna?

## BIODIVERSITY

Biodiversity or biological diversity generally refers to all living things within the environment and is a term widely used by scientists, the public, educators, environmental groups, conservationists, industrialists, agriculturalists, government agencies and economists. Miller (2002)(2002) states that;

*'Biodiversity encompasses a variety of species (species diversity), genetic variability among individuals within each species (genetic diversity), variety of ecosystems (ecological diversity) and functions such as energy flow and matter cycling needed for the survival of species and biological communities (functional diversity)'. (pp. G2)*

In laymen's terms biodiversity generally refers to the variety of life forms on earth such as plants, animals and micro-organisms, their genetic material and the ecological systems or communities in which they inhabit. Within the Environment Protection and Biodiversity Conversation Act 1999 (EPBC Act) and the National Strategy for the Conservation of Australia's Biodiversity (NSCABD) (Commonwealth of Australia, 1966) biodiversity is defined as:

*'the variability among living organisms form all sources including, inter alia, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are a part; this includes diversity within species, between species and of ecosystems.'*

This definition was extracted from Article 2 of the 1992 United Nations Convention of Biodiversity (United Nations CBD, 1992a); however the Commonwealth of Australia expanded this definition into three levels that relate to the biodiversity of Australia. These levels are:

1. genetic: the variety of genetic information contained in all of the individual plants, animals and micro-organisms that inhabit the earth – genetic diversity occurs within and between the populations of organisms that comprise individual species as well as among species.
  2. Species: the variety of species on earth
  3. Ecosystem: the variety of habitats, biotic communities and ecological processes.
- (Williams et al., 2001)

All levels of diversity rely on each other for survival; however a functioning ecosystem is dependent upon the species populations that are endemic to it. Take into consideration the ever expanding human population and the pressure it puts on much needed resources and infrastructure (i.e. housing, water, timber, food and electricity). Fragmented (i.e. impinged upon by this resource utilization). As a result, a number of these diversity factors will suffer dire consequences if appropriate management systems are not introduced and implemented.

### **Wildlife Corridors**

Wildlife corridors are necessary to provide species genetic diversity through a range of habitat types that allow for accessibility to resources throughout a landscape. It was reported by Wilson and Lindenmeyer (1995 p.53) that from a functional view point:

*'the effectiveness of corridors is gauged by their ability to facilitate dispersal and re-colonisation of patches within a patch-corridor-matrix landscape. Thus, the assessment of corridor effectiveness must be based on an evaluation of the corridor's role in establishing and maintaining connectivity between wildlife populations.'*

Ecosystem viability will be influenced by the presence of faunal activity throughout these corridors. Activity will be influenced by the movement of animals through a corridor, their rate of mortality (i.e. predation) and the ability of animals to use the corridor as a dwelling (Wilson and Lindenmeyer, 1995). All three factors will be subjective to the availability of food, shelter and breeding sites.

The size of a corridor will be a determining factor in its effectiveness in terms of wildlife using it as a source for genetic diversity, food or shelter. Wilson and Lindenmeyer (1995) recommended that the basic principle of wide corridors is more effective than narrow ones. This is because:

- a. there is greater interior/edge ratio
- b. a greater variety types and quality may be captured; and
- c. there is a higher probability of supporting resident fauna population (p32)



Davies and Nelson (1994) stated that a buffer zone of less than 10m wide did not significantly protect streams from changes in algal, macro invertebrate, fish biomass and diversity. However, they indicated that a buffer width greater than 30m was more likely to provide protection from short-term impacts within a variety of forest types and geomorphology, such as weed invasion and predation. Bennett (1999) concurs stating that: *'a linkage is wide enough when it effectively maintains connectivity for the species or assemblage of animals for which it is intended'* (p139). This indicates that the width of a corridor solely depends upon the function and purpose of the linkage, target species behavioural ecology and movements, as well as the employment of the adjoining land uses.

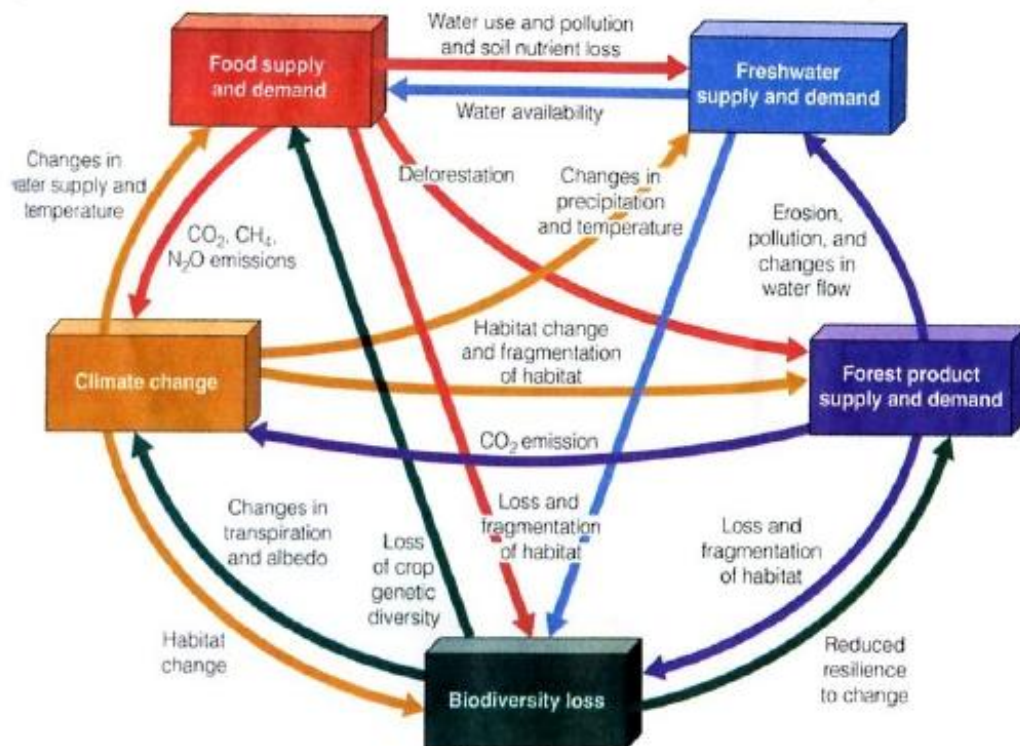
Linkages within a pine plantation or forested environment where movements of many native animals are restrictive, forested re-growth of mosaic formation and of varying age can influence the return of native and non-native species. This forest re-growth may facilitate non-forest dependent animals as oppose to dispersal through a mosaic matrix, therefore, linkage functions within a managed forest emphasizes habitat retention as opposed to pathways and channels (Lindenmayer, 1994; Lindenmayer, 1999; Lindenmayer et al., 2000). Bennett (Bennett, 1999) stated that retained habitats can enhance forest connectivity in several ways:

- *by monitoring continuity of resident populations in linked strips of suitable habitat among sub-optimal re-growth stands;*
- *by providing a source population for rapid re-colonisation of re-growth habitats as the vegetation becomes suitable;*
- *by providing resources (such as shelter and breeding sites) for species able to forage, but not live, within re-growth habitats;*
- *by enhancing movements and dispersal of species that are inhibited from moving through re-growth forests (p.121)*

Therefore, by creating and sustaining appropriate sized corridors between mosaic patches is vital for the survival of a population, its genetic diversity and its range of dispersal within a functioning ecosystem.

## Human Infrastructure on Biodiversity

Human infrastructure impinges on the environmental ecosystems in both a positive and negative way. However, with the ever expanding population requirement such as South- East Queensland will constantly erode a fragile ecosystem. Characteristics that have a tendency to increase biodiversity are; moderate environmental disturbance, a physically diverse habitat, the middle stages of succession, evolution and small variations in environmental conditions such as nutrient supply, precipitation and temperature (i.e. climatic change) (Miller 2002).



Source: Miller 2002

Figure 2: Impacts of human activity on biodiversity

On the other hand, factors that impinge and reduce biodiversity include environmental stress, extreme environmental disturbance (i.e. construction of a dam), harsh environmental conditions (i.e. drought and global warming), severe limitation of an essential nutrient, habitat, or other resource (i.e. salinity), introduction of an alien species (i.e. lantana, feral cats) and geographic isolation (Miller, 2002). Figure 2 shows how these factors connect and intertwine between human activity and the ecosystem biodiversity (Miller, 2002).

The effectiveness of biodiversity through wildlife corridors depends upon human infrastructure and how it affects genetic, species and ecosystem diversity, within an expanding population combated with continual climatic changes. Effective management procedures inclusive of biodiversity and improvements to maintain biodiversity will ensure species survival in the long term.

## TERRESTRIAL FAUNA IN WILDLIFE CORRIDORS

### Do Wildlife Corridors Work?

The concept of providing animals with a pathway via which they may move from habitat patch to habitat patch seems like a very smart and noble thing to do, but is there any evidence to suggest that corridors actually work? A number of studies have been conducted in an attempt to answer this question. Haddad et al (2003) studied species movement within patches and corridors consisting of early successional vegetation, within a recently harvested pine plantation. They investigated the movement of two butterfly species, one species of bee, two small mammal species, four plant species, and the pollen of another plant species. The results they acquired conclusively showed that wildlife corridors consistently directed the movement of diverse taxa, with 68% being the lowest recorded increase in species moving between connected habitat patches.

Another study of the use of wildlife corridors within a clear-felled plantation forest was conducted by Constantine et al (2004). This study took place in intensively managed loblolly pine plantations in coastal South Carolina. Unlike Haddad et al (2003), the corridors investigated by Constantine et al (2004) did not consist of native forest but were instead untouched areas of the original plantation, left by the forest managers in order to achieve the spatial heterogeneity required by the management guidelines. Interestingly, Constantine et al (2004) found biodiversity to be greater in harvested stands with corridors than in non-harvested stands. They proposed that this was due to richness in ecosystem diversity facilitated by the untouched plantation corridors and the early successional dense herbaceous under-storey provided in the felled areas. Constantine et al (2004) concluded that the retention of corridors, albeit consisting of exotic tree species, created ecotones increasing the niches available to indigenous wildlife. They went on to say that inclusion of corridors enhances habitat diversity and ecosystem maintenance, thus contributing to local biodiversity.

In terms of its application to corridors within the forest estate of the catchment study sites the major limitation of Constantine et al (2004) report is the fact that it focuses on corridors consisting of largely exotic species. The wildlife corridors vary from catchments to catchments at times consisting of native vegetation some introduced vegetation. In saying this, however, if it can be found that native fauna will quite happily inhabit a corridor that isn't natural, then there is no reason why they shouldn't inhabit a similar corridor if it were original native bush-land.

As Constantine et al focussed their studies on small mammals such as rodents and shrews, species that are similar to a number of Australian small mammals, it would be reasonable to assume their findings could be applied to Australian plantations. However, wildlife corridors should be aimed at conserving all animal species, not just small mammals. Species such as medium to large mammals, birds, reptiles and insect were also advantaged by clear felling

merits further to investigation.

### **Wildlife Corridors in Riparian Areas**

In many cases corridors across the landscape are not set up specifically for utilisation by wildlife, but are left in riparian areas, either due to management guidelines to protect aquatic habitats and maintain water quality, or simply because of a lack of access for machinery. In the last few decades ecologists have realised that these watercourse buffer zones may also act as wildlife corridors connecting patches of otherwise fragmented habitat. Darveau et al (2001) analysed the use of riparian strips by small mammals in native boreal balsam fur forests in Quebec. Their experiment involved the trapping of small mammals in 20m thinned, 20m, 40m, 60m and 300m strips next to creeks. They found no difference in capture rates between any of the treatments, having found that even the 20m thinned strips acted as refuge for one species during a dramatic population increase of one of its competitors. However, Darveau et al (2001) went on to say that 20 metre wide strips are not desirable because they leave only riparian habitat, which may not be desirable for some species, and lead to disruption of small mammal communities after clear-cutting of adjacent areas. Their highly precautionary conclusion is that their study did not have a large enough scope, and did not take enough socio-economic impacts into consideration to enable determination of the appropriate mixture of strip sizes for the landscape.

The final conclusions yielded from this study may not be overly constructive, however the preliminary results obtained can be applied to the study sites around Samoa where there are a vast majority of wildlife corridors present alongside creeks and drainage lines. The corridors at the sites vary from under ten to over 200 metres on either side of water-ways. The majority of buffer zones are greater than the minimum 20-metre width studied by Darveau et al (2001). Transferring Darveau et al's (2001) initial findings, would therefore suggest that the majority of wildlife corridors within each catchments are wide enough to support utilisation by small mammal species. However, in applying these findings it would have to be kept in mind that the Quebec forests are somewhat different to those on the Sunshine Coast. Firstly the forests in Quebec are native which may be important in that wildlife are adapted to utilising the whole landscape, before being forced into the corridors when the trees are felled. Around Upolu and Savaii many species of wildlife may never venture into the exotic plantation areas of the forest, and may only utilise the corridors and habitat patches. Another difference between the two areas is climate. Quebec has a mean annual temperature of 0.3oC, compared to Samoa where the mean annual temperature is in the high teens. Exactly what, if any, impact temperature has on the behaviour of wildlife in riparian wildlife corridors is beyond the scope of this study, but may well be an important factor.

Miller et al (2004)) also studied stream buffer zones as wildlife corridors. Their study was conducted in both pine plantation and natural riparian stands in Arkansas, USA. Here riparian

buffers or streamside management zones (SMZs) as they are known are a common component of pine plantation landscapes. Miller et al (2004) trapped small mammals in SMZs of five different size classes (1-20, 21-40, 41-60, 61-80, >100m) as well as natural riparian areas. Interestingly they found that SMZs from 1-20 metres wide tended to have greater small mammal diversity than did wider SMZs. They concluded that SMZs designed to meet water quality standards were likely to be sufficient for small mammal conservation.

The conclusion reached by Miller et al (2004) contradicts that of Darveau et al (2001), despite the fact that their studies investigated exactly the same thing. Perhaps the fact that two different studies in two different areas can achieve similar results yet come up with vastly different conclusions, reflects the fact that the deep down attitudes and ethics of those conducting a study, can have a greater influence on the findings than the actual results. Nevertheless, the fact that

Miller et al's (2004) study found that buffer zones less than twenty metres wide can provide desired levels biodiversity for small animals in plantation areas, augers well for the Beerburum Forest estate, whose current wildlife corridor system may well be sufficient. Once again however, it has to be kept in mind that this study was conducting in a study area with somewhat different ecosystem dynamics to those around Beerburum.

## **Species**

None of the literature presented so far has looked at species other than small mammals. Studies have however been undertaken on birds, reptiles, amphibians and invertebrates. Haddad and Baum (1999) studied the affect of habitat corridors on four butterfly species in plantation pine forest in South Carolina. They found that densities of the three habitat specialist butterflies were higher in habitat patches connected by corridors than those that remained isolated. The fourth butterfly, a generalist species, was found in constant densities throughout the landscape, including the plantations. The important aspect of Haddad and Baum's study (1999), was that they looked at populations within the habitat patches, not within the corridor. Corridors are mainly aimed at providing a pathway via which animals may move between habitats; they are not necessarily meant to be a habitat area in themselves. Species such as medium to large sized mammals and birds (and in this case butterflies) travel briefly through the corridor and therefore require only a minimum number of their lifecycle requirements to be met within it (Burbrink et al., 1998). Assessing the effectiveness of corridors for these species may therefore be better achieved by monitoring patch populations, not corridor populations. Conversely species such as reptiles and amphibians may spend generations travelling the length of a corridor, and will therefore require corridors that meet all of their life-cycle requirements (Beier and Lowe, 1992).

Burbrink, Phillips and Heske (1998) studied reptiles and amphibians along a riparian dispersal corridor in southern Illinois USA. Contrary to their initial expectations but similarly

to Constantine et al's (2004) study on small mammals, they found that narrow corridors (<100m) contained more reptilian and amphibian biodiversity than did the wider (> 1000m) corridors. Burbrink, Phillips and Heske (1998) accounted for their findings by stating that reptile and amphibian biodiversity in riparian corridors is probably more strongly influenced by habitat type than corridor width.

Application of these findings with the 5 catchment study sites would suggest that the existing corridors, that are thought to contain a wide range of different regional ecosystems, may well be sufficient to support high levels of reptilian and amphibian biodiversity. However, caution has to be exercised when extrapolating overseas findings into an Australian situation.

Another group of animals that needs to be given consideration in the establishment of wildlife corridors is birds. Bentley and Catterall (1997) conducted a study on the use of corridors and linear remnants by birds in south east Queensland. They found that that riparian corridors and linear remnants supported levels of avian biodiversity similar to those found in continuous riparian bushland. However they did quantify this result with the fact that increases in species they classified as "cleared land birds" compensated for decreases in abundance of "forest birds". Nevertheless, slightly undesirable biodiversity is better than none at all, and the fact that Bentley and Catterall (1997) found that riparian wildlife corridors were utilised by a wide range of species, particularly winter migrators, adds further support to the concept of maintaining corridors of native vegetation across the landscape.

### **Indicator Species**

In most cases it is simply not feasible to assess every single organism that may occasionally be found living within an ecosystem. What is far more logistically possible is to monitor the populations of species that have been identified as being especially sensitive to changes in particular ecosystems. Kavanagh and Stanton (2005) undertook an extensive study to determine how fauna species were affected by logging in northern forests of northern New South Wales in Australia. Species identified by Kavanagh and Stanton (2005) as being sensitive to logging.)

Kavanagh and Stanton (2005) believe that the species they identified as being sensitive to logging are likely to be worthwhile subjects for long term monitoring as indicator species. As a part of their study they segregated the species into 15 groups using cluster analysis, based on the similarity of inter-species associations (see letters in parentheses in Table 1 above). Species in groups with few other species are likely to have unusual habitats while species in groups with many others will be generalists. The majority of the 15 groups are represented in the lists of species identified as being particularly sensitive to logging. Therefore a possible method of selecting indicator species to gauge the health of a forest landscape would be to pick species from each of the fifteen groups identified by Kavanagh and Stanton (2005) to

those species listed in the table above and where possible should include one species both advantaged and disadvantaged by logging.

The findings of Kavanagh and Stanton's (2005) study can undoubtedly be applied, to a large extent at least, to the dynamics of the catchment sites. The vast majority of the species studied by Kavanagh and Stanton (2005) have ranges that extend the extra few hundred kilometres north to southeast Queensland. Furthermore, the vegetation types and climate of southeast Queensland are very similar to those of northeast New South Wales. And unlike most of the other studies on animal dynamics within forested landscapes, Kavanagh and Stanton (2005) include animals such as birds, reptiles and amphibians in their study.

Animal species such as those identified by Kavanagh and Stanton (2005) are what Lindenmayer, Margules and Botkin (2000) termed taxon based indicators. These authors go on to outline seven possible definitions of an indicator species ranging from; a species whose presence indicates the presence of a range of other species whose absence indicates the lack of a full species assemblage to; a species thought to be particularly sensitive and therefore able to serve as an early warning sign of environmental change to; a species whose presence indicates the effects of a disturbance regime. But for all environmental perturbations that indicator species may well have the potential to indicate, Lindenmayer, Margules and Botkin (2000) identify just as many reasons why using them to gauge ecosystem health may prove problematic. These reasons include the possibility of disturbance independent causes of population decline, such as pathogens, in possible indicator species, different responses by different species to the same disturbance and very high thresholds to disturbance by some species. Each of the shortcomings they identify would be overcome however, if indicator species are chosen from a wide range of different ecosystem niches, such as the groupings identified by Kavanagh and Stanton (2005). Selecting many different indicator species from all aspects of ecosystem functioning would mean that even if a few of the species were highly resilient to disturbance, or a couple were afflicted by some completely unrelated pathogen, the reactions of the remaining species would still give a true indication of ecosystem condition.

In light of the flaws that Lindenmayer, Margules and Botkin (2000) identify in the taxon based indicator species concept they propose what they term structure-based biodiversity indicators. They propose that these indicators should consist of:

- Stand Complexity – conservation areas such as wildlife corridors in logged forests should closely match the structural and floristic features of undisturbed native habitat.
- Heterogeneity – conservation areas should vary in terms of age classes, vegetation types, structure and floristic of both over and under storey vegetation, factors which directly relate to variation in soil types, terrain, aspect and elevation.
- Connectivity- here, the issues surrounding wildlife conservation in the five catchment sites come full circle. According to Lindenmayer, Margules and Botkin (2000), the

more connected patches are in the landscape, the greater biodiversity is likely to become full circle. According to Lindenmayer, Margules and Botkin (2000), the more connected patches are in the landscape, the greater biodiversity is likely to be.

Lindenmayer, Margules and Botkin (2000) believe that these structure-based indicators are far easier to monitor than those based on the presence or absence of various species of fauna. They do however state that little scientific evidence of the long-term effectiveness of these factors as indicators currently exists in the literature. As with many studies, they emphasize the need for further research.

For many species living in fragmented habitat, there is a need to have connectivity to other patches to mitigate the effects of isolation, small unviable populations, loss of genetic and species diversity and the impacts upon species from arrested ecological function. Therefore, land managers should assess the importance of connectivity within their sphere of influence and the possible management practises which can be used to bring about effective landscape connections. In this study fish was an indicator of healthy streams, algae also but not too much so the absence of these was indication of unhealthy streams.

### **Connectivity**

The connections between landscape elements and their functional roles have received a great deal of attention from scientists, ecologists as well as managers over the past ten years. The loss of landscape connectivity, often discussed as habitat fragmentation, is considered by some landscape ecologists to be among the greatest threats to natural biological diversity (Walker and Craighead 1997).

The concept of connectivity was generally used to describe a landscape's structural and functional continuity over both space and time scales (Dawson, 1997). Connectivity usually involves corridors and networks and describes how patches are connected in the landscape. Connectivity is both qualitative and quantitative, and these characteristics make a difference, both at the patch and the metapopulation level. Network connectivity can be used to determine the complexity and connectivity of a landscape. For example, high connectivity implies an increased interaction between the movements of animals, plants, heat, energy, water, and materials among elements (Cantwell and Forman, 1993).

Functional connectivity has been defined as the rate of movement needed to achieve a population or ecosystem goal within a preserve or fragment, regardless of the mechanism used to achieve the movement (Scott and Allen, 2002). To forest planners, the term "connectivity" means the degree to which various ecological components are linked to one another over time to form an interconnected network of forest matrix and corridors (Dawson, 1997). The characteristics of the linkages vary depending on an area's topography and natural disturbance regime (Dawson, 1997).



Analyses of connectivity can be used to test if a proposed corridor provides sufficient faunal movement to achieve a specific set of conservation goals. In reverse, it can be used to estimate the corridor conditions necessary to achieve management goals (Scott and Allen, 2002). When landscape connectivity is breached, certain continuous, stable populations become multiple separate populations that can become more and more disrupted and unstable (Dawson, 1997).

The elements that describe the value of connectivity to a patch are; the presence or absence of a connection; the size of the largest geometric figure to which the patch is connected, and the quality of that connection (Dawson, 1997). That means that the size and shape of the connection, and the size and shape of the fragments being connected, in conjunction with the condition of the connection in terms of habitat and refuge value to fauna. This equates to the value of that connection in mitigating the effects of landscape fragmentation. These elements should be carefully considered by managers in the planning process (Henein and Merriam, 1990).

Preserving habitat and dispersal routes to maintain landscape-scale connectivity is a popular research topic in landscape ecology. Habitat isolation and the attendant loss of natural species diversity can be reduced by designating connective corridors (Dawson, 1997). These important elements of landscape structure are usually continuous remnants of naturally occurring vegetation which allow species to move between patches of undisturbed habitat helping to maintain a large gene pool (Dawson, 1997).

A metapopulation is defined as a group of spatially isolated sub-populations in habitat patches, but functionally united through flows of organisms, seeds and pollen grains (Hanski and Gilpin, 1997). This concept is not new, however, the appropriate scale for metapopulations as opposed to population fragments are still debatable (Weis, 2005). Weis(2005) uses Levins' definition of Metapopulations

*“Original definition, a metapopulation is "a population of populations". Each component is a local population. A single local population occupies a patch.” (p.1)*

Henein and Merriam (1990), therefore, argued that a good research model is the one which can show how quality and quantity of connectivity in a heterogeneous landscape affect the size and persistence of fragmented populations and addresses the following questions:

- Does the quality of connections among patches affect the size of a metapopulation?
- Does the number of corridors in a metapopulation affect the overall metapopulation size?
- Do extinctions occur more frequently in patches with low quality connections?
- Is the proportion of low to high quality corridors a factor in metapopulation size and persistence?

In addition, connectivity should be examined by its potential contribution to specific population parameters (e.g., growth rate, demographic structure, fecundity, genetic structure, etc.) or ecosystem processes (e.g., flows of water or nutrients, trophic/species interactions, and recovery from disturbance) as these information can help managers and scientists to design a long term management plan (Scott and Allen, 2002).

Considering corridor characteristics may serve as circumstantial evidence in the protection of final linkages, reliance on physical indicators of connectivity is less satisfactory when difficult decisions must be made about land acquisition. An example of land acquisition and corridor maintenance was provided by the Caboolture shire council, where they have funding to acquire land for purposes such as landscape connectivity and protection on biodiversity (PRCCA, 2000).

Furthermore, Dawson (1997) indicated that it is essential for managers to decide if a corridor, defined for reasons other than connectivity, provides sufficient linkage to meet management goals. Managers need to consider all of these aspects when they manage existing or design new landscape linkages. These are to be considered within economic and political constraints in a manner that preserves connectivity and ecological processes.

### **Connectivity and Biodiversity**

Corridors may have different survivability values depending on their size and the degree of cover they provide metapopulations, but allows them to grow and stabilize with greater abundance than without connectivity (Henein and Merriam, 1990). By sustaining landscape connections, forest dwelling organisms can continue to spread out, move across and in between landscapes, conserving species and genetic diversity (Dawson, 1997).

Henein and Merriam (1990) argued that what constitutes a corridor for a particular species depends on an array of factors, such as the physical aspects of the landscape; cover, type of vegetation, moisture, elevation, etc.; the distance between patches, and the behaviour of the animals themselves. Small mammals in heterogeneous environments have been found to disperse along corridors connecting habitat patches (Henein and Merriam, 1990). This indicates that there is movement of genetic materials, and maintenance of sufficient numbers for the continued survival of these particular species.

Forested landscapes become fragmented when large contiguous forest patches are transformed into smaller patches surrounded by disturbed areas. These natural connections between forested ecosystems may also be severed by timber harvesting, as well as by urbanisation, agriculture, and other developmental activities (Dawson, 1997). This phenomenon has been termed fragmentation; used to describe small remnants of the original vegetation left scattered around the landscape. Natural features such as riparian habitats along a stream or river bank, often provide connections to these remnants and are important at

the landscape level because they encompass a diversity of habitats and topographic gradients (Dawson, 1997).

Forest fragmentation leads to declines in biodiversity in three ways:

- through habitat loss (e.g., by converting forests from natural to managed stands or to other uses such as pastures);
- through increases in “edge effects,” the modified environmental conditions found at the boundaries between habitats (e.g., by reducing the size of forest patches);
- through increases in habitat isolation (e.g., by imposing barriers to gene flow and dispersal) (Dawson, 1997).

The loss of natural connectivity in the forest matrix can be mitigated by maintaining networks of corridors that create linkages in the natural landscape; and managing the area between these corridors (i.e., the mature and old forest matrix) to create a mosaic of forest structures which fauna can utilise as habitat and shelter for movement purposes (Henein and Merriam, 1990). By logging the managed plantation in a mosaic pattern disturbance events will have less impact upon the connectivity values offered by the plantation.

Since most of the landscape represents the area between corridors, careful management to preserve the area’s connectivity and habitat attributes over time is critical (Dawson, 1997).

### **Maintaining Corridor Connectivity**

Ecological drawbacks posed by corridors are typically indicative by long, narrow habitats with extensive borders. They are difficult to manage as they incur high management cost per unit area and are at risk to spread of disease, pests and fire. These characteristics mean species populations are more susceptible to extinction (Walker and Craighead, 1997).

Depending on a unit’s connectivity objectives, corridors should be managed as either permanent or shifting features in the landscape (Dawson, 1997). While permanent corridors (i.e., those with a fixed location through time) are simple and flexible management tools, choice of location can be more biologically effective than shifting corridors. Shifting corridors only need to be maintained until the adjacent replacement linkages have developed the necessary attributes considered for species diversity (Henein and Merriam, 1990). An appropriate combination of approaches is the best way to preserve the integrity of these corridors.

### **Corridor Connectivity Design**

Three factors should be taken into consideration when designing corridor connectivity, corridor width and composition; continuity of linkages; and inhabitat quality (Dawson, 1997).

## **Corridor Width**

Corridor width and composition are important factors in determining how effective a network of interconnected corridors will be, but few guidelines exist to indicate how these design considerations actually influence animal movements (Dawson, 1997).

While narrow corridors can facilitate quicker movement of some species from one patch to another, the higher ratio of edge effects, affects the rate of mortality in animals, prone to predation (Soule and Gilpin, 1991). Mortality is enhanced at the vegetation interface, or ecotone, because a narrow corridor has a higher edge ratio compared to an area which is compact and of the same area. In the ecotone there is a higher mortality rate as opposed to the interior where there is a lower mortality rate, indicating that the width of a corridor can be a significant influence on species survival (Soule and Gilpin, 1991).

According to Cook (2002), wider corridors are deemed better because they will enhance all five functional characteristics of corridors (habitat, conduit, filter, source, and sink). The larger the internal area, the more area there is for species habitats (Yadlovski, 2003). A larger corridor provides more opportunities for migration for some species and is a refuge for organisms and materials to and from other areas (Yadlovski, 2003). Soule and Gilpin (1991) also indicated that at the other extreme, a very wide corridor has a high rate of occupancy and a relatively low rate of mortality because of the low ratio of edge to interior and as such, permits relatively unconstrained movement of individuals. This may be due to the amount of time spent wandering from side to side and not using the corridor as a conduit but as a habitat in its own right. Width increases incrementally, therefore, the marginal increase in capability lessens (Yadlovski, 2003). If designed for a specific species and effective dispersal corridor should be a size that responds to the needs of that species. Therefore, the life histories and requirements of the fauna that use a corridor should be assessed.

All linkages, regardless of their width, must connect areas of useful habitat; otherwise, they are not linkages but small strips of habitat. Planners would prefer set standards for corridor width that could be equitably applied to all land-use decisions. However, planners tend to emphasize corridor dimensions compared to wildlife biologists who are more likely to examine impediments to species movement within corridors. This cultural gap has left planners wondering why a simple question (How wide should a corridor be?) cannot be answered, leaving biologists troubled by an absence of corridor goals (What species need to use the corridor?) (Henein and Merriam, 1990). Linkage usefulness needs to be assessed during the design phase, because, there is no need to link patches of habitat where viable species populations already exist. However, characteristics of a target species need to be considered when implementing any linkages.

Non-corridor connectivity can occur when the degree of permeability across a landscape matrix approaches or exceeds the permeability of a wildlife corridor (Henein and Merriam,

1990). Situations with non-corridor connectivity typically involve species that can thrive in human-created habitats (e.g. Anna's hummingbird (*Calypte anna*) have exploited horticultural plants, feeders and have occupied human habitats to extend their range across California and Arizona deserts) (Scott and Allen, 2002).

### **Continuity of Linkages**

Corridors should be designed to maintain continuity through time. Therefore, consideration is geared towards the effects of both natural (i.e. insect mortality) and planned disturbances (i.e. harvesting or road building) (Henein and Merriam, 1990). If permanent corridors are to be used, then the number of road crossings should be minimized, allowing corridors the chance to be restored after a natural disturbance. If shifting corridors are to be used, then it is important to ensure that replacement corridors have the required attributes *before* existing corridors are harvested. In all landscape plans, connectivity objectives must acknowledge that linkages are a long-term requirement (Dawson, 1997).

### **Habitat Quality**

The habitat quality within networks is another important element of connectivity. An effective corridor must contain appropriate habitat or the appropriate mix to suit fauna utilising it (Henein and Merriam, 1990). In managed forests, corridors across harvested lands must provide areas of interior forest habitat characteristics to facilitate the movement of organisms. Landscape planning might be simplified by locating and indicating corridors as either inoperable or non-productive timber areas. However, connectivity must also be maintained in productive timber areas if a particular species prefer such a habitat (Dawson, 1997).

### **Managing the Forest Matrix**

Since corridors in managed landscapes will usually only cover a small proportion of the area, management of habitat in the surrounding matrix is also extremely important for maintaining connectivity (Soule and Gilpin, 1991). The maintenance of matrix connectivity requires limitation of the area of young and pole-tenance of structural attributes such as-aged silviculture in some portions of the matrix (Dawson, 1997). In plantation management this means strategic planning of compartment logging, so that a mosaic of ages is present across the plantation. Maintaining landscape connectivity is an essential aspect of forest landscape management for biodiversity. It is important to consider and implement connectivity recommendations carefully in each landscape plan (Dawson, 1997).

Edge effect is clearly an important factor in linkage management and needs to be considered when designing or maintaining landscape linkages for biodiversity.

## Edge Effect

Edge Effect occurs at the boundary between remnant forest and newly harvested areas or other very different land systems such as pasture that affects conditions within the forest. These effects can be felt 100-200 meters into the forest (Berry, 2001) This strongly changes light intensity, temperature variation, wind velocity, and relative humidity of the forest as result of the edge. This can affect species dwelling in the forest with the loss of adequate habitat to support life, to avoid predators, loss of food source, loss of biodiversity, increased exposure to the elements, and increased competition between introduced and native species (Absolute Astronomy, 2005).

Most often the term is used in conjunction with the boundary between wild lands especially within forest and on disturbed or developed land. When an edge is created to any natural ecosystem and the area outside the boundary is a disturbed or an unnatural system, the natural ecosystem is seriously affected for some distance in from the edge (Kapos et al., 1997). In the case of a forest where the adjacent land has been cut, creating an open-land/forest boundary, sunlight and wind penetrate to a much greater extent, drying out the interior of the forest, close to the edge and encouraging rampant growth of opportunistic species within the ecotone (Absolute Astronomy, 2005).

The amount of forest edge of this sort is of a greater magnitude now since the increase of human land development (Turton and Freiburger, 1997)). For instance, some species have opportunistically benefited from edge effect. An example of this is shown by Kapos (1997) the Brown-headed cowbird in North America, which is a brood parasite that lays its eggs in the nests of songbirds resting in forest near the forest boundary. Thus, the more edge in relation to the forest interior, the more cowbirds and the fewer songbirds as a result (Absolute Astronomy, 2005). In the case of developed lands as opposed to wild lands, problems with invasive exotics often occur; species such as Japanese honeysuckle and Multiflora rose have done terrible damage to natural ecosystems in Victoria (Berry, 2001).

Laine (2001) refers to edge effects as one of the mechanisms believed to be responsible for such changes in, community composition in fragmented habitats under the influence of artificially created habitat edges, or 'edge effects'. Artificially created edges are those resulting from human activities, usually the boundaries between forest habitat and cleared land, as opposed to natural boundaries between adjacent habitat types. Edge effects are defined as the interactions of adjacent ecosystems at habitat boundaries (Murcia, 1995). These effects can be physical, such as changes to air flow, light intensity, temperature, humidity and soil moisture (Saunders et al., 1991; Freidenburg, 1998), or biological, such as changes in the distribution and abundance-of a species, predator-prey relationships and competition (Murcia, 1995). Lovejoy et al. (1986) and Murcia (1995) distinguish between primary biological effects of edges and secondary biological edge effects. Primary effects are direct effects of the presence of an edge, such as greater tree mortality at edges, while

secondary effects arise indirect, for example a greater density of nesting birds due to changes in vegetation characteristics at edges (Murcia, 1995).

Laine (2001)(2001) refers to these studies as having demonstrated how changes to bird communities at forest edges and in forest remnants may be a secondary response to edge-associated changes to vegetation characteristics. King et al. (1997) observed that changes in the abundances of forest birds at forest edges in New Hampshire, USA, could be due to a difference in vegetation structure near the edge, rather than to edge avoidance by these species. Morgan and Gates (1982) attributed changes in bird species richness, abundance and diversity at forest/ farmland edges in Maryland, USA, to the presence of a shrubby hedgerow that attracted mixed-habitat species. Lynch and Whigham (1984) showed that in forest patches in Maryland, the abundance of birds appeared superficially to be related to patch size, but actually was due to vegetation variables related to patch size. Cale (1990) and Lynch and Saunders (1991) found that an increase in the shrubby understorey of sites increased habitat quality for forest dependant bird species in habitat remnants in the Western Australian wheat belt. Such findings highlight the importance of considering vegetation changes in studies of bird communities at forest edges and presence of edges (Kroodsma, 1982; Lovejoy et al., 1986; King et al., 1997). Species can be grouped according to their response to edges. ‘Edge’ species are those that increase in abundance at habitat edges.

Typically, these are habitat generalist or open-country species, and often they are species also found in greater numbers in small habitat remnants. In contrast, ‘interior’ species decrease in abundance or are absent from habitat edges; these are typically specialists, that have large home ranges, inhabit large forest areas, and are rare or absent from small habitat remnants (Ambuel and Temple, 1983; Ford et al., 1995; Canady, 1997; Luck, 1999). For example, Catterall et al. (1991) found that in forest–suburb boundaries in Brisbane, forest-interior birds were typically smaller and insectivorous, while forest-edge species were usually larger and fed on open ground.

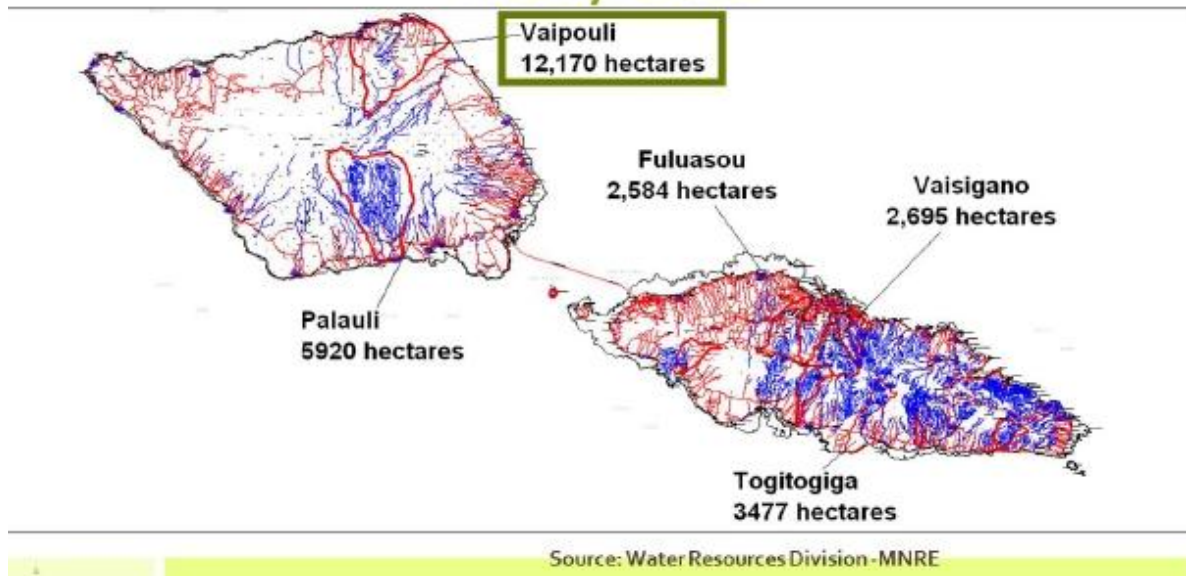
Pine wildings are moving into the natural forest at the remnant plantation edge. They are some cause for concern for plantation managers trying to manage for biodiversity as well as timber production

## **METHODOLOGY**

### **Study Areas**

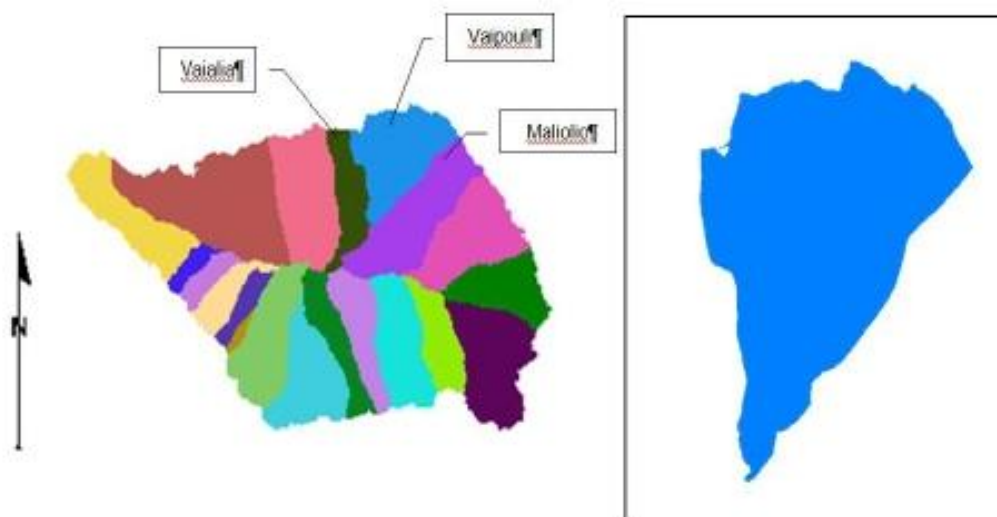
The study areas spanned across Upolu and Savaii, two sites on Savaii, Vaipouli Watershed the biggest watershed area out of the five (5) sites, 12,170 ha, Palauli watershed with area of 5920 ha. In Upolu, the biggest watershed area is Togitogiga with an area of 3477 ha, Fuluasou watershed with area of 2584 ha and Vaisigano with area of 2695 ha.

## Study Sites



### Vaipouli Watershed

Vaipouli Watershed is located in the island of Savaii, in the district of Gagaemauga No. 3 (Refer to Figure 4.1). It is bordered by Maliolio Catchment (right hand side) and Vaialia Catchment (left hand side). The total are of Vaipouli Catchment is approx 12,170 hectares from ridge to reef.



The geology of Vaipouli Catchment is dominated by deposits of Lefaga, this is from a moderately weathered olivine basalt parent material which means it's found in an average depth of 15-50cm, on the soil surface is mostly boulders and stones previous geology studies shows that the soil texture of the Lefaga comprises of clay, silty clay an silty clay loam, Vaipouli geology maps show that Lefaga geology is found predominantly around the catchment. The Aopo deposits forming 20% of the Vaipouli Catchment is from parent

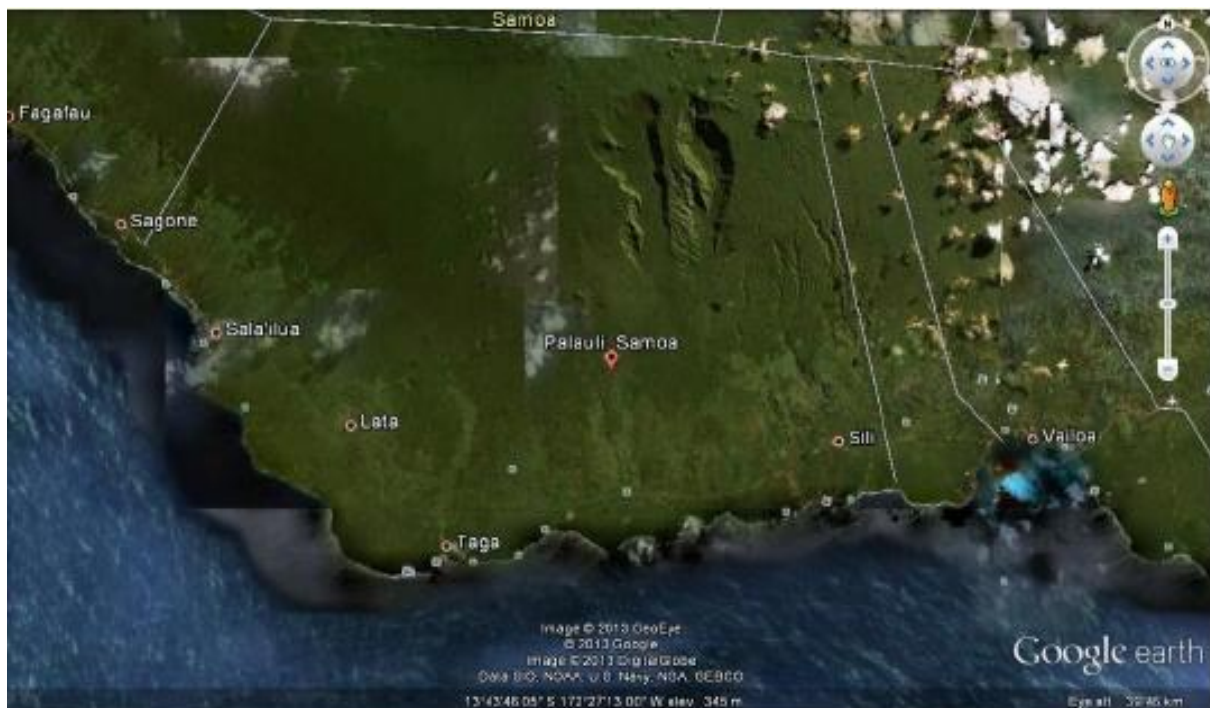


material of moderately to strongly weathered Olive basalt which has an average depth of soil as 50-100cm deeper than the Lefaga deposits, similarly it also has soil texture of clay and silty clay.

The Fagaloa deposits which are 17% of the catchment are from strongly weathered basalts including Basalt Andesite which has a strong landscape dissection. This geology deposit found deepest of the three with average depth of more than 100cm. The Fagaloa deposit soil surface consists of a few too many boulders and soil texture of clay and silty clay. The geology deposits are stated to be important in the determination of the landscape features of the catchment.

The population of the district of Gagamauga III which Vaipouli catchment is located in stated by the 2011 Population Census is 1896 which is an increase by 129 people since the 2006 Population Census. Increase in population can mean the increase in demand for water and land resources.

### Palauli Watershed

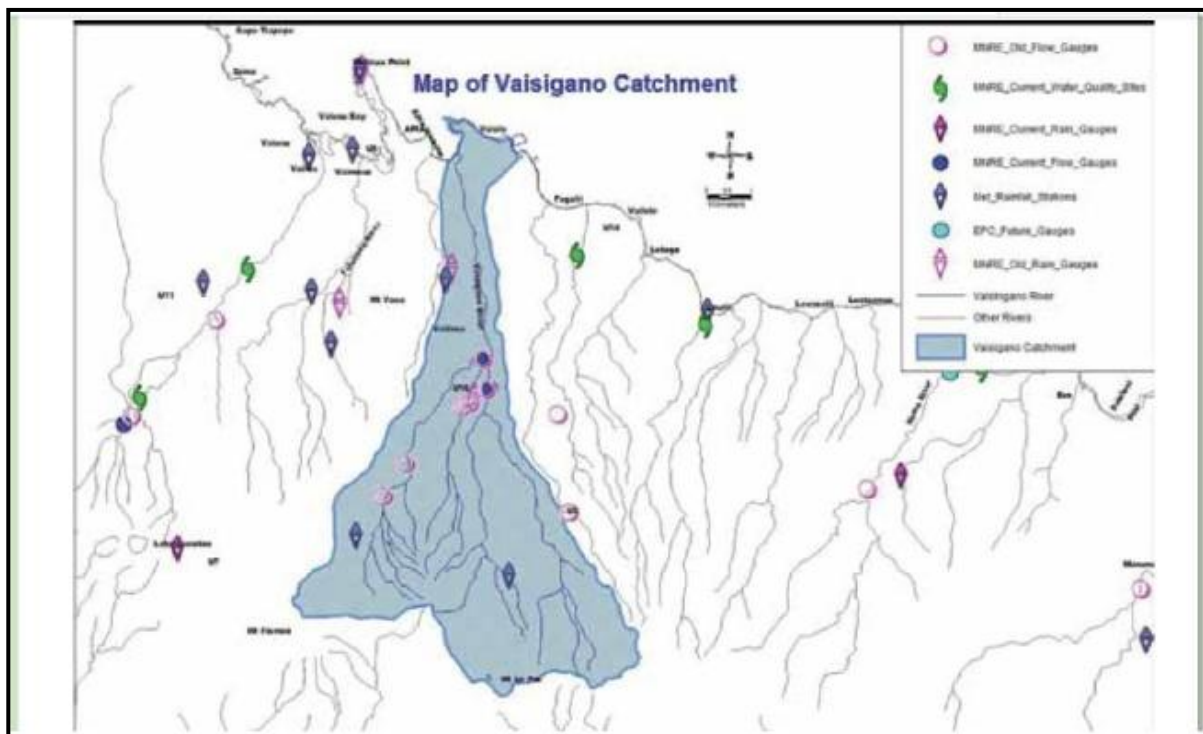


The Palauli Watershed located in the island of Savaii, is a district and village of Samoa with a population of approximately (2011 Census). It consists of two sections on the southern side of Savaii, the capital is Vailoa which is also referred to as Vailoa i Palauli. Vailoa Faleata River is protected in the Palauli Watershed which is the only Water Treatment plant in Savaii Island to date. This treatment plant feeds Vailoa, Salelologa up to Puapua. The climate is similar to that of the whole island that it does not vary greatly through the year. The wet season lasting from October to March and the dry season from April to September, average rainfall receiving <4000mm. Soils are volcanic derived with parent material of most soils in Savaii as olivine

basalt, soils are predominantly stony latosols of varying fertility (Kear and Wood, 1959). Literature shows that there are marked and consistent difference between soils of the lowlands and the upland of both islands. There tends to be an increase in thickness of mineral soil with increasing altitude due largely to heavier ash deposition in the uplands (Wright, 1963).

Temperature has had a very considerable effect on the nature and fertility of soils irrespective of parent material. Weathering proceeds most rapidly at lower altitudes due to higher temperatures (Wright, 1963). However, in general all soils have weathered quickly and soil fertility of the uplands tends to decline very quickly after removal of forest cover due to loss of the stabilizing influence of forest cover. Rainfall exceeds 4,200 mm, even soils from younger parent material are very strongly leached of bases, especially in the sub soil (Wright, 1963).

### Vaisigano (Alaoa East) Watershed



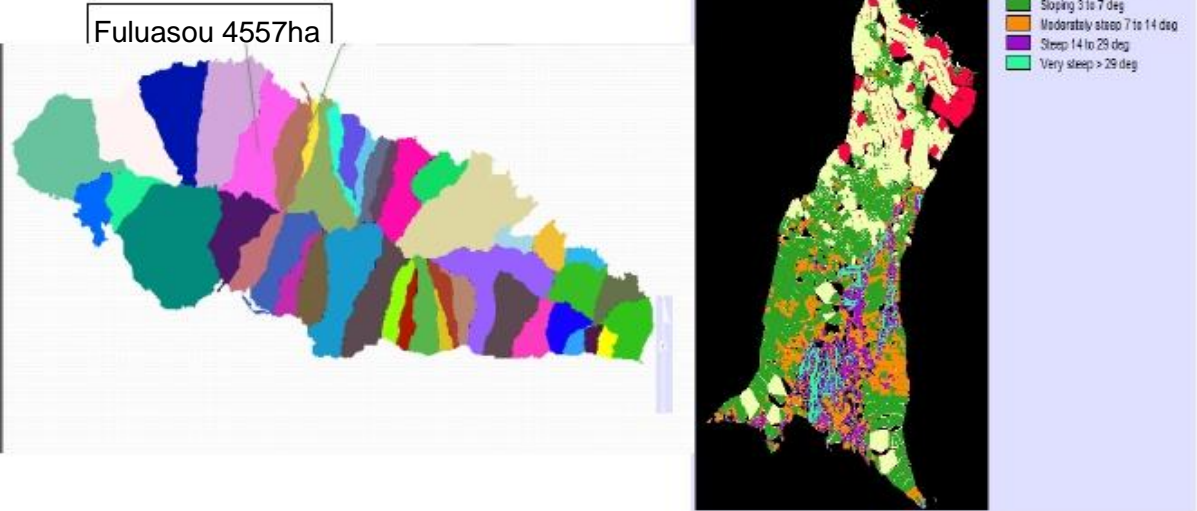
Source: Sopac/Hycos

Vaisigano Watershed 2695 ha in size, holds one of the two water treatment plants that feed the urban area (Vailele – Vaitele).

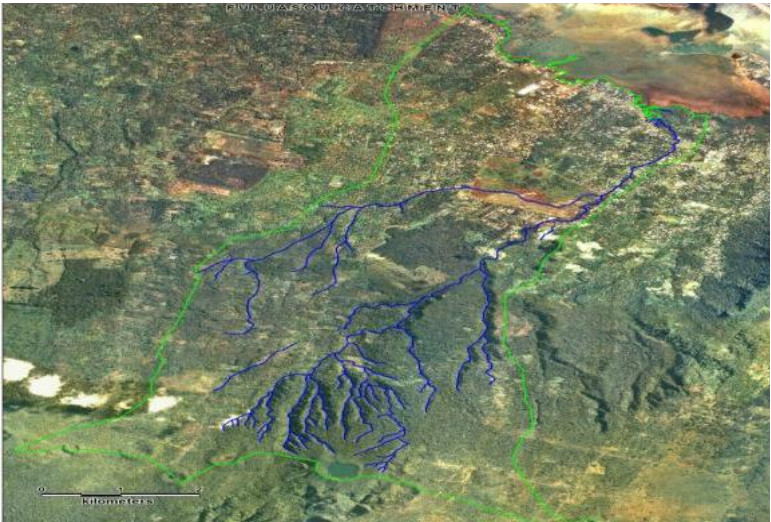


The Togitogiga catchment includes two distinctive water developments, Samoa Water Authority has a 40m<sup>3</sup> capacity rapid sand water treatment plant on the western side of the catchment capturing a single stream flowing towards the end of the dominating Salani geology, this water treatment plant supplies water to Togitogiga, Saleilua, Poutasi and part of Vaovai. East side of the catchment is where the majority of the river tributary flows which has the Togitogiga waterfall as its end point which is a popular visiting spot for local and foreign tourists. The landscape of the Togitogiga watershed is predominantly lowland and foothills.

**Fuluasou Watershed**



Fuluasou Watershed protects the Fuluasou River that extends from Lake Launutoo and empties into Vaiusu bay this is the other main water resource that supplies Apia Township. The population of the Fuluasou catchment is mainly from three main villages, Lepea, Vailoa and Vaiusu which are the outskirts of Apia. Fuluasou has three (3) sub catchments, East, Middle and West. The Fuluasou watershed is a valuable resource especially for the Urban Apia, its natural conservation and scenic aesthetic values are underestimated. Types of landuse available in Fuluasou include Forestry lands, urban residential the land tenure is that of government, STEC and customary owned, Freehold and Apia land district is approximately 80%.



## Experimental Design

According to Nicholls and Margules (1991), there are two types of questions or objectives of interest in corridor studies and each of them will need a different methodology (See figure 3).

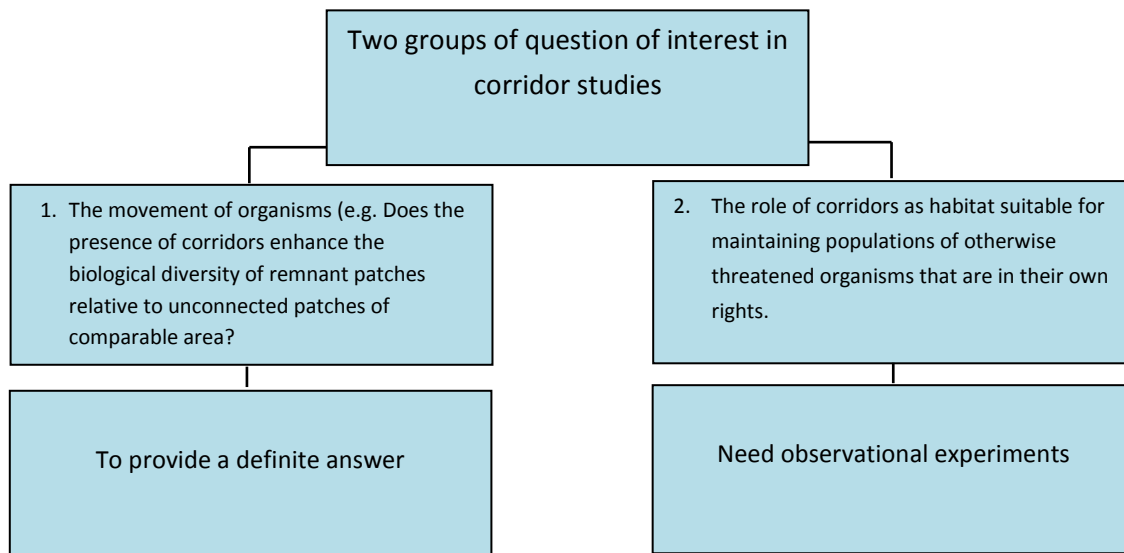


Figure 3: research objectives when assessing wildlife corridors.

This study will look at both to a degree, looking at corridors as habitat in managed pine plantation, assessing width as an inhibitor to wildlife utilisation, using nocturnal arboreal fauna as an indicator. For this we assessed tree species and some habitat value indicators to determine the habitat viability and value they represent to fauna that would be found at the sites.



## **Watershed Survey**

Watershed survey is a visual survey of the land surrounding the stream or lake, for the scope of this research a stream habitat walk was adopted taken from the combination of Environment Protection Agency and Kee Dae Kim et al (2011), filling in the survey form found in Appendix 1. Studying the stream is generally a onetime activity that should yield valuable information about the cultural history and the uses of the land surrounding it, it usually can give an indication of the land uses on the catchment area, and this was why this method was chosen for the purpose and time span allowed by this pilot study. To conduct the visual stream assessment portion of the watershed survey, walking along a defined stretch of stream observing water and land conditions, land and water uses and changes over time. These observations can be recorded on visual assessment data sheets.

## **DISCUSSION**

### **Limitations**

- The limited and inconclusive amount of data received has in many ways hindered the hydrological and statistical analysis of data. Water Resource Division was only established in 2006 and most of their water level and rainfall data can only be dated back to 4 to 5 years ago. Water quality in most ways didn't reflect seasonal changes that were expected of the study areas.
- However it is vital to note these as we go forward. The hydrology research of rivers behaviour and the characteristics of river physical make up haven't being heavily researched and not many researchers have focused much attention on this subject. To this effect, hydrology of rivers and flow behaviour for Samoa is a must research future subject as this highly influenced our water supply and state of natural habitats and biodiversity of Samoa. Equally important is the hydrologic significance flow duration curves have on stream health analysis. This involves comparing hydrologic indices taken from pre-alteration and post-alteration flow data periods and this is one area that needs research focus.
- A GIS component would have further assisted with this study as this would assist with more data analysis. Sample size was somewhat difficult with the limitation of representative distribution of groups for the results.
- Scope of our analysis was limited by the lack of reliable data available as this hindered significant obstacle in finding a more decipherable trend.
- Scope was hindered by timeframe perhaps more and spread out sampling sites

over the same period. This is a need acknowledged for further research.

- Lack of prior research studies on the topic and the scope was too large for the five (5) month timeframe, many studies take years for dependable data to be analysed and presented however this was the given time frame for this project. This is always a need for further research.
- Future research on data collection and more sampling methods

## **RESULTS ANALYSIS**

Our visual biological survey, a measurement of stream health was a count of 4 components. Fish an indication that the stream is of sufficient quality for other organisms. Aquatic plants provide food and cover for aquatic fauna. Algae are simple plants that do not grow true roots, stems but mainly live in the water, natural algae occurs in green and brown colours excessive algal growth may indicate excessive nutrients (organic matter etc).

As seen here, Palauli had a good distribution of our four indicators, Vaipouli we didn't site fish although Vaisigano and Fuluasou results showed it did. High algae percentage were seen in Togitogiga which to us it means excessive nutrients from the cattle farms, no fish were sighted in Togitogiga and no aquatic invertebrates were seen here also.

Total monthly precipitation during the study years was frequently above the 30-year average. More specifically, during 2008 eight out of 12 months were above average with March and May being 5 to 7 in. above the average. During 2009 sampling, only three out of 8 months were above average and 3 months were slightly below average. Storms during the winter and spring months were generally frontal precipitation events that covered the majority of the watershed. Conversely, summer events were typically convective thunderstorms that may have only occurred in a portion of the study area. Most of the precipitation that occurred was in the form of rainfall; however, during the 2008 winter one snowfall occurred a day before field sampling (20 cm).

## Stream Bank Conditions Survey

	Togitogiga	Fuluasou	Vaisigano	Vaipouli	Palauli
Artificial bank modification	YES	YES	YES	YES	YES
Stream shading	POOR	MODERATE	MODERATE	GOOD	EXCELLENT
<b>Stream Banks Condition Assessment</b>					
•Natural plant cover	30%	60%	55%	70%	80%
•Banks collapsed/eroded	YES	YES	YES	YES	YES
•Yard waste	NONE	NONE	NONE	NONE	YES
•Livestock in or within access to streams	YES	NO	NO	YES	NO

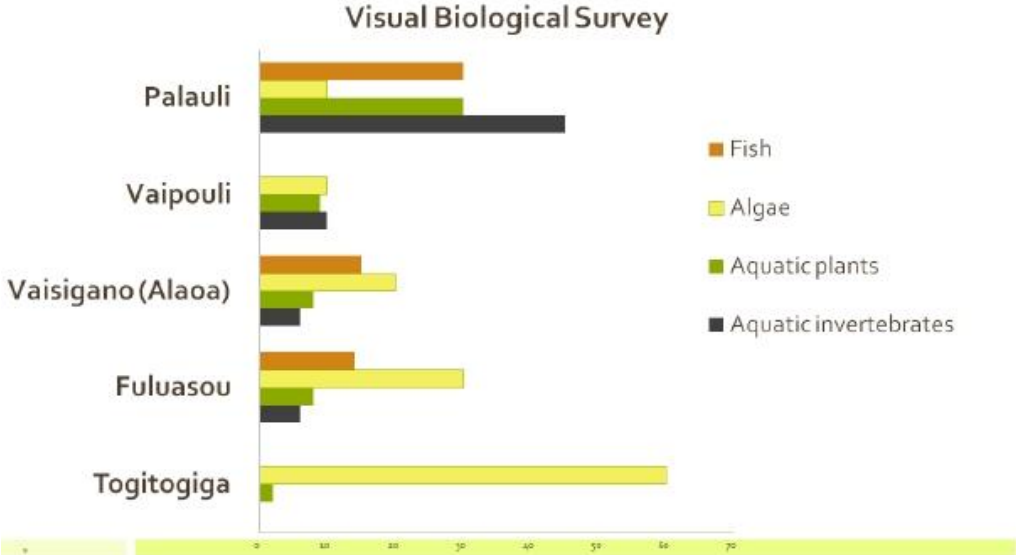
Data collected showed that the stream shading was the best at Palauli in majority of the stream that was assessed, with its higher natural plant cover although in all five sites there were evidence of bank erosion. At the sites that had SWA intakes yard waste was noted in Palauli intake with the clearing and cleaning of the intake area. Livestock right next to the streams were not sited in Fuluasou, Vaisigano and Palauli area where the watershed survey were undertaken. Livestock right next to the stream were observed in Vaipouli and Togitogiga.

## Local Watershed Characteristics : general landuse

	Togitogiga	Fuluasou	Vaisigano	Vaipouli	Palauli
Forests (>20' high)	25-50%	50-75%	25-50%	50-75%	50-75%
Shrub (0-20' high)	10-25%	25-50%	25-50%	10-25%	75-90%
Pasture (cattle grazing)	75-90%	0	0	50-75%	0
Open land (abandoned farm)	0	0	0	0	0
Crop (plantations)	10-25%	10-25%	10-25%	0	0
Residential	0	0	0	0	0
Commercial (Tourism, farming etc)	60%	0	0	0	0
Industrial	0	0	0	0	0
Transportation (access roads)	30%	20%	20%	20%	20%
Waste Disposal	0	0	0	0	0



General landuse in the five sites are seen in Table () with Vaipouli and Palauli showing the highest percentage of forests higher than 20’ and shrub of between (0-20’) observed in Palauli, some were observed in Fuluasou and Vaisigano. Plantation were sighted next to the streams for Togitogiga, Fuluaso and Vaisigano, access roads were sighted for all five sites as this was the access that was used.



Visual Biological Survey was undertaken as an indication of stream health in Palauli all four indicators were sighted with high count, followed by Visigano and Fuluasou. In Togitogiga no fish were sighted. Vaipouli data showed algae, aquatic plants and aquatic invertebrates though no fish was sighted.

**Rainfall Analysis**

A total period of almost 4 years (January 2009 to October 2012) was used for rainfall analysis. The reasons being the time period very restricted is data availability and quality assurance data used is up to the standard expected for better and representative result.

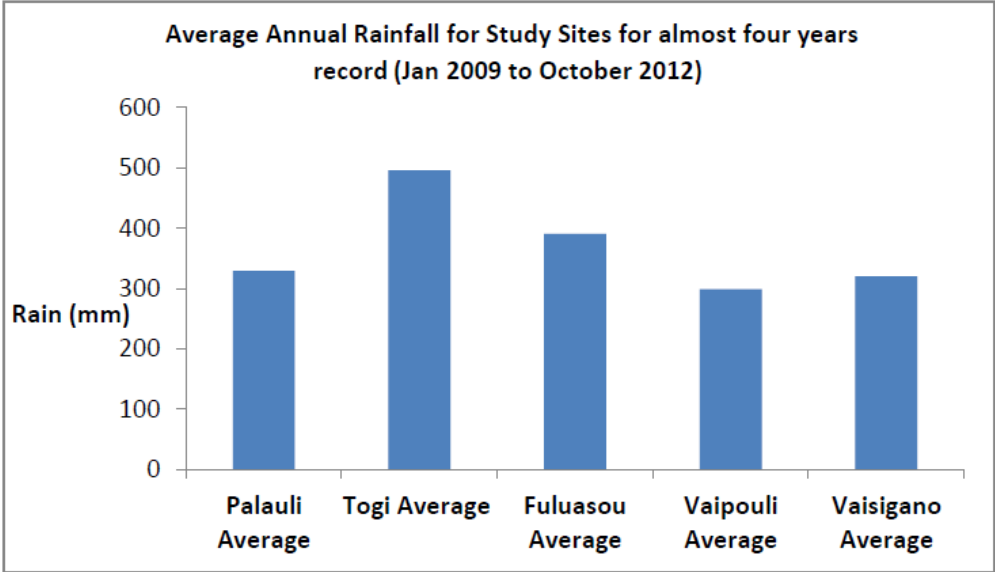


Figure 1.1

Annual average rainfall for study sites is taking into account which of the 5 catchments has the most recorded rain for the study period. Graph 1.1 implies that Togitogiga is the wettest catchment, followed by Fuluasou, Palauli and Vaisigano correspondingly. Vaipouli received the lowest annual average rainfall amount. The amount of annual average rainfall received by each of the 5 catchments aid us to comprehend, assess and estimate the river flow quantity and for how long the 5 rivers flow behaves throughout the year. In other words, average annual rainfall determines which of the 5 rivers is perennial and which is ephemeral.

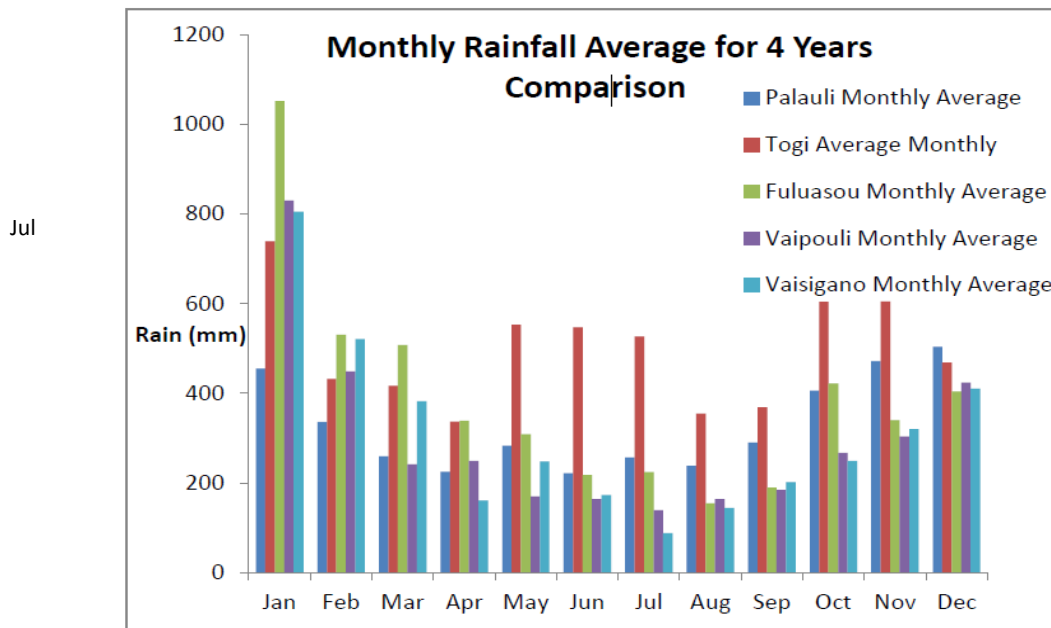


Figure 1.2

Monthly average assesses monthly rainfall amount received by each river. Equally important, monthly average determines an estimate flow quantity received by rivers each month. More decisively, it assesses an estimate flow quantity and how rivers respond to wet and dry season. For the second time, Togitogiga received the highest monthly average for almost all of the 12 months period, followed by Fuluasou, Vaisigano and Palauli. Yet again, Vaipouli received the lowest amount particularly in the dry season and towards early wet season.

Importantly, any significant anthropogenic watershed disturbances, such as land cover change and climatic conditions variability alter the relationship between rainfall and runoff. The hydrologic alterations of rivers and watershed areas heavily can be reflected in lag time of river(s) to respond to heavy rainfall. Following graphs explain rivers respond to rainfall (Figures 1.1 & 1.2) for the study period.

## River Flow Analysis

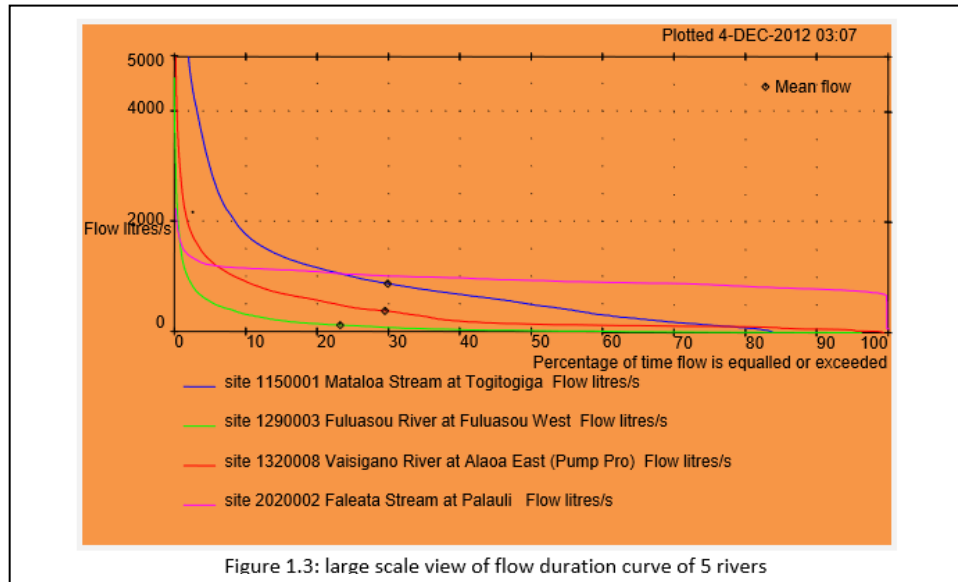


Figure 1.3: large scale view of flow duration curve of 5 rivers

Figure 1.3 implies that Togitogiga is quick to response to heavy rainfall and is the fastest to die out compared to other rivers, followed by Vaisigano east and Fuluasou west branch correspondingly. It is very vital to note that Vaisigano as the second fast to respond to heavy rainfall, one must remember that Vaisigano is perennial upstream with a SWA intake taking all water downstream during dry periods. Hence the main reason why we always see the Vaisigano river downstream dry out during arid season. Fuluasou west on the other hand is ephemeral with only more than 95% of time river was flowing. However, Faleata river flow behaves differently. It not only slow to respond to heavy rainfall but flat curve throughout indicates water storage presence, neutralising the flow all throughout the study period.

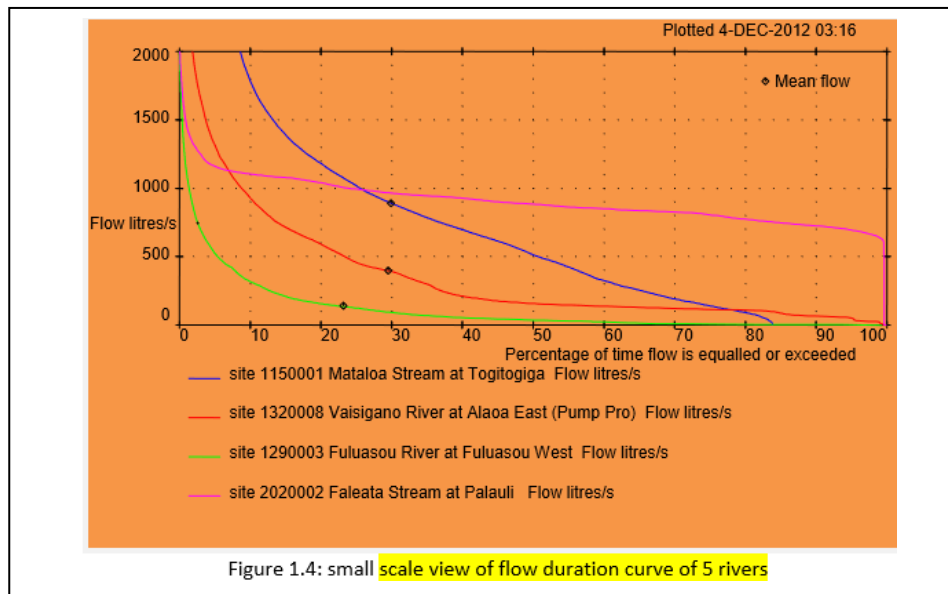


Figure 1.4: small scale view of flow duration curve of 5 rivers

Small scale view of the low flow for the 4 rivers. Only Faleata and Vaisigano have flow all throughout the study period.

## Water Quality

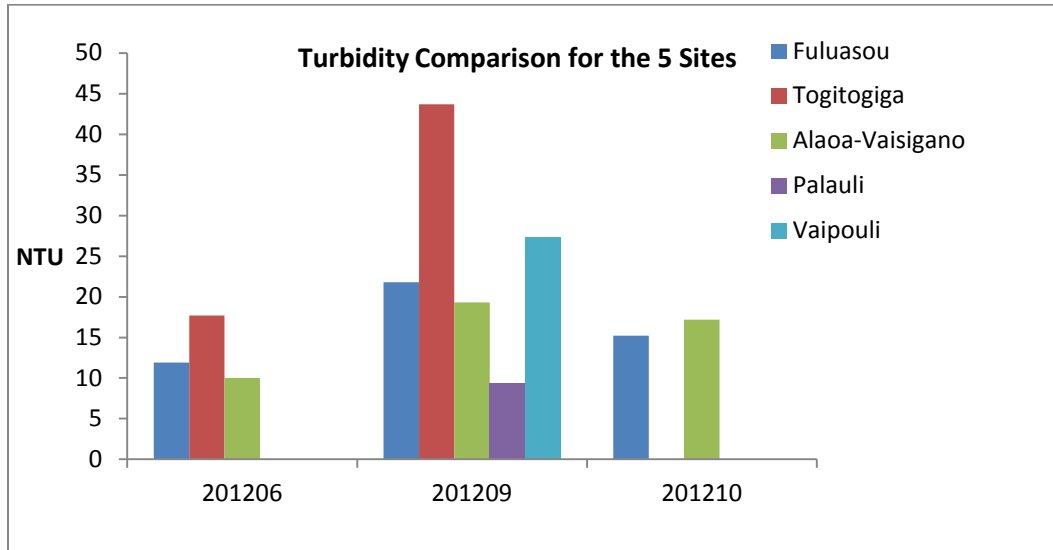


Figure 1.5

Turbidity is a good indicator of water quality. Referring to figure 1.5 implies that in September 2012 turbidity was measured highest in Togitogiga followed by Vaipouli then Fuluasou and Vaisigano east branch correspondingly. Palauli has the lowest turbidity level.

## Climate Change Impacts on Water Resources

### Temperature

Meteorology Division (2012) have confirmed that annual maximum and minimum temperatures have increased in Samoa since 1950. The same case scenario is reflected in all of the study catchments with fluctuating trend however it is evidently increasing. Changes in the amount of rain falling during dry season (WRD, Meteorology Division, 2012) provide evidence that the hydrologic cycle is already changing. Warmer temperatures increase the rate of evaporation and may dry out some areas and fall as excess precipitation on other areas. Meteorology has suggested in their Samoa's future climate (2012) a decrease in dry season rainfall and an increase in wet season rainfall over the course of the 21st century. As our catchments have already faced escalating scale of developments, increased intertemperature will further worsen the current status particularly the future state of our catchments.

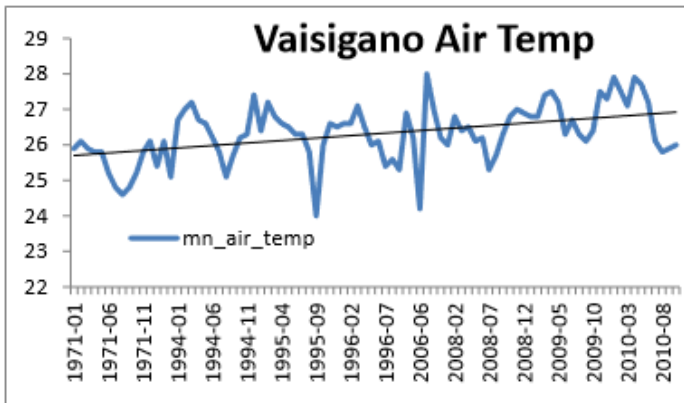


Figure 1.6

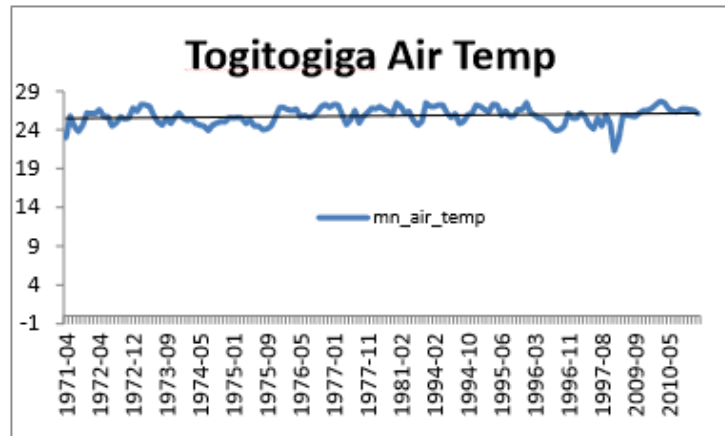


Figure 1.7

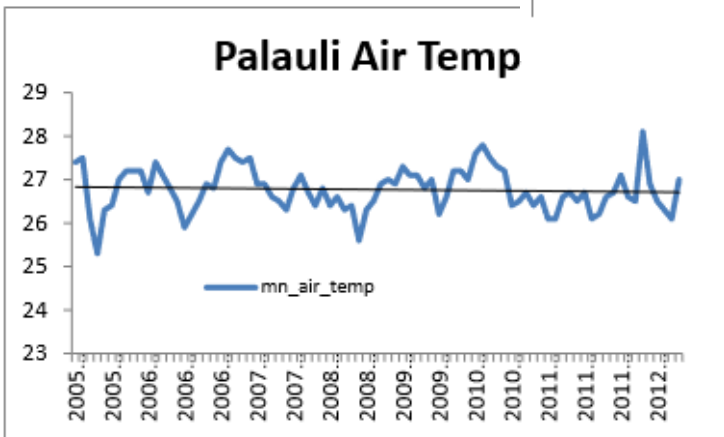


Figure 1.8

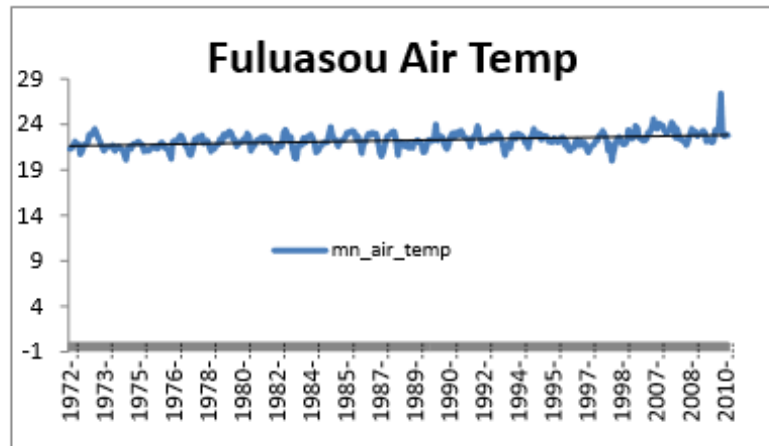


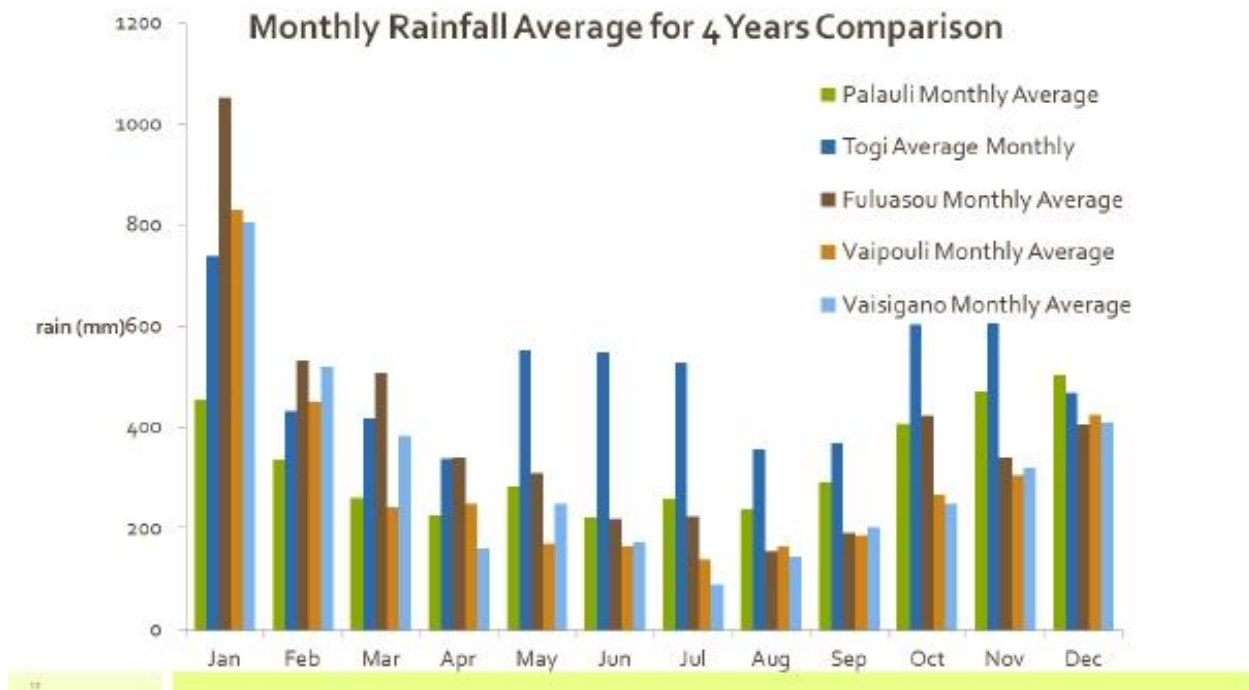
Figure 1.9

As the shape of the flow duration curve is determined by the hydrologic and geologic characteristics of the catchment area, the curve can be profoundly used to study the characteristics of a catchment or to compare the characteristics of one catchment to those of another. In this sense, it represents a compact signature of temporal runoff variability that can also be used to diagnose rainfall runoff responses, including similarity and differences between catchments (Zbigniew. W, Alice. R, 2000). A curve with a steep slope throughout denotes a highly variable stream whose flow is largely from direct runoff. Figure 1.4 implies that this is the case in Togitogiga where there is very less evatranspiration thus increasing direct runoff (James. K. S, 1969). A curve with a flat slope reveals presence of surface or ground water storage which tends to equalize the flow throughout the year. This is observed in Faleata Palauli where there is presence of heavy vegetation alongside river banks which slows down process of direct runoff whereas evatranspiration is increased. The slope of the lower end of the duration curve shows the characteristics of the perennial stream and a steep slope indicates a negligible amount. Vital to refer to figures 1.3 and 1.4 which implies that only Faleata and Vaisigano are perennial and Fuluasou and Togitogiga ephemeral.

Hydrologic alterations can result from land cover change and land use changes, climate change or the creation of surface water impoundments within the watershed (Mac. M, 1989). This was observed in some areas of Togitogiga where small scale tourism and serious cattle farming developments are being practised.

High level of turbidity presence in Togitogiga is understood by steepness of the curve and quantity of river flow during wet and dry season compared to flat curve for Faleata Palauli which indicates heavy presence of vegetation at the side of river banks. This also can explain by the decreasing level of evatranspiration activity alongside river banks thus direct runoff and erosion increases. Certainly high turbidity in Togitogiga and Vaipouli is explained by the scale of cattle farming alongside river banks as observed at time of field visits.

Water quality and physical habitat are degraded by changes in the hydrologic regime arising from climate variability, land cover and land use changes, such as farming and cattle developments. These changes disrupt the watershed by modifying the stream's hydrologic characteristics resulting in changes to the magnitude, duration and frequency of stream flow. From this stem a cascading effect on a variety of physiochemical features such as turbidity and biological characteristics of river bodies (US Environmental Protection Agency, 2007). These hydrological changes are often accompanied by water quality degradation due to increase pollutant loading into streams caused by decrease in evatranspiration and increase in direct runoff.



## CONCLUSION

The lag time for river to respond to heavy rainfall mirrors the physical characteristics of the catchment area. As the shape of the curve determines which river is perennial or ephemeral, it is very vital that we understand the river flow behaviour for a month, months or even a year to comprehend any changes in the physical characteristics and build-up of water catchment areas. To say that river flow pattern is particularly determined by climate variability is wrong in way, as we now have some understanding that river flow is mostly determined by the characteristics of the catchment to hold rainfall and for how long it can absorb and hold water.

- The most developed site out of the five study sites was Togitogiga Watershed
- Togitogiga Watershed yielded less water quantity and the highest turbidity compared to the other 4 sites, followed closely by Vaipouli
- Togitogiga is more likely to experience flash floods
- On the island of Savaii, Vaipouli is becoming a mirror image of Togitogiga on Upolu, with cattle farming on the increase and moving towards the stream
- Togitogiga has no riparian zone on some parts of the stream due to cattle farms
- The development of Togitogiga for commercial use may have resulted in the decrease in water quality and yield of the Togitogiga stream
- Togitogiga is a direct reflection of impact of development 20+ years ago affecting water quantity and water quality

- The vulnerability of the catchment areas to the impact of climate change is enhanced by development within the catchment

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**Comparative Study of Water Sector Governance between  
SWA and IWSA for Safata District  
Rev. Vavatau Taufao**

## INTRODUCTION

Clean water supply is a fundamental element for well being and survival. Sustainability of water sources is therefore essential in ensuring a continuous clean water supply. Thus Good Water Governance is necessary to better manage and address the numerous water problems that we continue to face. Like most Pacific nations water governance in Samoa can be complicated by its political and cultural structures. There is also diversity in traditional communities in terms of interests, rights and practices which are sometimes difficult to compromise with modern development. Inclusive awareness and advocacy programmes at all levels are therefore crucial in creating a meaningful framework (culturally based) for integrated water resource management. Partnership between water authorities and communities must be fostered to ensure collective responsibilities and roles in the conservation and management for a more sustainable water supply.

Ground works towards a more promising direction have been established. These include:

- Formulation of Samoa's National Water Resource Policy (NWRP) from consultations with stakeholders and it focuses on the management of water resources (B. Martin, May 2011).
- Water Sector Support Programme (WaSSP) in its analysis of Samoa Water Sector Institutions completed in 2007 focused its recommendations and action plans on Water Governance (WaSSP-07, p. 28).
- A National Water Resources Management Strategy (NWRMS) provides a framework for the protection, conservation, development and management of Samoa's water resources. This outlines a platform for close collaboration and cooperation among all agencies and stakeholders with interests in water at all levels (UNDP, p. 52).
- Water Act 1965 makes provision in relation to the conservation, supply and use of water, as well as protection of it from pollution:

Several other initiatives implemented by Government Ministries, organizations and individuals are needed to be taken into consideration for the improvement of Water Governance. Results and outcomes of this research intend to add valuable knowledge to national strategies.

The study sets to compare the water Governance between Samoa Water Authority (SWA) and Independent Water Scheme Association (IWSA). Safata district is the selected study site as significant proportions of this district are governed under both schemes. However, Siumu district is added to give a better comparison of the two schemes that is representative of Samoa. Comparisons of the two schemes look at "quantity versus quality", "cost versus affordability", and "health versus sustainability". The assessment is based on outcomes of "Customer Satisfaction" and their understanding of Water Governance.

## **Aim**

To compare the governance by SWA and IWSA in terms of (i) equity and efficiency, (ii) balance of water-use between socio-economic activities and ecosystem, (iii) inclusiveness in the formulation of water policies and legislations, and (iv) water users' awareness of their roles and responsibilities.

## **Objectives**

- Investigate and compare users' power and position within the governance of the two schemes (SWA and IWSA) in terms of allocation and distribution of their resources and services.
- Investigate and compare users' perception of the governance of each water scheme.
- Investigate and compare the two schemes in terms of their systems of check and balance in water-use between socio-economic activities and ecosystems.
- Compare how water users of each scheme were involved in the formulation of water policies and legislation.
- Investigate and compare water users' power, position and perception in policies and legislations of the two schemes.
- Investigate and compare which water users (those of SWA or IWSA) have better knowledge and awareness of their roles and responsibilities in managing water resources and services.
- Investigate and compare which water users (those of SWA or IWSA) have better knowledge and awareness of the roles and responsibilities of the governing bodies in the management of water resources and services.

## **Study Population**

The study units were the households. The initial intended researched population of interest was "the total households of Safata and Siumu". However, on initial contact with the study population, the village of Saaga refused to participate. Their reason for non-participation was that they were not comfortable with a researcher questioning them on their water supply and preferred someone from the authority instead. Attempts were made through close village contacts but again unsuccessful. Hence given Saaga's position the population size of the study was reduced from 1060 to 1000 (see Table 1) and the sample size was reduced from 278 to 262.

The list of households in both Safata and Siumu districts was requested from the Statistics Department but was declined based on their policies. Support from the Office of Internal Affairs was sought as an avenue but again unsuccessful. Hence five members of Safata district were

hired to help collect all the household names from all the villages in the two districts (Safata and Siumu). Table 1 presents a total population of households in each village which amounts to 1060 households. Also, because of the time constraints due to late disbursement of research funds, a prominent member from Vaie'e village was hired to assist the researcher with the data collection.

### Sample Selection

Sample size was calculated based on 95 percent confidence level (margin of error of  $\pm 5\%$ ) taking into account the fact of missing data. The required sample size was 262 households. This is stratified into the two water schemes to achieve balanced representation (Table 1) in terms of proportion. Selection of households from each village was done using the random function in R (statistical computer package). The sample size was further dropped to 245 because 17 selected families refused to participate. There was an additional drop in the comparison analysis because 17 selected households are neither under SWA nor IWSA. These families are classified as independent.

*Table 1: Population break down into individual village and the number of households required for the sample.*

	<b>VILLAGE</b>	<b>Number of Households</b>	<b>Number of Households Required</b>
1	Sa'aga	60	None
2	Siumu	162	42
3	Maninoa	57	15
4	Mulivai	64	17
5	Tafitoala	51	13
6	Fausaga	40	10
7	Fusi	81	21
8	Vaie'e	66	17
9	Niusuatia	53	14
10	Lotofagā	86	23
11	Sataoa	174	46
12	Sa'anapu	166	44
	<b>TOTAL</b>	<b>1060</b>	<b>262</b>

## **DATA COLLECTION**

There were several constraints which set back the data collection process:

- Several families were visited twice or three times due to the absence of household heads (father or mother). Some families (even with the mothers present) insisted to wait for the head of the household (father). Families were informed that any elderly member can represent their family and some did not accept it.
- A number of households were undecided if they should participate. This was time consuming as efforts were made to convince them on the benefits from the outcome of the research.
- The personal administration of the questionnaires method was used because it had the highest response rate. However, missing-data was a problem. Despite the fact that confidentiality was clearly spelt out to the respondents, there were unanswered questions as respondent regarded them as personal. Hence there is about eight percent non-response rate in the collected data.

A total of two hundred and forty five (245) questionnaires were administered and data collected for analysis are tabulated in the appendix.

## **LITERATURE REVIEW**

A lot has been written on the topic of “Water Governance” both locally and internationally. Evidently, there are a number of reports on Samoa Water Governance through the Joint Water Sector Steering Committee (JWSSC) as a result of Samoa Government taking measures to address the water problems at hand. Common elements in these literature on strategies to achieve good water governance are proper management of water sources/resources and management in water usage. Other important elements include participation, accountability, inclusiveness, transparency and responsiveness (Ian White). The analysis and report that follows reference some of this literature on the good head start that Samoa has made though it may need some redirection.

## **DATA ANALYSIS**

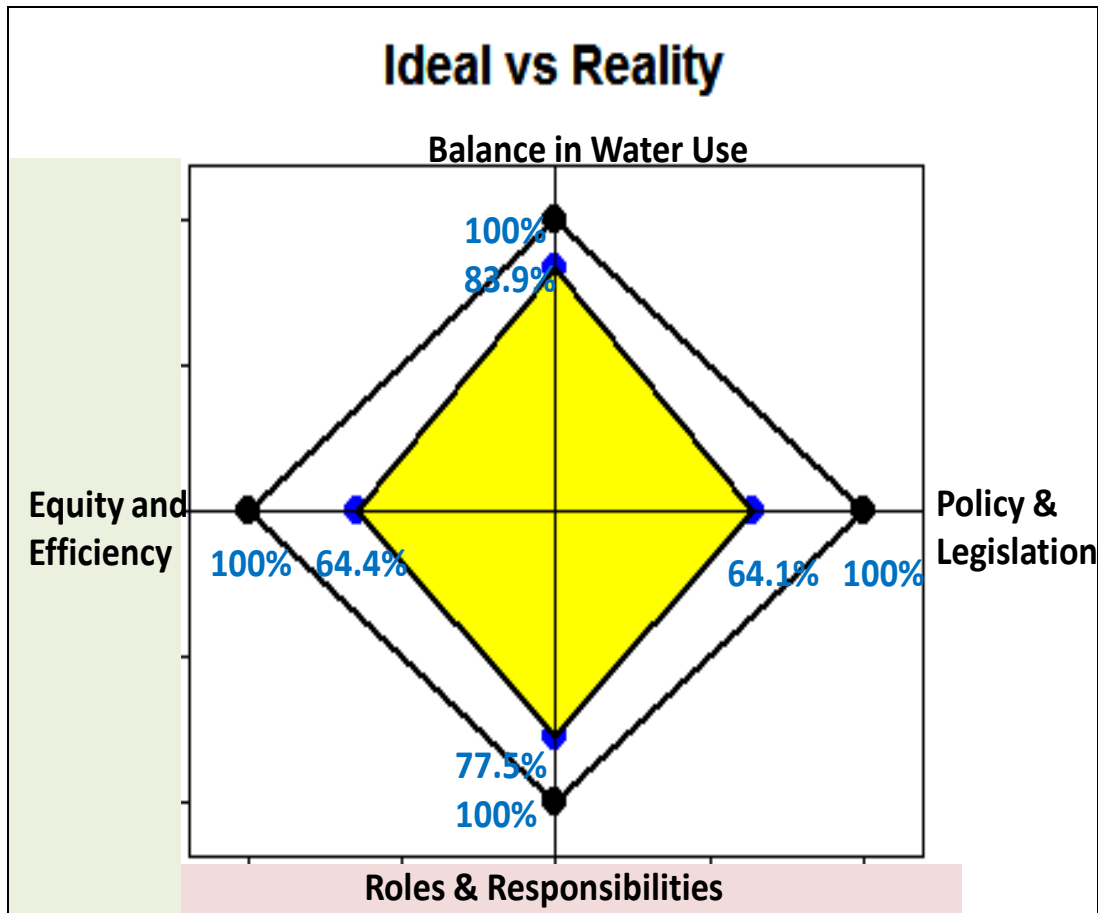
Data analysis took into account a best remedy for the non-response as mentioned above. Fixing the data to provide lesser error required the use of imputation by regression as the best option. The following are the required analysis for this study:

- Comparative study of the two water scheme in the four mentioned areas (Visual presentation of this comparison using Diamond analysis, Cross-referencing responses of the different areas)
- Check if there is a significant difference in the responses due to gender and age.
- Look at the question of affordability.

### Comparison of Two Water Schemes (SWA versus IWSA)

The general summary of the overall comparison is given by the diamond analysis below.

**Figure 1** Diamond comparison or Ideal versus Reality

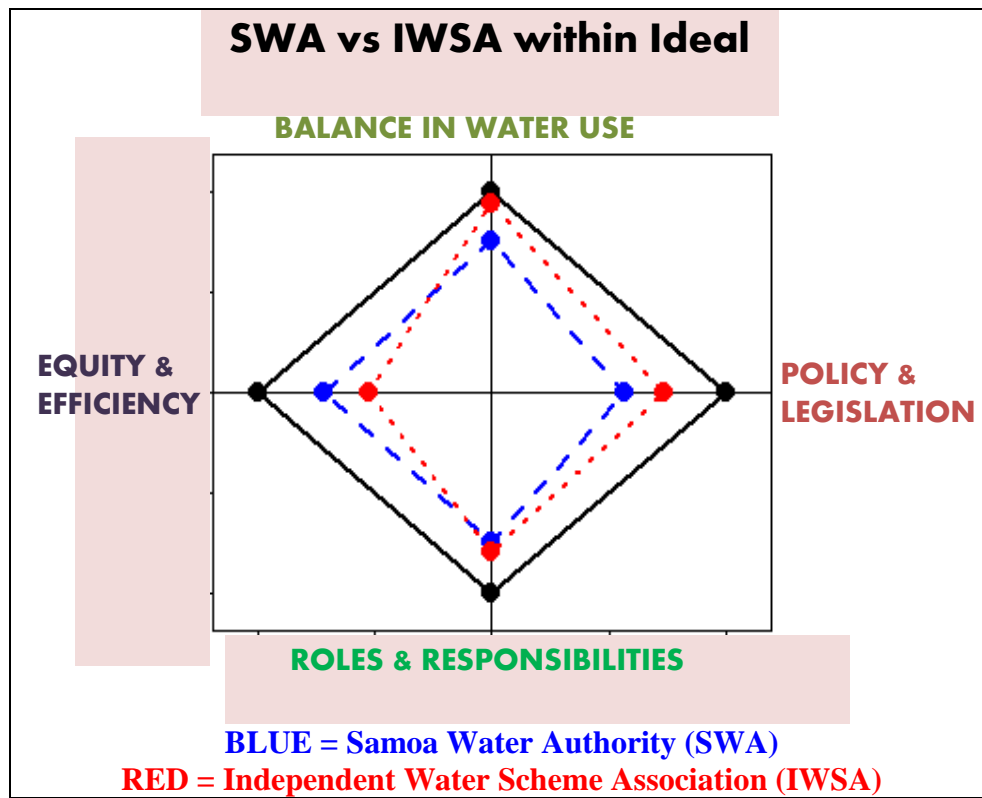


Jointly, both operations (SWA and IWSA) lack in all four studied areas as compared to the ideal targets. “Balance in Water Use” (BIWU) shows only a slight drop. “Equity and Efficiency” (EE) as well as “Policy and Legislation” (PL) are the worst areas that both fall short of by more than 35 percent. “Roles and Responsibilities” rate 22.5 percent less. Details of contributing factors by respective schemes to these drops are tabulated in Table 2 and displayed in the next diamond comparison (Figure 2).

**Table 2:** Breakdown of Effects as seen in Figure 1 for SWA and IWSA (lack)

Researched Aspects	SWA (%)	IWSA (%)
Equity and Efficiency (64.4%)	71.5 (28.5)	52.5 (47.5)
Balance in water uses (83.9%)	75.7 (24.3)	94.0 (6.0)
Policy and Legislation (64.1%)	56.4 (43.6)	73.6 (26.4)
Roles and Responsibilities (77.5%)	75.2 (24.8)	80.0 (20.0)

**Figure 2** Breakdown of Diamond comparison into Schemes – SWA vs IWSA



Below are the notable effects shown in Table 2 and Figure 2:

- The performances of the two schemes show significant differences in these three areas – (i) Equity and Efficiency, (ii) Balance in Water uses and (iii) Policy and Legislation. There is no significant difference shown in the area of “Roles and Responsibilities”.
- In terms of Equity and Efficiency of service it is the IWSA that pulls the schemes performance down to 64.4 percent with its 52.5 percent performance efficiency. SWA’s performance efficiency is 71.5 percent.
- IWSA excels in the Balance in water use with 94 percent and a slight down pull by SWA with 75.7 percent.
- The worst area for SWA is the Policy and Legislation. It pulled down the effort shown by IWSA of 73.6 percent, giving an overall of 64.1 percent (Figure 1).

## Equity and Efficiency

Problem 1: *“Equity and efficiency in the allocation and distribution of water services and resources”.*

Water sector reforms (since 2005) aim to ensure that both water resources and services are provided and managed with increased efficiency and cost effectiveness (MNRE, June 2012). This part of the study sought to provide how much of that had been achieved at the water-user level. Focus was placed on the two schemes treating everyone equally and the quality of water. Questions that were set up for the first two objectives of this research are used below to highlight the present situation. The complete data is given in Table 3 (appendix) from which the following tables (4 – 8) are extracted.

### 9.1A Water Supply and Water Users’ Expectations

**Question 1 : Water supply to my family meets our expectation e.g. 24 hours?**

*Table 4: Summary of responses to question 1*

	SWA		IWSA	
	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
<b>Totally agree</b>	15.56	6.1	1.08	2.1
<b>Partially agree</b>	47.41	8.4	30.11	9.3
<b>Uncertain</b>	37.03	6.3	37.63	9.8
<b>Partially disagree</b>	0.00	0.0	31.18	9.4
<b>Totally Disagree</b>	0.00	0.0	0.00	0.0

Results in Table 4 show that families under SWA are more satisfied with their water supply. An estimate of families whose expectations are “met fully” or to “some extent” is 63 percent. The rest of families under SWA were uncertain on their responses. Compared with IWSA, only 31.2 percent showed some satisfaction with the water supply while 37.63 percent were uncertain, and 31.2 percent indicated that their water supply may not be up to standard.

Although these figures show SWA in a better position than IWSA, SWA remains to improve its services. The proportion of 37.03 percent that were uncertain is too high especially when these results are generalized for Samoa. IWSA is way behind in terms of customer satisfaction with its water supply. Hence the aim of the water sector reform to ensure that both water resources and services are provided and managed with increased efficiency is not being achieved for Safata and Siumu. There is a need for both schemes to improve their water supply system to meet the expectations of their customers.



### 9.1B Water Services & Water Users Needs

**Question 2: Services by the authority are sufficient in meeting our needs and requests (SWA versus IWSA.)?**

**Table 5: Summary of responses to question 2**

Response	SWA		IWSA	
	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
Totally agree	23.70	7.2	0.00	0.0
Partially agree	43.71	8.4	34.41	9.7
Uncertain	32.59	7.9	40.86	10.0
Partially disagree	0.00	0.0	24.73	8.8
Totally Disagree	0.00	0.0	0.00	0.0

Of the SWA customers only 67.4

percent either “totally” or “partially” agreed to sufficient service by their authority. For IWSA customer, none of them totally agreed that their authority has given sufficient service. About 34.41 percent partially agreed. These statistics are alarming facts which indicate that the two authorities have a long way to go in achieving their goals (SWA, Corporate Plan 2012 – 2014 & IWSA powerpoint presentation). IWSA definitely needs to improve its services. However, the percentage of uncertain customers for SWA is also high (32.59%). Hence, its services also need to improve.

Some of IWSA’s customers indicated that their water problem is due to water supply being serviced and maintained by untrained and unskilled workers. For SWA the issue is slightly different. Customers reported they needed to tip authority personnel with either money or food to get service. One of their suggestions to improve service was to set up “Water Stations” like police stations at each district.

### 9.1C Authority's' Assistance in Building Water Supply

**Question 3: Does the authority provide sufficient assistance in building our water supply ?**

**Table 6: Summary of responses to question 3**

Response	SWA		IWSA	
	Estimate %	95% M. of Error	Estimate %	95% M. of Error
Totally agree	21.48	6.9	0.00	0.0
Partially agree	45.19	8.4	36.56	9.8

<b>Uncertain</b>	33.33	8.0	38.71	9.9
<b>Partially disagree</b>	0.00	0.0	24.73	8.8
<b>Totally Disagree</b>	0.00	0.0	0.00	0.0

Despite the fact that none of the two schemes is close to the ideal, SWA rates far better than IWSA. More than two third of its customers either totally or partially agreed that SWA had provided sufficient assistance for the establishment of their water system. For IWSA it seems individual households struggle to build their own. The authority offers either very little assistance or none at all. This could be the main reason why a significant proportion of households for both schemes have indicated that they do not have direct water supply into their homes.

About 10.31 percent of households in the study population (Safata & Siumu) do not have direct running water supply (taps) to their houses. This is a huge part of the population of Samoa when we generalize these results. Reasons given were largely due to costs borne by the customers based on either the distance between their homes and the main line, or their homes are located on the other side of the road.

#### 9.1D Authoritys' Regular Checks of Families' Water Systems

**Question 4: Authority personnel check our water supply regularl (eg. fortnightly )?**

*Table 7: Summary of responses to question 4*

Response	SWA		IWSA	
	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
<b>Totally agree</b>	12.59	5.6	0.00	0.0
<b>Partially agree</b>	40.74	8.2	22.58	8.5
<b>Uncertain</b>	46.67	8.4	45.16	10.1
<b>Partially disagree</b>	0.00	0.0	32.26	9.5
<b>Totally Disagree</b>	0.00	0.0	0.00	0.0

The figures in Table 7 show a huge gap in services rendered by governing authorities and warrant strategies for improvement. Only a slight majority (53.33%) of SWA and 22.58 percent of IWSA customers have indicated that there are any regular checks by personnel from the authorities. Several problems cited by the respondents are results of irregular or no checks at all. The following were highlighted by a significant number of households:

- they have never seen any member of the authority (SWA) before. Similar responses were given by some IWSA members from villages that share sources with neighbouring villages e.g. Vaie’e.
- when water leakages are reported it takes months before they are fixed (SWA).
- members of water committee fix water leakages with pieces of cloth or rubber and promise to return the next day but they never do.

### 9.1E Clean Water Supply

**Question 5: Our water supply is always clean – highly suitable for drinking and cooking and equally distributed throughout our village?**

*Table 8: Summary of responses to question 5*

Response	SWA		IWSA	
	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
<b>Totally agree</b>	7.41	4.4	0.00	0.0
<b>Partially agree</b>	47.41	8.4	15.05	7.3
<b>Uncertain</b>	44.44	8.4	50.54	10.2
<b>Partially disagree</b>	0.74	1.4	31.41	9.4
<b>Totally Disagree</b>	0.00	0.0	0.00	0.0

Betsan Martin (2011) accentuates that the health of water is closely related to the health of people and to economic sustainability. “How a country manages its water resources determines the health of its people, the success of its economy, the sustainability of its natural environment, and its relations with its neighbours. On the contrary the figures in Table 8 tell an alarming story in terms of health and inclusiveness. It is clear that SWA provides a far better supply and service in comparison to IWSA. However, more than 45 percent of SWA’s customers are “uncertain” or “Partially Disagree” to having clean water and equal distribution of water right across their village members. This is way too much.

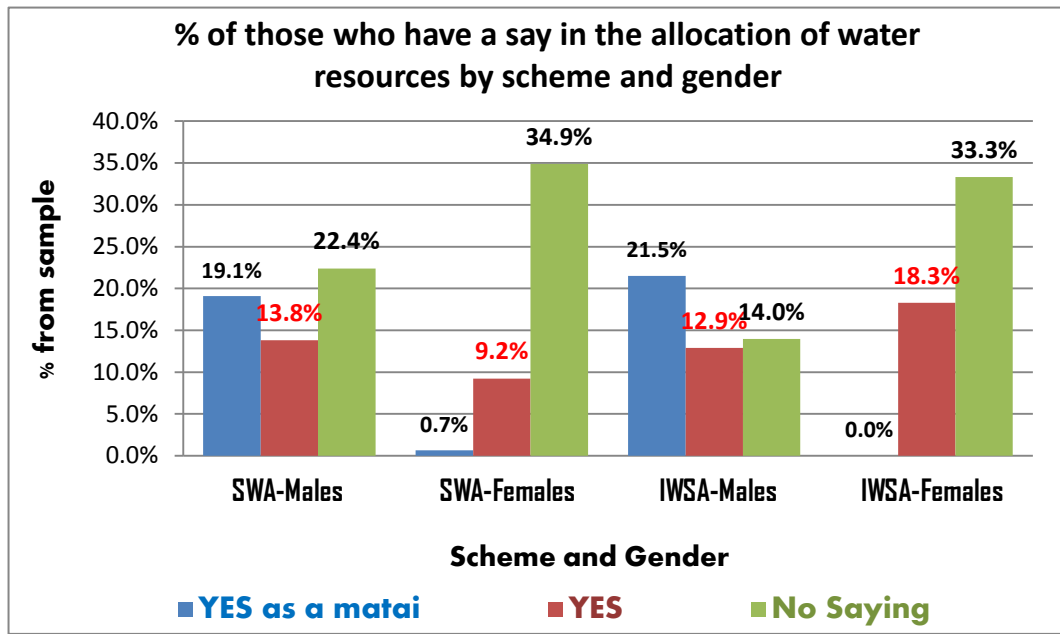
In 2007, a report titled “National Integrated Water Resource Management Diagnostic Report” stated that 15 percent of the treated water failed the standard test (UNDP p.40). This contradicts with findings in Table 8 or perhaps the problem is getting worse for at least Safata district. More than 81 percent of IWSA customers say the same thing. It poses a question on the goal of the Water and Sanitation Sector (WSS) that emphasizes the “Reliability, cleanliness, affordability of water and basic sanitation ... for all people in Samoa to sustain health improvements and alleviate poverty” (MNRE, June 2012).

### 9.1F Allocation and Distribution of Resources and Services

**Question 6: Do you have a say in the allocation and distribution of the water resources and services (SWA versus IWSA.)?**

The most notable trend in Figure 3 is that the vast majority of those who do not have a say in the allocation and distribution of water resources and services are women. Table 9 (appendix) shows that out of all the women that took part in the study from SWA, 78 percent of them do not have a say while 64.6 percent of those from IWSA are in the same category. A further breakdown by age shows that most of those that do not have a say are in the youngest age bracket of the study, which is 25-45 years.

**Figure 3:** Summary of responses to question 6



These results are quite a contrary to the set goals of all water sectors. Highly important elements such as community participation, accountability, inclusiveness, transparency and responsiveness cannot be achieved without the inclusion of the people’s say in the allocation and distribution of water resources and services.

### 9.1G Position within the Governance of Water Resources and Services

**Question 7 : What is your position in the governance of your water resources and services (SWA versus IWSA)?**

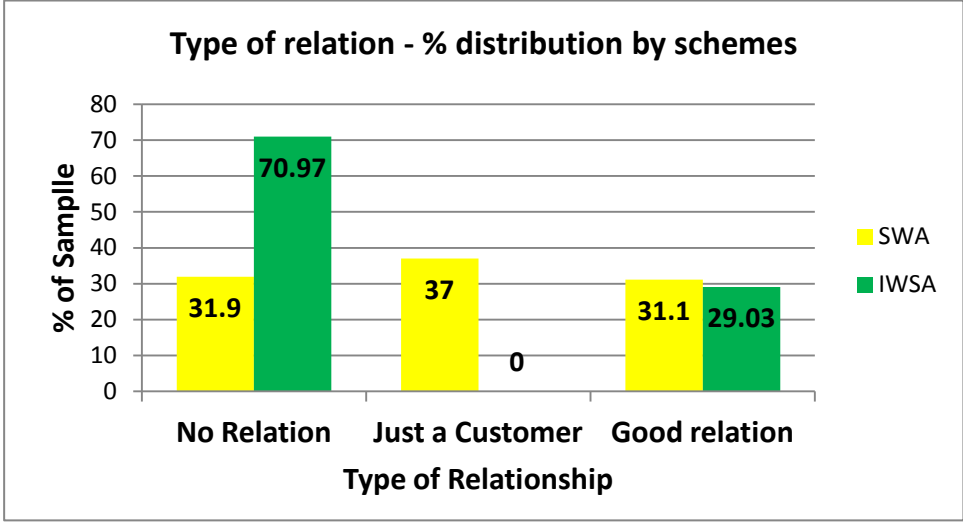
Responses to this question reflect the stereotype in the rural communities where the head of the families must be a male. Discriminatory results in terms of gender and age as seen in section 9.1F are shown here in another dimension. The proportion of women who have stated that they have no say within their water governance is highly significant (Figure 4). Males who said the same thing are mostly those that belong to the age range of 25-45 years. Moreover, it seems that the matai and heads of families assume that their positions within family and village structures give them a direct say in water governance. In other word, findings show that almost all water users have no position at all in the governance of their water.

These statistics are good indications of huge communication gaps between both schemes and their direct stakeholders. Water users are isolated in the governance of both schemes (SWA and IWSA). Evidently, UNDP reports that a lack of gender consideration is not seen as being a concern or a problem area is definitely a fallacy for at least Safata district (UNDP 2007).

**9.1H Perception of the Relationship between Water Users and Governing Authority**

**Question 8:** *Describe your perception of the relationship between you as a water user and the governing authority.*

*Figure 5: Summary of responses to question 8*



Samoa’s constitution recognizes the traditional fundamental rights and freedom, institution of traditional governance, customary (or chiefly) titles, and customary land ownership are clearly spelt out. The Internal Affairs Act 1995 established the recognition of village authority which is to stand as a system of local government throughout Samoa. Thus, UNDP states that “A lack of

community participation and consultation is therefore not seen as a concern in Samoa” (UNDP, p.38). In recognition of Samoa’s constitution and the Internal Affairs Act 1995 both SWA and IWSA are called to have full participation and engagement of water users in their water governance.

However, findings presented in Figure 5 are contrary to these. A high percentage of SWA customers (68.9%) see themselves as either having no status within their water governance or are just customers to generate revenue for the scheme. Only 31.1 percent stated that they relate well to SWA and is very helpful to them. As for IWSA, the governing body is interpreted as those that check and fix their water supplies when there is a problem. And because the governing body is inefficient in this respect as stated earlier a high percent (70.97) sees no active relationship with IWSA.

### **9.11 Equity and Efficiency - SUMMARY**

The overall evaluation of both schemes shows their performance lacking by more than 35.6 percent (see first diamond Figure 1). The breakdown of this into SWA and IWSA gives estimates of 24.5 percent and 47.5 percent respectively (see second diamond Figure 2) and so SWA is seen as performing better by 19 percent than IWSA. In summary, both schemes are not treating everyone equally, not supplying clean water to the users, not providing sufficient resources and efficient services, and not managing their operations efficiently. Water users’ perception of water governance is assumed to be the same as village governance in villages. Although it seems that SWA is providing better operation than IWSA in terms of Equity and Efficiency its present status remains to be improved. The gap between the ideal and unsatisfactory proportion (24.5%) is too wide (especially when these results are generalized).

### **Balance in Water Uses – Socio-economic Activities versus Ecosystem**

Problem 2: *“Balance of our water uses between socio-economic activities and protection of our ecosystem”.*

*“Sustainable development necessitates a balance between the needs of economic development ... and environmental protection” (UNDP, 2007). This part of the research checks how efforts such as that by the IWRM in the formation of community based monitoring programmes are working for at least Safata district. It evaluates the extent of problems such as the degradation of water sources largely through deforestation and over exploitation of existing supplies that have*

affected water resources (Reti, 2000; Amataga, 2007) at the study area. Questions that were set up for the third studied objective are used below to highlight the present situation (at least for Safata). The complete data is given in Table 10 (appendix) from which the following tables (11 – 14) are extracted.

## 9.2A Effects of the Development of Water System on Environment

**Question 9: The development of our water system has very little effect on our environment.**

Table 11: Summary of responses to question 9

Response	SWA		IWSA	
	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
<b>Totally agree</b>	36.30	8.1	49.46	10.2
<b>Partially agree</b>	45.93	8.4	49.46	10.2
<b>Uncertain</b>	14.81	6.0	1.08	6.3
<b>Partially disagree</b>	0.74	1.4	0.00	0.0
<b>Totally Disagree</b>	0.00	0.0	0.00	0.0

The majority of samples from both water schemes (82.23% from SWA and 98.92% from IWSA) either “totally agree” or “partially agree” that water system development has little effect on the ecosystem (see Table 11 above). The only questionable part of these figures is whether people actually understand factors that affect the ecosystem especially in the long term. Responses to the last research question show that people are witnessing the diminishing amount of water in their water sources as compared to ten years ago. The majority suggest that authorities should look at ways to improve water storage to safeguard long term water supply.

## 9.2B Village Efforts in Protecting and Sustaining Water Supplies

Findings in Table 12 show that all IWSA customers are well aware of the laws designed at the village level to ensure sustainability of water sources and supplies. They also all agreed that these laws are religiously observed by villagers and monitored with regular inspections ensuring protection of their water catchments. On the other hand, more than 63 percent of SWA customers indicated that these are also seen practised in their villages. However, a high number of them are uncertain on these laws and inspections. The main reason cited is that a lot of SWA customers seem to believe that water supply is the sole responsibility of the governing body.

Table 12: Summary of responses to question 10 & 11

<b>Question 10 Are there village laws to ensure sustainability of our water sources and</b>
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<i>supplies? – eg. Protection of forest near water sources.</i>				
	SWA		IWSA	
Response	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
Totally agree	8.89	4.8	87.10	6.8
Partially agree	54.81	8.4	12.90	6.8
Uncertain	32.59	7.9	0.00	0.0
Partially disagree	0.74	1.4	0.00	0.0
Totally Disagree	2.96	2.9	0.00	0.0
<i>Question 11: Are there regular village inspections to ensure water catchment protection?</i>				
	SWA		IWSA	
Response	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
Totally agree	20.00	6.7	89.25	6.3
Partially agree	51.11	8.4	10.75	6.3
Uncertain	25.19	7.3	0.00	0.0
Partially disagree	1.48	2.0	0.00	0.0
Totally Disagree	2.22	2.5	0.00	0.0

These results indicate a positive sign of active participation by customers in protecting and sustaining water supplies. There is a need to educate water users especially those of SWA on their required roles for sustaining water sources. What is clear from these results is that the role of “Protection and Sustaining Water Supply” can be better managed at the village level.

## 9.2C Controlling Water Usage

**Question 12: Are systems in place to control water usage? e.g. Water meters, leakage penalty.**

*Table 13: Summary of responses to question 5*

	SWA		IWSA	
Response	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
Totally agree	41.48	8.3	56.99	10.1
Partially agree	47.41	8.4	40.86	10.0
Uncertain	8.89	4.8	2.15	2.9
Partially disagree	0.74	1.4	0.00	0.0
Totally Disagree	1.48	2.0	0.00	0.0



The responses to this question show that both SWA and IWSA are doing well in terms of getting their customers to control the uses of water. However, problems cited in parts of the study include “customer cheating with meters” and “people wasting too much water from unmetered IWSA system”. SWA customers reported that meters that are close to the houses could be easily tampered so they suggested to place all water meters near the road. Others claimed that some meters do not work but they still get water, hence getting free supply. This raises the question if there is any check done by SWA on water meters. IWSA customers on the other hand reported that there were village regulations but were not properly monitored. They questioned whether the water committee is active in its role in overseeing this. Again, there is a call for the schemes to develop active partnership with every village because it seems that it is the best remedy for the problems.

## 9.2D Measures for Protection of Water Sources and Water Catchment Areas

**Question 13: Measures are in place to protect water sources and catchment areas – e.g. Monitoring excess use of fertilizer.**

Almost all IWSA customers (96.93%) agreed totally or partially that there are villages’ measures already in place to protect water sources and water catchment areas. These measures include the control of using fertilizers and weed killers, band cutting down of trees within 100 metres from water sources, band cultivation of lands near water catchments, and others. About 57.04 percent of participants from villages under SWA indicated that their villages also had similar regulations observed by their members. A significant 36.3 percent are uncertain while 6.66 percent disagree on the existence of any such regulation.

**Table 14: Summary of responses to question 13**

Response	SWA		IWSA	
	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
<b>Totally agree</b>	15.56	6.2	73.12	9.0
<b>Partially agree</b>	41.48	8.3	23.81	8.7
<b>Uncertain</b>	36.30	8.1	1.08	2.1
<b>Partially disagree</b>	2.96	2.9	0.00	0.0
<b>Totally Disagree</b>	3.70	3.2	0.00	0.0

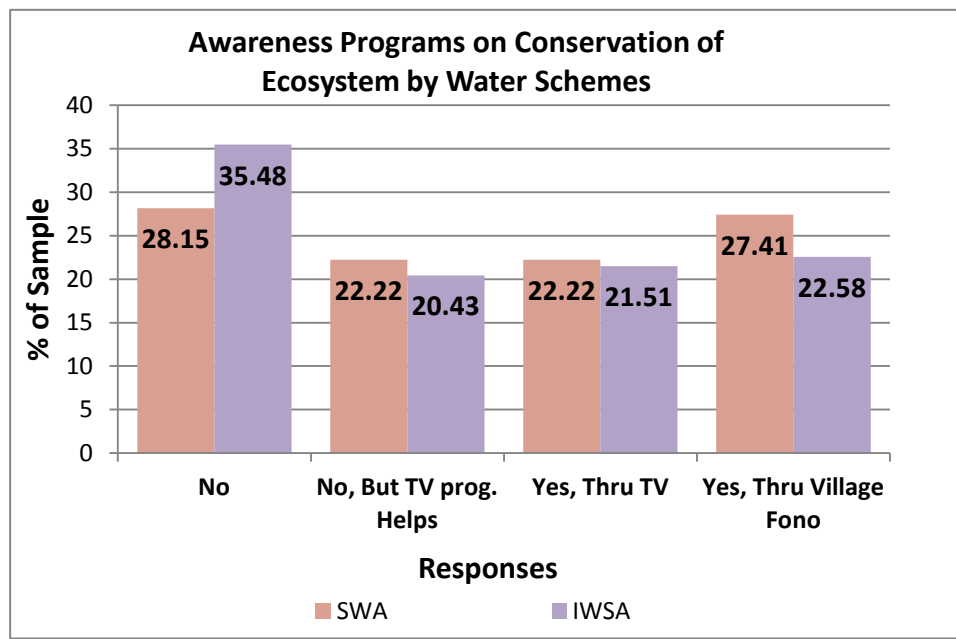
Like section 9.2B, the positive results indicated by these figures (especially for IWSA) are mainly due to the village councils’ active involvement among its members. All measures mentioned by the respondents are regulations that are set, implemented and monitored at the

village level. Hence SWA would do better if it delegates the role of protection of water sources and water catchment areas to the community as seen in the case of IWSA.

### 9.2E Awareness Program for Conservation of Ecosystem

**Question 14(i)**      *Water protection includes the conservation of the ecosystem. Did your governing authority make you aware of this? How?*

Figure 6:      *Summary of responses to question 14(i)*



SWA’s 44.44 percent and 41.94 percent of IWSA customers indicated they are made aware of the conservation of ecosystem through television programs. Despite the fact that some people are not aware that these programs are promotion programs by the water sectors the results are complementary to the efforts of the schemes. That is, their television programs are quite effective. These modes of communication should be continued as a way of educating rural people on water issues and policies. There are definitely discussions at the village councils on the subject of Conservation of Ecosystem. However, these do not reach the general village population as indicated by members who stated that there were no awareness programs.

### 9.2F Water User Contributions for Conservation of Ecosystem

**Question 14(ii)**      *Water protection includes the conservation of the ecosystem. What is your contribution to the conservation of your ecosystem?*

Figure 7: Summary of responses to question 14(ii)

**CODES**

**PFNWsWc = Protect forest near Water source & Water catchment**

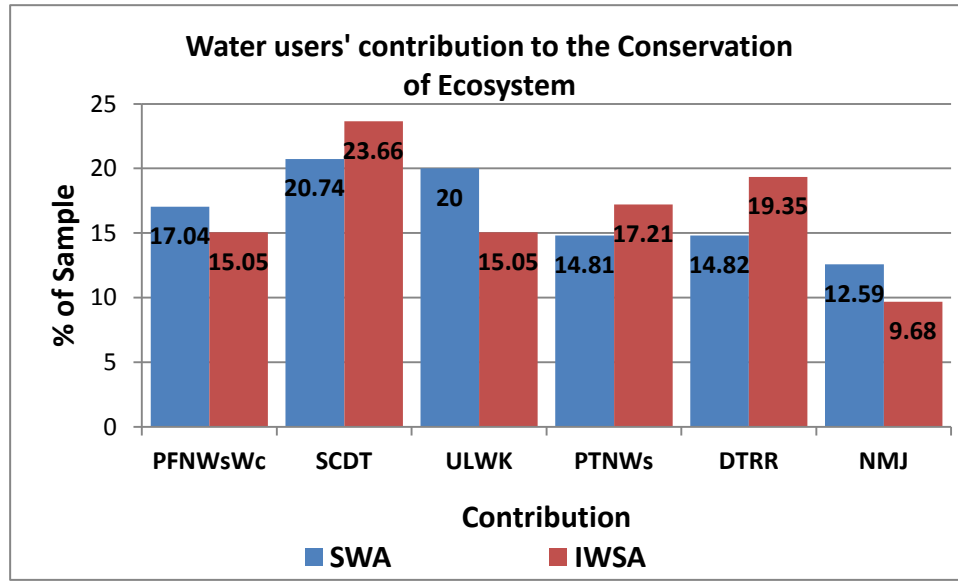
**SCDT = Stop cutting down of trees**

**PTNWs = plant trees near Water sources**

**NMJ = Not my job**

**ULWK = Use less weed killers**

**DTRR = Don't throw rubbish into rivers**



The figures indicate a positive response by the people to head start on what is required of them. The big majority of 87.41 percent and 90.32 percent of SWA and IWSA respectively show that users know their contribution to the conservation of the ecosystem. Moreover contributions given by respondents are all very important for such conservation. The tiny minority that sees it as “not my job” are those that either belong to the cluster that typically view water as “free God given gift” (Amataga, 2007) or just those who are simply ignorant of their responsibilities. Either way these results show that capacity building and awareness need to be part of this strategy.

**9.2G Balance in Water Uses - Summary**

An overall evaluation sees that there is a lack of about 16.1 percent in the present status quo (see first diamond Figure 1). The breakdown of this into SWA and IWSA gives estimates of 24.3 percent and 6 percent respectively (see second diamond Figure 2). These positive results are outcomes of the active participation of village councils in the protection of the ecosystem. Villages under SWA still need to improve on this aspect by fostering active partnership with local communities.

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**Policy and Legislation – Inclusiveness versus Exclusiveness**

Problem 3: *“Effective awareness programmes and Inclusiveness in the formulation of water policies and legislation”.*

Two of seven challenges on Samoa Water management given in the report of a case study on the topic “Water is Life: Governance, Policy and Local Responsibility in Pacific” are (i) insufficient knowledge and understanding of water resources and, (ii) lack of community understanding and appreciation of responsible water management (Martin, 2011). These challenges demand active community involvement at all levels of water management which include people’s direct involvement in the formulation of policies and legislations. The study examined how these challenges are taken up by the two water schemes (SWA and IWSA) and which water scheme provided effective awareness programmes. Figure 2 shows a huge down pull by SWA (17.2%) in this respect (see analysis below). Questions set up for the fourth and fifth studied objectives are used below to highlight the present situation (at least for Safata). The complete data is given in Table 15 (appendix) from which the following tables (16 & 17) are extracted.

**9.3A Water User Involvement in Formulation of Policy and Legislation**

**Question 16** *Have you been consulted in the formulation of the governing policies and legislation of our water supply?*

In the literature good water governance is defined as that which ensures policies are “based on broad consensus in society and that the voices of the poorest and most vulnerable are heard in decision making over the allocation of development resources” (Amataga, 2007). Results in Table 16 show a huge proportion (especially those of SWA) of water users that are only passive recipients of what governing bodies designed. Most IWSA customers believed that policies were formulated at the village level and which is why 84.95 percent agreed (partially or totally) to the question. There seems to be a contradiction when asked about their contributions in maintaining and sustaining their water supply to which IWSA customers are worse off (see Table 15 – appendix). In connection with the first two areas the problem seems to be that the necessary contributions by the authorities are not clear cut from those of water users. However, it seems to be working well with the IWSA governing because the village councils take up the responsibilities and make all villagers partake in water activities.

**Table 16:** *Summary of responses to question 16.*

	SWA	IWSA
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<b>Response</b>	<b>Estimate %</b>	<b>95% Margin of Error</b>	<b>Estimate %</b>	<b>95% Margin of Error</b>
<b>Totally agree</b>	0.00	0.0	21.51	8.4
<b>Partially agree</b>	18.52	6.6	63.44	9.8
<b>Uncertain</b>	54.81	8.4	13.98	7.0
<b>Partially disagree</b>	23.70	7.2	1.08	2.1
<b>Totally Disagree</b>	2.96	2.9	0.00	0.0

The question of “people’s concern being addressed by policies and legislations” gives another alarming picture (See Table 15, Results of question 17). The majority of SWA customers could not present views because they were totally lost when spoken to about policies. Only 1.48 percent totally agreed. Villages under IWSA emphasized ownership of their water. This works well for them as policies and legislations are indirectly formulated within the village fonon. It gives the results of 20.43 percent totally agreeing, and 64.52 percent partially agreeing that policies addressed their concerns adequately. There were water committees at the village level which represent the village in discussions with IWSA, the governing body, but it is advisable to have their policies and legislation in a written document.

The responses concerning water users’ position being clearly spelt out in the policies, for IWSA customers, indicate a bit of a discrepancy when cross referenced to previous questions (see Table 15, Results of question 19). For example, 82.79 percent agreed either totally or partially, and yet in section 9.1G only 60.2 percent stated that they have no position in the governance of their water resources and services. For SWA, 24 percent of its customers either totally or partially agreed but most of them see this position as just a customer or a matai of the village council (see Figures 4 and 5).

### **9.3B Power of Water Users in Water Policies**

#### ***Question 18 We have sufficient power as water users in the water policies.***

The results simply show that water users under SWA see that they have no defined powers within their policies and legislation. The down pull mentioned above is mostly due to this factor as in 58.35 percent advantage for IWSA. From the literature good and effective water governance must promote ownership, capacity building and incentives to participate. It must empower everyone with the knowledge to make informed decisions and promote equal participations of people disregarding levels and gender (Amataga 2007). These are better recognized in the governing by IWSA as seen in the active roles played by the village councils in section 9.2. They includes people’s power to stop unsustainable exploitation of water resources, power to protect community resources on which economic growth depends on while security of

water supply is assured, plus all other rights of ownership such as land. As seen in Table 17, IWSA does much better compared to SWA but there is still room for improvement. SWA needs to touch base with water users and establish a place for its direct stakeholders within its governing policies.

***Table 17: Summary of responses to question 18.***

Response	SWA		IWSA	
	Estimate %	95% Margin of Error	Estimate %	95% Margin of Error
<b>Totally agree</b>	1.48	2.0	17.20	7.7
<b>Partially agree</b>	22.96	7.1	65.59	9.7
<b>Uncertain</b>	62.22	8.2	16.13	7.5
<b>Partially disagree</b>	13.33	5.7	1.08	2.1
<b>Totally Disagree</b>	0.00	0.0	0.00	0.0

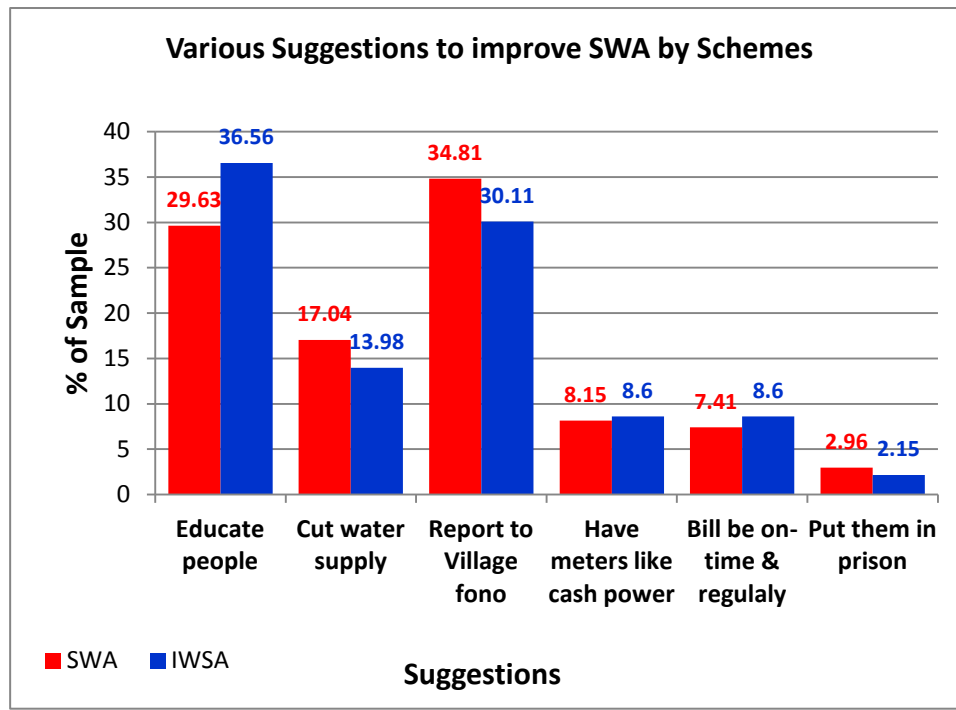
### **9.3C Suggestions to solve some of SWA’s Problems**

***Question 22 Two problems facing SWA are unpaid bills and non-revenue water from illegal connection. Can you suggest a policy or policies, from the water user level, that can help SWA solve these problems?***

Question 22 aims to allow the water users to suggest some input into some forms of policies to solve some of the serious problems in the water governance of SWA. The results as presented in Figure 8 give the following notable trends.

- The largest proportions of SWA customers (36.56%) put emphasis on education. It is believed that there wouldn’t be any problems with water meters if SWA had educated the water users before implementing meter systems. Problems such as tampering with meters would not have occurred if people were aware of the importance of saving water. IWSA customers showed agreement to all these as the second largest proportion (29.63%) of responses from them also emphasized educational programmes.
- Largest proportion of IWSA (34.81%) and second largest proportion of SWA (30.11%) customers emphasized that these problems can be easily solved at the village level. A lot of these people see that if SWA delegate this power to the village council their workload would be eased up. They do not have to chase unpaid bills because the village council would deal with it in their usual way. Moreover, they can monitor and inspect all the families’ water supply so that nobody tampers with the water systems.

• **Figure 8: Summary of Responses to Question 22.**



- One of the problems sighted during the study from water users under SWA is the irregularity of meter reading. They reported that sometimes their meters are not read regularly and the water bill is too much for them to pay at once.
- Others suggested that the termination of water supply, having water meters like cash power meters, and having policies that can put people with unpaid bills into prison.

### 9.3D Policies and Legislation (Water Users' Involvement in Formation) - Summary

In Section 9.2 positive effects of active participation of the local communities are seen and thus it is absolutely imperative that direct stakeholders participation must be clearly incorporated into governing policies and legislation. Formulation of these must be done in open consultation at all levels of local communities so that the sense of ownership is imbedded in their hearts. Yet as seen in the above analysis water governance by SWA lacks this dimension at a significant proportion while there is still room for improvement for IWSA. The call for both schemes, especially SWA, is to touch base with direct stakeholders (water users) in their operation as a response to the challenges alluded to at the beginning of this section (9.3). Water users' power and position must be clear cut in policies and legislations so they may freely perform their roles in contributing to water services. Finally, it is very important for both schemes to provide

continuous education programmes to clarify all of these and put water users' perception in the right perspective.

## Roles and Responsibilities

Problem 4: *“Roles and responsibilities regarding ownership and management of water resources and services”.*

“Water for Life” (report June 2012) refers to a framework for the allocation of water resources in Samoa which outlines principles, roles and responsibilities for relevant stakeholders involved with water resources management and regulation. From the civil society's point of view the most relevant stakeholders are the water users but their inclusion in the framework seems vague. The same report gives a *“Sector Governance Model”* with Community, Household, and Private Sector as a sole product. It places civil societies as passive recipients and hence the model must be improved by putting double sided arrows instead and recognize civil societies' involvement. Moreover, it is seen in sections 9.2 and 9.3 that the protection and maintenance of water sources and water catchments can be better managed at village level. Thus, it is important to emphasize active partnership between the governing authorities and villages. The point is that a relationship must be established between the two authorities (SWA and IWSA) and water users where roles and responsibilities must be shared to improve management. This part of the study looks at this area to see which scheme has better knowledge and awareness, from water users' perspective, of their roles and responsibilities in managing water resources and services. Questions that were set up for the last two studied objectives are used below to highlight the present situation (at least for Safata). The complete data is given in Table 18 (appendix).

### 9.4A Water Users Awareness of their own Roles and Responsibilities as well as those of governing authorities in managing Water Resources

The results show that a great majority of water users are aware of both their roles and those of the governing authorities (SWA or IWSA) in managing water resources (see Table 18, Results of questions 23 and 24). Cross referencing with other researched areas show that these results are a direct impact and influence of the television programmes. The IWSA customers are slightly above those of SWA (77.42% for IWSA compare to 68.89% for SWA) in this respect. This is most probably due to awareness raised within the village *fono*. Participants from IWSA talked much of the deliberations at the village level where water committee reports are discussed and where everyone is directed in saving water within their families and the whole village. The structure of having water committees which represent ISWA's governing body within the village level is also the reason why IWSA customers are more aware of the roles of the governing body



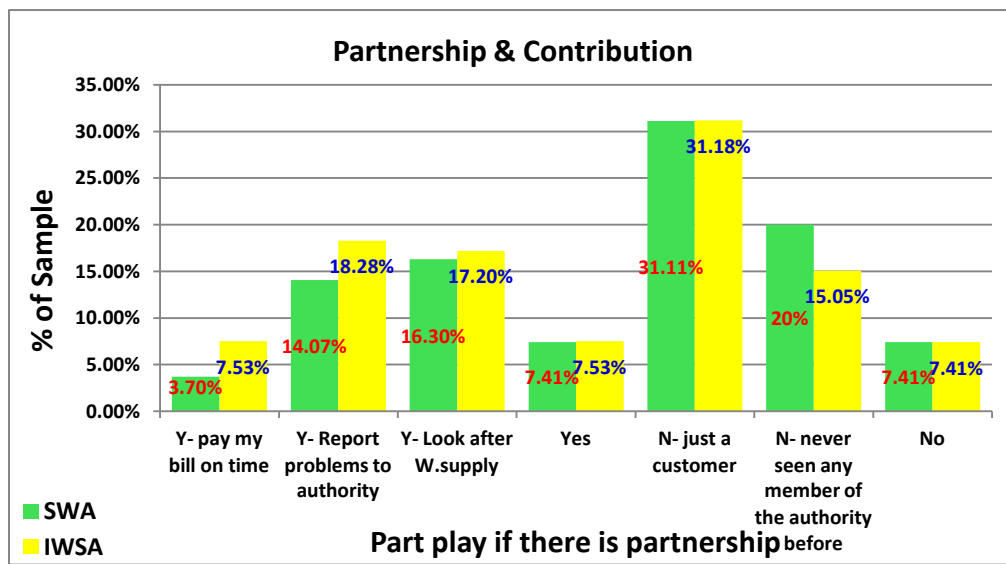
compared to the SWA customers (79.57% for IWSA and 73.33 for SWA). Because customers have a good understanding of their roles and the roles of the governing authorities, more than 80 percent from both schemes reported that they never have disagreements with the authority in performing their duties (see Table 18, Results of question 25).

### 9.4B Relationship between Water Users and Governing Authorities

The results of question 26 (see Table 18) give 77.78 percent for SWA and 79.59 percent for IWSA of families that are happy with their relationship with the governing authorities. However, the question of “the governing authority working in partnership with water users” gives a contradictory picture (see Figure 9). For SWA only 41.48 percent of families reported that there is partnership between them and the governing bodies. The 50.54 percent of those under IWSA reported the same thing. But when these families were asked about their part in this partnership, the majority of them either did not respond or reported that they are just customers and their part was to make sure they pay the water bills.

Those that responded “No partnership, they are only customers” are fairly even between the two schemes. Most IWSA customers who reported that they had never seen members of the authority before are from villages that get water from neighbouring villages. For example, Vaie’e that gets its supply from Niusuatia. Although IWSA seems to be more visible to its customers the results of this part show that both schemes require to touch base more often with the people that they are directly responsible for in terms of water supply.

**Figure 9 Partnership between Water Users and Governing Authority and Water Users’ part in such partnership**



## 9.4C Roles and Responsibilities (Ownership & Management) - Summary

There is no significant difference between the two water schemes in this studied area. The combined shortfall of 22.5 percent in Figure 1 is equally shared by the two although IWSA looks better (insignificant). The media awareness programmes (especially television) are shown to be quite effective in raising people’s awareness of their roles and responsibilities. However, there must be some added effort such as seminars and workshops where water users can have open discussion with governing bodies.

## 10. Is there a significant difference in responses due to Age and Gender?

The analysis of the Variance (ANOVA) on the 95 percent levels are used to check these. To do away with the technicalities of ANOVA the p-values of the tests are tabulated below and decisions are based on the usual convention that if the p-value is less than 0.05 then the test is significant. That is, a p-value of less than 0.05 shows that there is a significant difference in the compared characteristics.

An overall ANOVA shows that there are no significant differences in responses that can be attributed to age or gender (p-values of 0.997 and 1 respectively). However, an ANOVA performed on the breakdown by schemes and by studied areas show that in some areas the differences are very significant. These are summarized in Table 19

**Table 19** *p- values of 95% test of significant differences in responses due to age*

<i>Null hypothesis: There are no significant differences in the responses due to age and Gender</i>				
	AGE		GENDER	
Studied Areas	IWSA	SWA	IWSA	SWA
Equity and Efficiency	$1.7 \times 10^{-20}$	$1.3 \times 10^{-7}$	$3.5 \times 10^{-18}$	0.0006
Balance in water uses	1.0	0.0026	1.0	0.0850
Policy and legislation	0.771	$5.4 \times 10^{-9}$	0.8524	$1.7 \times 10^{-5}$
Roles and responsibilities	0.0193	$2.2 \times 10^{-7}$	0.0951	0.0004

The p-values for the area of Equity and Efficiency are all less than 0.05 and thus the data provides enough evidence to reject the null hypothesis. That is, there are significant differences resulting from difference in ages and gender. These differences are summarized as follows:

- (i) The majority of those that either totally or partially agree that “water supply meets their families’ expectation” and “authority personnel check their water supply regularly” are either of age greater than 55 or male.

- (ii) Almost all female participants disagree to any clean water supply for both schemes and they all say that they have no say in the allocation and distribution of water resources and services.
- (iii) A huge proportion of those at age less than 45 either disagreed (totally or partially) or uncertain of everything.
- (iv) Those who see no relationship between them and the governing authority are of age less than 55 or female.

In the area of “Balance in Water Uses” responses by SWA customers show a significant difference that is caused by the difference in age. This difference is mainly due to responses to questions 10, 11 and 13. More than 80 percent of the uncertain proportions in all three questions are those of age 25 – 45.

There is also a significant difference between responses from SWA customers in the areas of “policy and legislation” and “Roles and Responsibilities” caused by the difference in age and gender. These are summarized as follows:

- (i) Most of those who are uncertain that they understand their contribution in maintaining/sustaining their water supply (37.78%, see Table 15) are of age 25 – 45 years.
- (ii) When questioned about their involvement in the formation of policy and legislation (Question 16) almost all those who disagree are females. The 54.81 percent who are uncertain is also dominated by females and those of age 25 – 45 years.
- (iii) The same trend is seen, in terms of gender and age, in the results of questions 17 – 19 and 23 – 27.

Lastly, there is a significant difference in responses by IWSA customers in the area of “Roles and Responsibilities” that is caused by the difference in age. This is due to the response to questions 23 – 26. Those who selected “partially agree” or “uncertain” are dominated by age 25 – 45 years.

## 11. Question of Affordability

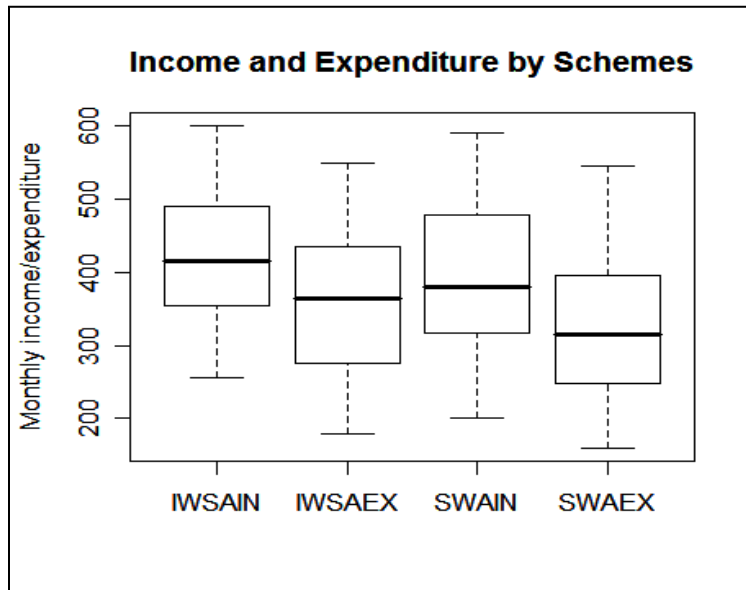
When asked if they were “**happy with the billing policies of their water authority?**” 100 percent of IWSA customers said yes (see Figure 10 Appendix). This is because they are paying very little like \$5 a month. A significant proportion of IWSA customers said that their water was free (e.g. those from Vaie’e). On the other hand 62.96 percent of SWA customers said no to the above question. A lot of these people disagree with the water meter system. As mentioned above, these are the people with the belief that water is a “free God given gift” and hence must

be free. This perception can be corrected by educating water users that development has a price.

To answer the question of affordability the 95 percent estimate of monthly water bills for SWA is compared to the difference between monthly income and expenditure. The responses to question 21 (see Table 15) give the estimated average to be between \$26.02 and \$31.98. An estimate of the difference between family monthly income and expenditure is calculated as follows.

Firstly, we need to consider if there is a difference between the distribution of both income and expenditure of SWA compared to IWSA. The boxplot below (Figure 11) clearly shows that there is no significant difference seen between families under SWA and those under IWSA.

**Figure 11:** Family Monthly Income versus Expenditure by Water Schemes.



Because there is no significant difference, results of both schemes are combined to give a general estimated monthly income of between \$382.76 and \$433.36. The general monthly expenditure is calculated in the same manner by giving an estimate of between \$298.60 and \$349.74. Hence the difference between income and expenditure (or the surplus) is estimated to be between \$58.32 and \$109.46. Comparing this with the estimated average of (26.02 – 31.98) confirms that the evidence provided by the data show that water is affordable.

## 12. General Suggestion for improvement

The last question of the survey allowed the respondents to give their suggestions on how water service can be improved in general. Results are summarized in Table 20 with some of the notable features listed below:

**Table 20** *Summary of suggestions to improve the quality of water services*

<b>Q28. Suggestion for general improvement in standard and quality of service ....</b>	<b>SWA</b>	<b>IWSA</b>
Everyone should have access to clean water. Authority must help families who are far away from the water source. Do something about declining water level	7.4	11.8
Must have educational programs for everyone. Solve problem of declining water level	34.1	25.8
Authority must educate water uses. Establish good working relation with village; Problem of declining water level should be solved soon.	14.8	21.5
Water must be free. Installing meters is a wrong thing to do. Declining water level is more serious than money.	6.7	2.2
There has to be regular checks/visit from the authorities to families' water supply. Do something to save water source.	15.6	10.8
Authorities must build water supply to all families instead of families paying for their own - that way everyone would have access to water. A lot of rivers are becoming dry now --- Government must do something about it	3.7	4.3
Authorities must work together with water users. Policies must be clear to all water users and guidelines must be clearly observed by everyone. Build large tanks to store water because water sources like rivers are becoming dry.	6.7	3.2
There are too many water shortage. The authority must build means of water storage with cleaning system so people can get clean water continuously.	1.5	5.4
There should be constant promotion on the radio and TV for water users to use water with great care.	5.2	5.4
There must be water centres at different parts of the country like police stations. Some problems occur at night time and we have to wait till the day. Sometimes it takes weeks before someone comes to fix our water supply.	4.4	9.7

- (i) Almost everyone had witnessed the degrading quantity of water in their water sources and is seeing it as the most serious problem.
- (ii) A high proportion of customers from both schemes emphasize the importance of educational programmes for water users and building good relationships between governing bodies and direct stakeholders.
- (iii) The majority, in recognizing that everyone must have access to water, suggest that governing bodies or government must secure this for everyone.

## 13 Recommendations

1. Water supply needs to be improved especially for IWSA. Both schemes are far from achieving one of the goals of the water sector reform (since 2005) – i.e. to ensure that both water resources and services are provided with increased efficiency – Section 9.1.  
Both schemes must be able to attend to problems immediately when requested by the water users instead of leaving them to a later day/week/month.
2. IWSA needs to upgrade plumbing skills of its members (e.g. water committee for each village under IWSA). The scheme also needs to establish a program so that it can be able to supply materials to fix water leakages and any other problems in water supply – Section 9.1B.
3. SWA needs to address corrupt practices such as its employees expecting customers to tip them with money or food before offering services that they are required to do as in their job descriptions – Section 9.1B.
4. If water is to be accessed by all, then the government should have a program to build water systems for everyone – Section 9.1C.
  - (i) Section 11 shows that customers can afford monthly water bills.
  - (ii) Evidence show that some families cannot afford the installation of water systems mainly because of the distance between their homes and the main line.
  - (iii) It costs at least \$250 to cross the road if a home is on the other side of the line. With the cost of pipes, fittings and labour a family is required to have at least \$500 and that is considered too expensive.
5. Both SWA and IWSA are required to improve in having regular checks on individual family's water supply. This is very crucial in maintaining and sustaining regular water supply – Section 9.1D
6. The most urgent recommendation is that both schemes must engage in immediate strategies to address the high level of unclean water – Section 9.1E.
  - (i) SWA must check its systems because customers are saying that when it rains their water supply gets dirty.
  - (ii) IWSA must seek assistance from the government or donors (funding agency) to have cleaning systems installed for its members. The goal of the Water and Sanitation Sector (WSS) emphasizing “Reliability, cleanliness ... of water and basic sanitation” ... for all people must be realized by both SWA and IWSA customers.

- (iii) For consumers' health and economic sustainability governance of both schemes must have in place proper measures to manage their water resources.
  - (iv) The Ministry of health should be active in its part as stipulated in the "*National Integrated Water Resource Management – Diagnostic Report*" (UNDP, 2007)
7. Water governance must have equality in terms of gender and age – Sections 9.1F, 9.1G and 10.
    - (i) Water governance must be set to empower women's involvement and participation at management level as they are more involved in water use than men.
    - (ii) Water governance must also empower youth in order for them to participate fully in all water activities.
  8. There is a need to have a clear cut terms of reference (TOR) for water committees because users' perception is that they are responsible for connecting pipes and fixing leakages – Section 9.1H.
  9. There is a need to raise the awareness of water users about their roles as well as the roles of the Authorities for both schemes – Sections 9.1 and 9.4A
  10. Both schemes must organize educational workshops so that water users can be aware that it is absolutely crucial for them to be fully engaged in water governance.
  11. Water users need to know that water is not a commodity sold for revenue and it is the responsibility of authorities for both schemes to supply it. Equally important is that water users have a responsibility to use water wisely. Money or authorities for both schemes cannot continue to supply water, if water users do not see their responsibility in water governance.
  12. There is a call for immediate action to solve the problem of diminishing water levels at water sources – Sections 9.2A and 12.
  13. Water sectors (Schemes) and the government must delegate more power to village councils on areas such as protection of water sources and water catchments – Sections 9.2B and 9.2D.

Findings have shown that the protection and sustaining of water supply is better managed at the village level.

14. Regulations and measures set to control water use must be properly monitored. Meters must be checked regularly by SWA and water committee for IWSA should be more active and involved in regular checks so that water uses observed village regulations – Section 9.2C.
15. Television programs are quite effective means of promoting awareness among water users on issues concerning water. Both schemes must continue to use these modes of communications to educate rural users on water issues and policies – Section 9.2E.
16. Village discussions of matters concerning water must be more inclusive to include youth and women – Section 9.2E.
17. Both schemes must provide programs for capacity building and awareness in the conservation of the ecosystem and therefore water supply – 9.2F.
18. The voices of all water users including the poorest and most vulnerable must be heard within the policies of water governance for both SWA and IWSA – Section 9.3A.
  - (i) Policies and legislations can only address water users' concern adequately if they are involved in designing them. This is because they know better about these concerns than anybody else.
  - (ii) The right of ownership is the best and free incentive for water users to fully participate in water activities. This can only be genuinely established within the heart of the customers when they know that they have a position within their water governance.
19. Water governance of both schemes must define people's power to stop unsustainable exploitation of water resources, power to protect community resources on which economic growth depends on while security of water supply is assured, plus all other rights of ownership such as land – Section 9.3B.
20. Both schemes must establish good active relationship and partnership with village councils. A lot of problems facing SWA can be better solved at the village level – Section 9.3C.
21. Water meters must be read regularly (e.g. monthly) so that bills do not pile up and the customers would find it hard to pay – Section 9.3C.
22. Government should encourage the establishment of active partnership of water governing authorities and villages. i.e. a relationship between the two authorities (SWA



and IWSA) and water users where roles and responsibilities must be shared to improve management.- Section 9.4.

23. Both schemes must be more visible to its customer – i.e. Both IWSA and SWA authorities need to touch base by means of activities and meaningful (genuine) consultations in order to achieve effective and efficient water governance – 9.4B.
24. In addition to media awareness to be continued and promoted as recommended above, there must be some added effort from both schemes such as seminars and workshops where water users can have open discussions with governing bodies – Section 9.4.
25. SWA must devise ways and means to incorporate village governance into its operation, at least for rural water supply. Evidence from findings show that this is the strength of IWSA in maintaining and sustaining water sources and water catchments.
26. SWA should look into delegating some of its power to the village council like collecting water bills.

## Appendix

**Table 3: Percentage breakdown on Equity and Efficiency of services by SWA and IWSA**

CODES: TA = Totally Agree PA = Partially Agree U = Neither Agree nor Disagree PD = Partially Disagree TD = Totally Disagree										
	SWA (%)					IWSA (%)				
	TA	PA	U	PD	TD	TA	PA	U	PD	TD
<b>Q1. W/supply meets our expectations</b>	15.56	47.41	37.04	0.00	0.00	1.08	30.11	37.63	31.18	0.00
<b>Q2. Efficient service by authority</b>	23.70	43.71	32.59	0.00	0.00	0.00	34.41	40.86	24.73	0.00
<b>Q3. There was sufficient assistance from authority.</b>	21.48	45.19	33.33	0.00	0.00	0.00	36.56	38.71	24.73	0.00
<b>Q4. Authority check our water supply regularly</b>	12.59	40.74	46.67	0.00	0.00	0.00	22.58	45.16	32.26	0.00
<b>Q5. Our w/supply is always clean &amp; equally distributed ...</b>	7.41	47.41	44.44	0.74	0.00	0.00	15.05	50.54	34.41	0.00
<b>Q6. Have a say in the allocation and distribution ...</b>	20% - Yes as a matai in the village 41.5% - No voice 15.5% - No 23% - Yes					21.5% - Yes as a matai in the village 23.7% - No voice 23.6% - No 31.2 - Yes				
<b>Q7. Position within Water governance ...</b>	9.6% - as head member of family 80% - no position 10.4% - as a matai we discuss in the village fono					20.4% - as head member of family 60.2% - no position 19.4% - as a matai we discuss in the village fono				
<b>Q8. Perception on the relation between w/users &amp; authority ...</b>	31.9% - No relationship 37.0% - Just a customer 31.1% - Good relationship, Authority is very helpful					70.97% - No relationship 0% - Just a customer 29.03% - Good relationship, Authority is very helpful				

**Table 9: Breakdown of responses to question 6 by schemes and by gender and age**

Responses	AGE Range	MALES (%)		FEMALES (%)	
		SWA	IWSA	SWA	IWSA
Yes, as a Matai	25-45	0.0	0.0	0.0	0.0
	45-55	0.0	0.0	0.0	0.0
	≥ 55	19.1	21.5	0.7	0.0
Yes	25-45	2.6	0.0	1.3	4.3
	45-55	9.2	11.8	6.6	7.5
	≥ 55	2.0	1.1	1.3	6.5
No say	25-45	13.8	7.5	15.1	15.1
	45-55	2.6	0.0	18.4	16.1
	≥ 55	5.9	6.5	1.3	2.2

**Table 10: Percentage breakdown on Balance in water use – Socio-economic activities versus ecosystem – SWA versus IWSA**

CODES: TA = Totally Agree      PA = Partially Agree      U = Neither Agree nor Disagree PD = Partially Disagree      TD = Totally Disagree										
	SWA					IWSA				
	TA	PA	U	PD	TD	TA	PA	U	PD	TD
Q9. W/system developments have little effect on our environment.	36.30	45.93	14.81	0.74	2.22	49.46	49.46	1.08	0.00	0.00
Q10. There are village laws for sustainability of w/supply	8.89	54.81	32.59	0.74	2.96	87.10	12.90	0.00	0.00	0.00
Q11. There village inspection to w/catchment	20.00	51.11	25.19	1.48	2.22	89.25	10.75	0.00	0.00	0.00
Q12. There system to control w/usage	41.48	47.41	8.89	0.74	1.48	56.99	40.86	2.15	0.00	0.00

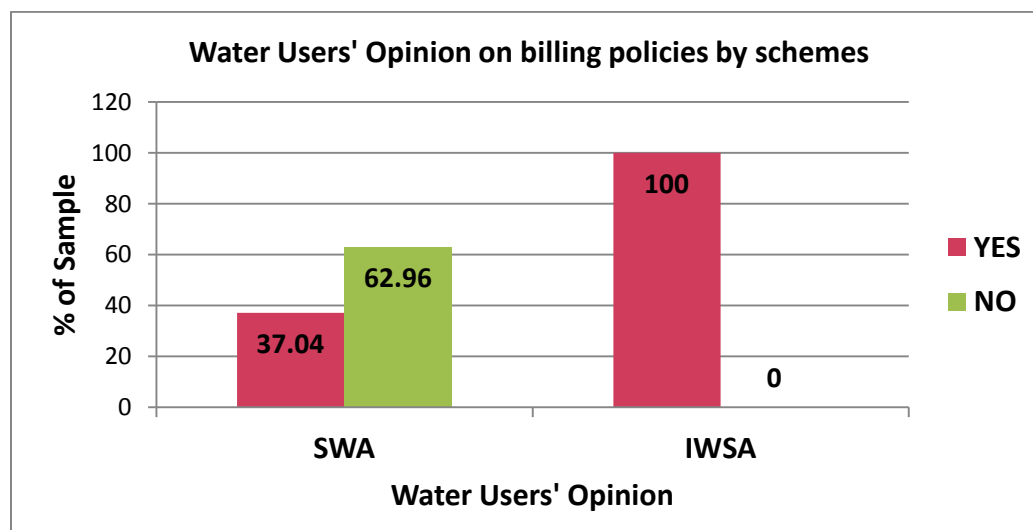
<b>Q13. There measures to protect w/source &amp; catchment</b>	15.56	41.48	36.30	2.96	3.70	73.12	25.81	1.08	0.00	0.00
<b>Q14(i). Did SWA/IWSA make you aware of water protection and conservation of ecosystem?</b>	28.15% - NO 22.22% - NO. But media program helps (e.g. TV) 22.22% - Yes, They told us thru TV 27.41% - Yes. Thru village fono					35.48% - NO 20.43% - NO. But media program helps (e.g. TV) 21.51% - Yes, They told us thru TV 22.58% - Yes. Thru village fono				
<b>Q14(ii). What is your contribution to the conservation of your ecosystem?</b>	17.04% - protect forest near w/source and w/catchment 20.74% - Don't cut down trees 20% - use less weed killers 14.81% - plant trees near w/source 14.82% - don't throw rubbish to rivers. 12.59% - Not my job					15.05% - protect forest near w/source and w/catchment 23.66% - Don't cut down trees 15.05% - use less weed killers 17.21% - plant trees near w/source 19.35% - don't throw rubbish to rivers. 9.68% - Not my job				

**Table 15** *Percentage breakdown on Policy and Legislation (Inclusiveness versus Exclusiveness) within water governance of SWA and IWSA*

	SWA					IWSA				
	TA	PA	U	PD	TD	TA	PA	U	PD	TD
<b>Q15. I u/stand my contribution in maintaining/sustaining ...</b>	8.15	50.37	37.78	3.70	0.00	7.53	22.58	60.22	9.68	0.00
<b>Q16. I was consulted in formulating policies ...</b>	0.00	18.52	54.81	23.70	2.96	21.51	63.44	13.98	1.08	0.00
<b>Q17. Our concerns are addressed in policies ...</b>	1.48	25.19	58.52	14.81	0.00	20.43	64.52	13.98	1.08	0.00
<b>Q18. We have sufficient power in the W.policies ...</b>	1.48	22.96	62.22	13.33	0.00	17.20	65.59	16.13	1.08	0.00

<b>Q19. Our position are clearly spelled out in W.policies</b>	2.96	21.48	56.30	17.78	1.48	12.90	55.91	27.96	3.23	0.00
<b>Q20. Are you happy with the billing policy ...?</b>	37.04% - Yes 62.96% - No					100% - Yes				
<b>Q21 (i) &amp; (ii) Quantitative</b>										
<b>Q22. Suggestion to solve ongoing problem in SWA (unpaid bills &amp; non-revenue water ...)</b>	29.63% - Educate people about meters 17.04% – Cut water supply 34.81% – Report to village fono 8.15% - Install meters like cash power, people pay first 7.41% - bills be on time and in regular period (*) 2.96% - have policy to put those with unpaid bills in prison					36.56% - Educate people about meters 13.98% – Cut water supply 30.11% – Report to village fono 8.6% - Install meters like cash power, people pay first 8.6% - bills be on time and in Regular period (*) 2.15% - have policy to put those with unpaid bills in prison				

**Figure 10:** Responses to Question 20 (Are you happy with the billing policies of your water authority?) SWA versus IWSA.



**Table 18: Percentage breakdown on Roles & Responsibilities, SWA vs IWSA in terms of Ownership and Management**

CODES: TA = Totally Agree PA = Partially Agree U = Neither Agree nor Disagree PD = Partially Disagree TD = Totally Disagree										
	SWA					IWSA				
	TA	PA	U	PD	TD	TA	PA	U	PD	TD
<b>Q23. I'm aware of my roles in managing our w/resources ...</b>	19.26	49.63	22.96	5.19	2.96	31.18	46.24	20.43	1.08	1.08
<b>Q24. I'm aware of the authority's roles ...</b>	20.00	53.33	18.52	5.19	2.96	30.11	49.46	18.28	1.08	1.08
<b>Q25. We never disagree or clashed with authority ...</b>	39.26	40.74	11.85	5.19	2.96	41.94	38.71	17.20	1.08	1.08
<b>Q26. We are happy with our relationship with authority ...</b>	20.74	57.04	14.07	5.19	2.96	34.41	45.16	18.28	1.08	1.08
<b>Q27. Is the authority working in good partnership with you? Your part ...?</b>									SWA	IWSA
Yes, pay my bill on time									3.7%	7.53%
Yes, Report any problem to authority									14.07%	18.28%
Yes, Look after my W.supply and use water appropriately									16.3%	17.2%
Yes									7.41%	7.53%
No, just a customer									31.11%	31.18%
No, never seen any member of the authority before									20%	15.05%
No									7.41%	7.41%

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**To Identify households in Samoa that are wholly reliant on rain water harvesting for their water Supply**

**Samoa Red Cross Society**

## **INTRODUCTION**

There are some areas of Samoa that do not receive reticulated water at present. Some of these areas are scheduled to receive new water schemes in the next 1-5 years. However, there are some areas where the conditions are such that it is not economic to construct a reticulated supply, so the households in these areas are reliant on springs, streams or rain water. The households in these areas fall outside the water sector initiatives that have been undertaken in the past, and represent some of the most vulnerable and poorest families in Samoa. There are now initiatives being developed to assist these families with harvesting rain water efficiently and effectively, ensuring a year round supply of clean drinking water. The problem is that the information to identify these families, and the level of support required, is not available. Projects to date have been reactive to proposals, and the sector is now placed to undertake a more proactive approach to the issue. This research will also contribute to the sector being able to identify the most vulnerable under the Millennium Development Goals. With the increasing number of projects that are being proposed through various donor sources, some kind of baseline data is required to inform donors as to which proposals are, in the view of the water sector, the most needy.

## **RESEARCH OBJECTIVES.**

The overall objective will be to identify those households in Samoa that are wholly reliant on rain water harvesting for their water supply.

Specific objectives will be:

- Clearly identify the extent and boundaries of all SWA and IWSA water schemes.
- Identify households or communities that have adequate alternate supplies, such as springs and wells.
- In the areas not included in the two points above, map the location of all households.
- Collect data for each household regarding current rain water harvesting capability and capacity.

## **METHODOLOGY**

### **Structure**

Phase one was a review of all mapped information from the Samoa Water Authority and the Independent Water Scheme Association showing the existing reticulated water pipelines, and the inclusion of all new water schemes, scheme upgrades and expansions. Evaluation of this information will determine those areas that are not currently covered by a reticulated water scheme nor are they included in any future reticulation plans.

Phase two was an on the ground assessment by household to determine:

- Current water supply sources, quantity of supply and storage capacity.
- Where the current water schemes finish.
- GPS Mapping of households in these areas
- Household survey to collect the required information.

Phase three was the evaluation of the information that had been gathered, the inputting of the data into a database so that it can be utilised in the future, and the preparation of the report including the mapping of the households.

### **Institution and Personnel**

The research was carried out by Samoa Red Cross. SRC has many years of experience in working at community level, and is seen by the community as a non-threatening organisation with a mandate to support the community.

SRC has undertaken household surveys and evaluations in the past, most recent examples being after the 2009 tsunami and the implementation of the UNDP SRC joint project in Aleipata.

The lead researcher, David Neal, is a Senior Manager with NZ Red Cross, and has previous experience in both the implementation of development projects and conducting household research.

The Team Leader, Tangaloatea Opeteia Opeteia is a Senior Manager with Samoa Red Cross and has been working on water and sanitation projects since the 2009 tsunami. He was trained by the NZ Red Cross and Australian Red Cross in Water and Sanitation (Watsan), and has attended the IFRC Watsan Basic Training Course.

The collation and evaluation of the data, as well as the management of the assessment teams in the field, was done by Rodney Su, Research Officer with SRC. There were a total of 18 volunteers who were utilised to

carry out the assessment, 12 in Upolu and 6 in Savai'i. Three SRC vehicles were allocated full time to the research.

A specialist in the development of GIS information and mapping was to be contracted as a TA, however, this function was undertaken by MNRE staff. This freed up some funding to allow Red Cross to utilise more volunteers than originally intended, as the assessments took longer than planned.

### **Mapping**

Both the Samoa Water Authority and the Independent Water Scheme Association provided detailed maps of their infrastructure using maps developed using the MapInfo programme. This is the same programme used by MNRE.

These maps were enlarged, combined and overlaid on the aerial maps developed by MNRE, which also showed roads and village names. This gave the research team a complete picture of all roads, villages and water reticulation pipelines in Samoa.

Both SWA staff and IWSA staff were interviewed regarding the extent and condition of each individual pipeline and this information transferred to the final reticulation system maps.

Each household that was assessed as meeting the criteria was then plotted using hand held Garmin GPS units, and this data was recorded against the assessment data for each household. This information was then converted into the MapInfo format, and a layer of information created that could be applied to the master maps.

The final results, in the form of GPS coordinates of each household surveyed, was converted into a MapInfo file, and is stored on the SRC network, with a copy backed up to an external hard drive. The mapping layer, and all the information that was used to develop the survey areas, is available in the MapInfo format to anyone in the water sector who requires it. Copies of the final assessment maps are at Annex 3, however these can be examined in more detail with the MapInfo data.

### **Household Survey**

Utilising teams of volunteers, every household that could be found that was outside the reticulated water areas was visited and a survey questionnaire was completed. The questionnaire focussed on gathering the information required to meet the objectives, and also to provide sufficient information about individual households so that the data could be used to set criteria for water harvesting projects in the future.

Both the Samoan version of the questionnaire, which was used in the survey, and the English version are attached at Annex 2.

## FINDINGS

### 1. Number of households

The initial estimate of the number of households that would meet the criteria was between 1,500 and 2,000. It was found that there were 991 households that met the criteria.

*Conclusion: This is significantly fewer than estimated.*

### 2. Distribution

The table below is a broad summary of how the households are distributed throughout Samoa. A more detailed table showing distribution by village is at Annex 2.

*Conclusions: Nearly 50% of the households that are not on reticulated water supply are in the area between Apia and Mulifanua, including the upland areas of Aleisa and Tanumalala. Fewer than 30% of households assessed were in areas above the water supply areas originally mapped for assessment. Many of the areas that were marked as having reticulated supply did not, or had a pipeline that had not functioned for over 2 years and were included. 70% of the assessed households came into this category. A major push to expand the reticulated supply in the area between Apia and Mulifanua would remove half the problems.*

Area	Population	Total No of H/holds	No of H/holds that meet criteria
Apia urban	36,735	6,003	81
Upolu Rural	106,683	15,744	705
Savai'i	44,402	6,435	205
Total	187,820	28,182	991

### 3. Household makeup

The table below shows the number of households with members that have special needs, either physical or mental. It also shows the number of large households. When prioritising households for intervention, these factors will be taken into account.

Area	No of H/holds that meet	No of H/holds with special	No of H/holds with 12+

	<b>criteria</b>	<b>needs</b>	<b>persons</b>
Apia urban	<b>81</b>	8	16
Upolu Rural	<b>705</b>	122	110
Savai'i	<b>205</b>	48	30
<b>Total</b>	<b>991</b>	<b>178</b>	<b>156</b>

#### 4. Types of Supply

A number of households surveyed have alternative sources of water that would reflect on their priority when intervention was planned. The table below shows the number of households with access to a constant supply of river or spring water, and where, particularly with those with access to a constant spring supply, alternative systems would be more effective and economic rather than reliance on rain water harvesting.

*Conclusions:* Very few households had access to a reliable alternative supply. Those with spring supply were generally satisfied it was safe to drink, but boiled the water anyway.

<b>Area</b>	<b>No of H/holds that meet criteria</b>	<b>River water only source for drinking</b>	<b>Springs only source for drinking water</b>	<b>Rain water only</b>
Apia urban	<b>81</b>	2	3	76
Upolu Rural	<b>705</b>	9	21	675
Savai'i	<b>205</b>	1	6	198
<b>Total</b>	<b>991</b>	<b>12</b>	<b>30</b>	<b>949</b>

#### 5. Current water storage capacity

The table below gives an indication of how households currently store their water. Those that have concrete or plastic tanks are identified, and would not probably meet the criteria for inclusion in a rain water harvesting project that focussed on the neediest. Those with large drums are generally susceptible to water borne diseases, as few of the drums have coverings. Small plastic containers are generally closed or covered, but do not allow for large quantities to be stored, so there is also a susceptibility to health issues.

*Conclusions:* 31% of the households assessed had a tank of some design. Many were plastic and had been installed relatively recently by CSSP, Red Cross, churches or other donors. Many of the concrete tanks were damaged, and if so were not counted. This leaves only 683 households in the sample that require a household tank.

Area	No of H/holds that meet criteria	Drums and or large containers	Small containers only	Concrete or plastic tank
Apia urban	81	71	4	6
Upolu Rural	705	367	123	215
Savai'i	205	112	6	87
<b>Total</b>	<b>991</b>	<b>550</b>	<b>133</b>	<b>308</b>

## 6. Type of roofing material

The type of roofing material currently in use will reflect the strategies that will have to be employed to provide a suitable catchment area for collecting rain water. In most cases where there is only traditional roofing material being used, either a quantity of iron will need to be provided or plastic sheeting or tarpaulins to cover the thatch.

*Conclusions:* 66% of households in the sample had part or all of their roof constructed of iron. Almost all those with existing tanks had invested in an iron roof, and among those households who rely on rain water there is an encouraging number investing in iron roofing.

Area	No of H/holds that meet criteria	Traditional	Iron
Apia urban	81	9	72
Upolu Rural	705	224	481
Savai'i	205	101	104
-Total	<b>991</b>	<b>334</b>	<b>657</b>

## 7. Type of Toilet

Despite the lack of water, many of the homes surveyed had flush or pour toilets that relied on water to operate. In almost all cases, rainwater was collected to operate the toilet. In almost all cases where the household had only a pit latrine, the latrine was not enclosed and posed a significant health risk to the members of the household, particularly the very young or very old. The table below shows what type of toilet each household surveyed was using.

*Conclusions:* There are a large number (55%) of households in the sample that have flush toilets or pour toilets. The number of latrines is smaller than expected. The recent census indicates that there are 1,110 households with latrines. This indicates that around 650 households within the reticulated water areas have latrines.

Area	No of H/holds that meet criteria	Flush	Pour	Latrine
Apia urban	81	37	33	11
Upolu Rural	705	137	254	314
Savai'i	205	35	35	135
<b>Total</b>	<b>991</b>	<b>209</b>	<b>322</b>	<b>460</b>

## CONCLUSION

The major conclusion is that there are not as many households that live in the areas without reticulated water as was initially estimated. Of those that do not receive reticulated water, the majority (over 70%) are in areas where it is possible to reticulate water economically. These are the areas that need to be prioritised by the Samoa water Authority for development, as the potential number of new customers is high, and they are concentrated in a small area. The number of households that are in areas that are considered to be reticulated is high, and it is in these areas that many of the projects that are proposed come from.

When all areas that can be economically reticulated have been provided service, there will, at today's population distribution patterns, be approximately 300 - 350 households that cannot be supplied.

The issue for the other areas is, then, how long will it be before reticulation is established, and how many households are there in unsurveyed areas that are equally as affected by the economic factors, and would be



better off with a tank instead of the cost of a reticulated supply. This needs to be the outcome of further work, under different criteria, to advance the MDG project.

However, this research also highlights the economic factor that currently prevents a significant number of households from accessing reticulated water – their household income is so low that to pay for water is not feasible. More emphasis needs to be placed on identifying these households in all areas, and developing strategies that can provide them with a consistent and adequate supply of drinking water. This may be by way of alternative strategies for donors, such as subsidised water connections and usage, in much the same way that AusAID and NZ Aid currently subsidise school fees.

**The major conclusion would be, therefore, that the number of households that will rely entirely on rain water harvesting into the future is small. Many installations of water tanks into households will only meet a short term need. There needs to be a clear recognition that investing in tanks for the areas where reticulation is possible may not be the most effective use of funding. It may be better for the Government and donor agencies in the long term to look at funding water reticulation growth and consistency of supply by providing bulk storage for systems, and investing in programmes that protect the watershed. Such a strategy would reduce the use of tanks and rain water harvesting to the status of an emergency supply for all but a handful of homes.**

## ANNEX 1

**Table 1 – Distribution of households by Village**

Area	Village	Number of Households
<b>APIA</b>		
	Palisi	22
	Malololelei	19
	Sogi	13
	Vailoa	10
	Others	17
	<b>Total</b>	<b>81</b>
<b>Apia to Mulifunua, including Aleisa</b>		
	Faleasiu	137
	Tanumalala	106
	Fasito'o	60
	Aleisa	48
	Tufulele	23
	Falemauga	17
	Leulumoega	16
	Mulifanua	15
	Matautu (Falelatai)	14
	Falelauniu	11
	6 other villages	23
	<b>Total</b>	<b>470</b>
<b>South Coast</b>		
	Lotofaga	27
	Siumu	15
	Saleilua	9
	Poutasi	7
	Sa'aga	7
	8 other villages	23
	<b>Total</b>	<b>88</b>
<b>Aleipata</b>		
	Saleaamua	19
	Maninoa	14
	Vailoa	13
	Mutiatele	11
	2 other villages	12
	<b>Total</b>	<b>69</b>
<b>North Coast</b>		

	Sauano (Fagaloa)	21
	Lotofa'a	18
	Saletele (Fagaloa)	16
	3 other villages	9
	<b>Total</b>	<b>64</b>
<b>Savai'i</b>		
	Neiafu	77
	Salailua	18
	Asau	16
	Sataua	13
	Gatavai	11
	Satoalepai	10
	Fagasa	9
	Foailuga	8
	21 other villages	41
	<b>Total</b>	<b>203</b>

## ANNEX 2

### 1. Household survey form – Samoan

(PEPA MO ASIASIGA)

### SRCS – WATSAN DEPARTMENT

---

Aso: \_\_\_\_\_

Taimi: \_\_\_\_\_

Suafa, ulu o le aiga: \_\_\_\_\_

Afioaga: \_\_\_\_\_

---

#### (FAAMATALAGA TAU I LE SUAVAI TAUMAFU)

1. O i ai se alapaipa?
  - a) Paipa a le malo b) Paipa a le vaitumaoti c) Leai se paipa
2. O iai se isivaega tau suavai e onomauamaiai e le aiga le suavaitaumafa mama
  - a) Vaipuna b) Vaitafeuamaeaeonafaamamaina c) Vaitimu
3. A faapea o le vaitimu, o a vaega o lo’ofaaogaina e tapueinaai le suavai
  - a) \_\_\_\_\_ b) \_\_\_\_\_
4. A faapea o i ai se talivai, o le a le umi
  - a) \_\_\_\_\_
5. O a vaega o lo’ofaaogaina e atoai le fale
  - a) Apa b) Lau c) Tapoleni
6. A faapea o le vaitimu, o a vaega o lo’ofaaogaina e sefeai le suavai
  - a) Tanevai Pau b) Paelo/Kaloge c) TanevaiSima
  - b) Nisi vaega e eseai \_\_\_\_\_

#### (FAAMATALAGA TAU I LE FALE UI/FALE LE TAUA)

1. O le a le ituaiga fale ui/fale le taua o lo’ofaaogaina

- a) Falasi b) Asu c) Eli
2. O le a le mamaomai le fale o le aiga  
a) \_\_\_\_\_
3. O lataiai se paipamo le fufuluina o lima, o le a le mamao – Faaogamaimita  
a) \_\_\_\_\_  
b) \_\_\_\_\_

### (AOFAIGA O LE AIGA)

1. E toafia sui o le aiga e lavea i lalo o vaega e peionataua
- |            |           |            |
|------------|-----------|------------|
| a. 0 – 5   | Tama_____ | Teine_____ |
| b. 6 – 12  | Tama_____ | Teine_____ |
| c. 13 – 18 | Tama_____ | Teine_____ |
| d. 19 – 45 | Tama_____ | Teine_____ |
| e. 46 – 65 | Tama_____ | Teine_____ |
| f. 66+     | Tama_____ | Teine_____ |
2. Aofaiga o sui o le aiga  
a. \_\_\_\_\_
3. Tagata e l aimanaogafaapitoa, e toafiaaeo a foimanaoga  
a. \_\_\_\_\_ b) \_\_\_\_\_

### (TULAGA TAU I TUPE MAUA A LE AIGA)

1. Faamatalaga o vaega tau tupe ,aia a le aiga
- Tagatafaigaluega
  - Faatoaga
  - Tupemauamaifafo
2. E le a le aofaigao se tupemaua a le aiga i vaiasotaitasi  
a. \_\_\_\_\_

GPS location

S \_\_\_\_\_ / W \_\_\_\_\_

### (NUMERA O LE TELEFONI)

Talefoni fale: \_\_\_\_\_

Selula: \_\_\_\_\_

Saini, sui o le aiga: \_\_\_\_\_

Saini, sui o le ofisa: \_\_\_\_\_

## 2. Household survey form – English

### SRCS – WATSAN DEPARTMENT

---

Date: \_\_\_\_\_

Time: \_\_\_\_\_

Name of family member: \_\_\_\_\_

Village: \_\_\_\_\_

---

#### (Main water supply)

1. Access to main pipeline
  - a) SWA
  - b) IWSA
  - c) No pipeline in place
2. Other existing water sources
  - a) Stream
  - b) Treated river water
  - c) Rain water
3. If rain water, is there guttering in place?
  - a) \_\_\_\_\_
4. If there's guttering in place, how long (width) is it?
  - a) \_\_\_\_\_
5. Type of roofing material
  - a) Iron
  - b) Thatches
  - c) Tarpaulin
6. Existing water conservation methods
  - a) Plastic Tank
  - b) Barrels/Empty oil drums
  - c) Segment Tanks
  - d) Other materials \_\_\_\_\_

#### (SANITATION)

1. Type of sanitary facility used by the family
  - a) Flush
  - b) Pour
  - c) Pit latrine

2. Distant from the house (in metres)
  - a) \_\_\_\_\_
3. Is there a tap adjacent for hygiene purposes, what is the distance? (in metres)
  - a) \_\_\_\_\_
  - b) \_\_\_\_\_

**(HH POPULATION)**

1. Number of family member which fall under each category
 

a) 0 – 5	Male _____	Female _____
b) 6 – 12	Male _____	Female _____
c) 13 – 18	Male _____	Female _____
d) 19 – 45	Male _____	Female _____
e) 46 – 65	Male _____	Female _____
f) 66+	Male _____	Female _____
2. Total number of family members
  - a) \_\_\_\_\_
3. Special needs
 

a) _____	b) _____
----------	----------

**(LIVELIHOOD)**

1. Main source of income?
  - a) Working member
  - b) Plantation
  - c) Remittance
2. Overall income per week
  - a) \_\_\_\_\_

GPS location  
 S \_\_\_\_\_ /W \_\_\_\_\_

**CONTACT INFORMATION**

Home phone: \_\_\_\_\_

Cell phone: \_\_\_\_\_

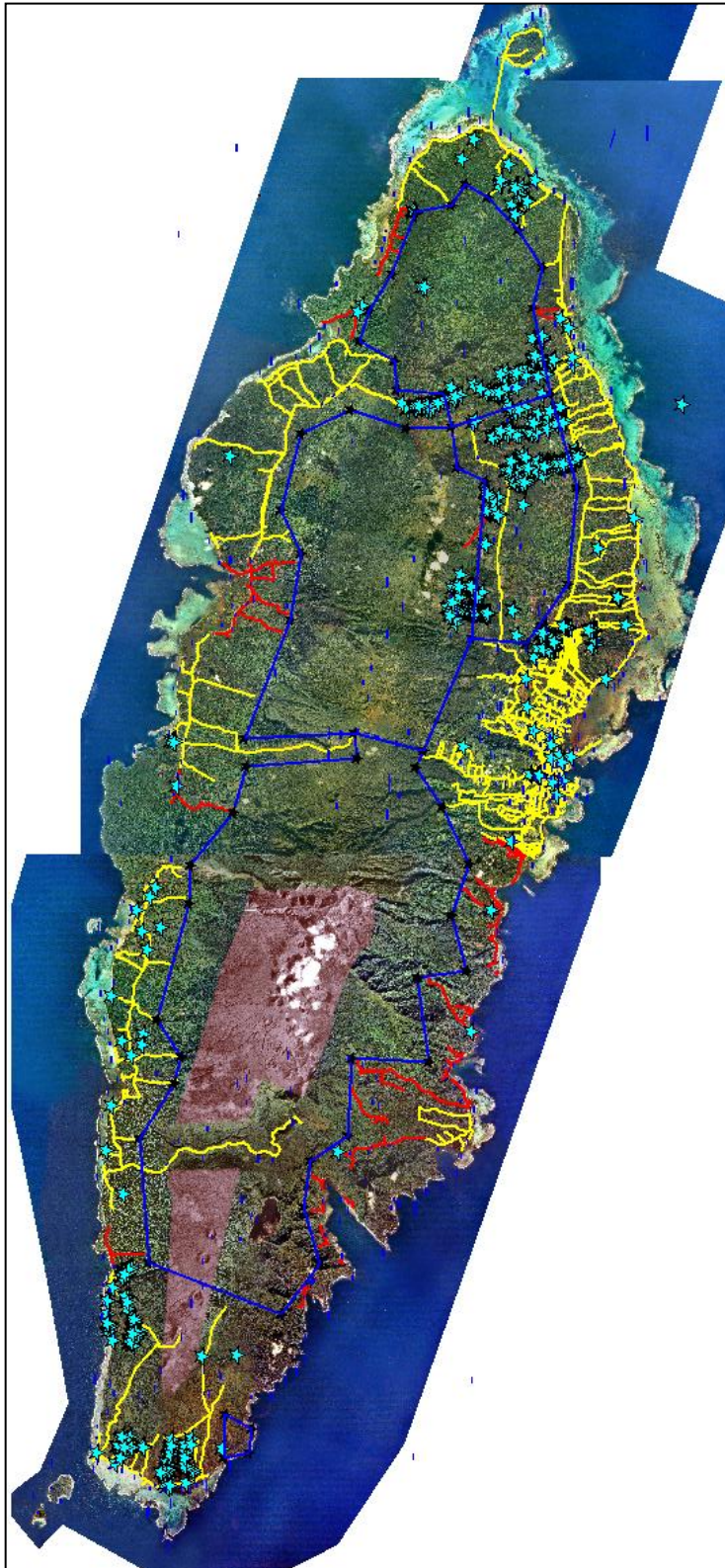
Signature of family member: \_\_\_\_\_

Signature of staff member: \_\_\_\_\_



## ANNEX 3

### 1. Assessment data Upolu



## 2. Assessment data Savai'i

