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Island Diagnostic Analysis Report for Kosrae State, Federated States of Micronesia



Island Diagnostic Analysis Report for Kosrae State, Federated States of Micronesia

Prepared by
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Produced and published by GEF Pacific International Waters Ridge to Reef Regional Project,
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ABBREVIATIONS

ABS	Areas of Biological Significance
CBO	Community Based Organisation
CCA	Climate Change Adaptation
CZM	Coastal Zone Management
DECEM	Department of Environment, Climate Change and Emergency Management
DLT	Dry litter technology
DREA	Department of Resources and Economic Affairs
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
FSM	Federated States of Micronesia
GEF	Global Environment Facility
ICM	Integrated Coastal Management
IDA	Island Diagnostic Analysis
IUCN	International Union for Conservation of Nature
IW	International Waters
IWRM	Integrated Water Resources Management
KCET	Kosrae Conservation Enforcement Taskforce
KCSO	Kosrae Conservation and Safety Organization
KIRMA	Kosrae Island Resources Management Authority
NPANPF	FSM National Protected Areas Network Policy Framework
NT	Near threatened (category in IUCN Redlist)
R2R	Ridge to Reef
SIDS	Small Island Developing States
SMP	Kosrae Shoreline Management Plan
TNC	The Nature Conservancy

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EXECUTIVE SUMMARY

The Pacific Ridge to Reef Programme is a Global Environment Facility (GEF) multi-focal area programme guiding coordinated investment of GEF grant funding across its focal areas of biodiversity conservation, land degradation, climate change adaptation and mitigation, sustainable land management, sustainable forest management, and international waters in Pacific Small Island Developing States (SIDS). It is a multi-agency initiative involving the United Nations Development Programme, the United Nations Food and Agriculture Organization, and the United Nations Environment Programme as GEF implementing agencies.

Executed regionally by the Pacific Community through the GEF Pacific Ridge to Reef International Waters project (GEF Pacific R2R IW), the operations of the R2R Programme are supported in areas of science-based planning, human capital development, policy and strategic planning, results-based management, and knowledge sharing. Implemented through the GEF Pacific R2R IW project, the R2R IW national pilot projects are designed to strengthen R2R integration by establishing synergies between sector agencies and the GEF National R2R STAR Projects, governments and communities, civil society, and the private sector.

All activities of the Island Diagnostic Analysis processes have a gender and social inclusion component. This ensures meaningful participation of men, women, youth, and all sectors of community in all initiatives undertaken including consultations, research, trainings, and workshops.

Generally, Kosrae receives a lot of rain every year. The large quantity of rainfall feeds into twenty-two (22) perennial streams and a number of rivers on Kosrae, including the larger rivers such as the Finkol, Innem, Tofol and Okat rivers. The drainage pattern is a radial or centrifugal drainage pattern characterised by radiating streams diverging from Kosrae's high central area through small catchments. Because of the steepness of Kosrae's mountain slopes, the streams discharge quickly but slow down as they reach the lowlands. The upper sections of these streams and rivers have very clear and clean water, but, as they flow into the lowlands, these streams collect sediments, which are discharged into the sea.

In 2018, Kosrae State Law 11-156 was enacted, which designated the Mahkontowe Conservation Area. This conservation area is a central watershed reserve located in the central part of the island, characterized by steep mountain slopes. It is intended to protect the most sensitive parts of the island's watersheds by encompassing the steepest land, the most erosive soils, and the upper elevations with the highest rainfall.

The FSM IW R2R project demonstration site is in Lelu located on Kosrae State, and it contains one mangrove channel flowing directly through the Awane Marine Protected Area. There are three rivers which are found in the demonstration site, and they include the Tofol, Srungansralu and Innem Rivers. The three rivers receive rainfall from the Mahkontowe Conservation Area, and they drain large amounts of freshwater into the Lelu Bay. The land-sea connectivity covering the overall upstream and downstream stretch of Tofol Watershed provides the basis for collecting and understanding important ecosystem goods and services in the watershed and uses the baselines to better identify and implement priority management measures.

This report is a diagnostic analysis of priority environmental problems in Kosrae State, and the results documented through literature review and two stakeholder workshops. The analyses of information suggest that the following issues as priority issues of concern in Kosrae:

- Invasive species
- Coastal erosion
- Solid & Liquid Waste

The diagnostic analyses were done to identify the root causes of these problems, along with key environmental impacts, environmental and socio-economic consequences together with the economic sectors that cause them. The main causes of the environmental problems in Kosrae were also identified as basis for potential leverage points where options for reform and intervention may be introduced. The diagnostic details in this report are also appropriate for performing similar tasks in other States of the FSM. It is also possible that the results could, despite the IDA focuses on Kosrae State, carefully considered appropriate for the identification of priority natural resource threats and root-cases, coupled with policy reforms and actions at the national level.

1. INTRODUCTION

1.1 Overview

The land, water, and coastal systems in Small Island Developing States are closely inter-connected. The integration of freshwater watershed management with coastal area management is considered essential to foster effective cross-sectoral coordination in the planning and management of land, water, and coastal uses. Inherent in the approach is the philosophy of cross-sectoral coordination in the planning and management of freshwater use, sanitation, wastewater treatment and pollution control, sustainable land use and forestry practices, balancing coastal livelihoods and biodiversity conservation, hazard risk reduction, and climate variability and change.

The Pacific Ridge to Reef Programme was formulated and designed to implement the above philosophy of cross-sectoral coordination in the planning and management of land, water, and coastal uses. It is a Global Environment Facility (GEF) multi-focal area programme guiding coordinated investment of GEF grant funding across its focal areas of biodiversity conservation, land degradation, climate change adaptation and mitigation, sustainable land management, sustainable forest management, and international waters in Pacific SIDS.

The Regional International Waters Ridge to Reef project is one of the 15 child projects of the Pacific Ridge to Reef Programme, which specifically sets out to test mainstreaming ridge to reef and innovative solutions through the integration of IWRM/ICM/CCA. In the FSM the IW R2R project site is Tofol Catchment in Kosrae State, and its target is to address degradation of habitats by protecting and rehabilitating 200 ha of forest.

1.2 IW R2R Participating Country of the Federated States of Micronesia

The Federated States of Micronesia (FSM) is a small island developing country spread across the western Pacific Ocean comprising more than 600 islands. Micronesia is made up of four island states, which are separated and isolated from one another, and sharing different culture and language: Pohnpei, Kosrae, Chuuk and Yap. FSM has a population of approximately 112,600 people and shares maritime borders with the Republic of the Marshall Islands, Palau, Guam, and Papua New Guinea. The capital, Palikir, is located on the island of Pohnpei.

¹FSM's economy is dominated by government services and external grants, with relatively limited private sector activity. FSM's small, remote, and dispersed population, narrow range of natural resources, and vulnerability to external shocks present challenges to growth. The fisheries sector provides the greatest development potential. With an EEZ of 2.7 million square kilometres, FSM has access to major equatorial tuna migratory paths and the fishing industry has been boosted by the introduction of the Vessel Day Scheme under the Parties to the Nauru Agreement. Fishery licensing fees account for nearly half of domestic budget revenue.

The tourism industry is another area of potential for FSM, particularly diving and ecotourism. Some 21,000 tourists visit the islands each year. Tourism development is, however, constrained by limited airline links, limited infrastructure, including roads, power, and water, and by the country's geographical isolation.

¹ <https://www.dfat.gov.au/geo/federated-states-of-micronesia/federated-states-of-micronesia-country-brief>

1.3 National Demonstration Site, Tofol Catchment in Kosrae State

Kosrae is one of the farthest states of Micronesia. It has high, steep mountains which form the shape of a woman, giving it the affectionate nickname of ‘island of the sleeping lady’. It is dotted with forests, waterfalls, mangrove jungles and citrus trees. The island offers pristine nature, giving access through jungle trails and to see the island’s mangrove forests and its endemic flora and fauna.

Surrounded by fringing reefs of hard coral well over 1000 years old and plenty of aquatic life, Kosrae is also a diver’s paradise.

Kosrae² has over 50 distinct dive-spots around it showcasing healthy coral gardens to schools of sharks, barracudas, and other pelagic fish. The visibility underwater goes up to over 200 metres on a good day. The Utwe/Walung Biosphere Marine Reserve is of note for all diving enthusiasts.

1.4 Key Environmental Challenges

Water resource and sanitation issues continue to be critically important priorities facing Pacific SIDS. Previous GEF support to addressing these issues has been targeted at improved coordination and planning for water resources and wastewater management to balance overuse and conflicting uses of scarce freshwater resources through the GEF Pacific Integrated Water Resource Management (IWRM) Project. The GEF Pacific IWRM Project built on achievements of previous investments via a focus on national IWRM demonstration projects aimed at providing an opportunity for participating countries to implement, and experiment with, new management models and methods.

The practical on-the-ground solutions to water and sanitation issues demonstrated by the national IWRM projects acted to stimulate support at both community and national government levels for policy reform and the mainstreaming of integrated approaches as part of national sustainable development planning. The experience and local capacity in integrated environmental and natural resource management generated through the GEF Pacific IWRM project has been recognised, both regionally, and within the 14 participating Pacific Island countries as an appropriate entry point for the testing of innovative approaches and measures to integrate land, forest, water, and coastal management, including climate change adaptation in Pacific SIDS.³

In the FSM, and certainly throughout the island state of Kosrae, water pollution and contamination pose a great health risk to local populations. Piggeries are major contributors of nutrient release to water bodies, which flows downstream from highlands and elevated mountain ridges to lower coastal and marine areas. Municipal waste along with that of animal and human waste continues to dominate waterways pollution in Kosrae, the FSM and the rest of Pacific SIDS. There are several poorly constructed and maintained dumpsites throughout the FSM and dumping of solid waste, in particular human excreta, is considered one of the foremost environmental health problems.⁴

² <https://www.hideawayholidays.com.au/micronesia-kosrae/>

³ <https://www.pacific-r2r.org/sites/default/files/2020-03/FSM.pdf>.

⁴ <https://www.pacific-r2r.org/sites/default/files/2020-07/workshop-summary-report-18-21.pdf>

Moreover, there are limited areas provided with sewerage systems and large numbers of households still have pit latrines or other unhygienic excreta disposal systems. Combined with frequent rainfall events, this can lead to contaminants entering the coastal ecosystems as well as being a critical public health threat. Considerable attention is required for planned drainage in the developed areas to protect the road pavement and foothill areas from land erosion and flooding.⁵

1.5 Suggested R2R Policy Reforms and Actions

Ridge to reef policy reforms and mainstreaming integrated innovative approaches across sectors as part of national sustainable development planning offer complementary alternatives to fix the above problems. The development, testing and scaling up successful integrated approaches to water resource and coastal management in Kosrae and the whole country provide examples of specific results achieved and lessons learned in integrated approaches to environmental and natural resource management.

Importantly, the FSM National R2R Programme Document⁶ outlines the linkages between the GEF R2R STAR and GEF International Waters R2R Projects, including programme support activities, which focus on science-based planning, human capital development, policy and strategic planning, results-based management, and knowledge sharing.

The FSM IW R2R Project in Kosrae, in collaboration with the FSM R2R STAR Project (STAR), the Kosrae Conservation and Safety Organization (KCSO), the Kosrae Island Resources Management Authority (KIRMA), the Lelu Town Government and the community members of Lelu Municipality, initially planned to address the issue of water quality of Mutunnenea Channel through a joint effort to reduce the nutrient load released into the water. It was agreed to convert regular existing piggeries along the banks of the Mutunnenea Channel. The site was predetermined, but the project will serve as a demonstration, a pilot site, as well as baseline for future such endeavours.

The project planned to convert these existing regular wash-down piggeries into piggeries that will be operated using the Dry-Litter Technology (DLT) system, eliminating the effluent to both land and water, eliminating the strong odour from pig pens, and produce fertilisers that farmers could use or sell to other farmers. Unfortunately, the COVID-19 restricting movements of people and cargoes by air and sea did not allow materials supplied from outside to get into Kosrae to allow constructing of DLT units. Plans to conduct water quality assessment were also cancelled. Nonetheless, outreach and awareness raising activities continue without demonstrative DLT units. It is uncertain if there was change of behaviour and attitudes to transition from wash-down piggeries to the use of DLT that does not use water and stores waste in septic tanks.

Enforcement and compliance are important policy actions that need close attention. Regulation 41-97 of the Kosrae State Code specifies the type of pen structures to be used throughout the island state. It requires constructed pig pens to have a concrete floor and be equipped with a proper drainage pit constructed of concrete or other material approved in advanced by the Environmental Health and Sanitary Division. However, with poor enforcement and compliance to the regulation, many pig farmers have just been operating their respective pig farms using the wash down method, without having a septic tank for the pens. Without a septic tank, the washed down manure and feed are then leached into the surrounding land and bodies of water. Thus, being a major contributor to pollution.

⁵ <https://www.pacific-r2r.org/sites/default/files/2020-03/FSM.pdf>

⁶ Ibid p.3

1.6 Purpose and Intent

The purpose of the IW R2R project is to test and demonstrate mainstreaming of R2R and innovative approaches through the integration of IWRM/ICM/CCA to manage wetland catchments in Kosrae, Federated States of Micronesia. The innovative solutions are as follows:

- i. At least two sustainable farming system demonstration sites successfully established, and experiences documented.
- ii. One dry-litter piggery demonstration site in Lelu successfully established and experiences documented.
- iii. Community awareness programme operating in target area.

More broadly, the project implements the Kosrae Shoreline Management Plan and earlier IWRM project, specific to but not limited to the following:

- i. Review and update the Kosrae State's section of the FSM Water Outlook.
- ii. Prepare and publish the Kosrae State Freshwater Management Plan and Monitoring Plan.
- iii. Strengthen local project monitoring and evaluation capacity.
- iv. Scaling up and replicating efforts in future R2R investments and ICM planning.

Moreover, the IW R2R project provides the opportunity to build and improve local capacity in R2R integrated catchment and coastal management and planning and promote best practice in coastal waters, land, and public health protection. To achieve such intent, the project aims to do the following:

- i. Community-based activities management body established for pilot project.
- ii. Partnership with relevant actors from community to cabinet established.
- iii. Awareness in the community and national level of best practices for sustainable development of Water, Land, and Coasts enhanced.

1.7 Rationale and Scope

The comprehensive Shoreline Management Plan endorsed by the Kosrae Government in 2013 forms the basis to support and direct efforts towards preserving and protecting Kosrae's Coastal Environment. The plan recommends the staged and planned relocation of coastal communities to upland areas, which are currently undisturbed. Unfortunately, such relocation will simply shift the problem from coastal to upland areas, thereby having major impact on land use and its associated impacts on waterways downstream into the coastal and marine areas.

The IW R2R demonstration project sought to complement the Shoreline Management Plan through development of the Kosrae State Integrated Freshwater Resources Management Plan. This will serve to catalyse an integrated Ridge to Reef approach to the sustainable development of upland catchments. The IW R2R actions complement earlier cross-sectoral planning and management initiatives of the GEF Pacific IWRM Project. For instance, the project testing results will improve land use practices, reduce pathogen and nutrient contamination of ground and

coastal waters, assess Kosrae's freshwater resources, establish community-based management of waterways and enhancing community and national level awareness of best practice in sustainable management.

Furthermore, it is anticipated that the project outcomes will provide the platform for scaling efforts of IWRM/ICM/CCA integration in other priority coastal areas of Kosrae State but more importantly, other states in the country.

1.8 Diagnostic Analysis

The R2R island diagnostic analysis (IDA) is a strategic planning tool applying a highly collaborative step-by-step process to identify, quantify, and set priorities for environmental problems that are cross-sectoral (from ridge-to-reef) in nature both at the site and country level. The IDA was also used to identify leverage points and options for reforms and actions. In particular, the tool guided the IDA work in Kosrae to:

- Identify and prioritise the ridge to reef problems.
- Gather and interpret information on the environmental impacts and socio-economic consequences of each problem.
- Analyse the immediate, underlying, and root causes for each problem and identify specific practices, sources, locations, and human activity sectors from which environmental degradation arises or threatens to arise.
- Identification and evaluation of options for reform and action.

The Kosrae IDA report further aimed to document priority environmental problems associated with the ridge to reef concept and its broader application on the island. The participatory process of stakeholders' consultations, interviews and questionnaire surveys also provide an opportunity to evaluate in detail the root causes and prioritise the main problems that can be realistically addressed with limited resources and innovative technologies particularly at the subnational and community level.

As required under the R2R Regional Programme, all activities of the IDA process have a gender and social inclusion component. This ensures meaningful participation of men, women, youths, and all sectors of community in all initiatives undertaken including consultations, research, trainings, and workshops.

2. METHODOLOGY

The approach taken for this Ridge to Reef Programme Island Diagnostic Analysis (IDA) has been derived from the Global International Waters Assessment, the GEF Transboundary Diagnostic Analysis, and Pacific IWRM Diagnostic Analysis methodologies. The substance of these methodologies has been adapted to suit the broader ecosystem services approach of the Ridge to Reef Programme and include terrestrial and marine ecosystems.

The bulk of the Tofol Catchment Site Diagnostic Analysis and the Kosrae State IDA reports are prepared based on literature review and most importantly, from the outcomes of two national stakeholder workshops. Representatives from the R2R Technical Committee and a range of Government Ministries, non-government organisations, civil society organisations, women and youth participated in the IDA consultations.

2.1 Participation and Targeted Multi-Stakeholders

Table 1: STAR and IW Technical Advisory Group, IW R2R Project, Kosrae

No	Government Agency	NGOs/CBOs	Partners	Beneficiaries
1	Kosrae Island Resources Management Authority (KIRMA)	Micronesian Conservation Trust (MCT)	Kosrae Conservation and Safety Organization	IL (Hamlet)
2	Department of Resources and Economic Affairs (DREA) - Fisheries - Trade Investment - Agriculture & Land Administration, - Economic Management and Planning	Conservation Society Organization of Kosrae (CSOK)	FSM National Government Department of Environment, Climate Change and Emergency Management (DECHEM)	Pansre (Hamlet)
3	Kosrae Conservation Enforcement Taskforce (KCET)	The Nature Conservancy (TNC)	GEF STAR R2R Project (FSM)	
4	Environmental Health Office	Lelu United Women's Association (LUWA) / Lelu Women Organization (LWO)	Lelu Town Government	
5	Kosrae Youth Development Association	Kosrae Women's Association (KWA)	Lelu Resource Management Committee	
6	Kosrae Small Business Development Centre		Micronesia Red Cross – Kosrae Chapter	

2.2 Step-by-step Process

2.2.1 Identifying and Prioritising Environmental Problems

- a. The facilitator introduced the idea of environmental problems and explained the problems in the context of whole-of-island or ridge to reef approach.
- b. The predefined list (Annex 1) was used to brainstorm a complete list of the environmental problems in country.
- c. Once the list was refined, the stakeholders focused in on the real environmental problems.
- d. Finally, the stakeholders prioritised the problems based on the criteria provided in Annex 1 using printed score sheets. Each team member was asked to score the environmental problems individually. Each participant was given a score sheet for the criteria and environmental problems and ranked them according to their own perceptions and knowledge of the problem. From this prioritisation the top identified environmental problems were identified.

2.2.2 Determining environmental and socio-economic impacts

- a. The facilitator explained the process of determining environmental and socio-economic impacts to the stakeholders prior to dividing them up into two small but gender inclusive breakout groups. The groups consisted of 7 to 8 people.
- b. Each group deliberated on their assigned priority cross-sectoral problems and identified the following:
 - The environmental impacts
 - The direct and indirect socio-economic impacts
 - The linkages between impacts and other island environmental problems
 - The geographical location(s) of impacts/consequences

2.2.3 Developing Causal Chain

- a. The facilitator explained the process of developing the causal chain to the stakeholders followed by small breakout groups. Three mixed groups of five men and women were formed.
- b. Each group was assigned to review one of the top three priority environmental problems and their associated environmental and socio-economic impacts.

- c. For each problem, the group identified and listed:
- The key sectors (e.g., industry, agriculture, fisheries etc)
 - The immediate causes
 - The underlying resource uses and practices that contribute to each immediate cause
 - The underlying social, economic, legal, and political causes of each immediate cause
 - Link the resource uses and practices, and social, economic, legal, and political causes
 - Determine the root causes
- d. The group developed and shared the causal chain during plenary.

2.2.4 Report back and discussion

All notes and discussions were submitted to the workshop facilitators to inform the development of the IDA report.

3. DESCRIPTION OF KOSRAE, FEDERATED STATES OF MICRONESIA

3.1 Physical and Geographic characteristics

Kosrae is the eastern-most and second largest island of the FSM, located approximately 372 miles (598 km) southeast of Pohnpei (Kosrae SDP 2019). Kosrae has a land area of 42 square miles (112 square km). It is the only state in the FSM without an outer island. It is divided into four municipalities, with respective populations as follows: Lelu (2160), Malem (1300), Tafunsak (2173) and Utwe (983). Geographically, the state is characterised by steep mountains and deep valleys covered with thick, fertile tropical vegetation and forests, and dense mangrove forests in coastal areas. About 70% of the island’s interior is made up of mountain ridges, peaks, and valleys; the remaining land area is foot slopes, alluvial fans and bottomlands, mangroves, and coastal strips. Mt. Finkol offers the highest peak in Kosrae, standing 2064 feet (629 metres) above sea level (Kosrae SDP 2019).

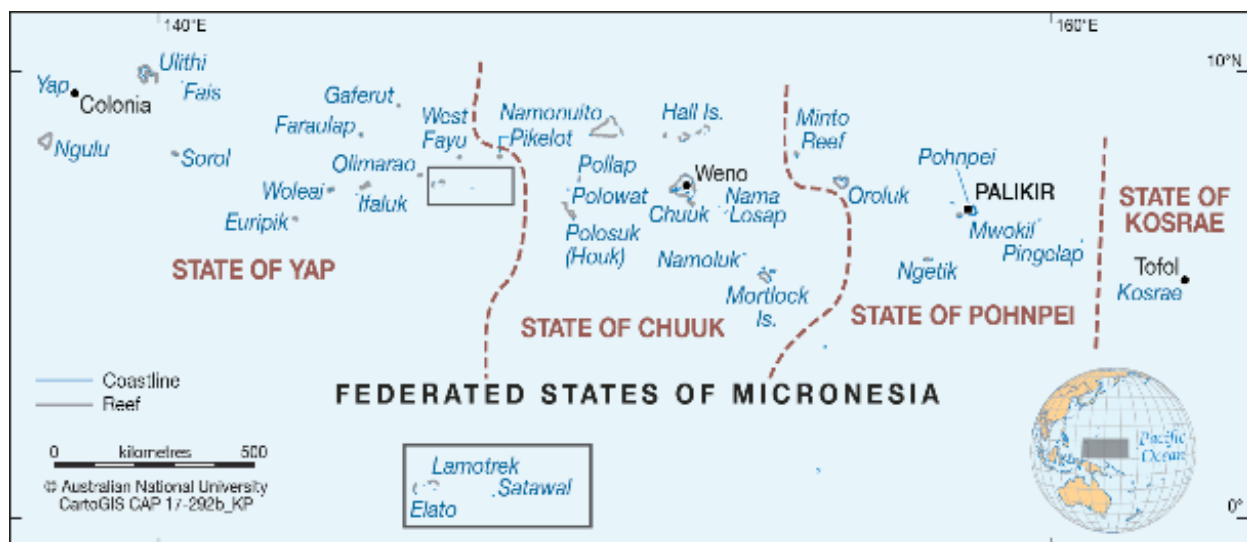


Figure 1: Map of FSM (Federated States of Micronesia - CartoGIS Services Maps Online - ANU)

⁷Approximately 14% of Kosrae is vegetated by mangrove swamps. Other vegetation types include upland forest, swamp forest, mangroves, cloud forest, secondary forest, agroforest, marsh, and savanna grassland. The island is fertile, though much of it is steep and inaccessible. The watersheds are steep and heavily vegetated and in the mid to upper parts of the catchment are in relatively natural state. However, where clearing or deforestation on sloping areas does occur, intense rainfall quickly denudes exposed soil. Invasive vegetation is a significant problem and has taken a foothold in many of the lower parts of many of the catchments.

Kosrae is surrounded by a fringing reef, mangroves, and coastal strand forests. The fringing reef is narrow and covered with boulders of coral heads that have been removed from the forereef during occasional cyclone events. Kosrae’s fringing reef is broken only by four natural harbours: Lelu in the east, Utwe in the south, Okat in the north-west and Yela in the west. Kosrae has jurisdiction over water within 12 miles off its engulfing fringing reef (Kosrae SDP 2019).

⁷ U.S. Forest Service and the FSM (2010) Federated States of Micronesia State-Wide Assessment and Resource Strategy 2010–2015+.

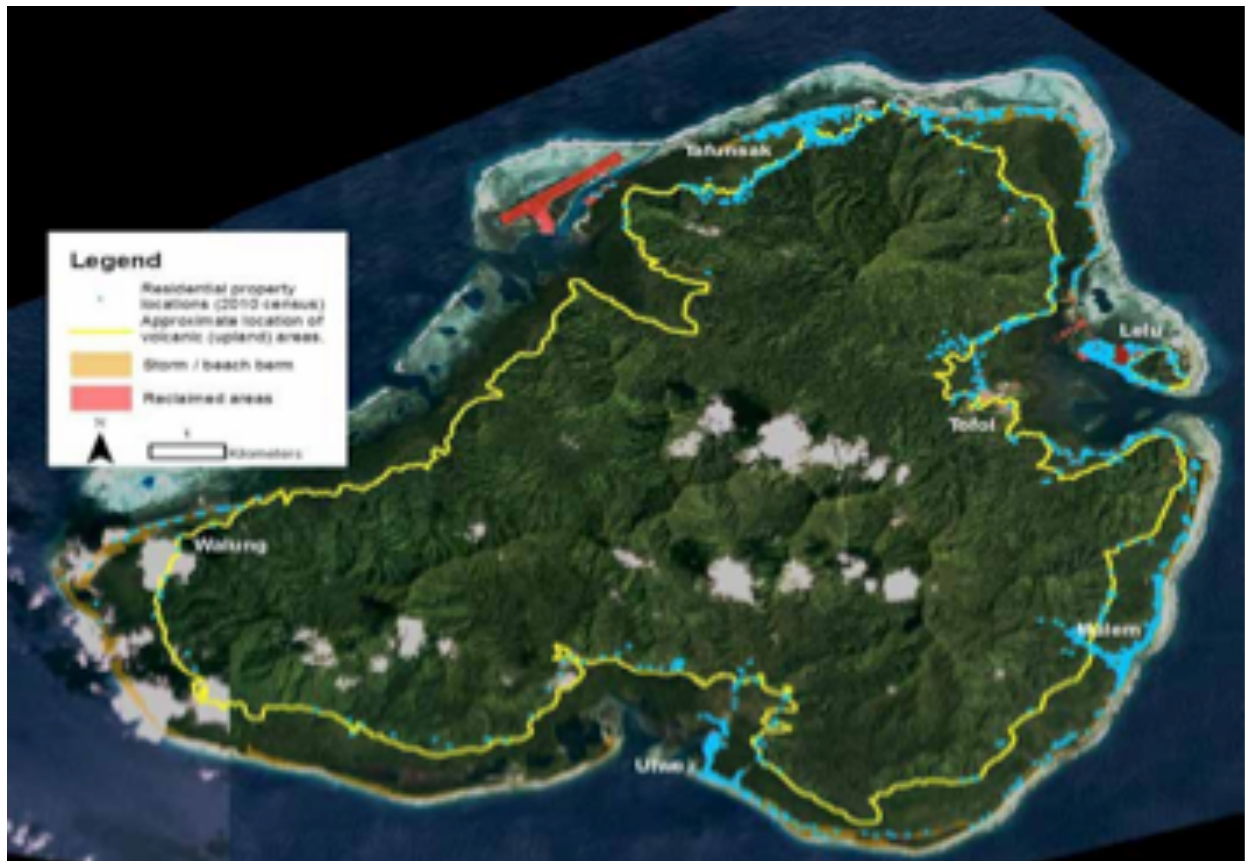


Figure 2: Map of Kosrae, Federated States of Micronesia (KIRMA Office)

3.1.1 Soil and Topography

Soil is the foundation of basic ecosystem function. It filters water, provides nutrients to forests and agriculture, and helps regulate the Earth's temperature as well as many of the important greenhouse gases. In Kosrae, soil, forest and agriculture systems are intimately connected. There are estimated to be 17 different kinds of soil on Kosrae (Laird 1983). The soils in the mountainous areas generally are moderately deep to shallow, well drained, and gravelly or cobbly. The use of these soils is limited mainly by the steepness of the slope.

The soils are categorised into various types:

- a. Soils on coastal strands and in coastal tidal marshes:
 - Naniak-Insak – moderately deep and very deep, very poorly drained, level and nearly level soils; in coastal tidal marshes. Slope is 0% to 2%. The main limitations of this soil type for most uses are wetness and flooding.
 - Ngedebus-Ngedebus Variant – very deep, somewhat excessively drained, level and nearly level soils; on coastal strands. Slope is 0% to 2%. The main limitations of this soil type are the hazard for flooding and seepage potential.
- b. Soils on bottom lands:
 - Nansepsep-Inkosr – very deep, somewhat poorly drained, and poorly drained, level and nearly level soils; on bottom lands. Slope is 0% to 2%.
 - Ngerungor – very deep, very poorly drained, level and nearly level soils; on bottom lands. Slope 0% to 1%. The main limitations for most uses are wetness and flooding.

c. Soils on uplands:

- Fomseng-Oatuu – shallow and very shallow, well drained, steep to extremely steep soils; on uplands. Slope is 30% to 100%. The main limitations for most uses are shallow rooting depth, steepness of slope, and a hazard of erosion.
- Finol-Dolen – moderately deep and very deep, well drained, steep to very steep soils; on uplands. Slope is 30% to 60%. The main limitations for most uses are steepness of slope and a hazard of erosion.

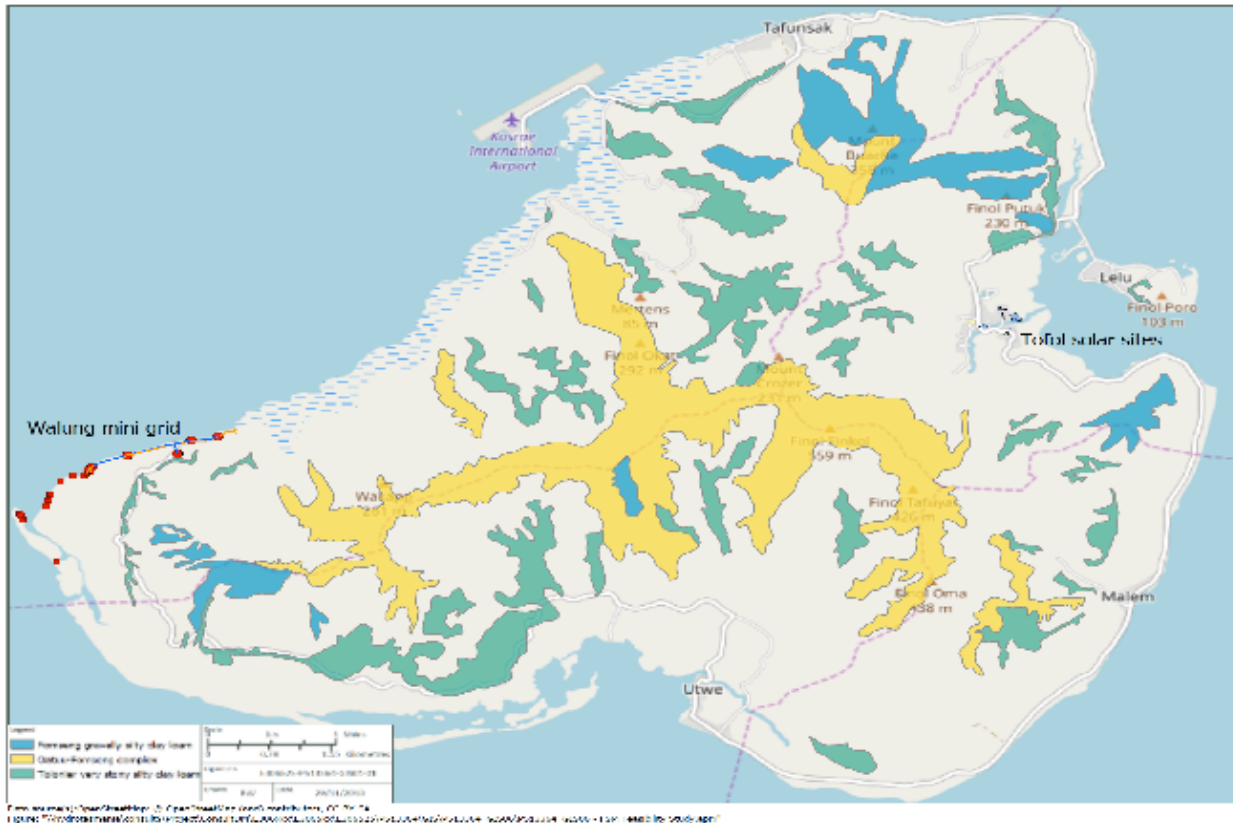


Figure 3: Highly erodible soils of Kosrae

3.1.2 Climate and Natural Disaster

Kosrae has a wet tropical climate with an average annual temperature of 26°C, with little seasonal variation, and is characterised by two distinct seasons, with a dry season between May and October, and a rainy season from November to April.

Humidity is high, with relative humidity typically above 80% throughout the year. North-easterly trade winds are also dominant between December and February. An increase in westerly winds and reduction in trade winds tends to occur during El Niño with stronger trade winds experienced in La Niña periods.

Kosrae has an average annual rainfall in excess of 5000 mm that is generally well distributed throughout the year, with April tending to be the wettest month. During periods of El Niño, Kosrae can experience drought conditions with the typical rainfall pattern being reduced between October and December, and significantly reduced rainfall between January and March in the following year.

Heaviest rainfall tends to occur between July and October, particularly when typhoons, tropical depressions and storms track close to Kosrae, and when El Niño conditions are developing. Many of the typhoons that affect western Micronesia often originate around Kosrae as tropical depressions or storms developing into full typhoons to the west and north of the island. Short periods of extremely high intensity rainfall are common, for example an hourly rainfall of 100 mm has approximately a 16% likelihood of occurring in any one year.

Natural disasters are of special concern to Kosrae and to FSM as a nation due to its fragmented composition of smaller islands and dependence on subsistence agriculture and tourism, which are vulnerable to natural and environmental disasters. Effects of natural disasters usually have long-lasting impacts on the economy, and the rehabilitation costs are extremely high. Fortunately, major storms do not often impact Kosrae, however, typhoons frequently originate near Kosrae and gather strength as they move west.

3.1.3 Vegetation

The island of Kosrae is characterised by steep mountains covered with dense forest. The cover and distribution of vegetation/habitat types on Kosrae are shown in (Table 2). This shows that upland forest is the dominant vegetation type (46% coverage) and occupies the central portions of the island. Agro-forest is the next dominant vegetation/habitat type occupying 23% of Kosrae. Agro-forest is found around the coastal fringe, especially on the northern, eastern, and southern fringe. Mangrove forest (14%) is more prominent on the northeast, western and southern shorelines. Secondary vegetation (11%) is dispersed across the island. Other vegetation types (dwarf forest, swamp forest and non-forest types) make up a minor component of the vegetation/habitat types of Kosrae island.

Table 2: General vegetation/habitat types of Kosrae’s high island

Major land class/ habitat type	Vegetation/habitat type	Cover in 1983 (ha)	Percent cover
Closed Forest	Mangrove	1,562	14%
	Swamp Forest	345	3%
	Upland Forest	5,090	46%
Agroforest	Agroforest	1,659	15%
	Agroforest with coconuts	926	8%
Shrub	Dwarf Forest	69	1%
	Secondary vegetation	1,272	11%
Nonforest	Nonforest (grasslands, savannah, developed/ disturbed areas, marshes)	263	2%
Total Area		11,186	100%

According to Falanruw (2002), approximately 421 species of ferns and flowering plants occur in Kosrae, including 75 ferns, two gymnosperms, 82 monocots (76 natives, 20 introduced) and 227 dicots (195 natives, 53 introduced). Kosrae has the highest percentage of native species (83%) of all the FSM states, with the flora of other states composed of 60% – 63% native species.

3.1.4 Water Resources

There are six sources of freshwater on Kosrae: wells and springs (groundwater), streams, dams, swamps, and rainwater catchments attached to tin roof buildings or structures.⁸ All take advantage of the island's abundant rainfall, which averages 200 inches near the coast and 240 inches in the mountainous interior.

The abundance of rainfall feeds many streams and rivers, with 22 perennial streams recognised on the island. Some of the most significant rivers on Kosrae are the Finkol, Innem and Okat. The streams run quickly through narrow valleys in steep mountain slopes, but slow down when they reach the lowlands. Most flow into the three harbours of Utwe, Okat and Lelu. A number of other smaller perennial and intermittent streams and springs also occur around the base of the volcanic part of the island. Variations in discharge of the rivers and streams can be significant and rapid due to the high rainfall intensities, small catchment sizes and steep slopes. The Kosrae Land Use Plan recognises eleven primary watersheds draining into dams that supply water to the villages (Kosrae Land Use Plan 2003).

Streams and rivers discharging from the catchments are filtered through the various areas of freshwater, brackish and mangrove swamp. The hydrology of these low-lying swamp and mangrove areas is complex. Relatively little water seeps through the soil and into cracks and pores in the volcanic rocks. In some parts of the coastal fringe, wells tap a shallow layer or lens of freshwater underlain by saltwater. However, these wells only rarely provide drinking water because their water quality is poor. Groundwater is, therefore, not an important water source on Kosrae. There are, however, many natural springs that issue water from the ground and are highly respected as sources of water of excellent quality.

3.2 Socio-economic Situation

The economic activities in FSM consist primarily of subsistence farming and fishing. Primary farm products include black pepper, tropical fruits and vegetables, coconuts, cassava, betel nuts, sweet potatoes, pigs, and chickens. The islands have few mineral deposits worth exploiting. The potential for a tourist industry exists, but the remote location, lack of adequate facilities and limited air connections hinders development⁹.

3.2.1 Demographics

FSM's 2010 census recorded a total population of 102,843, comprising of 52,193 males and 50,650 females (Table 3). This represented a decline in population of 4178 since the 2000 census, at an average annual growth rate of -0.40%. According to the 2010 census, Yap state had a population of 11,377 (11% of FSM), with 5741 males and 5635 females, which represents a population density of 247 people per square mile. By comparison, Chuuk state had the highest population (48,654; 47% of FSM) and population density (993 people/sq mile). Yap state recorded the second highest average annual growth rate (0.12%) after Pohnpei state (0.48%), while Chuuk and Kosrae both recorded a declining growth rate.

⁸ Water for Life. 2013. Fresh Water in Micronesia: An Island-by-Island Overview Guide.

⁹ FSM Department of Transportation, Communications & Infrastructure (2015) Federated States of Micronesia Infrastructure Development Plan FY2016-FY2025

Table 3: Demographic information for FSM (source 2010 census)

Feature	FSM	Yap State	Kosrae State	Pohnpei State	Chuuk State
Land area (sq Km)	702	102	110		127.2
Land area (sq m)	271	45.6	42		49.2
Population	102,843	11,377	6,616	36,196	48,654
Male	52,193	5,635	3,352	18,371	24,835
Female	50,650	5,742	3,264	17,825	23,819
Average annual growth Rate	-0.40%	0.12%	-1.50%	0.48%	-0.97%
Population Density (person/sq mile)	379	247	156	274	993
Population -Percent urban	22.3	7.4	32.6	16.8	28.5
Population -Percent rural	77.7	92.6	67.4	83.2	71.5
Place of birth - FSM	96.9	94.4	93.9	95.3	99.0
Place of birth - Yap	10.5	92.7	0.1	0.6	0.0
Place of birth - Chuuk	47.6	0.9	0.4	2.2	98.8
Place of birth – Pohnpei	32.7	0.8	2.4	91.8	0.2
Place of birth - Kosrae	6.1	0.1	90.9	0.6	0.0
Median age (years)	21.5	25.1	21.6	21.8	20.7
Median age - male (years)	21.5	23.8	21.4	21.4	20.5
Median age – female (years)	21.9	26.4	21.9	22.2	20.9
Average family size	4.4	3.7	4.2	4.2	4.8
Average household size	6.1	4.9	5.7	5.6	6.9
No. of Households	16,767	2,311	1,143	6,289	7,024

Between 1997 and 2010, the Kosrae population declined by 12% to its current population of 6616 people (FSM Census 2010). The negative population growth is largely due to considerable out-migration to the United States and its territories. Accordingly, the working population age has dramatically declined, significantly reducing the productive work force and local production (UNFPA 2013). This trend is mainly attributed to poor economic performance and reductions in the public sector, which has traditionally been the main employer. As of 2010, the unemployment rate in Kosrae was significantly high at 23%. The significant outward migration does not necessarily translate to reduction in resource use and/or less upland development. In Kosrae, the government owns most of the upland forests above the Japanese line and with available overseas aid dominated by funding coming from the Amended Compact, public infrastructure developments on government lands are continuing.

3.2.2 Education

Education in FSM is compulsory for children aged 6 years to 13 years. FSM has a national Department of Education. Each FSM state has its own department of education that operates and manages public schools. The curriculum includes subjects such as science, mathematics, language, arts, social studies, and physical education. Public elementary and secondary schools are free for all Micronesian students. The College of Micronesia provides accredited post-secondary education from six campuses spread across all states.

According to the 2010 census, in Kosrae, 101% of 6 – 13-year-olds go to elementary school (indicating students repeating years), 93% of 14 – 17-year-olds attended high school and 25% of 18 – 24-year-olds attend college. The 2010 FSM census also showed that 85% percent of Kosraeans aged 25 years and over had completed elementary education; 55% had completed high school, and 39% had attended college or other higher level education institute with approximately 16% graduating. A further 2% were recorded as never having attended school. At the post-secondary level 12.6% of men vs. 9% of women have graduated from tertiary/vocational institutions (HIES 2013/14), although at the college level there are considerable differences between the most populated state of Chuuk (8.8% of males) and the other states (Census 2010). The FSM government has prioritised eight targets to promote life-long learning, the first six of which directly address the need for more gender sensitive and responsive interventions in education.

3.2.3 Water supply and sanitation

Most houses in Kosrae have access to water from the municipal systems as well as from roof catchment water tanks, with only a small number of people having private, gravity-fed piped sources where they have springs on their land. Municipal supplies are sourced primarily from small watersheds. No treatment is conducted of the water, resulting in unacceptable water quality for consumption due to its high level of suspended sediments, brown discoloration, and foul odour, which causes concern to the islands inhabitants and impacts on the developing tourism industry. As such, the majority of residents (59%) tend to use roof-catchment tank water for consumption, with 99% using the public water system for non-potable uses such as laundry, washing, crops and animal feeding since the public water system is not fit for drinking purposes (NIWA 2016). Most households use flushing toilets and private septic tanks. But the situation is not the same in other parts of FSM. The outer island atolls continue to suffer from long periods of drought as well as from saltwater intrusion into their water reservoir. Drought is a major threat to water resources and water supply in the small outer atoll islands of FSM with no surface water and these islands have heavy reliance on rainwater and vulnerable groundwater.

The GEF Pacific IWRM project made significant contributions to overcoming the barriers in the water and sanitation sector. Specifically, the GEF Pacific IWRM project supported improvements in natural resource and environmental management and addressed water and land development issues in the International Waters focal area. The subsequent International Waters R2R project supports demonstration of innovative approaches to Integrated Ridge to Reef Catchment Management on Kosrae Island by providing technical support through capacity building, awareness and advocacy related to the management of water resources and the provision of water supply and sanitation services (IWRM National Diagnostic Report, 2007).

3.2.4 State of Economy

In the era of Compact II (2004–2023) FSM is at a critical point in its development. In a relatively short time frame, each FSM state is challenged not only to continue developing a self-sufficient economy, but also to modernise without sacrificing valued cultural traditions and natural resource assets.

Geographical isolation and poorly developed infrastructure are major impediments to FSM's long-term growth. Over the years, agriculture's socio-cultural role as a safety net for the disadvantaged has greatly diminished. Inequality of income and the incidence of families with incomes below the poverty line are among the highest in the Pacific region. Poverty is a concern and, based on a 2008 poverty assessment (UNDP, 2008), 11% of the FSM population suffered from food poverty, while 29.9% of the population suffered from basic needs poverty. Opportunities for income generation were seen to be limited, especially in rural areas. Poverty concerns are particularly relevant because FSM's poorest populations are the most vulnerable to natural disasters.

The public sector plays a central role in the economy, and it is highly dependent on development funding. About 65% of national government revenue and 75% of states' revenues come from US aid and compact funding. The national and state-level governments employ over half of the country's workers and government services and public enterprises account for 38% of GDP.

Kosrae's GDP in 2015 was estimated at USD\$14.6 million (or USD\$1963 per person). While the population of Kosrae is partially dependent on fishing and farming for their livelihoods, non-farm activities contribute significantly to income. Major economic sectors in the State of Kosrae are marine resources, tourism, agriculture and small-scale businesses. The reopening of a fish processing and cold storage plant in Kosrae contributed to a reported 4% national economic growth rate in 2010.

The State Government owns and operates all infrastructure facilities, health facilities and most education services, small enterprises, and an extensive commercial activity in the fishery. The private sector provides employment through retail outlets, restaurants, resorts, farming and some service businesses. The employee earning per institution in 2015 was US\$1.822 million for the private sector and US\$17.051 million from the State Government. The subsistence economy is based on small-scale horticulture and fishing. These two activities are not mutually exclusive as most farmers are also fishermen. Some have livestock for food production. This traditional subsistence economy is still vital for Kosraeans, and this is an area where men, women, youth are all actively engaged in. Households that are headed by women on average earn 9% less than male headed households.¹⁰

¹⁰ FSM HIES 2013/14: Main Analysis Report.

3.3 Ecological status

3.3.1 Areas of Biodiversity Significance

Biodiversity in all of FSM is rich and abundant with high levels of endemism and is a recognised part of the globally important Polynesia-Micronesia biodiversity hotspot (CEPF 2007). Biodiversity hotspots are not only biologically rich but also threatened, usually containing at least 1500 endemic plant species and having lost at least 70% of their original surface area (CEPF 2018). In FSM, species richness declines from east to west across the country, with increasing distance from landmasses.

Among the 130 Areas of Biodiversity Significance (ABS) identified in FSM in 2002, 12 were in Kosrae, including two terrestrial, one marine, five coastal marine and two coastal freshwater ecosystems. These areas totalled about 8261 ha.

3.3.2 Important Terrestrial and Marine Species in Kosrae

There are six endemic bird species in Kosrae. Two are considered extinct as they were last recorded in the 1800s: Kosrae starling, *Aplonis corvina*, and Kosrae crake, *Zapornia monasa* (Table 4)¹¹. The other four endemic species are relatively common in their restricted range and are of Least Concern: Caroline reedwarbler, *Acrocephalus syrinx*; Caroline swiftlet, *Aerodramus inquietus*; Kosrae fruit-dove, *Ptilinopus hernsheimi* and Kosrae white-eye, *Zosterops cinereus*. The Caroline reedwarbler, Kosrae fruit-dove and Kosrae white-eye are found across a range of habitats, while the Caroline swiftlet prefers caves and subterranean habitats. In addition, there are two additional, restricted-range bird species, including the Critically Endangered migratory species, Beck's petrel *Pseudobulweria becki*; and the Micronesian imperial-pigeon, *Ducula oceanica*, which is considered Near Threatened.

Table 4: Restricted-range and threatened birds of Kosrae (source Birdlife International)

Common name	Scientific name	IUCN Category	Comments	Habitat
Non-migratory species				
Kosrae starling	<i>Aplonis corvina</i>	Extinct	<i>Aplonis corvina</i> was endemic to Kosrae. It is only known from two specimens collected in 1828 and was extinct by 1880.	It inhabited mountain forests.
Kosrae crake	<i>Zapornia monasa</i>	Extinct	<i>Zapornia monasa</i> was endemic to Kosrae. Two specimens were collected in 1827–1828, and the species was regarded as uncommon then. It declined to extinction over the next half-century.	It inhabited coastal swamps and marshes, taro patches and "continually wet, shadowy places in the forest.

¹¹ BirdLife International (2021) Micronesia, Federated States of

Common name	Scientific name	IUCN Category	Comments	Habitat
Caroline reedwarbler	<i>Acrocephalus syrinx</i>	Least Concern	Endemic to FSM	Found in subtropical/tropical dry grasslands but has also been recorded in subtropical/tropical moist montane forest and rural gardens
Caroline swiftlet	<i>Aerodramus inquietus</i>	Least Concern	Endemic to FSM and is described as common to abundant. The population on Yap has not been quantified but the species' population in the rest of its range is estimated to be 83,500 individuals.	Found in caves and subterranean habitats (nonaquatic) but can also occur in subtropical and tropical moist lowland forest
Kosrae fruit-dove	<i>Ptilinopus hernsheimi</i>	Least Concern	Endemic to Kosrae and RMI	Prefers subtropical/tropical mangrove vegetation above high tide level but also found in subtropical/tropical moist lowland forest, subtropical/tropical moist forest, and rural gardens
Kosrae white-eye	<i>Zosterops cinereus</i>	Least Concern	Endemic to Kosrae	Kosrae State Bird. Found across a range of habitats including subtropical/tropical moist lowland and degraded former forests, subtropical/tropical seasonally wet/flooded grasslands, dry savanna, subtropical/tropical moist shrubland, plantations and arable land

Approximately 421 flora species occur in Kosrae including 75 ferns, two gymnosperms, 82 monocots (76 natives, 20 introduced) and 227 dicots (195 natives, 53 introduced)¹². Kosrae has the highest percentage of native species (83%) of all the FSM states, with the flora of other states composed of 60% – 63% native species. There are three IUCN listed threatened flora species (one Endangered and two Vulnerable); and one near threatened (NT) flora species associated with Kosrae. Of these species, one species (NT) is not endemic to Kosrae, but instead a cultivar from the islands of Pohnpei and Chuuk (*Metroxylon amicarum* – Ivory nut palm). Two of the threatened species are lowland forest tree species (*Intsia bijuga* – thorrot, *Pterocarpus indicus* - lach), with *Pericopsis mooniana* from coastal forest and *Cycas micronesica* – from closed forest. The other threatened species, *Dendroceros japonicas*, is a hornwort that grows on tree-trunks or occasionally rocks, in temperate and subtropical evergreen forest.

Kosrae also supports 18 endemic plant species, with a further 20 found only in the Eastern Carolines (Kosrae, Pohnpei and Chuuk) and one species only found in Kosrae, Pohnpei and Palau (see Table 8). In addition, 19 endemic species are found across the Caroline Islands (FSM and Palau), including Kosrae.

¹² Josekutty P.C., Wakuk E.E. and Joseph M.J. 2002. Invasive/Weedy Angiosperms in Kosrae, Federated States of Micronesia. *Micronesica* Suppl 6:61-65.

Table 5: Endemic plant species specific to Kosrae (source: Costion et al. 2012)

Species	Distribution	Form	Notes
Endemics limited to Kosrae			
<i>Selaginella kusaiensis</i>	Kosrae	Herb	often occurring along rocky stream banks or moist rocky outcroppings
<i>Elaphoglossum kusaiense</i>	Kosrae	Herb	
<i>Peperomia kusaiensis</i>	Kosrae	Epiphyte	epiphytic in the cloud forests of Kosrae
<i>Agrostophyllum kusaiense</i>	Kosrae	Epiphyte	Orchid
<i>Bulbophyllum fukuyamae</i>	Kosrae	Epiphyte	Orchid
<i>Bulbophyllum kusaiense</i>	Kosrae	Epiphyte	Orchid
<i>Phreatia kusaiensis</i>	Kosrae	Epiphyte	Orchid
<i>Rhynchophreatia pacifica</i>	Kosrae	Epiphyte	Orchid
<i>Robiquetia kusaiensis</i>	Kosrae	Epiphyte	Orchid
<i>Pandanus amissus</i>	Kosrae	Tree	
<i>Pandanus kusaicolus</i>	Kosrae	Tree	
<i>Polyscias subcapitata</i>	Kosrae	Tree	
<i>Cyrtandra kusaimontana</i>	Kosrae	-	
<i>Medinella diversifolia</i>	Kosrae	WL	
<i>Psychotria hosokawae</i>	Kosrae	Tree/shrub	
<i>Psychotria rhombocarpa</i>	Kosrae	Tree/shrub	
<i>Planchonella micronesica</i>	Kosrae	-	
<i>Elatostema fenkolense</i>	Kosrae	Herb	
Endemics limited to Kosrae and Carolines			
<i>Cinnamomum carolinense</i>	Carolines (Pohnpei, Kosrae and Palau)	Tree	
Endemics limited to Kosrae and Eastern Carolines			
<i>Selaginella kanehirae</i>	Eastern Carolines (Kosrae and Pohnpei)	Herb	
<i>Dicranopteris weatherbyi</i>	Eastern Carolines (Kosrae and Pohnpei)	Herb	
<i>Terminalia carolinensis</i>	Eastern Carolines (Kosrae and Pohnpei)		large, buttressed tree found in the swamp forests
<i>Elaphoglossum carolinense</i>	Eastern Carolines	Herb	
<i>Diplazium ponapense</i>	Eastern Carolines	Herb	
<i>Ponapea ledermanniana</i>	Eastern Carolines	Tree	
<i>Hypolytrum dissitiflorum</i>	Eastern Carolines	Herb	
<i>Mapania pacifica</i>	Eastern Carolines	Herb	

Species	Distribution	Form	Notes
<i>Dendrobium carolinense</i>	Eastern Carolines	Epiphyte	Orchid
<i>Dendrobium ponapense</i>	Eastern Carolines	Epiphyte	Orchid
<i>Freycinetia ponapensis</i>	Eastern Carolines	WL	
<i>Garcinia ponapensis</i>	Eastern Carolines	Tree	
<i>Elaeocarpus carolinensis</i>	Eastern Carolines	Tree	
<i>Elaeocarpus kusaiensis</i>	Eastern Carolines	Tree	
<i>Elaeocarpus kusanoi</i>	Eastern Carolines	Tree	
<i>Cyrtandra urvillei</i>	Eastern Carolines	-	
<i>Syzygium stelechanthum</i>	Eastern Carolines	Tree/shrub	
<i>Maesa carolinensis</i>	Eastern Carolines	Tree/shrub	
<i>Hedyotis ponapensis</i>	Eastern Carolines	Herb	
<i>Timonius ledermannii</i>	Eastern Carolines	Tree	
<i>Elatostema kusaiense</i>	Eastern Carolines	Herb	

There are two endemic species of bats of the genus *Pteropus* occur in Kosrae state. These two species include the Kosrae flying fox (*Pteropus ualanus*; Vulnerable) and the Kosrae fruit bat (*Pteropus mariannus ualans*; Endangered), both of which are endemic to Kosrae¹³. There are also three threatened reptiles known to occur in Kosrae. Two migratory marine turtle species nests on beaches in Kosrae – the hawksbill (*Eretmochelys imbricate*) listed as Critically Endangered, and the green turtle (*Chelonia mydas*), which is listed as Endangered. The other reptile is the Micronesia saw-tailed gecko (*Perochirus ateles*), which is endemic to the Marianas Islands and FSM and listed as Vulnerable. No threatened invertebrate species listed on the IUCN Red List are known to occur in Kosrae.

3.3.3 Major Threats and Concerns

Besides the ongoing pressures brought about by climate change, biodiversity in Kosrae and FSM faces a number of other threats including habitat loss, invasive species and over-exploitation, and pollution (Kingsford et al. 2009). An assessment of the proportions of selected amphibians, birds, mammals, and plants affected by different threats by Kingsford et al. (2009) suggested that 90% of assessed species in FSM are affected by habitat loss, 38% by invasive species, 48% by over-exploitation and 10% by pollution. Whilst the numbers of species assessed in this analysis were fairly low, this does illustrate the pressure that biodiversity in FSM is under.

¹³ Wortel O. 2010. Federated States of Micronesia Fourth National Report on the Convention on Biological Diversity.

4. RIDGE TO REEF MANAGEMENT IN KOSRAE, FSM

4.1 Natural resources

4.1.1 Freshwater

There are six sources of freshwater on Kosrae: wells and springs (groundwater), streams, dams, swamps, and rainwater catchments attached to tin roof buildings or structures (Figure 4). The abundance of rainfall on the island provides regular and consistent supply of freshwater. The island's abundant rainfall averages 200 inches (5080 mm) near the coast and 240 inches (6096 mm) in the mountainous interior¹⁴.



Figure 4: Important watersheds of Kosrae¹⁵

A Central Watershed Reserve known locally as “Mahkontowe” has been designated by the Kosrae State Government¹⁶. It encompasses the steep mountain slopes in the central part of the island. By encompassing the steepest land, the most erosive soils, and the upper elevations with the highest rainfall, the reserve would protect the most sensitive parts of the island's watersheds. The Kosrae Land Use Plan also recognises eleven primary watersheds draining into dams that supply water to the villages (Kosrae Land Use Plan 2003):

- Mutunte River Basin
- Yekula River Basin

¹⁴ Pacific Adaptation to Climate Change: Inception Workshop Presentation 2009, https://www.globalsupportprogramme.org/sites/default/files/downloads/pacc_fsm_inception_meeting_presentation.pdf

¹⁵ U.S. Forest Service and the FSM. 2010. Federated States of Micronesia State-Wide Assessment and Resource Strategy 2010–2015+.

¹⁶ <https://irma.kosraestate.gov.fm/mca/>

- Pukusruk River Basin
- Innem River Basin
- Tofol River Basin
- Tafuyat River Basin
- Malem River Basin
- Mosral River Basin
- Palusrik River Basin
- Tafuot River Basin
- Walung River Basin

Streams and rivers discharging from the catchments are filtered through the various areas of freshwater, brackish and mangrove swamp. The hydrology of these low-lying swamp and mangrove areas is complex. However, during the Japanese era, many of the rivers and streams were straightened to aid drainage to support intensive agriculture, and a runway was developed within the freshwater swamp between Yeseng and Mosral in the Municipality of Malem. This results in rivers discharging straight to the reef flat which, despite the healthy vegetative cover in the catchment, can result in high suspended sediment loads during periods of heavy rain.

Relatively little water seeps through the soil and into cracks and pores in the volcanic rocks. Groundwater is, therefore, not an important water source on Kosrae. There are, however, many natural springs that supply water from the ground and are highly respected as sources of clean water for the local communities.

4.1.2 Integrated Coastal Zone Management (ICZM)

Under the FSM constitution, each state has the power to function as a semi-autonomous government, able to enact its own legislation to address issues relating to natural resources, and each state has its own set of environmental laws and regulations. State governments hold jurisdiction over coastal waters up to 12 nautical miles from land. Beyond this, the FSM national government has jurisdiction over the remainder of the EEZ, i.e., from 12 nautical miles to 200 nautical miles from land (FSM NBSAP 2018).

Kosrae coastal zone is managed under its CZM strategy, known as the Kosrae Shoreline Management Plan (SMP). Amongst the FSM states, only Kosrae has developed its coastal zone management strategy (Ramsay et al. 2013). This strategic plan addresses coastal zone management in view of adverse impacts of coastal hazards and climate change on development and infrastructure of Kosrae. The SMP was developed with considerable community consultation between 1998 and 2000 and updated with further consultation in each municipality in 2013. The SMP sets out the principles for coastal development in Kosrae over the coming decades, and details eight key strategies for responding to climate change and sea level rise and increasing the resilience of Kosrae's coastal communities over the next one to two generations (20 – 50 years).

Table 6: Kosrae Coastal Zone Management Strategies

Strategies	Description
Strategy 1	Continued development and strengthening of community awareness including outreach activities with a focus on effective natural coastal defence and Kosrae-relevant climate change impacts and adaptation options.
Strategy 2	Amendment of the KIRMA Regulations for Development Projects to incorporate climate change considerations and strengthening of regulation implementation to support successful long-term risk reduction and adaptation.
Strategy 3	Over the next one to two generations the primary coastal road network and associated infrastructure currently located on the beach/storm berm is developed inland away from long-term erosion and coastal inundation risk
Strategy 4	Ensure new development (property, infrastructure) is located away from areas at risk from present and future coastal hazards or is designed with coastal hazards in mind.
Strategy 5	Implement a program to encourage existing residential property owners to reposition homes away from areas of high risk from present and future hazards. This may be a staged approach over time as homes are routinely replaced or renovated. Objective prioritization of properties most at risk should also be explored.
Strategy 6	Incorporate a grant component into the housing loan program to help encourage new property to be constructed in areas not exposed to coastal, river floor or landslide hazards.
Strategy 7	Commence community and state discussions to develop a relocation strategy and identify potential approaches to support relocation from areas exposed to coastal hazards where no alternative land is available.
Strategy 8	A strategic approach is adopted for the ongoing provision of coastal defenses. These should be considered only where: <ul style="list-style-type: none"> -- it is a sustainable long-term option, or --where it is accepted as a transitional approach to protecting areas over the short to medium term to enable relocation

In Kosrae, a shift in coral composition was observed over the period 1986–2016. The branching *Acropora* species were spatially consistent around Kosrae’s reefs in 1986, but in 2015, *Acropora* spp. were mainly restricted to the high wave energy zones around the islands (McLean et al. 2016). High wave energy reefs in 2015 were characterised by branching and foliose growth forms coral species, while low wave energy reefs were dominated by massive *Porites* and *Galaxea* corals.

These changes in coral species composition are driven by fishing pressure. Fishing pressures remove predators and large herbivores, thus reducing overall resilience of coral reefs. The impact of elevated water temperature and freshwater runoffs due to typhoons and cyclones has also contributed to the shift in live coral cover and distribution around the island coastal areas. It is uncertain exactly which factor(s) potentially cause such trends in coral cover and fish composition and distribution. The trend observed in Kosrae reefs was observed in other FSM states as well, where changes in species composition were also influenced by environmental conditions.

4.1.3 Land Rehabilitation

Kosrae has a relatively large area of land and forests that are still not developed. The small population on the island and high rate of migration to the US mainland may be why the forest and untouched biodiversity remain protected. However, there are plans to allow settling in higher uplands and away from the coastal zone. Land clearance to allow developments will impact on the ecosystem goods and services, including export of sediments through the rivers downstream to coastal areas.

Rehabilitation of degraded forest and mangroves in Kosrae is an ongoing focus for environmental agencies of the government and their NGO and community partners. Efforts have been consistently made by these local environmental groups to maintain and restore degraded areas impacted by development and overharvesting of trees for timbers and firewood. According to Kosrae Forestry Office, over the past five years, more than 5000 native coastal plants and 10,000 mangrove seedlings were planted throughout Kosrae’s coastal forest and mangrove areas. These replanting efforts involved participation of youth, women, and various community groups.

4.1.4 Forest

The cover and distribution of vegetation/habitat types on Kosrae is shown in Table 7. This shows that the upland forest is the dominant vegetation type (46% coverage) and occupies the central portions of the island. Agroforest is the next dominant vegetation/habitat type occupying 23% of Kosrae. Agroforest is found around the coastal fringe, especially on the northern, eastern, and southern fringe. Mangrove forest (14%) is more prominent on the northeast, western and southern shorelines. Secondary vegetation (11%) is dispersed across the island. Other vegetation types (dwarf forest, swamp forest and non-forest types) make up a minor component of the vegetation/habitat types of Kosrae island (Falanruw 2002).

Table 7: General vegetation/habitat types of Kosrae ¹⁷

Major land class/ habitat type	Vegetation/habitat type	Cover in 1983 (ha)	Percent cover
Closed Forest	Mangrove	1562	14%
	Swamp Forest	345	3%
	Upland Forest	5090	46%
Agroforest	Agroforest	1659	15%
	Agroforest with coconuts	926	8%

¹⁷ Falanruw M. 2002. Terrestrial Biodiversity of the Federated States of Micronesia. Prepared for the FSM National Biodiversity Strategy and Action Plan Project

Major land class/ habitat type	Vegetation/habitat type	Cover in 1983 (ha)	Percent cover
Shrub	Dwarf Forest	69	1%
	Secondary vegetation	1272	11%
Nonforest	Nonforest (grasslands, savannah, developed/ disturbed areas, marshes)	263	2%
Total Area		11,186	100%

These forests help to conserve and shelter Kosrae’s animal species and terrestrial biodiversity and provide resources such as firewood, lumber, **food, local medicine, etc. to the local communities.** Forests prevent severe soil erosion and play a key role in sequestering carbon, keeping a check on the global temperature. The role played by forest ecosystems for the well-being of the Kosrae and the FSM population, highlights the importance of managing and protecting these ecosystems from degradation and destruction.

4.1.5 Minerals

In FSM, subsurface property rights are synonymous with surface rights such that there are no state-owned subsurface mineral or water rights in any of the states. FSM citizens treat land as their most significant asset and leasing of private lands can be time-consuming due to fractional ownership and uncertain boundaries and titles. In addition, there are privately-owned quarries for sand, gravels, and rocks in Kosrae. The largest operational quarry is the Puk Quarry, which can produce roughly 60 cubic yards of gravels and black sand per day, according to the Construction & Engineering Division of the Kosrae Department of Transportation & Infrastructure.

4.1.6 Biological

A number of flora and fauna are commonly found in the watersheds of Kosrae. *Sonneratia alba* and *Nypa fruticans* are often the most dominant trees found at the mouths of most rivers in Kosrae. Various other species of mangroves are often established upriver including *Rhizophora apiculata*, *Rhizophora stylosa*, *Rhizophora mucronata*, *Rhizophora x lamarckii*, *Bruguiera gymnorrhiza*, and *Lumnitzera littoralis*. Further upriver where the freshwater wetlands are located, the *Hibiscus tiliaceus*, *Inocarpus fagifer*, *Xylocarpus granatum*, *Derris trifoliata* and the grasses *Ischaemum polystachium* and *Phragmites karka* are dominant. The common trees and ferns in the upland part of the river include: *Terminalia carolinensis*, *Horsfeldia irya*, *Neubergia celebica*, *Camptosperma brevipetiolata* and *Hibiscus tiliaceus*. Ferns are common too: *Asplenium nidus*, *A. laserpitifolium*, *Nephrolepis obliterated*, *Angiopteris evecta*, *Bolbotis heteroclita*, *Sphraopteris lunulata* and *S. nigricans*, *Antrophyllum callifolium*, *Davalia solida*, *Tectaria grandiflora* and *Huperzia phlegmaria*. The grasses *Ischmaemum polystachium*, *Phragmites karka*, *Bambusa vulgaris* and *Centosteca lappacea* are also common. A mixed of different vegetations and ferns are found in the upper reaches of Kosrae watersheds (Maxwell 1982). Most endemic plants in Kosrae are found at higher elevations and include *Astrodinium carolinense*, *Bulbophyllum fukuyamae*, *Cyrtandra kusaimontana*, *Elatostema kusaiense*, *Medinella diversifolia*, *Psychotria rhombocarpa* and *Syzygium stelanchantoides*.

The fauna found in the estuaries are: fishes – *Lutjanus fulvus*, *L. argentimaculatus*, *Crenimugil crenilabis*, *Siganus punctatus*, *Chanos chanos*, *Periophthalmus argentilineatus*. The more prominent fishes are the mudskippers and the snappers. Birds found in this area include the Pacific reef heron, the white-eyes, and starlings. The invertebrates such as gastropods, *Neritina variegata*, *Septaria* sp. and *Littorina* sp. are the dominant species. The crustaceans include the *Uca crassipes* fiddler crab, and the *Sesarma* sp. (Tikuhl). All these crustaceans are common in the estuary. Monitor lizards can also be found there.

Fauna in the upland part of the rivers includes the gastropods *Neritina pulcherina*, *Neritina* sp., a *Septaria* sp. and another unidentified snail. The *Septaria* found upriver has different pattern of lines in the shell than the *Septaria* found in the estuary. Also, they are found in different salinities. The researcher was unable to identify the species. Shrimps present and common here include: *Machrobrachium lar*, *M. latimanus* and *Caridina* sp. Fishes here are: *Kuhlia rupestris*, *Stiphodon elegans*, *Stiphodon caeurulus*, *Anguilla marmorata* and an unidentified fish. The *Kuhlia* and the two gobies are common in this area. The gobies will be the fishes to reach the highest reaches of the rivers, because of their abilities and adaptations to climb the steep rivers and waterfalls. Two dragonflies were seen: *Diplacoides bipunctata* and *Tholomys tillagra*.

Fauna found in the upper portion of the watersheds include the threatened Micronesian imperial pigeon (Ule), and the endemics: fruit dove (Fon) and white-eye (Tuhram). Other birds found here are the starling (Wac) and the migratory island cuckoo, *Eudynamys taitensis* (Won Pangpang Mos). All the bird species populations are stable except for the imperial pigeon, which is hunted, and their numbers are low. Various skinks and geckos are also found the upper portion of the watersheds in Kosrae (Buden et al. 2016).

4.2 National Protected Areas

Across the FSM, government, NGO, and community partners have worked closely together to establish state and municipal, legislated and/or community-declared protected areas covering a wide range of marine and atoll ecosystems. The reasons for prioritising protected areas include the need to protect endemic species, control and reduce extent of indiscriminate over-harvesting of targeted biodiversity of flora and fauna; and meet FSM's international obligations, including that of the UN sustainable development goals such as life beneath and above water, and the Micronesia Challenge. In addition, effective protected areas result in more resilient ecosystems, which are better able to withstand the impacts of climate change. Marine protected areas have also been proven to be one of the best ways to protect diverse and healthy marine ecosystems and coral reef communities (FSM NBSAP 2018).

In 2010, the Kosrae State Protected Areas Act of 2010 was signed into law. The law provides legal protection to marine and terrestrial areas designated into the Protected Areas System through a process authorised by the Act. The law specifically requires each community-declared protected area to have a conservation management plan for the site to be considered for legal protection and status by the government.

Since 2010, several protected areas were designated. Some have now been legally recognised and gazetted and are included in the Kosrae Protected Areas System. The law mandates the KIRMA Administrator to administer the Kosrae Protected Areas System in consultation with the mayors of the municipalities of Kosrae.

Key terrestrial protected areas of Kosrae are listed in **Table 8** and include:

Yela Ka Forest is a conservation area of ka trees (*Terminalia carolinensis*) in the Yela Valley on the island of Kosrae in the Federated States of Micronesia. A conservation easement, the first achieved outside the Americas, protects 78 acres (31.6 ha) of the 1400-acre (567 ha) valley.

Olum Watershed Protected Area is an ABS site (310.3 ha) with native upland forest that includes cultural and historical sites. The area is managed by KIRMA in partnership with landowners.

Mahkontowe Conservation Area was enacted into Kosrae State Law 11-156 on June 7, 2018. This area refers to a 15 square kilometre area (1500 ha), which hosts a variety of significant cultural, archaeological, and natural aspects (Figure 5).

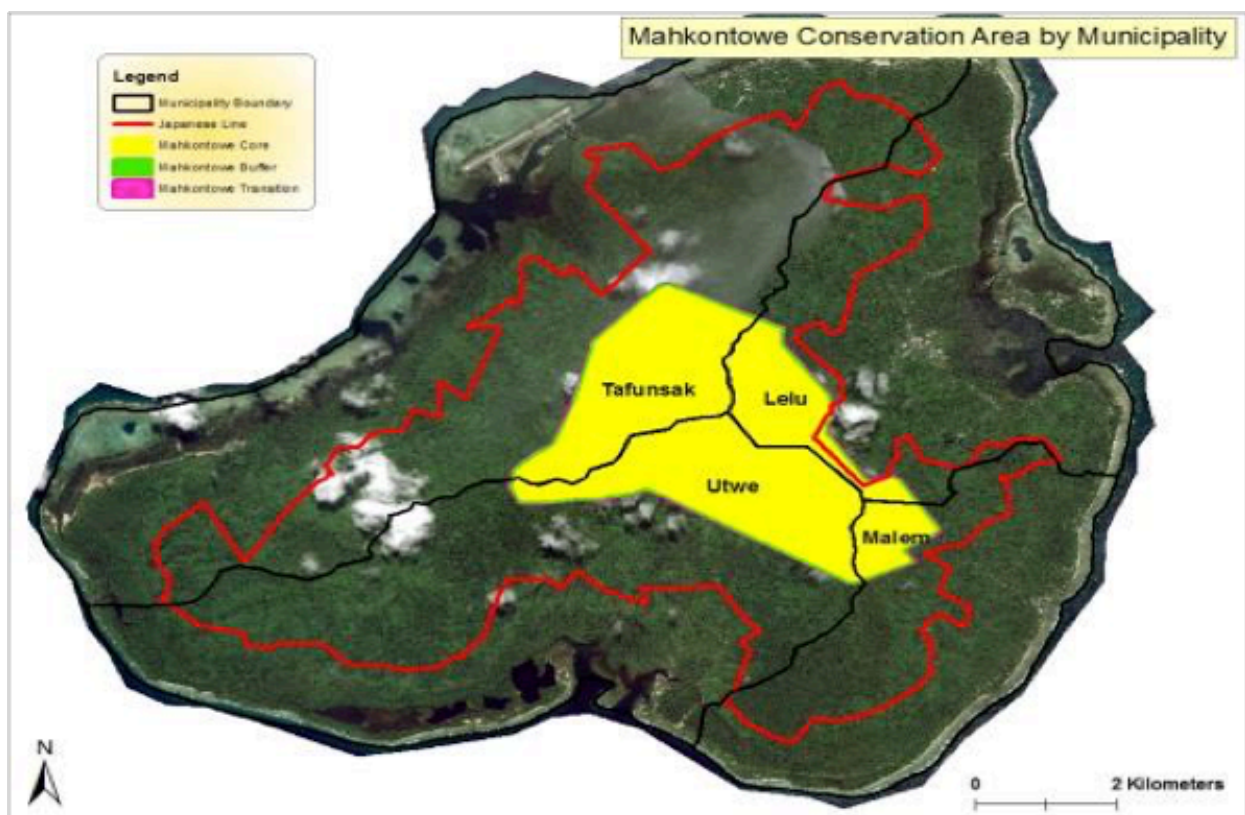


Figure 5: Mahkontowe Conservation Area (yellow)

Table 8: List of protected areas in Kosrae¹⁹

0	Protected area name	Terrestrial or Marine	Area (ha)	Gazetted
1	Tafunsak MPA	Marine	58.8	yes
2	Utwe Biosphere Reserve (includes the Utwe- Walung Marine PA)	Marine	130.88	yes
3	Awane MPA	Marine	131.2	yes
4	Tukasungai (<i>Trochus niloticus</i>) Sanctuary	Marine	277.8	yes
5	Olum Watershed PA	Terrestrial	310.3	no
6	Pikensukar MPA	Marine	20	no
7	Kuuplu Mangrove Forest Reserve	Terrestrial	44.8	no
8	Tukunstrup MPA (Mangrove Forest)	Marine	150A	no
9	Yela Ka Forest	Terrestrial	520.3	yes
10	Mahkontowe Conservation Area	Terrestrial	1500	yes

Other than the legislations on protected areas, the FSM National Protected Areas Network Policy Framework (NPANPF) also provides policy guidance in the establishment and management of protected areas. The NPANPF was developed and endorsed in September 2018. It outlines a transparent, fair, and efficient system governing the designation and operation of a nationwide protected areas network, inclusive of state-level protected area networks in Kosrae and the rest of the FSM states.

This nationwide network is designed to facilitate the national government’s delivery of assistance to its states in the protection of significant areas of biodiversity, key habitats, and other valuable resources. The NPANPF establishes procedures for the management entities of protected area sites to apply to join the protected area management network and outlines the benefits of membership in the nation-wide network, including access to long-term and sustained technical and financial assistance.

4.3 Island Vulnerability

4.3.1 Types of Disaster

FSM is among many small island countries with the highest vulnerability to natural hazards, including typhoons, droughts and flooding. Climate change has the potential to raise the frequency and intensity of these threats, bringing new threats, in the form of coastal flooding and seawater inundation from sea level rise. The highest elevation of low-lying atolls in the FSM is only a few metres above sea level. Under various climate change scenarios, there is a real possibility these low-lying atolls will see a considerable reduction of their landmass.

This climate change concern is also present for Kosrae and other high islands in the nation. Due to sea level rise, high islands are experiencing a reduction of their landmass with increased land

¹⁸ Wortel O. 2010. Federated States of Micronesia Fourth National Report on the Convention on Biological Diversity.

fragmentation. The road and other coastal built infrastructures are impacted by coastal flooding and erosion. Coastal taro swamps and farmlands are also being inundated and destroyed by the sea water. The isolation from major markets and dependency on imports by sea and air means food security and livelihoods on the vulnerable islands like Kosrae can be seriously impacted by natural hazards and climate change.

4.3.2 Issues and Concerns – natural vulnerability and resilience

Natural variability contributing to vulnerability in Kosrae includes:

1. Natural climate variability resulting in shoreline repositioning.
2. El Nino Southern Oscillation (ENSO) events affecting rainfall and sea levels (2–5 year cycle).
3. Decadal/Interdecadal Pacific Oscillation (20–30 year cycle).
4. Typhoon Activities.

Ongoing development practices in hazardous areas and areas close to the coast have enhanced levels of vulnerability and worsen the impacts of coastal hazards. In Kosrae, most public infrastructure are located near the coast and are exposed to these hazards. Key human-induced drivers of vulnerability include:

- Sand and coral rubble removal from the reef flat (particularly along Kosrae’s east coast between Finaunpes and Mosral).
- Beach mining (removal of sand, gravel, and cobble) from the beach, primarily for construction aggregates.
- Dredging of the reef flat in front of the Tafunsak Village.
- Stream outlet repositioning or changing swamp drainage patterns and flows.
- Inappropriate building of seawalls, exacerbating erosion elsewhere or resulted in further development in high-risk areas.
- Land reclamation in areas already prone to flooding.
- Shoreline protection solutions which disregard coastal hazard risk reduction.
- Road development across wetlands/mangrove areas, and reclaimed lands.

Table 9: Kosrae’s Natural and human-induced hazards (Kosrae Shoreline Management Plan)

Key Natural Hazards	Key Human Induced Hazards
Higher-than-normal high tides (occur every year usually between December and February and associated with strong phases of La Nina)	Fire
Large sea swells (caused by north Pacific storms, occur once in a generation)	Contamination of water supply
Tropical storms and typhoons (occur once in a lifetime and usually affect the eastern southern and northern coastlines)	Outbreak of epidemic diseases

Key Natural Hazards	Key Human Induced Hazards
Drought	Commercial transport accidents
Rain-induced landslide (primary forest is still intact which decreases the risk of landslides)	Dam failure (no recorded events amongst Kosrae's 12 water tanks/catchments)
Earthquake (no reported events)	Hazardous materials accident
Tsunami (no recorded disaster events)	

4.3.3 Issues and Concerns – Solid and Liquid Wastes

As with other states of Micronesia, waste management in Kosrae is a continuing challenge, with unsatisfactory solid waste disposal and collection service. Improper disposal of waste causes local pollution problems. Disposal of scrap metal is also a continuing problem, with abandoned vehicles a source of pollution from chemical leakage. The recent increases in urbanisation and the importation of non-biodegradable materials and chemicals have brought with them ever-increasing pollution problems and the urgent need for proper collection, disposal, and management programmes for wastes. The current level of pollution from solid and liquid waste in Kosrae is increasing, particularly in areas where the main population concentrates.

Steps are being taken across states of the FSM to improve management of waste. In Kosrae, the centralised landfill in Tofol utilises the Fukuoka Method to manage municipal waste and garbage (FSM, 2018). This method is being replicated in other parts of FSM. Additionally, a recycling programme is in place in Kosrae to deal with aluminium, plastic bottles, and glass, which are then shipped abroad for further processing.

According to the 2010 census, most households (98%) in Kosrae have flushing toilets and private septic tanks (94%) with draining services available. Once the primary tanks are full, homeowners pay \$100 to the Department of Transport and Infrastructure to drain the septic tanks and transport the sewage to the oxidation pond located in Tofol. Lelu used to be the only municipality maintaining a public sewer system, with raw sewage from each household or commercial unit being treated through a primary treatment process. Today, raw unprocessed sewage is disposed through an outfall pipe away from the mouth of the Lelu harbour.

The issues of wastes getting into the underground water and surface water systems causing contamination and pollution are real and challenging. It is recommended that innovative technologies such as dry litter compost may be considered or use of sand filter systems or other form of improved systems considered in by the authorities. There are expensive options to invest in proper sewage processing facilities with sewer lines linking to households. Another option is to channel the outfall pipe to allow discharge to take place below the thermocline. This practice is used in other Pacific SIDS to avoid detrimental effects on the biodiversity and in turn local population.

5. INSTITUTIONAL, LEGAL AND POLICY FACTORS

5.1 Institutional Arrangements

FSM is a constitutional democracy with an overarching national government retaining responsibility for negotiating and entering into multilateral environmental agreements. The national government is based in Palikir, Pohnpei, and is comprised of executive, legislative and judicial branches. Each of the four states has its own constitution, elected legislature, and governor. Each state has the power to function as a semi-autonomous government.

5.2 Coordination Mechanisms

The states can enact their own laws and legislations to address issues relating to natural resources within the state jurisdiction. Each state has its own set of environmental laws and regulations. State governments hold jurisdiction over coastal waters up to 12 nautical miles from land. Beyond this, the national government has jurisdiction over the remainder of the EEZ, i.e., from 12 nautical miles to 200 nautical miles from land.

The States take the lead role in ensuring that development is avoided in vulnerable areas and ensuring that critical natural systems are protected. Each state has made efforts to control development and manage natural resources through the creation of land use plans, coastal zone plans, legislation, and regulations. The national government provides guidance and technical assistance to the states when needed and requested on matters related to planning, economic development, natural resources, fisheries, and the environment.

5.3 Monitoring, Enforcement and Compliance

In Kosrae, the Kosrae Island Resource Management Authority (KIRMA) has autonomous responsibility for State Environmental Impact Assessment (EIA) Regulations and other environment-related legislation. Activities undertaken by the national government, or its agencies, are assessed under the National Act. Otherwise, activities are assessed under the state-level legislation and regulations.

5.4 Issues and Concerns

As seen in other states of FSM, the laws are poorly monitored, with low enforcement and compliance. This possibly has to do with the level of resources to support such work, or possibly due to poor commitment. For example, the code for constructing piggery house is not necessarily followed by local farmers in Kosrae. Current piggeries are of great concern due to the impact on water quality and human health. Inadequate sanitation, pits and open defaecation contaminate freshwater and increase the likelihood of disease breakout among the population. In a survey conducted in 2018 by KIRMA, it was determined that a greater number of sites for coastal waters and rivers were below recreational standards where bathing is not allowed.

Sometimes the attitudes of local population to comply can be assisted through simple traditional talks and consultations.

6. PUBLIC AND STAKEHOLDER PARTICIPATION

An essential part of any project preparation in Kosrae is the consultative process and the ongoing engagement of community and relevant stakeholders in the planning and implementation. This is particularly so in R2R management.

Involvement and participation of stakeholders from government, NGOs, communities, and representation of men, women, youth, disability other groups across the states is necessary to ensure that views and responses of the stakeholders are captured and considered.

Proper community engagement allows for community members to have a greater sense of belonging and responsibility to participate and support projects and/or activities. There are no traditional protocols to follow in Kosrae when it comes engaging stakeholders and there are various ways to engage communities.

7. NATIONAL PRIORITY ISSUES

7.1 Introduction to Key Problems

The following three environmental problems were identified as priority issues of concerns during the IDA workshop:

- Invasive species
- Coastal erosion
- Solid & Liquid Waste

7.2 National Priority Issue 1 – Invasive Species

7.2.1 Description of problem and its national importance

Small islands are particularly vulnerable to the impacts of alien and invasive species. The impact of invasive species translates to impacts on human well-being, since invasive species can reduce the ability of ecosystems to provide the arrays of goods and services that many of the people of the FSM are dependent on. Across the FSM a number of introduced plants and animal species have become increasingly widespread. The pathways of entry of invasive species into the FSM are the air and shipping services. Introduced species account for 22% of plants in Kosrae, 40% in Pohnpei, 37% in Chuuk and 39% in Yap (NBSAP 2018). The IUCN Invasive Species Specialist Group identified 592 introduced species considered invasive or potentially invasive; among these 89% are plant species, approximately 10% are animals and the remaining percentage is represented by small bacteria, fungi, and virus. Several invasive species established in the FSM are of concern for the natural environment and biodiversity of the country, as well as economic and health impacts for the population.

There are clear effects of invasive species on *Kosrae's ecosystem* and the welfare of people of Kosrae. The key environmental impacts, environmental and socio-economic consequences of invasive species together with the economic sectors that caused the impacts and consequences (Table 10.)

Table 10: Environmental and Socio-economic Impact of Invasive Species

Environmental Problem	Environmental Impacts and socio-economic consequences	Sector	Locations
Invasive Species	Loss of endemic food crops, soil erosion and loss of fertility, disrupted ecosystem composition, degraded near shore breeding grounds and decrease in commercial fish species	Shipping	<ul style="list-style-type: none"> • Inshore marine areas around Kosrae • Areas of extensive land degradation in Kosrae • Whole of Kosrae
	Loss of species, cultural heritage, genetic diversity	Agriculture	
	Reduction of recreational value, loss of income from fisheries and traditional use of forest resources, loss of access to subsistence food sources, increase in imported food consumption	Infrastructure and development	
		Community practices	

7.2.2 Immediate, underlying and root causes

The following shows the primary causes, underlying causes, and root causes of the problem “invasive species” in Kosrae.

Primary/Immediate Causes

- Historical introduction of foreign opportunistic species
- No natural predators for introduced species
- Deforestation and land clearing
- Newly cleared land available for fast growing invasive species to thrive

Underlying Causes

- Increase priority on development
- Demand for construction materials and land

Root Causes

- Inadequate control management measures or monitoring for spread
- Lifestyle expectations changing faster than the measures to manage change
- Underdeveloped legislation or enforcement of development

7.3 National Priority Issue 2 – Coastal Erosion

7.3.1 Description of problem and its national importance

Coastal erosion has been a problem for Kosrae’s communities for years now. It was identified by the Walung community in 2015 as one of three key hazards during a vulnerability assessment conducted by Kosrae Conservation & Safety Organization (NGO) and its partners. Walung coastline has been devastated by strong waves and high tides over the years and, since more than 90% of Walung’s population live on coastal areas, coastal erosion has become a challenging threat to the community livelihood. Coastal erosion was also identified by the Malem through a process called the Local Early Action Planning process (LEAP) as a threat. Malem community noted that chronic erosion has occurred since the 1970’s, when the first seawall was built. They have witnessed a decline in coastal trees, rocks, and sand along the shoreline. Mangrove trees along the shoreline that used to be dominant are not present anymore, but some patches of mangroves are slowly coming back. Infrastructure along the shoreline has been impacted due to erosion and flooding events. Some areas of the coastal road are being eroded, causing telephone lines and electric poles to be damaged. The Kosrae Shoreline Management Plan was developed to address such shoreline erosion problems in Kosrae. The plan provides adaptation recommendations with strong emphasis on preventative measures that remove exposure to the hazard rather than focusing primarily on impact reduction (e.g., through continuing to build seawalls).

The table below lists environmental and socioeconomic impacts of coastal erosion identified during the stakeholder consultation meeting.

Table 11: Environmental and Socio-economic Impact of Coastal Erosion

Environmental Problem	Environmental Impacts and socio-economic consequences	Sector	Locations
Coastal Erosion	Loss of infrastructure, loss of access to food and resources, reduced income for women, saltwater intrusion and inundation	Urbanisation <ul style="list-style-type: none"> increase in settlements, roads, sanitation 	Coastal areas all over Kosrae
	Loss of habitat and species diversity	Community practices <ul style="list-style-type: none"> beach mining 	
	Decrease in cultural heritage and available land		

7.3.2 Immediate, underlying and root causes

The following shows the primary causes, underlying causes, and root causes of the “coastal erosion” problem in Kosrae.

Primary Causes

- Change in wave dynamics and sea level
- Need to protect property from inundation
- Unregulated beach mining
- Coastal Development
- Mangrove harvesting
- Cutting down coastal trees

Underlying Causes

- Changes in climate conditions
- Poorly constructed coastal protection (sea walls)
- Mined materials for construction of housing, graves & tombs, public infrastructure, and beautification projects

Root Causes

- Change in lifestyle expectations to improve dwellings
- Mined materials from the beach are the cheapest option for construction and no identified alternatives
- Underdeveloped coordinated response to inundation of coastal areas/properties – coastal processes and risk areas not identified
- Poor coordination or planning for building activities that require mined materials
- Weak regulation and enforcement of illegal beach mining
- Limited alternatives to beach sand and gravels
- Infrastructure development a priority for the state and nation

7.4 National Priority Issue 3 – Solid & Liquid Waste

7.4.1 Description of problem and its national importance

Improper waste disposal poses a significant threat to both human health and environmental health in Kosrae. To mitigate such threat, the expansion of collection services by the public private cooperation and proper final disposal will continue to be key to improve human and environmental health. Accumulation of hazardous waste on private lands also poses a major health and environmental issues in Kosrae and all of FSM.

The table below lists environmental and socio-economic impacts of coastal erosion identified during the stakeholder consultation meeting.

Table 12: Environmental and Socio-economic Impact of Solid & Liquid Waste

Environmental Problem	Environmental Impacts and socio-economic consequences	Sector	Locations
Solid & Liquid Waste	Risks to public health through contaminated water, decrease in soil fertility, decreased agricultural products, increase in potential of water borne diseases, reduced amenity	Agriculture – community and commercial	Tofol Landfill
	Degradation of aquatic ecosystems through increases in nutrient load, increase in potential of algal bloom at coastal sites	Transportation & Infrastructure	Settlement areas
	Decrease in bio-resources (fish stocks), leading to loss of subsistence food source and income, additional cost to government	Industry – private sector	Port
		Urbanisation – increase in settlements, roads, sanitation	Sewage Outfall

7.4.2 Immediate, underlying and root causes

The following shows the primary causes, underlying causes, and root causes of the “solid & liquid waste” problem in Kosrae.

Primary Causes

- Importation of non-biodegradables
- Improper disposal of waste
- Wastewater leakage
- Excessive use of foam products
- Illegal dumping

Underlying Causes

- Poor wastewater infrastructure
- Demand for imported products for convenience
- Lack of awareness
- Poor waste management capacity
- Convenience/lifestyle change

Root Causes

- No recycling for products other than aluminium, battery, glass, etc
- Existing recycling program is inconsistent
- Waste management is not a priority for many on the island
- No storage capacity to safely store used oil on island or to send used oil offshore for disposal.
- Customs and traditions for community feasts and gatherings (excessive use of non-biodegradable products such as foams and plastics during community

8. PRIORITISED OPTIONS FOR REFORM AND ACTION

There are a number of possible intervention(s), ideas, opportunities, or solutions that could significantly and positively influence and improve the invasive species problem in Kosrae. The following is a prioritised list of potential ideas and solutions for the invasive species problem in Kosrae:

Environmental Problems	Ideas/Opportunities/Solutions
Invasive Species	<ul style="list-style-type: none"> • Strengthen enforcement & monitoring ensuring gender participation in local gender and monitoring activities. • Utilize traditional practices for control and management • Improve border control • Develop WASH Down protocols for farm equipment
Solid & Liquid Waste	<ul style="list-style-type: none"> • Increase trash collection coverage throughout Kosrae • Require use of incinerators for energy production • Expand recycling programs to include other wastes • Replicate and fully resource Fukuoka type landfill at the municipal level • Improve awareness programs using images and social media • Mandatory monthly inspection enforcement with fines • Require plastic ban with National Level • Impose tax on importation products • Dry litter Piggery method • Reuse of Waste products • All interventions and awareness programs will be gender inclusive, ensuring the participation of men, women, youths, and other vulnerable members of communities.

Environmental Problems	Ideas/Opportunities/Solutions
Coastal Erosion	<ul style="list-style-type: none"> • Strengthen EIA Regulations and enforcement for beach mining • Involve communities in rehabilitation efforts and ensure specific gender rehabilitation projects are targeted to ensure accountability by all sectors of the community. • Enhance collaboration with relevant stakeholders making sure that all NGOs and CSOs that deal with women, youth and other groups are included. • Capacity building development to be gender responsive, and all the different needs of men, women, youths, and other vulnerable groups are met. • Develop zoning regulations • Build shoreline protection around Kosrae
Sedimentation	<ul style="list-style-type: none"> • Develop and implement zoning regulations • Create environmental enforcement unit in the police force to enforce development regulations etc. • Increase buffer zones from rivers banks/ mangrove channels • Expand Lelu causeway(channel) to improve water circulation • Promote green belt method

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ANNEX 1:

Predefined list of Environmental Problems in Kosrae

Water systems	Exploitation of resources (living/non-living)	Global changes	Habitat and community modification	Pollution
Deterioration of water quality	Decline in commercial fish stocks	Coastal erosion	Habitat and biodiversity changes	Eutrophication
Changes in hydrological flow	Deforestation	Changes in hydrological cycles	Invasive species	Microbiological
Stress on ground and surface water resources	Deterioration of soil productivity	Increase in catastrophic events	Land degradation	Solid and liquid waste management
		Flooding	Ecosystem degradation (nearshore, terrestrial, surface water)	Suspended solids
		Sea level Changes		

