TUVALU INTERNATIONAL WATERS RIDGE TO REEF PROJECT

RESULTS AND LESSONS LEARNED REPORT

Contents

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INTRODUCTION

The Global Environment Facility (GEF) Pacific Ridge to Reef (R2R) Programme is a global test case aimed at achieving the sustainable development of Pacific Small Island Developing States (Pacific SIDS) within a truly integrated environmental and natural resource management framework.

The goal of the GEF Pacific R2R programme is "to maintain and enhance Pacific Island countries' ecosystem goods and services (provisioning, regulating, supporting and cultural) through integrated approaches to land, water, forest, biodiversity and coastal resource management that contribute to poverty reduction, sustainable livelihoods and climate resilience."

The programme supports and addresses national priorities and development needs of 14 Pacific Island countries while delivering global environmental benefits by focusing on a more crosscutting and integrated approach to water, land and coastal management. It is a GEF multi-focal area, multi-GEF agency and multi-country initiative that guides the coordinated investment of GEF grant funding across its focal areas of biodiversity conservation, land degradation, climate change adaptation and mitigation, sustainable land, sustainable forest management, and international waters in Pacific SIDS. Countries are allocated funding for this programme under GEF's System for Transparent Allocation of Resources (STAR).

The Pacific Regional International Waters Ridge to Reef (IW R2R) project – Testing the Integration of Water, Land, Forest & Coastal Management to Preserve Ecosystem Services, Store Carbon, Improve Climate Resilience and Sustain Livelihoods in the Pacific (IW R2R) is a component of the GEF Pacific R2R programme and is regionally executed by the Pacific Community (SPC) in 14 Pacific Island countries.

The over-arching objective of the IW R2R project is to test the mainstreaming of ridge to reef, climate resilient approaches to integrated land, water, forest, and coastal management in the PICs through strategic planning, capacity building and piloted local actions to sustain livelihoods and preserve ecosystem services.

The Regional Programme Coordination Unit (RPCU), implemented by the Pacific Community's Geoscience, Energy and Maritime Division in the Fiji Islands, is tasked with the provision of technical, operational, reporting and monitoring support as requested by the participating Pacific Island Countries.

The Tuvalu IW R2R project commenced in May 2016 and followed on and built on the GEF-funded Integrated Water Resources Management (IWRM) Project that had run from 2009 to 2015.

The Tuvalu IW R2R project aimed to meet its objectives through the following inputs: (i) building a demonstration site for testing the dry litter composting system for pig waste in Funafuti by conversion of 10 per cent of near shore wash-down pig pens to dry-litter composting systems; (ii) implementing targeted scientific approaches to optimise on-site waste management systems and to identify causal links between land-based contaminants and the degradation of coastal waters; and (iii) building and improving national and local capacity for waste management implementation to enable best practice in coastal waters, land and public health protection in Tuvalu. The results of the demonstration help establish baseline data consistent with Step 1 of the R2R science to policy framework, which is important for monitoring the impact of R2R investments focusing on DLT.

The project was led by the Government of Tuvalu through the Ministry of Local Government and Agriculture.

The Tuvalu project was expected to conclude in September 2020, however this was deferred to allow completion and approvals of project closure documentation.

This publication showcases some of the most significant changes through project highlights and lessons over the four-year term of project implementation. It also discusses the adaptive management processes that were necessitated during the project and highlights the practicalities of implementing projects with limited human resources in country. The lessons learned will potentially guide the planning, development, and implementation of future programmatic approaches to ridge to reef management.

Tuvalu

TUVALU – RIDGE TO REEF IN CONTEXT

Tuvalu comprises three reef islands and six true atolls covering an exclusive economic zone (EEZ) of 900,000 km2. The total land area of Tuvalu is 26 km2. It has a population of 10,645 people (5486 males and 5159 females) counted at a mini census conducted on 12 November 2017 (Central Statistics Division 2017). Over half the population (6149) is aged between 15 years and 59 years. The capital island of Funafuti has a land area of 240 hectares (2.4 km^2) and is densely populated, housing over 60 per cent (6387 people) of the population. The island is long and narrow with the width varying between 20 m and 400 m wide and encircles a large lagoon 18 km long and 14 km wide. Farming and fishing are the primary economic activities.

With increasing urbanisation from neighbouring atolls and development, Funafuti faces several environmental challenges ultimately impacting on human health and on the coral lagoon. Environmental concerns include water supply shortage as there is no surface or potable groundwater, wastewater pollution (of the lagoon), beachhead erosion, damage to coral reef, spreading algal blooms, contaminated land, and the effects of climate change as rising sea levels.

Studies of Funafuti groundwater indicate that the groundwater and near shore coastal waters and sediments are heavily polluted with nutrients associated with human and animal wastes, thereby contributing to proliferation of algae and incidence of ‘fish kill’ in the lagoon.

Significant loss of near shore habitat and reductions in fish numbers are forcing fisherfolk to fish further into the western end lagoon and outside the breakers away from areas adjacent to main settlements for similar catches.

Natural disasters that can contribute to the vulnerability of Tuvalu include cyclones and drought, both of which could be exacerbated by climate variability and change, and sea-level rise. Climate models are not yet able to state with any certainty what changes in variability and extremes may occur.

The Tuvalu IW R2R project built on lessons learned and experiences from past projects, including the GEF Pacific Integrated Water Resource Management (IWRM) Project, which had focused on a cross-sectoral planning and management approach to addressing Tuvalu's water resource issues as impacted by climate change and growing population. The need was identified to address the deteriorating water quality of Funafuti lagoon through an integrated "ridge to reef" approach that would consider several inter-related factors and bring together all key players and sectors.

Under the IW R2R project, Tuvalu identified approaches that would focus on reducing the pressures on the lagoon and surrounding environment through land-based measures under three components.

Component 1: Demonstration of innovative approaches to pig waste management on Funafuti atoll.

Under this component, the project aimed to reduce nutrient runoff into the lagoon from pig waste through the application of dry litter composting technology (from the traditional wash-down method) in nearshore pig pens. This included identifying appropriate methods of measuring nutrient and pathogen loads from pig effluent, improving community awareness and "buy-in" as well as building capacity for effectively using the dry litter composting technology.

Component 2: Targeted scientific approaches to optimise on-site waste management systems and to identify causal links between land-based contaminants and the degradation of coastal waters

The project aimed to use science-based approaches to establish the evidence required to improve and optimise the design and scaling up of eco-sanitation for human waste management; and dry litter composting systems for piggeries, to meet international standards for water safety and use of human compost and animal compost respectively, in Tuvalu. It further aimed to characterise the ecological health of the coastal waters of Funafuti Atoll and establish the land-based contamination processes towards planning and investment for integrated coastal management (ICM).

Component 3: National and local capacity for waste management implementation built to enable best practice in coastal waters, land, and public health protection.

Under this component, the project aimed to enhance a culture of environmental protection in Tuvalu, increase householder uptake of and donor support for onsite sanitation systems and to increase public awareness through enhanced access to effective information relating to on-site waste management issues and linkages with environmental and public health.

Due to a change in funding support from government for eco-sanitation (compost) toilets, the work under components 2 and 3 was revised to focus on dry litter compost for piggeries instead of human waste management.

The subsequent sections highlight the approaches taken, project results and lessons learned.

COMMUNITY TO CABINET APPROACH

The community to cabinet approach underpinned the success of the previous IWRM project, which identified the need for engagement and involvement of communities, especially landowners and community leaders, in the development and uptake of national policy. It is well-recognised that the participation of civil society organisations and community leaders in development planning is essential to increase the local relevance of management actions and secure sustainable results. The following outlines existing cross sectoral coordination arrangements and efforts to engage stakeholders in the Tuvalu IW R2R project.

Cross-sectoral Coordination and Planning

By its nature, the ridge to reef approach requires cross-sectoral coordination and planning. Different government agencies and regulatory bodies will have jurisdiction over different areas, and they will need to identify ways of working together. The GEF funded Pacific Ridge to Reef programme in Tuvalu was through the STAR R2R and the IW R2R project. The STAR R2R focused on a national level multi-focal area approach such as biodiversity conservation, land-use, and climate adaptation while the IW R2R focused on wastewater management to reduce pollution in the lagoon.

Originally, both the STAR and the IW R2R were housed under the Department of Environment as the lead agency, but with different project managers. However, soon after commencement of the IW R2R project, on the recommendation of the Regional Programme Coordination Unit (RPCU) and the Director of Waste, Cabinet approval was granted to transfer the project to the Department of Waste Management under the Ministry of Home Affairs and Rural Development (now the Ministry of Local Government and Agriculture). The primary reason for the transfer was because the Department of Waste Management (previously the Solid Waste Agency of Tuvalu or SWAT) has overall responsibility for waste management and would be able to coordinate the supply of shredded green waste required for the Dry Litter Compost process.

The Department of Waste Management was established under the Waste Operations and Services Act 2009 and is the only governmental agency that is fully responsible for all waste management activities and programmes in Tuvalu, including Funafuti and all outer islands. Thus, it has full responsibility for collection of all solid and partly liquid wastes on the islands. Its work is outlined in the Tuvalu Integrated Waste Policy and Action Plan 2017 – 2026. This policy and action plan also outlines the need for cross-sectoral coordination and notes the necessary involvement of other agencies including: the Ministry of Health, the Department of Environment, Marine Department and the Kaupule.

The IW R2R demonstration project was governed and guided by the National Project Steering Committee (NPSC). The makeup and principles of the NPSC follow those of the previous National Water and Sanitation Steering Committee, which oversaw the IWRM project. As with the previous committee, the NPSC has a wide membership including government and non-government actors, the Kaupule (Island Council) and representatives of women's groups (see Table 1). The NPSC met regularly to review and monitor progress of the IW R2R. In addition to ensuring shared understanding and vision for the IW R2R project, the NPSC also focused on knowledge exchanges and sharing of experiences in integrated water resource and coastal management. It also aimed to develop a shared vision of the broader opportunities and benefits emerging from the project implementation and outreach.

A challenge for the establishment of the project governance structure was the requirement under the memorandum of agreement with SPC for a joint steering committee for the STAR and IW ridge to reef projects. This was not considered feasible for the STAR R2R project, which indicated that it had a wider group of stakeholders (including beyond Funafuti), and it was considered that the joint steering committee would hinder the progress of both projects. Furthermore, the two projects were not harmonised in terms of timing and the site selection. The two projects thus worked in parallel, complementing each other, but with their own separate steering committees.

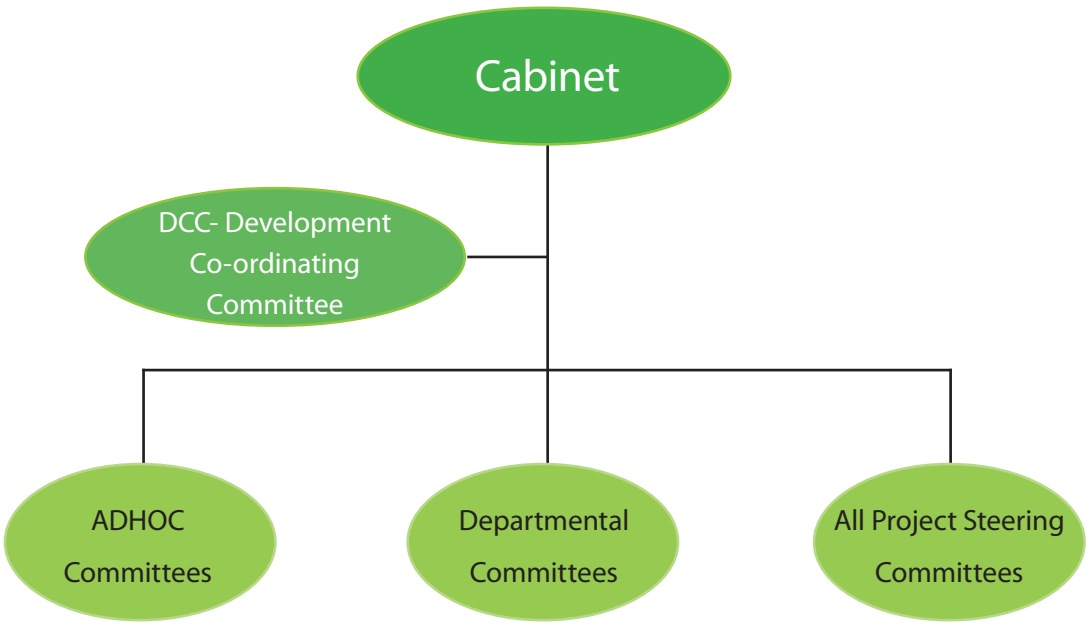

Figure 1: Project governance structure. The multi-stakeholder National Project Steering Committee for IW R2R reports through DCC to Cabinet

Table 1: Details of key stakeholders and members of National Project Steering Committee

Stakeholders	Synergies	Collaboration
Dept. of Fisheries	Lagoon Water Monitoring Collaborating with STAR objectives	Staff training, monitoring programme Can work together with STAR on common objectives Members of National Project Steering Committee
Dept. of Agriculture	Pig waste Provide advice on pig waste, composting, avenues for use	Collaborating with STAR Project objectives Collaborate on any compost/gardening trainings Can work together with STAR on common objectives Member of inter-ministerial committee Member of National Project Steering Committee
Dept. of Lands	Pig waste management	Collaborating with STAR Project objectives Support with mapping current piggery locations Relating this to land management planning Member of inter-ministerial committee Member of National Project Steering Committee
Dept. Environment	Expertise in the aspects of Environment	Member of National Project Steering Committee Political Focal Point of the IW Dept
Public (Environmental) Health	Provide all related matters on heath aspects	Member of National Project Steering Committee
Kaupule	Falevatie Pig waste management	Support monitoring and community consultation Support community engagement for piggeries Member of National Project Steering Committee

Stakeholders	Synergies	Collaboration
Dept. of Waste Management	Pig waste management Provide mulch for pilot pig pens free of charge – with MoA	Collaborate on waste management training/workshops Chairman National Project Steering Committee
National Council of Women	Community engagement activities Provide an entry point for gender mainstreaming in all activities 11	Member of National Project Steering Committee
Women Department	Gender Department	Collaboration on matters with women. Government support on Gender issues Member of National Project Steering Committee
Public Works Dept	Falavatie Pig waste management Monitoring and redesign Provide technical assistance for the construction/modification of piggeries Would need an MoA	Member of National Project Steering Committee
TANGO	Identifying finance options for waste management Waste management options Work with GEF Small Grants Programme	Collaborate on community engagement activities Member of National Project Steering Committee
TNPSO	Engage with Private Sector Collaborate on engagement with public and private	Member of National Project Steering Committee
STAR R2R	Water Monitoring and share all synergies activities in line with IW. Collaborate on engagement with public and private	Member of National Project Steering Committee From the inception workshop of the Tuvalu IW on 7th December 2016 the engagement has these Objectives.

Linking Local and National Coordination

Two key processes have provided the foundation for progressing the IW R2R work and enabling coherence and partnership throughout the various phases of the project.

Funafuti is the capital of Tuvalu and therefore there are mixed settlements of indigenous people of the island and others who reside in the capital for work, to visit hospitals and families and other business. The land is relatively small and therefore the governance structures governing the local population may be clearly articulated on policies, plans and regulations. However, for someone not familiar with these arrangements, it can be difficult to understand, particularly in terms of linking local and national coordination.

All projects in the country must follow the existing arrangements and structures as set out in Figure 1. Representatives from relevant agencies and groups are selected and co-opted to ad-hoc committees as may be required. The IWRM and R2R Committees fall under this categorisation of ad-hoc committees. The gravity of decision-making rests with the DCC, which is a body of all Permanent Secretaries and the Attorney General of the Government. All operational matters are often sorted out the lower-level committees.

The people of Funafuti Island are the major stakeholders and beneficiaries in the undertaking and were represented through the Funafuti Island Council (Kaupule). The Kaupule is the executive body representing the island community and is responsible for developing and implementing the Funafuti Community Island Strategic Plan (ISP). The ISP is an approved island community development document that provides an overarching framework for Funafuti communities. The Kaupule may make by-laws under the Falekaupule Act 1997 in relation to any matter and perform the function, including waste management.

At the national level, Te Kaakega III (the Tuvalu National Strategy for Sustainable Development 2016 to 2020), provides the vision and strategic framework for Tuvalu's overall development aspirations.

The IW R2R project ensured that community leaders were members of the project committee, thus ensuring increased community engagement in governance.

The importance of these strategic processes was underscored during the decision-making to upscale the dry litter compost approach (discussed below) using a municipal level approach (encouraging a communal approach to pig husbandry) that would enable waste to be managed and compost collected at one site. The communal piggery was agreed at community level and incorporated into the ISP of Funafuti community (indigenous people of the island), which aligns with the national goals of TKIII relating to food security and improved waste management.

Stakeholder Engagement

The Tuvalu IW R2R project aimed to generate local and national support for integrated R2R approaches and enable learning exchange between and among community leaders, as well as with project stakeholders of the national GEF System for Transparent Allocation of Resources (STAR) projects planned under the broader Ridge to Reef programme. It also aimed to develop local experience in linking integrated water resource management (IWRM) to coastal area management; and stimulate cross-sectoral participation in the planning of coordinated investments in land, forest, water, and coastal management in the participating countries.

Given the breadth of stakeholders and sectors involved, the preparation phase of the Tuvalu IW R2R project was based on an extensive consultative process involving national government agencies, community representatives (indigenous and others) and civil society organisations, including the National Women's Council, to ensure that their perspectives and stakeholder inputs elicited during the preparation phase were incorporated in the results framework for the pilot project.

With the commencement of the project, further meetings were organised with stakeholders to create a common understanding of and support for the project vision, goals, objectives, and implementation plans. As the project progressed, face to face meetings, presentations, and printed publications were used to continue to engage and inform community stakeholders. However, it was also observed that interest from stakeholder groups waned as the project progressed, including attendance at the NPSC meetings. While no studies were conducted to assess the reasons for this, it is theorised that the drop in interest may have been due to:

(i) No immediate tangible benefits evident at the individual level. The ridge to reef approach promises tangible benefits but these may take some years to come to fruition. This is likely to cause impatience and disinterest after some time, particularly for those who are only in for quick fix and not engaged in a hands-on manner with the project.

(ii) Demonstration projects don't necessarily attract attention because the products are not being tested; rather it is the process that is being tested. In the case of Tuvalu, the demonstration projects budget could not provide materials for the construction of DLT units for every household and investment was needed from households.

(iv) Lack of stipends or sitting fees to those expected to attend meetings and consultations. While commitment was high early on, this eventually became a disincentive for attendance at meetings and activities.

(iv) "Competition" for space and recognition of the project. The IW R2R was a far smaller and significantly less well-resourced component of the GEF Pacific Ridge to Reef programme, whereby the better resourced and nationally focused STAR component did take priority and was able to draw greater interest from the community. Funafuti is small enough that the same individuals are often involved in several activities or initiatives, including meetings and consultations.
The IW project manager made efforts to address these issues by working closely where possible, with the R2R STAR project and maintaining regular communication and efforts. These challenges are ongoing.

PROJECT RESULTS

Process indicators

The GEF International Waters process indicators were developed to help characterise the completion of institutional processes on the multi-country or national level that will result in joint action of needed policy, legal and institutional reforms and investments that aim to reduce environmental stress. Traditionally, process indicators have been a measure of progress in project activities involving procurement and production of goods, physical structures, and services. Capacity and human resource development and stakeholder involvement have also been recognised as important to achieving sustainable project outcomes (GEF 1996). The complex nature of many GEF International Waters (IW) projects requires that additional process indicators are adopted to reflect the extent, quality, and eventual on-the-ground effectiveness of the inter-ministerial, and cross-sectoral efforts that are at the heart of the GEF IW approach.

Below are the most significant results for the Tuvalu IW R2R Project.

Building partnerships in implementing the Dry Litter Piggery Demonstration

Partnerships are imperative in any project, and this was also the case with the establishment of the IW R2R pilot project and the demonstration piggery. For the project to be effective, it needed the cooperation, advice and engagement of technical experts or skilled experienced staff in agriculture, pig husbandry and waste management. Partnerships were developed with the Department of Solid Waste Management, the Taiwanese Development Program, and the Department of Lands. This enabled land to be identified and secured for a dry litter piggery trial site and the design and construction of a demonstration dry litter technology (DLT) piggery in 2018. The Taiwanese Development Program provided significant technical advice during the process. The demonstration piggery provided stakeholders with a working example of the technology.

The dry litter technology (DLT) incorporates the use of dry litter (shredded leaves, coconut fronds, etc), sloping pen floors and requires no water for pen clean-up. The pig wastes are mixed into the dry litter and discharged out of the pens by the pigs. Through this process, odour is significantly reduced. The manure and leafy mix is then properly composted and can be used as fertiliser in gardens. Farmers interested in participating in the trial were advised they would be provided with much, shredded brown leaves or coconut fronds by the Waste Management Department. The availability and sustainability of shredded brown leaves in Tuvalu where land is limited and there are no forests, is an important limiting factor needing consideration.

Building acceptance through communication and awareness raising

By continually focusing on communication and engagement, the project actively engaged a large proportion of the Funafuti community through workshops, community, and school events and Kaupule meetings. These activities helped raise awareness of the links between land-based practices and the water quality of the lagoon. They were also used to share the "case" for a new approach to pig waste management.

During the concept design phase for the trial, farmers expressed interest in the proposed new technology, but many remained somewhat cynical, and no farmer was willing to participate in the trial. The establishment of the demonstration pig pen was key to the awareness raising and helped address several concerns and elicit support for the concept. It is noted that despite the shift in perceptions and attitude to the concept, there remained general unwillingness by Funafuti farmers to commit to converting their household pens to DLT.

With further assessment, it was decided to consider the idea of a communal piggery that would remove the need for farmers to invest in converting individual pens. This required community and political support. It is believed that the availability of compost for backyard gardening from this initiative served as the "turning point" in terms of public interest and, in gaining the support of the Funafuti Kaupule, which has identified food security as one of the goals of the island development plan. As part of its strategy to deal with the COVID-19 pandemic, Tuvalu is looking to engage with nature and reduce its reliance on imported products. The compost generated from a communal dry litter piggery will be invaluable for Funafuti. More critically, water is relatively scarce in the country, particularly during extensive periods of drought. Equally, conserving and ensuring underground water and the adjacent lagoon are not contaminated are key factors influencing farmers interests.

During the Saugavaka Piggery Project community consultation.

The value of the demonstration project

During the consultations, many people did not like the concept at first, as they [saw] it as very unattractive since people have to work with the pig waste…it is [also] totally opposite to the current wash down system. But, when they were given a chance to see the demonstration, they were able to see that the concept was not as they had thought.

Maryanne Vunisarati, Funafuti Island Strategic Plan (ISP) Manager

Upscaling efforts – towards a "communal" piggery

The concept for a municipal piggery area for community owners had been considered prior to the IW R2R project, with the idea of producing biogas to support Funafuti's energy requirements while addressing the pig waste management issue. The IW R2R project enabled the development of a proposal for the Saugavaka Piggery Project, which aims to re-locate pig pens from the current locations by the ocean side of the airstrip to one place further away from settlements using a communal management approach. The proposed piggery uses the results of the current project to scale up opportunity to invest in a commercial setup piggery project that adopts the dry litter technology and may also produce biogas. The proposal was approved by the Funafuti Council and has been incorporated into the Island Development Strategy and is articulated in Te Kaakega III (the Tuvalu National Strategy for Sustainable Development 2016 to 2020).

In the upscaling efforts of the Dry Litter Piggery a partner was established by the Funafuti Kaupule and the New Castle University Faculty of Engineering who showed interest in allocating a student to pursue a master's in engineering to do research on an organic waste

processing plant on Funafuti. The output has been shared and delivered. And the a success story is that the Tuvalu government cabinet has endorsed funding of the proposal and work is currently underway to implement this multi-million dollar commercial piggery project for the Funafuti Falekaupule (community).

It is important to note that while the demonstration did not quite deliver on its target and reduce nutrients discharge from land to the lagoon, the lessons based on awareness raising, design and construction, and practical demonstration of the DLT and using dried leaves, and use of manure for compost, is what matters. It is expected that ongoing monitoring of the lagoon coastal waters and underground waters or inland ponds will continue to ascertain if change in the nutrients discharge as influenced by investing in upscaled DLT piggery.

Monitoring the lagoon health and citizen engagement and science

A key aspect of the IW R2R project involved establishing the scientific basis for the project interventions. For Tuvalu, monitoring of the coastal waters was necessary for establishing baselines, confirming causal relationships between land-based pollution and health of the lagoon and eventually, identifying impact of the interventions.

A collaborative and coordinated approach to monitoring of Funafuti coastal waters was agreed with the R2R STAR officials and the Fisheries Coastal Department and with support from the University of the South Pacific. Under the IW R2R project, baseline data was collected on water quality from the IW R2R proposed DLT demonstration site as well as from the R2R STAR sites. The data obtained showed high levels of nutrients in the lagoon, particularly in areas with wash-down pig pens and poorly designed septic systems.

Knowledge transfer and capacity building on R2R

James Cook University Post-Graduate Course

Four national experts from Tuvalu were enrolled in the James Cook University Post Graduate Course in R2R Sustainable Development. Participation in the post graduate course helped to contextualise the science and theory of the IW R2R project. The IW R2R project manager found that the course helped him understand the link between the science (monitoring, baselines, etc) and the practical aspects of establishing demonstration sites and development of policy.

Figure 2: Feagaiga Penivao, one of the JCU course graduates' shares information with a school group

Knowledge Exchange with American Samoa Environmental Protection Agency

Tuvalu attended this knowledge exchange event, which brought national representatives from Tuvalu, Kiribati, FSM, and the Cook Islands to American Samoa for a one week learning exchange programme in October 2019. The programme objective was to expose participants to a long-term, operational and coordinated programme that is addressing pig waste management in a Pacific Island context. It provided participants an opportunity to see governance arrangements in action, understand how compliance mechanisms can work, how to build community buy-in, and experience world class water quality monitoring and the key role it plays in communicating effectiveness of a program and ensuring public health safety.

The exchange programme was considered useful for Tuvalu, particularly in terms of highlighting the need for ongoing communication and consultation to encourage community uptake. However, it was noted that there are significant differences between American Samoa and Tuvalu, not least the ready availability of green waste on larger islands.

Eco-sanitation toilets – lessons from pilot householder surveys

A planned activity of the project was to optimise the management of eco sanitation compost toilets, which had been designed and demonstrated under the previous IWRM project. However, a follow up survey conducted by the IW R2R project found that most households are not using the toilets. The reasons include the fact that leaves must be collected for litter, the women do not like using the toilets and the toilets are set away from the home. In some cases, the toilets are used during periods of drought (when flush toilets can't be used) but this was not common. The lack of uptake of these toilets has resulted in the government decision to not provide funding support for further development of these toilets. Further sociological research will be needed to develop a clearer understanding of individual needs, drivers, motivators, and barriers to uptake of such technology.

Stress Reduction

Stress reduction indicators relate to the specific on-the-ground measures implemented by the country. The Tuvalu IW R2R project stress reduction target aimed to reduce nutrient and pathogen loads from pig pen effluent discharging directly into the receiving environment through demonstration of dry-litter composting systems. The unit of measure is the total nitrogen (TN) reduction in kg per year (TN kg/yr). The initial and subsequently revised stress reduction targets for Tuvalu IW R2R project are shown in Table 2. The initial targets were estimated based on an assessment of the number of pig pens in the area.

Table 2: Stress Reduction Target for Tuvalu IW R2R Project

Stressor	Activity	Initial stress reduction target	Revised stress reduction target	Unit
Municipal waste pollution reduction	Dry-litter piggeries	1422	536	TN kg/yr
			150	TP kg/yr
Pollution reduction in Aquifer	Dry-litter piggeries	7.60	11.0	TN kg/yr

The water quality monitoring conducted in the Fogafale lagoon in 2018 provided a snapshot of water quality at some sites, and the basis from which future conditions can be compared. The water quality report also provided the baseline data for the DLT demonstration piggery installation at the Tafua Pond. Monitoring surveys were performed once to measure the nutrient offload into the surrounding environment. however, this was not done for aquifers or underground water, thus no data is available for this.

Water Quality Testing at Tafua Pond

The project was only able to achieve municipal waste pollution reduction of 164 TN kg/yr as opposed to the target of 536 TN kg/yr. This is due to the limited number of DLT piggeries established under the project. It was expected that around 24 pig pens would need to be converted to DLT to meet the reduction target. However, only one semi-commercial sized piggery was established, which approximates to about four standard size piggeries.

Despite the limited scientific/quantitative data, the demonstration pig pen did provide qualitative indication that the process is viable in the Funafuti context. The dry litter technology was successfully demonstrated, showing conversion of pig waste to valuable compost, rather than washing it away into the groundwater and the lagoon. Importantly, the demonstration helped alleviate concerns relating to odour and negative perceptions surrounding the idea of working with pig waste. The results were useful contributions in diagnostic stakeholder consultations that led to proper decisions in resource management and governance and helped mobilise resource for financing, investment planning and promotion in Tuvalu.
Furthermore, lessons learned from the demonstration site will be incorporated into the design of the planned municipal piggery.

ENVIRONMENTAL STATUS INDICATORS

For projects addressing transboundary issues, collaborating countries must harmonise their sampling, laboratory, and analysis methods so that they all agree on what parameters should be sampled to track progress toward a goal. The State of the Environment and State of the Coast reporting represent this.

These agreed status indicators are measures of actual performance or success in restoring and protecting resources. They have been established jointly by GEF project participating countries so that they can be monitored by countries undertaking harmonised monitoring programmes and reported to the relevant parties and stakeholders. Social indicators help to measure whether communities and stakeholders benefit from the changes in environmental conditions brought about by the project. The agreed list of governance, socio-economic and environmental indicators for the IW R2R activities is provided in the Regional Guidelines for Implementing R2R Science to Policy Strategic Framework. The framework also provides suggested data collection techniques for each of the indicators.

Visible and detectable on-ground changes because of R2R interventions may take many years to become evident and often rely on several variables and stress reduction measures. For change to be measured effectively, the first step is to establish clear baselines, preferably quantitative, although qualitative baselines could also be used. Regular monitoring of identified indicators will be needed, and a database established that remains accessible to and can be updated by national managers over time. The regional IW R2R project, with the assistance of the Geo-informatics Section within Geo-science, Energy and Maritime Division of SPC design and developed a data repository as a basis for storage, analysis, modelling and mapping of available data.

LESSONS LEARNED

The IW R2R achieved the objective of demonstrating the dry litter compost technology in Funafuti. However, it was not able to complete the assessments that would provide the scientific evidence for (a) confirming the causal link between pig waste and lagoon water quality and (b) demonstrating the level of reduction of nutrients entering the lagoon and aquifer.

Despite this, at the community level there has been increased interest in the dry litter compost concept and support indicated for a municipal piggery. It is noteworthy that other complementary initiatives had been proposed prior to the IW R2R implementation. These included a proposal to convert pig waste to biogas and a focus on national food security. The management of pig waste is also an objective of Te Kakeenga III. The IW R2R project has served to catalyse these ideas and bring them together in a coherent manner.

Some key lessons and insights from the project are outlined here.

Lesson 1: Formalise partnerships and build on existing local processes and strategies as the entry point for mainstreaming R2R.

It is generally understood that any intervention is most successful if it takes a community-based approach that ensures it is grounded in the community's (who are often the resource owners) own needs and priorities. These needs and priorities have often already been articulated through existing local planning processes. While the ridge to reef approach requires intersectoral coordination and focus on multiple areas, it is important to find the points of entry that will best garner interest and potentially support, for the proposed interventions. In the case of Funafuti, this "entry point" was the Island Strategic Plan (ISP), which is developed by the Kaupule through extensive consultation with the island community. The ISP reflects the vision and aspirations of the resource owners and the community. It is linked to the national development goals through Te Kakeenga III – the Tuvalu Sustainable Development Strategy. The Kaupule can make by-laws to assist with implementing the ISP.

The ISP process played a key role in community and political acceptance of the dry litter piggery proposal and its upscaling through a formalised partnership between the Kaupule and the project. This ensured that the project would reflect the needs of the community (food security, potential economic wellbeing) while addressing the issue of water quality of the lagoon.

Lesson 2: Invest in identifying, understanding, and communicating the project benefits from the perspective of the stakeholders

Stakeholders will have different perceptions of the project and its benefits, and their level of interest and engagement will likely depend on what motivates them. Thus, while environmental benefits and stress reduction were the rationale for the project, this may not necessarily be what drives the community motivation and eventual behaviour change. For example, concepts of lagoon and reef health may be well understood in the context of land-based pollution, but this does not resonate as effectively as translating it to impediments or enhancement of immediate access to basic needs.

In the case of the DLT piggery, the project aim was to trial and demonstrate the dry litter piggery as an innovative technology that may ease the pressure to the local environment by reducing land-based pollution of groundwater and the lagoon. Despite awareness programmes and education, including the demonstration pig pen, there was limited "buy-in" to the idea. The "benefit" of a potentially cleaner lagoon was not sufficient incentive to convince farmers to invest in making changes to their pig farming methods. The concept gained ground however, as realisation grew of its potential for producing highly valuable compost for home gardens. In fact, the piggery waste management has now been incorporated into the food security goals of the Funafuti ISP and the focus is on developing a managed communal piggery that will produce compost for home gardening and potentially wider commercial use.

Similarly, it was noted that the attendance at the NPSC was high at the outset but over time engagement and commitment of permanent members and department staff decreased. There were several reasons suggested for this, with one being that there was no monetary incentive to attend the meetings on a regular and prolonged basis. However, it was also suggested that because immediate and tangible benefits were not forthcoming, interest waned.

Understanding these "drivers" at an early stage would have perhaps enabled faster uptake and greater engagement of stakeholders in the pig waste management project.

Perceived benefits from the implementation of project activities, in this case, outweigh perceived benefits from achieving the outcomes. For IW R2R Project stakeholders, particularly the members of the National Project Steering Committee, demonstrating how environmental benefits translates to imminent physiological and safety benefits for resource challenged communities is key for human behavioral motivation and community mobilization and advocacy. Concepts of lagoon and reef health understood in the context of land-based pollution does not resonate as effectively as translating it to impediments or enhancement of immediate access to basic needs.

Lesson 3: Develop partnerships with other initiatives and agencies to address gaps in the scientific knowledge and technical skills and access to equipment.

An ongoing challenge for small islands like Tuvalu is the limited availability of scientific and technical expertise in-country. This was disempowering for the project manager and his team whereby they were working on implementing interventions without benefit of fully understanding the science or technical aspects of the dry litter piggery. This was considered to have impeded the project manager's ability to confidently discuss the technology, creatively adapt design and to conduct effective and meaningful monitoring activities.

The IW R2R project was able to identify alternative partnerships with agencies that were likely to be able to assist in addressing this deficit. These included government agencies (e.g., agriculture), non-government agencies and the Taiwan agency. These partnerships strengthened the project manager's own understanding and helped to ensure design and construction of the DLT piggery.

The parallel post-graduate diploma course, undertaken by the project manager as part of the IW R2R capacity building objective, played a significant role in growing his knowledge and understanding of the science underpinning the R2R concept.

The project manager also learnt, during consultations, that the dry litter technology had been introduced by the Department of Agriculture in Tuvalu many years ago, however, little information was available on this.

The limited funds available from the RPCU to set up the Dry Litter Demonstration which includes the appropriate support in terms of scientific advice and on how to manage the new innovative technology

SUMMARY

The IW R2R project successfully established and demonstrated the dry litter composting technology for small scale piggeries on Funafuti Island. The full suite of steps in the R2R science to policy was not followed, however the focus on demonstrating the dry litter innovation from start (planning) to finish (designed unit in place with use of dried leaves and use of manure for compost) provide useful lessons for locals to consider investing time and resources into DLT.

The baselines on nutrient levels in the lagoon, ground freshwater and inland ponds were collected in the margins of training and workshops to demonstrate the use of water quality test kits. A monitoring plan was prepared as part of this training and with the expectation that regular monitoring of marked sites in the lagoon (and preferably on land as well) can be conducted into the future beyond the life of this project.

In a small, crowded place like Funafuti, it is possible to introduce tools and approaches that would generate benefits. The R2R project is no different. While several stakeholders got bored and abandoned participating, most stakeholders and farmers continued with the project and eventually understood the long-term impacts and benefits. For example, unless everyone helps to reduce nutrient discharges from point and non-point sources, particularly human and animal wastes, the effect of ground water contamination, polluted coastal areas and degraded habitats and resources as impacted by high levels of toxicity and pollution in the water column, continue to face with algae blooms and stinky seaweeds piling up on beaches, fish kills, and water borne diseases to local population swimming in the lagoon.

Although a quantitative baseline of the environmental status was not established, the project proceeded on the assumption that the measures (improved animal waste management) would contribute towards reducing nutrient pollution to the coastal waters and aquifer, and eventually, through upscaling, improving the quality of the Fogofale lagoon.

As a result of the project efforts, the government has approved the development of a new commercial pig pen for the community to serve as the new site for a communal piggery. The piggery will be located on Fogafale at the ocean side .

The human waste management activities (eco sanitation toilets) were eventually not carried out due to a lack of overall support for these toilets. There is scope to conduct further studies on the non-acceptance of these toilets as they were installed after significant consultations and discussions on the subject.

The project was able to proceed in the main, through partnership and active support of the Funafuti Kaupule, with the Island Strategic Planning Committee paving the process for consultation and advocacy with landowners and ensuring that potential benefits of the project were adequately conveyed.

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The GEF Pacific R2R programme was developed to provide an opportunity for Pacific small island developing states (SIDS) to develop and implement integrated approaches for the sustainable development of island economies and communities. Partnerships are key to realizing benefits at the local, regional, and global levels.

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