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"Implementing Sustainable Water Resources and Wastewater Management in Pacific Island Countries"

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APPROACH TO WATER USE EFFICIENCY IN THE PACIFIC

1. INTRODUCTION

1.1 Purpose

This paper examines how water use efficiency (WUE) can be most appropriately incorporated into the unique environments of Pacific islands and considers it in the context of IWRM at a local, island, national and regional level.

1.2 Context

In seeking to mainstream WUE into Pacific countries, it is important that the context is well understood – why are we trying to improve WUE and what is the outcome that we are seeking? Ultimately, water use efficiency is about increasing the valuable use of water resources. The context for this can be environmental, social and/or economic.

Is it to improve cost-effective use of water? The World Bank suggests that "*only 15 percent of projects that attempted cost recovery achieved their goal. Those that have succeeded have generally improved the efficiency of water institutions at collecting fees.*" (World Bank 2010) So, if this is the objective, then most development work struggles to achieve this outcome.

As an indicator of national water use efficiency, the UNEP Freshwater Vulnerability Assessment methodology uses the dollar production value for each cubic metre of water used. The basket of high-producing countries generate US$23.8 per cubic metre of water used (Babel and Wahid 2008). By comparison, Papua New Guinea generates approximately $800 per cubic metre of water used.

The typical per-capita water use of residents of Australia, Britain and the United States is of the order of 300 $l.capita^{-1}.day^{-1}$ (Watkins et al. 2006). Tuvaluans commonly use 30 to 50 $l.capita^{-1}.day^{-1}$ and for extended periods of drought Nauruans operate on as little as 10 to 20 $l.capita^{-1}.day^{-1}$.

The above isn't to suggest that water use efficiency isn't a concept of value in the Pacific, but rather the opposite. In many parts of the Pacific, as much through necessity as through choice, water is being used as efficiently as availability, technology and resources permit.

As stated at the 7th AWDO workshop, "*whilst many principles and assumptions apply generally, they often don't apply to outliers. For much of water management, the whole of the Pacific is an outlier*."

The challenge is therefore to ensure that the outcomes are achieved through use of the appropriate tools, rather than assume that the tools will work everywhere.

1.2 Background

The Project Document contains multiple references to WUE, including within the project objective: "*To improve water resources management and water use efficiency in Pacific Island Countries in order to balance overuse and conflicting uses of scarce freshwater resources through policy and legislative reform and implementation of applicable and effective Integrated Water Resources Management (IWRM) and Water Use Efficiency (WUE) plans*".

Further the Project Document recommends the "*demonstration of IWRM and WUE methodologies that are applicable to all SIDS*", that demonstration projects undertake policy, legislative and institutional reform for WUE and that WUE forms a core component of the regional indicator framework.

It is therefore necessary to identify the most appropriate approach to mainstream WUE into country policies and practices.

2. WATER USE EFFICIENCY

2.1 Definition

The definition of water use efficiency differs depending upon the context. Whilst broadly, the definitions relate to maximising the value (social, economic and environmental) obtained from the use of limited water resources, the context of application tends to define the use. For example, within the agricultural or commercial context, water use efficiency commonly relates to productivity (in crop yield, product weight or dollar value) against water input.

2.2 Context for Application of WUE

The broad definition of WUE, to maximise the value obtained from limited water resources, provides the options consistently adopted for increasing WUE, namely:

- Increasing the value of the use: this can be expressed in terms of crop or product cash value, or in social terms such as increased access to water
- Achieving the same value with less water: such as achieving the same economic or health outcomes on reduced water

Importantly, all of the above applies to a limited resource. In the Pacific atoll countries and some of the uplifted coral islands, water is an extremely limited resource, to the point of restricting development. In the larger volcanic islands however, water availability at a broad national level is not an issue. A simple comparison against one of the common benchmarks for water stress, the Falkenmark Water Stress Index (Falkenmark and Widstrand 1992) shows the broad differences across some Pacific islands in their available water resources (Figure 1). Whilst this approach is designed for basins, and not necessarily reflective of groundwater resources or the strong reliance of Pacific islands on rainwater harvesting, it provides a coarse comparison point. A further caveat on interpretation of Figure 1 is that whilst water governance decisions are often made at a national or provincial level, water resource management is almost always restricted to an island level – i.e. inter-island transfers are generally not an option (with the exception of islets within an atoll).

A core aspect of an analysis maximising the value obtained from use of limited water resources is defining the impacts on social, economic and environmental values. The values a broad and often are not direct outcomes, but rather secondary responses; for example, reducing water demand on a system may alleviate the need for increased infrastructure, enabling the capital investment instead to be channelled into supplying additional homes.

Table 1 presents an indication of the linkages in the social, economic and ecosystem values that may be enhanced through WUE, and would need to be considered as part of an assessment of WUE initiatives.

The approaches and strategies for optimising water use efficiency are responding to many common drivers across the Pacific (including economic development, increasing population, increasing urbanisation and climate change). However the disparities in water resources from island to island and country to country mean that the environmental hydrological regimes and the resulting water resource stresses differ significantly.

Table 1 Impacts on values that can be achieved through water efficiency strategies

	Community	Catchment / Island	Country
Social	Increased availability of water at a household and community level Access to improved water sources for a larger part of the community, particularly the more vulnerable individuals Sustainable improved sanitation available in new areas Increased reliability of supply reduces hygiene risks and improves health	Greater flexibility in water availability and transfers Increased potential to supply water for improved water sources Balancing storages to increase efficiency can reduce flood impacts Maintaining positive pressure reduces pollution and associated health impacts Increased community resilience associated with healthier coastal fisheries	Greater ca
Economic	Cost savings through reduced water bills Increased reliability of supply reduces cash crop failure, increasing confidence and investment	Allocation of water to higher productivity increases the catchment economy Increased reliability of supply increases investor confidence Reduced leakage reduces associated infrastructure damage Reduced coastal pollution associated with strategies to reduce wastewater generation (such as composting toilets) improve coastal fishery catch	
Ecosystem	Reduction in local pollution through composting toilets Improved freshwater ecosystem services due to increased environmental flow	Capacity increased to maintain migratory species Estuarine and river fish and ecosystems maintained through flow regimes Strategies such as composting toilets dramatically reduce impacts on groundwater systems and lagoons	

The overwhelming majority of Pacific Islanders (81%) are not on centralised water supply systems (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2010), and even fewer are on centralised sanitation systems, which are generally restricted to major urban areas. This is despite several atoll islands having extremely high population densities; approximately 2,900 people.km^{-2} on Majuro and 3,200 people.km^{-2} on Funafuti, about half that of Hong Kong and Singapore, without any of the water supply or sanitation infrastructure.

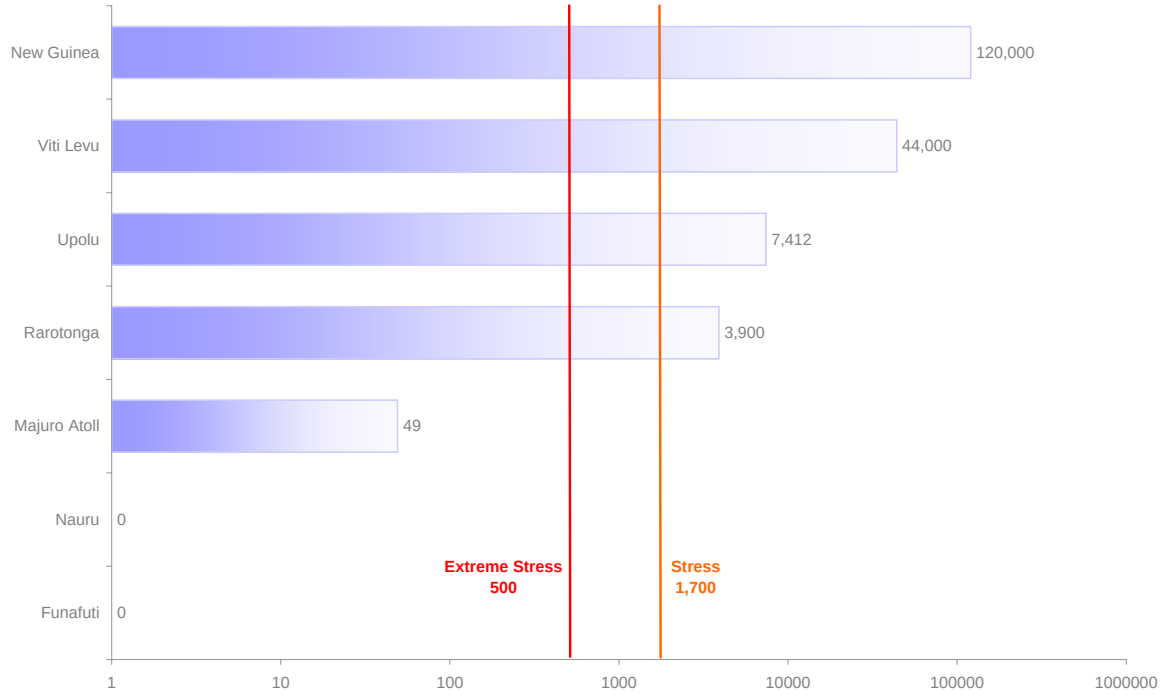

Figure 1 Available Water Resources on selected Pacific islands $m^3.capita^{-1}.year^{-1}$ compared with Falkenmark thresholds

2.3 Water Use Efficiency strategies

Globally there are a range of WUE strategies, often restricted only by engineering imagination and the resources to implement. Addendum 1 contains a range of strategies from UNEP (Correlje et al. 2008) and their relevance to different developing country contexts (centralised to decentralised). Broadly, the WUE approaches can be categorised as technological, capacity building or governance and institutional:

- Technological solutions: includes constructed technologies from the simple (such as rainwater tanks) to the complex (treatment and reuse of sewage) and strategic (such as optimising pumping or river off-take regimes)
- Capacity building: from awareness raising and community engagement, a critical component of improving decentralised systems, through to increasing national skills to manage complex water and sanitation management systems
- Institutional and governance: incorporating an IWRM approach to water resource management, including mainstreaming

Many approaches will be multi-faceted, such as rainwater collection management in atolls, requiring: household level design of guttering and tanks; awareness raising to assist householders to maintain the tanks and the water quality; technological solutions at the island/national level to understand the rates of water use and rainfall and provide advice accordingly; a national policy framework and strategy that links household and communal water management and governance that can make informed decisions at appropriate levels.

The specific nature of the challenges to Pacific island water resources however means that selection of appropriate technologies and strategies will often be required at a local scale. The next section considers the key challenges in each of the Pacific countries in terms of WUE and the broad needs to address these.

3. WATER USE EFFICIENCY IN THE PACIFIC

3.1 Analysis of countries

Figure 2 presents the estimated and reported water use[1] for each of the Pacific countries.

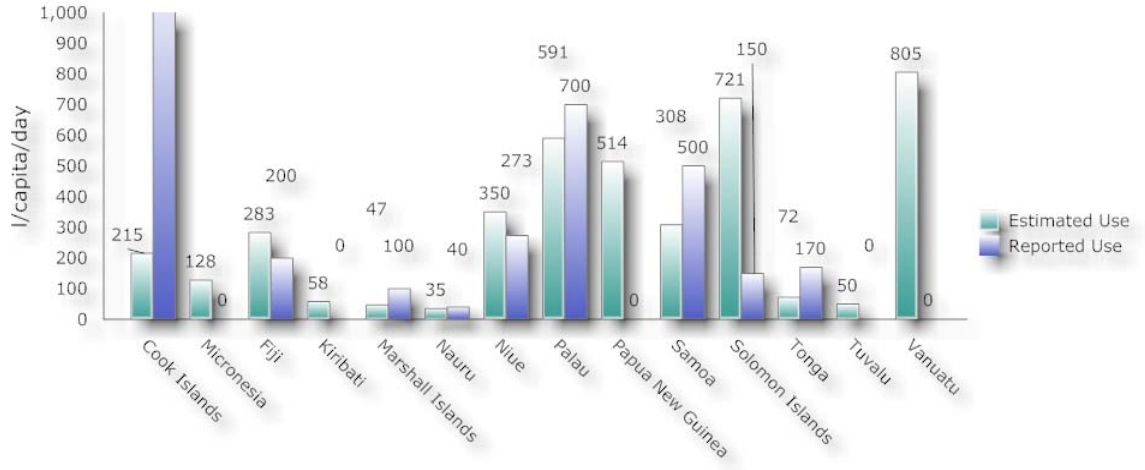

Figure 2 Estimated and reported water use in Pacific Island countries (Overmars 2009)
nb. zeroes indicate that reported figures not available. Note also that Papua New Guinea figures relate to mains supply connections

Estimated and reported domestic use can vary significantly for various reasons. In the Cook Islands, reported domestic use (1,200 l/capita/day) includes a significant component of irrigation water, which is supplied together with domestic supplies free of charge. Estimated use in Palau, Solomon Islands and Vanuatu are particularly high by global standards, exceeding all reported national water use rates (Watkins et al. 2006); however there is significant uncertainty around these figures (note discrepancy between estimated and reported use in Solomon Islands). It is hoped that the Outlook processes[2] in these countries will provide reliable data on use.

The Pacific island countries could therefore be divided into three broad categories in terms of water use:

- Countries with abundant resources that appear to have minimal constraints on water use (Cook Islands, Niue, Palau, Papua New Guinea, Solomon Islands and Vanuatu), where use appears restricted by capacity to deliver at a local, catchment or inter-catchment scale, rather than any demand constraints or restraint. Cook Islands is included on the grounds of irrigation using household mains supply.
- Countries with abundant water resources and moderate water use (Fiji, Micronesia and Tonga). Notably, these countries have some cost recovery mechanisms; however, Fiji is also somewhat constrained by infrastructure limitations and Tongans make wide use of rainwater harvesting at a household level[3]
- Countries with very limited resources that are using rainwater harvesting and/or limited groundwater supplies to provide marginal levels of water supply (Kiribati, Marshall Islands, Nauru and Tuvalu). Notably all these countries suffer frequent periods of drought and severe water restrictions

Not surprisingly in this context, the WUE challenges facing countries differ significantly. Countries with very limited water are investing heavily in alternative water sources including reverse osmosis, costing over $20/kl in Nauru. Table 2 presents the broad WUE challenges facing each of the Pacific countries and options for addressing these challenges.

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[1] The reported values have been extracted from official national reports (such as NSDS, UNCCD, etc). The estimated values are derived from SOPAC or other organizational studies

[2] National and regional Outlook reports are being developed as part fo the review of the Regional Action Plan (see RSC paper SOPAC/GEF/IWRM/RSC.3/13

[3] Although the use of only small sections of most roofs mean that there is significant capacity for expansion of this resource at minimal cost

Table 2 Water Use Efficiency Challenges in Pacific Island Countries

Country	Piped Supply[1]	Central Sanitation	WUE Challenges[7]	Cost Recovery	Example Options
Cook Islands	95%	No[4]	System leakage High household use Demand beyond supply Agricultural use of mains Low value of water Disparate wastewater responsibilities	No	Options for cost recovery aligned to use reduction Household management plans Demand Management Groundwater-sourced irrigation Leak detection and repair Supply mains upgrade Household water audits
FSM	N/A	4 major urban areas	Lack of integration in water management Pollution limits alternative sources Technical capacity gaps Salinisation of groundwater Need education and awareness raising	Yes[5]	Development of State level water management bodies Groundwater management plan to manage extractions Targeted education and awareness campaigns Building capacity Household water audits
Fiji	19%	Major urban areas	System losses estimated at 55%[6] Nadi supply beyond system capacity Lack of full cost recovery on water supply Minimal development of rainwater capacity Moderately high domestic use	Partial	Policy options for balancing commercial and domestic demands Moving to full cost recovery of supply Review of rainwater harvesting options[8] Awareness and education on WUE Household water audits
Marshall Islands	1%	Partial in Majuro – untreated ocean outfall	Pollution of main groundwater source Limited water resources Losses from limited surface water storage Supply system failure rate is high Capacity for increased rainwater harvesting Leakage from reticulated system	Partial	IWRM project address pollution impacts including exploration of alternative sanitation options Exploration of alternative sources Optimisation of rainwater harvesting Exploration of storage options to increase supply security Leak reduction programme Explore alternative sanitation options Household water audits

Country	Piped Supply[1]	Central Sanitation	WUE Challenges[7]	Cost Recovery	Example Options
Nauru	0%[2]	No	Extremely limited groundwater resources Dependent upon reverse osmosis (RO) desalination plant Pollution of groundwater resources High proportion of household water use on toilets Limited storage capacity Rainwater harvesting capacity underused	Limited	Optimise groundwater / RO / saltwater systems to suit preferred use Explore alternative sanitation options Review of rainwater harvesting options at household and national level Review of water infrastructure to optimise production / storage and supply Household water audits
Niue	80%	No	Extremely high household water use No cost recovery Significant system leakage Significant household water losses	No	Targeted education and awareness campaigns Installation of meters Options for cost recovery Complete system loss management plan actions Household water audits
Palau	N/A	Koror	Extremely high household water use Limited cost recovery Significant system leakage	Partial	Targeted education and awareness campaigns Review options for cost recovery System loss management plan and leak detection and repair Household water audits
Papua New Guinea	10%	Major urban areas	Extremely high household water use Limited cost recovery Significant system leakage (over 30%) Limited national technical capacity to support WUE Droughts can cause severe restrictions on Port Moresby	Yes	Options for large-scale inter-catchment transfers to be considered Expand cost-recovery options System Loss Management Plan Building national capacity in targeted areas Household water audits

Country	Piped Supply[1]	Central Sanitation	WUE Challenges[7]	Cost Recovery	Example Options
Samoa	57%	Apia	Significant supply system losses (over 40%) High household water demands Demographic changes altering demand patterns Limited storage challenges capacity to balance demands Intakes are not ideally situated to optimise yields Salinisation of groundwater due to over-extraction	Yes	Expansion of water demand management programme System loss management plan Explore conjunctive use with groundwater resources Optimise intakes Optimise balancing storage Groundwater management plan and policy Options for cost recovery aligned to water saving Targeted education and awareness campaigns Household water audits
Solomon Islands	13%	30% of Honiara	Unreliable water supply linked to power supply Water pump stations not optimised Limited water sources System losses high (estimated 40%) Several systems reaching the limit of capacity	Yes	System loss management plan Optimise intakes Options for cost recovery aligned to water saving Targeted education and awareness campaigns Household water audits
Tonga	75%	No	Limited use of rainwater harvesting System losses high (estimated 40%) Several systems reaching the limit of capacity Groundwater salinisation occurring due to overpumping Groundwater pollution threatens groundwater-sourced supplies	Yes	Optimise conjunctive use of rainwater harvesting and mains supplied groundwater Groundwater modelling and management planning Targeted education and awareness campaigns Exploration of alternative sanitation options to mitigate groundwater pollution Household water audits
Tuvalu	0%[3]	No	Extremely limited/ no groundwater resources Dependent upon rainwater harvesting augmented by RO desalination plant High proportion of household water use on toilets Limited storage capacity Poor understanding of island level storage including balance of private and public storage	No	Targeted education and awareness campaigns Explore alternative sanitation options (composting toilets) Exploration of alternative harvesting and storage options National drought strategy / policy Public / private water management agreements Rainwater storage model and management plan Household water audits

Country	Piped Supply[1]	Central Sanitation	WUE Challenges[7]	Cost Recovery	Example Options
Vanuatu	44%	No	Significant supply system losses (about 30%) High household water demands Uncertainty in the groundwater resource sustainable yield Limited storage challenges capacity to balance demands Water shortages severe in rural and peri-urban areas during droughts due to lack of alternative supply	Yes	Expansion of water demand management programme System loss management plan National drought strategy policy Optimise balancing storage Options for cost recovery aligned to water saving Targeted education and awareness campaigns Household water audits

Notes: 1. (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2010); 2. Author's experience; 3. WHO/UNICEF 2010 states 97%; 4. Small sewered area by airport; 5. Linked with power fees and subsidies; 6. (Overmars 2009); 7 Derived largely from national Diagnostic Reports; 8. It is likely that rainwater harvesting will not be cost-beneficial in settings where piped water can be accessed

Due to the very different economic, social and environmental context at the community, catchment and island level within each country, a "one size fits all" approach will not be appropriate for both outer islands and larger islands. For example the value to the community of additional water on water-stressed atolls mean that significant resources may be spent that would not be justified in a straight financial assessment. The options presented in Table 2 need to be assessed against the complex links between social, economic and environmental values associated with WUE strategies. In Tuvalu, the uptake of composting toilets will not only reduce household water stress, but should dramatically reduce the pollution to the lagoon, in turn aiding the lagoon ecosystem recovery and improving near shore fishing catch and lagoon food production. The suggested public/private water management agreements provide significant scope for capacity building and a potential entry point for more direct community engagement for cooperative management of other limited resources such as food and energy.

An analysis of the above issues and options identifies two consistent strategies across most countries: targeted awareness campaigns and household water audits. The two are obviously closely linked to changing community practices. Every country with distributed supplies identified the need to manage system losses through plans and on-ground works and there was also a strong correlation of developing options for cost-recovery with a focus on demand reduction.

Beyond these general directions, WUE pressures and options were generally divided between smaller atoll and raised limestone islands with limited supplies, and larger islands with more available water:

- Atolls and limestone islands generally were driven by significant use of available resources on toilets, groundwater resource pollution, limited water resources and limited storage capacity, yet commonly needed a better understanding of the status of current resources Options to improve WUE in these countries included optimising rainwater harvesting and alternative sources, exploring alternative sanitation options such as composting toilets to reduce water use and groundwater resource pollution, optimising storage and better management approaches to collective public and private rainwater storage
- Islands with more available water were generally driven by opportunities to reduce further capital investment in systems under stress. In addition to loss reduction strategies, strategies considered included exploring and optimising conjunctive groundwater use, developing demand management strategies, better management of infrastructure (particularly storages) and national capacity development.

4. PRIORITISING INVESTMENT

In many of the Pacific island countries, delivering basic human rights in access to improved water supplies and improved sanitation remain a priority in water investment. Access to both is only marginally above 50% across the region (WHO/UNICEF Joint Monitoring Programme for Water Supply and Sanitation 2010), and so will remain a national priority for many countries for both internal and donor investment, particularly as 2015 approaches.

Within this context, it is necessary for water use efficiency initiatives to deliver tangible returns. Whilst the World Bank has suggested that cost recovery is difficult to achieve (or at least demonstrate) on WUE development projects, it is important to recognise the benefits of WUE that extend beyond direct water supply costs. These include reduced infrastructure damage from burst pipes and slow leaks, ecosystem benefits from reduced abstractions and social benefits of maintaining supply.

Efficiency measures need to be considered carefully within the Pacific context. Whilst loss levels are high in many distribution systems, the marginal costs of delivering additional water to cover these losses may not be offset by the high costs of system maintenance and repair. Beyond simple cost-benefit analyses of leak reduction, such as that undertaken for Niue (Overmars 2009), little work has been done to assess the value of many of the WUE strategies in the Pacific region. Given the extreme water shortages of some islands and the abundant water resources of others, an analysis of WUE approaches in these settings incorporating economic, social and environmental sustainability considerations would help countries prioritise options for incorporating into water resource management strategies and national mainstreaming.

An analysis of WUE approaches to enable the social, economic and environmental context to be considered within the Pacific context. Undertaking pilot studies for atoll and large island urban and rural environments would provide an important first step towards mainstreaming water efficiency strategies. However, the varied nature of the social, environmental and economic context of each country means that, in order to make recommendations about local, catchment and national scale approaches, there is a need for country level assessments. This work is required before targeted national strategies can be developed. Whilst many of the GEF Pacific IWRM country demonstration projects address key water efficiency issues

5. WUE AS PART OF IWRM

Integrated water resource management (IWRM) is defined (Global Water Partnership Technical Advisory Committee 2000) as:

"IWRM is a process which promotes the co-ordinated 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".

The Global Water Partnership identified that "*improving efficiency in the use of water and related resources (including financial resources) is another way to maximize the economic and social welfare derived from water as a scarce resource, and is an integral part of an IWRM approach*" (Global Water Partnership Technical Committee 2004), highlighting WUE as a component of IWRM delivery.

Within the GEF Pacific IWRM project, WUE has been incorporated directly as part of the delivery of IWRM. This in part reflects the integration of WUE principles within the projects, with demonstration of system loss reduction in Tonga, Samoa and Niue; household audits in Tonga and Tuvalu; composting toilets in Tuvalu, Nauru, Tonga and RMI; rainwater harvesting and drought management strategies in Tuvalu; demand management strategies in Samoa and Solomon Islands and conjunctive groundwater use being explored in Cook Islands and modelled in Tonga.

This above conceptual statement and examples of practical implementation would suggest that, rather than developing separate IWRM and WUE strategies and approaches, mainstreaming IWRM into countries, with an emphasis on appropriate WUE strategies may be an effective delivery mechanism for WUE.

6. SUGGESTED APPROACH

The key discussion points through this paper suggest that:

- There are differences between the WUE approaches required in atoll and low-lying islands with limited water resources and larger islands with more abundant resources
- Countries are incorporating relevant WUE approaches within their demonstration projects, including some cost-benefit analyses
- There is a potential knowledge gap in the assessment of the value of various WUE measures within the Pacific context
- WUE approaches are encapsulated within an IWRM approach, and mainstreaming of WUE can be effectively achieved through mainstreaming IWRM, with an emphasis on appropriate WUE strategies

It is suggested that, in order to address the knowledge gap of the value of WUE measures in the Pacific context, that a targeted cost-benefit analysis study be undertaken to develop an assessment tool to guide WUE investment decisions. It is likely that similar but different tools would be developed for countries with very limited water resources and for larger islands and countries without severe resource constraints. The tool(s) would need to consider WUE approaches for both centralised and decentralised systems.

The timing of the RAP review and associated reviews of national strategies present opportunities to facilitate the mainstreaming of IWRM and appropriate WUE strategies. Currently, many countries are developing national IWRM strategies, embedding appropriate WUE strategies. It is anticipated that most other countries will do so as part of the RAP review process. It is therefore suggested that the cost-benefit analyses be undertaken as soon as practically possible to inform the development of national strategies.

Further work is required to identify appropriate WUE strategies within each country. The analyses will be the first steps in this process; however, there is a need to assess options for improving water efficiency within the unique social, economic and environmental context of each country. This work is required before targeted national strategies can be developed

It is suggested that the RTAG recommend to the RSC that:

- ***Recognise that applicable WUE principles will be incorporated into national IWRM planning strategies rather than as specific separate strategies***
- ***Recognise that WUE strategies need to be developed in the context of improving social, economic and environmental values, which will differ at a local, catchment, island and national scale***
- ***An analysis of WUE approaches applicable to the Pacific be undertaken, considering different drivers and needs of atolls with limited water resources and larger islands with more abundant resources, as well as considering both options for WUE in urban centralised systems and at a household level***

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ADDENDUM 1: WUE APPLICATIONS AND POTENTIAL SCALES OF APPLICATION

Section of water cycle		EST	Technologically and institutionally embedding		
		Environmental Sound Technology	Public	Collective	Individual
		Technology, know how for & management of	centralized system	semi-decentralized system	decentralized system
Water storage & augmentation	keeping quantity & quality	Ponds and reservoirs	+++	++	+
		Artificial recharge of groundwater	+	+++	+++
		Water tanks	+	++	+++
		Rainwater harvesting - runoff in surface water	++	+++	++
		Rainwater harvesting - runoff in groundwater	+	++	+++
		Rainwater harvesting - runoff in tanks	____	++	+++
		Treated sewage - effluent in surface water	+++	++	+
		Treated sewage - effluent in groundwater	+++	+++	+++
Water supply & distribution	providing water efficiently & safe	Surface water abstraction	+++	++	+
		Groundwater abstraction	++	+++	++
		Water supply reservoirs	++	+++	++
		Transfer of water	++		
		Single pipeline system (one water quality)	+++	++	+
		Dual pipeline system (two water qualities)	+	+++	++
		Water containers (bottles and tanks)	____	++	+
		Centralized treatment systems	+++	+	
		Point of use treatment systems	____	++	+++
Water use & saving	using water efficiently	Waterless toilets (e.g. compost & dry)	____	++	+++
		Water-saving toilets	____	+++	+++
		Water-saving urinals	____	+++	+
		Waterless urinals	____	+++	+
		Water-saving taps	____	+++	+++
		Water-saving showerheads	____	+++	+++
		Pressure reducers	+++	+++	+
		Water-saving household appliances	____	+	+++
		Economised water use for personal hygiene	____	++	+++
		Economised water use for cleaning and watering	+++	++	+++
Water reuse, recycling & safe disposal	purifying water safely	Domestic rainwater use	+	+++	+++
		On-site treatment of grey water		+++	+++
		Constructed wetlands	+	+++	+++
		On-site and near-site treatment of black water and mixed sewage	____	+++	+++
		Separating rainwater from sewer systems	____	++	+++
		Environmentally sound centralized sewage treatment in developing countries for reuse	+++	+	
legend					
Level technologically and institutionally embedding			low	medium	high
Active operation and maintenance			+	++	+++
Support and creating conditions (legal, financial, skills)			_	__	____