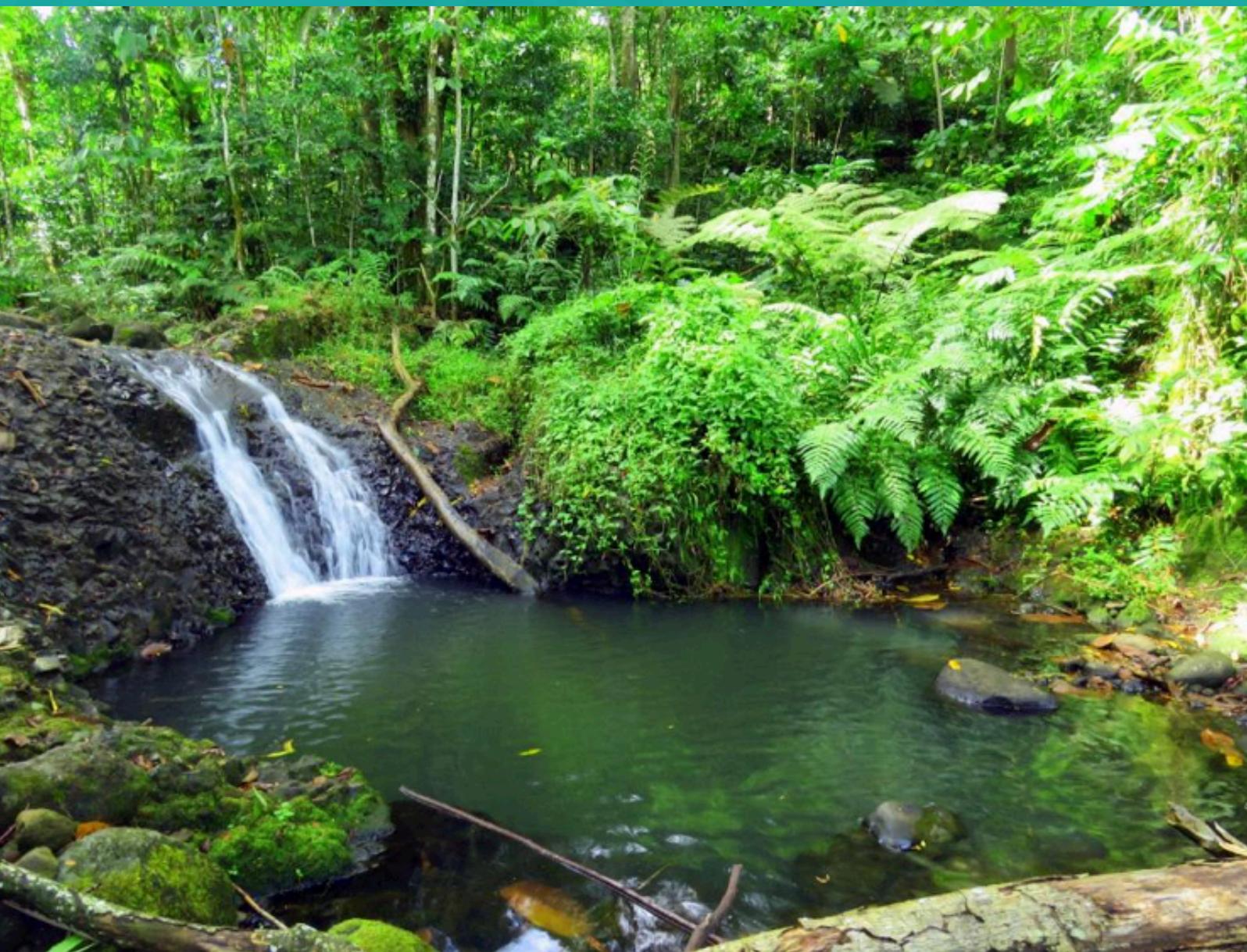




# Fagali'i Catchment Biorap Survey Report: Rapid Assessment of Priority Coastal Areas for Fagali'i, Samoa





# **Fagali'i Catchment Biorap Survey Report: Rapid Assessment of Priority Coastal Areas for Fagali'i, Samoa**

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Suva, Fiji, 2021

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Cover Photo: A small waterfall and pool on the Fagali'i stream at around 230 m elevation - James Atherton

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## ABBREVIATIONS

DEC	Department of Environment and Conservation
GEF	Global Environment Facility
GIS	Geographic Information System
GPS	Global Positioning System
ICM	Integrated Coastal Management
IUCN	International Union for Conservation of Nature
IWRM	Integrated Water Resource Management
IW R2R	International Waters Ridge to Reef
MNRE	Ministry of Natural Resources and Environment
MPA	Marine Protected Area
PUMA	Planning and Urban Management Agency
R2R	Ridge to Reef
RapCA	Rapid Coastal Assessment
REP	Relative Erosion Potential
WRD	Water Resources Division

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# 1. INTRODUCTION

The purpose of the Regional International Waters Ridge to Reef Project is to test the mainstreaming of 'ridge-to-reef' (R2R), climate resilient approaches to integrated land, water, forest, and coastal management in Pacific Island countries through strategic planning, capacity building and piloted local actions to sustain livelihoods and preserve ecosystem services.

The regional project provides the primary coordination vehicle for the national R2R STAR projects that are part of the Pacific R2R programme, by:

- building on nascent national processes from the previous GEF IWRM<sup>1</sup> project to foster sustainability and resilience for each island through reforms in policy, institutions, and coordination;
- building capacity of local institutions to integrate land, water, and coastal management through on-site demonstrations;
- establishing evidence-based approaches to integrated coastal management (ICM) planning; and
- improved consolidation of results monitoring, and information and data required to inform cross-sector R2R planning approaches.

All projects and studies done for the Pacific R2R Programme consider gender and social inclusion requirements. This is to ensure that planning, implementation of interventions and reporting include the status and priorities of men, women, youth, and all key sectors of communities.

## Samoa IW R2R Project – Demonstration Site

The Samoa IW R2R demonstration site is the Fagali'i Watershed Catchment, and its assessment and survey provide the opportunity to collect the baseline information and data relevant to establish the indicators. This project will also focus attention on harnessing support from all sectors of communities, including men, women, youths, elders and traditional community leadership and governance structures to improve the relevance of investment in ICM planning, including marine protected areas (MPA), and the roll out of demonstrating the 'community to cabinet' approach in natural resource management.

The Fagali'i catchment is roughly 500 km<sup>2</sup> in area and has a population density of 1439 (PUMA and MNRE 2014). The Fagali'i River is critical as it is one of the main water sources in Samoa. Located in the capital of Apia, the increasing population and land developments are a major cause of degradation in the area. Clearing of land for farming and housing along the upper catchment coupled with poor waste management, often leads to the reduction of water in the lower catchment during prolonged dry season resulting in soil erosion and sediment loading along the waterways. The rationale for conducting the survey in the Fagali'i catchment was because a key component of the national R2R project was to provide information needed for the conservation and management of the site and its surroundings ([www.pacific-r2r.org](http://www.pacific-r2r.org)).

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<sup>1</sup> Global Environment Facility Integrated Water Resources Management

## Relevant Policies and Legislation

The following policies and legislative frameworks have a direct bearing on the conservation and management of the Fagali'i catchment:

The Land Surveys and Environment Act (1989), which was amended in 2016, has provisions for the conservation and protection of the environment and the establishment of National Parks and other forms of protected areas ([www.palemene.ws](http://www.palemene.ws)).

The Waste Management Act (2010) provides for, amongst other things, the designation of waste management service areas by the Minister and for the designation of approved waste management operators by the Ministry. The Act also requires a permit to be obtained for dumping and incineration of wastes at sea and provides for community involvement in waste management ([www.paclii.org](http://www.paclii.org)).

- i. The Water Resources Management Act (2008) makes provision for the management, conservation and use of water resources in Samoa, including coastal waters where freshwater discharges or accumulates ([www.paclii.org](http://www.paclii.org)). The result of this Biorap/RapCA survey would support an application for the conservation and management of the Fagali'i catchment if communities deemed it appropriate.
- ii. The Forestry Management Act (2011) provides for the effective and sustainable management of Samoa's forestry resources, and for related purposes. It also allows the Ministry of Natural Resources and Environment to have the principal responsibility for management of the forestry resources and gives them sole power to issue rights to exploit the resources ([www.paclii.org](http://www.paclii.org)).

## Purpose and Scope

The objective of the rapid assessment of the Fagali'i catchment is to:

- conduct fieldwork/survey on forest and mangroves biodiversity in one of the key biodiversity areas;
- provide information needed for the conservation and management plans of the site, and their surrounding areas; and
- establish the baseline information and indicators for the R2R project.

This report presents a review and the rapid coastal assessment results of the Fagali'i catchment survey that was conducted from 3<sup>rd</sup> to 10<sup>th</sup> of December 2018. The full scope of works for the survey is shown in Annex 1. The key outcomes for the project are as follows: -

- Survey of the fauna, flora, and avifauna on the Fagali'i catchment;
- MNRE staff, local villagers and Fagali'i Village Committee trained on surveying skills and techniques;
- Community involvement and participation strengthened. This engagement is gender inclusive and participatory in nature to allow for consultations and engagement within cultural norms and restrictions; and
- Protection and conservation management policies and sustainability options developed for climate resilience.

## 2. METHODOLOGY

### 2.1 Ecological Indicator, E1 Diversity

The survey sites were selected to sample a range of habitats from the coastal zone to the upper watershed area of the Fagali'i catchment (Figure 3). The research team used a map depicting the sites and habitat types sourced from available reports. The sites were haphazardly selected based on accessibility and representation of flora and fauna. A total of 18 sites were surveyed over 5 days (see details on GPS locations in later sections).

Unfortunately, the team discovered on the first day of the survey that the map of the Fagali'i watershed in the Fagali'i watershed management plan (Water Resources Division (WRD) 2016) included the Vaivase catchment (1004 ha) but was missing the adjacent Fagali'i catchment (644 ha). Therefore, adjustments had to be made to the survey plan so that both the Fagali'i and the Vaivase stream catchments could be surveyed.

Different tasks were delegated and shared between the groups who conducted the survey (Figure 1).

- i. Record and GPS reader
- ii. Bird surveys
- iii. For the terrestrial fauna, a visual survey method was conducted to record skinks, snakes, butterflies, and birds for each site
- iv. Filming and photographs
- v. Team leader was responsible for general observation and assessment of the status of different plant species and compilation of list.

For each site, observation was made for the general habitat (vegetation), the level of human disturbance, topographic features, and presence of invasive species, birds, butterflies, reptiles, and freshwater fauna. The sites were marked and recorded using a Garmin GPS. Dominant tree species were recorded, and a list was compiled, which included all dominant species observed within the allocated sites. Endemic and invasive plants within the area were also noted.

### 2.2 Ecological Indicator, E3 Habitat Quality

The field survey was conducted over five days between the Fagali'i and Vaivase stream (see Figure 3). The team spent time conducting freshwater and terrestrial faunal survey targeting freshwater invertebrates, insects, and other terrestrial invertebrates, herpetofauna and avifauna.

For the terrestrial fauna, a visual survey method was conducted to record skinks, snakes, butterflies, and birds for each site. Birds were documented based on actual sightings and on recognised bird calls.

For the macro-invertebrates, a single sample was collected from each site using a hand-net. The nets were placed downstream of the water flow and the habitats was disturbed to drive the targeted species out. The survey schedule and sites visited are shown in Table 1 and Figure 1.

## 2.3 Methods for GIS Watershed Analysis

A GIS based watershed analysis was also conducted as part of this project. A separate technical report has been prepared, which covers the approach used and findings in detail, but a summary is provided below.

Using Quantum GIS tools, watershed features were modelled to produce a map of the status of Samoa's watersheds and predictive impact of existing land cover and development pressures on the land. The model was developed to identify critical watersheds for conservation because of their particularly important role in protecting terrestrial soil and freshwater resources and downstream marine resources such as coral reefs and local fisheries. The model combined an analysis of Relative Erosion Potential with an index of Watershed Development to give a composite threat index for Samoa's watersheds.

## 2.4 Survey Schedule and Sites Visited

Table 1: Survey Schedule (see also Figure 1)

Date	Area surveyed
Monday Dec 3	<ul style="list-style-type: none"> <li>Survey the lower catchment where it meets the sea – Moata'a mangroves and the Fagali'i river outlet (sites 1 to 6)</li> </ul>
Tuesday Dec 4	<ul style="list-style-type: none"> <li>Continue inland to survey the lower part of the Vaivase and Fagali'i catchments near Fagali'i uta (sites 7 to 11)</li> </ul>
Wednesday Dec 5 (am only)	<ul style="list-style-type: none"> <li>Survey the mid part of the Fagali'i catchment (sites 12 and 13)</li> </ul>
Thursday Dec 6	<ul style="list-style-type: none"> <li>Meet with Emma Newland of SPC</li> <li>Survey the mid and upper catchment of the Vaivase stream (sites 14 to 16)</li> </ul>
Friday Dec 7	<ul style="list-style-type: none"> <li>Survey the mid and upper parts of the Letogo and Fagali'i catchments (sites 17 and 18)</li> </ul>

## 2.5 Survey Team

The survey team and their positions are shown in Table 2.

Table 2: Survey Team and Positions (see Figure 1)

Division	Name	Role
Water Resource Division	Niuava Fata Eti Malolo	Survey logistics including transport, food, and community liaison
	Paulo Amerika	Filming and assistance with survey logistics
	Vitolina Taupau	Assistance with surveys
	Vave	Driver
Department of Environment and Conservation -DEC - Parks and Reserves Section	Piula Hakai	Assistance with bird surveys
Community Representatives	Friday, Rambo, Pasese, Toa, Isaako	Assistance with all survey elements



Figure 1: The survey team at the Moata'a mangroves (site number 1)



Figure 2: Taro farming on steep slopes of the Fagali'i catchment (site number 10)

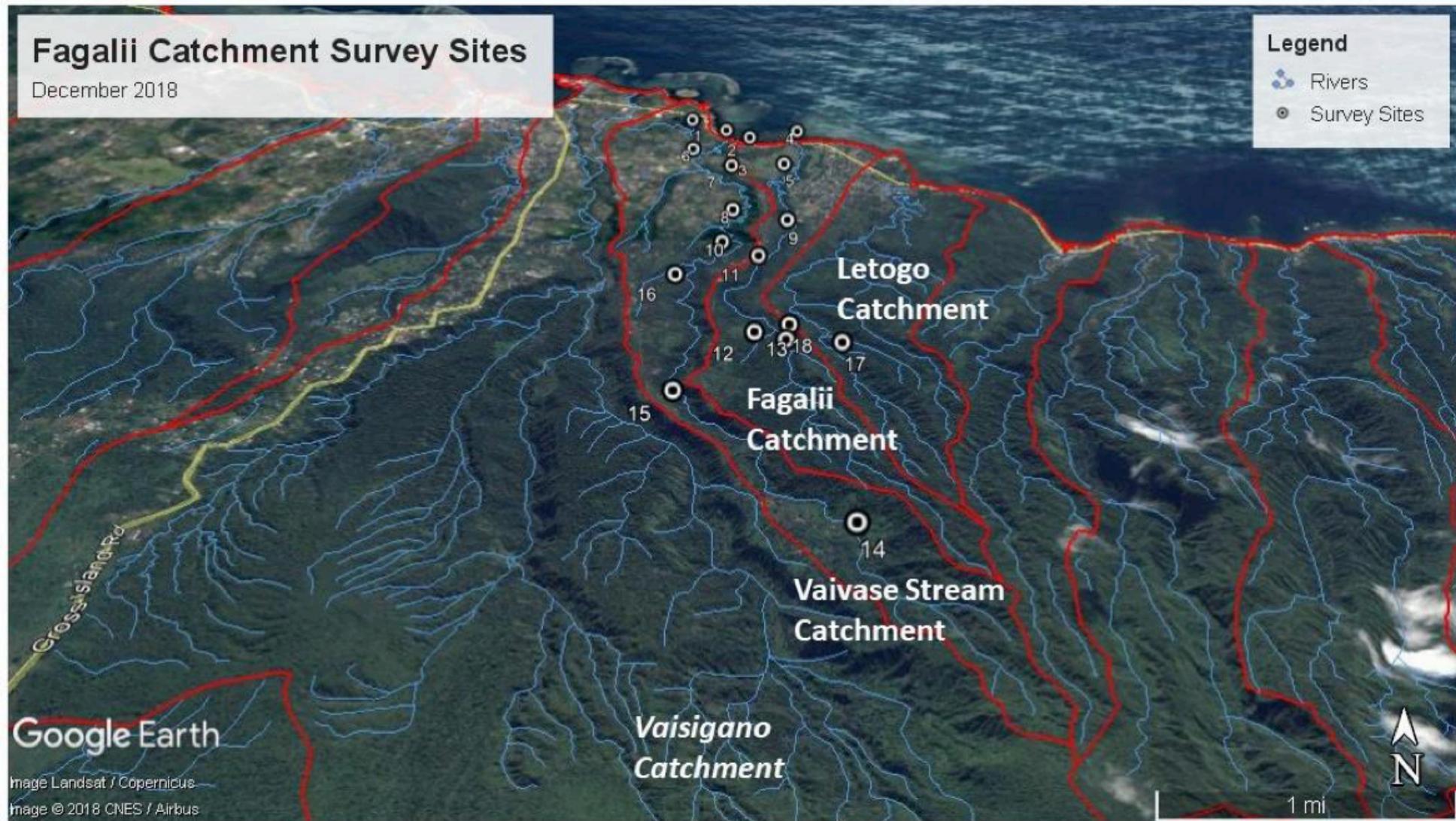


Figure 3: Survey sites visited

## 3. RESULTS

The full survey results, including GPS positions for each survey site are shown in Annex 3. A summary of the results is described below, including some key findings of the GIS analysis conducted for the Fagali'i and Vaivase catchments. A separate report describes in full the GIS analysis of catchment health and relative erosion potential (REP) that was conducted.

### 3.1 Fauna, Flora and Avifauna on the Fagali'i Catchment

The survey was successfully completed, and 18 sites were visited, stretching from the coastal zone to inland and as high as 480 m above sea-level. Due to the steep topography, some sites such as 14 and 15 could not be visited so were observed from the nearest overlook from the road using binoculars. As noted earlier, the Fagali'i river catchment was added to the survey area to give an overall survey area of 1648 ha (i.e., 16.5 km<sup>2</sup>).

The survey findings by taxonomic group are presented below.

#### Plants and vegetation

- Total diversity of species recorded
- Dominant tree species
- Rare, endemic, and endangered species
- Species of conservation value

Overall, both the Vaivase stream and the Fagali'i catchment were found to be in relatively good condition, especially away from the coastal villages. The Fagali'i catchment forest cover exceeds 50% and about 39% for Vaivase Stream (see Table 3, Annex 3). Plants and vegetation indicators also demonstrate relatively good conditions. The Moata'a mangrove area (site 1) was found to be in good health with relatively high cover (*Rhizophora mangle*). However, the team observed a small marshland of Sa'ato (*Acrosticum aureum*) and Gatae (*Erythrina fusca*) and indiscriminate piles and dumping of rubbish at site 3 (called Gataivai spring by the locals).

Riparian strips along Vaivase and Fagali'i rivers are generally healthy relative to ecological indicators measured or estimated in this study, although in many cases, are dominated by introduced invasive plants such as Tamaligi (*Albizzia chinensis* and *Albizzia falcataria*), Pulu mamoe (*Castilla elastica*) and Pulu vao (*Funtumia elastica*). Patches of native forest are found along both rivers, especially above around 200 m elevation and on steep slopes. Tava (*Pometia pinnata*) and Maota (*Dysoxylum* species) are the dominant native tree species in both the Fagali'i and Vaivase catchments.

#### Birds

The specific measures of bird counts include the following:

- Total diversity of species recorded
- Dominant species
- Species of conservation value



Common name	Site 1	Site 2	Site 3	Site 4	Site 5	Site 6	Site 7	Site 8	Site 9	Site 10	Site 11	Site 12	Site 13	Site 14	Site 15	Site 16	Site 17	Site 18
Polynesian Triller	Y	Y	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	Y	N
Polynesian Starling	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	N	N	N
Mao	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y
Many-coloured Fruit-dove	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Long-tailed Cuckoo	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Flat-billed Kingfisher	N	N	N	N	N	N	N	N	N	N	N	N	N	Y	N	Y	Y	Y
Cardinal myzomela	N	N	N	Y	N	N	N	N	Y	N	N	N	Y	Y	Y	N	Y	N
Buff-banded Rail	N	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Blue-crowned Lory	N	N	N	N	N	N	N	N	Y	N	N	N	N	Y	N	N	N	N
Barn Owl	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
White-browed Crake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Spotless Crake	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Shy Ground-dove	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Australian Grey Duck	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
<b><i>Shorebirds/seabirds</i></b>																		
White Tern	N	N	N	N	N	N	Y	Y	N	N	N	N	Y	N	Y	Y	Y	Y
White-tailed Tropic-bird	N	N	N	N	N	N	N	Y	N	N	N	N	N	N	N	N	Y	N
Black Noddy	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Brown Noddy	N	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	Y	Y	Y
Tahiti Petrel	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Golden Plover	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
Totals	4	6	4	4	3	3	4	7	5	7	6	2	6	9	6	12	11	12

**KEY** N: Not present Y: Present

## Species of special conservation interest due to endemism and rarity

The sites with the highest bird diversity were in inland areas where native forest cover was the highest- sites 16 (206 m), 17 (262 m) and 18 (229 m) where more than 10 bird species were recorded, including either the rare and threatened Maomao (*Gymnomyza samoensis*) or the Samoan Broadbill, Tolai fatu (*Myiagra albiventris*) (see Figure 3, Annex 3).

## Other Taxa observed

A basic survey of reptiles, butterflies and freshwater fauna was conducted. Common butterflies seen at most sites were the Grass Yellow (*Eurema hecabe xexicanacea*) and occasionally the Blue Tiger (*Tirumula hamala melittula*). The most common reptile seen was the Black Skink (*Emoia nigra*) observed at most sites, and occasionally the Blue-tailed skink (*Emoia impar*). Interestingly, no flying foxes were recorded during the survey.

The freshwater diversity was highest in the cleaner waters of the upper catchments and included Ula vai (*Macrobrachium* spp) and a freshwater eel (tuna, *Anguilla marmorata*) at site 13 at 256 m on the Fagali'i stream (see Figure 3). Where water was more turbid, introduced fish such as *Poecilia asexicana* and *Gambusia affinis* (mosquito fish) and Tilapia (*Oreochromis mossambicus*) were found. The native Inato (*Kuhlia rupestris*) was common in most of the inland sites while mudskippers (Apofu) were common in the Moata'a mangrove area (*Periophthalmus* spp) (Figure 3 & 6; Annex 3).

## Invasive species

The main invasive species recorded were invasive plants – in particular, various Tamaligi species (*Samanea saman*, *Albizia chinensis* and *Albizia falcataria*), Pulu mamoe (*Castilla elastica*) and Pulu vao (*Funtumia elastica*) as well as invasive birds, the Common Myna (*Acridotheres tristis*), Jungle Myna (*Acridotheres fuscus*) and Red-vented Bulbul (*Pycnonotus cafer*). Additionally, most sites had Giant African snails (*Lissachatina fulica*). Invasive species were found in all sites visited (see Figure 3 & 6; Annex 3).

## Threatened species and environmental threats

Threatened biodiversity, as listed by IUCN Red List, included the Maomao (*Gymnomyza samoensis*) and the Tolai fatu or Samoan broadbill (*Myiagra albiventris*) observed at a few inland sites as well as the native bush palm, Niu vao (*Clinostigma samoense*). It is likely that other threatened species are found in patches of native forest especially in the remote inland parts of both catchments. Generally, the areas of highest biodiversity are the areas where there are patches of native forest, and these are mostly found in the middle to upper reaches of the catchments (Figure 3 & 6; Annex 3).

The health of the Vaivase and Fagali'i catchments continues to suffer from the spread of invasive plants into the interior of the catchments, crop farming (mostly taro) on steep slopes and near rivers, cattle encroachment into some river valleys from adjacent cattle ranches (Figure 3). The team also observed indiscriminate dumping of municipal waste and other types in some areas (e.g., at the entrance to the Moata'a mangroves as well as at the Fagali'i and Vaivase river mouths) and this needs to be addressed and discussed with all members of the community to ensure there is wider accountability for waste management.

## Assessment of Habitat Quality

The University of Samoa has carried out water quality assessments in the Fagali'i catchment, and the results of that study can be referred to as appropriate. Similarly, lessons and comparison can be carried out with other previous studies for better understanding on tempo-spatial impacts, if any.

### Assessment of Coastal/ Marine Areas of Fagali'i

The assessment of the Fagali'i fish reserve, covering the area adjacent to the mouth of Fagali'i river, shows an area dominated in seagrass and macroalgae. The diversity and abundance of fish and invertebrates is low. A total of 145 individual fish within 1000 m<sup>2</sup> was observed across 7 species from 6 common finfish families (Table 4). The rabbitfish species (*Siganus vermiculatus*) was the most dominant species, with an average length of 8 cm.

Table 4: Finfish species density, size, and biomass at Fagali'i Fish Reserve

Common name ( <i>Scientific name</i> )	Density (#/1000m <sup>2</sup> )	Density (% composition)	Avg length (cm)	Biomass (kg)
Vermiculated spinefoot ( <i>Siganus vermiculatus</i> )	34	23.45	8.0	13.8
Dash dot goatfish ( <i>Parupeneus barberinus</i> )	30	20.69	12.2	37.9
Humbug damsel ( <i>Dascyllus aruanas</i> )	24	16.55	11.5	45.0
Sixbar wrasse ( <i>Thalassoma hardwicke</i> )	21	14.48	11.7	20.7
Thumbprint emperor ( <i>Lethrinus harak</i> )	15	10.34	23.0	106.3
Whiteband damsel ( <i>Plectroglyphidodon leucozonus</i> )	8	5.52	5.3	1.0
Convict surgeonfish ( <i>Acanthurus triostegus</i> )	7	4.83	14.0	17.0
Oval butterflyfish ( <i>Chaetodon lunulatus</i> )	6	4.14	10.7	7.2
<b>Total</b>	<b>145</b>	<b>100</b>		

Seagrass (Other), mainly (*Halophila ovalis* and *Syringodium isoetifolium*) dominated the substrate groups in the reserve, accounting for about 55% of the total substrate observed (Figure 4). Abiotics (sand and rubble) and macroalgae (*Padina*, *Sargassum* sp.) followed with lower percentage cover. Live coral cover only accounts for about 3%, suggesting the reserve is relatively unproductive and unsuitable habitat for fish.

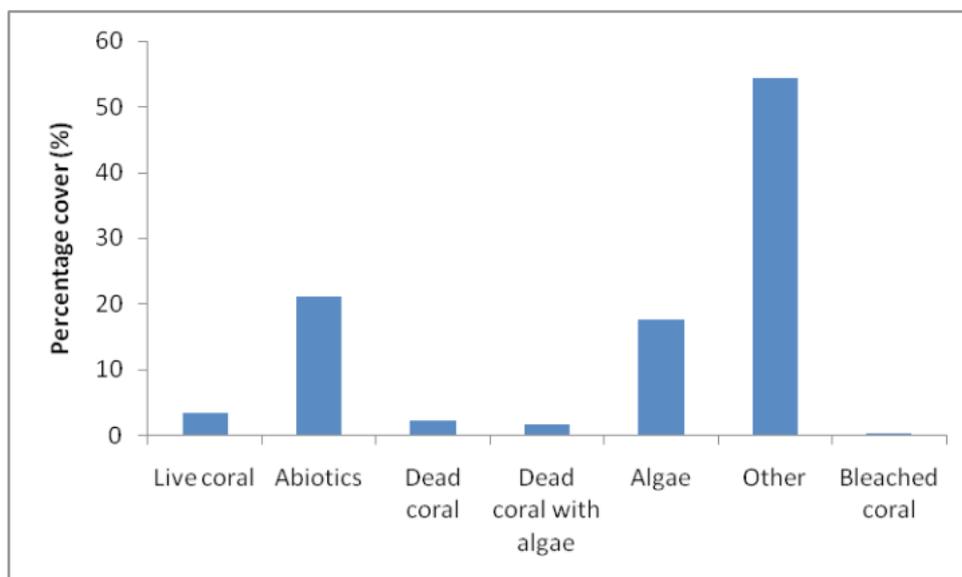


Figure 4: Percentage cover of the main substrate groups in the Fagali'i fish reserve.

Regarding invertebrates, the rock boring urchin (tuitui) (*Echinometra mathaei*) was the dominant species, with lollyfish (*Holothuria atra*) and the blue starfish (*Linkia laevigata*) in very low numbers (Figure 5).

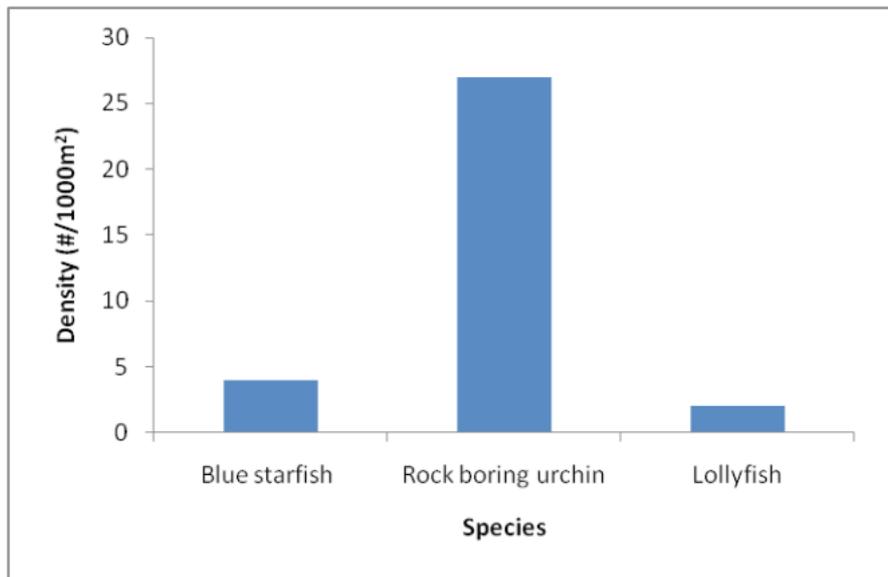


Figure 5: Invertebrate species diversity in the Fagali'i Fish Reserve

The areas surveyed are exposed during low tide, thus, the dominance of rock boring urchins in those habitats. This also means that low abundances of live corals in the reserve have been likely replaced by dominating macroalgae species. Possibly, pollution in the area triggers high macroalgae growth, likely due to the very close proximity of the reserve to the discharges and offloads from the adjacent coastal communities. The research team did not observe this trend of invertebrate composition in areas further offshore beyond the reserve boundary; rather there was an increase in the presence of live corals there compared to the reef flat. The area closer to and on the reef drop off had much stronger wave action, providing favourable clean water conditions for healthy corals.

This area near to and on the drop off was also suggested in the past assessment (2013) to be included in the boundary of the fish reserve, however the community decided to demarcate the boundary only on the reef flat. As such, this assessment once again reiterates the importance of extending the boundary further offshore to include better live coral habitats and thus better protection of more diverse and richer fish and invertebrate populations.

With the community's request to restock giant clams in the reserve, the current location of the reserve is not feasible given its high exposure during low tide and the lack of favourable habitats and conditions for the clams to survive. Unless the reserve is extended further offshore to deeper and favourable clam habitats, this request cannot be considered.

## 3.2 Summary of key GIS statistics for the Vaivase and Fagali'i Catchments

A summary of the key GIS statistics for the Vaivase and Fagali'i catchments is given in Table 4 while Figure 4 is a map of the 2013 land cover of the two catchments from the Forestry Division. A full explanation of the GIS analysis findings is presented in a separate report describing in full the GIS analysis of catchment health and relative erosion potential (REP) that was conducted.

Table 5: Key GIS statistics for the Vaivase and Fagali'i catchments

Catchment Name	Area (Ha)	Mean Relative Erosion Potential	Rd Length (m)	Rd Length (m/Ha)	Creek Crossings	Creek Crossings/Km <sup>2</sup>	Catchment Forest Cover 2013 (Percent)	Percent Deforested 1999 to 2013
<b>Fagali'i</b>	644.1	8.5	19971	31	2	0.3105	54.13	5.54
<b>Vaivase</b>	1004.6	9.5	23448	23	4	0.3981	37.87	8.08

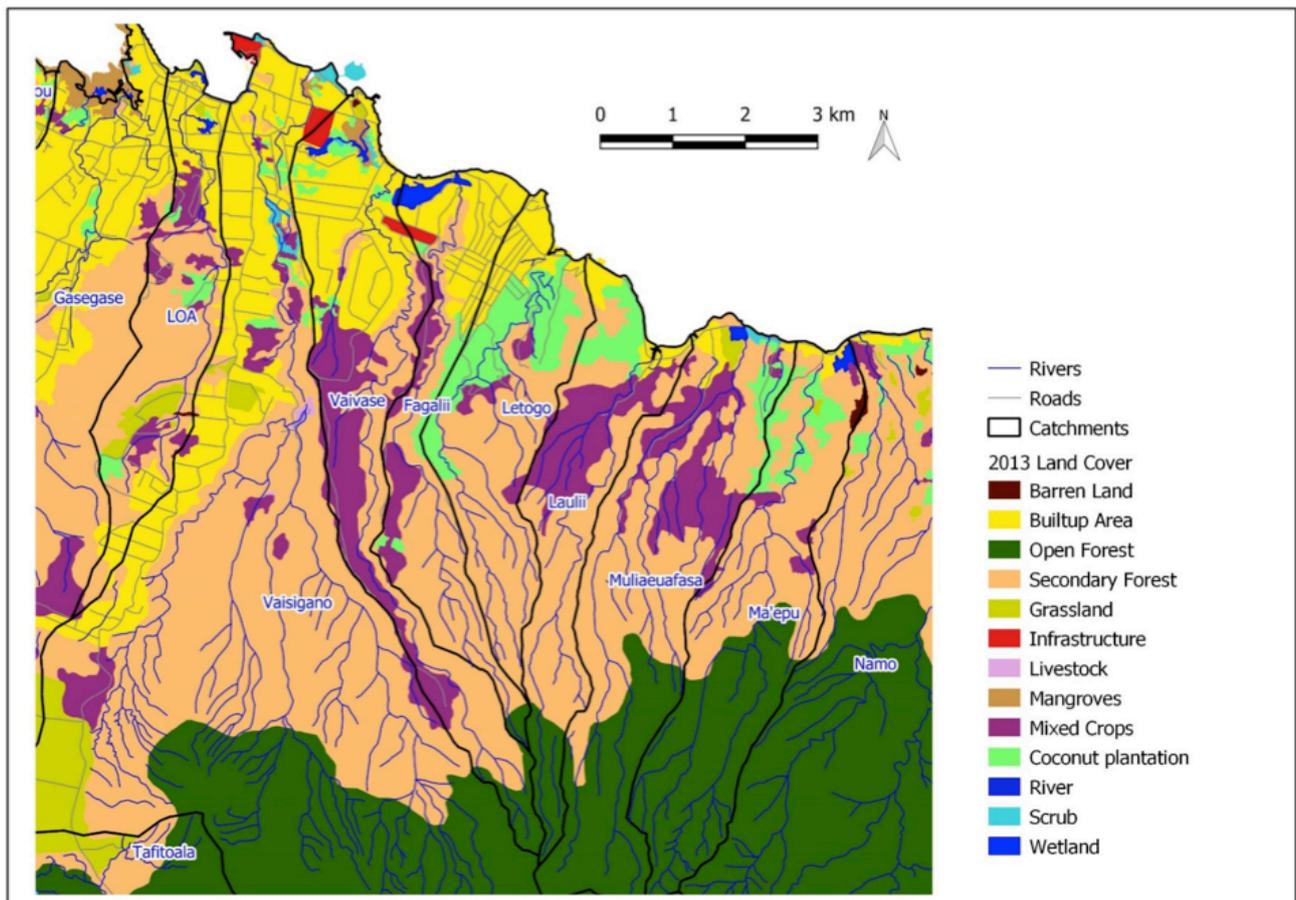


Figure 6: 2013 Land Cover of the Fagali'i, Vaivase and adjacent catchments



### 3.3 MNRE staff, local villagers and Fagali'i Village Committee trained in surveying skills and techniques

All members of the survey team, including the five village representatives, were trained in the survey approach and in species identification. The MNRE team of Fata, Lina and Piula took turns to record data while other staff called out their observations during the fieldwork. The survey team was divided into teams focused mostly on vegetation and another focused-on birds. The community representatives focussed mostly on invasive species, reptiles, and freshwater fauna under the supervision of the Team Leader and other Specialists.

### 3.4 Community involvement and participation strengthened

Community involvement which included the participation of all members of the community (men, women, youth, and other sectors of the communities), was key to the success of the project. As noted above, five community representatives were involved in the survey and were trained in biodiversity survey techniques. Feedback from the community representatives was positive and all learned a lot during the week.

A community consultation was also held on the 14<sup>th</sup> of March at the Fagali'i Pulenu'u fale where the results of the fieldwork were presented. There was wider community engagement and representation, and the consultation was attended by the Ridge to Reef committee, including Matai and Women's Committee.

### 3.5 Protection and conservation management policies and sustainability options developed for climate resilience

The recommendations section of this report discusses recommended management options for the conservation of the catchments.

## 4. CONCLUSION AND RECOMMENDATIONS

The rapid biodiversity assessment successfully assessed the core terrestrial biodiversity values of the Fagali'i and Vaivase catchments. The Fagali'i catchment forest cover exceeds 50% and about 39% for Vaivase Stream, thereby demonstrating relatively good health, particularly good forest cover on the steep erodible slopes.

While both catchments were found to be in relatively good condition, with good riparian strips along both rivers, the main threats to catchment health relate to the continued spread of invasive plants inland, some crop farming (mostly taro) on steep slopes and near rivers, cattle encroachment into some river valleys from adjacent cattle ranches and some trash in some areas (e.g., at the entrance to the Moata'a mangroves as well as at the Fagali'i and Vaivase river mouths).

The Fish Reserve established adjacent to the mouth of the Fagali'i serves to address overfishing in the area. The habitats remain relatively poor with live coral cover < 8% and the area dominated with dead corals, algae, and presence of high counts of sea urchins. The reef flat in the reserve is dry during low tide, and discharge from land and at the river mouth add further pressure to the dynamics of a healthy ecosystem in the area. Identifying men and women fishing activities, methods of fishing can help identify interventions that can address overfishing.

Several recommendations are provided below for improving ecosystem health of the Fagali'i catchment.

### *(1) The baseline for healthy ecosystems in various types of Fagali'i forests and vegetation*

While both catchments do have large agricultural areas, these areas tend to be on gentle slopes on the coastal plain, or on ridges inland. The river valleys remain largely forested although much of the forest is dominated with invasive plants, especially *Samanea saman*, *Albizia chinensis*, *Albizia falcataria*, *Castilla elastica* and *Funtumia elastica*.

Of the two catchments, the Vaivase stream catchment has a lower forest cover and has had a higher rate of forest loss in recent years (8% of the catchment was deforested between 1999 and 2013) and thus needs more attention regarding conservation measures.

A complete biodiversity assessment of the area focusing on taxa that were not thoroughly assessed in this study (i.e., entomology, mammals, herpetofauna and freshwater vertebrates and invertebrates)

Water quality biophysical assessments of the area need close and regular monitoring to better understand the impacts of policy interventions including R2R investments and planning. Consider using several more indicators or the full suite of 22 indicators for measuring environmental stress reduction in Fagali'i catchment and others in the country.

### *(2) Management and rehabilitation of the catchments*

Site specific recommendations are given in Annex 3. The key recommendations for catchment health are the maintenance of riparian strips along rivers as well as the maintenance of forest cover on steep slopes. Replanting and restoration efforts should continue along riverbanks, especially in areas where riverbank vegetation is sparse. It is recommended that the tree planting programme along riverbanks is continued, especially in areas with poor riparian strips. Engagement of all sectors of the communities (men, women, youth, and vulnerable groups) in management and rehabilitation efforts could result in wider support for the work to be done and commitment to interventions planned which can result in sustainable outcomes.

Public awareness programmes should be on-going- targeting men, women and youths and their different areas of interest and this should continue to promote the role of riparian strips to reduce erosion, stabilise riverbanks and promote native biodiversity as well as to discourage the dumping of waste in rivers, streams, and swamps. Public awareness programs and capacity building exercises should be gender and social inclusive and community members should also be discouraged from growing crops on steep slopes and near rivers and encouraged to fence cattle away from rivers so that they don't cause riverbank erosion or pollute water supplies.

*(3) Key biota indicators that could be used for monitoring changes in forest and mangrove ecosystem of the Fagali'i catchment and in the freshwater systems as well*

The two main indicators recommended for monitoring ecosystem health in the Fagali'i and Vaivase catchments are: a) land cover mapping and b) bird distribution and abundance. Land cover mapping is a standard tool for assessing catchment health as it provides the status of forest and other land cover (e.g., cropland, settlements etc.) in the catchment as well as changes over time.

Ideally, land cover mapping would try to separate forests dominated by introduced trees (often termed secondary forest) from forest dominated with native trees. Birds are a good indicator of catchment health as bird diversity and abundance is closely related to the quality of the forest habitat. Native Samoan birds evolved in rainforests so tend to be most abundant where there are native trees to feed on or nest in. Conversely, areas dominated by introduced bird species tend to also be dominated by introduced plants.

The summary table below shows the recommended environmental monitoring approach and periodicity for the two catchments.

*Figure 6: 2013 Land Cover of the Fagali'i, Vaivase and adjacent catchments*

Monitoring parameter	Repeat frequency	Method	Source of data	Comments
<b>Land cover</b>	At least once every 10 years	National land cover mapping using high resolution aerial photography or satellite imagery	Forestry Division or can also be done at lower resolution by Water Resources Division using Google Earth imagery or drones.	Important to use similar land cover classes as past land cover mapping so that meaningful comparisons can be made
<b>Bird distribution and abundance</b>	Annual or every two years	5-minute bird counts	DEC monitoring	Can be done at a sample of sites representing lower, middle, and upper catchment at same sites as past 5-minute bird counts

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# ANNEX 1.

## Scope of Works

The main tasks to be undertaken for the successful delivery of the Baseline Ecological Surveys are as follows:

- Developing and selection of survey methods and a time schedule of works and deliverables for the overall study, in liaison with the R2R Project Manager and survey teams. This shall include an implementation plan, including site area cover, survey methodology for each site, logistics and engagement/consultations with local communities;
- Conduct the field surveys and baseline data collection at the sites, and their surrounding areas for assessing the biodiversity of the coastal mangroves and forest. Among key tasks related to the surveys, these should include, but not be limited to:
  - Collect possible new plants/weeds for identification and analysis
  - Site and record status of other forestry resource species such as birds, reptiles, flying fox etc, where necessary and provide result analysis;
  - Assess and report separately on rare and endangered endemic species on the coastal mangrove areas;
  - Report on the presence of and impacts of human activities in the sites surveyed;
  - Identify invasive plants/weeds and report on its impacts as well as identify possible options for prevention, control and eradication;
  - Identify areas of conservation/rehabilitation priority within the study area; and,
  - Types of conservation/rehabilitation methods to be used in different areas of the watershed.
- Perform an analysis on the Relative Erosion Potential (REP) of the Fagali'i Watershed Area, utilizing the Universal Soil Loss Equation (USLE) and other spatial techniques.
- Provide a detailed technical and scientific report with results and findings, including conclusions and recommendations on (1) the baseline for healthy ecosystems in the various types of vegetation in the forests of Fagali'i; (2) management and rehabilitation of the coastal mangrove areas of Fagali'i (3) key biota indicators that could be used for monitoring changes in forest and mangrove ecosystem of the Fagali'i Catchment.
- Assist the R2R project team in the restitution of the survey results to the local stakeholders and village communities by providing visual material and simplified text of results and findings for presentations. Local stakeholders should include men, women, youths, and other vulnerable members of communities.
- Where relevant, provide specialized trainings and capacity building sessions for MNRE and project staff on methods to be used for the different specialist biota surveys and identification of species within the coastal area of Fagali'i and mangroves, as well as on the REP analysis and the use of spatial/USLE tools. These specifically targeted training should be gender inclusive.

## ANNEX 2.

### Observations Record Sheet for each survey site

Surveyor's names			
Site/Location name			
Date:	Time:	Weather:	
WP Number:	Lat:	Long:	
Elevation (m):	Photo numbers:		
<b>Habitat (main vegetation type):</b>			
<b>Human use and level of disturbance:</b>			
<b>Topographic Features (e.g., crater, slope, ridge, valley etc)</b>			
<b>Invasive species presence:</b>			
<b>Birds seen/heard:</b>			
<b>Other indigenous biota</b>	# seen	Comment/spp./etc	
Insects (e.g., butterflies)			
Reptiles			
Flying foxes			
Freshwater fauna			
<b>Comments on other biota:</b>			
<b>Site management recommendations:</b>			

# ANNEX 3.

## Survey Data

Site Number	Surveyors	Site Name	Date	Time	Weather	GPS - W	GPS - S	Elevation (m)	General Habitat (Vegetation)	Human Use and Level of Disturbance	Topographic features	Invasive Species	Birds (Seen/ Heard)	Freshwater Fauna	Other Comments	Site Management Recommendations
1	Paulo, Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James	Moata'a Mangroves	03-12-18	10am	Partly Cloudy/showers	-171.74522	-13.83963	14	Rhizophora Mangrove Forest (togo fafine)	Low (but trash near entrance to site)	mangrove swamp	Tamaligi-Samanea saman (rain tree)	jungle myna bird (h), bulbul (h), seu (h), miti tai	avaava, aua, ise, lupo, tilapia, apofu	Many paa limanu (fiddler crab)	well managed-but can clear trash from entrance road
2	Paulo, Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James	Vaivase Stream (River mouth close to the bridge)	03-12-18	10:40am	Partly cloudy	-171.74137	-13.84215	5	Mixture of mangroves (togo fafine), tamaligi raintree, and hibiscus, while the eastern side is more open and grassy	medium (eastern side is a reclaim area)	flat riverbank/ riparian strip	Samanea saman (rain tree), black tamaligi-Albizia chinensis, Coccinia grandis (ivy gourd); Wedelia trilobata	jungle myna; brown noddy; ve'a; miti tai; bulbul; golden plover (tuli)	pelupelu, aua, tilapia	Turbid river	During past cyclones tree logs blocked the river mouth into the lagoon at the bridge. The western side needs to be planted with trees and well maintained (riparian strip). Some trash in the river
3	Paulo, Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James	Gataivai Spring	03-12-18	11:20am	Partly Cloudy	-171.73877	-13.84388	4	Herbaceous marsh (sa'ato); dying gatae (Erythrina fusca); bamboo; nonu; fau; tulutulu; niuafa	high (rubbish/ tree cutting)	swamp	Tamaligi-Samanea saman (rain tree)	common myna bird; honey eater; brown noddy; toloa (only when it rains)	na	Large Pterocarpus indica (from PNG) planted on site- food for pigs	Rubbish found in the area, recommended for waste management
4	Paulo, Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James	Fagali'i Stream Mouth	03-12-18	12:30pm	Partly Cloudy	-171.73344	-13.84247	12	Secondary forest. Tamaligi rain tree, fue malo, fau, nonu, laugapapa, lau mafiafia, salato (main vegetation: fau, tamaligi raintree)	Medium (minor trash)	flat riverbank	Tamaligi-Samanea saman (rain tree)	common myna bird, segasega mauu, bulbul,vea	avaava, ise,tilapia, aua, apofu	Well vegetated riparian strip	Maintain the riparian strip

Site Number	Surveyors	Site Name	Date	Time	Weather	GPS - W	GPS- S	Elevation (m)	General Habitat (Vegetation)	Human Use and Level of Disturbance	Topographic features	Invasive Species	Birds (Seen/ Heard)	Freshwater Fauna	Other Comments	Site Management Recommendations
5	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James	Fagali'i Ford	03-12-18	1pm	Partly Cloudy	-171.73523	-13.85064	32	Western side is mostly dominated by pulu mamoe (Castilla elastica); eastern side- canopy level: Samanea saman, Albizzia chinensis; sub canopy: Trema cannabina (magele) ; shrubs: Macaranga stipulosa (laupapata), Hibiscus tiliaceous (fau), crepe ginger ground cover: grass, ta'amu and ferns. Also, revegetation zone nearby of Malili, Tava and Leva	varies from low to medium	Incised Riverbank	Mostly dominated by Castilla elastica (pulumamoe) and Funtiumia elastica (puluvaio), plus some Samanea saman	common myna & bulbul (seen); iao (heard)	ulavai, inato		to maintain the riparian zone and continue the good management by MNRE and Fagali'i Community
6	Fata,Vave,Lina, Piula, James	Vaivase stream bridge	03-12-18	1:40pm	Partly Cloudy	-171.74499	-13.84689	32	Secondary forest - lau fu'afu'a, papata, and black tamaligi	medium (a bit disturbed with minor trash surrounding the area	Incised Riverbank	Black tamaligi (A.chinensis), (Difffenbachia) dumb cane, Tamaligi rain tree- Samanea saman	ve'a (s); common myna (h); mitivao (h/s)	0% freshwater biodiversity as river is dry	river is dry	Maintain the riparian strip

Site Number	Surveyors	Site Name	Date	Time	Weather	GPS - W	GPS - S	Elevation (m)	General Habitat (Vegetation)	Human Use and Level of Disturbance	Topographic features	Invasive Species	Birds (Seen/ Heard)	Freshwater Fauna	Other Comments	Site Management Recommendations
7	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	U131 Nr Fagali'i airstrip	04-12-18	9:30am	Partly Cloudy; Breezy	-171.74082	-13.85092	52	Secondary forest- lau papata, black tamaligi, pulu mamoe, mosooi, fau (mostly dominated by fau tree)	medium (invasives dominated)	top edge of the river; gently slope near the ridge	black tamaligi; tamaligi rain tree; pulu mamoe	common myna (h); manutagi (h); gogo sina (s); bulbul (s)		Had planned to conduct a quantitative transect plot here, but too steep and dominated with invasive plants	strengthen riparian zones, protection especially in the flat areas
8	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Vaivase Stream (Siona)	04-12-18	10:25am	Partly Cloudy	-171.74075	-13.86071	52	Secondary forest- pulu mamoe, toi, tamaligi rain tree, faapasi, tava, fu'afu'a, puluvao, sika sogga (mostly dominated by tamaligi raintree-secondary forest)	medium (taro plantation)	bottom of the river valley; medium incised; low river flow	African snail	manusina, tolai, mitivao, pe'ape'a, common myna, bulbul, tava'e	igato, ulavai, and tilapia	water flows here but not 2km downstream at the bridge (site 6)	manage plantation on the riparian zones, replant riparian strips
9	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Fagali'i Stream (Siona)	04-12-18	11.35am	Partly Cloudy	-171.7354	-13.86305	63	Secondary forest with pulu mamoe, pulu vao, black tamaligi, lopa	Medium with sone small maumaga	Incised river valley with waterfall		Common myna birds, Seu, Cardinal honey eater, Segavao and lao	Ula vai	Fast flowing and clean stream, popular swimming area with waterfall and pool	Maintain the riparian strip
10	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Vaivase Stream (Siona)	04-12-18	1:15pm	Partly Cloudy	-171.74181	-13.86718	79	Secondary Forest: puluvao; pulumamoe; atone; ifi; big aoa (F.obliqua); tava; maota; nonu; ferns (mostly dominated by tamaligi and pulu vao)	medium	incised river	puluvao, pulumamoe, and tamaligi	tolaifatu (s/h); iao (h); pe'ape'a (s); tolaiula (s); lupe (h); manutagi (h); se'u (h)	Ulavai	Large Aoa sign of native forest, river flow much lower than the Fagali'i stream	Maintain the native forest in the riparian zones

Site Number	Surveyors	Site Name	Date	Time	Weather	GPS - W	GPS - S	Elevation (m)	General Habitat (Vegetation)	Human Use and Level of Disturbance	Topographic features	Invasive Species	Birds (Seen/ Heard)	Freshwater Fauna	Other Comments	Site Management Recommendations
11	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Fagali'i Stream	04-12-18	2.15pm	Partly Cloudy	-171.7384	-13.87008	83	Secondary forest with pulu mamoe, pulu vao, black tamaligi uliuli, Samanea saman	Low- Med with signs of cocoa trees	incised river	puluvaao, pulumamoe, and tamaligi uliuli	Se'u (s/h); heard: iao, manutagi, tolaifatu, seu, miti vao, common myna	Ulavai and inato	Good flowing stream, shotgun pellets seen	Maintain the riparian strip
12	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Vaiti (Berking Land)	05-12-18	10am	Partly Cloudy/showers	-171.73909	-13.88436	259	Secondary Forest mostly dominated by Pulu vao, pulu mamoe and white tamaligi with some Tavai (Rhus taitensis)	Medium	next to stream, incised valley	Pulumamoe, puluvaao, white tamaligi	Se'u (h); lupe (s)		SWA intake	cattle management- i.e., keep them away from the stream
13	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Fagali'i stream/ near the Berking Property) Vaiti	05-12-18	10:30am	Partly Cloudy	-171.73647	-13.88537	256	Secondary Forest with emerging aoa	medium	incised river	Pulu vao and pulu mamoe, mostly dominated by pulumamoe	myna bird (s), manusina (s); pe'ape'a(s); vasavasa (s); segasega mo'u (s); lupe (h)	ula vai, tuna, igato,	Former SWA intake damaged	Stabilize the road cutting next to the intake
14	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika,Emily	Vaivase Stream headwater	06-12-18	10.30am	Partly cloudy and showery	-171.73267	-13.9088	480	Secondary forest with white tamaligi, PM, Gatae and patches of native forest	Medium with small maumaga areas of bananas, coconut, and taro	incised river	PM and White tamaligi (Albizia falcataria)	vasvasa, miti vao, fuia, common myna, peapea, iao, tiotala, segasega mauu (h/s); segavao (h)	Ula vai	EPC water intake	Improve riparian zone- move taro plantation away from stream
15	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika,Emily	On ridge looking into Vaivase stream valley	06-12-18	11.30am	Partly cloudy	-171.74564	-13.89279	389	Secondary forest. Tamaligi and tava. Good native forest on east side of valley. On ridge is maumaga with bananas, cassava, taro	Medium due to maumaga	On ridge	Tamaligi paepae (A.falcataria)	Manusina, lupe, common myna, manutagi, peapea, segasega mauu		Landowner wants to plant pine trees on ridge top	Protect riparian strip

Site Number	Surveyors	Site Name	Date	Time	Weather	GPS - W	GPS - S	Elevation (m)	General Habitat (Vegetation)	Human Use and Level of Disturbance	Topographic features	Invasive Species	Birds (Seen/ Heard)	Freshwater Fauna	Other Comments	Site Management Recommendations
16	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika,Emily	On ridge overlooking Vaivase stream near Magiagi	06-12-18	12.20pm	Partly cloudy	-171.74608	-13.87396	206	Secondary forest dominated with tamaligi uliuli PM and PV. Area is banana and taamu plantation	Medium	On ridge		manusina (s); ma'o (h); lupe (h); tiotala (h), common myna (h/s); fuia (h/s); pe'ape'a (s); iao (h); tolaiula (h); manutagi (h); brown nody (h/s); vasavasa (h)		Cannabis seen and photographed	Replant with natives
17	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Letogo stream SWA intake	07-12-18	9.30am	Partly cloudy	-171.73184	-13.886	262	Lowland rainforest-tava, maota with secondary forest trees (e.g., PM, PV, Albizzia falcataria). Area around intake planted with Malili, Tava and Maota by WRD in 2012	Low- good native forest dominated with Maota	Incised river	PM, PV, both tamaligi sp, African snail	Peapea, Tolai fatu, Vasavasa, Brown nody, kingfisher (h/s); lupe (h); pe'ape'a (s); iao (h/s); manusina (s); segasegamauu (s); miti vao (h/s); tolaiifatu (h); tava'e (s);	Ula vai	Clear, clean water, but more than 50% tapped by SWA. Best native forest seen during the survey	Maintain the riparian strip; forest is in excellent shape
18	Fata,Vave,Lina, Piula,Friday, Rambo, Pasese,Toa, Isaako, James, Simaika	Fagalli stream across from the Berking land (site 13)	07-12-18	10.40am	Partly cloudy then rainy	-171.73607	-13.88272	229	Tava and Maota forest on the riverbank, but large taro maumaga next to this area	Low on w side, high on east side with maumaga stretching down to the river	Incised river	PM,PV, Samanea saman, African snail	manusina (s); ma'o (h); lupe (h); tiotala (h), common myna (h/s); fuia (h/s); pe'ape'a (s); iao (h); tolaiula (h); manutagi (h); brown nody (h/s); vasavasa (h)	Ula vai	Plantation stretches to within 5m of the river, tava trees have been burnt and there is evidence of glyphosate usage to clear weeds	Talk to landowners about the taro plantation stretching too close to the river and also about not killing native trees



