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Ridge to Reef Diagnostic Analysis Workshop Report

Kiribati



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Ridge to Reef Diagnostic Analysis Workshop Report Kiribati

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Suva, Fiji, 2022

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Reviewed by George Naboutuiloma, Samasoni Sauni, John Carreon and Fononga Vainga Mangisi-Mafileo.

Conceptual Design: Navneet Lal, Pacific Community (SPC)

Layout and Design: Sailesh Sen, Tanisha Graphics

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Private Mail Bag, Suva, Fiji, 2022
www.spc.int | spc@spc.int

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Abbreviations

ADB	Asian Development Bank
DLT	Dry Litter Technology
EIA	Environment Impact Assessment
GCF	Green Climate Fund
HIES	Household Income and Expenditure Survey
IUCN	International Union for Conservation of Nature
IW R2R	International Waters Ridge to Reef
MELAD	Ministry of Environment, Lands and Agriculture Development
MOP	Ministry Operational Plan
NAPA	National Adaptation Program of Action
NAP	National Action Plan
NCSA	National Capacity Self-Assessment
NEAPs	National Education and Awareness Plans
NEMS	National Environment Management Strategy
NGO	Non-Government Organization
NIS	National Implementation Strategy
PV	Photovoltaic system
RESPAC	Disaster Resilience for Pacific Islands Developing States
SoE	State of Environment
SOPAC	South Pacific Applied Geoscience Commission
STWSP	South Tarawa Water Supply Project
UNDP	United Nations Development Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WASH	Water, Sanitation and Hygiene
WHO	World Health Organization
WWF	World Wildlife Foundation

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*Fish Pond at South Tarawa, Kiribati.
Photo by Anesh Kumar - Pacific Community*

Executive Summary

The purpose of the Ridge to Reef Diagnostic Analysis workshop is to provide an opportunity engaging stakeholders and discuss challenges and remedial actions pertaining to pollution and contamination of underground water lenses and surface water in the Bonriki Water Reserve. This is the only Water Reserve on the island and also the main water supply source for 52.9% of the population of the Republic of Kiribati.

The Kiribati IW R2R project demonstration site is the Bonriki/Buota Water Reserve and testing innovative DLT to address or minimize pollution and contamination of grounder water lenses from animal and human wastes.

The report started with the presentation of data collected from the Bonriki residents residing in the designated area allowed for settlement on the ocean side of the Bonriki water reserve area. Relevant information and results from past reports and studies were also presented to the workshop to inform discussion.

The top priorities identified and discussed at the workshop are insufficient water quantity to meet demand for South Tarawa and decline in the marine resources and Land Erosion. Participants also discussed the priority issues to determine the immediate causes, underlying causes, and root causes with an objective to find ideas and options for reform and actions.

The workshop considered policy interventions and reforms which are practical and cost effective to local communities in their collective efforts to address the above root causes of the problems. For instance, support for income generating activities so that the residents of Bonriki and Buota do not undertake activities that will harm the ecosystem such as sand and aggregate mining for income. One activity that can be undertaken that do not harm the ecosystem is the eco-friendly activities including use modern farming methods such as food cubicle gardens that is currently promoted by Live & Learn. The compost from the Dry Litter Piggery can be used in the farming of root crops and other plants.

The interventions would be designed to ensure women, youth and vulnerable persons would also be direct beneficiaries.

1 Introduction

The production of an initial diagnosis of Bonriki is crucial to the development of activities that would assist in maintaining the integrity of the reserve as one of the main source of water for the population of South Tarawa and Betio which is accommodate 52.9% of the total population of the Republic of Kiribati.

Based on the consultation with the people of Bonriki living on the portion allowed for settlements, the priority environmental issue that must be tackled in relation to the R2R IW project are; 1) Insufficient quantity of freshwater supplied from Bonriki and Buota to meet the growing water demand for South Tarawa and Betio, 2) Decline in marine resources and finally, but the least, 3) Coastal Erosion.

The main problems with the above issue are caused by a variety of factors, but they can all be summed up in one word: lack of governance. People living on the part of Bonriki that is suitable for settlement are also poor and lack regular income-generating activities to improve their standard of living. This has forced them to engage in activities that are endangering the freshwater lens' existence, particularly on Bonriki, such as sand mining, polluting activities, and encroachment.

The government should help people living near the water reserve to become self-sufficient by providing them with economic opportunities so that they can act as custodians of the water reserve, coastal, and land areas, rather than threats.

The purpose of this workshop is to help identify and prioritize environmental and socio-economic issues that are of priority to the Bonriki and Buota site. Once this is identified, the impacts will be identified along with the consequences and the sectors that are responsible. After identifying and prioritizing these issues, a causal chain analysis will be developed to further identify the root causes and the impacts of the identified issues. Highlighting these identified issues would significantly assist decision makers in making scientifically sound and accurate decisions due to stakeholder consultations and diagnostic analyses involving experts in the region.

2 Methodology of Diagnostic Analyses at the Bonriki and Buota site

2.1 Identify and agree on the scope, objectives and responsibilities pertaining to the focus area under investigation

It was resolved that the consultation workshop would be conducted at Bonriki water reserve area as it was the most problematic area. The consultation workshop was conducted at the Catholic Maneaba named Santo Betero Tianere, Wednesday night, 22nd July 2021, starting at around 21:00 hour, and ended two (2) hours later at 23:00 hrs.

There were 60 participants attending comprising of 34 females and 26 males. Out of the 60 participants there were also 10 youth participants who are mostly under the age group ranging from 18 to 26 years of age. The youth participants are 8 females and 2 males.

The consultation workshop started with the introduction of the team and the explanation of the objectives of the workshop. The first question to participant was to write down environmental issues under three categories namely: water, land, and the marine, and then stick them on the white paper. When there were sufficient issues stick under the three categories, participants were then split into three groups to identify, analyse the issues, problems, impacts and solutions.

2.2 Identify and analyse the issues, problems, and impacts (and the environmental and associated socio-economic impacts) using problem-tree and causal-link analyses

2.2.1 Water Issues

Three (3) environmental issues were identified under the water issues category. These issues are:

Table 1. Environmental issues identified under the Water category.

Issues		Impacts and Problem	Root Causes
1	Water in some parts of Islands in Kiribati becomes brackish after the long drought and do not have sufficient fresh groundwater to meet the growing demand due to increase in population	Impacts on the plants will affect food security	Caused by climate change – seawater overtopping and high evapo-transpiration
		Impacts on health due to drinking water with excessive salt content	Water withdrawal is greater than sustainable yield causing saltwater intrusion
		Reduce revenue from sales of vegetable and fruits	Long drought period causes shrinkage of the water lens and low rainwater tank storage
			Sufficient fresh groundwater cannot meet water demand
		High and excessive water usage	

Issues		Impacts and Problem	Root Causes
2	Water in village areas of Kiribati becomes contaminated due to human activities	Causes diarrhoea and other water-related diseases such as skin diseases	Lack of WASH programmes
		Increase in the cost of water treatment	Use of pit latrines and other toilets with poor waste storage Lack of hygiene practice in household which allows for contaminants to infiltrate freshwater wells
3	Water is insufficient to meet growing water demands to some villages in rural Kiribati	Low water pressure would lead to unequal water distribution	Low water pressure would lead to unequal water distribution
		The more vulnerable groups in the community will find it harder to get access to potable water sources	Lack of policy enforcement
			Lack of WASH programmes
			Lack of sanitation policies
		Water conservation is not widely practised	

2.2.2 Marine Issues

The marine issue working group identify three issues namely, 1) coastal pollution, 2) ecosystem destruction and 3) Decline in marine resources.

Table 2. Issues identified under the Marine category.

Issues		Impacts and Problem	Root Causes
1	Coastal pollution	Decrease in marine resources	Dumping of rubbish into the ocean
		Disturbance of marine food web and ecosystems	Erecting pig pens near the coastline
		Increase in the use of tinned imported sources of protein	Open defecation on the beach
		Increase in non-communicable diseases	
2	Ecosystem destruction	Decrease in marine food supplies	Building of seawalls would slowly cause erosion in areas not protected
		Decrease in land space especially at the beach front	Building of recreational areas on the coast
		Shifting of fish species away from Bonriki site due to change in marine habitat	Beach sand and gravel mining would also increase erosion and decrease land area
		Decrease in the number of seagrass due to destruction of habitat	
3	Decline in marine resources	Poor health due to the shortage of fresh protein source	The use of inappropriate fishing gears and methods used by fishermen
		Heavy reliance on imported food	increase in the population means higher fishing pressures in certain areas
		With decline of edible marine life in the reef area people would move out into the ocean beyond the reef to fish	Climate change causes bleaching of coral reefs resulting in the destruction of fish habitat
			Removing of rocks for building seawalls

2.2.3 Land Issues

Four land related issues were identified namely 1) Coastal Erosion, 2) Plastic pollution, 3) Open defecation and 4) Uncontrolled animals.

Table 3. Issues identified under the Land category.

Issues		Impacts and Problem	Root Causes
1	Coastal Erosion	Living with stress and uncertainty	Land degradation due to the poorly designed seawalls
		Displacement which can cause overcrowding on lands	Clearing trees near the coasts
		Political and social tensions over the use of the land	Beach sand and gravel mining
		Social inequality	Lack of policy enforcement on sand mining
		Loss of land	
2	Plastic Pollution	The uncontrolled disposal of plastics will contaminate the groundwater	Plastic wrappers from imported foods
		Disposed plastic can be ingested by marine organisms	Shops providing plastic shopping bags
		Plastic would get into our food systems	Lack of awareness on the threats plastic posed
		Chemical or toxic waste is a burden on the environment	
3	Open Defecation	Increase in water borne diseases	Unavailability of proper toilets
		Water contamination	Unemployment
		Unpleasant smell	Increase in household population leads to resorting in open defecation
		Affects human and health of animals	Lack of awareness
		Increase in vector borne diseases	
		Gender based violence	
4	Uncontrolled Animals	Increase in the number of stray animals	Animals are not registered
		Increase in animal waste	No control of pets
		Degradation of land and water sources	Lack of enforcement of policies regarding animals
		Increase in diseases	

2.3 Prioritise the issues using risk assessment and problem-tree analysis

Table 4. Prioritization of issues using risk assessment tools.

Water Issues	Marine Issues	Land Issues
Deterioration of water quality (Brackish)	Pollution Oceans	Coastal erosion
Deterioration of water quality. (Microbiology)	Ecosystem Destruction	Plastic Pollution
Insufficiency quantity of freshwater	Decline in marine resources	Open Defecation
		Uncontrolled Animals

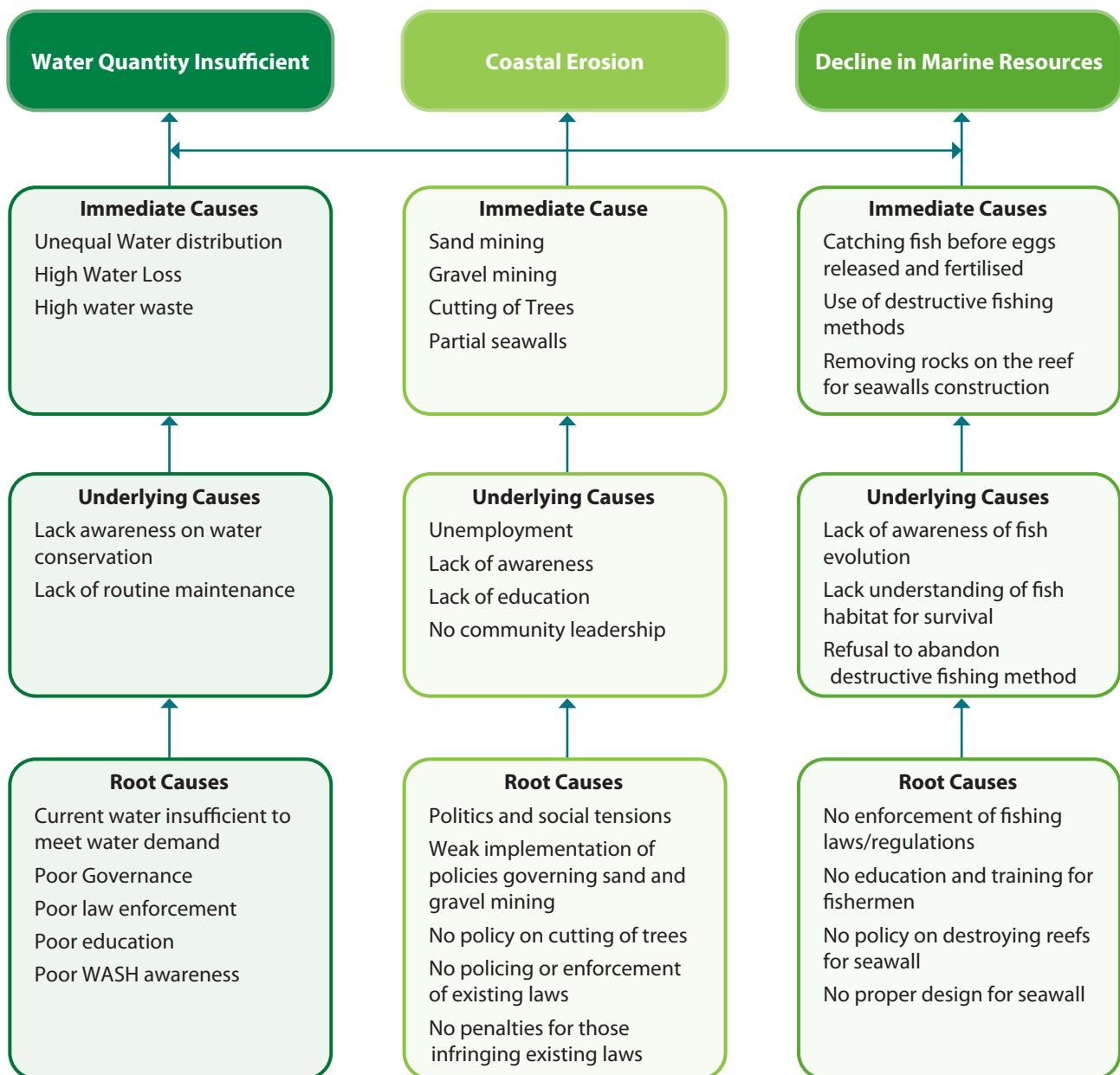
National Location		Water Issues			
		Brackish Water	Contaminated Water	Insufficient Quantity	
Criteria	Weighting (1 – 4)				
Whole-of-island nature of a problem – geographical and temporal scale.	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance	4	3	3	
Future risk of the problem – (in 10 years)	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance 4	4	4	3	
Relationship with other environmental problems.	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance 4	4	3	3	
Expected multiple benefits that might be achieved by addressing a problem.	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance 4	4	4	3	
Progress in addressing this problem at the national level	1 = high progress 2 = moderate progress 3 = low progress 3 4 = no progress	3	3	3	
Urgency of addressing this problem	1 = no urgency 2 = low urgency 3 = moderate urgency 4 = high urgency 4	4	4	3	
TOTAL		23	17	18	
Marking Summary					
Land Issues		Coastal Erosion	Plastic Pollution	Open Defecation	Animals
TOTAL		23	18	20	14
Marine Issues		Marine pollution	Ecosystem Destruction	Decline in Marine Resources	
TOTAL		18	19	23	

Local Location Criteria	Rating	Weighting (1 – 4)	Brackish Water	Contaminated Water	Insufficient Quantity	
Size of the affected area (as percentage of the total national land area)	1- < 10sq.km 2- 10 to 100sq.km 3- 100 to 1000sq.km 4- 1000 to 10,000sq.km 5- >10,000sq.km	1 = no importance 2 = low importance 3 = moderate importance 4 = high importance	3x4=12	3x2=6	3x2=6	
Affected population (as percentage of national population)	1- < 1000 2- 1000 to 10,000 3- 10,000 to 100,000 4- 100,000 to 500,000 5- >500,000		3x4=12	3x3=9	3x2=6	
Extent to which the natural catchment, aquifer or receiving coastal and marine waters support the livelihood of local communities (e.g., subsistence or commercial farming, forestry, mining, tourism, fisheries)	1- very low importance (<10%) 2- low importance (10-30%) 3- average importance (30-50%) 4- important (50-80%) 5- very important (>80%)		5x4=20	5x3=15	5x3=15	
Extent to which the natural catchment, aquifer or receiving coastal and marine waters support the national development (e.g., commercial farming, forestry, mining, tourism, fisheries)	1- very low importance (<10%) 2- low importance (10-30%) 3- average importance (30-50%) 4- important (50-80%) 5- very important (>80%)		4x4=16	4x3=12	4x2=8	
Extent to which the site is a recognized government priority (refer to National Sustainable Development Strategy, or other strategic action plans e.g., NEAPs)	1- no, not a priority 2- yes, low priority 3- yes, medium priority 4- yes, high priority 5- yes, very high priority		4x4=16	4x3=12	4x2=8	
Extent to which the site is of regional and/or global significance and priority (see WWF ecoregions, IUCN categories, UNESCO world heritage sites, etc.)	1- no, not a priority 2- yes, low priority 3- yes, medium priority 4- yes, high priority 5- yes, very high priority		5x4=20	5x3=15	5x2=10	
Degree of Degradation at the site (e.g., type of degradation)	1- very low 2- low 3- average 4- high 5- extremely high		4x4=16	4x3=12	4x2=8	

Local Location Criteria	Rating	Weighting (1 – 4)	Brackish Water	Contaminated Water	Insufficient Quantity	
Extent of degradation on catchment and/or aquifer and any receiving coastal and marine resources and systems	1- very low 2- low 3- average 4- high 5- extremely high		4x4=16	4x3=12	4x2=8	
Cultural or traditional value of the site	1- very low 2- low 3- average 4- high 5- extremely high		5x4=20	5x3=15	5x2=10	
Extent of community management at the site	1- very low 2- low 3- average 4- high 5- extremely high		4x4=16	4x3=12	4x2=8	
TOTAL			154	125	87	
Summary Markings						
Land Issues			Coastal Erosion	Plastic Pollution	Open defecation	Animals
TOTAL			138	102	102	58
Marine Issues			Ocean Pollution	Ecosystem Destruction	Decline in marine resources	
			104	102	138	

Based on the prioritisation process, Environmental Issues with the highest points are further analysed and the problem tree is drawn for each of them. The prioritised environmental issues were 1) water becoming brackish or no groundwater on some islands under the water issues, 2) decline in marine resources under the marine resources category, and 3) coastal erosion under the land Issues category.

Problem-tree analysis



2.4 Develop priority systems and plans for actions and interventions

The root causes of the main environmental issues are all connected to poor governance, poor leadership, lack of education and awareness, and the lack of enforcement. The increasing population of South Tarawa due to migration from the outer islands to seek socio-economic opportunities and climate change is exacerbating the issues. Therefore, the plans of actions and interventions would be developed in line with the root causes.

Under the water issues of insufficient water quantity to meet the growing water demand. The gradual increase of the population in South Tarawa (Betio included), has already added pressure and stress on the limited capacity of both the Bonriki and Buota water resources. To address the issue, the government with assistance from the Green Climate Fund, World Bank, and the Asian Development Bank (ADB) are going to invest some US\$58 million to improve the water supply system through the installation of desalination plants with initial capacity of 6,000 m³/day. The desalination plant would supplement the Bonriki and Buota water sources to enable a 24/7 water supply for the whole of South Tarawa and Betio. The project would also benefit the residents of Bonriki who are settling on the 50 m strip of land along the coast and the residents of Buota.

To make sure the operation of the water supply is sustainable, there is a need to enforce existing policies and to develop new policies to ensure water wastage is minimal, if not eliminated and water users are willing to pay for the water service. The water tariff must be affordable and there must be a free quota set for consumption. Once the quota is reached, water consumptions beyond that must be paid accordingly.

The water needs of the ecosystem to make sure the flora and fauna could survive need to be considered and to make sure the pumping rates of gallery pumps at Bonriki and Buota does not exceed the sustainable yield. Exceeding the sustainable yield would cause saltwater intrusion and would also deny flora water access.

On another note, insufficient water quantity provides potential interventions through implementation of innovative farming methods and technologies to boost household income generation and community resilient. These technologies include, food cube systems, wicking based systems and drip irrigation systems to maximize yields from limited water, and organic resource recovery through dry litter systems for piggery and poultry operations.

The coastal erosion issue is a threat to the Bonriki water reserve if it not addressed. The coastal erosion would result in the loss of coastal land and would slowly reduce the land mass or the width of Bonriki which would lead to destruction and loss of the water reserve. The construction of a properly designed coastal protection structure such a sheet piling is one method that could be used. The sheet of pile would be inserted along the coast of the Bonriki starting at the eastern end of the runway toward Tanaea.



Figure 1 Example of Sheet piling method.

There is a need to conduct the feasibility study to check or confirm the practicality and cost of the sheet piling coupled with the EIA before it can be seriously developed into a full-scale project.

Existing laws prohibiting sand and gravel mining should be strictly enforced, along with public awareness and education about the negative effects of sand mining before penalties are imposed through legal proceedings.

The government should also help the people of Bonriki improve their living conditions so that they can stop sand mining. These include assisting them in using environmentally friendly gardening techniques for subsistence and commercial purposes, as well as providing them with employment opportunities such as providing security services to ensure that the water reserve is not encroached upon again.

The decline in the marine resources issue has link to the land issues and water issues as far as governance and law enforcements are concerned. Overfishing and the use of destructive fishing methods, as well as the disturbance of fish habitat caused by the removal of stones and rock from the reef, have negative effects on marine resources and coastal erosion. The lack strong leadership in the village is an issue. For instance, when someone build a seawall to protect his land from erosion, will affect his neighbours. No one in the neighbourhood can stop someone from building the seawall as it is his right on his own land. This is where government can intervene to penalise that person, however, this is not happening especially when it comes to sand mining.



Figure 2 Sand mining is still practised

3 Socio-Economic Characteristics & Baseline of the Bonriki and Buota site

3.1 Physical Environment

Bonriki and Buota water reserve areas are located on the south-eastern end of the Tarawa Atoll. The two areas are major water source for the South Tarawa Water Supply system and located about 30 km away from the furthest water distribution area, Betio, at the south-western end of the Tarawa Atoll.

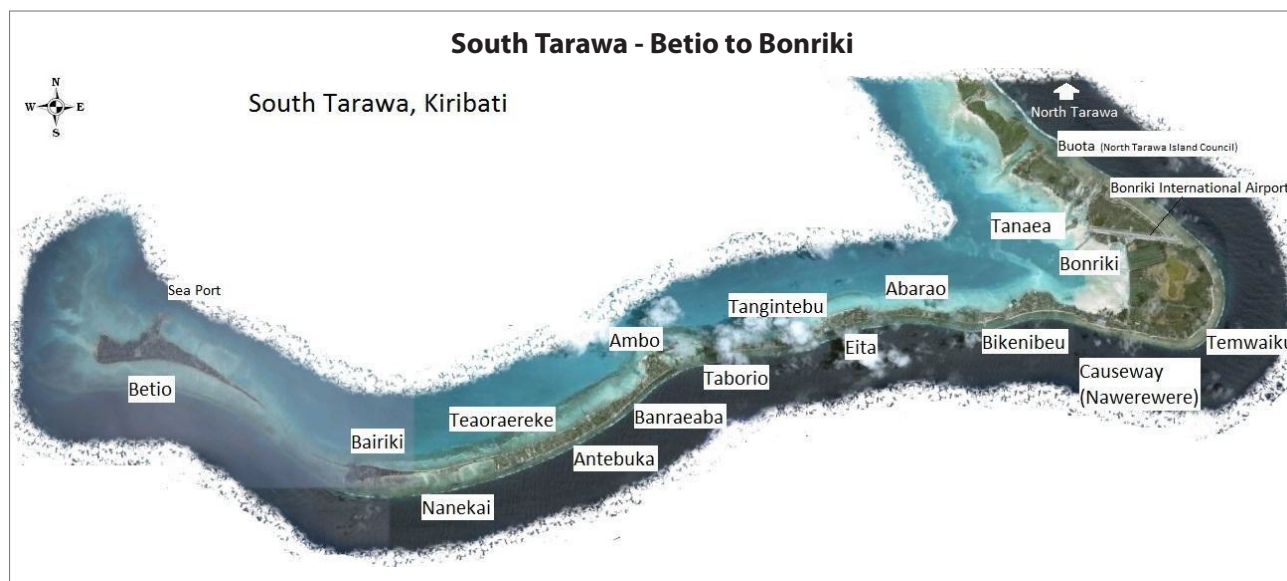


Figure 3: Map of Bonriki and Buota site

In Bonriki, human habitation is mostly found toward the ocean and lagoon side where the thinner part of the water lens is known to exist. The settlement areas are also far from the island's centre, where the thickest part of the water lens is known to exist. The total land areas used specifically as water reserve areas are 0.67 km² and 0.44 km² for Bonriki and Buota, respectively.

The Bonriki and Buota water reserves are the only current sources of reticulated safe drinking water for South Tarawa, the capital of Kiribati. These islands supply 52.9% (2020 Preliminary national census result) of the nation's population and support the livelihood of more than 80% of local communities. The reserves support more than 80% of national development and are a top government priority, but they have a high risk of degradation due to both human and natural causes.

3.2 Demographic Information

The population of South Tarawa (including Betio) according to the 2010 and 2015 national population census are 50,182 and 56,388, respectively. According to the 2015 Kiribati population census, they live in a total of 7,877 households with 5,584 on South Tarawa and 2,293 on the small islet of Betio. The preliminary results from the 2020 National population census indicated that the population of South Tarawa and Betio has increased to 63,439 with 9,576 households. The national census 2020 also indicate that males make up 48% of the total population of South Tarawa and Betio while females make up the remaining 52%.

The population of Kiribati 2010 was 103,058 and 110,136 in 2015, indicating an annual growth rate of about 2.0%. In 2020, the total population was 119,940. This means that the percentage of the Kiribati population residing in South Tarawa and Betio continue to increase from 48.6% in 2010 to 51.2% in 2015 and 52.9% in the year 2020. Out of the total population of 119,940, the male and female populations are 59,154 and 60,786, respectively.

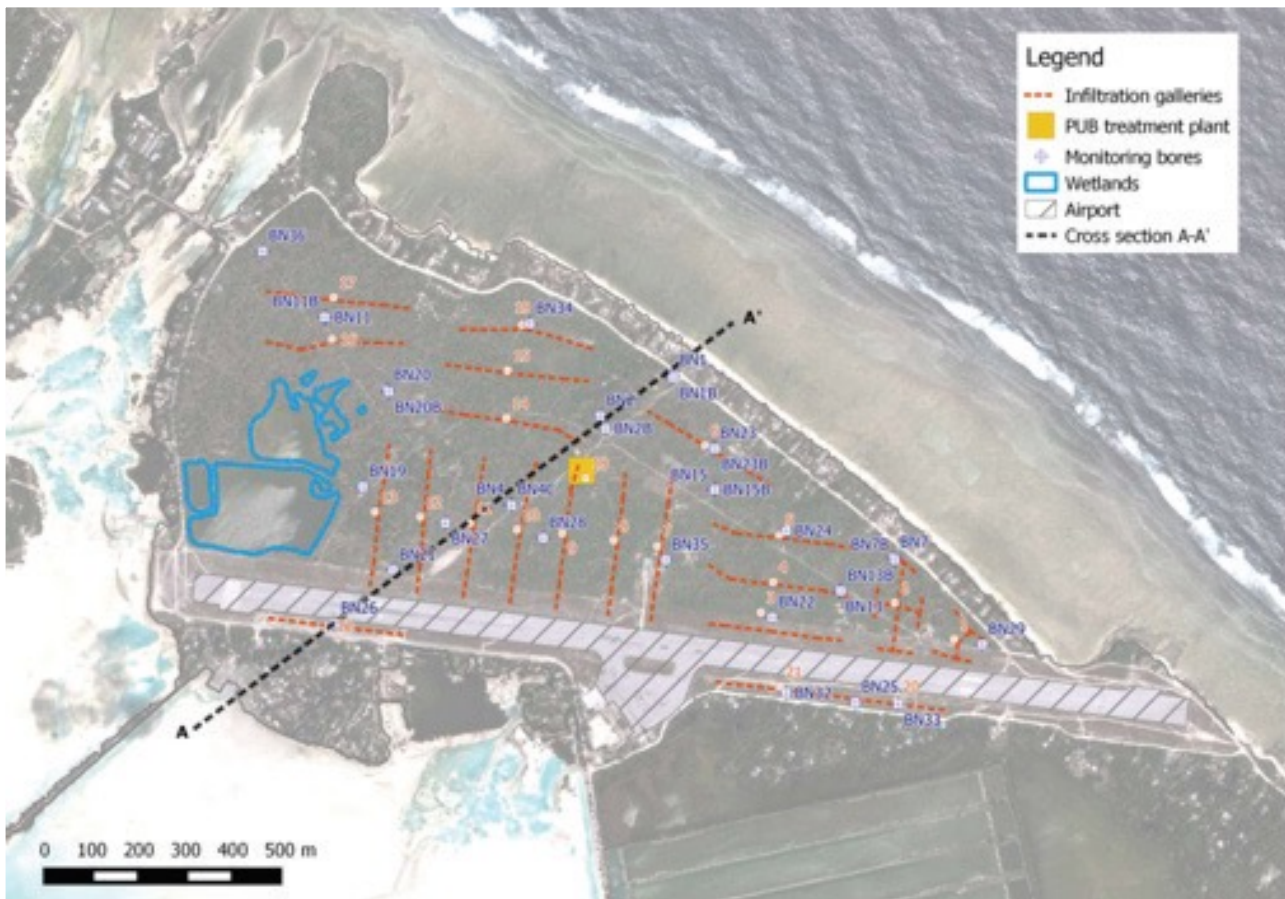


Figure 4: Bonriki Water Reserve Area

According to the national census, between 2015 and 2020, the population of these two areas continue to increase at a rate of approximately 2.0 percent per year, based on linear growth rate calculations.

Bonriki had a population of 2,355 in 2010 and it increased to 2,829 in 2015. Boua’s population grew as well from 1,469 to 1,756 within the same period.

The population of Bonriki continue to increase in the year 2020 to 3075 of which 1486 are male while 1589 are females. In Boua, which has a population of 1647, there are 811 males and 836 females.

3.3 Development & Employment Opportunities

The recent development in the Bonriki area include the installation of solar farm arrays on the water reserve, and the installation of variable speed pumps at all 24 gallery pumps at Bonriki and Boua to maintain optimum safe yield of the galleries to some 2,000 m³/day.

The part of the Bonriki water reserve area where people are allowed to settle is approximately 50m from the high-water mark into the water reserve area. The area does not have the water supply system, but they use rainwater and well water which may be unsafe for drinking.

There is a plan to extend the South Tarawa Water Supply System to serve remaining areas in Bonriki that are not currently served under the on-going ADB/World Bank/GCF funded STWSP. There will also be another project that will extend the Solar PV in Bonriki under the South Tarawa Renewable Energy Project. These projects will provide employment opportunities to people living in the area.

The occurrence of abundance freshwater resources at Bonriki make it attractive for local residents to use the area for commercial and subsistence farming activities. There are quite a number of people in Bonriki that are growing cucumbers, watermelons, rock melons in the area where settlement is allowed and sells them to local restaurants and local markets. However, there are also quite a number of people who are doing organic farming at the center of the Bonriki water reserve, which is strictly prohibited.

3.4 Natural Resource Use and Dependence

The main natural resource use and dependence of Bonriki is the water resource in which 52.9% of the total population of Kiribati rely on for survival. The abundance of groundwater in the area makes it attractive for farming of vegetable and greens, however, eco-friendly farming methods should be encouraged.

3.5 Pollution and Introduction

The pollution activities in the Bonriki water reserve area are all related to human habitation. These are:

- 1) The use of pit latrines and other unsafe toilet that will pollute the underlying groundwater,
- 2) The raising of pigs within the household vicinity which also pollute the underlying groundwater.
- 3) The continuous of the Bonriki public cemetery located right at the centre of the Bonriki water reserve, and
- 4) The continuous mining of sand on the coast and inland which will accelerate the erosion of the coastal area and reduce the depth of the water table. These activities would reduce the amount of land available for settlement and increase evaporation due to the shallow water level. This problem will force people to move inland into the actual water reserve area and increase the risk of pollution.

3.6 Catchments and Coastal protection

With the continuous increase of population settlement on the allocated area at Bonriki, the protection of the catchment would be threatened with encroachment in the actual water reserve area coupled with coastal protection due to the continuous mining of sand. There are indications that sand/aggregate mining in the middle of the water reserve area is also practiced, and this also threatens the safety of the water lens.

4 Environmental Status of the Bonriki and Buota site

4.1 Ecosystem Management

- **General overview of the natural features of the site**

Over-harvesting and unsustainable use of natural resources are the major direct drivers of biodiversity loss in South Tarawa and Kiribati in general, especially at the marine jurisdiction. At the community and national level, fisheries form the basis of socioeconomic development and sustainable livelihoods. Since fish is a major component of the local diet and fishing licenses are a major revenue for the government, overfishing and unsustainable use of marine resources will become more common as the population grows and the country strives for strong economic growth and food security.

- **Overview of marine studies and findings**

Since the people of Tarawa rely heavily on marine resources, their health and well-being are directly linked to the health and well-being of the wider marine ecosystem. Fish and shellfish from the lagoon, for example, are important food sources. In order to protect human health, it is necessary to have a current understanding of when and where water safe and unsafe.

Urban South Tarawa has experienced extremely rapid population growth as people relocate from outer islands to take advantage of the education and employment opportunities. Poor water quality in the lagoon and in the coastal waters around South Tarawa is harmful to both human and ecosystem health.

During the two-week survey in March 2019¹ the team found dangerously elevated concentrations of bacterial tracers of sewage and evidence of the negative impacts of excess nutrient inputs known as eutrophication. Eutrophication can cause excessive growth of marine plants and reduce the availability of dissolved oxygen in lagoon water killing fish and other marine organisms.

- **Overview of terrestrial studies and findings – flora and fauna**

The terrestrial biodiversity in Kiribati is not particularly rich or endemic and what exist is threatened by human development and expansion activities across a limited land area. Its indigenous land-based flora and fauna are limited and is among the poorest worldwide. Much of this has to do with its soil quality as it is composed mainly of alkaline coral with high porosity. As reported in the Kiribati 5th National Report, there is a declining in number of some traditional staple food crop species.

The declining traditional staple food crop include the Pandanus (*Pandanus tectorius*), breadfruit (*Artocarpus mariennesis*, *A. altilis*, *A. mariennesis*), giant swamp taro (*Cyrtosperma merkusii*), native fig (*Ficus tinctoria*) and coconut (*coco-nucifera*). Other important plants were observed to have declined and these are Te Kiaiai (beach hibiscus), te ukin (beach almond), te uri (Guettarda), te ren (tree and beach heliotrope) and Te mao.

The generally poor atoll soil offers little potential for agricultural development apart from the major agricultural export crop, copra, which is harvested as coconuts from abundant coconut trees and processed locally. Despite the infertile soil condition, there is an increase in a number of households on South Tarawa who are doing home gardening. According to the National Census 2015, out the total number of households on South Tarawa and Betio of 7,877; 790 household grow cabbage, 288 grow tomatoes, 282 grow cucumber, 131 grow watermelons and 1,214 have vegetable gardens. It is now becoming a source of household income.

1 CEFAS – Commonwealth Marine Economies Program <https://marinescience.blog.gov.uk/>

- **Overview of freshwater studies and findings – flora and fauna**

There is no surface water on South Tarawa. The main freshwater sources come from groundwater and rainwater. Groundwater are the main water sources for the South Tarawa Water Supply system resources which are located at Bonriki and Buota. Groundwater resources in other area on South Tarawa and Betio are already polluted and in other areas already brackish and therefore unfit for drinking, but can be still used for washing, gardening, and feeding pigs.

- **Overview of wetland studies – mangroves, seagrass, fruit plants**

The lagoon side of Bonriki and Buota is covered with mangroves planted by volunteers from the Churches women groups and on one occasion the former Beretitenti of Kiribati was physically involved in the planting of mangroves. The mangroves are now protecting the lagoon seashore from further erosions.

The existence of the seagrass on both the lagoon and ocean side of the Bonriki and Buota area is growing quite well and in abundance and continue to be a source of protein to residents.

4.2 Natural Vulnerabilities

- **Review of studies regarding natural hazards; inundation, erosion, water quality impacts**

The islands are at risk due to their limited land availability, population pressures and, in the case of atolls, their low-lying topography making them vulnerable to sea level rise. Kiribati is considered a 'textbook case' for climate change studies due to its high vulnerability to climate impacts. Impacts on human health are also expected to become more prevalent. For example, longer periods of drought will limit the availability of fresh water and lead to poor sanitation.

Poor sanitation in Kiribati is a driver for increased rates of diarrhoea. There have also been mosquito-borne disease outbreaks, such as dengue fever and lymphatic filariasis, in the last 50 years which are caused by the warmer and wetter conditions of the South Pacific (Ministry of Health and Medical Services & WHO, 2011).

- **Disaster preparedness initiatives**

The mitigation for the disaster is governed by the National Activation System under the National Disaster Risk Management plan 2012. As far as the preparedness for climate changes are concerned, there are at least a number of quantitative and qualitative situation analyses that have been conducted that can be used for risk assessment purposes. With support from international NGOs, some data has been able to be collected, analysed, and managed. Kiribati is part of the Pacific Regional Information System Management (PRISM) along with 22 other PICs, which focuses on accessibility and user-relevance of statistical information systems and databases across all sectors such as education reports and household income and expenditure survey (HIES) data (SOPAC, 2018). Kiribati is also covered the Disaster Resilience for Pacific Islands Developing States (RESPAC), a project which aims to improve Pacific islands developing states resilience to climate-related hazards by collecting and analysing sex-disaggregated data for post-recovery processes (UNDP, 2016).

- **Potential impacts of climate change**

Sea level rise and extreme heat is a significant concern for an atoll nation. As the number of extreme weather events increase, this will lead to inundation of the atoll islands. Furthermore, the warming of the oceans is likely to decrease the number of reefs acting as coastal defences (Bell, et al., 2011). With the number of healthy reefs decreasing, infrastructure, fisheries, and agriculture sectors are likely to be affected as well as the natural biodiversity of the ecological systems.

4.3 Environmental Issues

The main environmental issue facing South Tarawa are population pressure, coastal erosion due to both climate change and human intervention such as sand mining, pollution by waste oil and other chemical and land pollution from poor management of solid waste.

The priority environmental issue identified under section 2.4 above would be further analysed.

- i. **Water inadequacy to meet water demand:** This is the water demand for water consumption by human beings, plants, animals, and the development activities. The water consumption would also create another issue water pollution from household activities such as washing, cooking, toilet flushing, etc. These contaminants will percolate into the groundwater and would slowly flow out into the sea. With most houses in Kiribati constructed near the coastline, this pollutant would accumulate at the seashore destroying the marine resources. At the centre of the island these pollutants would contaminate the ground if it accumulated in one area and could had adverse on human beings and flora and fauna.

In the three main centres on South Tarawa of Betio, Bairiki and Bikenibeu, the sewerage system is collecting and dispose these contaminants to the sewage outfall assigned for each of the 3 centres. Even though, the sewage is now discharged at a depth of some 30 m below mean sea level, the damage these sewage at that depth is unknown.

- ii. **The decline in marine resources:** The impact of the decline in marine resources on human beings could be disastrous particularly reef fish and shells. On Bonriki and Buota people in this area are relying on marine resources from the lagoon side of the island. The root cause of this issue can be due to sand and gravel mining on the ocean side of the islands, and the cutting of trees along the coast as it tends to disturb marine habitat for reef fish, octopus, and other seafood. The discharged of pollutants from land-based activities such as effluent from the septic tanks constructed near the coast could easily seeped through the sand into the sea or through rainfall runoff.
- iii. **The coastal erosion:** The link among the environmental issues is quite obvious. The coastal erosion would cause reduction in the land mass which would lead to the loss of the freshwater lens if the erosion continued unabated. The impact of coastal erosion would also have adverse impact on the marine resources.

5 Governance

5.1 Governance System

Kiribati is a unitary republic with two levels of government, **national and local**. The national government is located on South Tarawa, whilst Local government are located in the outer island. In the urban area, there is also a local government for the Betio Town Council and the Teinainao Urban Council which is South Tarawa.

There are significant mechanisms that maintain accountability in the political process, most important of which is the power of the traditional elite, particularly the power of the unimane (the old men who are traditional leaders of I-Kiribati society). Ideally, in society, leadership is consensual, avoiding confrontation or the public criticism or embarrassment of others. Leaders should be seen as expressing a community view. Because leadership was traditionally exercised by men, women seldom speak in public meetings and only three have ever been elected to parliament. (Macdonald B. 1996). However, these days' women and the youth are now vocal in community meeting through their participation in women and youth groups. The woman, youth and vulnerable group are now recognised in the development of policies of the community.

The land tenure system is passed from father to son and other sibling. All land on South Tarawa is privately owned by families, but quite a lot of land are leased by government under the 99 years land leased agreement. Most lease agreement are already expired, and leased extension would be done with new landowners. However, with an increase in population, landowners are now demanding more compensations, but government can always apply the land acquisition Act for the public interest.

5.2 Policy

The overarching policy is the Environmental Act 1999 and its amendment of 2007. There is now new amendment 2021 first reading which had just recently passed in the recent Parliament meeting in August 2021. The Environment Act is enforced and managed by the Environment Conservation Division of the MELAD. The new amendment when pass in the second reading at the next Parliament meeting would come with heavy penalty for the polluters. There is also the New Kiribati Vision for 20 years famously known as the KV20.

The Environment Act 2007 is supported by the following Acts and Ordinances:

- Wildlife Ordinance 1977
- Quarantine Ordinance 1977
- Native Land Ordinance 1977
- Foreshore and Land Reclamation Ordinance 1977
- Land Planning Ordinance 1977
- National Disaster Act 1993
- Recreation Reserves Act 1997
- Mineral Development Licensing 1998 CAP58
- Public Utilities Ordinance 1999
- State Lands Act 2001
- Squatters Act 2005
- Phoenix Island Protected Areas (PIPA) Regulations 2008
- Fisheries Act 2010.
- Fisheries Conservation and management of coastal marine resources regulations 2019

Resource Management:

- Building Code 2010;
- South Tarawa Roadmap for water supply and sanitation 2011-2030;
- National Water Resources Policy 2008;
- National Sanitation Policy;
- National Action Plan (NAP) to address Land Degradation and Droughts 2007;
- Tarawa Lagoon Management Plan.

A number of key policy and strategic actions documents exist for the following thematic areas:

1. Climate Change:

- First National Communication 1999;
- National Implementation Strategy (NIS) 2001;
- National Adaptation Program of Action (NAPA);
- Climate Change Adaptation Strategy 2005;
- Draft Climate Change Framework;
- National Energy Policy.

2. Biodiversity Conservation and Management:

- Kiribati Country Report;
- Second National Report;
- Fourth National Report 2010;
- 2nd National Report to the Cartagena Protocol on Biosafety 2011;
- National Biodiversity Strategy and Action Plan 2007-2011;
- Key Biodiversity Area Report;
- Invasive Alien Species Strategic Action Plans;
- PIPA Management Plan 2010-2014;
- National Bio-Safety Framework 2010
- Kiribati Integrated Environment Policy 15
- Waste Management and Pollution Control:
- Draft National Waste Management Strategy;
- National Marine Pollution Contingency Plan;
- National Chemical Profile;
- Persistent Organic Pollutants (POPs) National Implementation Plan (NIP);
- Capacity Assessment for the Sound Management of Chemicals and National Strategic Approach to International Chemical Management (SAICM) Implementation;
- Electrical and Electronic Waste Baseline Study;
- Draft Landfill Operational Guidelines;
- National Programme of Action (NPA) to protect the marine environment from land based pollution activities;
- National HCFC Phase-out Management Plan.

3. Resource Management:

- Building Code;
- Tarawa Water Master Plan;
- National Water Resources Policy 2008;
- National Sanitation Policy;
- National Action Plan (NAP) to address Land Degradation and Droughts 2007;
- Tarawa Lagoon Management Plan.

4. Environmental Governance:

- Environment Impact Assessment (EIA) Process;
- National Environment Management Strategy (NEMS) 1994;
- State of Environment Report (SoE) 1993;
- State of Environment Report (SoE) 2004;
- National Capacity Self-Assessment (NCSA) 2011;
- Kiribati Development Plan 2008-2011;
- MELAD Ministry Operational Plan (MOP);
- Environment Legislative Review 1993;
- Draft National Environment Communication Strategy;
- Memorandum of Understanding for PIPA.

5.3 Communities and other stakeholders

Table 5: Stakeholders and the role they play within the community.

Category	Stakeholder	Role
Village	Village Council	Decision making body for village Development
	Faith based Groups	Spiritual growth and assistance to the Congregation
	Community based groups	Development of community health
	Clinics	Health Awareness programs
	Schools	Pre Schools and Primary Schools
	Private Sectors	Education promotion

5.4 Public Participation

In South Tarawa, the participation of the public in the civic planning are mainly through the Church groups and community-based groups. The council meetings and school meetings are only attended by members who are elected by the people. The council members are elected while school members are nominated by the church and community-based groups.

6 History of interventions

Table 6: Different projects and history of interventions.

Name of Project	Implementing Agency	Outcome	IW R2R Linkage
South Tarawa Sanitation Improvement Sector Project 2012-2019	Funded by the Asian Development Bank and implemented by the Ministry of Infrastructure and Sustainable Energy	Improvement of sewage disposal at the Betio, Bairiki and Bikenibeu. Sewage – solids removed before discharge at about 30 m below means sea level at three different sites.	Protect reef from destruction as sewage is discharged 30 m below sea level. Improve sanitation situation at Betio, Bairiki and Bikenibeu.
Modelling Sea-level and inundation effect of freshwater lens 1997-2014	Secretariat of the Pacific Community with MISE	Improve understanding of: Potential for wave overtopping of Bonriki water reserve. Probability of inundation of Bonriki Water Reserve is relatively low. Over-abstraction and low rainfall at Bonriki water reserve are more critical than inundation.	Improve knowledge on inundation due to climate change.
Solar photovoltaic systems connected to PUB;s grid 2015 – 2016	United Arab Emirate – 500 kw solar arrays installed at Bonriki, plus others 400 kw by Japan and another 516 kw by World Bank	Result in PUB saving US\$800,000 in fuel cost as the result of some 1.4 MW solar array capacity connected to PUB's grid.	
Protection of fresh water sources and fresh water supply at the cost of US\$10.8 million	Funded by the World Bank through the KAPIII and MISE.	Replacement of gallery pump with variable speed pump and installation of pilot 24/7 water supply system in Tanaea, part of Eita village and Nanikaai villages on South Tarawa.	
Future Projects			
South Tarawa Water Supply Project 2020	Funded by Green Climate Fund, Asian Development Bank, World Bank US\$58 million	Water supply would run 24/7 including water system to Bonriki and Buota water reserve resident.	Improve water supply by installation of 6.0 Mega litre of water per day Reverse Osmosis Desalination Plants to supplement Bonriki and Buota water sources.

7 GEF-IW Ridge to Reef Project logframe for Bonriki and Buota

The main component is to ensure the people of Bonriki have access to an income generating activity so they would stop doing activities that would threaten the existence of the fresh groundwater resources in Bonriki and at the same time preserve the land mass from erosion and destruction of marine habitat for the marine resource.

Other component would be the construction of a more permanent coastal protection infrastructure to avoid further erosions. The use of sheet piling would be considered with appropriate feasibility study to check its viability and level of investment that would be needed for implementations.

The people of Bonriki and Buota would be provided with technical assistance and funding to apply farming techniques that would have minimal impact on the fresh groundwater. This would also give them economic opportunity to raise income to improve livelihood and avoid doing income generating activities that would damage the marine, land, and water environment.

The use of compost toilet would also be implemented on a small scale to demonstrate its use with farming so it can encourage local farmers to see the tangible benefits. It would be done first on a voluntary basis.

8 Key Findings

8.1 Summary of main findings

The main findings of this report can be summarised as follow:

1. The issue with coastal erosion is threatening existence of the Bonriki freshwater lens, coastal area, and the marine resources.
2. The continue encroachment of the centre of the Bonriki water reserve by landowners is threatening the integrity of the water source for 52.9% of the total population of Kiribati.
3. The continued use of the public cemetery at the centre of the Bonriki Water Reserve would continue to pollute the freshwater lens.
4. The lack of enforcement of existing law that prohibit sand and aggregate mining would accelerate the coastal erosion and destruction of the marine habitat for the survival of seafood.
5. The use of pit latrine and other unsafe on-site sanitation would continue to pollute fresh groundwater and the reef if the toilets are constructed close to the seashores.

8.2 Opportunities

Some of the factors that exist in Bonriki Water Reserve site that can be harnessed for successful implementation of the GEF-IW Ridge to Reef project include:

1. Ensure compliance to government policies and legislations prohibiting human habitation and other related activities such as cemetery within the boundary of the Bonriki and Buota Water Reserves. Enforcement of these measures strongly encouraged and full extent of the laws applied for non-compliant.
2. Construction of a more permanent seawall that is made of sheet piling.
3. The provision of the water supply system to the area that is operating 24/7 to every household under the forthcoming South Tarawa Water Supply project.
4. The trial construction of compost toilet to selected households to test it viability with farming.
5. The use of eco-friendly farming techniques to selected households with a view to improve income generation. For instances the use of food Cubes Gardens
6. Employment opportunities of Bonriki residents by acting as custodians for the water reserve area.
7. Opportunity to use the Dry Litter Pig pens to minimise the contamination of the groundwater from pig dung.
8. The Bonriki residents would be encouraged to start income generating activities that would not cause environmental damages such as sand and aggregate mining.
9. The residents of Bonriki and Buota would be provided with WASH programmes so they can live a more hygienic behaviour.
10. The resident of Bonriki and Buota would be provided with the facilities to produce biogas from the waste from pigs and chickens as an alternative income generating activity.

8.3 Risks

Some of the risk factors that exist for the successful implementation of the GEF-IW Ridge to Reef project at Bonriki and Buota include:

1. The funds to implement some of the proposals may not be available.
2. The residents of Bonriki and Buota may not be willing to undertake income generating activities.
3. The encroachment of the water reserve could continue if government cannot get alternative land for resettlements.
4. The resident may continue to reject the compost toilet proposal and the related Dry Litter Piggery System.

