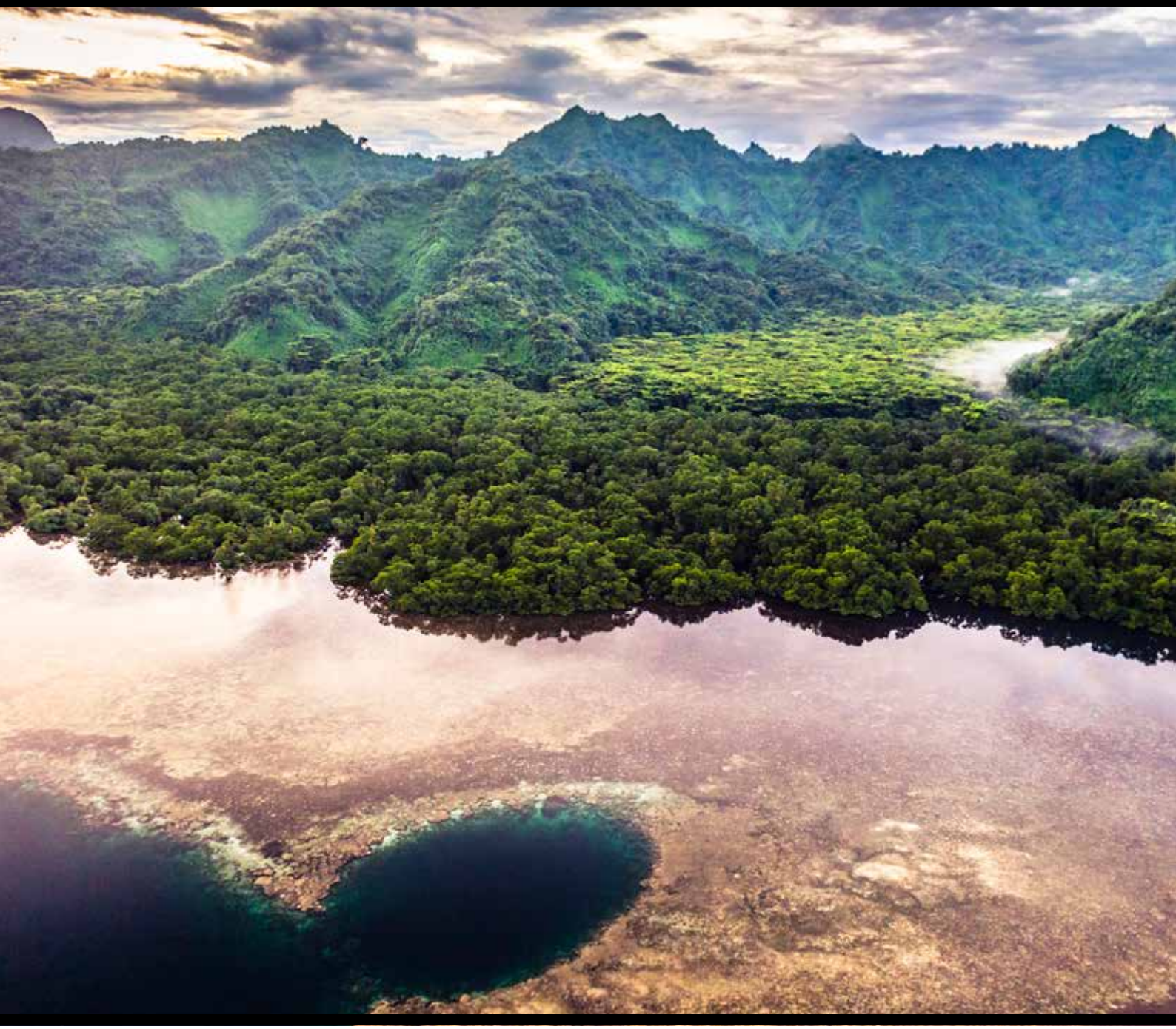
FEDERATED STATES OF MICRONESIA STATE OF ENVIRONMENT REPORT 2018



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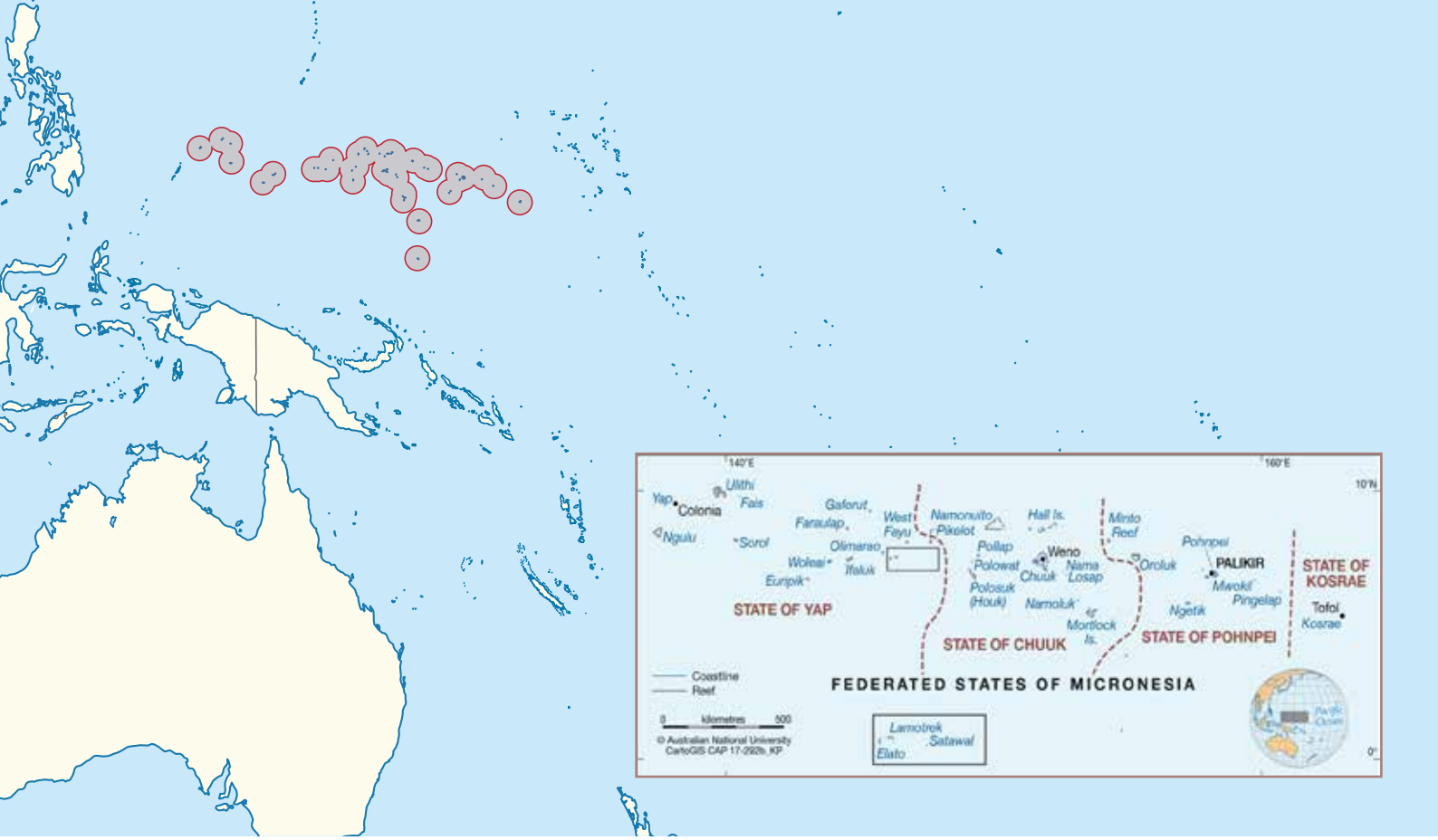

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Our vision: A resilient Pacific environment sustaining our livelihoods and natural heritage in harmony with our cultures.

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ACRONYMS

AF	Adaptation Fund
CBD	Convention on Biological Diversity
CFC	Chlorofluorocarbon
CH_4	Methane
CO_2	Carbon dioxide
COT	Crown of Thorns (starfish)
CCS	Chuuk Conservation Society
CSP	Conservation Society of Pohnpei
DECEM	Department of Environment Climate Change and Emergency Management
DMR	Department of Marine Resources
DRM	Disaster Risk Management
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
EbA	Ecosystem-based Adaption
EPA	Environmental Protection Agency
FFA	Pacific Islands Forum Fisheries Agency
FSM	Federated States of Micronesia
GCF	Green Climate Fund
GDP	Gross Domestic Product
GHG	Greenhouse Gases
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbons
IPPC	International Plant Protection Convention
JSAP	Joint Strategic Action Plan
KCSO	Kosrae Conservation and Safety Organization
KIRMA	Kosrae Island Resource Management Authority
MCT	Micronesia Conservation Trust
MEA	Multilateral Environment Agreement
MPA	Marine Protected Area
MSY	Maximum Sustainable Yield
NBSAP	National Biodiversity Strategic Action Plan
NDC	Nationally Determined Contribution
NEMS	National Environmental Management Strategy
NGO	Non-Government Organization
NH4	Ammonium
N_20	Nitrous Oxide
NO3	Nitrate
NORMA	National Oceanic Resource Management Authority
ODS	Ozone-depleting Substances
PIC	Pacific Island Countries
PNA	Parties to the Nauru Agreement
R&D	Department of Resources and Development
SoE	State of Environment
SOPAC	Pacific Islands Applied Geoscience Commission
SPC	Secretariat of the Pacific Community
SPCZ	South Pacific Convergence Zone
SPREP	Secretariat of the Pacific Regional Environment Programme
SST	Sea Surface Temperature
TNC	The Nature Conservancy
TMP	Tuna Management Plan
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
USD	US Dollar
VCA	Vulnerability and Capacity Assessment
VDS	Vessel Day Scheme
WCPFC	Western and Central Pacific Fisheries Commission

MESSAGE FROM THE SECRETARY OF DECEM

The FSM State of Environment report presents concise information on the state of the environment for the Federated States of Micronesia. It was prepared with the approval of the FSM national Government through the leadership of the Department of Environment, Climate Change and Emergency Management (DECEM) and States representatives and supported by the Secretariat of the Pacific Regional Environment Program (SPREP), in partnership with The Nature Conservancy.

The report revealed the current state of knowledge about the environment in FSM along the following thematic areas: atmosphere and climate, water, land, marine, biodiversity, built environment, and culture and heritage. The report informed that there are a lot of environmental challenges in the FSM and the report will be used as a vehicle to the national and state governments and how it can improve its decision and policy making mechanisms.

The State of Environment report will act as a benchmark for the FSM Government in setting its targets and reviewing its strategies so that they are aligned to the national and states environment status. It contains data and information on the reporting obligations to regional commitments and Multilateral Environment Agreements. The report is the primary basis for the development of the FSM National Environment Management Strategies.

The FSM Government in using this report always aims for sustainable development whereby a balance is maintained between economic development, environmental protection and social development.

Honorable Andrew Yatilman

Secretary, Department of Environment, Climate Change and Emergency Management

Jez O'Hare

MESSAGE FROM THE DIRECTOR GENERAL OF SPREP

The natural environment has always been part of Pacific island cultures. It has shaped and influenced our way of life over the centuries and, as the primary source providing for our Pacific communities, it has fed, clothed and kept us safe over the years.

Despite its immense value, our environment is under growing pressure due to economic development, tourism expansion and the threat of global climate change. Therefore, it is important that we continue monitoring and maintaining the quality of our environment for future generations.

The 2018 State of Environment (SoE) Report of the Federated States of Micronesia (FSM) updates the last report completed in 1993. The report assesses seven themes as well as the baseline information for new and emerging environmental challenges.

This report places the emphasis on data-based conclusions and presents supporting evidence for all indicators.

The 2018 SoE Report is a new baseline for future reports and can help the Federated States of Micronesia with national, regional and international reporting obligations, including multilateral environmental agreements. This report has already informed environmental planning and decision-making, and has guided the development of the National Environmental Management Strategy.

SPREP is pleased to have partnered with the Department of Environment, Climate Change and Emergency Management (DECEM) and The Nature Conservancy (TNC) in developing this document, as well as the many other agencies and civil society organizations that contributed to the consultative process.

I would like to sincerely thank the individuals and all the government ministries and departments for their contributions. It is important that regular updates to this SoE Report are conducted to assess FSM's environmental conditions. I encourage you all to use this report to help track, manage, plan and report on natural resources and the environment.

Kosi Latu

Director General
Secretariat of the Pacific Regional Environment Programme

Ami Vitali

EXECUTIVE SUMMARY

The Federated States of Micronesia (FSM) is an independent sovereign nation located in the North Pacific comprising four states from east to west: Kosrae, Pohnpei, Chuuk and Yap. The four states each have considerable autonomy. Formerly part of the United Nations Trust Territory of the Pacific Islands under US administration, the FSM ratified its own constitution in 1979. In 1986 the FSM signed a Compact of Free Association with the United States, and full independence was recognized in 1991 with the termination of the United Nations trusteeship.

The FSM is composed of 607 islands, which vary in size from small islets that disappear at high tide, to atolls, and large volcanic islands of more than 80km^2. About 65 islands are inhabited. The most striking physical characteristic of the FSM is the small land area spread over a great expanse of water. Its marine and terrestrial biodiversity are the nation's living wealth and play an important role in traditional cultures and livelihoods.

The 2018 State of Environment (SoE) Report for the FSM updates the 1993 SoE Report, and uses the Drivers, Pressures, State, Impact and Response (DPSIR) model of reporting. The main aims of this report are to:

- Identify the key drivers and pressures behind the changing environment;
- Update the assessment of the environment since the 1993 SoE Report, through use of the best available information for seven key thematic areas: Atmosphere and Climate, Inland Waters, Land, Marine, Biodiversity, Built Environment and Culture and Heritage;
- Document the social, economic and environmental impacts that result from changes in the state of the environment;
- Document current responses to address changes in the state of the environment that better protect and manage resources; and
- Provide recommendations to address key challenges and build on existing strengths, which are linked to actions outlined by the National Environmental Management Strategy (NEMS).

This report is comprised of three discussions:

1. Drivers and Pressures in the FSM: A summary of the main points discussed in the Pressures and Drivers section of the report.
2. The State of Environment and Impacts on the Society, Economy and Environment: Key findings for each of the seven themes.
3. Responses and Recommendations – Challenges in Moving from Policy to Action: This presents key responses, opportunities, challenges and recommendations.

DRIVERS AND PRESSURES IN THE FEDERATED STATES OF MICRONESIA

The FSM is rapidly changing and so is the environment. The changes are driven by broader social, economic, technological and cultural forces referred to as 'drivers'. These include Population demographics and migration; Globalization and geography; Economic and technological development; Traditional and contemporary values, attitudes, lifestyles and governance; and Climate change and variability. These drivers are a source of further pressure on the environment, but they can also offer potential solutions to problems.

The pressures on the environment are grouped into three main categories for the SoE:

- Land development (urban, agriculture and invasive species)
- Resource extraction (forestry and fishing,)
- Consumption and waste (energy consumption, vehicle ownership and solid waste generation)

Most of these pressures on the FSM's environment are steadily increasing and include overexploitation of biological resources; habitat loss and degradation; climate change; pollution; spread of alien invasive species, and infrastructure development.

THE STATE OF ENVIRONMENT IN THE FSM AND IMPACTS ON THE ENVIRONMENT, SOCIETY AND ECONOMY

Information was gathered from local stakeholders, experts and available data on the seven major themes to provide a summary of the state, impact, response and recommendations to a number of topics. A brief synopsis is included at the beginning of each theme for a quick review. The following provides a summary of each major topic covered in the SoE Report:

ATMOSPHERE AND CLIMATE

GREENHOUSE GASES (GHGs): The FSM contribution to GHGs is marginal. The country ratified the UNFCCC in 1993 and the Kyoto protocol in 1999. As a party of these conventions, FSM then ratified the Paris Agreement Accord on July 2016 and committed to reduce 28% of GHG by 2025 below 2000 levels (FSM Intended Nationally Determined Contribution, 2015). As part of this process a nation-wide climate change policy was adopted in 2009 which focused on mitigation and adaptation actions for the country. The Climate Change policy was enacted through The Climate Change Act of 2013.

OZONE-DEPLETING SUBSTANCES: Ozone depleting substances were greatly reduced in the FSM. Starting in 2009, the FSM phased out the use of CFCs reducing consumption to zero.

PHYSICAL CLIMATE AND CLIMATE TRENDS: While on the west side of the FSM (Yap and Chuuk) annual mean air temperatures show little change since the 1950s, on the east side (Pohnpei and Kosrae) annual mean air temperatures have increased. The FSM has experienced sealevel rise well above the global mean average per year. The FSM has strategies in place to address climate change impacts. These plans include The Climate Change Act of 2013 and joint strategic action plans (JSAP).

CLIMATE ADAPTATION: FSM recognizes the importance of increasing its adaptive capacity to adjust to actual and expected climate effects. While the FSM has developed policy (The Climate Change Act) and action plans (JSAPs) to prioritize activities and projects across development sectors, there is a need for better access to climate adaptation finance, increased capacity for implementation of adaptation activities and mainstreaming of climate adaptation across sectors. Successful ecosystem-based adaption strategies (EbAs) have already been implemented in communities across the four states.

WATER

WATERSHED CONDITION: Management of watersheds has become a priority issue for protection of inland and coastal waters. Several issues for water quality are associated with the degradation of watersheds on the main islands. Lack of regulations or enforcement along with climate change impacts, are accelerating the decline of watershed areas. Among the threats for watershed degradation are infrastructure, deforestation, invasive species droughts, wildfires and storms. Due to the strong link between watershed health and a positive water quality on islands with small landmasses, it is crucial for the FSM to preserve its watershed areas, as these come with an array of services and goods for the communities.

SURFACE WATER: In the FSM about 60% of water resources exist as surface water in the form of small, intermittent streams that drain catchment areas of limited aerial extent. While the high islands of Pohnpei and Kosrae have perennial waterways, in Yap the streams are dry for about 20% of the year. Populations in Pohnpei and Kosrae use surface water as sources of drinking water, but this is prone to bacteriological contamination and requires extensive and costly treatment to reduce high turbidity, undesirable taste and odours, and to remove all microorganisms. Concerns regarding water-related diseases are high, since leptospirosis, hepatitis and amoebiasis are endemic in some of the four states.

GROUNDWATER: In the FSM 40% of the water resources exist as groundwater, which is accessed through extractive wells. The hydrology on most islands is suitable for low to medium yielding wells, but not high yielding wells. Shallow wells are common, particularly in the outer islands and in the islands in Chuuk lagoon. The shallow wells are not always able to meet water demand during droughts and require appropriate design to suit the environment and community demands.

LAND

FORESTS: Although forests in the FSM have a long history of disturbance from human settlement and use, which has influenced the forest structure and species composition over time, no major changes in forest structure were observed between 2006–2017. The largest expanse of forest, around 330km^2, is found within Pohnpei, while Yap contains the smallest forest of the four states with almost 70km^2. The role played by forest ecosystems for the well-being of FSM's population highlights the importance of managing and protecting this ecosystem from degradation and destruction.

MANGROVES: In the FSM mangroves are particularly important to coastal protection and subsistence economies. They provide services such as firewood, building material and other wood products as well as help in regulating water quality, storm wave protection, harbouring high biodiversity and being a key nursery habitat for the juveniles of many commercial marine species. Another important benefit from the extensive FSM mangrove stands is carbon sequestration – hence the loss of mangrove contributes to the release of carbon in the atmosphere, resulting in positive climate feedback.

AGRICULTURE: Agroforestry is an integral part of the FSM's culture and subsistence economy. Crops such as breadfruit, taro, yam, coconut and banana are the basis of the national diet. Crops are used for subsistence and

sources of income. Among these income-generating crops are *sakau* (*Piper methysticum*, kava) in Pohnpei and betel nut in Yap. Climate change is posing a great threat to traditional agroforestry systems through saltwater intrusion, droughts and typhoons.

SOIL: Soil supports the basic ecosystem. 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. The soil, forest and agriculture systems are intimately connected and if managed properly can provide a series of benefits and co-benefits, however, there is limited data available on soil quality and status in the FSM.

MARINE

OFFSHORE MARINE ENVIRONMENT

The FSM is heavily dependent on marine resources for its economy as it has very limited land of 702 sq km, but an extensive Exclusive Economic Zone (EEZ) of 2,992,597 sq km. The EEZ has seen an increase in fishing vessels in recent years as well as the associated economic benefits. The tuna fishery sector has become critical for the national economy, providing up to 15% of GDP in FY2016 (ADB, 2017).

INSHORE MARINE ENVIRONMENT

LIVE CORAL COVER: Coral reefs are important ecosystems for FSM communities who still depend on marine resources, both economically and culturally. There are three types of coral reef formations surrounding the islands: fringing reefs, barrier reefs and atolls. It has been suggested that of the 4,925 km^2 of FSM's coral reefs, 30% are under medium to high threat caused by local pressures, such as overfishing, land-based pollution, poor land use and urbanization (Chin et al. 2011; Houk et al. 2015).

REEF FISHERIES: Coastal fisheries have supported FSM society for countless generations, providing for food, recreation, social cohesion, facilitating cultural practices, and more recently income (Gillett 2016; Johannes 1981). Yet, changes in fisheries paradigms over decades have resulted in unsustainable fishing regimes that threaten their future, and the basic services they provide. While available fisheries time series are limited, the health of coastal fisheries resources generally appear to be declining and are currently harvested at unsustainable levels.

MARINE PROTECTED AREAS: Across the FSM, government, NGO and community partners have worked closely together (through participatory processes and consultation) to establish state, municipal, and community legislated and/or traditionally declared marine protected areas covering a wide range of marine and atoll ecosystems. About 39% of the FSM's nearshore marine area is under some form of management.

ENDANGERED AND ICONIC MARINE SPECIES: Throughout the FSM, cetaceans, turtles, rays and sharks face a wide range of threats in a rapidly changing environment. Due to their migratory nature these marine animals are prone to several threats. The unknown size of populations, life history, and migration patterns of these species is particularly challenging for designing effective management regulations. In addition, these taxa are an important tourism attraction, providing alternative sources of revenue and jobs to those working in the dive sector.

BIODIVERSITY

ENDEMIC, NATIVE AND THREATENED SPECIES: Biodiversity in the FSM is crucial for the well-being of its people, who rely on the great variety of endemic and native species for subsistence, revenue, traditional medicine and the customs and traditions that characterize this country. Loss of biodiversity is generally associated with economic loss and has the potential to severely harm traditional knowledge and their transfer to future generations. Many native and endemic species are used in various aspects of daily living and for years traditional knowledge, practices and modes of resource management have protected and conserved the FSM's biodiversity.

INVASIVE SPECIES: Small islands are particularly vulnerable to the impacts of alien and invasive species. Invasive species affect human well-being by reducing the ability of ecosystems to provide the array of goods and services that many people depend on. The main pathways of entry for invasive species into the FSM are the air and shipping services.

TERRESTRIAL PROTECTED AREAS: Terrestrial Protected Areas are clearly delineated areas of land or mangroves set aside for conservation. As mentioned in the section on MPAs, government, NGO and community partners have worked closely together (through participatory processes and consultation) to establish state, municipal, and community legislated and/or traditionally declared protected areas covering a wide range of habitats. At least 15% of FSM's land mass, and 27% of its mangrove forests, is in terrestrial protected areas.

BUILT ENVIRONMENT

ENERGY: The energy sector in the FSM is heavily dependent on imported fuel. In the past, the rising cost of fuel, combined with the global economic recession has severely impacted the utilities' ability to provide reliable electricity, demonstrating the volatility of this sector. In addition, rising costs of equipment and essential supplies needed by the states' utilities providers, explains the reasons for the longterm financial insolvency of most of them. The total value of energy product use in FSM increased 25% between 2009 and 2015, from $32.4 million to $40.4 million.

WASTE MANAGEMENT: In the FSM solid waste collection and disposal is managed by the states and municipalities. Each state has a public final disposal site, generally managed by the public sector. This is run by the Department of Public Works and Transportation in Yap,

Department of Transportation and Public Works in Chuuk, and Department of Transportation and Infrastructure in Kosrae. In Pohnpei, the Office of Transportation and Infrastructure contracted an external company to manage the final disposal site. In Yap there remain several community dumpsites, which are managed by each community. Final disposal sites in Yap, Pohnpei and Kosrae employ a semi-aerobic method.

WATER AND SANITATION: As of 2010, water access reached 88.5% of households while only 56.5% of the households had proper sanitation. The FSM National Water Resolution identifies the need to address sanitation as one of the country priorities. This is also in line with the Sustainable Development Goal 6 (SDG-6). The main sources of freshwater in the FSM are rainfall harvesting, groundwater and surface water. Water capacity in the outer islands is limited, mostly due to the inadequate storage capacity and absence of a water grid for water distribution. Most of the water in the outer islands and Chuuk lagoon islands is collected at household level and therefore the quality is more difficult to control.

CULTURE AND HERITAGE

HISTORICAL AND TRADITIONAL SITES: The FSM boasts a wealth of historical and traditional sites. These sites are conserved for their value and significance to the people. Historical and traditional sites refer to sites, structures, buildings, objects, and areas of significance in local history, archaeology, or culture. Few sites in the FSM have formal preservation or management in place, but due to respect and land ownership there is limited access to these sites. As a result, many sites are not documented.

TRADITIONAL MANAGEMENT: Traditional knowledge refers to the knowledge, skills, and practices that are developed and sustained within a cultural community and passed on from generation to generation, forming part of its cultural identity. Historically, traditional knowledge, practices and modes of resource management have protected and conserved the FSM's natural resources. Many native and endemic species are used in various aspects of daily living, including customary practices and traditional medicine.

Jez O'Hare

INTRODUCTION AND BACKGROUND

INTRODUCTION AND BACKGROUND

ENVIRONMENTAL REPORTING IN THE FEDERATED STATES OF MICRONESIA

While there is no national mandate specifically for the development of a State of the Environment report, several of the FSM's Acts relating to climate change and the environment mandate reporting by specific agencies to congress. DECEM submits an annual report to Congress in May when budgets are discussed. As a party to several MEAs, the FSM must also meet those reporting requirements.

PURPOSE OF THE STATE OF ENVIRONMENT REPORT

The purpose of the FSM SoE Report is to present the best available information about the current state of the environment as the basis for effective environmental management and planning. The SoE Report examines the major drivers of change to the environment that emerge from global, regional and national factors. The SoE Report evaluates the main environmental pressures created by these drivers, and examines their social, economic and environmental impacts.

State of Environment (SoE) reporting is an internationally accepted reporting method that analyses the condition of a geographic area or jurisdiction's ecosystems and associated natural resources. SoE Reports compile and analyse quantitative and qualitative data from a variety of local, national, regional, and international sources to provide an holistic picture of a location's current state of the environment. SoE Reports also identify environmental trends, including anthropogenic impacts to natural environments.

SoE Reports prioritize the most important environmental attributes of a given location and identify issues that impact the state of the location's environment. The reports have included the condition of flora and fauna species as well as habitats such as native forests, marine and inland water bodies, soils, and vegetation cover. The reports also address key aspects of highly modified agricultural and built environments.

Many SoE Reports predict a location's future state, which is often related to problems within that environment. These predictions can help to address growing concerns about the impacts of climate change by offering an idea of the future state of the environment under 'business as usual' scenarios. This can inspire climate change adaptation and mitigation strategies that address emerging issues and threats. SoE Reports can also provide well-researched information for local, municipal, and national planners and managers in areas such as natural resource management, town and urban planning, tourism, and resource development.

AUDIENCES

The main audiences for the FSM SoE Report are:

- FSM government personnel, particularly in areas relating to the environment, planning and infrastructure, health, and education
- Citizens and community groups
- Donor organizations
- Non-government organizations
- International conventions including multilateral environmental agreements
- Research institutions and universities, and researchers with interests specific to the SoE report's thematic areas

THE 1993 AND 2018 SOE REPORTS

The 1993 SoE provided basic information on the FSM's environmental sectors in areas such as geology, vegetation, fauna and marine resources. The report provided an important vehicle for raising awareness at the state and national level of the importance of environmental issues and how they could be integrated into decision-making processes.

The 1993 SoE highlighted several environmental issues:

- Natural hazards of storms and typhoons (magnified by human influences)
- Global impact of climate change
- Local impacts of hazardous substance and waste product disposal
- Water pollution and resource loss due to erosion, sedimentation and inadequately managed resource use

The 2018 State of Environment (SoE) Report updates the 1993 SoE with a focus on data collected in the interim between the reports. Many of the issues identified in 1993 remain today, with further escalation of the noted trends. Some progress has been achieved through the implementation of various government policies and a community-based approach to resource management. The collection of better data has clarified some issues and shed light on new ones.

It is difficult to make quantitative comparisons of the two reports because in 1993 there was little data to determine baselines or trends, so much of the assessment was done by expert opinion. The 2018 SoE contains not just a summary of the state and actions required to protect the environment, but also a summary of the best available data and information on each theme. The purpose of the 2018 SoE is not to provide an exhaustive list of data to develop new research questions, but to provide a baseline and assessment for future reporting.

As FSM is composed of four semiautonomous states, with different cultures and natural histories, there is a significant amount of information that could not be included in this report. Specific information for every state could not be included for every indicator, and information was prioritized based on stakeholder input and advice from DECEM. There was also not consistent or similar data available from each state for all the themes, so information available for each indicator varies from state to state. This highlights the need for unified monitoring protocols across the four states. The SoE for the FSM requires large data collection and revision from stakeholders including a validation workshop. Given the large quantity of material produced, a revision of the SoE is recommended in five years.

APPROACH TO THE 2018 FEDERATED STATES OF MICRONESIA (FSM) STATE OF ENVIRONMENT REPORT

THE DRIVERS, PRESSURES, STATE, IMPACT AND RESPONSE (DPSIR) MODEL IN SOE REPORTING

The Drivers, Pressures, State, Impact and Response (DPSIR) model (Figure 1) is used in SoE reporting. The model is a global standard for SoE reporting and part of a systems approach that takes into account social, political, economic, and technological factors, as well as forces associated with the natural world.

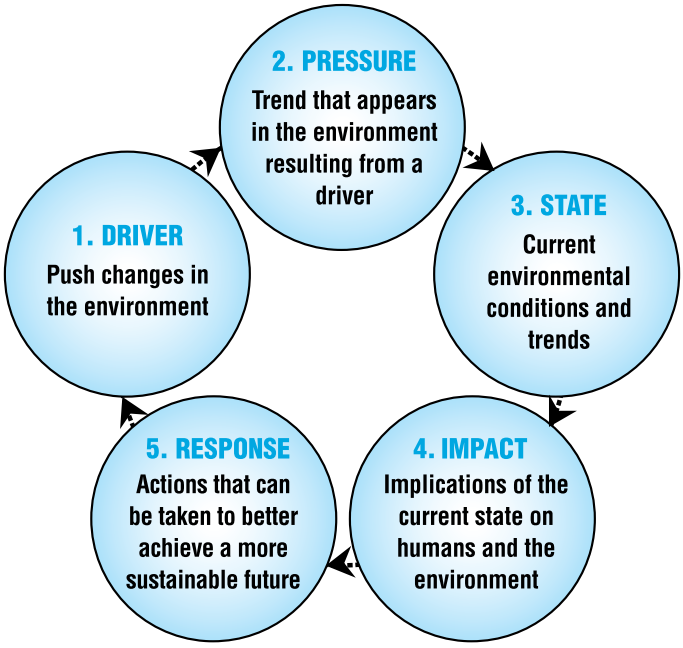


FIGURE 1. SoE Report Framework (DPSIR Model).

THEMES FOR THE FSM 2018 STATE OF ENVIRONMENT REPORT

The 2018 SoE Report includes seven thematic areas with important ecosystems and environmental issues addressed under each theme. Themes are divided into sub-topics, and indicators were developed for each one. The specific aspects of the environment that are assessed in the 2018 SoE are given in Table 1.

The indicators for each sub-topic are used to assess the state of that specific sub-topic. For example, the sub-topic 'Physical Climate and Climate Trends' has three key indicators: Temperature, Precipitation and Sealevel rise. The indicators are individually rated for State (Good, Fair, Poor), Trend (Deteriorating, Stable, Mixed, Improving) and Confidence in the Data (Low, Medium, High). The indicators are then integrated into the sub-topics under each theme (highlights section), and a similar rating for State, Trend and Confidence is assigned to each theme. For more information, refer to 'A Reader's Guide to the 2018 State of Environment Report'.

TABLE 1. Themes, sub-topics and indicators for the 2018 Federated States of Micronesia SoE Report.

Theme	Sub-Topic	Indicator (s)	MEAs & Regional Framework
Atmosphere and Climate	Greenhouse Gas (GHG) Emissions	GHG emission trends and mitigation efforts to date	SDG – Goal 13 (Climate Action): Affordable & Clean energy; Goal 14: Life Below Water. S.A.M.O.A. Pathway [Climate change; Sustainable Energy; Disaster Risk Reduction]. UNFCCC [Article 2, Article 4.1, Article 4.2] Kyoto Protocol
	Ozone-depleting Substances	ODS consumption trends and reduction efforts to date	Montreal Protocol S.A.M.O.A. Pathway – Climate Change (45)
	Physical Climate and Climate Trends	Mean, max and min air temperature trends over time	SDG – Goal 13 (Climate Action); Goal 14 (Life Below Water) S.A.M.O.A. Pathway – Climate Change (44a-d)
		Precipitation trends over time	
		Sealevel rise over time	
	Climate Change Adaptation	Water and food security adaptation actions	CBD – Aichi Biodiversity Target: Goal D [Target 14] SDG – Goal 6 (Clean water and sanitation) NBSAP – Theme 6
Inland Waters	Watershed condition	Land clearing, deforestation	CBD – Aichi Biodiversity Target: Goal B [Target 5; Target 7]; Goal D [Target 15] SDG – Goal 15 (Life on Land)
		Land tenure	
	Surface water quality	Trends in faecal coliforms, Total coliforms	SDG – Goal 6 (Clean water and sanitation) CBD – Aichi Biodiversity Target: Goal B [Target 8]
	Groundwater	Availability, quality and withdrawals	
Land	Forests	State and trends in forest areas	CBD – Aichi Biodiversity Target: Goal B [Target 5; Target 7]; Goal D [Target 15] SDG – Goal 15 (Life on Land)
	Mangroves	State and trends in mangrove areas	
	Agriculture	Percentage of households engaged in agriculture and land use for agricultural activities	CBD – Aichi Biodiversity Target: Goal A [Target 4], Goal B [Target 7]; Goal C [Target 13]
	Soil	Types and Status	SDG – Goal 15: Life on Land
Marine	Offshore Marine Environment	Tuna and bycatch harvested	SDG – Goal 14: Life Below Water SDG – Goal 2: Zero Hunger
	Inshore Marine Environment	Live coral cover	CBD – Aichi Biodiversity Target: Goal B [Target 6, Target 10]
		Reef Fisheries	CBD – Aichi Biodiversity Target: Goal B [Target 6] NBSAP – Theme 3
		Marine Protected Areas	CBD – Aichi Biodiversity Target: Goal C [Target 11] SDG – Goal 14 (Life below water)
	Endangered marine species	Turtles, Cetaceans, Sharks and Rays	CBD – Aichi Biodiversity Target: Goal C [Target 12] Convention on the Conservation of Migratory Species of wild animals NBSAP – Theme 3
Biodiversity	Endemic, threatened and native species	Status and trends of endemic species	CBD – Aichi Biodiversity Target: Goal C [Target 12] SDG – Goal 15 (Life on land)
	Invasive Alien Species under management or eradicated	Status and trends of invasive species	CBD – Aichi Biodiversity Target: Goal B [Target 9] SDG – Goal 15 (Life on land)
	Terrestrial Protected Areas	Status and trends of terrestrial protected areas	CBD – Aichi Biodiversity Target: Goal C [Target 11, Target 15] SDG – Goal 15 (Life on Land)
Built Environment	Energy consumption	Access, sustainability and efficiency Energy consumption, availability and renewables	S.A.M.O.A. Pathway – Sustainable Energy [47, 48, 50]; Oceans & Seas [53]; Sustainable Transportation [67] SDG – Goal 7 (Affordable and Clean Energy)
	Waste management – solid waste	Solid waste status and composition	SDG – Goal 12 (Responsible Consumption and Production)
	Water and sanitation – Water Systems and Capacity	Access and quality of drinking water Access and quality of sewage treatment	CBD – Aichi Biodiversity Target: Goal B [Target 8] SDG – Goal 6 (Clean water and sanitation); SDG – Goal 14 [Life below water – by 2025, prevent and significantly reduce marine pollution of all kinds, in particular from land-based activities, including marine debris and nutrient pollution. Stockholm Convention (POPs) UNCLOS Noumea Convention (Dumping Protocol, Emergencies Protocol)
Culture and Heritage	Traditional and Historical Sites	Listed historical sites, status and protection	CBD – Aichi Biodiversity Target: Goal E [Target 18] Convention on the protection of the World Cultural & Heritage (WHC 1972) SDG – Goal 11 UNESCO
	Traditional Management	Traditional methods for sustainable fishing and agroforestry	CBD – Aichi Biodiversity Target: Goal E [Target 18]

TABLE 2. Lead national and state government departments and agencies for the thematic areas.

No	Thematic Content	Thematic Lead
1	Atmosphere and Climate	Department of Environment, Climate Change and Emergency Management (DECEM) Yap, Chuuk and Pohnpei Environmental Protection Agencies (EPAs) Kosrae Island Resource Management Authority (KIRMA)
2	Inland Waters	Department of Resources & Development (R&D) DECEM Yap, Chuuk and Pohnpei EPAs KIRMA
3	Land	Department of Resources & Development (R&D) • Division of Agriculture in R&D • Division of Forestry in R&D State Departments of R&D
4	Marine (Inshore & Offshore)	National Oceanic Resource Management Authority (NORMA) pelagic fishery Department of Resources & Development (R&D) for coastal fishery and Protected Areas State Inshore Fisheries: Chuuk Department of Marine Resource, Kosrae Department of Fisheries, Pohnpei Office of Fisheries and Aquaculture and Yap Department of Marine Resources.
5	Biodiversity	Department of Resources & Development (R&D) Division of Agriculture in R&D Division of Forestry in R&D State Departments of R&D
6	Built Environment	DECEM (waste) Division of Energy Department of Resources & Development (R&D) Department of Transportation, Communication, and Infrastructure (TC&I) State departments of Transport and Infrastructure
7	Culture and Heritage	National and State Historic preservation Office Division of Agriculture in R&D KIRMA

A READER'S GUIDE TO THE 2018 STATE OF ENVIRONMENT REPORT

HOW TO READ THE REPORT

A State of Environment report condenses a large amount of information on various aspects of the environment into a readable and actionable report. Given the broad spectrum of topics covered, the report has been broken into themes for easier use. The report can be read as a whole, or according to different themes, noting that most of the themes are connected to each other and to the pressures and drivers behind them. Symbols were designed for each indicator to summarise the State, Trend and Confidence in each assessment. Symbols were also designed for groups of indicators that describe a habitat or sub-topic within a theme. Symbols were not designed for each theme because the variety of potential states limits a meaningful summary statement.

GUIDE TO THE SYMBOLS USED

This SoE Report integrates many data sources and expert opinions. For the FSM SoE Report, while more data and knowledge has been generated since the 1993 SoE, there are still significant data gaps. There may not be enough information available to make quantitative assessments of the state of an environment for every indicator using, for example, an index of 1–10, or a quantitative threshold figure, that could be compared across themes. Consequently, a generic index was developed that used expert opinions and best available data to inform 'Status' ratings of either 'Good', 'Fair', and 'Poor'.

Assessment symbols (Figure 2) summarise the 'State' of each indicator. The assessment symbols establish baselines to compare the state of each indicator for future assessments, including SoE Reports. The symbol includes ratings for 'Status', 'Trend' and 'Confidence'. Table 3 provides a guide to interpret the symbols and explains how the symbols were derived.

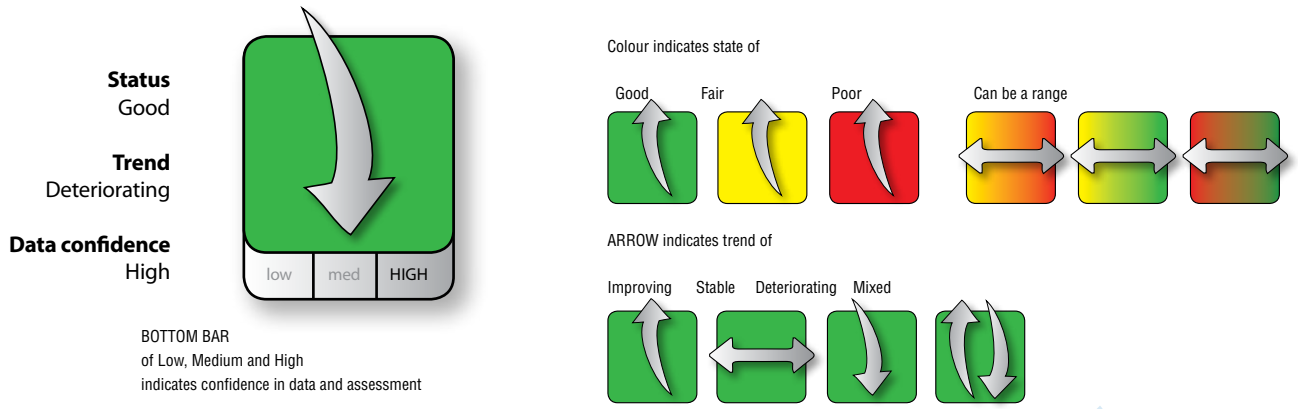
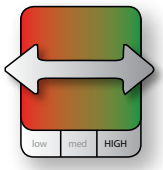
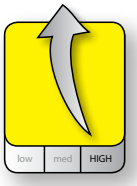
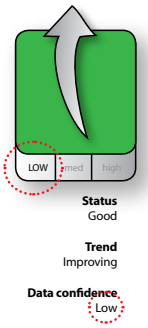


FIGURE 2. Explanation of the Indicator symbol.

TABLE 3. A guide to interpreting the symbols

	CATEGORY	DESCRIPTION	HOW IS IT DERIVED?	EXAMPLE
State (can be a range)	**GOOD** **FAIR** **POOR**	The level to which the indicator meets or exceeds (good), is close to meeting (fair) or is well below (poor) a given standard for healthy ecosystems, habitats, species, watersheds or an urban environment.	Assessment is based on: Recent trends; • Comparison with similar jurisdictions; and • Comparison with "healthy" habitats and systems. Where little data exists to make an assessment based on these criteria, expert opinion is used.	
Trend	**IMPROVING**	The state of the environment related to the indicator is getting better.	Trends show a significant increase, or based on weight of evidence, indicators are improving.	
	DETERIORATING	The state of the environment related to the indicator is getting worse.	Trends show a significant deterioration, or based on weight of evidence the indicator is worsening.	
	STABLE	The state of the environment related to the indicator shows no detectable change.	Trends show no significant increase or decrease or, based on weight of evidence, the indicator is stable.	
	MIXED	The state of the environment related to the indicator shows a mixed trend; some worse, some better, some better and some stable	Used primarily for sub-topics with multiple indicators, or in cases where data shows two distinct trends.	
	UNDETERMINED	The state of the environment related to the indicator is unclear.	Not enough data exists to determine a trend.	
Confidence	**HIGH**	Confidence in the data and assessment process is high.	Data is of high quality and provides good spatial and temporal representation.	
	MEDIUM	Confidence in the data and assessment process is medium.	Data is either lower quality, geographically sparse or limited temporally.	
	LOW	Confidence in the data and assessment process is low.	Data quality is poor and does not meet any of the above criteria.	

SDG – SUSTAINABLE DEVELOPMENT GOALS

The Sustainable Development Goals (SDGs), otherwise known as the Global Goals, are a universal call to action to end poverty, protect the planet and ensure that all people enjoy peace and prosperity. The SDGs provide clear guidelines and targets for all countries to adopt in accordance with their own priorities and the environmental challenges of the world at large. The goals are interconnected – often the key to success on one will involve tackling issues more commonly associated with another.

Throughout this report, the Sustainable Development Goals will be linked to the different indicators, by using the symbols shown in Figure 3.

FIGURE 3. Overview of the Sustainable Development Goals.

AICHI BIODIVERSITY TARGETS

The Strategic Plan for Biodiversity 2011–2020, under the Convention on Biological Diversity (CBD), consists of five strategic goals, including 20 Aichi Biodiversity Targets. An overview of these goals and targets is given in Table 4. The Aichi targets will be linked to the indicators in this report, using the different symbols.

TABLE 4. Overview of Aichi Biodiversity Targets.

Strategic Goal A: Address the underlying causes of biodiversity loss by mainstreaming biodiversity across government and society	
 **TARGET 1** By 2020, at the latest, people are aware of the values of biodiversity and the steps they can take to conserve and use it sustainably.	**OBJECTIVE 1** People are aware of the value of biodiversity and the steps they can take to conserve and use it sustainably
 **TARGET 2** By 2020, at the latest, biodiversity values have been integrated into national and local development and poverty reduction strategies and planning processes and are being incorporated into national accounting, as appropriate, and reporting systems.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations
 **TARGET 3** By 2020, at the latest, incentives, including subsidies, harmful to biodiversity are eliminated, phased out or reformed in order to minimize or avoid negative impacts, and positive incentives for the conservation and sustainable use of biodiversity are developed and applied, consistent and in harmony with the Convention and other relevant international obligations, taking into account national socio economic conditions.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations
 **TARGET 4** By 2020, at the latest, Governments, business and stakeholders at all levels have taken steps to achieve or have implemented plans for sustainable production and consumption and have kept the impacts of use of natural resources well within safe ecological limits.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation

Strategic Goal B: Reduce the direct pressures on biodiversity and promote sustainable use	
 **TARGET 5** By 2020, the rate of loss of all natural habitats, including forests, is at least halved and where feasible brought close to zero, and degradation and fragmentation is significantly reduced.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 6** By 2020 all fish and invertebrate stocks and aquatic plants are managed and harvested sustainably, legally and applying ecosystem based approaches, so that overfishing is avoided, recovery plans and measures are in place for all depleted species, fisheries have no significant adverse impacts on threatened species and vulnerable ecosystems and the impacts of fisheries on stocks, species and ecosystems are within safe ecological limits.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 7** By 2020 areas under agriculture, aquaculture and forestry are managed sustainably, ensuring conservation of biodiversity.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 8** By 2020, pollution, including from excess nutrients, has been brought to levels that are not detrimental to ecosystem function and biodiversity.	**OBJECTIVE 2** Both economic development and biodiversity conservation recognise and support sustainable livelihoods, cultural heritage, knowledge and expressions, and community resilience and development aspirations **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 9** By 2020, invasive alien species and pathways are identified and prioritized, priority species are controlled or eradicated, and measures are in place to manage pathways to prevent their introduction and establishment.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 10** By 2015, the multiple anthropogenic pressures on coral reefs, and other vulnerable ecosystems impacted by climate change or ocean acidification are minimized, so as to maintain their integrity and functioning.	**OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation

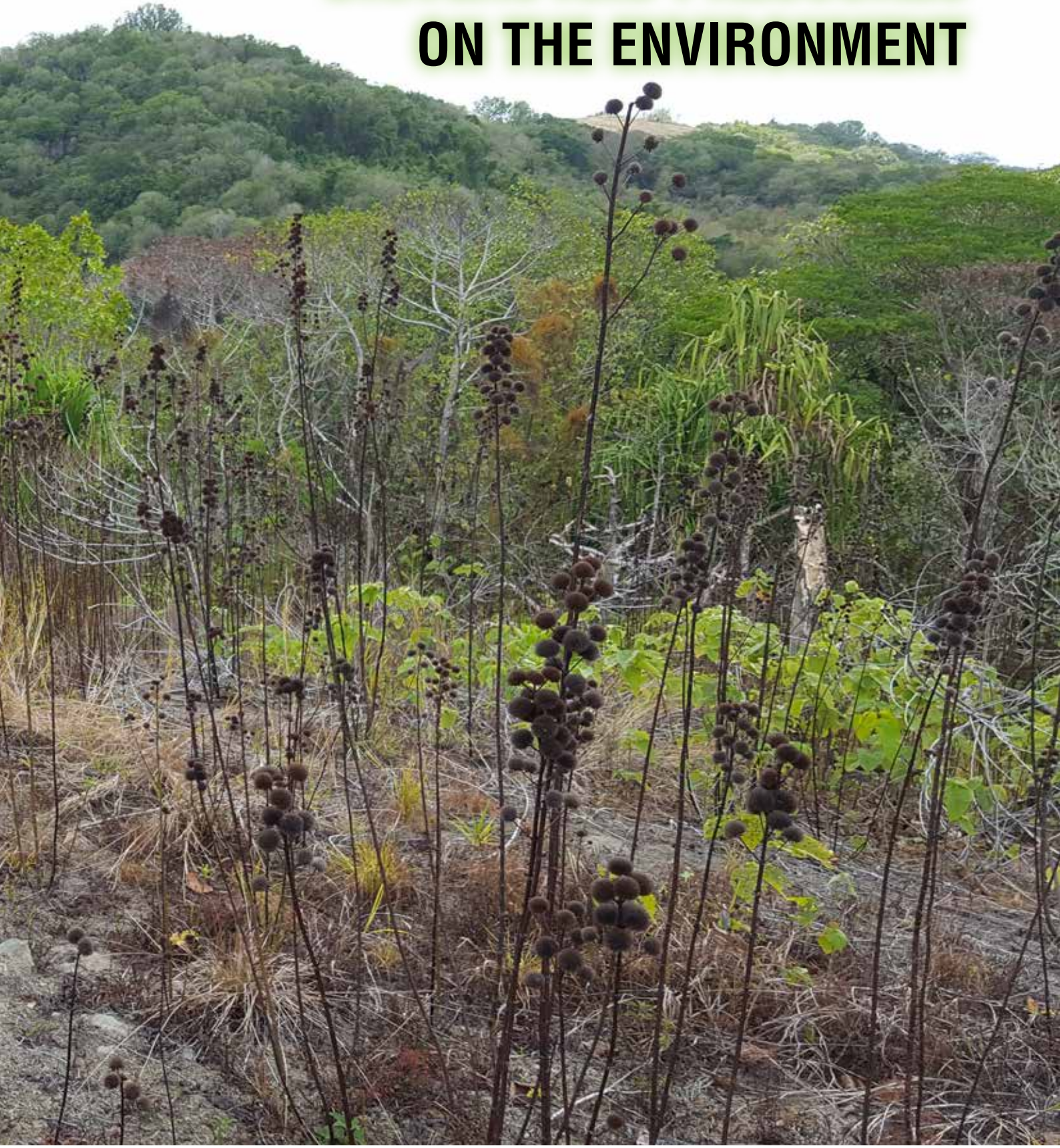
Strategic Goal C: To improve the status of biodiversity by safeguarding ecosystems, species and genetic diversity	
 **TARGET 11** By 2020, at least 17 per cent of terrestrial and inland water, and 10 per cent of coastal and marine areas, especially areas of particular importance for biodiversity and ecosystem services, are conserved through effectively and equitably managed, ecologically representative and well-connected systems of protected areas and other effective area-based conservation measures, and integrated into the wider landscapes and seascapes.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites
 **TARGET 12** By 2020 the extinction of known threatened species has been prevented and their conservation status, particularly of those most in decline, has been improved and sustained.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance
 **TARGET 13** By 2020, the genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives, including other socio-economically as well as culturally valuable species, is maintained, and strategies have been developed and implemented for minimizing genetic erosion and safeguarding their genetic diversity.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance

Strategic Goal D: Enhance the benefits to all from biodiversity and ecosystem services	
 **TARGET 14** By 2020, ecosystems that provide essential services, including services related to water, and contribute to health, livelihoods and well-being, are restored and safeguarded, taking into account the needs of women, indigenous and local communities, and the poor and vulnerable.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites **OBJECTIVE 5** Manage threats to biodiversity, especially climate change, invasive species, over-exploitation, and habitat loss and degradation
 **TARGET 15** By 2020, ecosystem resilience and the contribution of biodiversity to carbon stocks has been enhanced, through conservation and restoration, including restoration of at least 15 per cent of degraded ecosystems, thereby contributing to climate change mitigation and adaptation and to combating desertification.	**OBJECTIVE 3** Identify, conserve, sustainably manage and restore priority sites, habitats and ecosystems, including cultural sites
 **TARGET 16** By 2015, the Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization is in force and operational, consistent with national legislation.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance

Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building	
 **TARGET 17** By 2015 each Party has developed, adopted as a policy instrument, and has commenced implementing an effective, participatory and updated national biodiversity strategy and action plan.	**OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5
 **TARGET 18** By 2020, the traditional knowledge, innovations and practices of indigenous and local communities relevant for the conservation and sustainable use of biodiversity, and their customary use of biological resources, are respected, subject to national legislation and relevant international obligations, and fully integrated and reflected in the implementation of the Convention with the full and effective participation of indigenous and local communities, at all relevant levels.	**OBJECTIVE 4** Protect and recover threatened species and preserve biodiversity, focusing on species and genetic diversity of ecological, cultural and economic significance **OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5
 **TARGET 19** By 2020, knowledge, the science base and technologies relating to biodiversity, its values, functioning, status and trends, and the consequences of its loss, are improved, widely shared and transferred, and applied.	**OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5
 **TARGET 20** By 2020, at the latest, the mobilization of financial resources for effectively implementing the Strategic Plan for Biodiversity 2011–2020 from all sources, and in accordance with the consolidated and agreed process in the Strategy for Resource Mobilization, should increase substantially from the current levels. This target will be subject to changes contingent to resource needs assessments to be developed and reported by Parties.	**OBJECTIVE 6** Build capacity and partnerships that strengthen synergies between science, policy, local knowledge systems and indigenous sciences and enhance local and international agreements, to effectively mobilise resources to achieve Objectives 1–5

PART 2

DRIVERS AND PRESSURES ON THE ENVIRONMENT



DRIVERS AND PRESSURES

WHAT ARE THE DRIVERS OF ENVIRONMENTAL CHANGE IN THE FEDERATED STATES OF MICRONESIA?

Human activities, such as urban development, overfishing, pollution and climate change, are placing pressure on the natural environments of the FSM and their Exclusive Economic Zone (EEZ). These activities are driven by broad social, economic, technological and cultural forces. These drivers interact to produce changes in the environment, which impact the livelihoods and well-being of individuals, communities and nations. The 2018 FSM SoE Report identifies five broad-level drivers of environmental change (Table 5).

TABLE 5. Federated States of Micronesia environmental drivers and key indicators used in the SoE Report.

Drivers	Population and demographic changes	Globalisation and geography	Economic and technological development	Traditional & contemporary values, attitudes, lifestyles and governance	Climate change and variability
Key Indicators	Regional and national population changes	Shipping connectivity	Access to internet and cell phones	Land tenure system in the four states of FSM	Global carbon dioxide (CO_2) emissions
	Migration trends	Regional and national visitor arrivals	Global and FSM national economic trends	Trends in the use of customary crops (sakau and betelnut)	Global average air temperature, sea surface temperatures (SST) and sealevel rise (SLR)
		Multilateral environmental agreements	Gross National product (GDP) per capita and distribution across the Pacific and FSM		

Drivers can have diverse social, economic and environmental impacts; are not exclusively negative or positive; and should be viewed objectively with respect to their various management contexts.

DRIVER 1: POPULATION DEMOGRAPHICS AND MIGRATION

Population growth is recognized as a major driver in changes in ecosystem states and built environment. The FSM population has been stable with only minor growth across years. It is projected to increase up to 2040 and to then slightly decline by 2050 (Figure 4). In the FSM, about 50% of the population lives in Chuuk, 33% on Pohnpei, 10% in Yap and 7% in Kosrae (2010 FSM Census).

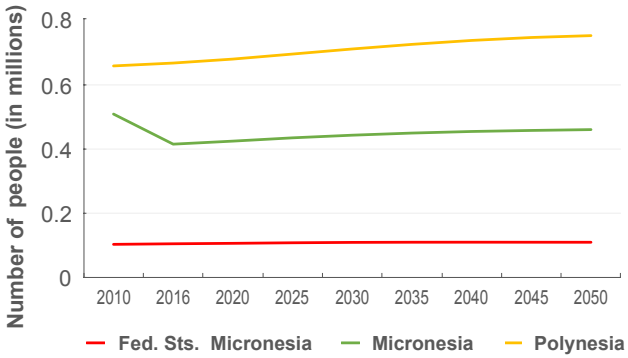


FIGURE 4. Pacific islands past, current and projected populations (SPC- Statistics for Development Division, 2016).

The FSM shows an increase in population growth between 1973 and 1994, but after 1994 growth has reached a plateau with only small fluctuations in the last 20 years. In the FSM, between 2000 and 2010 a negative growth rate (-0.4%) was recorded and total population showed a strong variability across states (Figure 5), translating into considerable differences in population density. Among the FSM states Chuuk has the highest density (993 persons per sq. mile,) which increases to 1000 persons per sq. miles for its outer islands, followed by Pohnpei (274 persons per sq. mile), Yap (247 persons per sq. miles) and Kosrae (156 persons per sq. miles). In general, high population density entails health and social challenges, and increasing pressure on the environment and infrastructure.

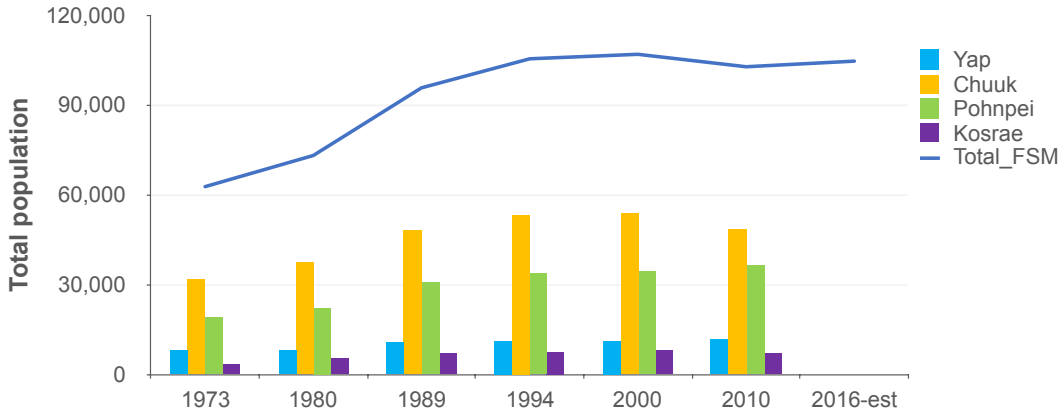


FIGURE 5. Distribution of population across the four states of the Federated States of Micronesia (FSM Division of Statistics). Total population of the FSM from data collected during census and projected for 2016 (World Bank).

Although the FSM age dependency ratio[1] has declined, in line with that observed for other Pacific small island states, it is still considered high by international standards. Based on the last census data (2010 Census, Summary Analysis of Key Indicators) the age dependency ratio for the FSM population was approximately 70%, with a higher dependency ratio recorded for Kosrae (77%) and Chuuk (71%), followed by Pohnpei (68%) and Yap (65%). This high age dependency ratio (Figure 6), and generally low income, corresponds to a burden on the working population, which has to cover household expenses. This translates into a larger number of people engaging in extra activities – e.g. agricultural or fishing activities for subsistence, and consequently increasing pressure on the environment.

Internal migration showed a limited movement of persons between the states from 1994–2010 (Census 1994, 2000, 2010). However, two kinds of migration are known to occur and impact on ecosystems. Within the same state, outer islanders are moving to high islands in response to climate change and to seek education, health services and economic opportunities.

1 The Age dependency ratio is the ratio of persons in the 'dependent' ages (defined as persons younger than 15 plus older than 64), relative to those in the 'economically productive' age group (defined as people aged between 15–64 years).

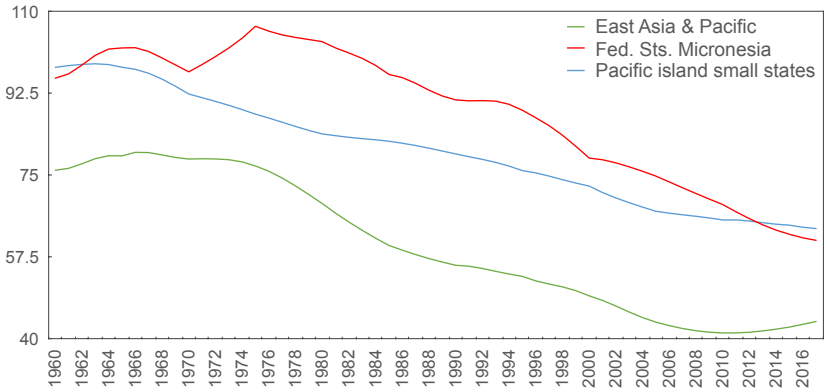


FIGURE 6. Age dependency ratio in the Federated States of Micronesia and Pacific small states compared to the cumulative values for the Asia-Pacific region. Data is shown as the proportion of dependents per 100 working-age population (World Bank).

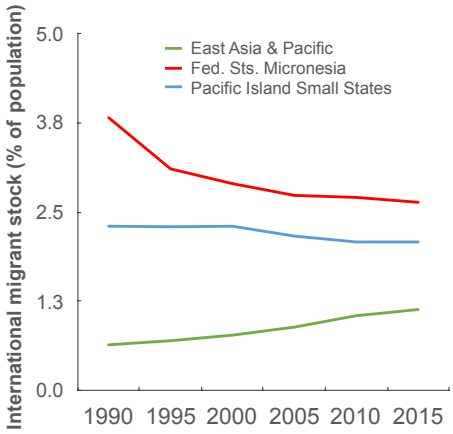


FIGURE 7. Percentage of migrant stock from FSM, Pacific island small states aggregate and East Asia and Pacific regional aggregate (includes all income levels) (World Bank).

While residents of high islands are increasingly moving inward as a result of coastal erosion and shifting weather patterns. These movements are contributing to habitat fragmentation and degradation due to the increasing demand for housing and infrastructure (Fifth National Report to the Convention on Biological Diversity the Federated States of Micronesia 2014).

The negative population growth recorded between 2000 and 2010, and projected toward 2050, is largely due to the massive out-country migration; with 44.5% of the total households recorded in 2010 having an immediate family member residing abroad. Although the percentage of migrants has declined from 1990s, in the 2000s estimates show that 39.2% of population emigrate (majority to the US). Overall, FSM presents the highest rates of migration in the region (Figure 7), with migrants contributing significantly to the household economy through cash remittances, estimated at US$ 7.7 million in 2010. Outmigration is leaving many previously managed agroforestry areas abandoned, allowing in many cases for invasive species to flourish (Fifth National Report to the Convention on Biological Diversity by the Federated States of Micronesia 2014).

Photo 1: Coastal erosion in Chuuk (Photo: Chiara Franco)

DRIVER 2: GEOGRAPHY AND GLOBALISATION

The FSM has an Exclusive Economic Zone (EEZ) of 2,980,000 km^2 (Figure 8), comprising 607 islands, which occupy a total land area of 702 km^2. The FSM has around 50 per cent of its EEZ bordering Papua New Guinea, the Republic of Palau, Guam, and the Republic of the Marshall Islands, with the remaining EEZ bordering international waters.

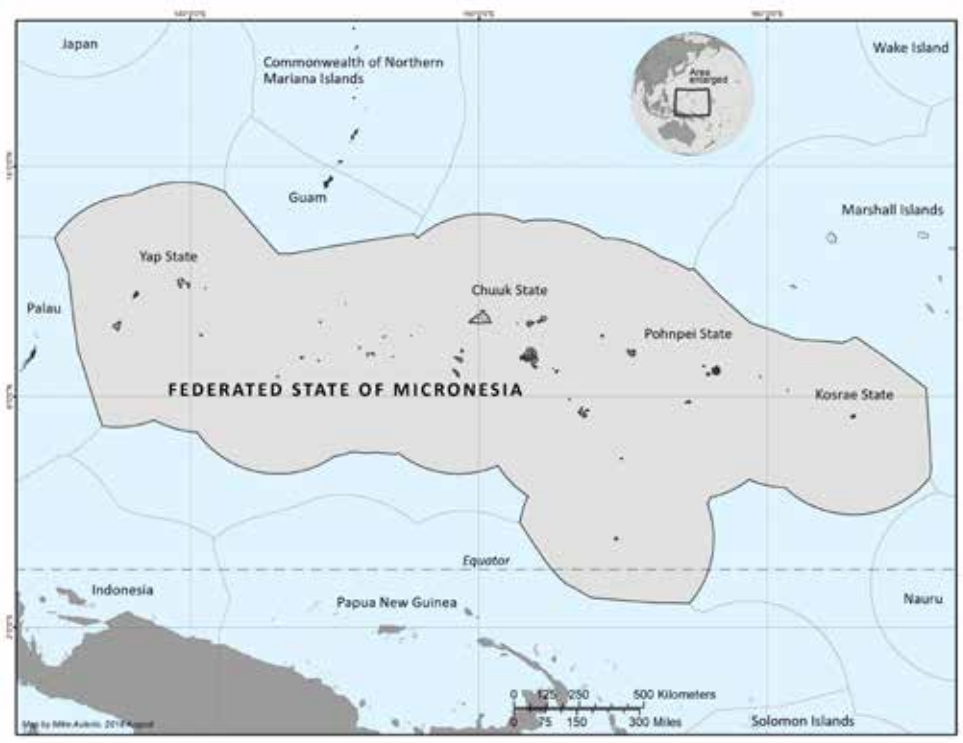


FIGURE 8. Map of the Federated States of Micronesia's Exclusive Economic Zone (EEZ) (adapted from SPC).

The limited land area, high population density and shift from subsistence to a cash-based economy, increase the need for services and connection. Small island countries encompass physical limitations, which reduce opportunities for economic growth and infrastructure development. Therefore, connection with other countries is essential to access goods and markets that can support the development of key sectors. However, FSM has a low Liner Shipping Connectivity Index (LSCI[2]) score, which translates to a poor service for the import and export of manufactured goods when compared with other countries. In part, this is due to constrained access to ports and roads and underdeveloped capacity for container deployment within the ports of entry.

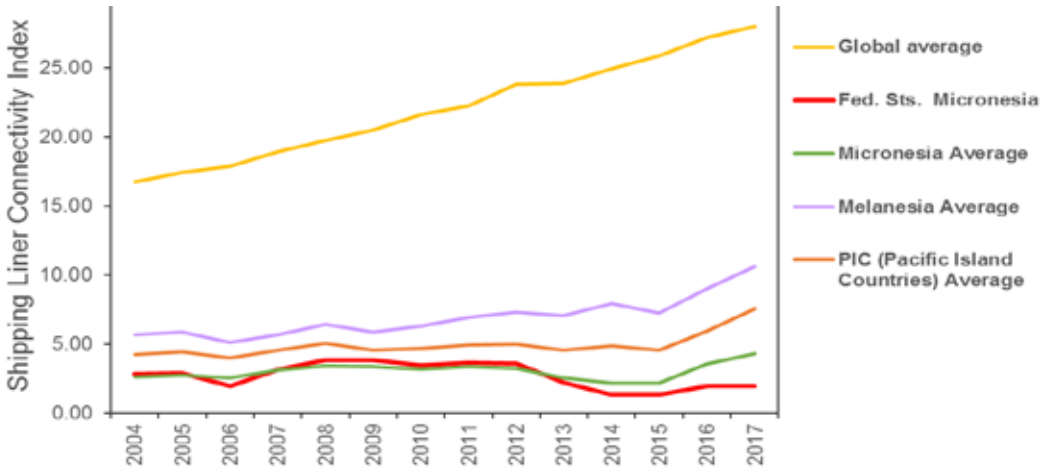


FIGURE 9. Shipping Liner Connectivity Index (2004–2017) at country (FSM) and regional level. Average for the Micronesia region excludes the US Territories of Guam and Northern Mariana Islands (UNCTAD; http://unctadstat.unctad.org/EN/Index.html).

2 The Liner Shipping Connectivity Index is based on 100 and capture how well countries are connected to global shipping networks.

In the FSM, tourists represented 69% of the total visitors entering the country between 1996 and 2016. Total tourist arrivals declined from about 16,058 in 1997 to 10,062 in 2016, albeit this decline is insignificant with respect to other global tourism (Figure 10). In 2013 Chuuk attracted the largest number of tourists in the FSM (50.31%) as an internationally recognized wreck diving destination, followed by Yap (27.7%) that also attracts a large number of scuba divers. In the same year, Pohnpei received more tourists (18%) than Kosrae (4%). Kosrae suffers from limited airline access. In general, the geographic isolation of FSM from major tourist markets, such as China and Japan, and the reduced airline capacity increases the costs of arrival. In addition, tourism infrastructure is limited, slowing the growth of the tourism sector.

FSM aspires to grow its tourism sector to support the growing economy (FSM strategic development plan 2004–2023, Vol I: Policies and Practices for Development 2004). With limited land and freshwater resources, there needs to be a balance between tourism growth and environmental protection and management. The FSM has potential to develop sustainable eco-friendly tourism that creates beneficial effects on the society and environment. Focusing on quality tourism, rather than mass tourism, can contribute to the protection of the fragile natural environment and would help maintain its attractiveness to tourists. Mass tourism will put a strain on FSM's limited natural resources and infrastructure. In particular limited freshwater capacity can be exacerbated during climate-related droughts, since the tourist industry requires a constant supply of water. More tourists also increase pressure on the natural environment through the production of waste. In addition, due to the current lack of regulations for access of tourists to FSM's historical sites, a large number of visitors represent a potential threat to the extremely fragile monuments. The social and cultural impacts of growing tourism sectors should also be considered in planning and decision-making.

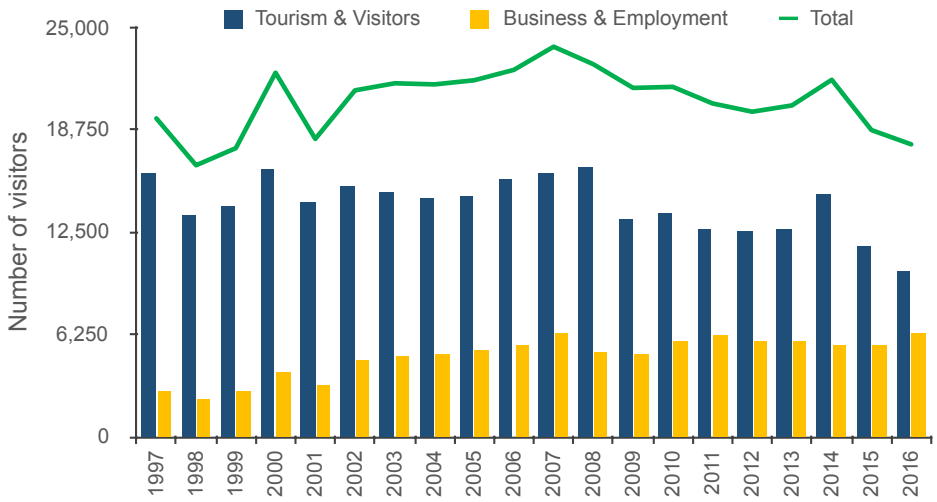


FIGURE 10. Visitor arrivals to the Federated States of Micronesia. Total visitor arrivals include arrivals of seamen, crewmembers, volunteers, religious, etc. (FSM Fiscal year 2016, Statistical appendices).

FSM is a signatory to a number of international treaties and conventions that relate to the national and global environment, biodiversity and climate change (NBSAP 2018). Below is a list of the Multilateral Environmental Agreements (MEA) for the country.

TABLE 6. FSM's Multilateral Environmental Agreements (NBSAP 2018).

Treaty/Convention/Subsidiary Agreements	
• Convention on Biological Diversity	• Ratification: 20 June 1994
• United Nations Framework Convention on Climate Change	• Ratification: 18 November 1993
• Kyoto Protocol to the United Nations Framework Convention on Climate Change	• Ratification: 21 June 1999
• United Nations Convention on the Law of the Sea	• Accession: 29 April 1991
• Convention for the prohibition of fishing with long driftnets in the South Pacific	• Ratification: 20 December 1990
• Treaty on fisheries between the Governments of certain Pacific Island States and the Government of the United States of America	• Ratification: 10 November 1987
• United Nations Convention to Combat Desertification in those Countries Experiencing Serious Drought and/or Desertification, Particularly in Africa	• Ratification: 25 March 1996
• Montreal Protocol on Substances that Deplete the Ozone Layer	• Ratification: 6 September 1995
• Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal	• Accession: 6 September 1995
• Convention to ban the importation into Forum island countries of hazardous and radioactive wastes and to control the transboundary movement and management of hazardous wastes within the South Pacific Region (Waigani Convention)	• Ratification: 23 May 1997
• International Plant Protection Convention	• 6 July 2007 (Contracting party only)
• World Heritage Convention	• Acceptance: 22 July 2002
• Stockholm Convention on Persistent Organic Pollutants	• Ratification: 22 May 2001
• Nagoya Protocol on Access to Genetic Resources and the Fair and Equitable Sharing of Benefits Arising from their Utilization (ABS) to the Convention on Biological Diversity	• Signature: 11 January 2012
• The Convention for the Protection of Natural Resources and Environment of the South Pacific Region (the Noumea Convention)	• Signature: 29 November 1988
• Vienna Convention for the Protection of the Ozone Layer	• Accession: 6 September 1995
• Implementation of Part XI of UNLCOS of 10 December 1982 –	• Ratified: 6 September 1995
• Agreement Implementing Provisions of December 10 1982 on Straddling Fish Stocks and Highly Migratory Fish Stocks	• Ratified: 23 May 1997
• The Kigali Amendment to the Montreal Protocol on Substances that Deplete the Ozone Layer	• Ratified: 17 May 2017

DRIVER 3: ECONOMIC AND TECHNOLOGICAL DEVELOPMENT

Geographic and capacity constraints have held back growth in FSM and other Pacific island countries. The challenges that FSM is facing include extreme remoteness from major markets, small population and landmass size, geographic dispersion over a vast tract of the Pacific, vulnerability to external shocks and environmental fragility. These challenges result in very high cost of production of goods and services by both the private and public sector, limiting the range of economic activities in which the country can be competitive (World Bank 2017).

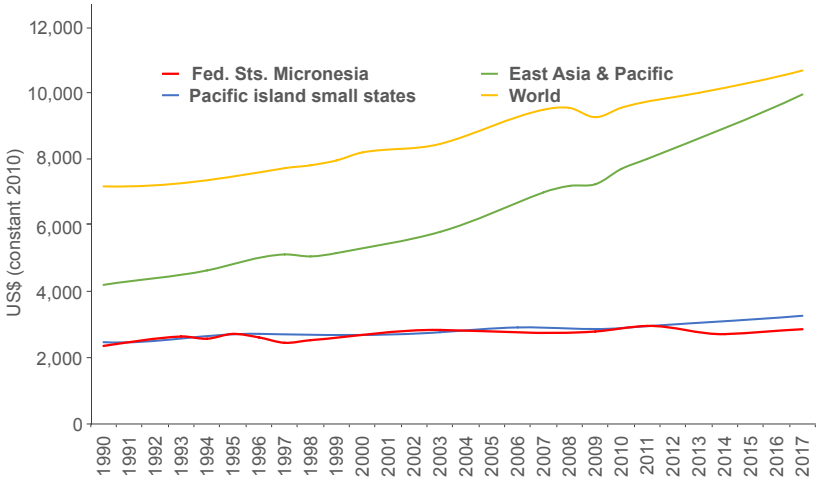


FIGURE 11. FSM, World, Pacific Small States and East Asia & Pacific GDP per capita changes since 1990 (World Bank, 2018).

The FSM has a low annual real GDP growth, which averages to -0.2% growth per annum between 2003 to 2016, since the outset of the Amended Compact in 2004 (FSM Office of Budget & Economic Management 2017). Foreign aid and the selling of fishing rights are the main drivers of the economy. The sale of fishing rights represented approximately 80% of the National Government's domestic revenue in the fiscal year 2016, contributing to 4.3% GDP growth in the same year (FSM Office of Statistics, Budget, Overseas Development Assistance and Compact Management 2017).

The main source of foreign exchange for FSM are the funds from the Compact of Free Association (COFA) with the United States, which make up about 33% of the government expenditure for fiscal year 2016. Overseas development aid has changed little in the past and remains around US$ 0.2 million for agriculture, US$ 1 million for fishing and US$ 0.4 million for environment protection and management (FSM Office of Statistics, Budget, Overseas Development Assistance and Compact Management 2017).

The domestic economy is highly dependent on imports, since exports play a minor role in the economy. Annual import of goods is distributed mainly across food and fuel, accounting for US$ 47.5 million and US$ 27.3 million respectively in 2016. Among the top 10 commodities imported by the FSM in 2016 are rice (18,350 tonnes) and non-alcoholic beverages (11,061 tonnes) (FAO country profile 2018).

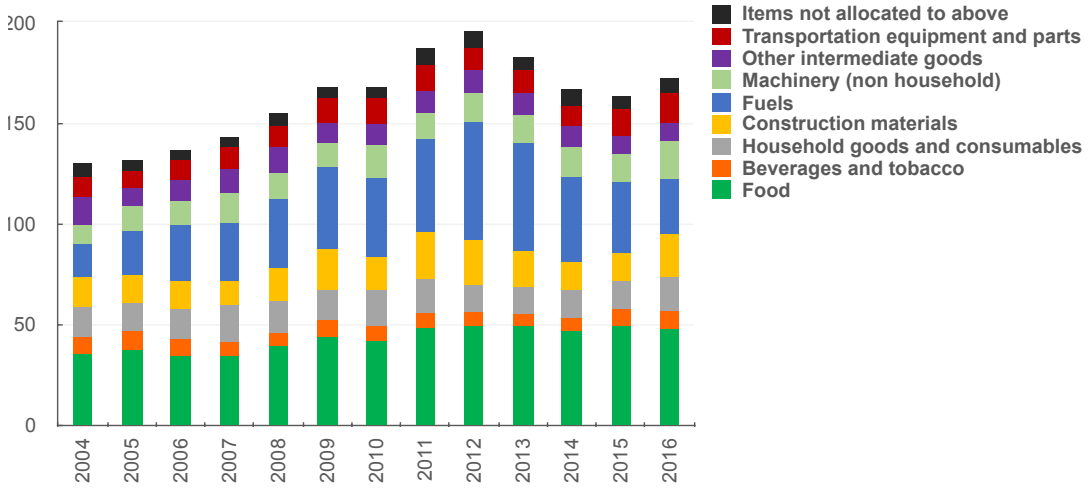


FIGURE 12. Imports by major categories in the FSM (in US$ million) since 2004 (FSM Fiscal year 2016, Statistical appendices).

In the FSM household income remained stable between 1998 and 2005. Between 2005 and 2015, household income began to decline with households losing 3.3% of their purchasing power each year (FSM 2013/14 Household income and expenditure survey). Based upon the 2013/14 Household Income and Expenditure survey, the average household income across the FSM is approximately $13,000 (FSM Office of Statistics, Budget, Overseas Development Assistance and Compact Management 2014). Most of the household budget is spent on food and household fixed expenditures (i.e. water, gas, electricity, housing; Figure 13). The majority of FSM households engage in some form of subsistence activities such as agroforestry, fishing or raising livestock (FSM Office of Statistics, Budget, Overseas Development Assistance and Compact Management, n.d.), non-cash expenditures contribute to 12% of the total household budget (cash and no-cash) for food and non-alcoholic beverages.

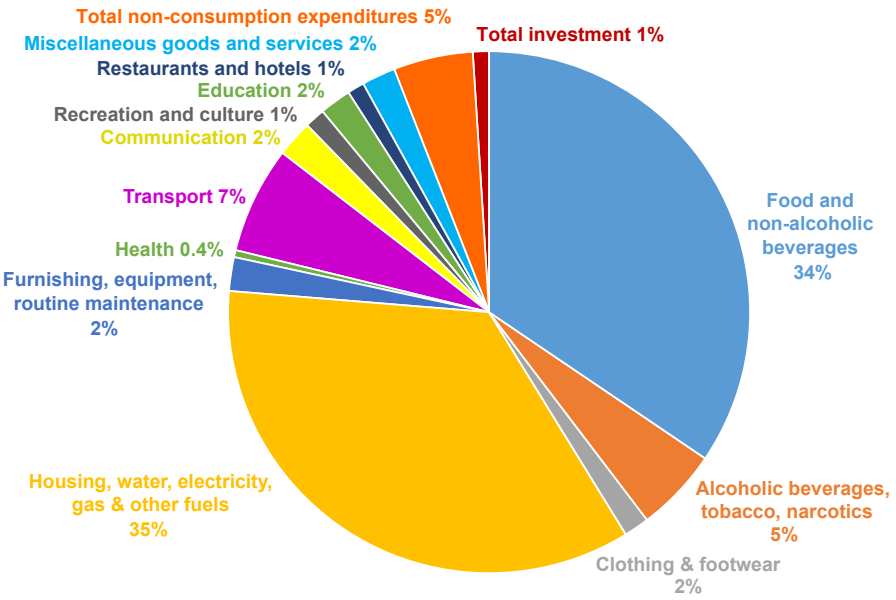


FIGURE 13. Average annual expenditure by expense category (FSM 2013/14 Household income and expenditure survey).

Development in the information and communication technologies can have positive and negative impacts on the environment. Based on the 2013/14 household surveys, 45.8% of FSM's households have access to a cell phone, while only 9.2% had internet connection. Improved connectivity can allow better marketing of the tourism sector, and help strengthen environmental management (e.g. spread environmental knowledge, raise awareness, and support monitoring of fishing activities). However, increasing demand for technological tools is likely to create an electronic waste burden to the already congested waste management of the FSM. Access to new technologies can also influence society, bringing access to a global culture that grows the demand for external goods (e.g. cars, televisions, tablets, etc.), further increasing the waste management challenge for a nation with limited landmass.

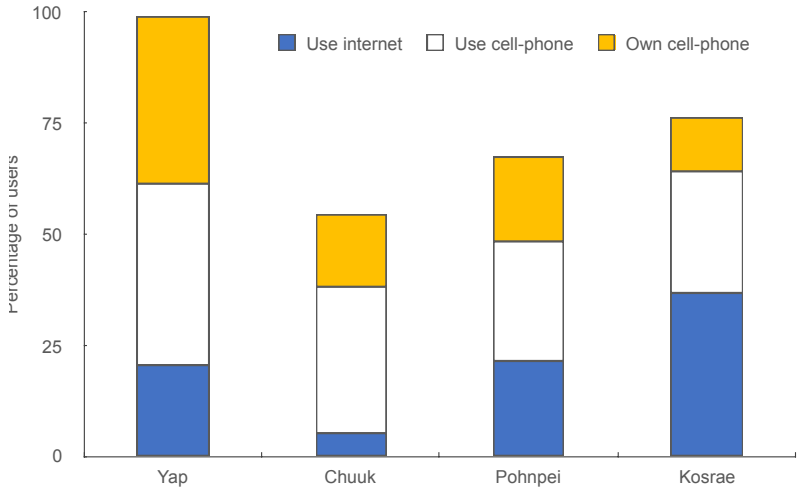


FIGURE 14. Percentage of households that use cell phones across the four FSM states, including cell phone owners (FSM 2013/14 Household income and expenditure survey Fact Sheet).

DRIVER 4: TRADITIONAL AND CONTEMPORARY VALUES, ATTITUDES AND LIFESTYLES

The history of the FSM is one of settlement by Micronesians as well as colonization by foreign powers. In the late 1800s, Spain established colonies across Micronesia and named their colony “Caroline Islands” after Queen Caroline of Spain. Then, Spain sold the part of that colony which includes present day FSM to Germany. The Germans invested in the islands through the production of copra until World War I. As an ally to Germany, Japan assumed control of the region from Germany until the end of World War II. In 1947, the United Nations through a trusteeship agreement gave the United States the responsibility to administer the same area which also included Palau, Northern Marianas, Marshall Islands and the islands that now make up the FSM. This marks the beginning of a gradual move towards independence with the ratification of a sovereign Constitution in 1979. In 1986, FSM became an independent country with its own sovereign Constitution and adopted a western form of government.

Ingrained in the FSM Constitution is the protection of customs and traditions that govern people, land, sea and natural resources. Thus, traditional systems for the organization of society and exercise of power still play an important role. The ‘chiefly’ system is recognized and integrated in the laws and regulations of the state of Chuuk and Yap, while in Pohnpei the chiefly system is informally recognized and valued during decision-making processes. It should be noted that land reform continues to be a focus and challenge for state governments in light of increasing population, pressures on use of natural resources (both terrestrial and marine), cash-dependent livelihoods, and for the most part, new rules that require individual ownership of land in order to access financial loans from lending banks in the name of progress and development. In all of the four states, the land tenure system continues to be reformed by aspirations for development.

The land tenure system varies across the four states. All have adopted the Torrens land registration system, which places the authority of registration of titles and recording of liens, leases and other land transactions with each state government. Certificates of title are issued by each state land authority, and land transactions pertaining to the parcel are also annotated on the certificate. In Yap, approximately 98% of land is privately owned by family and clan groups, with the majority of state-owned land located in the capital of Colonia, in the municipalities of Rull and Weloy. In Yap, both land and the reef system are privately owned. Non-citizens cannot own land in Yap, but they can lease land for a maximum of 99 years, including options to renew. Leasing of land, or making landowners partners or shareholders of projects, is viewed as the most appropriate arrangement. Almost all land in Yap and aquatic areas are owned or managed by individual estates and usage is subject to traditional control. Most property is held as family trusts and land use rights are passed down from generation to generation within the extended family system. The Yap Land Resources Office is responsible for registration, surveying and recording of titles and land transactions. In Chuuk, there is very little public land owned by the state. All lands are privately owned either by the individuals, an entire family, a clan or lineage, or heirs of deceased owners. Western land registration procedures and land tenure practices are increasingly adopted, but customary land tenure systems still strongly influence a majority of lands in Chuuk. The state’s role in the land tenure system through the Chuuk Land Commission is primarily registration of titles, record keeping and to adjudicate in land disputes. Land and nearshore marine areas are owned by families, and customary rights of ownership, use, inheritance and transfer are still followed. Disputes over titles and land registration seriously complicate the efficient application of land tenure practices, development and use of land.

In Pohnpei 60% of the total land area of the main island has been declared ‘public land’. The Constitution of Pohnpei limits acquisition of permanent interest in land to Pohnpei citizens (pwilidak). However, non-citizen individuals and business can obtain land on longterm leases. Pohnpei is unique in that the sale of real property is forbidden except as authorized by law, however, land transfers by gift are allowed. In Pohnpei, while land can be privately owned, the reef system is public. There is a Public Lands Board of Trustees that administers and manages the distribution of land parcels within the public lands in Pohnpei. A Court of Land Tenure presides over all land matters, including registration of titles and recording of liens, leases and other land transactions. The majority of Kosrae’s land mass consists of steep mountains reducing their potential for agriculture and settlement. As a result, Kosrae has a relatively small amount of inhabitable land. This coupled with a small population in Kosrae lends itself to a less rigid land tenure system with fewer rules and regulations, and fewer difficulties of ownership conflict and dispute settlement. Also, in Kosrae, land can be privately owned, but the reef system is public. The Kosrae Constitution limits acquisition of title to land to citizens of Kosraean descent. The Kosrae Land Court presides over all land matters and is responsible for registration and recording duties.

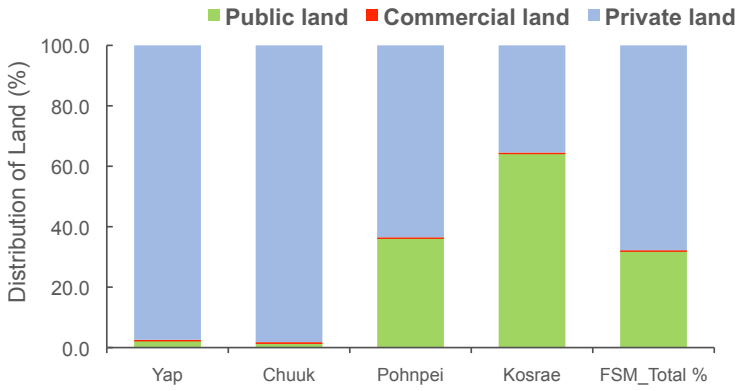


FIGURE 15. Percentage distribution of land across the four FSM states, including outer islands, and for the entire country (FSM Division of Statistics, Census 2000).

Migration of outer islanders to the main islands, for education and work opportunities, as well as possible impacts from climate change, can have negative and positive impacts. Indeed, an increase in population comes with an array of challenges such as cultural inclusion and environmental pressure (wastewater, solid waste) and provisioning of services like food and water.

Yap state provided land to outer island populations to relocate voluntarily in Tamil. In some cases, the location of the relocation was mandatory, in order to keep communities intact and united. In large part, current settlements in Yap are still defined by past relocations. In Chuuk, some outer islands like those from the Mortlocks were relocated to Pohnpei and given land by the state. Others who moved to the main island of Weno for work and school, usually live with family already settled there. Kosrae does not have outer islands, so migration occurs mostly to other states or to other countries.

The same is true for Pohnpei which serves as the capital of FSM. In general, members of the different island groups that have relocated to Pohnpei, tend to live together in their own communities. For those relocated due to natural disaster, the state provided land while those moving for work, e.g. jobs in the national government, are often provided a stipend for housing. While marriages, land ownership or even apartment and house rentals allow the dispersing of people to live outside of their own communities, most communities are still defined by where the members originally came from. There are also areas defined by the large communities of people from the other states, such as a community for those who come from Chuuk, Kosrae and Yap respectively.

Agroforestry takes up 35% of the country's landmass. While 80 to 90% of the consumed root crops and food tree products are home-produced, households spend 35% of the total household budget on imported food and non-alcoholic beverages. Rice is among the top 10 food imports with 80% of the households consuming this staple. Similarly, the percentage of households consuming instant noodles (65%), canned meat (47%) and canned fish (45%) are considerably high considering the level of home production for subsistence. The change in lifestyle and diet over the past half-century was accompanied by a shift from subsistence to a cash economy with a decline in the population's health. There has also been an increase in the number of cases, and associated economic burden, of non-communicable diseases (NDCs) (World Bank 2017). Since this time, the increasing cost of imported food, development of local markets for domestically produced food, and growing health concerns have promoted a return to the use of local foods (FSM Fifth National Report to the Convention on Biological Diversity 2014).

Reliance on cash is still considerably high for covering household expenses for energy, school and health, promoting excessive extraction or destruction of natural resources. For instance, in Pohnpei, where almost all the sale of sakau (*Piper methysticum*) occurs in the FSM, there has been an increase in deforestation of the native forest (Figure 16). Sakau is a culturally and economically important crop, contributing to 57% of household income in Pohnpei. This high value of sakau is driving farmers towards land conversion and monocropping, in some cases encroaching into remaining native upland forest areas. The removal of native forest and habitat fragmentation has direct impact on biodiversity, affecting vulnerable species such as the Pohnpeian short-eared owl and facilitating expansion of invasive plants. In addition, forest removal affects other services provided by this ecosystem, increasing erosion, diminishing soil fertility and water quality (FSM Fifth National Report to the Convention on Biological Diversity 2014).

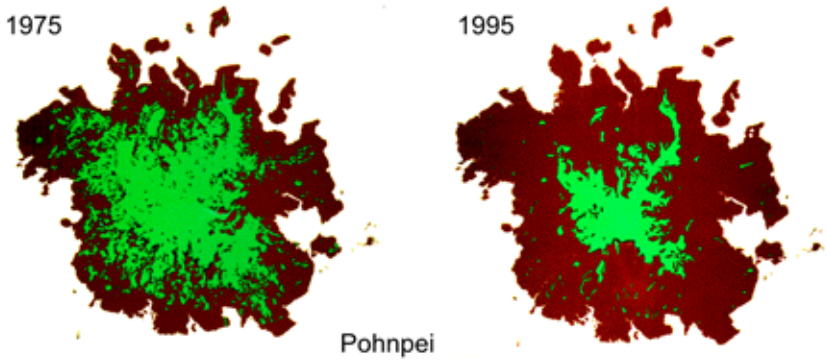


FIGURE 16. Changes in Pohnpei native forest cover between 1975–1995
(Map courtesy of The Nature Conservancy through processing of historical satellite imagery).

DRIVER 5: CLIMATE CHANGE

Climate change is another driver of change that can exacerbate current human pressures. The FSM is among those 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, and bring new threats, in particular in the form of coastal flooding and seawater inundation from sealevel rise. Although climate change and natural disasters have an overall negative impact on the FSM population and national economy, implementation of climate adaptation measures has the potential to protect jobs, and also create new jobs primarily in the construction sector (climate-proofing public infrastructure and private buildings; World Bank 2017).

Carbon dioxide emissions, those stemming from the burning of fossil fuels and the manufacture of cement, in the FSM are lower when compared to the global emissions, with less than two metric tons of CO_2 produced per capita. In the FSM, sources of CO_2 emissions are mainly associated with the burning of fuel during energy production (power plants).

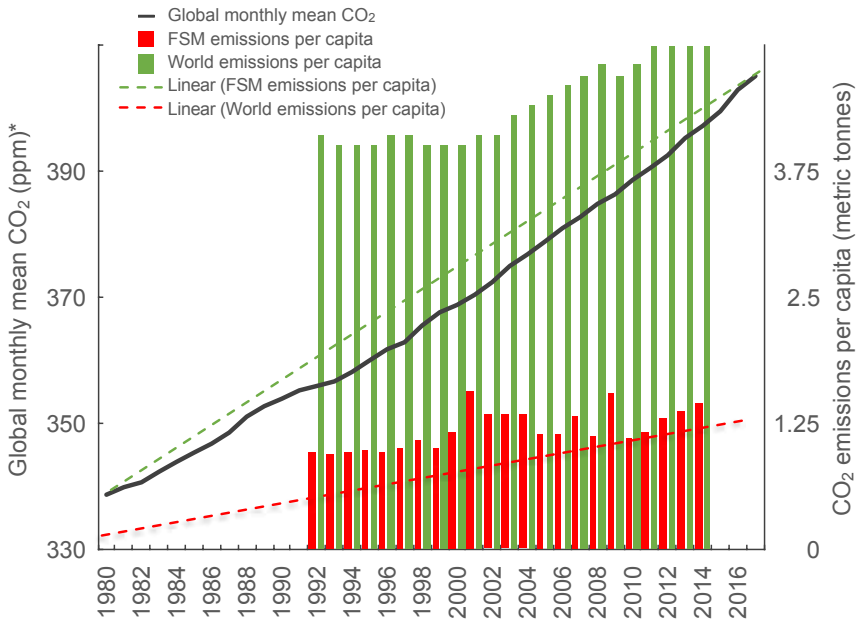


FIGURE 17. Global monthly mean carbon dioxide emissions (NOAA, last accessed 08/07/2018[3]) and FSM and world trends per capita carbon dioxide emission from 1994 to 2014 (World Bank). *CO_2 expressed as a mole fraction in dry air, micromol/mol, abbreviated as ppm.

Sea surface temperature increased during the 20th century and continues to rise from 1901 through 2018 (Figure 18). Sea surface temperature has been consistently higher during the past three decades than at any other time since reliable observations began in 1880.

3 NOAA ESRL: https://www.esrl.noaa.gov/gmd/ccgg/trends/

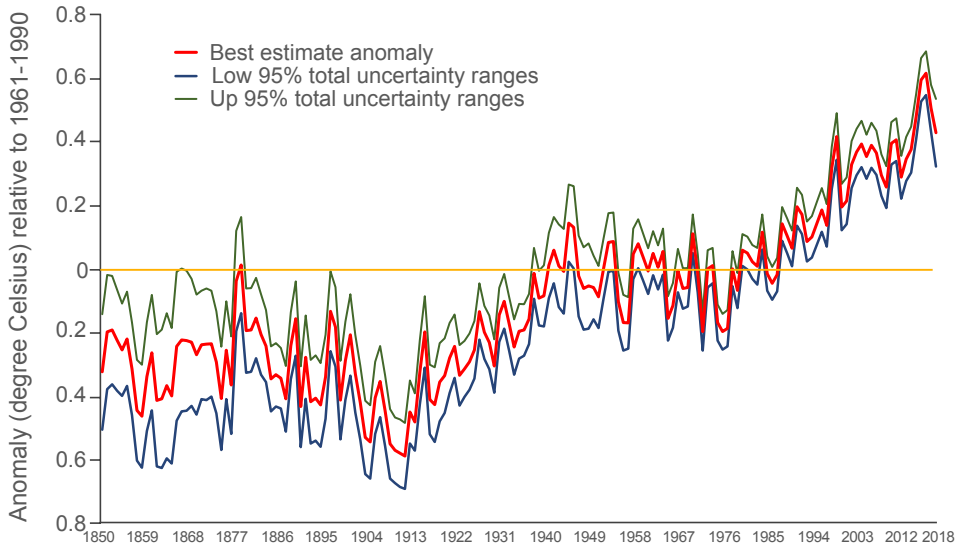


FIGURE 18. Global average sea-surface temperature anomalies from HadSST3[4] (relative to the 1961–1990 average). The red line is the median estimate and the green and blue lines represent the successive addition of the uncertainty components.

In the FSM's low-lying atolls, the highest elevation is only a few meters above sealevel. Under various climate change scenarios, there is a real possibility the low-lying atolls may reduce in landmass. This concern is present also for many of the FSM's high islands, which, due to sealevel rise, will be likely to see a reduction of their landmass with increased land fragmentation, impact to coastal built infrastructures and limited access to traditional agricultural sites e.g. coastal taro swamps. Due to the traditional land tenure system for some states, loss of landmass can potentially trigger inequalities among the communities and an increase in migration to other countries, or other FSM islands.

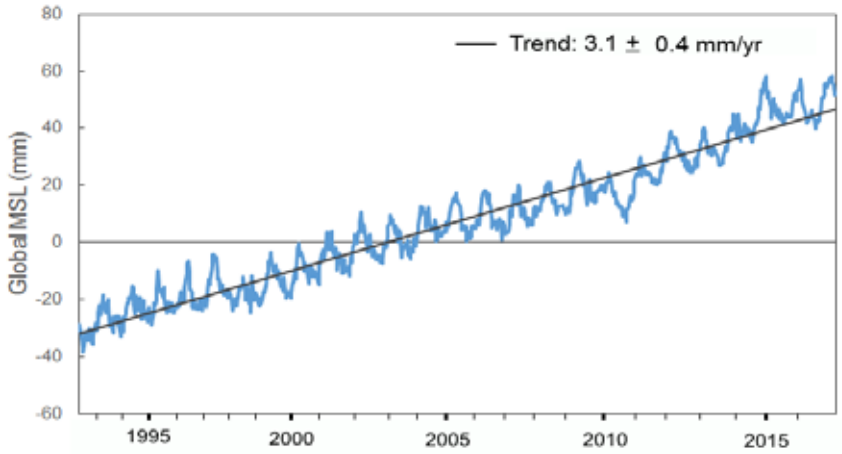


FIGURE 19. Global mean sealevel according to satellite altimetry from 1992–2018[5] (Nerem et al. 2018).

4 Met Office Hadley Centre for Climate Change. Last accessed 08/10/2018. https://www.metoffice.gov.uk/hadobs/hadsst3/index.html

5 Nerem, R. S., B. D. Beckley, J. T. Fasullo, B. Hamlington, D. Masters, and G. T. Mitchum (2018). Climate-change–driven accelerated sea-level rise detected in the altimeter era. Proceedings of the National Academy of Sciences. https://doi.org/10.1073/pnas.1717312115

WHAT ENVIRONMENTAL PRESSURES ARE THE DRIVERS CREATING?

This section highlights the key pressures on the Federated States of Micronesia's environment and society created by the overarching drivers identified in the previous section. Pressure indicators present data about the main human activities that could adversely affect the environment, and each indicator is linked to at least one of the drivers. Pressure indicators are organised using three classifications: land development, resource extraction, and consumption and waste (Table 7). Some pressures will be covered in the 'State' section.

The pressures on the environment fall into three categories for the SoE Report:

- Land Development (urban, and agricultural)
- Resource Extraction (commercial fishing and forest extraction)
- Consumption and Waste (energy, vehicle ownership and solid waste)

TABLE 7. Key environmental pressures in the FSM.

PRESSURES	KEY INDICATORS
Land development	• Formal urban development
	• Agricultural expansion and contraction
	• Invasive species
Resource extraction	• Forestry
	• Fishing
Consumption and waste	• Energy consumption
	• Vehicle ownership
	• Solid waste generation


Chiara Franco

PRESSURE 1: LAND DEVELOPMENT

INCREASE URBAN DEVELOPMENT AND IN-COUNTRY MIGRATION

In the FSM, urban population is estimated to have grown by up to 22.7% in 2018. This growth corresponds to an annual rate of 1.05% change in urbanization. The urban areas experienced an increasing trend since 2010, with more people moving towards urban centers to access education, jobs and health care. The annual rate of urbanization indicates that FSM is still in an early stage of the urbanization process (FSM Census 2010). Nevertheless, the increasing number of people in urban areas can put pressure on the environment by increasing fragmentation/removal of sensitive habitat. Increasing demand for sand/coral materials for construction have a direct impact on nearshore areas, where dredging activities impact coral reef ecosystems by altering habitats and water circulations. Lack of regulations or enforcement on dredging, further worsen the impacts from this activity.

Challenges of urbanization are related to waste production, upgrade of wastewater systems and access to sanitation. Currently, none of the urban areas in the four states (Kolonia in Pohnpei, Weno in Chuuk, Colonia in Yap and Lelu in Kosrae) has building codes to address the challenges that can come with increasing urban populations. Regulations regarding solid waste management, sanitation, wastewater management, and earthmoving are enforced by the Environmental Protection Agencies (EPA) of Yap, Chuuk and Pohnpei, and the Kosrae Island Resource Management Authority (KIRMA). In Pohnpei however, where a Public Corporation has been established to ensure the provision of water and sewer services to customers, the Pohnpei Utilities Corporation has the responsibility to ensure that proper sewer waste infrastructure is in place. While challenges exist, due in large part to funding needs, overall waste management in all the states also receive aid from various foreign governments and development partners.

Movements from the outer islands to the main islands, and of high island residents to urban areas or inland, are increasing the demand for housing and infrastructure, including roads, utilities and community facilities (FSM Fifth National Report to the Convention on Biological Diversity 2014). This contributes to increases demand of environmental resources such as freshwater, raw material (e.g. logs), sand and gravel for construction.

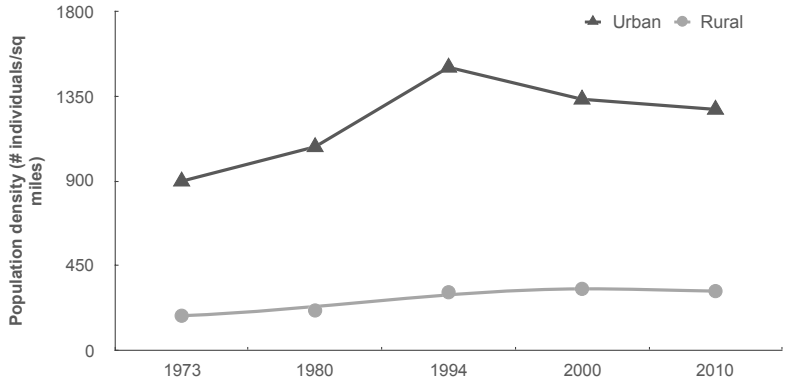


FIGURE 20. Population density in urban versus rural areas across the FSM (FSM Division of Statistics, Census 2010).

AGRICULTURAL DEVELOPMENT

Agriculture is a key component of the FSM, with 75% of households generating subsistence income (hidden value of subsistence products) from this activity (FSM Fiscal year 2016), and 80 to 90% of the fresh fruit and tubers home-produced (FSM 2013/14 Household income and expenditure survey). Many households in the FSM are involved in agriculture, and local crops are important means to provide food security for cash-poor households, as well as for customary use. Sixty-four percent of households in the country are involved in agricultural activities, mainly in the form of agroforestry[6] (FSM Fiscal year 2016). In some states, migration had led to the abandonment of traditionally cultivated land, with potential expansion of invasive species. In other states (e.g. Pohnpei), migration from outer islands or lagoon islands has increased the population and fragmentation of habitats, due to more people encroaching into native upland forest for agroforestry expansion.

Agriculture remains a key source of products for the nation – e.g. in Yap, 90% of the households are engaged in agricultural activities, mostly for subsistence. The spread of pests and diseases affecting crops (e.g. whitefly across the four states), high production costs, loss of arable land caused by land development, soil impoverishment and climate change (saltwater intrusion), expansion of monocrop cultures taking over more diverse production (e.g. sakau plantations in Pohnpei) and forests are impacting agricultural productivity.

6 Agroforestry is described as a "sustainable land-management system that combines the production of crops and forest plants and/or animals on the same unit of land and applies management practices that are compatible with the cultural practices of the local population" (King and Chandler 1978).

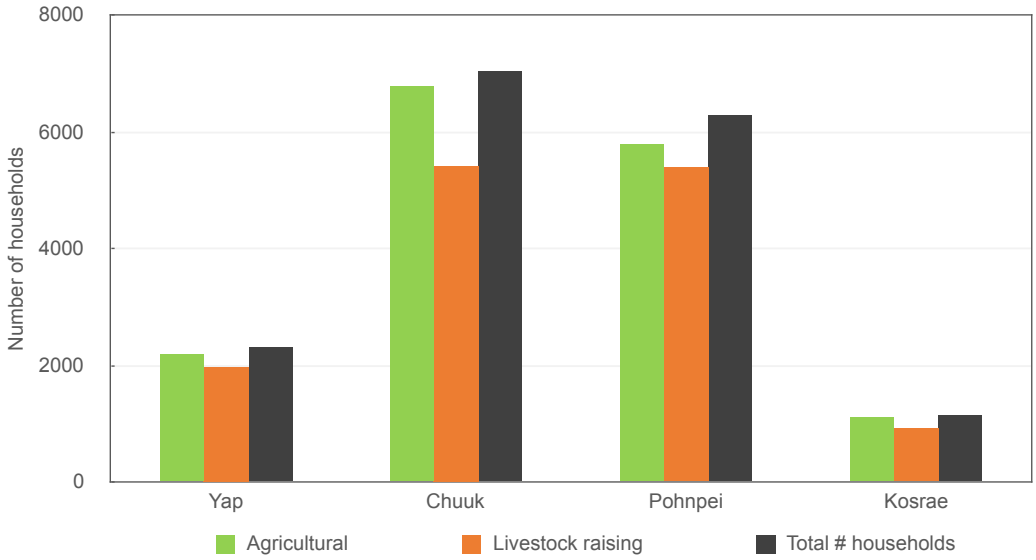


FIGURE 21. Number of households engaging in agriculture and livestock activities in 2010. Total number of households surveyed in 2010 are reported to show the magnitude of agriculture and livestock raising across the country (FSM Division of Statistics, Census 2010).

INVASIVE SPECIES

Invasive species in the FSM have had visible impacts on agricultural production and forest health, as well as contributing to the spread of some diseases. A number of introduced plants and animal species are increasingly widespread. 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, about 10% are animals and the rest are small bacteria, fungi and viruses (GRIIS 2018). Several invasive species are of concern for the natural environment and biodiversity of the country, as well as economic and health impacts for the population.

Invasive species are recognized globally as one of the direct drivers of biodiversity loss, posing a serious threat also to the high biodiversity of the FSM states. For example, from its introduction in the late 1990s, the citrus canker, a pest that impacts citrus, has seriously impacted citrus production in Kosrae. Similarly, outbreaks of white fly have impacted agriculture production in all the states. The black sock fungal disease (*Phillenus noxius*) has been reported affecting native forest trees and agroforestry in Pohnpei, Yap, and Kosrae.

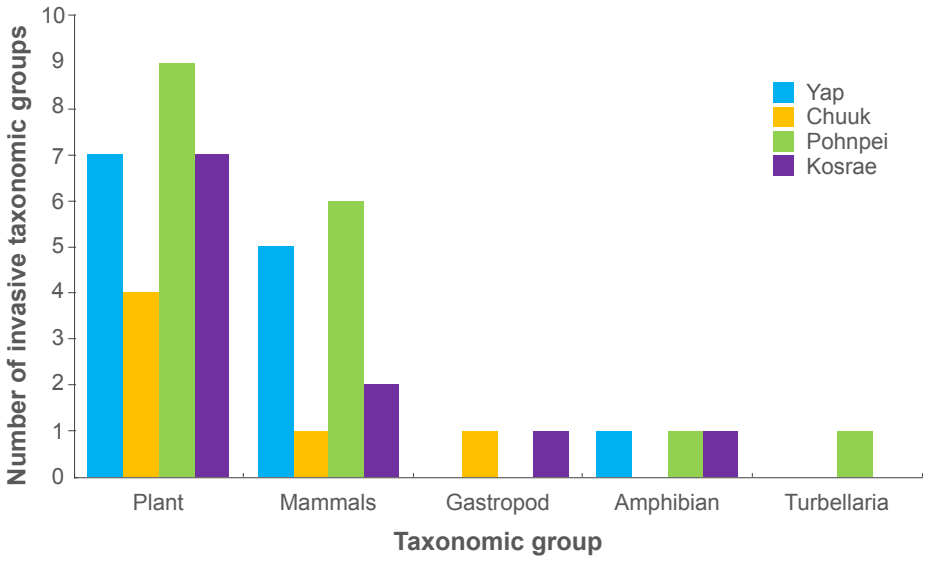


FIGURE 22. Number of taxonomic groups invasive to the FSM (IUCN 2018).

PRESSURE 2: RESOURCE EXTRACTION

FORESTRY

The forests in the FSM have a long history of disturbance from human settlement, which has influenced the forest structure and species composition. Over the years, changes in human settlements have been accompanied with land use changes that involved conversion of forest to agricultural and urban use. For instance, in Pohnpei, encroachment of sakau farmers into the upper watershed has reduced the area of primary forest significantly – from 15,000 ha in 1975 to 5,200 ha in 1995 to 4,200 ha in 2002. Forests in all four states are being degraded by activities such as bulldozing, unsustainable timber harvests, conversion to other uses and wildfires. Across the FSM, siltation of the fringing reefs, as a result of deforestation and subsequent erosion, is causing significant damage to traditional marine food supplies. Key pressures from these activities lead to land degradation, loss of biodiversity and loss of the ecological services provided by forests and watersheds. In addition, impacts from climate change, such as strong typhoons and extensive wildfires associated with severe El Niño-Southern Oscillation (ENSO), further impact forests. Another pressure is introduction of invasive species to degraded areas, making areas even more vulnerable. For example, the invasive weed *Chromolaena odorata* smothers tree seedlings and made sites more vulnerable to wildfires.

Photo 2: Awareness fire control in Tamil, Yap (Photo: Chiara Franco)

FISHERIES

The coastal and offshore fisheries sector is highly important for the FSM. Coastal fisheries are mainly used for subsistence, traditional customary obligations, and limited commercial sale, while the offshore fishery is mainly for revenue. However, artisanal and industrial fisheries have impacts on biodiversity and increase pressure on the marine environment, particularly when marine resources extraction is unregulated, or regulations are not fully enforced. The shift from subsistence to a cash economy has eroded traditional fishing practices and methods to more unsustainable practices (e.g. night fishing) that has led to a general decline of the coastal fish stocks (Houk et al. 2012). Reef fish are overharvested in many islands of the FSM (Houk et al. 2012, Houk et al. 2016, Rhodes et al. 2018). This affects reef health as declines in herbivorous fish can trigger phase shifts to algal dominated systems (McLean et al. 2016). Of the 89% of households in the FSM that consume fish regularly, 47% fish for their own consumption (subsistence), while the other half purchase from local fishermen or at fish markets, contributing to 1.8% of the total wage and salary income (FSM 2013/14 Household income and expenditure survey). Industrial fisheries have generated US$ 47.5 million annually in the period from 2012 to 2016, contributing approximately 15% of the national GDP (ADB 2017). The increase in fishing license revenues highlight the need to ensure compliance with catch limits to avoid erosion of the resources and maintain valuable tuna stocks. Fish catches show a variation associated with the ENSO climate pattern, with catches decreasing during years characterized by strong El Niño events. This suggests that stocks need to be managed in the face of the high uncertainty associated with climate change.

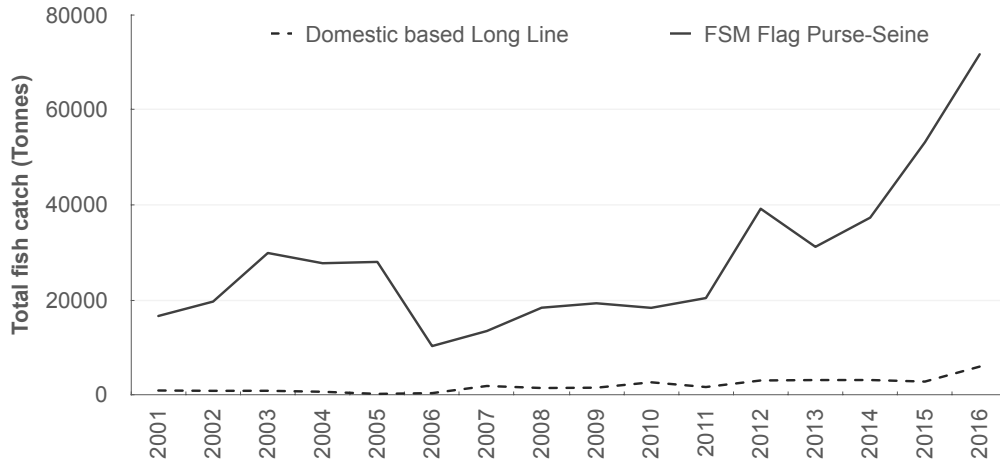


FIGURE 23. Total fish catch in tonnes by FSM domestically based vessels between 2001–2016 (FSM Fiscal year 2016; Statistical appendices).

PRESSURE 3: CONSUMPTION AND WASTE

ENERGY

In the FSM, access to electric appliances has increased in the years, with a growing number of households purchasing and using televisions, fridges and DVD players. The increase in the use of electric appliances, also partially relate to an increase in the number of households accessing electricity. In the 2010 census, about 55% of the housing units had electricity, compared to 54% in 2000, 51% in 1994 and 28% in 1980. In 2000, electricity production accounted for approximately 42% of the total CO_2 emission, corresponding to 1.4 tCO_2e of GHG per capita emission. In 2012, all urban areas in the FSM were served by electricity, while in rural areas electrification was covering almost half of the households (45%). As part of its Energy Action Plan (2010–2020) the FSM government is aiming to reach 90% of electrification in rural areas, and to increase the "share of renewable energy sources to at least 30% of total energy production, while energy efficiency will increase by 50% (including reduction of energy loss)".

In 2015 the total electricity produced in the FSM was 20.1 MW[7], mostly from fossil fuel (96% from diesel), while some was produced from renewable energy (4% from solar PV).

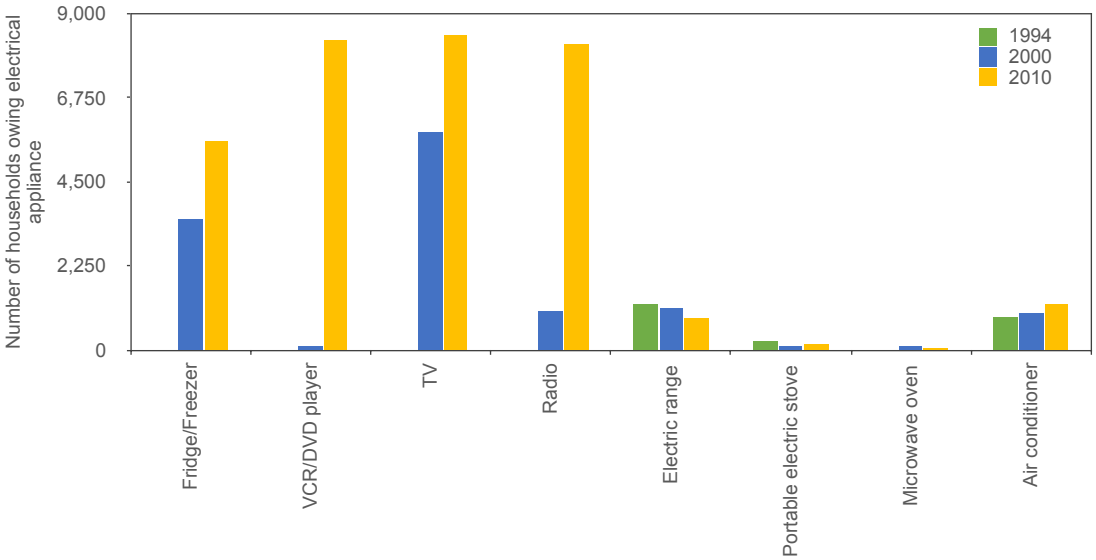


FIGURE 24. Changes in electric appliances owned by FSM households between 1994 and 2010 (FSM Division of Statistics 2000 Census, 2010 Census).

7 MW: Megawatt; One megawatt (MW) = 1,000 kilowatts

VEHICLE OWNERSHIP

In the FSM part of the imported fuel is directed to motor vehicles. While it is cheaper to import older used cars, most are not energy efficient. Vehicles have a direct impact on air quality and waste generation, through vehicle emission and disposal of old cars. Transport in the FSM accounts for 38% of the total carbon dioxide emissions in 2000, corresponding to 57,000 tCO_2e (tons of CO_2 equivalents[8]). Disposal of old cars is unregulated in all the states, with large vehicles abandoned on the roadside, in home gardens or into unregulated dump sites. This increases significantly the threat of oil spills and dispersal of toxic waste in the natural environment.

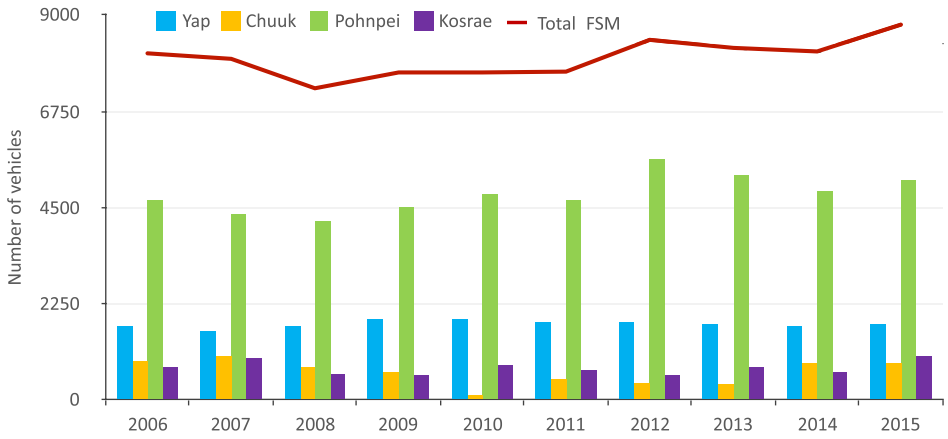


FIGURE 25. Registered vehicles in the FSM (Total_FSM) and by State between 2006 and 2015 (FSM Division of Statistic).

SOLID WASTE GENERATION

The increased levels of imported goods for household consumption directly affects the production of household waste. This increases the burden on the FSM to manage and dispose of waste effectively to reduce potential impacts on freshwater, marine resources and population health from burning garbage, illegal dumping, littering and disposing hazardous waste. Based on recent surveys, per capita generation of municipal solid waste (MSW) is approximately half of that of the United States. It will be difficult for the FSM to maintain or reduce the current level of waste generation despite future economic development.

For a more detailed discussion of solid waste in the FSM refer to the Built Environment Theme.

8 A measure that allows comparing the emissions of other greenhouse gases relative to one unit of CO_2. It is calculated by multiplying the greenhouse gas's emissions by its 100-year global warming potential.

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STATE OF FSM'S ENVIRONMENT, IMPACT AND RESPONSES

THEME 1 ATMOSPHERE AND CLIMATE

Kaday Village, overlooking the Nimpal Marine Protected Area, Weloy Municipality, Yap State.

OVERVIEW

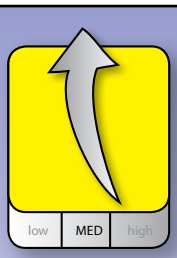
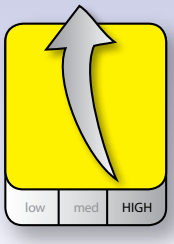
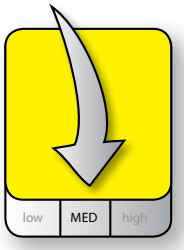
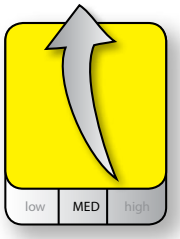
This chapter on the state of the FSM's Atmosphere and Climate focuses on four areas: Greenhouse gases (GHGs); Ozone-depleting Substances (ODS); Physical Climate and Climate; and Climate Adaptation.

The FSM ratified the UNFCCC in 1993 and the Kyoto protocol in 1999. While the FSM's contribution to GHG is marginal, the FSM is committed to reducing its GHG emissions. ODS were also greatly reduced in the FSM. Starting in 2009, the FSM phased out the use of CFCs reducing consumption to zero.

As with other Pacific island countries, the FSM is extremely vulnerable to the impacts of climate change. The country relies on its ecosystems and services for coastal protection, food and water provision. Therefore, climate change is likely to have immediate impacts on people and infrastructure as well as impacts on the functioning of ecosystem services, affecting water and food resources, and coastal protection provided by coral reefs and mangroves. FSM will have to manage the costs associated with loss and damage from climate change impacts as well as those for adaptation.

The cross-cutting nature of climate change, the high dependence on nature, the relatively small land mass, the vast geographic dispersion of the country and the entangled flow of ecosystem services from ridge to reef require a holistic approach to enhance the sustainable use of natural resources for healthy communities and future generations.

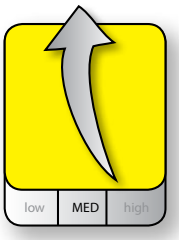
ATMOSPHERE AND CLIMATE HIGHLIGHTS

TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
GREEN HOUSE GASES	 **Status** Fair **Trend** Improving **Data confidence** Medium	The FSM contribution to GHG is marginal. FSM ratified the Kigali Amendment to the Montreal Protocol in May 12, 2017. This led to the phase-down of HFC consumption. HFC gases are thousands of times more potent than carbon dioxide. The global phase-down of these GHGs is projected to avoid global heating of up to 0.7 degrees F (0.4 degrees C)	The country ratified the UNFCCC in 1993 and the Kyoto protocol in 1999. As a party of these conventions, FSM then ratified the Paris Agreement Accord on July 2016 and committed to reduce 28% of GHG by 2025 below 2000 levels (FSM Intended Nationally Determined Contribution, 2015). As part of this process a national climate change policy was adopted in 2009, which focused on mitigation and adaptation actions for the country. FSM has a Climate Change Act of 2013 and an Integrated Climate Change and Disaster Risk Policy enacted in 2013. Funding under the UNFCCC and the GEF will go towards supporting initiatives to reduce GHG emissions.
ODS	 **Status** Fair **Trend** Improving **Data confidence** High	Ozone depleting substances were greatly reduced in the FSM from 2012–2018. Starting in 2009, the FSM phased out the use of CFCs reducing consumption to zero. The FSM has phased out 97% of its HCFC consumption baseline from 2009–2010.	The FSM is a member of the Vienna Convention for the Protection of the Ozone Layer and became Party to the Montreal Protocol on Substances that Deplete the Ozone Layer in 1995. The FSM is in the process of establishing a regulation to ban the import of HCFC-based equipment and has already established the RAC (Refrigerating and Air Conditioning) Association to support the implementation of HCFCs phase-out activities.
PHYSICAL CLIMATE	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium	Mean surface temperatures are increasing, rainfall is decreasing in all states, except in Yap, where rainfall is observed to be slightly increasing. Greater frequency of El Nino activity in the FSM. In the past five years, more frequent and more intense tropical cyclones activity in the Micronesia region. Two record strength tropical cyclones were documented in the past five years. Mean sealevel rise is also observed to be on an increasing trend together with rising sea surface temperatures.	The FSM has strategies in place to address climate change impacts. These plans include a climate change policy adopted in 2009 and enacted in 2013 and joint strategic action plans (JSAP). FSM Weather Service created a monthly conference aimed to assess and analyse quarterly climate data to provide El Niño and climate outlooks with all FSM states.
CLIMATE ADAPTATION	 **Status** Fair **Trend** Improving **Data confidence** Medium	FSM recognizes the importance of increasing its adaptive capacity to adjust to actual and expected climate effects. Several communities in the four states have implemented Ecosystem based adaptation strategies (EbAs).	FSM has multiple adaptation projects underway: Adaptation Fund, GEF Ridge-to-Reef, and the EU funded RENI project. All Funding under the UNFCCC and GEF will go towards supporting initiatives to implement other adaption projects. While the FSM has developed policy (The Climate Change Act) and action plans (JSAPs) to prioritize activities and projects across development sectors, there is a need for better access to climate adaptation finance, increased capacity for implementation of adaptation activities and mainstreaming of climate adaptation across sectors.

GREENHOUSE GAS EMISSIONS

INTRODUCTION

The Kyoto Protocol, ratified by the FSM in 1999, recognizes six greenhouse gases (GHG): carbon dioxide, methane, nitrous oxide, sulphur hexafluoride, perfluorocarbon and chlorofluorocarbons. GHGs are gases that contribute to the greenhouse effect by absorbing infrared radiation. Through the greenhouse effect, the increase in concentration of these gases in the atmosphere causes global warming and climate change. This section looks at FSM's GHG contributions and efforts to reduce them.



Status
Fair

Trend
Improving

Data confidence
Medium

Taro suffering from drought. Photo: Chiara Franco

SDG	SAMOA Pathway	UNFCC
13 CLIMATE ACTION; 14 LIFE BELOW WATER	44	Article 2 Article 4.1 Article 4.2

TABLE 8. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Fair	Fair
Trend	Improving	Improving	Improving	Improving
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND FINDINGS

The atmospheric concentrations of the greenhouse gases carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) have all increased since 1750 due to human activity (IPCC, 2013). Since 1750, cumulative anthropogenic CO_2 emissions have accumulated in the atmosphere, in natural terrestrial ecosystems and have been taken up by oceans. The increase in concentration of GHG has contributed to global mean surface warming, ocean warming, global mean sealevel rise, and likelihood of the occurrence or strength of extreme weather and climate events or both (IPCC, 2013). As reported from the International Panel for Climate Change "Continued emissions of greenhouse gases will cause further warming and changes in all components of the climate system. Limiting climate change will require substantial and sustained reductions of greenhouse gas emissions".

The FSM ratified the United Nations Framework Convention for Climate Change (UNFCCC) in 1993. As party to the UNFCCC, the FSM submitted its first and second National Communication in 1997 and 2015, respectively. The National Communications included information on vulnerability to

climate change, climate change adaptation efforts and information on national greenhouse gas emissions (GHG). The Second National Communication in 2015 provided estimates on GHG emissions by sectors for 2000.

Based on *The Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventory*, which identifies known sources of human-related GHG emissions, sectors that contributed to GHG emissions and relative contributions were reported for the four FSM states in the Second National Communication to the UNFCCC. On a global scale FSM's contribution to CO_2 emissions is significantly low, 0.003% of global CO_2 emissions.

The energy sector in the FSM, particularly through electricity generation, is the biggest source of GHG emissions (Figure 26). The GHG inventory conducted in 2010 identified five sectors associated with the GHG emissions. The energy sector was the most influential in determining FSM emissions, with liquid fossil fuel used for energy production and biomass fuel used mainly for traditional cooking activities. Between 1994 and 2010 the total amount of CO_2 emissions from fossil fuel decreased by 7.7%, from 164.5 CO_2 Gg to 151.9 CO_2 Gg. This decrease is mostly due to the efforts of the FSM government to move toward renewable energy.

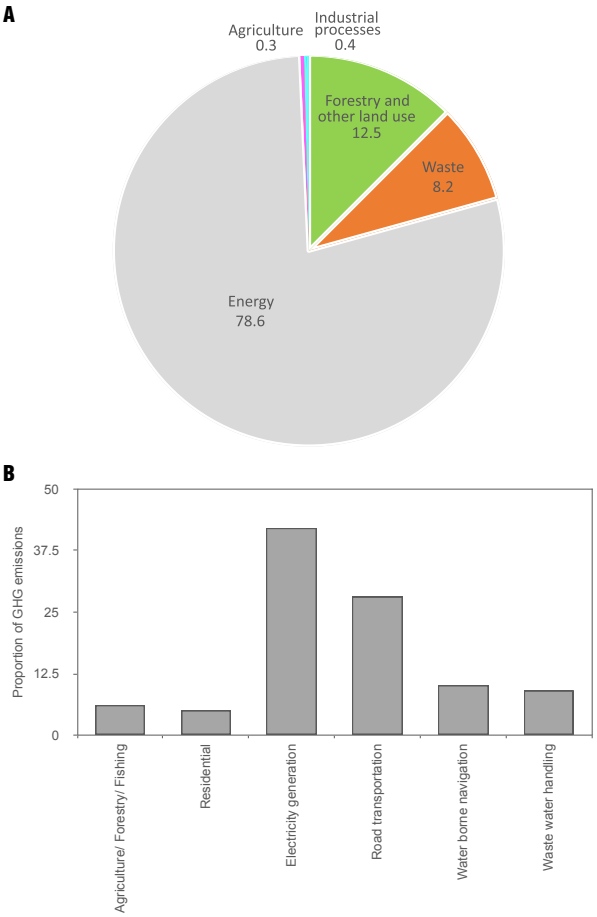


FIGURE 26. **A)** proportion contribution of different sectors to the FSM total GHG emissions ($GgCO_2e$) in 2000. **B)** Activities that contribute to GHG emissions ($GgCO_2e$) in the FSM in 2000 (2nd National Communication to the UNFCCC, 2016).

Through its Intended Nationally Determined Contribution (INDC) FSM identified the energy sector as the primary contributor of CO_2 emissions, with electricity generation and transport sub-sectors as main producers, accounting for 42% and 38% of total CO_2e emissions, respectively (INDC, 2015). Therefore, as part of its commitment to reduce GHG emissions with its Energy Policy (2012), FSM seeks to achieve at least 30% renewable energy by 2020.

In the FSM, land-use changes are not main contributors to CO_2 emissions due to a lack of intense agriculture and low soil disturbance. Agriculture is largely done at household level for subsistence and contributes a small part to the total GHG emissions. Domestic livestock and manure management are sources of nitrous oxide (N_20) and methane (CH_4). Livestock are an important source of protein for households, which usually raise pigs and chickens, but commercial operations are rare. Overall methane emissions from agriculture are low (0.028 CH_4 Gg) and contributions from nitrous oxide are insignificant with respect to global scales (0.00001 N_20 Gg). Among the activities that contribute to GHG emissions is the burning of savanna areas, especially in Yap and Chuuk. Intense droughts, as with those occurring during El Niño years, tend to exacerbate wild fires, destroying grassland and contributing to GHG emissions through the release of CH_4 (0.00066 Gg), N_20 (0.00001 Gg), oxides of nitrogen (NO_x = 0.00029 Gg) and carbon monoxide (CO = 0.01723 Gg) into the atmosphere. Also, mangrove removal is likely to contribute to the release of carbon in the atmosphere, resulting in positive climate feedback.

Solid waste disposal in landfills and human sewage contributed 8.2% of the total GHG emissions with 0.061 gigagrams (Gg) of CH_4 and 0.048 Gg of N_20.

The FSM GHG inventory identified few industrial processes contributing to GHG emissions in the country. There is no large industry base and manufacturing is limited to a small-scale clothing industry and bakeries, coconut product manufactures and lime producers. Therefore, industrial processes contribute only 0.037% to the total FSM GHG emissions.

IMPACT

While the FSM GHG emissions are negligible (0.003%) with respect to emissions at a global scale, the country is extremely vulnerable to impacts of climate change. In fact, the FSM has already experienced frequent and serious weather-related impacts, as well as other natural hazard events. In addition to exposure to natural threats (typhoons, drought), human induced threats (development impacts) also make the FSM more vulnerable to climate change impacts. For example, on several of the main islands, important infrastructure like schools and hospitals are found in coastal low-lying areas and relocation may prove impossible or too costly (State JSAPs).

RESPONSE

- Although FSM's total GHG emissions are negligible on a global scale, the country must play a role in the global effort to combat climate change because of its high vulnerability to climate change impacts. This commitment is reflected in FSM's Intended Nationally Determined Contributions (INDC) and proposed post-2020 targets that were communicated to the UNFCCC. The FSM commits to reduce its emission of GHGs to 35% below 2000 level by 2025.
- The Green Micronesia Initiative was endorsed in 2010 to promote a clean energy drive for four of the Micronesian island countries: FSM, Nauru, Palau and Republic of the Marshall Islands (RMI). The key goals are to achieve 20 percent of power generation through renewable energy by 2020, and improved energy efficiency. Increased energy efficiency in the household, business, government, transport and utilities sectors would be encouraged with support and development of renewable energy sources by the national government.
- FSM Climate Change policy enacted in 2013 – Integrated Climate and Disaster Risk Policy – The Climate Change Act of 2013. All Funding under the UNFCCC and GEF will go towards supporting initiatives to reduce GHG emissions.

RECOMMENDATIONS

- Reduce reliance on fossil fuels to decrease GHG emissions
- Set a manufactured year limit on used cars
- Support at least one renewable energy project in all four states
- Promote public transportation through incentives
- Improve road infrastructure or develop green village infrastructure that promotes safe walking and bike riding
- All development projects should meet FSM emission requirements

SOURCES

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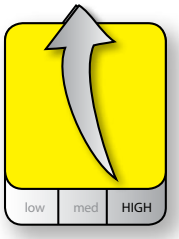
Jez O'Hare

OZONE DEPLETING SUBSTANCES

Ozone is a gas that is naturally present in our atmosphere. Most ozone (~90%) is found in the stratosphere, which begins about 6–10 miles above Earth's surface and extends up to about 31 miles altitude. The stratospheric region with the highest ozone concentration is commonly known as the 'ozone layer', which extends over the entire globe with some variation in altitude and thickness. Chlorofluorocarbons (CFCs), Hydrochlorofluorocarbons (HCFCs) and other Ozone-depleting Substances (ODS) deplete the stratospheric ozone by reacting with it and breaking it down. ODS are found in many products and household items such as those used in refrigeration, air conditioning, solvents and fire extinguishing applications. This section looks at the FSM's ODS contribution and efforts to reduce them.



Status
Fair

Trend
Improving

Data confidence
High

SAMOA Pathway

45

Coastal erosion. Photo: Chiara Franco

TABLE 9. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Fair	Fair
Trend	Improving	Improving	Improving	Improving
Data Confidence	High	High	High	High

STATUS AND FINDINGS

The FSM is a member of the Vienna Convention for the Protection of the Ozone Layer and became Party to the Montreal Protocol on Substances that Deplete the Ozone Layer in 1995. The FSM is also part of the London, Copenhagen, Montreal, and Beijing Amendments and ratified the Kigali amendment in 2017. As party to this Convention and its Protocols the FSM is required to phase out the consumption and production of entire groups of harmful ozone-depleting chemicals, including chlorofluorocarbons (CFCs), hydrofluorocarbons (HCFCs), hydrobromofluorocarbons (HBFCs), halons, methyl chloroform, carbon tetrachloride, methyl bromide and other halogenated CFCs.

In 2009, FSM proposed an amendment to the Montreal Protocol to phase down the production and consumption of hydrofluorocarbons (HFCs) under the treaty. This proposed amendment aimed to prevent HFC emissions equivalent to up to 100 billion tons of CO_2 by 2050. This effort resulted

in the adoption of the Kigali Amendment to the Montreal Protocol on HFC phase down in October 2016 calling for use of alternatives to HCFCs that have minimal impacts on climate change. FSM ratified the Kigali Amendment to the Montreal Protocol in May 12, 2017. In doing so, FSM will begin to phase down its HFC consumption starting in 2024. FSM is exploring ways to link activities under the Kigali Amendment to the country's greenhouse gas reduction, energy efficiency and climate action goals.

Under Article 5 of the Montreal Protocol the FSM is entitled to assistance from the financial mechanism of the Montreal Protocol known as the Multilateral Fund. The Fund provides financial and technical assistance to developing countries to enable their compliance with the Protocol's control measures. From 2009 the FSM phased out the use of CFCs, reducing consumption to zero Ozone Depleting Potential (ODP) units (UNEP, 2018). Similar progress is under way for the HCFCs, which are also being phased out. The imports of HCFCs decreased by 97% from a baseline consumption of 2.55 metric tonnes to 0.065 metric tonnes in 2017. In 2017 the consumption reduction of HCFCs surpassed the 35% reduction target from its baseline, indicating that the country is in the advanced stages of phasing out HCFC consumption ahead of the Montreal Protocol reduction schedule. In 2030, the global community is expected to reach a total phase-out of HCFC consumption.

In general, between 2011 and 2018 the consumption of HCFCs has dropped below 0.1 ODP tonnes (Figure 27). The FSM is in the process of establishing regulations to ban the import of HCFC-based equipment, and has established the RAC (Refrigeration and Air Conditioning) Association to support the implementation of HCFCs phase-out activities (UNEP, 2018). The FSM has distributed across the four state RAC Associations servicing equipment and tools that comprise: (i) a recovery machine, (ii) recovery cylinders, (iii) servicing tool boxes, (iv) refrigerant recovery kit and (v) vacuum pumps. The country complies with the reporting of illegal trade to the Ozone Secretariat. In 2015, in efforts to curb trade of mislabelled refrigerants, the FSM confiscated and stored 180 canisters for a total of 45 kg of Dichlorodifluoromethane (CFC). The FSM ceased imports of CFCs in 2008 even before the global ban in 2010. The FSM is progressing well in the total phase-out of HCFC consumption, reaching a 97% reduction of HCFC imports in 2018.

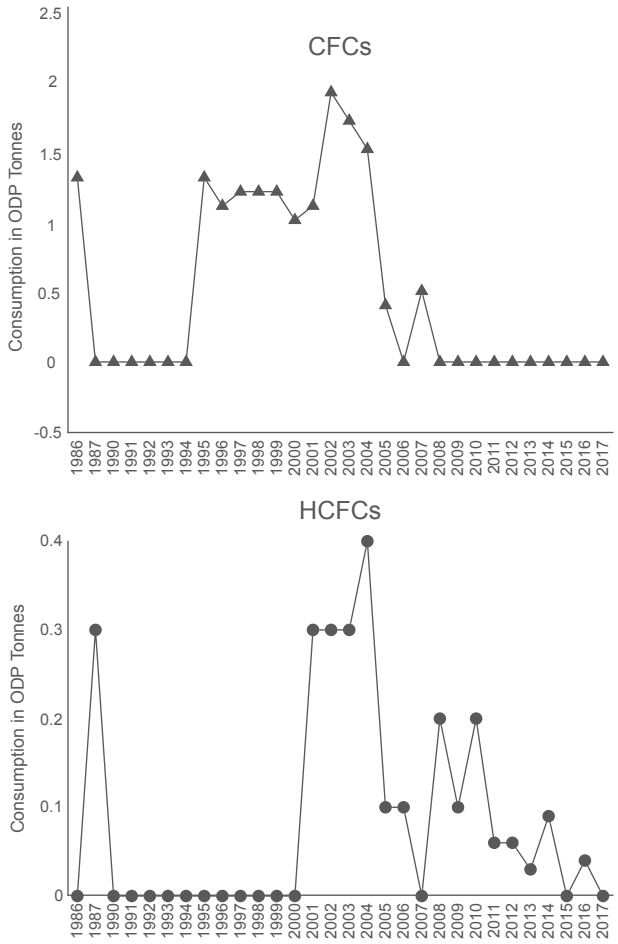


FIGURE 27. Consumption of CFCs and HCFCs in the FSM between 1986 and 2017. Values are given in ozone depleting potential (ODP) units, which is a measure of the relative amount of degradation to the ozone layer that ODS chemicals can cause (UNEP Data Center).

IMPACT

Ozone Depleting Substances (ODS) are not only harmful to the ozone layer, but also operate as extremely potent Greenhouse Gases (GHGs). Despite their low global emission rates, HCFCs have a Global Warming Potential (GWP) of 2000–3000 times that of CO_2. To put that in perspective, one kilogram of the HCFC R-22 traps the same amount of heat equivalent to 1,810 kilograms of CO_2. The global phase-out of ODS not only helps to protect the ozone layer, but also benefits climate change mitigation through a direct reduction of GHG emissions. The FSM's smooth phase-out of ODS ensures that the local economy is insulated from adverse trade implications and is compliant with all obligations as a Party under the Montreal Protocol.

While the FSM continues to work to phase out ODS, there are several challenges towards implementing the phase-out management plan for Pacific island countries:

- High turn-over rate of the National Ozone Officers (NOOs).
- Difficult for the NOU to identify the use of HCFCs in the fisheries sector.

- Development and implementation of refrigeration and air conditioning (RAC) standards are challenging as most Pacific island countries have no local expertise or, in some cases, no Government Department is responsible for the formulation and implementation of standards.

RESPONSE

- Adoption of the Kigali Amendment to the Montreal Protocol on HFC removal in October 2016 calling for alternatives to HCFCs that have minimal impacts on climate change.
- Licensing system for control of ODS imports which includes addressing storage issues.
- 97% phase-out of HCFCs from the 2009–2010 baseline together with a total phase-out of CFCs since 2010.
- Refrigeration and Air-Conditioning (RAC) Associations set up in each of the four states.
- Legislation to ban the importation of new HCFC-based equipment.
- Process to draft new regulations to implement a licensing and permit system for HFC gases.
- Adoption of the World Customs Organization 2017 Harmonized Commodities codes for better trade monitoring.

RECOMMENDATIONS

- Improve monitoring, data, enforcement, and disposal options on ODS imports.
- Strengthen support from ODS units at national and state levels.
- Awareness plans for fishing companies to be compliant with ODS regulations.
- Improve capacity for management of ODS at the state level.
- Public awareness on the linkages between HFC phase-down, energy efficiency and climate action under the Kigali Amendment.

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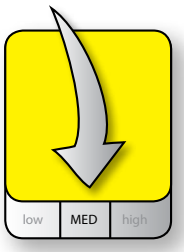
View of the Okat valley (foreground) and the Innem valley (background). Photo: Nick Hall

PHYSICAL CLIMATE

INTRODUCTION

Physical climate refers to longterm weather patterns usually with a focus on average temperatures and precipitation levels. This section looks at the physical climate of the FSM across the four states and the expected impacts due to climate change.



Status
Fair

Trend
Deteriorating

Data confidence
Medium

SDG	SAMOA Pathway
13 CLIMATE ACTION, 14 LIFE BELOW WATER	44a-d

TABLE 10. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Poor	Fair	Fair
Trend	Deteriorating	Deteriorating	Deteriorating	Deteriorating
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND FINDINGS

The FSM has two distinct seasons – a wet season from November to April and a dry season from May to October. Due to the geographical spread of the islands, the climate can vary. Recent studies by the Australian Bureau of Meteorology and the National Weather Service Offices of the FSM have divided the country on an east-west basis for analysis. In the FSM climate variation is relatively stable with seasonal variation in temperature of less than 3°F (1.5°C) between the average hottest and coolest months (Figure 28). However, while on the west side of the FSM (Yap and Chuuk) annual mean air temperatures show little change (+0.06°C) since the 1950s, on the east side (Pohnpei and Kosrae) annual mean air temperatures have increased (~1°C) since 1951.

The states of Yap, Chuuk and their adjoining outer islands are prone to extremely damaging natural disasters, in the form of typhoons, extended drought, landslides, tidal erosion and extensive floods. Major storms do not often impact Kosrae and Pohnpei, however, typhoons frequently originate in the area and gather strength as they move west.

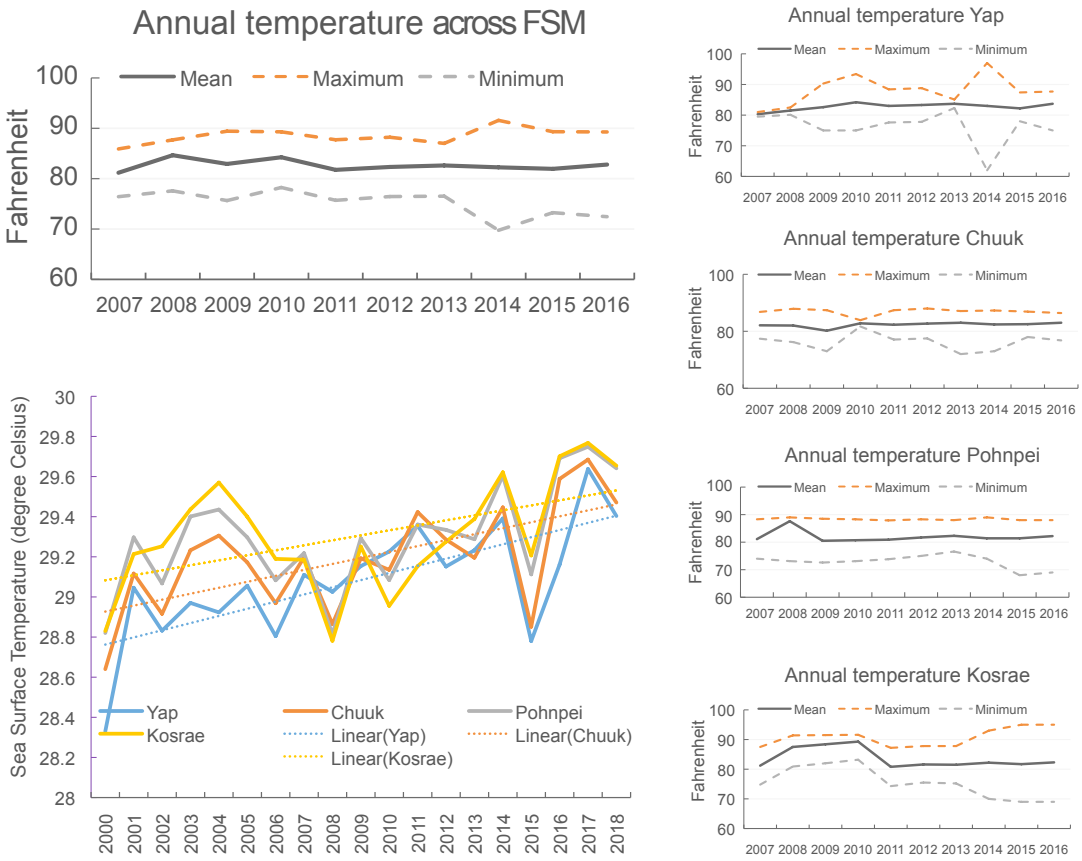


FIGURE 28. Annual air temperatures (average, minimum, maximum) and Sea Surface Temperature (SST)* for the Federated States of Micronesia: Pohnpei and Kosrae in the east, Yap and Chuuk in the west. (Figure adapted from Australian Bureau of Meteorology and CSIRO, 2014). **SST data reference: NOAA Coral Reef Watch, last accessed 2018.*

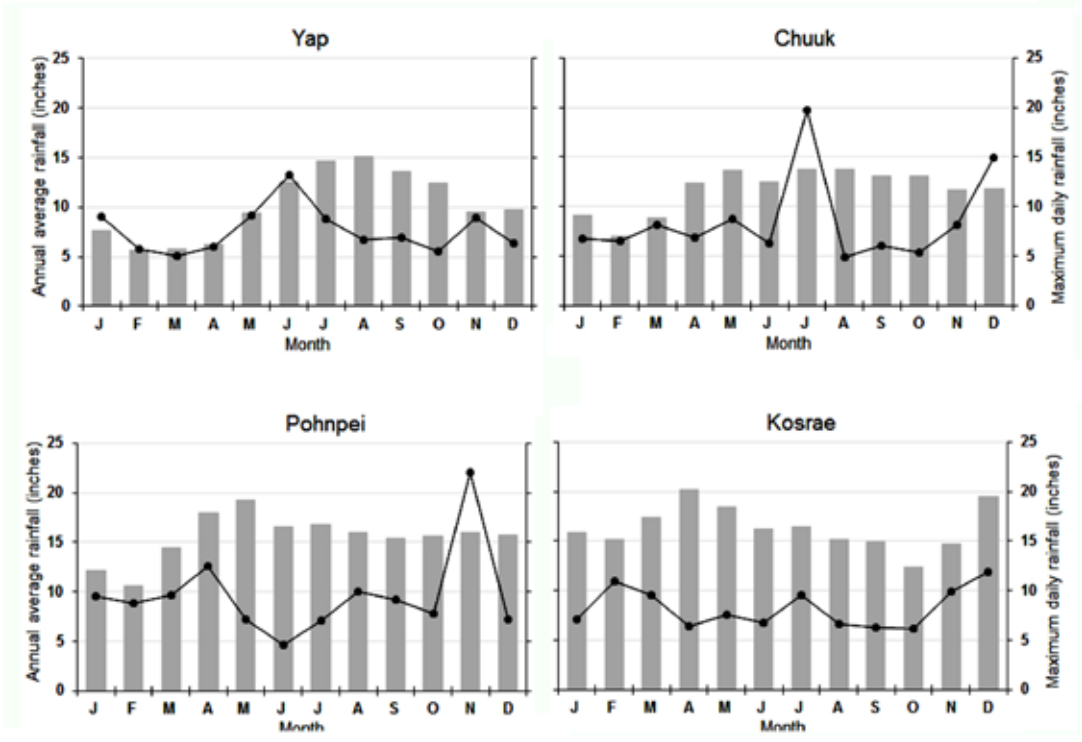


FIGURE 29. Seasonal rainfall (average and maximum) for the east (Pohnpei and Kosrae) and west (Yap and Chuuk) regions (National Weather Service, FSM).

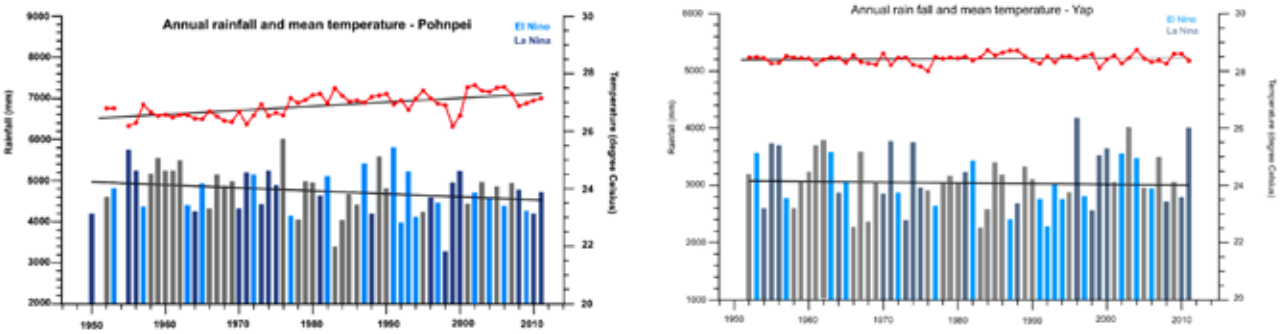


FIGURE 30. Observed time series of annual average values of mean air temperature (red dots and line) and total rainfall (bars) at Pohnpei and Yap. Light blue, dark blue and grey bars denote El Niño, La Niña and neutral years respectively. Solid black trend lines indicate a least square ft. (Australian Bureau of Meteorology and CSIRO, 2014).

Rainfall in the FSM is affected by the movement of the Intertropical Convergence Zone. The wet season occurs when the Intertropical Convergence Zone strengthens and moves north close to the FSM. The West Pacific Monsoon also impacts rainfall, bringing additional rain during the wet season supporting a switch from very dry to very wet conditions. In Yap, average annual precipitation is approximately 132 inches, in Chuuk average annual precipitation increases to 140 inches while in Pohnpei and Kosrae, one of the wettest places on earth, average annual precipitation reaches 187 inches and 197 inches, respectively (Figure 29).

Climate variability is modulated by the El Niño-Southern Oscillation (ENSO). El Niño events are associated with drier conditions and occasional droughts. Fires, water shortages and food shortages have occurred during severe dry events. Tropical cyclones affect the FSM mainly between June and November and are more likely to occur in El Niño years (above-average numbers of tropical storms) and less likely in La Niña years. Droughts, typhoons, storm waves, flooding and landslides all affect the FSM. Impacts vary depending on ENSO years, but affect sealevel, precipitation patterns, temperature (air and sea), and storm patterns resulting in intense flooding and drought. In Chuuk, drought may occur in the year after a moderate/strong El Niño. ENSO also can impact coral reefs (e.g. coral bleaching).

Sealevels have risen globally by 4–8 inches over the last 100 years: the FSM generally experiences higher sealevels during La Niña and lower sealevels during El Niño. During La Niña, higher sealevels associated with wind-driven waves can cause coastal flooding with impacts to public infrastructure and private buildings. These changes in sealevel are highly coherent across the region from Yap to Chuuk, Pohnpei, and Kosrae. Protracted La Niña-like conditions during the first decade of the 21st century caused marine inundation that required provision of emergency food and water supplies to some FSM communities. In 2007, and again in 2008, many FSM communities were flooded by a combination of large swells and spring high tides that eroded beaches, undercut and damaged roads, intruded into aquifers and wetlands, and inundated communities (FSM 2nd National Communication to UNFCCC, 2015).

Tide gauge data in Yap indicates a sealevel rise of ~4.7 inches since 1969, less than surrounding areas due to tectonic uplift (University of Hawaii Sea Level Center, 2015). Similarly, in Pohnpei, tide gauge data indicates sea-level rise of ~6 inches since 1974 (Australia Bureau of Meteorology 2015). Since 1993 sealevels in the tropical western Pacific have risen an average of 0.2–0.4in (5–10 mm) per year. For FSM specifically, the value is over 0.39 inches (10 mm) per year. This is well above the global mean of about 0.12 inches (3mm) per year over the same period. The rise is partly linked to a pattern related to climate variability from year to year and from decade to decade (Australian Bureau of Meteorology and CSIRO, 2011). Sealevel rise exacerbates flooding from high tides and storms. This can increase the potential for loss of lives, damage and loss of coastal homes, lands, and infrastructure, contaminated drinking water, and destruction of crops. Increased coastal erosion can result from higher sealevels especially when combined with large waves. Salinity intrusion can damage coastal aquifers and agricultural land.

Over the last two centuries in the FSM, the aragonite saturation state (a proxy for coral reef growth rate) has declined from 4.5 to 3.9. Currently coral reef ecosystems are not found at seawater aragonite saturation states below three, which are described as marginal conditions to support coral reefs growth.

IMPACT

Regionally, the Pacific will experience an increase in the average temperature, the number of extremely hot days, the number of extreme rainfall events, ocean acidification and sealevel rise. Projections from all IPCC[9] emissions scenarios indicate that annual mean temperatures and extremely high daily temperatures, as well as Sea Surface Temperature (SST), will continue to rise. Sealevel is projected to increase in line with the predicted global average sea-level rise of 0.18 to 0.59 metres by 2080–2099. Most of the FSM communities (> 80%) are vulnerable to SLR and flooding, as most are settled along coasts, rivers, and streams.

Annual average rainfall is expected to increase while tropical storms and cyclones are expected to decrease in

[9] The Intergovernmental Panel on Climate Change (IPCC) developed four greenhouse gas and emissions scenarios, called Representative Concentration Pathways (RCPs). These scenarios cover a range of possibilities based on four different carbon dioxide atmospheric concentrations (parts per million, ppm): very low (RCP2.6), low (RCP4.5), medium (RCP6.0) and very high (RCP8.5) emissions scenarios.

TABLE 11. Climate change projections for FSM based on the IPCC emissions scenario 'very high' (RCP8.5), for 20-year time periods centred on 2030, 2050 and 2090. In the summary table differences in projections across FSM are noted Eastern (E; Pohnpei and Kosrae) and Western (W; Yap and Chuuk).

Climate variable	Expected change	Projected change 2030	Projected change 2050	Projected change 2090	Confidence level	IMPACTS
Air temperature	Annual temperatures will to continue to rise.	+ 0.8°C [+33.4°F]	+ 1.4°C [+34.5°F]	+ 3°C [+37.4°F]	High	Impacts to human health and health systems related to heat stress if working outside or outdoor recreation. Increased need for cooling systems and energy required for cooling. Air temperature impacts sea surface temperature, storms, and precipitation, also impacting agriculture and water resources.
Rainfall patterns (% change)	Average rainfall is projected to increase over the FSM.	~2% (W) ~ 3%(E)	~5% (W) ~ 6%(E)	~10% (W) ~ 12%(E)	Moderate	Increases in rainfall intensity will lead to increasing flooding, damage to crops, and increases in run-off/pollutants into coastal waters. A wetter climate may also lead to increases in vector-borne diseases (e.g. dengue). Impacts will be felt from periods of drought affecting human health, water supply and agriculture.
Sealevel rise	Sealevel is projected to increase.	~5 in [13 cm]	~10 in [24 cm]	~25 in [64 cm]	High	Sealevel rise exacerbates flooding from high tides and storms. This can increase the potential for loss of lives, damage and loss of coastal homes, lands, and infrastructure, contaminated drinking water, and destruction of crops. Increased coastal erosion can result from higher sealevels especially when combined with large waves. Salinity intrusion can damage coastal aquifers and agricultural land.
Sea Surface Temperature (SST)	Sea Surface Temperature is projected to increase.	~0.8°C [~33.4°F]	~1–2°C [~33.8–35.6°F]	~2–4°C [~35.6–39.2°F]	High	Coral bleaching is expected to increase. When sea temperatures increase 1–2°C above the normal maximum for > 4–6 week, coral bleaching is likely. Coral diseases may also increase due to warming seas. Coral bleaching and disease can adversely affect reef-dependent species and reduce services reefs provide (tourism; coastal protection; food and livelihoods; habitat; medicine).
Ocean acidification (maximum aragonite saturation state, Ωar)	Ocean acidification will continue to increase	~3.5 Ωar	< 3.0 Ωar	< 3.0 Ωar	High	Ocean acidification (OA) affects many marine organisms that rely on calcium carbonate to build their shells/skeleton (e.g. corals, clams, mussels). OA can result in decreased growth and reproduction and weaker and more brittle skeletons, prone to increased damage from storms. Corals are critical because they provide habitats for fish, support food and livelihoods, income from tourism, medicines, and coastal protection to islands.
Storm Patterns	Typhoons are projected to be fewer but of higher intensity.	↓ 20–50%	↓ 20–50%	↓ 20–50%	Low	More severe cyclones when they do occur and combined with sealevel rise will result in increased flooding and potentially coastal change resulting in damage and loss of lives, coastal homes, land, and infrastructure.

[a] Climate projection data are obtained from the Australian Bureau of Meteorology and CSIRO (2014). Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports. Climate projections are derived using the Global Climate Model data from the Coupled Model Intercomparison Project, Phase 5 (CMIP5). Projections provided are for the greenhouse gas and aerosol concentration emission scenario RCP8.5 (Representative Concentration Pathway: very high emissions).

frequency but increase in intensity. Droughts are projected to occur less often, but with increased severity. More intense (heavy) rainfall events are also expected to occur. There will still be wet and dry years and decades due to ENSO-related variability, but most models show that the longterm average is expected to be wetter. Indeed, El Niño and La Niña events will continue to occur in the future, but there is little consensus on whether they will change in intensity or frequency. Globally, cyclones are projected to be fewer but of higher intensity. Models show inconsistent results for the FSM: most suggest a decrease in formation (20–50%), but the confidence for these projections is low.

As atmospheric CO_2 concentrations continue to rise, oceans will warm and continue to acidify. Models suggest the aragonite saturation state will continue to decrease to 3.5 (marginal conditions to support coral reefs) by 2030 and decrease further to values where coral reefs have not historically been found (< 3.0). Ocean acidification affects many marine organisms that rely on calcium carbonate to build their shells/skeleton (e.g. corals, clams, mussels). Declining aragonite saturation state results in decreased growth and reproduction and weaker and more brittle skeletons, prone to increased damage from storms. Corals are critical because they provide habitats for fish, support food and livelihoods, generate income from tourism, provide medicines, and protect the coast.

Natural disasters are of special concern to the FSM due to its spread of smaller islands and dependence on subsistence agriculture and tourism, which are vulnerable to natural and environmental disasters. The natural disasters usually affect the economy and natural environment, and the rehabilitation costs are high.

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RESPONSE

While the main response for Climate Change impacts for the FSM will be adaptation, it is important that the FSM also address physical changes in climate patterns though mitigation. The FSM will mitigate CO_2 emissions by increasing renewable energy production and using improved technology. These actions are set out in the Intended Nationally Determined Contribution (INDC) under the UNFCCC. The national government should also continue to provide technical and funding support to the states for implementation of their JSAPs. It is also important for the FSM to continue to monitor and assess climate trends and future risks, through the establishment of a formalized monitoring program in collaboration with international and regional partners. The FSM Weather Service created a monthly conference aimed to assess and analyse quarterly climate data to provide El Nino and climate outlooks with all FSM states.

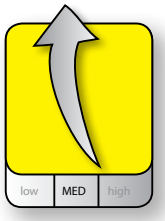
RECOMMENDATIONS

- Scaling up of adaptation practices.
- Monitor and assess climate trends and future climate risk.
- Provide technical support, capacity building and funding to states for implementation of JSAPs.
- Increase public awareness of climate change.
- Institutional Capacity Development.
- Strengthen existing development and environment legislation by incorporating climate proofing requirements.
- Strengthening existing partnership with partnership with private sector.
- Develop framework for accessing funds by community.

Mahkontowe Conservation Area, view from Lelu Harbor. Photo: Ashley Meredith, FSM National Cultural Anthropologist, KIRMA

INTRODUCTION

Climate change adaption seeks to lower the risks posed by the impacts of climate change. Adaption strategies may be implemented in advance or put in place in response to local pressures. These measures can be large-scale infrastructure (building defences), ecosystem based (planting to reduce erosion), or behavioural (using less water, planting different crops). This section looks at the adaptation strategies already being undertaken within the FSM.



Status
FAIR

Trend
Improving

Data confidence
Medium

SDG	CBD	NBSAP
6 CLEAN WATER AND SANITATION	14	Theme 6

TABLE 12. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Poor	Fair	Fair
Trend	Improving	Mixed	Improving	Improving
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND FINDINGS

The people and governments of FSM already face significant climate threats and related impacts associated with climate variability such as droughts, flooding and rising sealevel. The FSM's remoteness, with states dispersed over a large EEZ, small size, underdeveloped infrastructure and low technical capacity is considered highly vulnerable to external threats, including climate change impacts (Briones, 2017). The 2017 FSM Rapid Vulnerability Assessment showed that sensitivity (how severely resources are impacted by increased climate hazards) is high for all states, while the sectors' adaptive capacity across FSM is low to medium, suggesting that the country is highly vulnerable to climate change impacts. FSM recognizes the importance of increasing its adaptive capacity to adjust to actual and expected climate effects (IPCC, 2014).

In its climate change policy (2009), the FSM recognized the importance of reducing and managing the impacts and risks related to climate change through adaptation. As such the policy recognizes (i) the importance of traditional knowledge for conservation practices, (ii) the strategic role that ecosystems can play to enhance communities' resilience by sustaining food and water security, and (iii) the importance of climate proofing to ensure that projected climate changes are taken into account for new infrastructure and buildings.

The Climate Change Act was enacted in 2013 to implement the Climate Change Policy by introducing climate change-mainstreaming obligations for departments and agencies of the national government. The nation-wide Integrated Disaster Risk Management and Climate Change Policy of 2013, which focused on creation of disaster coordination offices in the states which led to the development of The Joint State Action Plans for Disaster Risk Management and Climate Change (JSAPs). The JSAPs were developed to take the policy forward by identifying priority activities and projects that establish, at state level, consistency with climate change-related objectives, strategies and outcomes across development sectors. Currently, the FSM has multiple adaptation projects underway. Among these are the Adaptation Fund, GEF Ridge-to-Reef, and the EU-funded RENI project. All funding under the UNFCCC and

GEF are to support initiatives to implement climate change adaption projects.

Through the JSAPs, each state identifies its vulnerable sectors and priority activities to mainstream climate change adaptation across development sectors. In the four FSM states, water resources, agriculture, fisheries, coastal ecosystems and biodiversity were identified among the vulnerable sectors to climate change. As of August 2017, the JSAPs have been endorsed by all the states.

As a Party to the UNFCCC, the FSM has access to the Green Climate Fund (GCF) and the Adaptation Fund (AF), the financial mechanisms established under the Kyoto Protocol and launched in 2007 for adaptation projects and programs for developing countries Parties. In line with the environment, agriculture and fishery sector vulnerabilities that the states identified in their JSAPs, projects that enhance food and water security, while increasing the resilience of terrestrial and coastal ecosystems, will be the focus of the country climate finance (Briones, 2017: FSM Proposal to the adaptation fund, 2018). Vulnerability to climate change is high in the FSM states while adaptive capacities vary from medium to low (Table 13).

The priority areas identified in the JSAPs, for increasing the resilience of communities and environmental sectors to climate change, were related to ecosystems management and improved awareness and education. The need for enhancing shoreline protection and management, including mangrove protection and rehabilitation, was identified as a strategy for climate change adaptation by all four states. The state of Yap does not specifically state mangrove ecosystems, but it plans an ecosystem management approach for natural resources and the use of Ecosystem-Based Adaptation (EbA) strategies for adapting to climate change.

A recent project concluded by The Nature Conservancy, in partnership with local NGOs (KCSO, CSP, CCS, YAPCAP and TRCT), the Micronesia Conservation Trust, RARE and the Helmholtz Centre for Environmental Research-UFZ, showed the importance that EbAs have in increasing the resilience of local communities and ecosystems. The main outcomes of the project call for leveraging protection of ecosystems to ensure the flow of their associated services, to enhance coastal protection, food and water security. At national and state level, ecosystem management and protection are fully embraced as climate change strategy. The JSAPs from the four states highlight the importance of protecting ecosystems through land management plans and watershed reserves. Watershed protection is known to be crucial for ensuring water security for the high islands of the FSM.

The GEF Ridge-to-Reef project has an ecosystem-based approach, recognizing the importance of conserving and managing island ecosystems from ridge to reef in order to ensure long term resilience to island residents.

All four states recognized the need for ensuring food security: Pohnpei specifically focused its strategy on expanding the use of saltwater and drought resistant crops, while for Yap traditional crops and transfer of traditional agroforestry knowledge was recognized as the way to adapt to climate change. The importance of strengthening traditional practices and knowledge, as a means for climate change adaptation, is recognized in the JSAPs. Relocation of outer island communities, while enhancing socio-cultural resilience, is among the strategies identified in Yap and Pohnpei for adapting to climate change.

TABLE 13. Climate risks and vulnerabilities for FSM's States. (FSM joint Action plans 2016; FSM Rapid Vulnerability Assessment Report, 2016).

State	Climate impact	Sensitivity	Adaptive capacity	Vulnerability
Yap	Typhoons, flooding, drought, and high seas storm surges in its outer islands.	High	Medium	High
Chuuk	Droughts, typhoons, tropical storms, storm-waves, flooding, landslides, and high sea surges in its outer islands.	High	Low in all sectors, medium in fishery, coastal ecosystem and biodiversity	High
Pohnpei	Droughts, variable rainfall patterns, typhoons during El Nino periods, tropical storms, and high sealevels. during El Nina	High	Medium	High
Kosrae	Landslides, higher than normal high tides, large sea swells, increased impact of storm surges and flooding as a result of sealevel rise, drought, tropical storms and typhoons	High	Medium in all sectors, low in private sector (nature-based tourism)	High

IMPACT

A positive way to help people to adapt, which is identified in the JSAPs, is by managing ecosystems such as coral reefs, mangroves and forests. Healthy ecosystems will be more resilient to the impacts of climate change while providing the ecosystem services required by the communities.

On the other hand, human induced impacts can jeopardize the state and national efforts in increasing communities' adaptive capacity. For instance, impacts on forests and water flow can increase erosion and reduce soil fertility, reducing the opportunities for improving food and water security. Similarly, overfishing and illegal fishing decrease the resilience of communities, by impacting one of the major sources of food in the country. These drivers of ecosystems change can be exacerbated in case of rapid population growth and external market shocks, which have the potential to increase resources extraction by those more in need.

RESPONSE

- All adaptation projects to undergo an EIA process.
- Multiple adaptation projects are underway: Adaptation Fund, GEF Ride-to-Reef, and the EU-funded RENI project. All funding under the UNFCCC and GEF will go towards supporting initiatives to implement other adaption projects.
- Development of state Joint Strategic Action Plans (JSAPs) to address Climate Change and Disaster Risk Management.
- Existing Ecosystem-based adaptation plans including community-based Local Early Action Plans (LEAP) developed through a participatory approach.

RECOMMENDATIONS

- Build on examples and challenges encountered by previous adaptation projects (e.g. SPREP Pacific Adaptation to Climate Change-PACC, The Nature Conservancy adaptation project) for upscaling adaptation practices in the nation.
- Increased awareness and understanding of CC and DRM to increase community knowledge on available adaptation strategies and actions.
- Strengthen (1) governance capacity, (2) capacity to improve knowledge management, (3) capacity in terms of budget, staff and equipment.
- Development and infrastructure planning that include climate proofing.
- Development of partnership with the Private Sector for investing in adaptation. Climate proofing specialization represents an opportunity for expansion of the private sector.
- Leverage access to climate finance by increased opportunities for communities to access climate-related grants.
- Strengthen consultative process to include most vulnerable in adaptation planning, including children, elders, women and communities from the outer islands in order to effectively develop or enforce management plans.
- Promote and focus adaptation actions on the most vulnerable islands.

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OVERVIEW

In the FSM different types of water resources vary by island. The main volcanic islands of Pohnpei and Kosrae have an abundance of water resources, including surface and groundwater. In Yap and Chuuk, groundwater is the main source of water for many communities. The outer islands of the FSM, due to their coral soil and small size, rely on rainwater and groundwater in the form of atoll water lenses. Overall outer island water resources are extremely limited since the atolls receive considerably less rainfall than high islands. These communities are heavily impacted by drought events. For high islands, major concerns are associated with degradation of watershed conditions due to deforestation, which increases sediments entering waterways, affecting the surface waters. Other concerns are a lack of proper sanitary systems, shifts in land use, inappropriate management of livestock, etc. Groundwater exploitation is operated through wells at household level in Chuuk lagoon, while Yap has in place a water system connected to surface reservoirs and groundwater aquifers.

In the FSM water quality is of great concern for the health of the population. For instance, encroaching farming activities in Pohnpei's watershed and poor wastewater control increase the risk of bacterial contamination. Limited knowledge on water capacity of FSM's groundwater aquifers increases the uncertainty for future abstraction.


Shelly Lebehn-Amor

WATER HIGHLIGHTS

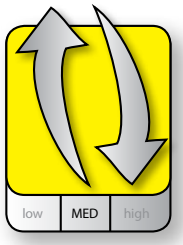
TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
WATERSHED CONDITION	 **Status** Fair **Trend** Mixed **Data confidence** Medium	Management of watersheds has become a priority issue for protection of inland and coastal waters. Several issues for water quality are associated with the degradation of the watersheds in the main islands. Lack of regulations or enforcement along with climate change impacts, are accelerating the decline of watershed areas.	• Development of Ridge to Reef management plans and protected areas that encompass numerous ecosystems and conserve critical watershed. • Increase funding and capacity for monitoring and enforcement.
SURFACE WATER (QUANTITY AND QUALITY)	 **Status** Poor **Trend** Mixed **Data confidence** Low	About 60% of water resources exist as surface water in the form of small, intermittent streams that drain catchment areas of limited aerial extent. While the high islands of Pohnpei and Kosrae have perennial waterways, in Yap the streams are dry for about 20% of the year.	• Existing National Water Framework and State Water and Sanitation Policies to be strengthened. • Expansion of Dry Litter Piggery. • Improve regulations for sanitation and enforcement of regulations. • Updated land use management plans.
GROUNDWATER (QUANTITY AND QUALITY)	 **Status** Fair **Trend** Unknown **Data confidence** Low	40% of the islands' water resources exist as groundwater, which is accessed through extractive wells. Shallow wells are common in the FSM, particularly in the outer islands and in the islands in Chuuk lagoon.	• Hydrological surveys, especially for Yap that has high dependence on groundwater. • Develop groundwater conservation plans.

WATERSHED CONDITION

INTRODUCTION

The term watershed refers to a region of land where water flows down into a specified body of water such as a river, wetlands or ocean. This section looks at the condition of watersheds and status of management across the four FSM states. Several issues for water quality are associated with the degradation of the watersheds in the main islands. Due to the strong link between watershed health and a positive water quality in islands with small landmasses, it is crucial for the FSM to preserve its watershed areas, which come with an array of services and goods for the communities.


Chiara Franco



Status
Fair

Trend
Mixed

Data confidence
Medium


Ami Vitale

SDG CBD

TABLE 14. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Unknown	Unknown	Mixed to deteriorating	Unknown
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND FINDINGS

Management of watersheds has become a priority issue for protection of inland and coastal waters. Lack of regulations or enforcement, along with climate change impacts, are accelerating the decline of watershed areas. Among the threats for watershed degradation are infrastructure, deforestation, storms, droughts, wildfires and invasive species. As suggested in the 2010 SWAR, “Taking a watershed approach is not only ecologically sound but will help people to see their place in the ecological landscape and the connection between ecological integrity (biodiversity), food production and need for sustainable production and harvest.”

Differences in land tenure systems require innovative approaches for the management of the main watersheds in the four states. Many watersheds are impacted by construction activities such as roads, airstrips, earthmoving activities, and dredging. In Pohnpei, the Watershed Forest Reserve was established to reduce the pressures from increasing population moving inland and

encroaching in the upland areas of the watersheds. Disputes over the boundary of the Watershed Reserve have delayed demarcation. To date, all municipalities have agreed to the boundary except one. This creates challenges for effective management of the reserve. Regulation and management of the watershed area is expected to maintain the flow of services associated with watershed ecosystems (e.g. forests). In Kosrae, the upland watershed areas are steep and access is limited by the terrain. The states of Chuuk and Yap have more scattered, smaller watersheds. Chuuk has several watersheds in its lagoon islands, but the current land tenure system requires alternative land management approaches that integrate a ridge-to-reef (R2R) vision. This will ensure that the benefits from sustainable resource extraction is reflected in the coastal areas. In Yap, somewhat similar to Chuuk, where land tenure is held under traditions and customs, the Tamil municipality through a community-endorsed declaration has protected the watershed area that feeds the aquifer used by the Gagil-Tamil Water Authority. Indeed, watersheds integrate natural habitats from ridge to reef and greatly affect the quality of downstream habitats. For instance, soil erosion originating in upland areas is transferred to downstream habitats through riverine and watershed areas. In Yap, wildfires are a serious threat to the scattered watersheds, since areas burnt by wildfires tend to increase habitat fragmentation. Activities in the upland watershed areas has direct impacts on coastal areas, resulting in the siltation of nearshore marine habitats, including areas important for the dive trade and other ecotourism, areas of biological significance and marine protected areas.

IMPACT

Watersheds provide important ecosystem services, most importantly access to abundant clean freshwater crucial for life. Negative impacts of degraded watersheds are accelerated erosion, poor water quality, landslides, siltation of rivers and nearshore marine, and increased flooding downstream.

RESPONSE

- In 1987, the Pohnpei State legislature passed the Pohnpei Watershed Forest Reserve and Mangrove Protection Act in which close to 5,000 hectares (12,500 acres) of upland forest were set aside as a protected Watershed Forest Reserve.
- Kosrae has several protected watersheds e.g. the Yela Easement detailed in the forestry theme and the Mahkontowe Conservation Area, a terrestrial upland/watershed protected area. Both have accompanying management plans.
- In Yap, the municipalities of Weloy and Tamil, using their traditional authorities, have protected key areas of their watersheds: namely, the Weloy Forest Stewardship Conservation Area declared in 2016 and management plan endorsed in 2017, and the Tamil Watershed Managed Area declared in 2017, respectively.
- There have been limited rehabilitation projects through the FSM.

RECOMMENDATIONS

- Research on physical and environmental components of the watersheds and their interrelationships.
- Recognizing the interrelationships of watersheds and other ecosystems, support development of Ridge to Reef management plans and protected areas that encompass numerous ecosystems and conserve critical watershed.
- Increased funding and capacity for monitoring and enforcement.
- Continue to engage traditional leaders for their commitment to protection for the watershed and support traditional practices of watershed management.
- Update and improve relevant regulations and laws.
- Engage private landowners in watershed management through awareness and capacity building.

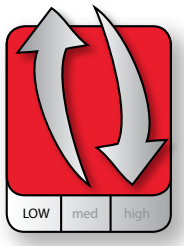
SOURCES

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

SURFACE WATER QUALITY

INTRODUCTION

Surface water is water that collects on the ground. In the FSM about 60% of water resources exist as surface water in the form of small, intermittent streams that drain catchment areas of limited aerial extent. While the high islands of Pohnpei and Kosrae have perennial waterways, in Yap the streams are dry for about 20% of the year. For this indicator, surface water quality is assessed by looking at trends in faecal coliform levels across the FSM.



Status
Poor

Trend
Mixed

Data confidence
Low

SDG	CBD
6 CLEAN WATER AND SANITATION	8

TABLE 15. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Poor	Poor	Poor	Poor
Trend	Mixed	Mixed	Deteriorating	Mixed
Data Confidence	Low	Low	Medium	Low

STATUS AND FINDINGS

Population in Pohnpei and Kosrae use surface water as a source of drinking water, but this is prone to bacterial contamination and requires extensive and costly treatment to reduce high turbidity, undesirable taste and odours, and to remove all microorganisms. Concerns regarding water-related diseases are high, since leptospirosis, hepatitis and amoebiasis are endemic in some of the four states. For instance, epidemic outbreaks of cholera were reported in Chuuk in 1982–83 and Pohnpei in 2000 (SPREP 2010).

Assessment of the high island watershed has showed that development of island-wide catchment systems for surface water (dams) is not cost-effective due to the topography in the stream basin (SOPAC 2009). Degradation of forest, developments and inappropriate waste disposal are a cause of concern for surface water pollution. Water scarcity rarely occurs in the high island of Pohnpei and Kosrae, although droughts can severely affect water supplies, mostly due to infrastructural flaws rather than scarcity.

In Yap, surface freshwater is sporadic and most of the streams form during the wet season, from June to October-November. The only perennial stream found in Yap is Mukong, which shows reduced flow during droughts, but never dries out. In Yap, groundwater is the main source of water, so there is a lack of information on surface water quality and capacity.

Chuuk lagoon has several islands with surface water and streams. These water sources are generally not assessed for water quality because of the logistical difficulties of transporting samples to the laboratory in Weno. Importantly, due to recurrent ENSO events, communities have developed a knowledge of the surface freshwater sources that are drought-resistant. Due to the land tenure system in Chuuk, most of the surface freshwater sources are found on private land. Access to these vital resources is granted by landowners during emergency, increasing resilience of communities to droughts. Currently, in many islands in the lagoon of Chuuk, surface freshwater management is the sole responsibility of the landowners.

In the high island of Pohnpei, rivers and streams are important recreational sites and their water quality directly impacts health for the resident population of the main island. Some rivers and streams showed improvement over the years especially in the municipalities of Madolenihmw and Kitti. Freshwater in urban areas did not show any improvement over the years (Figure 31). Overall water quality of Pohnpei has improved between 2012 and 2018, although many rivers and streams have been fluctuating between suitable, and not suitable, conditions for recreational standards.

In Kosrae, the Kosrae Island Resource Management Authority (KIRMA) has the mandate for assessing coastal and freshwater quality. The most recent analysis showed a variation from May 2017 to June 2018 among sites 'above recreational standards', where bathing is not allowed, and sites 'below recreational standards'. More data needs to be collected to account for seasonal variability. At the moment, data suggests that a greater number of sites were below recreational standards for coastal waters and rivers in January and September 2018.

IMPACT

In the FSM streams, rivers and waterways are threatened by pollution, sealevel rise, floods from storms and unusual rainfall. In particular, sources of pollution vary across islands and affect waters differently. Current piggeries are of great concern, particularly in Pohnpei, due to the impact on water quality and human health. Similarly, inadequate sanitation, pits and open defecation can contaminate freshwater and increase the likelihood of disease outbreaks among the population. In some cases, the inadequacy of water storage facilities increases the chance of contamination. Deforestation and inappropriate agriculture activities can potentially increase the probability of water contamination, especially during flood events and heavy rainfall.

THE CASE OF LEPTOSPIROSIS IN POHNPEI

Leptospirosis is an infectious disease endemic in many Pacific countries. Human transmission can occur through indirect contact with the bacteria Leptospira present in the environment, in particular rivers and streams. Rodents, pigs and dogs are carrier animals for this disease and they can contaminate water and soil environment by excreting the bacteria in the urine. This disease is considered of significant concern in Pacific islands where populations live in close proximity with the animals carrying the disease or in direct contact with a contaminated environment. In Pohnpei, it is common practice to place pig pens near waterways or to have uncaged animals roaming free. Pig waste has been recognized as one of the major causes of water contamination, with runoff from the piggeries reaching several water courses.

Cases of leptospirosis, have been reported in Pohnpei. A study from Colt et. al. (2014), on 66 hospital patients in Pohnpei, showed that the burden of leptospirosis disease in Pohnpei is high to a point that a specific strand, LT751, seems to exist for Pohnpei. The authors identified some risky behaviours that can increase the probability of contact with the bacteria especially if individuals present wounds, cuts or skin damage. Among these behaviours are stream bathing, bare foot walking in the mud, tending to gardens or crops. The study recommended preventing animal urine entering waters to avoid contamination.

The example of Pohnpei shows how contamination of surface waters from animal waste can have major impacts on human health. This prompted the engagement of local organizations and government to identify piggery management approaches, such as the dry litter piggery approach.

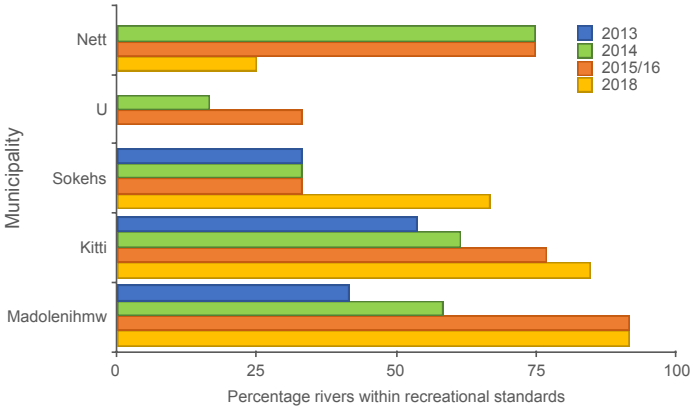


FIGURE 31. Changes in water quality over time (2013 to 2018) at rivers and streams sampled at the five Municipalities in Pohnpei main. The Pohnpei Environmental Protection Agency (EPA), set the threshold for recreational standards at 576 mpn 100ml^{-2} *Escherichia coli* (Pohnpei EPA).

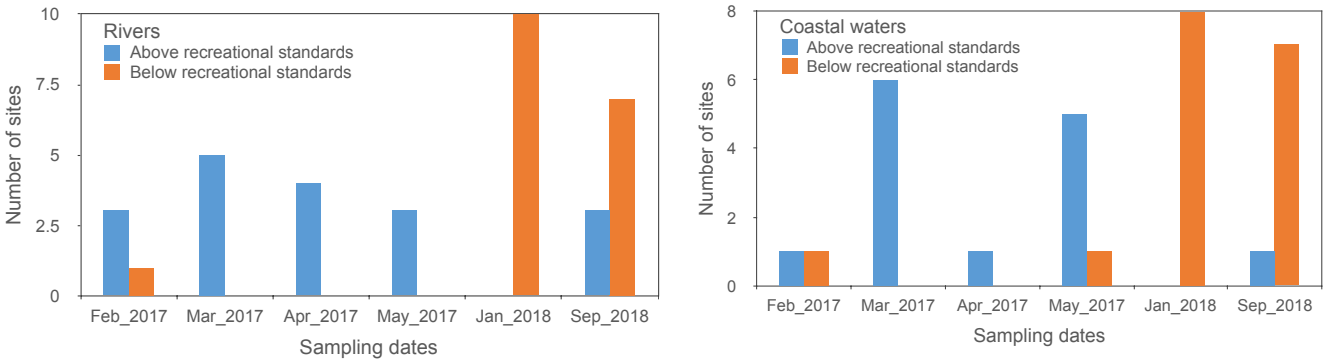


FIGURE 32. Changes in water quality among rivers and coastal waters sites sampled between 2017 and 2018 in Kosrae. KIRMA sets the threshold for recreational freshwater at 576 mpn 100ml^{-2} *Escherichia coli* (KIRMA).

RESPONSE

- Dry litter piggery implementation and relocation of piggeries from riverbanks or streams.
- Marine and freshwater quality regulations enforced by the Environmental Protection Agencies (EPAs) of Yap, Chuuk and Pohnpei, and the Kosrae Island Resource Management Authority (KIRMA).
- Amendment to the Kosrae Safe Drinking Water Act of 2014: provide for the continuing administration of a program for the abatement or prevention of the contamination of public drinking water systems.
- The FSM's national water Resolution No. 01–2011, (2011) recognizes the central role of fresh water for the lives and culture of all island communities, acknowledging its importance for the development of all economic sectors, public health and population well-being. The resolution reaffirms the role and duties of traditional leaders in ensuring secure access to safe drinking water and sanitation, as well as the important role that landowners, non-government organizations, churches, women's groups, and local, state and national government play in water resource management. In addition, the policy reaffirms the obligation under a variety of Multilateral Environmental Agreements to sustainably use natural resources and conserve the environment, including the management and conservation of watersheds to enable adequate flow of clean water from ridge to reef.
- In 2018, Pohnpei aligned to the national water Resolution by developing and signing its state water policy. The policy sets the foundation for the sustainable use and conservation of water resources, and it creates the enabling framework for the equitable distribution of water. Importantly, the policy recognizes the distinct difference between the way water management must take place on high islands and atolls. It identifies the need for a holistic approach to water management and distribution, including the recognition of the role played by nature and a healthy environment in supporting water quality and quantity.

Jez O'Hare

RECOMMENDATIONS

- Healthy watersheds and environment are important for ensuring water quality standards. Where land use plans exist, they are usually part of development plans and are outdated and do not include outer islands and privately-owned lands. It is recommended to revise existing plans and integrate, through innovative mechanisms, new strategies addressing the needs and responsibilities of outer islands and landowners.
- Where land use and zoning plans exist at state level (e.g. Pohnpei), there is a need to build capacity in terms of funding resources and increase awareness to ensure effective implementation and enforcement.
- Improve regulations focused on sanitation and enforcement.
- Revise toilet regulations.
- Regulations for animal husbandry need to be developed for all the states. Both national and state governments provide funding resources that support animal husbandry involving new breeds of livestock. Yet, no regulation exists to ensure proper safeguards are put in place to prevent negative impacts of such programs. Many farmers use traditional animal husbandry methods for their livestock.
- Increase education and awareness.
- Develop safeguard guidelines.
- Improve infrastructure for delivering water.
- Have proper data base system for storing water quality data.
- Secure funding sources for water quality management.

SOURCES

Colt, S., Pavlin, B.I., Kool, J.L., Johnson, E., McCool, J.P., Woodward, A.J. (2014). Human leptospirosis in the Federated States of Micronesia: a hospital-based febrile illness survey. BMC Infectious Diseases, 14:186

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Environmental Protection Agency of Chuuk State.

Kosrae Island Resource Management Authority.

SOPAC (2009). The Pacific Integrated Water Resources Management Programme. Pacific IWRM Programme, SOPAC.

SPREP (2010). Proceedings of the Pacific Regional Consultation on Water in Small Island Countries; Country Briefing Papers-Federated States of Micronesia. Secretariat of the Pacific Regional Environmental Programme.

GROUNDWATER

INTRODUCTION

In the FSM, 40% of the water resources exist as groundwater. This is fed from rain seeping and percolating into the ground, accumulating into water tables and lenses in high islands and low islands. Groundwater is assessed by availability, quality and withdrawal.

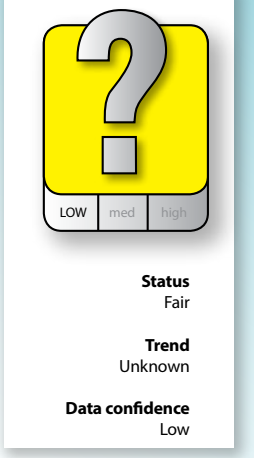


Photo: Chiara Franco

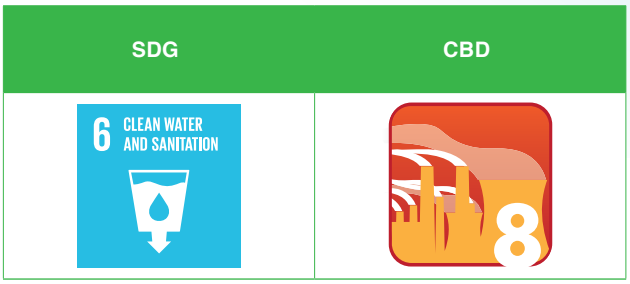


TABLE 16. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Poor	Poor	Fair
Trend	Unknown	Deteriorating	Deteriorating	Unknown
Data Confidence	Low	Low	Medium	Low

STATUS AND FINDINGS

Groundwater is accessed through extractive wells. Water accumulates in dispersed zones of sedimentary deposits, which are not conducive to the development of high yielding wells. This type of hydrology is suitable for numerous low to medium yielding wells, especially where water grids are non-existent (SOPAC 2009). Shallow wells are common, particularly in the outer islands and in the islands in Chuuk lagoon that, due to their dispersed nature, require development of individual water grid systems. However, shallow wells are not always able to meet water demand during droughts and require standardization and appropriate design to suit the environment and community demands.

In the main high islands, groundwater quality is generally good and suitable for cooking and bathing, but this is not the case for many of the outer islands. Recent water quality testing (2017–2018) on the island of Weno, in Chuuk, revealed that of the 90 sites tested, 78% were within the parameters used by Chuuk EPA for drinking water (less than 1 mpn 100 ml-2 *E. coli*). Most of the sites tested in Chuuk were wells or water systems in Weno, where the EPA laboratory is located. Sampling on the other islands in the Chuuk lagoon is constrained by time of transportation of the samples to the laboratory for analysis. This limiting condition is similar also to other states that do not have access to portable testing equipment.

On the main islands of Yap, most of the water accessed from the communities is in the form of groundwater in the Gagil-Tamil system, the Central system and the Southern Yap system, connected to a well-developed water grid. Water quality assessments are therefore conducted on the quality of water supplied by these systems and accessed by Yap's main island population. In Yap, of the 1129 samples collected between 2013 and 2017, 93% were negative to the presence of *E. coli*, and were within the standards for drinking water. Most of the water in

Yap is channeled through man-made water grids, wells and tanks, and a description of this system is presented under the 'built environment' theme. Importantly, although Yap population and sectors are highly dependent on groundwater, the capacity of the groundwater aquifers is unknown, decreasing resilience to climate change and potentially becoming a limiting factor for the development of economic sectors. The lack of knowledge on groundwater capacity reduces the opportunity of managing water extraction sustainably during droughts.

In the FSM's outer islands extensive bacterial contamination of wells has been reported over the years (Detay et al. 1989, Miller et al. 1991). Less than half of the FSM population resides in the outer islands where water lenses are generally unable to meet the demand for a large abstraction, particularly during droughts (Bailey and Jenson 2011). People on the outer islands are heavily dependent on water catchment systems, but they still access well water for cooking and bathing. However, most of the atolls are less than 0.3 square miles in area and they tend to be too narrow to produce the conditions that will give rise to a freshwater lens of significant thickness. Indeed, atoll water resources are extremely vulnerable to El Niño-induced droughts due to their unique geology of the shallow subsurface, small rain catchment spatial area, low-lying topography, and isolation from other island communities (Bailey and Jenson, 2011).

In the outer islands of the FSM, the communities rely on rain catchment water for domestic use (i.e., drinking, cooking, and washing). However, during times of water stress, associated with an El Niño event, people turn to groundwater to meet the water demand (Bailey et al. 2008). Therefore, it is sensible to affirm that the water resources of the islands composing the 32 atolls of the FSM are under continual threat due to El Niño-induced droughts and potential sealevel rise, while Bailey and Jenson (2011) found that only six would retain a fresh body of groundwater able to sustain the community during a drought similar to that experienced in 1998.

IMPACT

Poor management of groundwater can impact the availability and quality of groundwater for present and future generations. Poor land management can also impact groundwater quality through contamination of groundwater sources. These risks are higher for the outer island communities that have limited water availability and are susceptible to saltwater intrusion.

RESPONSE

- Several projects in all states optimizing the storage of water for use during drought conditions as part of disaster risk efforts.
- Municipality of Onesiomw, Chuuk, developed an MOU between landowners to provide water from wells to other people in their municipality during drought. In exchange, landowners would receive support for well maintained projects on their land.
- National water Resolution and Pohnpei water policy (mentioned above).
- Enforcement of environmental laws and water quality regulations.

RECOMMENDATIONS

- The high vulnerability of outer islands groundwater to contamination indicates the need to equip the State EPAs with appropriate tools (portable water quality instruments) to conduct assessments.
- Improve assessment of groundwater, especially on outer islands, to have a better understanding of their extent and quality. Also assess the impact of climate events on these resources.
- Awareness on groundwater conservation.
- Develop groundwater conservation plans for communities.
- Mainstream groundwater management at all levels planning.
- Secure funding source to help address the impacts to groundwater.
- Develop clear guides with recommendations/methods for best water systems to use, including outer islands (for planning and development purposes).
- Increase rainwater harvesting and storing systems.

SOURCES

Bailey R.T., Jenson J.W., Olsen A.E. (2008). An atoll freshwater lens algebraic model for groundwater management in the Caroline Islands. Technical Report No. 120. University of Guam, Water and Environmental Research Institute of the Western Pacific, Guam.

Bailey R.T., Jenson J.W. (2011). Groundwater resources analysis of atoll islands in the Federated States of Micronesia using an algebraic model. Technical Report No. 134. University of Guam, Water and Environmental Research Institute of the Western Pacific, Guam.

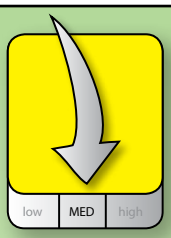
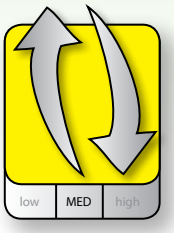
Detay M., Alessandrello E., Come P., Groom I. (1989). Groundwater contamination and pollution in Micronesia. J. Hydrol. 112: 149–170.

Miller F.D., Moravcik P.S., Siren N., William S. (1991). Bacterial Contamination of Water Resources on Moen, Truk Islands, Federated States of Micronesia. Tech. Memorandum Report No. 83, Water Resources Research Centre, University of Hawaii at Manoa, Hawaii, 45pp.

OVERVIEW

The FSM's terrestrial ecosystems are composed of a wealth of habitat types that vary from island to island. These resouces provide numerous ecological services including timber, food security and cultural uses. This theme looks at the status and mangement of forests, mangrove forests, agriculture and soil. While the forests of the FSM have a long history of impacts from humans there are still areas of intact native forest, though conversion to agroforestry is commmon. With wider awareness of the role mangroves play in shoreline protection and as a nusery habitat for fish, there has been an increased focus on management of mangrove habitats. Agroforestry is an integral part of the FSM's culture and subsistence economy. Crops such as breadfruit, taro, yam, coconut and banana are at the basis of the local diet. In addition to crops used essentially for subsistence, some are cultivated as a source of income. Soil health is a crucial component of the ecosystem services provided by forests and agriculture.

LAND HIGHLIGHTS

TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
FORESTS	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium	FSM has a long history of disturbance from human settlement and use, which influenced the forest structure and species composition over time. This is usually marked by conversion of native forest to agroforestry. In 2016 the percentage of forest area showing signs of disturbance from human activities and climate events was 45%.	• Development of improved land use plans for all four states. • Improve enforcement of existing polices. • Formalization and funding for invasive species groups for all four states.
MANGROVES	 **Status** Fair **Trend** Mixed **Data confidence** Medium	In the FSM mangroves are particularly important to subsistence economies and provide numerous ecological services. Mangroves are threated by poor land use practices and climate change impacts.	• Legislation in all four states for mangrove and management and harvesting. • Regulations on coastal development (zoning plan-mangroves). • Awareness and education on the importance of mangrove forest and associated ecosystem services.
AGRICULTURE	 **Status** Fair **Trend** Mixed **Data confidence** Medium	Agroforestry is an integral part of the FSM's culture and subsistence economy. Crops such as breadfruit, taro, yam, coconut and banana are the basis of the local diet and some are cultivated as a source of income.	• Survey/expansion of disease and drought resistance crops. • Emergency response plan/ improved water catchment & systems. • Expansion of farmer associations to other states.
SOIL	 **Status** Fair **Trend** Mixed **Data confidence** Medium	Soil is the foundation of basic ecosystem functions. In the FSM soil health is a crucial component of the ecosystem services provided by forests and agriculture. While there is general knowledge about the distribution of soil types, there are major gaps in soil feritility data.	• Development of land use plans for all four states. • Incorporate information from soil assessments into Environmental Impacts Assessments.

FORESTS

INTRODUCTION

The forests of the FSM vary from east to west due to differences in climate, geology, topography and geographical isolation. As a result, forest type varies from state to state. This section assesses the status and trends in the forested areas of the FSM.

Status
Fair

Trend
Deteriorating

Data confidence
Medium

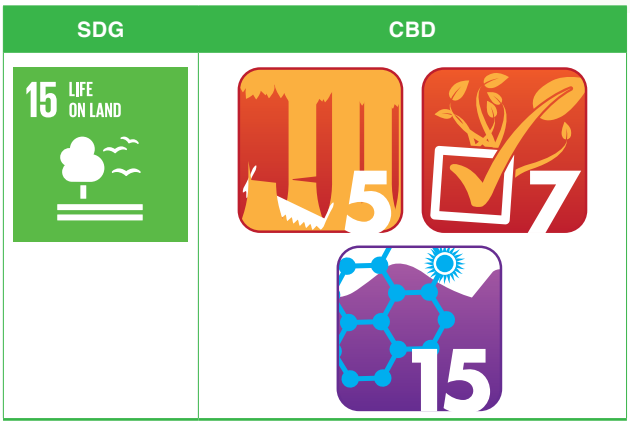


TABLE 17. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Fair	Fair
Trend	Deteriorating	Deteriorating	Deteriorating	Mixed
Data Confidence	Medium	Medium	High	Medium

A river of Finkol Valley. Photo: Ashley Meredith, KIRMA

STATUS AND FINDINGS

Although the forests in the FSM have a long history of disturbances from human settlement and use, which has influenced the forest structure and species composition over time, no major changes in forest structure were observed from 2006–2017. The largest forest, around 330km^2, is found within Pohnpei, while Yap contains the smallest forest with almost 70km^2.

Over the years, changes in human settlement have been accompanied by land use changes that involved conversion of forest to agricultural and urban uses. Conversion of forest into agroforestry land has supported the flow of provisions, and regulated services associated with forests. The value of forest systems is great, contributing to population

subsistence and maintaining cultural identity. Forests provide food and raw materials, help to maintain clean water and the local climate for soil fertility and productivity, regulate erosion and the amount of sediments reaching coastal waters, and affecting coral reefs habitats. The forests are home to a large endemic diversity of plants and animals.

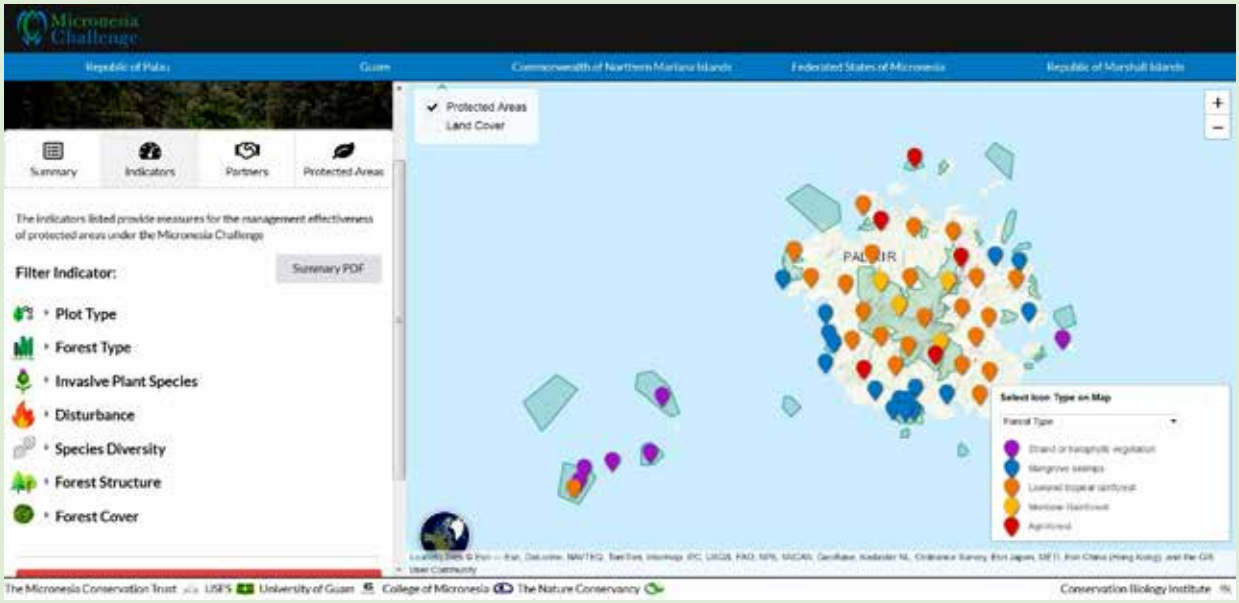
The role played by forest ecosystems for the well-being of people and the islands, highlight the importance of protecting this ecosystem from degradation. This called for a large regional protection effort that started in 2006, the Micronesia Challenge (MC). The MC targets 20% of forest protection by 2020 across Micronesian countries, including the FSM. To measure and evaluate tangible results associated with forest protection, the MC has developed a suite of terrestrial measures (see Box text). The SoE includes some data as baseline information from this set of measures.

A comparison of forest cover can be made between 1976 and 2006 through estimates based on aerial photography and satellite imagery. In 2006 total forest cover was estimated to be 161,917 acres from aggregating area totals in GIS (Geographic Information System). In 2016 the FIA plot assessment revealed 134,390 acres of forest from 75 FIA plots across the FSM. Differences in forest cover are due to the different estimation methodologies and therefore 2006 data for forest cover are not compared directly with the 2016 dataset. However, in the SoE, data collected through random plots are compared for 2006 and 2016 through the FIA inventory design. The 2016 survey includes FSM outer islands for the states of Yap, Chuuk and Pohnpei, which are largely characterized by strand and agroforest (Table 18). Classification of forest and non-forest categories for the FSM is provided in Table 18. In 2016 the FIA inventory classification was done in five main groups that included forest and non-forest plants: (1) strand or halophytic vegetation; (2) mangrove swamp, corresponding to the mangrove forest; (3) lowland rainforest; (4) montane rainforest, corresponding to the upland forest; (5) agroforest.

THE MICRONESIA CHALLENGE REGIONAL TERRESTRIAL MONITORING INITIATIVE

The goal of the Micronesia Challenge Regional Terrestrial Monitoring Initiative is to '*Provide a regional framework to assess the regional monitoring indicators that measure the status of managed conservation areas set aside under the Micronesia Challenge.'*

A terrestrial measure indicator tool was developed to allow access to the forestry inventory data collected under the MC goal of protecting 20% of Micronesian forest by 2020. The information in this online tool is derived from the Forest Inventory and Analysis (FIA) program, which conducted systematic inventories of the forests of Kosrae, Chuuk, Pohnpei, and Yap in 2005–2006 and 2016. In 2016 additional plots were established. In the 2016 inventory, 151 FIA plots were assessed in the FSM, 71 of which were MC plots.



The MC terrestrial measure indicator tool (https://mcterrestrialmeasures.org) was created with funding and support from regional partners and paid by the U.S. Forest Service Forest Inventory and Analysis program and the USDA Forest Service Landscape Scale Restoration Program. The MC Terrestrial initiative has been supported by regional partners such as The Micronesia Conservation Trust, the U.S. Forest Service, University of Guam, College of Micronesia, The Nature Conservancy, Conservation Biology Institute, as well as from Government such as the Republic of Palau, the Federated States of Micronesia, the Republic of Marshall Islands, the Commonwealth of the Northern Mariana Islands and the U.S. Territory of Guam.

The prior vegetation surveys in 1976 estimated forest cover to be 83% of total land in the FSM; 15% of total land cover was non-forest vegetation, and 1% was estimated as urban. In 2006 the urban area was 3% of the total land area, forest cover was 89% of the total land area and the remaining 8% was non-forest vegetation (Donnegan et al. 2011).

Between 1976 and 2006 there was a decrease in savanna area across the FSM (-11%), while other forested areas showed a general increase. Agroforest cover showed a considerable increase in Chuuk (+36%), while the opposite was observed for Kosrae with a decrease in agroforest cover (-10%), suggesting abandonment or conversion of agroforest land. In 2006, 46% of the forested lands in the FSM were classified as highly drought resilient, while the remaining 54% was medium (51%) to low (3%) drought resilient (Donnegan et al. 2011). In 2016, lowland rainforest was dominant over the 75 FIA plots across FSM (60.6% cover), followed by agroforest (18.2%) and mangrove swamps (15.7%; Figure 33).

TABLE 18. Forest types in the Federated States of Micronesia (Donnegan et al. 2011; Falanruw et al. 1987, Micronesia Challenge terrestrial measures, 2018).

2006 Forest classification (Donnegan et al. 2011)	
Forest cover	**Definition**
Upland forest	Highland forest of tropical, primarily native and naturalized, tree species.
Dwarf forest	Highland, wet moss forest with low growing trees.
Palm forest	A forest composed primarily of palm species.
Mangrove forest	Lowland, tidally inundated forest composed of mangrove tree species.
Swamp forest	Forest occurring in areas where soils are inundated with fresh or slightly saline water.
Atoll forest	Primarily native forest occurring in the interior of larger, wetter atolls.
Agroforest	Land where trees, shrubs, and herbs are cultivated for food or medicines among a cover of other forest trees.
Plantation forest	
Coconut plantations	Stands of planted coconut trees used for commercial purposes.
Non-forest cover	**Definition**
Strand	Coastal vegetation occurring in narrow strips on sandy, rocky coasts. May include forest species as this vegetation grades into interior forest.
Secondary vegetation	A vegetation type characterized by small, fast-growing trees and vines, usually weedy invaders.
Grassland or savanna	Non-forest land with less than 10 percent tree cover that is dominated by grasses and may be associated with shrubs, ferns, and other vegetation.
Cropland	Non-forest land used for growing food or fiber crops.
Marsh, fresh and salt	A perennially wet substrate forest in lowland areas where drainage is hindered. Dominated by freshwater or saltwater.
Urban build up	Non-forest land that is urban land use.
Urban agriculture	Non-forest land that is under cultivation in urban areas.
Barren	Non-forest land that has little or no vegetation cover.
Water	Streams, lakes, or other water bodies.

2017 Forest classification (Micronesia challenge terrestrial measures, 2018)	
Forest cover	**Definition**
Montane rainforest	Predominant forest type on moist hilltops and mountain slopes characterized by forests of low stature rich in epiphytes and shrubs.
Lowland rainforest	Multi-storied with many canopy-dwelling epiphytes, open ground, and shrub layers.
Mangrove forest	Contain trees with high salt tolerance growing on tidally inundated shores and in land-locked depressions.
Agroforest	Contains tree species in crop or animal production agricultural ecosystems.
Non-forest cover	**Definition**
Strand or halophytic vegetation	Near the shore with species adapted to high evaporation by wind and high salt concentrations from wind-blown spray or saltwater inundation.

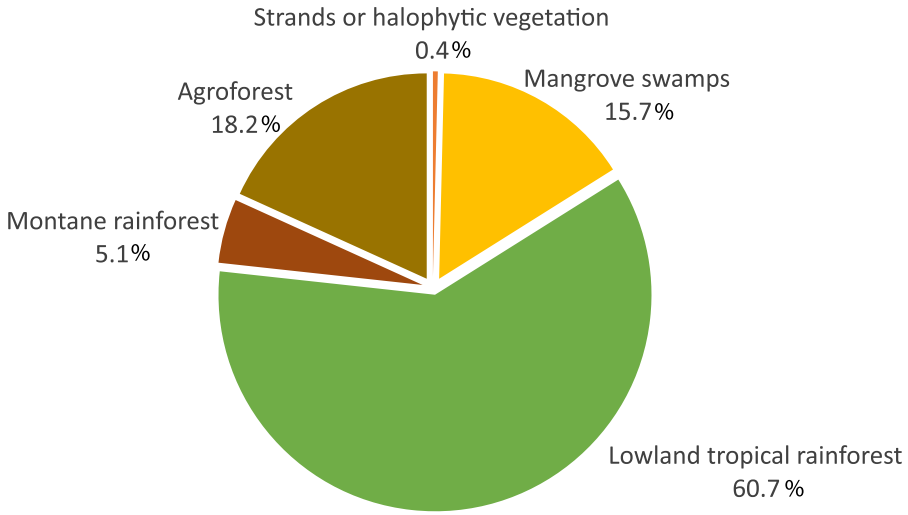


FIGURE 33. Percentage of forest area by forest community across Micronesia in 2016. The 71 plots for the Micronesia Challenge measures were not included in the presented data. Data are representative of low and high islands of the FSM's states (MC terrestrial measures, 2018).

For the 2006 FIA inventory 96 tree species were measured on 73 plots (Donnegan et al. 2011). In 2016, the inventory reported 110 tree species in 75 plots (MC terrestrial measures, 2018). The average number of tree species found per plot in 2006 and 2016 was seven. In 2016, lowest tree species richness was recorded for plots in Chuuk, with an average of five tree species in 10 plots, while highest was in Yap with 10 tree species in 13 plots.

In 2016 the percentage of forest area showing signs of disturbance from human activities and climate events was 45%. The 2006 FIA survey estimated that 11% of the individual trees in the FSM showed signs of damages. Silvicultural activities and site preparation for agroforest are generally considered positive disturbances, indicating forest management activities rather than deterioration (Figure 34).

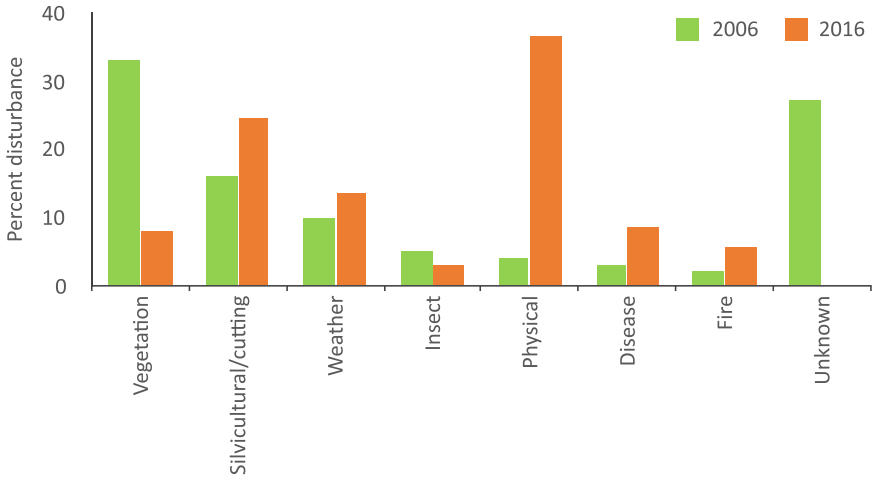


FIGURE 34. Percentage of disturbance affecting forests in the FSM (Donnegan et al. 2011, MC terrestrial measures 2018).

Forest regeneration has been assessed by measuring sapling density, which capture the density of young trees. Regeneration of forest can occur after disturbances, such as land clearing, fires or typhoons. In some cases this regeneration has been impaired by invasive vines such as *Merremia peltata*. When compared with the density of trees, sapling density represents a direct measure on the state of forest regeneration. For instance, greater sapling density indicates that a disturbance has recently occurred as showed by Yap's plots (Figure 35). In Chuuk, after typhoon Maysak (2015) observed regeneration succession was different, with opportunistic species such as *Merremia peltata* spreading over destroyed areas. This has an impact on the ability of native tree seedlings and saplings to regenerate and establish. This was especially observed in Nantaku watershed area in Weno. Pohnpei and Kosrae have understoreys of native tree species and better management of invasive species, therefore regeneration of native seedlings and saplings is observed.

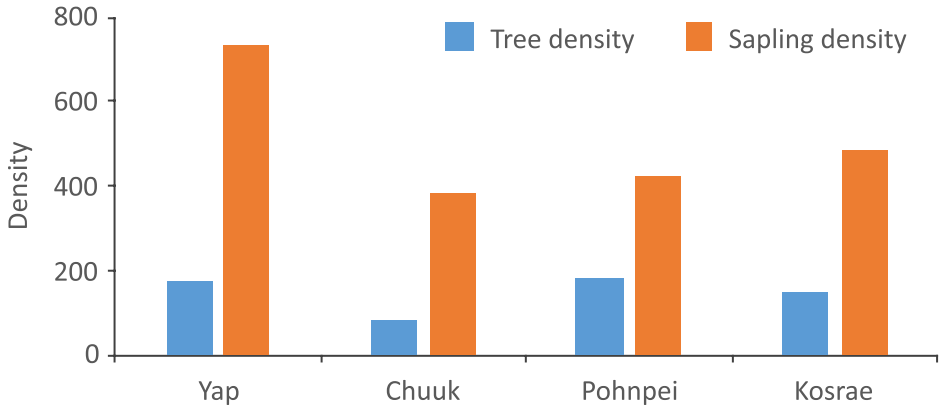


FIGURE 35. Tree and sapling densities from 2016 FIA survey of high and low islands in the FSM's states (MC terrestrial measures 2018).

The FSM's states show diversities in forest type and composition associated with diverse climate, soil type and island topography. Forest characteristics differ between high islands and outer islands, with the latter presenting a smaller forest community diversity.

In Pohnpei main, the majority of the land area is classified as steep and mountainous. Vegetation is mainly upland forest (56%) mostly in the interior, while the coastal areas and lower slopes are characterised by agroforestry (33%) and secondary vegetation (5%). Agroforestry has been expanding rapidly in the last decades, replacing the native forest and secondary vegetation. Kava (*Piper methysticum*) production is currently a major threat for Pohnpei native forest, with farmers altering upland forest for access to more fertile soil (FSM 5th National Report to the Convention of Biological Diversity 2014).

Similar to Pohnpei, Kosrae is characterized by a steep topography that had limited the access to the upper watershed, where a dense upland rainforest still persists. The lowland areas of Kosrae are typically used for agroforestry, but saltwater inundations have deteriorated soil quality to a point that these areas have been abandoned for cultivation.

In Chuuk, much upland native forest was cleared during WWII and these areas have not recovered, either being converted to agroforestry areas or become overgrown by invasive species. Invasive vines appear to be more prevalent in the upland forests, but confirmation on extent of growth needs to be determined. WWII military actions disturbed forest dynamics and promoted a shift from forest land to agriculture and agroforestry land (Donnegan et al. 2011). Indeed, the lagoon islands of Chuuk State have the highest percentage of agroforestry of the high islands of Micronesia (FSM SWAR 2011). Most importantly, with the decline in native forest over the years an increase in areas covered by aggressive invasive vines, such as *Merremia peltata*, has been observed (FSM SWAR 2011). Chuuk outer islands, characterised by low-lying coralline islands have a system of designated, agreed upon, parcels of land or islands that are developed only for farming. This management mechanism helps outer island communities to preserve and better manage atoll forest and agroforestry.

In Yap main islands much of the native vegetation was altered for agroforestry use that supported extensive human populations. Most of the main Yap islands were forested prior to human occupation (Donnegan et al. 2011; Falanruw and Ruegorong 2015). The decline of forest on Yap's main islands took place about 300 years ago with an increase of the proportion of savanna species (Falanruw and Ruegorong 2015). Currently, major vegetation type comprises secondary vegetation, savanna vegetation, mangroves, agroforestry and scattered remnants of native forest (Falanruw and Ruegorong 2015). Although there is no Yapese word for 'forest', the population has a clear understanding of the benefits provided by this ecosystem (Yap State Division of Agriculture and Forestry 5-year plan 2009–2014).

IMPACT

Poor forest or land management practices result in forest degradation, loss of biodiversity and loss of the ecological services provided by forests and watersheds. This includes degraded water quality from sedimentation, loss of shading, spread of invasives, sediment deposition on coral reefs and the loss of important habitats for endemic plants and animals.

On Pohnpei, encroachment by squatters growing kava into the upper watershed has reduced the area of primary forest significantly – from 15,000 ha in 1975 to 5,200 ha in 1995 to 4,200 ha in 2002. Siltation of the fringing reefs, as a result of deforestation and subsequent erosion, is causing significant damage to traditional marine food supplies. Yap's forests are currently being degraded by activities such as bulldozing, unsustainable timber harvest, conversion to other uses and wildfires.

The FSM forests have already faced impacts such as typhoons and extensive wildfires associated with severe El Niño-Southern Oscillation (ENSO) related droughts, which are expected to intensify due to climate change impacts.

YELA FOREST IN KOSRAE, THE LAST STRAND OF *TERMINALIA CAROLINENSIS* FOREST IN THE WORLD

The Yela Conservation Easement is a landmark undertaking which brought together governments (United States Forest Service, Kosrae State Government), non-government organizations (The Nature Conservancy, Kosrae Conservation and Safety Organization) and landowners. It represents the first easement outside of the United States and in Micronesia.

The easement involves a species of tree known as Ka, *Terminalia carolinensis*, which flourishes in an undisturbed valley known as Yela. The Yela forest is the largest remaining stand of Ka trees in the world. With the Conservation Easement in place, the landowners retain the title to their land, but in return agree that no development will occur in the area that will compromise the health and integrity of the forest. A Trust Fund was established, which compensates the landowners annually. The success of this arrangement means that the landowners and the state of Kosrae will ensure that the forest is managed and conserved in perpetuity, while at the same time the landowners can continue to reap pecuniary benefits from their land without negative impacts to the forest.

Yela forest in Kosrae, Federated States of Micronesia (Photo: Nick Hall, The Nature Conservancy).

RESPONSE

- State wildfires plan endorsed in order to empower the Division of Public Safety fire and rescue section to prevent and manage fires. (e.g. Yap State wildfire plan 2009–2013).
- Invasive species groups at the state level and management plans.
- Regulations on harvesting.
- Partnership with USFS to conduct Forest Inventory Analysis.
- FSM Department of Resources and Development conducted agriculture census in 2018.
- Land use and zoning.
- Disposal regulations.
- Earth moving permits required from State EPAs.
- Few important species protection.
- State legislations for mangrove protection and controlled harvesting or removal in Kosrae.
- The SWAR (now known as Forest Action Plan) will be updated in 2020 (to 2030).

RECOMMENDATIONS

- Formalization and funding for invasive groups for all four states.
- Improved land use plans for all.
- Forest restoration.
- Wildfire management plan in all states.
- Improve Biosecurity (inter island/states).

SOURCES

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Mountain tops of the Mahkontowe Conservation Area (MCA). Left to right: Finol Finkol, Finol Tafonkol, Tafonkol ridge (foreground), Finol Mutunte (background). Photo: Ashley Meredith, KIRMA.

INTRODUCTION

In the FSM mangroves are particularly important to subsistence economies. They provide a series of services such as firewood, building material and other wood products, as well as help in regulating water quality. The mangroves also offer storm wave protection, while harbouring high biodiversity and being a key nursery habitat for the juveniles of many commercial species. Another important benefit from the mangrove stands is carbon sequestration, hence the loss of mangroves contributes to the release of carbon in the atmosphere, resulting in positive climate feedback. This section looks at the status and trends in mangrove areas across the FSM.

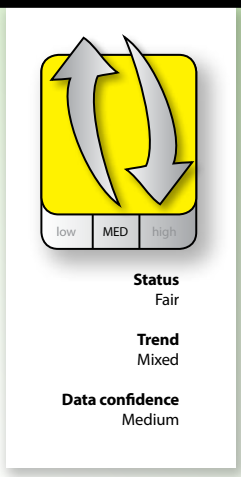

TABLE 19. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Unknown	Unknown	Stable	Unknown
Data Confidence	Medium	Medium	Medium	Medium

Although FSM mangrove forest showed a 6% increase, particularly in Chuuk with a 63% increase between 1976 and 2006, the states of Kosrae and Yap had a slight decrease in mangrove cover (2% and 3% respectively). A 2012 survey showed that approximately 10% of Yap's extensive mangroves had died since 2006. Most of this loss of mangroves in Yap was attributed to the impact of typhoon Sudal, a category 3–4 cyclone, which passed over the state in 2004 (Cannon et al. 2014). However, to some extent regeneration has occurred and some species such as *Sonneratia alba* showed vigorous sprouting from the damaged basal area of the plants (Kauffman and Cole 2010).

Other factors contributing to the loss of mangroves in the four states are related to sealevel rise, high tide wave action, conk-forming basidiomycetes, and human impacts from new developments, as well as harvesting and removal (through girdling or ring-barking) for wood products and open channels for boat transportation (Cannon et al. 2014). Importantly, loss of mangroves was reported following oil spills in Kosrae and Yap, suggesting that pollution from oil spills can have a severe impact on mangrove endurance and indicating the need to assess the value of this ecosystem for compensation that can help restore damaged areas (Allen et al. 2001, Cannon et al. 2014). For instance, Yap State has filed a court case for the oil spill affecting their marine ecosystems, which they won. The case resulted in the recognition that the people of Yap and their environment including the mangroves are inextricably linked and when damage is done to the mangroves, such as an oil spill, the impact is significant. Therefore, the court finds that the people of Yap are entitled to compensation for the loss of culture, livelihood, recreation and other factors associated with affected mangroves.

In 2016, the FIA survey reiterated the differences across the states in mangrove cover extent, with a larger presence of mangroves in Pohnpei inventoried land (71%; Figure 36). The dominant species in the FSM is *S. alba*, which is considered of least concern for the IUCN Red List, although showing a decreasing trend.

A previous study from Cole et al. (1999) suggested that Pohnpei's mangrove forest experienced large-scale disturbances in the past, potentially from the last typhoon in 1905, and that the current mangrove population is still recovering. The same study found that Kosrae's mangrove forest is characterized by very large trees growing at a rate three times faster than in Pohnpei, although the two islands have similar climate and topography. Kosrae's mangrove forest is considered to be largely intact with many trees of *S. alba* that reach exceptionally large sizes, although modifications of coastal areas, freshwater input and pollution have led to irreversible losses of mangroves in some areas (Allen et al. 2001).

Due to the important services that mangroves provide to the FSM population, understanding their dynamics and succession is crucial to sustain appropriate management and protection that allows for recovery after disturbances.

Mangroves have recently been found to be among the most carbon-rich forests in the tropics (Donato et al. 2011). In Yap, the ability of mangroves to store carbon ranged from 853 Mg/ha in the seaward zone to 1,385 Mg/ha in the landward zone (Kauffman et al. 2011). Mangroves sequester about 34% of the carbon held by all of the island's vegetation, although they compose only 12% of the land area of Yap's main islands (Donato et al. 2012). The projected rising sealevel of approximately one meter by 2100 (Australian Bureau of Meteorology and CSIRO 2014) can impact the ability of the mangroves to withstand

this change in sealevel and potentially cause their loss and carbon release.

Overharvest of mangroves is known to occur in some areas of Chuuk, as in Tol, where large gaps in the mangrove forest were observed (SWAR, 2011). In Chuuk efforts are being made to conduct mangrove assessments in certain regions of the lagoon to better understand mangrove management measures that need to be taken. In addition, draft mangrove legislation was introduced at the Chuuk State Legislature as well. There is also local interest to reassess the ABS classifications in relation to the FSM Blueprint for Conservation.

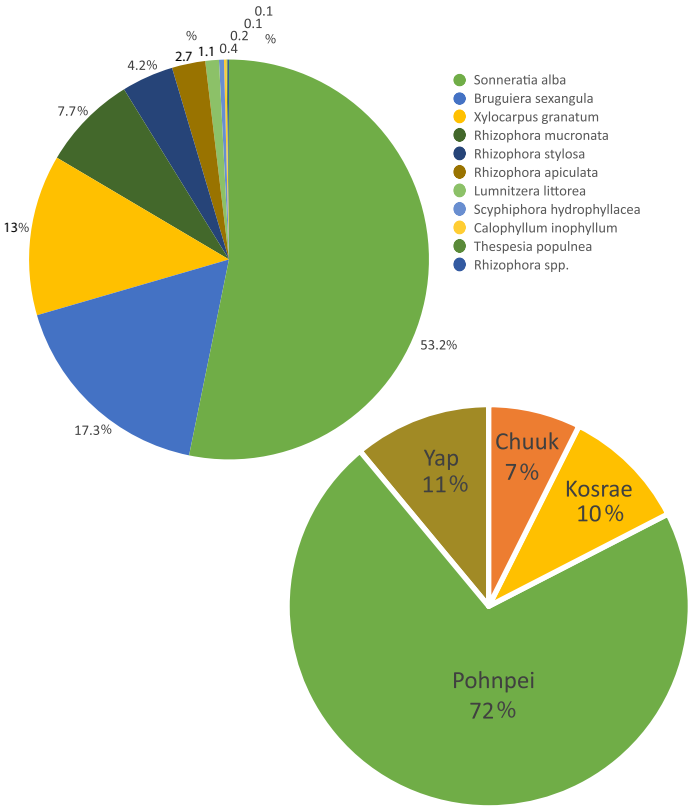

FIGURE 36. Percentage cover of mangroves within the 2016 FIA plots and mangrove species dominance in the FSM (MC terrestrial measures 2018).

IMPACT

Mangroves are important ecosystems providing numerous ecosystem services. Loss of mangroves reduces a key fish nursery and crab and bird habitat, resulting in an economic loss to communities that rely on them. Mangroves also provide protection to shorelines against storm surges and can reduce toxins and sedimentation from freshwater runoff.

Loss of mangroves will impact the culture, as they provide fuel, shelter and medicine. Mangroves are also a major carbon sequestration source for mitigating greenhouse gas emissions.

RESPONSE

- As part of the Micronesia Challenge (MC) several mangrove protected areas were either declared or mangrove habitat was included in marine protected areas. Across the four states, since the declaration of the MC, management of existing mangrove reserve continues to improve with the combination of research relevant to the impact of climate change, how mangroves serve as natural barriers during natural disasters, the carbon stored in mangroves and swamps, among other benefits.
- There are several new mangrove reserves proposed with stronger community involvement in the establishment of such reserves.
- Mangrove Harvest Ordinance *(Pohnpei Municipal Government)*, Kosrae State legislation for mangrove protection and controlled harvesting or removal.

RECOMMENDATIONS

- Improve legislation in all four states for mangroves focused on management and harvesting.
- Regulations on coastal development (zoning plan: mangroves).
- Awareness and education on the importance of mangrove forest and associated ecosystem services.
- Investigate mangrove management and restoration at state and municipal level.

SOURCES

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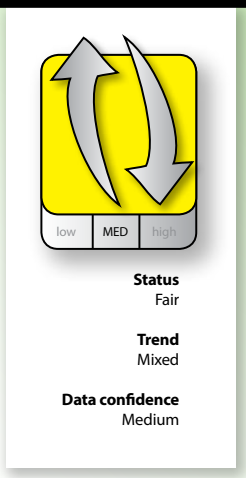
INTRODUCTION

Agroforestry is an integral part of the FSM's culture and subsistence economy. Crops such as breadfruit, taro, yam, coconut and banana are the basis of the local diet. In addition to crops used for subsistence, some are cultivated as a source of income. Among these income-generating crops are sakau (*Piper methysticum,* kava) in Pohnpei and betel nut in Yap. Climate change is posing a great threat to traditional agroforestry systems through saltwater intrusion, droughts and typhoons. Between 2015 and 2017, FSM agroforestry was impacted by typhoon Maysak and the El Niño-induced drought of 2016–17, considerably affecting FSM's household subsistence economy. This section looks at the percentage of households engaged in agroforestry and land use for agricultural activities.



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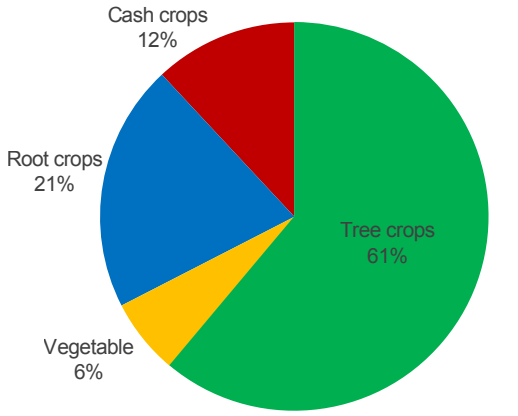


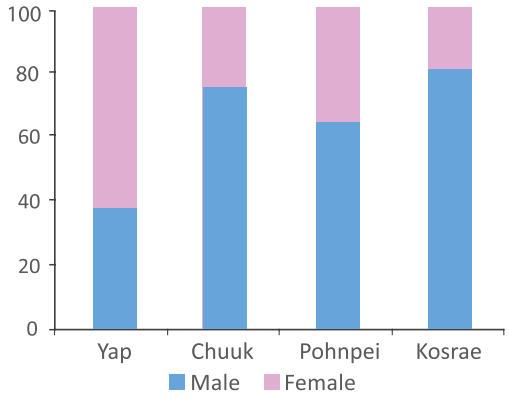


FIGURE 37. ABOVE: percentage of men and women engaging in agricultural activities in the FSM. BELOW: percentage of crops cultivated by households (R&D, agriculture census 2017–18).

TABLE 20. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Mixed	Mixed	Mixed	Mixed
Data Confidence	Medium	Medium	Poor	Medium

STATUS AND TRENDS

The 2013/14 household census data indicate that out of the 63% of FSM's households that engage in agroforestry, 23% engage in agriculture as their main source of income. Nearly 40% of FSM's households are engaged in agroforestry for subsistence. Overall agriculture and livestock account for 14% of household income in the FSM (Household income and expenditure survey 2013/2014 Factsheet). Agricultural production varies across states, in relation to the different climatic conditions and traditions. In Yap the most important food crop is taro, in Pohnpei yam, in Chuuk breadfruit and in Kosrae bananas. In Pohnpei the most valuable non-food crop is sakau (kava), representing 57% of the income from sales of agricultural products. In Yap betel nut represent 84% of all crop sales. A recent agriculture census conducted in 2017 indicated that 90% of households in the FSM are engaged in agriculture activities, while 10% do not conduct any type of agricultural activity (R&D agriculture census data 2017). Almost 64% of men are engaged in agricultural activity versus 36% of women (Figure 37).

More than half of the crops cultivated by the FSM's households are tree crops (e.g. papaya, breadfruit, banana, coconut) and root crops (e.g. taro, tapioca, sweet potatoes) followed by cash crops (Figure 37). Vegetables are less important for FSM households and represent a potential area for development through the production of nutritious crops to replace imported food.

In 2017 in the FSM, 67.2% of households own livestock, of which 48.7% is for household consumption and the remaining 18.5% for selling. In a 2013/2014 household survey, pigs represented 94% of the total value of livestock production sold, consumed or gifted, the remaining 6% were chickens and other livestock.

IMPACT OF CLIMATE CHANGE ON TRADITIONAL AGROFORESTRY- LOSS AND DAMAGE IN AGROFORESTRY:

The intrusion of the ocean on garden patches that are almost sacred in their social value has a profound effect, particularly on the women. The anguish brought by such an event on Ulithi atoll was recorded in a church newsletter by Father J. Hagileiram, SJ (2011):

'On Falalop Ulithi, the women, the custodians of the taro patches, reported that over 90 per cent of all the taro patches on the island had been rendered useless wasteland. For some reason it seems that their traditional taro patches, the ones they inherited from their great ancestors, are the ones mostly affected. They held these taro patches in esteem, for they represented something of their past as well as their future.

Culturally, the taro patches mean a lot to the women. They are reserved for very special occasions like the Raaliire Mwaale, Men's Day, when they like to show off their biggest and best taros. It is in these traditional taro patches where taros for very special people, like their children, their brothers and uncles, are kept. A taro can be harvested and re planted so that one taro plant can feed many generations of dear ones. Mothers take pride in that very special taro that is kept in the traditional taro patch. They nurse it with that special mother pride, as they often collect the wilted leis from their children and dear ones and use them as compost around that very special taro. The son who returns home after a long absence is welcomed with that very special taro. Losing these taro patches is like losing a very significant part of your identity as a woman. It is the worst thing that can happen to you as a mother' (Hagileiram, 2011).

From: Falanruw and Ruegorong, 2015

IMPACT

Negative impacts, contributing to agriculture decline in the FSM, include invasive species and climate change. In the past there was an increase in the use of imported food, but more recently, through awareness and education, there has been a return to locally produced food, which has boosted agroforestry practices. Invasive species are a major issue in vegetable production impacting household gardens (e.g. white fly). Climate change is another great impact for agroforestry and agriculture production. Droughts and saltwater intrusion have prompted researches to focus on the identification of salt and drought tolerant crop varieties to allow for adaptation. Loss of knowledge on how to traditionally cultivate and take care of local crops was an impact highlighted during consultations. Loss of traditional knowledge and changes in weather patterns due to climate change will greatly impact future crop production in the FSM.

RESPONSE

- Promotion of disease resistant crops in the four states.
- 2018 Forest Inventory Analysis and Agricultural census.
- FSM's Agriculture Policy.
- Conservation of water for droughts.
- Farmers associations in Pohnpei and Kosrae.
- Land use and zoning in Kosrae.
- Island Food community of Pohnpei promotes the use of local food.

RECOMMENDATIONS

- Survey/expansion of disease and drought resistance crops.
- Emergency response plan/improved water catchment and systems.
- Expansion of farmer associations to other states.
- Improved land use plans.

SOURCES

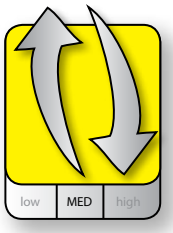
Falanruw M.V.C., Ruegorong F. (2015) Dynamics of an island agroecosystem: Where to now? In: Cairns, M., ed. Shifting cultivation and environmental change: indigenous people, agriculture and forest conservation. New York: Routledge: 367–386. Chapter 19.

FSM. Federated States of Micronesia. Household Income and Expenditure Survey 2013/2014.

Agriculture data were derived from the raw data collected during the 2017–2018 Agriculture Census from the FSM's Department of Resources & Development.

INTRODUCTION

Soil is the base of a 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. Soil organic matter (SOM) plays a crucial role for climate change adaptation and mitigation. Managing SOM comes with an array of benefits such as (1) improvement of soil quality through increased retention of water and nutrients, (2) greater productivity of plants in natural environments, (3) enhanced food security, and (4) erosion control that lead to improved water quality in groundwater and surface waters (Ontl and Schulte 2012). This indicator assesses FMS's soil types and status.



Status
Fair

Trend
Mixed

Data confidence
Medium

SDG

TABLE 21. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Mixed	Mixed	Mixed	Stable
Data Confidence	Medium	Medium	Low	High

TABLE 22. Type of soils in the FSM (USGS and NRCS).

Area of interest	Soil characteristics	Native vegetation	Production
Coastal mangrove swamps, coastal strands and bottomland.	The soil in these areas are formed by inorganic deposits and coral sand. This soil is generally poorly drained and limited by wetness.	The native vegetation associated with this soil are mangrove forest, atoll stand forest and water tolerant grasses.	This soil is suitable for the production of wood, coconuts and wetland taro. It is also considered suitable for urban development.
Upland.	The soil in this area is derived mainly from basic igneous rock and is very well drained. This soil is generally deep and limited by steep slopes and stoniness.	Native forest.	Optimal for subsistence farming, including production from subsistence trees (e.g. breadfruit, mango).

STATUS AND TRENDS

Classification of soil is essential for identifying areas susceptible to flooding and landslides. Information on soil formation and soil type are also important for understanding the trends in farming systems in the FSM, and the vulnerability of these systems to climate change. Sustainable management of soil received support at the Rio summit in 1992, the UN Framework Convention on Climate Change, the 1994 UN Framework Convention to Combat Desertification and Articles 3.3 and 3.4 of the Kyoto Protocol (Lal 2003). This indicator looks at the types and fertility of soil across the FSM.

Soil fertility and stability are a key aspect for the development of agriculture in islands with a small land mass. While high islands are characterized by two soil major groups and several sub-groups (Table 22), with small variation between one island and another, the outer islands are characterized mainly by coralline soil. In high islands, fertility of the upland soil is normally greater than in the lowlands. In the FSM bottomland soil is characteristic of the geologically older islands, hence present in a higher percentage in Yap (23.1%) and Chuuk (24.7%) than Pohnpei (17.6%) and Kosrae (6%) (Hunter-Anderson 1991).

In the FSM soil assessments were conducted in 1979–80 by the Soil Conservation Service of the United States Department of Agriculture (U.S. Dept. of Agriculture Soil Conservation Service Soil Survey reports for Micronesia, 1980–83).

Yap presented both degraded soil and fertile soil. In Yap proper, most fertile alluvial soils are located in the bottomland areas, below the zones of sealevel rise and storm surges, and therefore more vulnerable to saltwater intrusion (SWAR 2010). The lateritic[10], highly weathered interior soils of Yap support relatively extensive non-forested areas of various endemic grasses and ferns and, in places, individuals and small stands of Pandanus. This type of soil is poor in nutrients impairing other plant growth. Yap population has developed, for food production, methods to cope with the issues associated with poor degraded soils or soils exposed to saltwater intrusion. Mangroves, marshes, and swamp forests, where the giant swamp taro (*Cyrtosperma chamissonis*) is cultivated, are supported by 'hydromorphic' high fertile alluvial soils. Although the poor savanna soil is not suitable for most crops, Yapese developed methods such as mulched beds for growing heritage bananas for special occasions and pyramid trellises for growing yam (Falanruw and Ruengoron 2015).

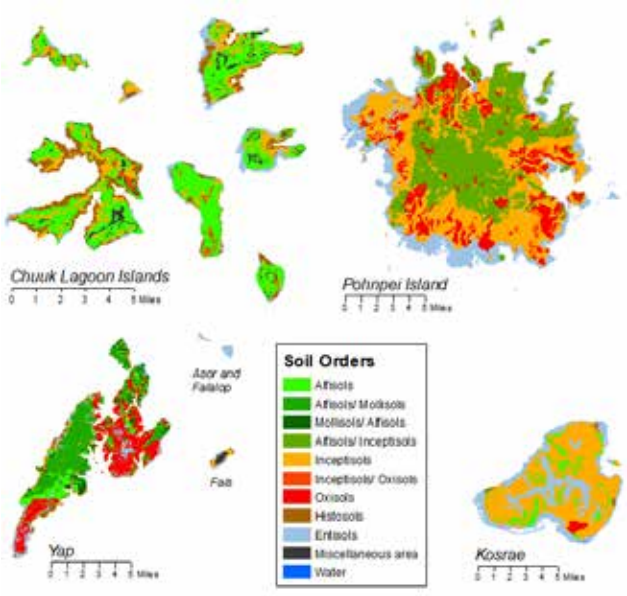


FIGURE 38. Map showing the soil composition in the four FSM states. Yap, Chuuk, Pohnpei, Kosrae (Map courtesy. USDA-NRCS, Pohnpei field Office, 2018).

The high islands of Pohnpei, Kosrae, and Chuuk suffer from landslides and soil runoff due to the clay-rich texture of the soil derived from volcanic bedrock and humid climate. The interior upland soils of these high islands support various types of forest. The lower islands and atolls lose valuable shoreline every year and the poorly drained soil type contributes to seawater intrusion leading to loss of crops. In Chuuk lagoon the islands are characterized by steep uplands with highly erodible soil.

10 Laterization is a process of "*leaching under heavy rain and high temperatures wherein soluble bases and silicas are reduced leaving non soluble material such as iron and aluminium compounds in high concentrations. Iron oxidation gives the lateritic soil their characteristic red colour.*" (Hunter-Anderson, 1991)

In Kosrae soils are classified as highly erodible, including those on the steep inside of the island. Vegetation and native forest are crucial in regulating soil stability, reducing erosion and subsequent sediment runoff. Vegetated streamsides serve as filter strips and buffers that mitigate erosion generated from agroforestry, although most of the farming activities in Kosrae occur in the freshwater swamp areas and below the Japanese line[11].

In Pohnpei, the inceptisols found in the bottomland are suitable for taro production. At mid-elevation the inceptisols (mainly Dolokei, Fomseng and Dolonei) are fertile soils with high organic matter on the surface. These types of soil are important for traditional agroforestry production (Deenik et al. 2011). Oxisols are strongly acid soils with low fertility, but with proper management they can become very productive soils. The alluvium soil found in the mangroves (Naniak) can become extremely acidic if drained, due to its high sulfur content (Deenik et al. 2011).

Although forest removal contributes to carbon emissions into the atmosphere, there is the opportunity of storing carbon in the soil through afforestation and management of the remaining forested areas. In the FSM, terrestrial protected areas and forest management are two ways for improving carbon storage in soil. Soil, forest and agriculture systems are intimately related and if managed properly can provide benefits to the island populations.

IMPACT

Conservation of soil is important for the health of plant life in Micronesia, as well as for agriculture production. The way land is used can impact on the health of soil. Activities that expose soil to wind and rain, like forest clearing, can lead to soil loss. In the FSM, seawater intrusion and inundation also impact the health of soil. Poor soil health can impact plant diversity and abundance resulting in a loss of the ecosystem services they provide.

RESPONSE

The national and state governments and communities recognize the importance of soil health, but there are limited actions specifically targeting improved soil health. The responses detailed in the forest sections above serve to improve or maintain soil health.

11 During the period of Japanese occupation (1930 to 1945), public lands were expanded to include all upland forest areas above an arbitrary line, named "Japanese Line" and the shoreline below mean high water. Access to the upland areas was therefore restricted access, reducing development in the upland native forest (Ramsey 2016). The forest, being above the Japanese line, is state-owned, however there is provision in the Kosrae State Constitution for the state to parcel and transfer this land to the original owners, their heirs or assigns (KIRMA Protected Area Regulations 2013). To date, minimal development has occurred above the Japanese line.

RECOMMENDATIONS

- There is a gap in soil fertility data, and this gap was identified in the SWAR.
- Restore highly degraded soils to ensure agroforestry productivity and food security, as a response to climate change. Restoration of organic matter levels in soil requires an understanding of the ecological processes important for SOM storage. Proper restoration techniques can help restore terrestrial ecosystem functions (Ontl and Schulte 2012).
- Implement afforestation as natural climate solution.
- Improve agroforestry management and reduction of soil degrading activities.
- Incorporate information from soil assessments into Environmental Impact Assessments (EIA) to allow groups to select the best area and practices for development.
- Build knowledge and raise awareness on soil types and best practices in agriculture for those soil types.

SOURCES

Deenik J.L., Santos G., Phillip J. (2011). Soils of Pohnpei. University of Hawaii at Manoa, Hawaii.

Falanruw, M.V.C., Ruegorong, F. (2015). Dynamics of an island agroecosystem: Where to now? In: Cairns, M., ed. Shifting cultivation and environmental change: indigenous people, agriculture and forest conservation. New York: Routledge: 367–386. Chapter 19.

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

Hunter-Anderson, R. (1991). A review of traditional Micronesian high island horticulture in Belau, Yap, Chuuk, Pohnpei and Kosrae. *Micronesia* 24 (1):1–56.

Lal R. (2003). Soil erosion and the global carbon budget. Environment International 29: 437– 450.

Ontl T.A., Schulte L.A. (2012). Soil carbon storage. Nature Education Knowledge 3(10):35.

Ramsey D. (2016). Malem to Utwe Inland Road Relocation Initiative Environmental Impact Statement for the inland road. NIWA, Report No 2016032HN.

U.S. Dept. of Agriculture Soil Conservation Service Soil Survey reports for Micronesia, 1980–83.



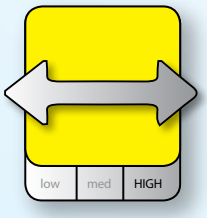


OVERVIEW

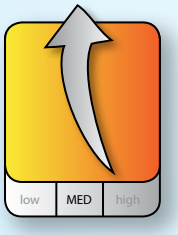
The FSM has an extensive marine environment and the people have a strong reliance on marine resources, both economically and culturally. Pelagic fisheries contribute to the economy but are at risk of overexploitation and climate change impacts and therefore need to be effectively monitored and managed. Overfishing and other threats have greatly impacted the FSM's nearshore coral reefs and its associated fisheries. However, there is hope through a holistic approach to marine management where traditional and modern styles are integrated. This is evidenced by several successful marine protected areas established throughout the country and increases in coral fisheries related regulations. There is limited date regarding iconic marine species, but these species face a wide range of threats in a rapidly changing environment.

Nick Hall

MARINE HIGHLIGHTS

TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
OFFSHORE ENVIRONMENT	 **Status** Fair **Trend** Stable **Data confidence** High	The FSM EEZ has seen an increase in industrial fishing vessels in recent years as well as the associated economic benefits. The tuna fishery sector has become critical for the national economy, providing up to 15% of the FSM GDP in FY2016 (ADB, 2017).	• The FSM needs to carefully manage its offshore fisheries to ensure tuna stocks are not overfished. • Strengthen monitoring and enforcement to ensure foreign fishing vessels comply with FSM's laws.
INSHORE MARINE ENVIRONMENT PERCENT LIVE CORAL COVER	 **Status** Fair **Trend** Deteriorating **Data confidence** High	In the FSM, 42% of the major reef habitats exceeded the ecosystem-condition threshold established by the Micronesia Challenge. Fishing pressure is the main driver of coral reef changes (Houk et al. 2015).	• Develop new and strengthen existing legislation that targets threats to coral reefs. • Strengthen enforcement of marine protected areas and other regulations.
INSHORE MARINE ENVIRONMENT REEF FISHERIES	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium	Changes in fisheries paradigms in past decades have generally resulted in unsustainable fishing regimes that threaten the future of coastal fisheries, and the fundamental services they provide. While available fisheries time series are limited, the health of coastal fisheries resources generally appear to be in decline and are currently harvested at unsustainable levels.	• Formalize permanent fisheries monitoring programs/networks to support adaptive fisheries management that ensures healthy ecosystems alongside food and economic security. • An holistic approach to fisheries management that builds upon sound science and traditional knowledge. • Develop additional policies that complement existing protected areas networks by protecting stocks outside these areas.

MARINE HIGHLIGHTS

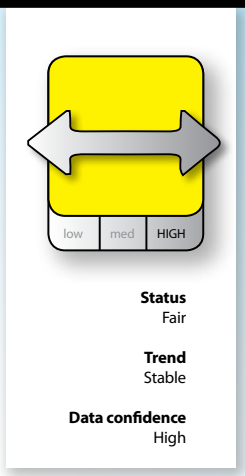
TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
INSHORE MARINE ENVIRONMENT MARINE PROTECTED AREAS	 **Status** Fair to Poor **Trend** Improving **Data confidence** Medium	Government, NGO and community partners have worked closely together (through participatory processes and consultation) to establish state, municipal, and community legislated and/or traditionally declared marine protected areas covering a wide range of marine and atoll ecosystems.	• Work with local governments on improving monitoring and enforcement. • Increase size and number of MPAs to meet MC goal for 30% protection by 2020 and ensure adequate protection of different habitat types of fish species. • Support MPA sites to be declared under national and state PAN frameworks to be eligible for funding and capacity support.
ICONIC MARINE SPECIES	 **Status** Poor **Trend** Mixed **Data confidence** Medium	While there is limited data to determine the true state of iconic marine species in the FSM, these species face a wide range of threats in a rapidly changing environment.	• Improved monitoring and data collection for species of interest by increasing resources allocated to research and identifying a direct reporting agency to report and document encounters.

Nick Hall

OFFSHORE MARINE ENVIRONMENT – TUNA AND BYCATCH HARVESTED

INTRODUCTION

The FSM is heavily dependent on marine resources for its economy as it has very limited land of 702 sq km but an extensive Exclusive Economic Zone (EEZ) of 2,992,597 sq.km. The FSM EEZ has seen an increase in fishing vessels in recent years as well as of the associated economic benefits. The tuna fishery sector has become critical for the national economy, providing up to 15% of the FSM GDP in FY2016 (ADB, 2017). Offshore fisheries production is an important indicator of pelagic (offshore) fish stock health. This indicator measures the state of offshore fisheries and management, as well as the general state of commercial species and bycatch trends, including sharks and other species.



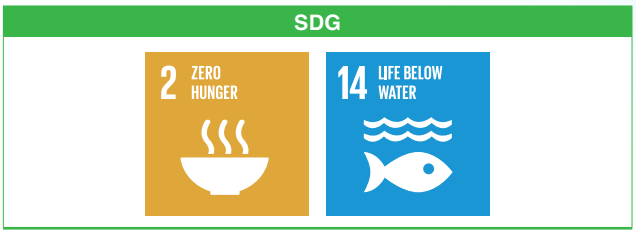


TABLE 23. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Poor	Fair	Fair
Trend	Stable	Unknown	Stable	Stable
Data Confidence	High	Low	High	High

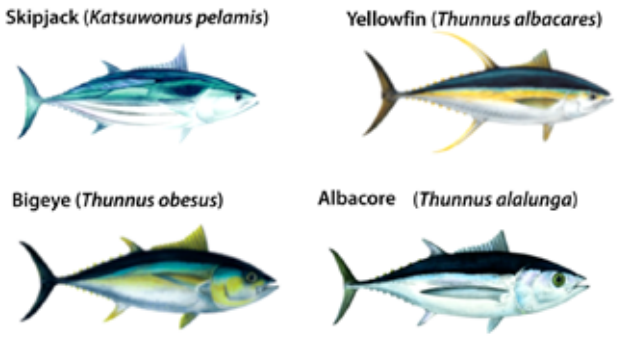


FIGURE 39. Tuna species in the Western and Central Pacific Ocean (WCPO). © Pacific Community (illustrations by Les Hata).

STATUS AND TRENDS

Tuna stocks are subject to transitory factors e.g. El Niño, illegal fishing and potential overexploitation. Recognizing the need to manage and protect one key sector of the national economy, the FSM National Oceanic Resource Management Authority (NORMA) adopted, in 2015, the Tuna Management Plan (TMP). Under the TMP, NORMA has the mandate to ensure "*effective and sustainable conservation, management, exploitation and development of tuna fisheries in the country.*" Fishing efforts and vessel limits in the FSM's EEZ are regulated according to the TMP implemented by NORMA, with support from the Forum Fisheries Agency (FFA) and the Secretariat of the Pacific Community (SPC). The FSM is also a member of the Western and Central Pacific Fisheries Commission (WCPFC) and the Parties to the Nauru Agreement (PNA).

The main species targeted by the tuna fishery industry (Figure 39), for local consumption and for export, are skipjack tuna (*Katsuwonus pelamis*), yellowfin tuna (*Tunnus albacares*), bigeye tuna (*Tunnus obesus*) and albacore tuna (T*unnus alalonga*). The main export destinations for these tuna species are Japan and USA (Yellowfin and Bigeye), Thailand, Philippines and other tuna cannery industry

countries (*skipjack*). Local Micronesia fishermen catch tuna for the local market through two methods: (1) ocean surface trolling using plastic lures and (2) "stone drop" fishing off the outer barrier reefs.

Regular assessment of stocks for tuna species captured in the Western and Central Pacific Ocean (WCPO) revealed that, for the year 2018, skipjack, yellowfin and bigeye tuna stocks are not in an overfished state although for the bigeye stocks depletion differs among regions (McKechnie et al. 2016).

In the FSM's EEZ total tuna catch in 2016 was around 200,000mt, slightly increasing from the previous two years. Skipjack tuna contributes to most of the tuna catch in the FSM's EEZ in the last 20 years (76%), followed by yellowfin tuna (19%) and bigeye tuna (5%). While skipjack is largely caught by purse seiners, yellowfin and bigeye tuna are targeted by longline vessels. Skipjack tuna are also a primary target of the pole and line fishing method accounting for 2% of the total catches in the FSM's EEZ between 1997 and 2016. Purse seine gear accounts for 94% while long line gear accounts for 4% of the fishing efforts in the FSM EEZ between 1997 and 2016.

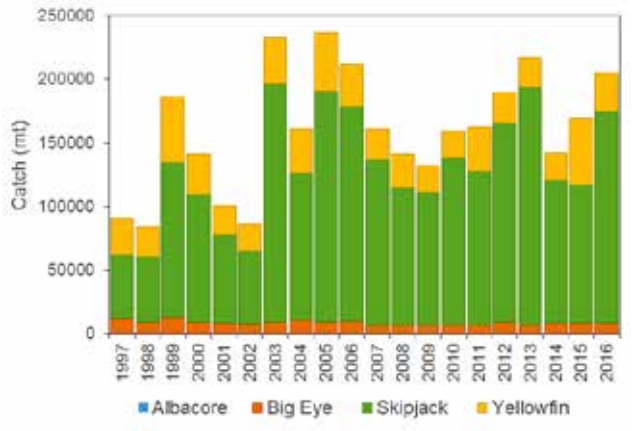


FIGURE 40. Tuna catch trends in FSM EEZ by species between 1997 and 2016 (WCPFC catch estimates, 2018).

Bigeye tuna longline catch in FSM's EEZ showed a decrease in catches from over 6,000mt in 1999 to 864mt in 2016, while for yellowfin tuna catches changed from above 3,000mt in 1998 to 769mt in 2016 (Figure 40).

FSM-flagged and national fleet within the WCPFC Convention area showed a rise in tuna catch between 1991 and 2016 for both longline and purse seine (Figure 42). In 2016 the total tuna catches, for both longline and purse seine from national fleets in the WCPO, was 77,144mt.

FSM percentage of net fishing capacity, estimated as foreign-owned fishing vessels, in 2015 was 75% for purse seiners and 100% for long lines (Allain et al. 2016). In 2018, of the 37 registered fishing vessels 54% were operating as purse seiners and the remaining 46% as long liners (WCPFC 2018).

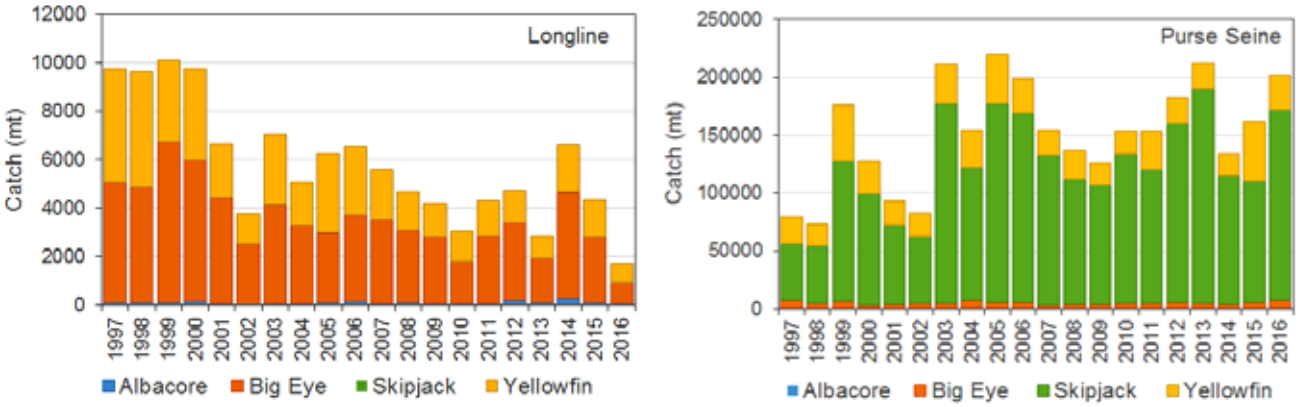


FIGURE 41. Total tuna catch (metric tons) by gear in the FSM EEZ between 1997 and 2016 (WCPFC catch estimates, 2018).

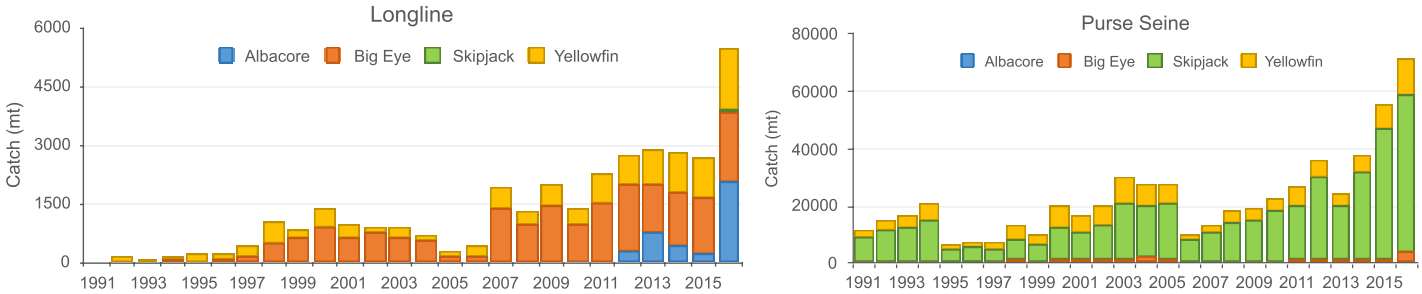


FIGURE 42. Total tuna catch (metric tonnes) by national fleets in the WCPO (annual catch estimates 2018). (WCPFC, 2017).

FLEET STRUCTURE

The Vessel Day Scheme (VDS) and other agreements allow for licenses to fish in the FSM EEZ. Over the period 2010–2017 the majority of vessels operating in the FSM EEZ were purse seiners. The pole and line fishery has always been below 30 licenses and the vessels were all from Japan.

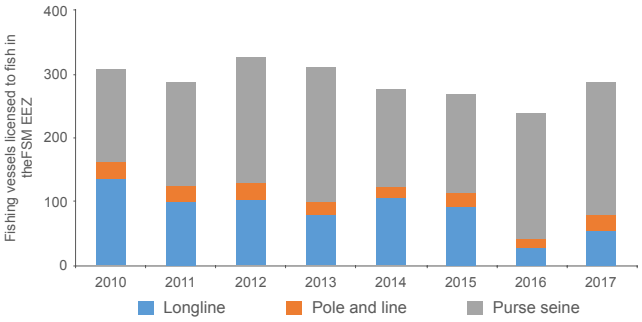


FIGURE 43. Number of fishing vessels licensed to operate in the FSM EEZ over the period 2010–2017 (WCPFC, 2018).

BYCATCH

Tuna fishing gear and practices impact other species of fish and marine organisms, such as marine mammals, seabirds and turtles. The main bycatch species caught by the FSM fleet are blue marlin (*Makaira nigricans*), swordfish (*Xiphias gladius*), silky sharks (*Carcharinus falciformis*), oceanic whitetip shark (*Carcharinus longimanus*), blue shark (*Prionace glauca*) and black marlin (*Istiompax indica*).

In total bycatch of billfish species (Table 24) accounted for 2,043 metric tons between 2012–2017. Shark bycatch accounted for 500 metric tons. The highest bycatch was recorded in 2017, with over 850 metric tons caught by the FSM vessels in the WCPFC area. Overall shark bycatch increased considerably over the period 2012–2017, passing from zero metric tons of sharks bycatch reported in 2012 to 409 metric tons in 2017.

The 2015 TMP for the FSM requires that the fishing vessels comply with the WCPFC conservation and management measures in the FSM EEZ. NORMA is responsible for the monitoring of shark catches, as well as measures to reduce sea bird and turtle bycatch, and monitoring of sea birds and turtles bycatch. Currently, all the four FSM states have enacted shark laws, and the national government amendment to Title 24 (2015) calls for the management and protection of sharks.

There is a significant impact of tuna fishing gear and practices on bycatch species in the WCPO, with sharks being increasingly targeted, especially by longline vessels (Figure 44). Among the most impacted species was the silky shark, showing a sharp increase in the bycatch between 2016 and 2017. This species is considered endangered and the assessment conducted by Clarke and Langley (2014) suggests that the stock showed steady signs of decline. Other shark species considered overfished are the Mako shark and the oceanic whitetip shark (Clarke et al. 2014). The significantly depleted stocks of the oceanic whitetip shark (*Carcharinus longimanus*) and silky shark (*C. falciformis*) need immediate management actions to allow for re-building of their population (SPC, 2014).

A higher number of marine mammals were caught in 2017 than in 2016 (Figure 45). Due to lack of previous information, catch trend over time for marine mammals cannot be described. Sea turtles are caught as bycatch in purse seines and longlines (42% and 58% respectively), while sea mammals are mostly caught through purse seines (92%). Whale sharks were reported as purse seine bycatch in 2015 (4 individuals), 2016 (2 individuals) and 2017 (7 individuals).

In addition, although not reported in the bycatch metric tons estimates for FSM, rays were previously observed in the bycatch. Over the period 2013–2015 a total of 209 individuals of different species of ray were caught. All the manta rays caught over the same period were purse seine bycatch, while pelagic stingrays were caught by longline vessels.

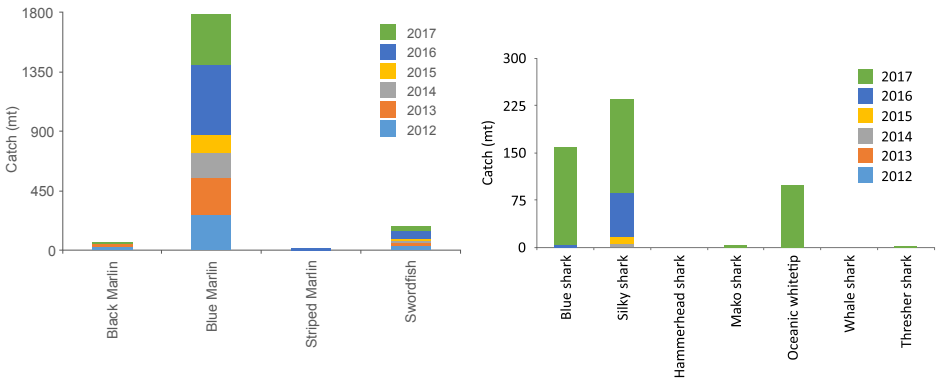


FIGURE 44. Annual catch and effort (mt) in the WCPFC Convention Area by species for the FSM purse seine and longline fleet. (WCPFC, 2018)

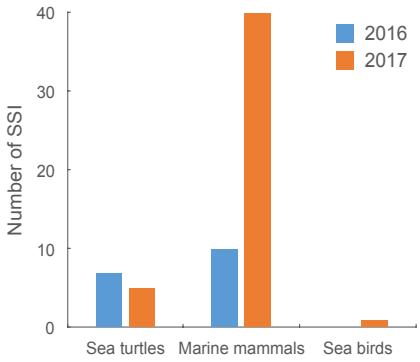


FIGURE 45. Total number of species of special interest (SSI) caught in 2016 and 2017 by FSM vessels in in the WCPFC Convention Area. (WCPFC, 2018).

TABLE 24. List of bycatch species caught by tuna fishery FSM longline (LL) and purse seine (PS) vessels in the WCPFC (Adapted from. Allain et al. 2016).

Common name	Scientific name	Gear
Billfish		
Black marlin	*Istiompax indica*	LL, PS
Blue marlin	*Makaira nigricans*	LL, PS
Striped marlin	*Kajikia audax*	LL, PS
Swordfish	*Xiphias gladius*	LL
Sharks and rays		
Blue shark	*Prionace glauca*	LL
Mako shark	*Isurus* sp.	PS
Oceanic whitetip shark	*Carcharhinus longimanus*	PS
Silky shark	*Carcharhinus falciformis*	LL, PS
Thresher shark	*Alopias sp.*	LL
Hammerhead shark	*Sphyrna sp.*	PS
Crocodile shark	*Pseudocarcharias kamoharai*	LL
Cookie cutter shark	*Isistius brasiliensis*	LL
Whale shark	*Rhincodon typus*	PS
Manta ray	*Mobula* sp.	PS, LL
Pelagic stingray	*Dasyatis violacea*	PS, LL
Devil manta	*Mobula nei*	PS
Species of special Interest (SSI)		
Green turtle	*Chelonia mydas*	PS, LL
Loggerhead turtle	*Caretta caretta*	PS, LL
Olive Ridley turtle	*Lepidochelys olivacea*	PS, LL
Minke whale	*Balaenoptera acutorostrata*	PS
False killer whale	*Pseudorca crassidens*	PS
Bride's whale	*Balaenoptera edeni*	PS
Long-beaked common dolphin	*Delphinus capensis*	PS
Bottlenose dolphin	*Tursiops* sp.	LL
Seabirds		LL

IMPACT

The leading cause of overfishing or unsustainable fishing is economic exploitation. Unsustainable fishing leads to a collapse in stock, which unbalances the marine ecosystem. While the FSM is party to the PNA and follows recommendations to ensure tuna are fished sustainably, vessels not licensed to fish in the FSM EEZ and licensed vessels not adequately reporting (Illegal unregulated unreported-IUU) contribute to unsustainable harvesting. Albacore tuna in the South Pacific is currently exploited within sustainable limits, but overfishing is believed to be occurring in the North Pacific.

The removal of key species in the form of bycatch can impact offshore ecosystems. Shark populations are extremely vulnerable to overfishing because sharks grow very slowly and have a much lower capacity to reproduce than bony fish. Sharks play a key role in maintaining trophic balance. Discarded fishing gear also has major negative impacts on marine ecosystems. For example, lost or drifting fish aggregating devices (FADS) can cause damage and ghost nets can keep fishing after detachment.

Climate change will also impact FSM's fisheries. The physical and biological oceanic environment is known to profoundly affect the migratory patterns, abundance and ability to catch target stocks. The effects of El Niño variability is already well documented, with El Niño events tending to result in eastwards displacement of tuna resources and fishing activity, higher catches by purse seine fisheries through shoaling of the thermocline, positive effects on recruitment for skipjack, yellowfin and bigeye tunas and negative recruitment effects for albacore (SPC 2018).

RESPONSE

FSM National Oceanic Resource Management Authority (NORMA) has the mandate to assist an "effective and sustainable conservation, management, exploitation and development of tuna fisheries in the country". In addition to its country TMP, the FSM is part of formalized regional and sub regional alliances, such as the Western and Central Pacific Fisheries Commission (WCPFC) and the Nauru Agreement (PNA), which assist in developing management measures and provide science-based information to support an effective management of tuna fishery. As party to the PNA, constituted by eight country Parties that control the world's largest tuna purse seine fishery as well as around 50% of the global supply of skipjack tuna (Allain et al. 2016), the FSM uses the Vessel Day Scheme (VDS) to regulate tuna fishing within the country's EEZ. VDS requires the country to charge fishing vessels for active fishing days rather than by the tonnage they land. The total number of days is determined based on scientific advice from the Scientific Committee of the WCPFC regarding the status of the tuna stocks and management objectives (Allain et al. 2016).

A public campaign was implemented for the conservation of 10% of the FSM's maritime EEZ, to extend the "no commercial fishing zone" from 12 miles per the four states to 24 miles, and combining state waters (12 miles) to national waters (12 miles). This led to a bill being passed in the FSM Congress to make this maritime conservation obligation under the Convention on Biological Diversity.

The FSM President announced at the 2018 Ocean Conference held in Bali Indonesia, that by 2023 FSM will have a Total Tuna Transparency Industry. This means that FSM will have 100% observer coverage through the use of electronic monitoring and human observer coverage in all industrial fishing vessels operating in Micronesia's territorial waters. NORMA has partnered with Luen Thai Fishing Venture (LTFV) and The Nature Conservancy (TNC) to pilot an Electric Monitoring (EM) program that aims to fill foundational gaps in the monitoring of the nation's longline tuna fisheries (http://www.norma.fm/electronic-monitoring-project/).

RECOMMENDATIONS

- Improve electronic monitoring to reduce IUUs.
- Improve chain of custody to carry out Marine Stewardship Council certification (PACIFICO logo promoted in European countries e.g. country passes a law that can serve only fish from MSC.
- Ban on discarded fishing gears.
- Improve observer coverage and Monitoring Control and Surveillance (MCS) scheme in the Pacific – FSM part of the MSC scheme
- Improve FAD use by enforcing bio-degradable FADs, enforcing non-entangling FADs and monitoring, tracking and retrieval of FADs.
- Build the capacity to address and respond to offshore fishery needs.


Nick Hall

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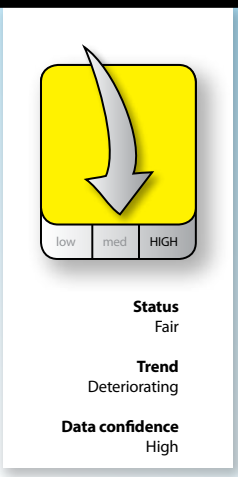
Nick Hall

INSHORE MARINE ENVIRONMENT – LIVE CORAL COVER

INTRODUCTION

Coral reefs are important ecosystems for FSM communities who still rely on marine resources, both economically and culturally. FSM is characterized by three types of coral reef formation surrounding its islands: fringing reefs, barrier reefs and atolls. Of the 4,925 km^2 of FSM's coral reefs, 30% are under medium to high threat caused by local pressures, such as overfishing, land-based pollution, poor land use, urbanization (Chin et al. 2011; Houk et al. 2015). Coral cover provides a measure of impacts to coral reefs. It is a fundamental data type for most reef surveys. This indicator assesses live coral coverage across the FSM based on data collected through the Micronesia Challenge coral reef monitoring program.



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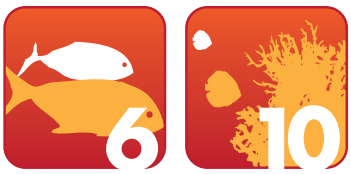

TABLE 25. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Deteriorating	Mixed	Deteriorating	Deteriorating
Data Confidence	High	High	Medium	High

STATUS AND TRENDS

Coral reef management involves government agencies, local organizations [such as Yap Community Action Program (YapCAP), Chuuk Conservation Society (CCS), Conservation Society of Pohnpei (CSP), Kosrae Conservation and Safety Organization (KCSO)], international NGOs, academia (e.g. University of Guam, University of Hawaii) and community groups. The latter are becoming increasingly engaged in the modern management of local resources, promoting, together with NGOs, the integration of traditional environmental ethics and customs into the state legislative system.

The FSM is a signatory to the Micronesia Challenge (MC) and has vowed to effectively conserve 30% of nearshore marine resources by 2020. In line with the MC coral reef monitoring program, data is collected by a consortium of organizations that includes NGOs, academia and government agencies. This report makes use of data products provided by the Micronesia Coral Reef Monitoring Program, CSP, KCSO, CCS, YAPCAP, University of Guam (UOG), Yap Department of Marine Resources, Chuuk Department of Marine Resources, Pohnpei Office of Fishery and Aquaculture, Kosrae Island Resource Management Authority (KIRMA). The analysis and

interpretations of the data presented here are solely that of the current authors' agencies.

At national level, the 2002 National Biodiversity Strategy and Action Plan identified, among the 'Areas of Biodiversity Significance' (ABS), 86 marine and coastal sites (NBSAP, 2002). In December 2004, state and national government agencies signed the National Implementation Support Partnership to establish a nationwide network of protected areas to help meet obligations under the Convention on Biological Diversity (Chin et al. 2011). The Micronesia Challenge is part of the strategies adopted by the government to meet the CBD obligations. Each FSM state has embraced regulations to support the achievement of the MC goals.

Management actions differ across states in line with the different marine tenure systems in place. For instance, while in Pohnpei and Kosrae all the ecosystems below the high watermark are considered owned by the state, in Yap and Chuuk most reefs are privately owned within a complex system of marine tenure.

Recent ecological assessments provide data that can be used in conjunction with traditional ecological knowledge to support management practices implemented by local organizations and communities and within the traditional management system.

Threats that impact coral reefs have increased, leading to a general decline in coral reef resources, especially near main population centers. In the FSM fishing pressure appears to be the main driver of coral reef health, with overfishing primarily caused by the erosion of traditional management systems alongside the commercialization of fishing (Houk et al. 2015). The reefs around the highly populated islands of Pohnpei, Chuuk, Yap and Kosrae are most at risk from these threats. In addition, by 2030, projections for thermal stress and ocean acidification suggest that all FSM reefs will be threatened with about 50% at high, very high, or critical threat levels (Burke et al. 2011). This indicates a need to reduce pressures on the coral reefs given the threat of climate change.

For three of the four states mean coral cover remains nearly 50% to date, although coral cover is declining in Chuuk and Kosrae. Houk et al. (2015) conducted biological surveys to assess the percentage of reefs across the FSM that can be considered to be above the 'effectively conserved' threshold in the context of the Micronesia Challenge, based upon a number of criteria contributing to an overall ecosystem condition score. They found that in FSM 42% of the major reef habitats exceeded the ecosystem-condition threshold established by the Micronesia Challenge and fishing pressure is the main driver of coral reef changes (Houk et al. 2015).

YAP

Yap main and outer islands support 214 confirmed species of reef-building corals in 50 genera from 15 *Scleractinian* families, with atolls having lower hard coral diversity (167 coral species in Ngulu and 180 species in Ulithi) than main island of Yap (214 coral species), suggesting isolation from seeding sources due to geology and regional surface currents (Houk and Starmer 2007). In addition, in 2007 coral evenness in Yap main was lower than in the outer islands of Ngulu and Ulithi, suggesting for Yap main a higher impact from land-based pollution due to development and high human population (Houk and Starmer 2007; Starmer and Houk 2007). Notable coral assemblages, calling for special attention for management and protection, are found in: (1) Yap main island in Tamil channel, Goofnuw channel, Miil channel; (2) the entire Ngulu atoll; (3) Ulithi in Lizard island, Falalop and Turtle (Houk and Starmer 2007).

The more exposed coral reef environment (outer reef) was characterized by strands of branching *Acropora* species, while massive species such as *Porites* spp. were most abundant in low energy shallow coral reef environments, as inner and channel reefs (Houk and Starmer 2007). These findings are consistent with those observed in other FSM islands as reported later in this section for Chuuk, Pohnpei and Kosrae.

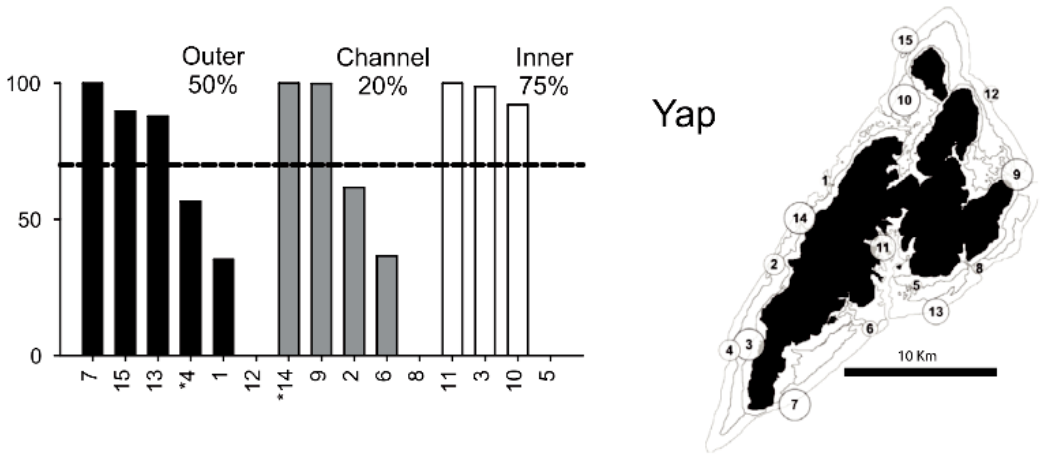

FIGURE 46. Ecosystem-condition scores across Micronesia dashed lines depict the 'effective-conservation' threshold used to assess progress towards the Micronesia-Challenge conservation goals. Percentages indicate the proportion of sites currently above the threshold (Houk et al. 2015).

In Yap main island, 50% of outer reefs, 20% of channel reefs and 75% of inner reefs meet the 'effectively conserved' threshold indicated by Houk et al. (2015) for the achievement of the MC goals, suggesting that coral reefs in Yap main island are in a general good health (Figure 46). Between 2013 and 2015 crustose coralline algae decreased by approximately 10% leaving space for turf algae to expand (Figure 47). During the same period on average coral cover showed a slight increase.

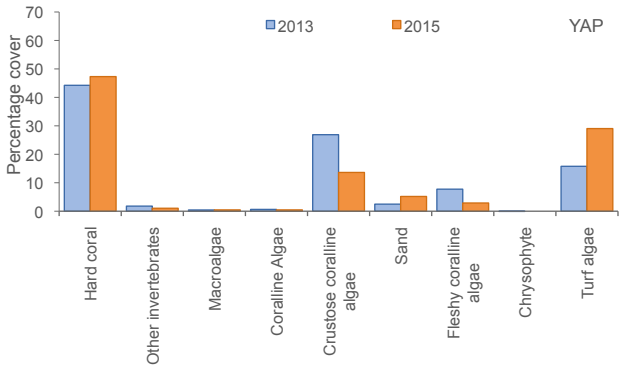

FIGURE 47. Changes in benthic cover in Yap coral reefs between 2013 and 2015.

Figure 46 and Figure 47: products provided by the Micronesia Coral Reef Monitoring Program, University of Guam Marine Laboratory; CNMI Coastal Resources Management Office; Conservation Society of Pohnpei; Yap Community Action Program Marine Division; Chuuk Department of Marine Resources; Conservation Society of Chuuk; The Nature Conservancy Asia Pacific Program.

CHUUK

Chuuk State contains some of the largest lagoons in Micronesia, 11 atolls and three single islands. Based on the Micronesia Challenge conservation goals 17% of outer reefs, 17% of patch reefs and 43% of inner reefs in Chuuk meet the 'effective-conservation' threshold used to assess progress towards the MC goals (Houk et al. 2015).

In 2008 a total of 330 *Scleractinian* coral species were identified through a rapid ecological assessment (REA) conducted at 69 sites in Chuuk lagoon, Hall and the Mortlock islands. In the same year coral diversity was higher in Chuuk lagoon than at the outer atoll reefs, while the highest abundance of hard corals was recorded at the outer atoll reefs (Houk et al. 2008). Coral cover and population density was higher in the wave-protected inner reef compared to the exposed outer reef. However, in terms of coral diversity, the greatest diversity was found on the wave-exposed outer reefs that presented a higher abundance of fast growing Acropora corals (e.g. table, corymbose and tabulate), while the reefs inside the lagoon were dominated by Porites species (Houk et al. 2008). In the outer islands coral diversity was relatively high and large parts of the coral reef framework were formed by carbonate deposited over time by *Acropora palifera* and *A. cuneata*. These species have higher growth rates and support a faster accumulation of calcium carbonate to the reef framework increasing its ability to keep pace with rising sea levels.

Threats for Chuuk's coral reefs include dynamite fishing and outbreaks of crown of thorns (COTS) starfish (Houk et al. 2008). Dynamite fishing can rapidly shift healthy and diverse coral reefs to rubble fields. Outer reefs appeared to be more resilient to this threat due to their solid reef matrix and faster recovery than inner reefs (Houk et al. 2008).

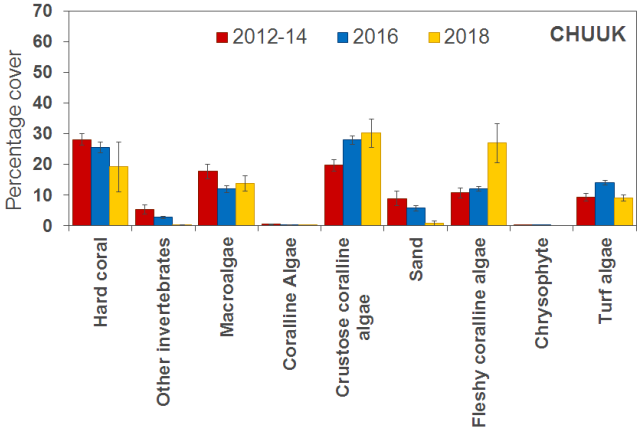

FIGURE 48. Changes in benthic cover in Chuuk Lagoon.

Figure 48 and Figure 49. products provided by the Micronesia Coral Reef Monitoring Program, University of Guam Marine Laboratory; CNMI Coastal Resources Management Office; Conservation Society of Pohnpei; Yap Community Action Program Marine Division; Chuuk Department of Marine Resources; Conservation Society of Chuuk; The Nature Conservancy Asia Pacific Program.

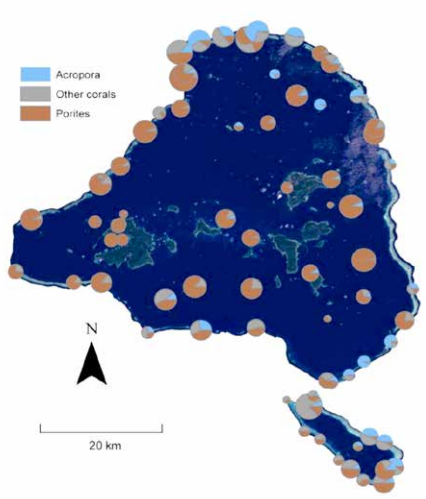

FIGURE 49. Distribution of coral abundances around Chuuk in 2016. Circle size is proportional to total coral cover in 2016 (range from 3% to 67%), colours indicate proportional cover of the three groups used for analyses (Houk et al. 2016).

A second REA conducted in 2016 captured the changes that occurred on Chuuk's lagoon reefs over eight years. Since 2008 two major disturbance events occurred on Chuuk's coral reefs: (1) outbreaks of the coral predator crown of thorns (COTS) starfish (*Achantaster planci*), which feeds on coral polyps leaving only the dead skeleton behind; (2) typhoon Maysak in 2015 that caused damages to reef habitats. COTS population estimates remained the same over the years, but this coral predator was seen more consistently on Chuuk's coral reefs since 2012 (Houk et al. 2016).

In the last ten years mean coral cover in Chuuk lagoon has declined from 28% to below 20% (Figure 48). Houk et al. (2016) highlighted that although between 2012 and 2016 *Porites* spp. cover remained stable across Chuuk's lagoon this taxon became dominant over the years. Other reef-building species (e.g. *Acropora* spp.) showed a considerable decline in cover across reef habitats, with the exception of the patch reefs in the lagoon (Figure 49), and was associated with a general decline in coral reef complexity. Coral reef services such as coastal protection, habitat for species and nursery ground can be disrupted by the decline in coral cover and diversity and loss of structural complexity.

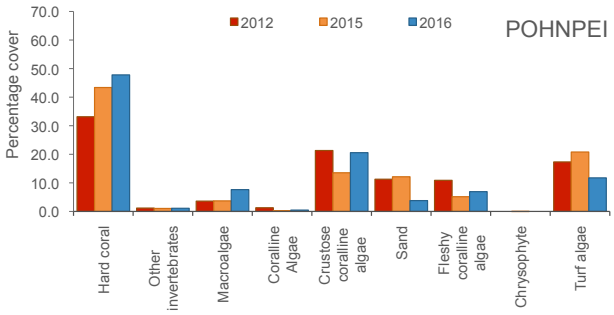

FIGURE 50. Changes in benthic cover in Pohnpei over the period 2012–2016.

POHNPEI

Pohnpei coral reefs support nearly 330 species of reef-building corals in 61 genera from 14 *Scleractinian* families (Turak and DeVantier 2005). In 2005, average coral cover was 33% in Pohnpei main, And (known also as Ant) and Pakin. Highest diversity and cover (more than 50%) was observed in the mid-lagoon and outer reef areas with distance from main Pohnpei, while coral reefs close to the populated centers showed signs of degradation with coral covers close to 10% at some sites (Turak and DeVantier 2005). Pohnpei is home to approximately 20 species with restricted global distribution ranges, providing a high degree of global importance to the area and conferring international conservation value to these reefs (Turak and DeVantier 2005). Similar to other main islands in the FSM, surrounded by lagoon systems, nearshore Pohnpei coral reefs comprise mainly *Porites* spp. (massive and weedy forms), while *Acropora* spp. are characteristic of the outer reefs exposed to high wave energy. Pohnpei's coral reef ecosystems have been adversely affected by sediment runoff, overfishing, dredging and predation by COTS, which have modified species composition and the structure of coral communities (Turak and DeVantier, 2005; Houk et al 2015).

Following the 2006 assessment, coral reef monitoring became a routine within the MC monitoring program. In Pohnpei coral cover showed an overall increase of 15%, from 33% cover in 2012 to 48% cover in 2016 (Figure 50). At sites surveyed over 2012–2016, this increase was associated with an increase in the cover of *Porites* species (+ 14% *Porites* spp. in 2016). This suggests that a phase shift in species composition is still occurring in Pohnpei coral reefs.

In the context of the MC, in Pohnpei 14% of inner and 30% of outer reefs are considered within the 'effectively conserved' threshold, while the remaining reefs are degraded to different levels due to extensive fishing pressure (Houk et al. 2015).

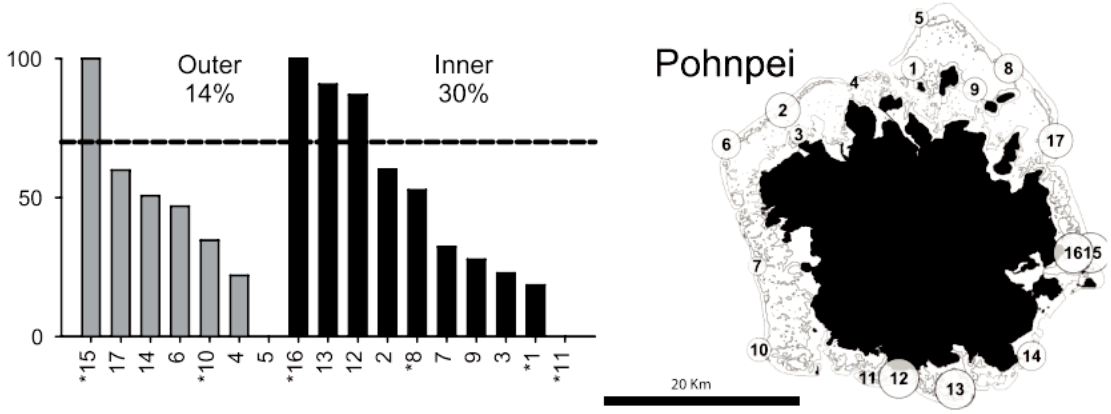

FIGURE 51. Ecosystem-condition scores across Micronesia dashed lines depict the 'effective-conservation' threshold used to assess progress towards the Micronesia-Challenge conservation goals. Percentages indicate the proportion of sites currently above the threshold (Houk et al. 2015).

Figure 50 and Figure 51. products provided by the Micronesia Coral Reef Monitoring Program, University of Guam Marine Laboratory; CNMI Coastal Resources Management Office; Conservation Society of Pohnpei; Yap Community Action Program Marine Division; Chuuk Department of Marine Resources; Conservation Society of Chuuk; The Nature Conservancy Asia Pacific Program.

KOSRAE

In Kosrae a general shift in coral composition was observed between 1986–2016. While in 1986 branching *Acropora* species were spatially consistent around Kosrae's reefs, in 2015 *Acropora* spp. were mainly restricted to the high wave energy zones around the islands. High wave energy reefs in 2015 were characterized by branching and foliose growth forms coral species, while low wave energy reefs were dominated by massive *Porites* and *Galaxea* corals (McLean et al. 2016). Kosrae coral reefs showed tangible changes in coral species composition, with *Acropora* spp. common on the leeward side of the island in 1986, while not observed in 2015 (McLean et al. 2016). These changes in coral species composition are driven by fishing pressure, which removes keystone fish species, particularly predators and large herbivores, reducing overall resilience of coral reefs. The trend observed for Kosrae reefs presents similarities with other FSM coral reefs, where changes in species composition is also influenced by environmental conditions (low and high energy environments). Sixteen per cent of Kosraean reef-building coral species are considered vulnerable to extinction on a global scale, potentially with a higher risk of regional diversity loss than expected (Richards 2014).

Only 20% of the reefs are within the 'effectively conserved' threshold used to assess progress towards the Micronesia-Challenge conservation goals (Houk et al. 2015). A general decline in reef-building corals was recorded in Kosrae, with hard coral cover decreasing by more than 20% between 2011–2017 (Figure 52). An outbreak of COTs in 2017 caused further loss of coral cover in Kosrae, although this is yet to be quantified (Andy George pers. Comm.).

MACROINVERTEBRATES

More than 70 species of sea cucumbers were recorded across the wider Micronesia region, performing an essential nutrient cycling function (Bossarelle 2017). At least 42 species are present in the waters of Chuuk (Kerr et al. 2014), with 28 species recorded in Pohnpei (Bossarelle 2017), 37 species in Yap (Kim et al. 2014) and less than 40 species in Kosrae (Kerr et al. 2008). A 2017 survey of sea cucumbers in Pohnpei Island and And Atoll suggest that stocks are low, below regional reference densities, and dominated by a small number of species (Bossarelle 2017). This is considered to be due to prior over-harvesting. Harvesting of sea cucumber has been regulated in all FSM states, with management plans for best practices and management.

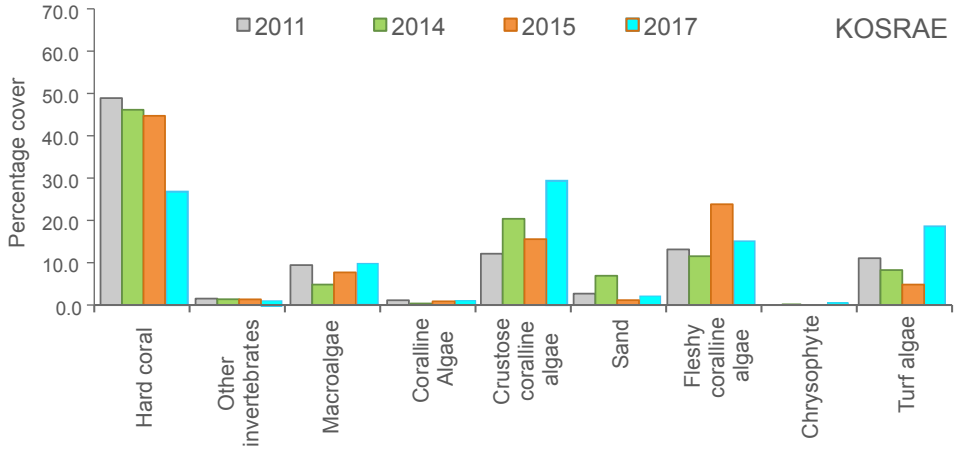

FIGURE 52. Changes in benthic cover in Kosrae, at sites re-surveyed between 2011–2017 (products provided by the Micronesia Coral Reef Monitoring Program, University of Guam Marine Laboratory; CNMI Coastal Resources Management Office; Conservation Society of Pohnpei; Yap Community Action Program Marine Division; Chuuk Department of Marine Resources; Conservation Society of Chuuk; The Nature Conservancy Asia Pacific Program.).

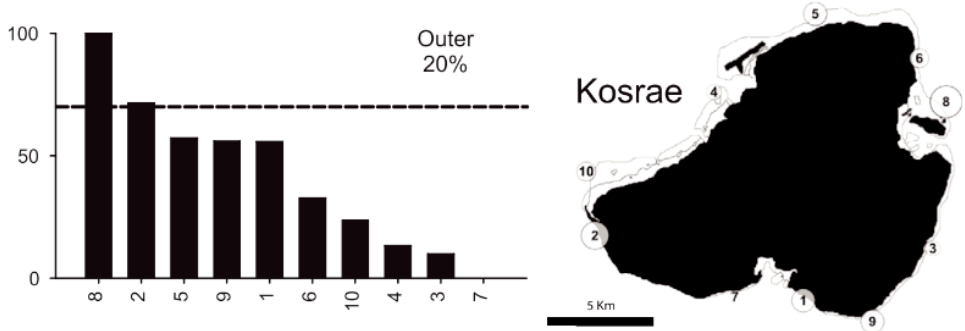

FIGURE 53. Ecosystem-condition scores across Micronesia dashed lines depict the 'effective-conservation' threshold used to assess progress towards the Micronesia-Challenge conservation goals. Percentages indicate the proportion of sites currently above the threshold (Houk et al. 2015).

IMPACT

Coral reef ecosystems face numerous threats/impacts, which are accelerating their decline. Among these are land-based impacts such as sedimentation from deforestation and other activities. Similarly, coastal development and dredging represents other important stresses for coral reefs, generally associated with reef smothering and removal. Physical damage to the coral reef framework is caused by anchoring and coral mining. Pollution of coastal waters is increasingly threatening near urban areas, where sewage water discharge is uncontrolled. In addition, marine-based pollution (e.g. oil spill from ships) is considerable in those states that are a base for pelagic fishing vessels. All these threats are exacerbated by climate change impacts, with coral bleaching affecting large areas of the reef and ocean acidification weakening coral reef framework due to the reduced ability of reef building corals to deposit calcium carbonate.

Reefs support a host of fish, marine invertebrates, and mammals, each playing an important role in maintaining the balance of the inshore ecosystem. A loss of the reef system directly impacts livelihoods through several ecosystem services they provide. The people of the FSM rely on coral ecosystems for subsistence and commercial fishing, shoreline protection and ecotourism in some of the states.

RESPONSE

As mentioned previously one response of significant importance to conservation in the FSM was the establishment of the Micronesia Challenge in 2006.

Detailed in the Marine and Terrestrial Protected Areas sections, the passing of the National Protected Area Network Framework (PAN) and state PAN regulations is a major response to leverage resources to support management of protected areas.

There have also been numerous responses at the state level:

Kosrae State Sea Cucumber Regulations of 2013, which provide for the protection and sustainable commercial harvesting, commercial processing, and commercial exportation of sea cucumber in the State of Kosrae, consistent with an approved Sea Cucumber Fishery Management Plan for Kosrae. Based on these regulations harvesting of sea cucumbers can occur only if in possession of an approved permit from KIRMA.

Development of a management plan for the sea cucumber fishery of Yap State (2010), which aim to provide a management framework that will enable the State Authority to guide the exploitation and harvesting of the sea cucumber fishery in Yap. This is in response to Section 1013 of Title 18 of the Yap State Code (the Law), and Regulation number 2009–01 from the Yap State Department of Resources and Development (the Department), the 'Yap State Sea Cucumber Regulations' (the Regulations). The Regulations came into effect on 2 February 2009. This regulates harvesting, selling or buying of any sea cucumber unless during a declared open season.

The Chuuk Coastal Fisheries Protection Act of 2016 (Act No. 13–21 of Chuuk State Law 13–16–16) provides for comprehensive protection of Chuuk's fisheries resources. It bans destructive fishing practices (dynamite fishing) that damage reefs, and prohibits commercial harvesting and export of corals. The Act bans sea cucumber fishing, except with an expert permit issued from the Director of DMR and those permits can only be issued for one year, every seven years.

RECOMMENDATIONS

- One of the main drivers to coral reef degradation is overfishing, so control of overfishing is highly recommended.
- Regulate mooring buoys and increase the number of moorings in all states.
- Coral dredging is a major threat to reefs. Recommendations included:
  - reduce reliance on coral for construction and use aggregate instead
  - increase cost of coral materials to make it cost prohibitive
  - Monitor coral harvesting
  - Require use of silt curtains
  - Strengthen legislation and enforcement of regulations that impact coral reef ecosystems.

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Kosrae underwater world. Photo: Ashley Meredith

INTRODUCTION

Coastal fisheries have supported FSM society for countless generations, providing for food, recreation, social cohesion, culture, and more recently income (Gillett 2016; Johannes 1981). Yet, changes in the fisheries over decades have generally resulted in unsustainable fishing regimes that threaten the future of those fisheries, and the fundamental services they provide. While available fisheries time series are limited, the health of coastal fisheries resources generally appear to be in decline and are currently harvested at unsustainable levels (McLean et al. 2016; Rhodes et al. 2018; Houk et al. 2016) (Figure 54a). For this indicator we look at trends in inshore fishery catch and reef fish densities and biomass from intensive fisheries-dependent monitoring programs that have been implemented in all four states over the few last years (P. Houk et al. 2017; Cuetos-Bueno et al. 2018; Houk et al. 2012).

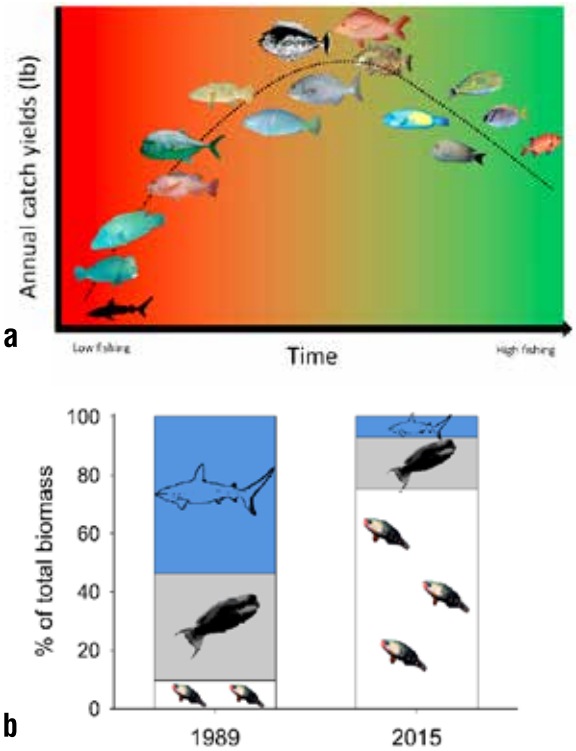

FIGURE 54. Over time changes in the FSM fisheries (background colour indicates status/resilience of different type of fish; (a) More resilient species (red background) have now become very rare in the FSM and are rarely found in landings today. Mid-sized species (orange background) dominate current FSM commercial landings, yet, clear evidences of overharvesting for many of these species are becoming evident (i.e. decreases in sizes). Lastly, small-size species that are very resilient to fishing are more common in landings, but at a socio-ecological cost (i.e. loss of coral resilience). A clear example of this shift was found in Kosrae, where changes were noted in the fishery over 25 years (b).

Status
Fair

Trend
Deteriorating

Data confidence
Medium

CBD	NBSAP
	THEME 3

TABLE 26. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Deteriorating	Deteriorating	Deteriorating	Deteriorating
Data Confidence	Medium	Medium	Medium	High

The fisheries-dependent monitoring programs in the FSM have provided accurate information regarding the status of both coastal ecosystems and fisheries resources needed to implement useful forms of ecosystem-based fisheries management (EBFM). Results from these assessments highlight the importance of inshore fisheries for food and economic security in the FSM, and the need for enhanced management to maintain those services (Table 27). Those assessments also provide great insights into what families and species are more prevalent in the FSM inshore fisheries, providing for management actions that maximize returns (Figure 55). Yet, given resource limitations, data collection efforts have almost exclusively focused on the main inhabited islands of Pohnpei, Chuuk lagoon, Kosrae, and Yap.

TABLE 27. Data derived from existing studies (Peter Houk et al. 2017; Houk et al. 2012; Cuetos-Bueno et al. 2018; Hernandez-Ortiz et al. 2016) Guam, Yap, and Pohnpei. Initial examinations found that calm weather and low lunar illumination predicted between 6% (Yap on commercial nearshore fisheries in FSM. Human pressure index (people per square mile of reef area), estimated annual commercial landings of reef and nearshore pelagic fish (x1,000 lb per year), estimated annual value of combined nearshore commercial landings (USD $ millions per year), and estimated proportion of overall annual economic value that results in net income for fishing families (x1,000 $ per year), for each state and the whole FSM.

State	Population (2010)	Person per reef area (person/mi2)	Reef landings (x1000 lb)	Pelagic landings (x1000 lb)	Overall landings (x1000 lb / year)	Value (million $)	Fishers income (x1000 $)
Chuuk	36152	41	583	134	717	1.25	703
Kosrae	6616	739	16	22	38	0.07	20
Pohnpei	34789	262	552	235	787	1.38	772
Yap proper	7371	142	132	56	188	0.33	159
FSM			1283	447	1730	3.03	1654

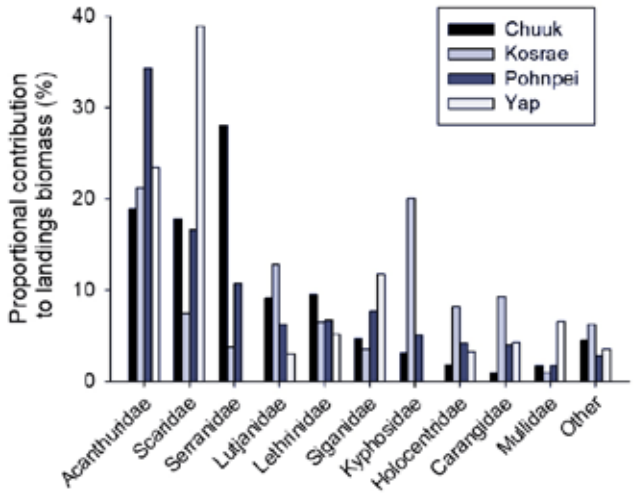

FIGURE 55. Proportional contribution to commercial landings of main reef-fish species for each FSM state.

As expected, the status of reef fisheries appears closely associated with levels of human pressure, and more compromised resources and fisheries were found in islands with high populations and low reef area (Figure 56a). The following pattern has now been documented in published and ongoing studies (Peter Houk et al. 2017; Cuetos-Bueno et al. 2018; Houk et al. 2012; Hernandez-Ortiz et al. 2016)which permits unrestricted use, distribution, and reproduction in any medium, provided the original author and source are credited. The consistent supply of fresh fish to commercial markets may mask growing fishing footprints and localized depletions, as fishing expands to deeper/ further reefs, smaller fish, and more resilient species. To test this hypothesis, species-based records and fisher interviews were gathered over one year within a large, demand-driven coral-reef fishery in Chuuk, Micronesia. We first assessed catch statistics with respect to high windspeeds and moon phases that are known to constrain both catch and effort. While lower daily catch success was predicted by higher windspeeds and greater lunar illumination, total daily landings fluctuated less than fishing success across environmental gradients. Instead, daily landings were mainly driven by the number of flights from Chuuk to Guam (i.e., international demand:

1. Large species that are most vulnerable to fishing have become rare on most FSM reefs, and are seldom found in fisheries landings today. These species represent large and iconic species of groupers, the Napoleon Wrasse, and the Bumphead parrotfish. Given their slow growth these species have been the first to disappear from Micronesian commercial fisheries despite their high value to culture, tourism, and reef ecology (red area, Figure 54a).
2. Many medium-sized target fish that are commonly found in our commercial markets are now showing strong declines in mean body sizes (orange area, Figure 54a). This was seen for many of the same species across most of FSM. This results in many fish being captured before they reach optimal sizes, and often before they have a chance to reproduce (Figure 56).
3. Modern fish landings are slowly becoming dominated by smaller-sized herbivores that can grow and reproduce quickly (green area, Figure 54a). The dominance of these species comes at a major ecological and financial cost. Fishers must spend more time catching more smaller fish to meet the same economic demands. Ecologically, smaller species have disproportionally lower ecological functions and cannot keep reefs free of algae that take over space on the reef.

IMPACT

While overall reef-fish stocks in FSM may be considered as fair, strong gradients occur within. The status of stocks is highly correlated to human pressure gradients, with more compromised stocks in the more populated urban islands. Limited historical datasets suggest changes on fisheries paradigms over the last decades (i.e. technology and commercialization) as the main drivers of these unsustainable regimes and declining resources. Given the high reliance on reef fisheries for food and economic security, especially of more vulnerable groups, their continued decline is of concern.

RESPONSE

Several advances in fisheries management have occurred, including:

- State bans on harvesting and/or commercialization of endangered species e.g. the Yap State Legislature passed YSL 9–2 to restrict the sale of Bumphead Parrotfish (also known as Humphead Parrotfish, or *Bolbometopon muricatum*) and Napoleon Wrasse (also known as Humphead Wrasse, Napoleon Fish, or *Cheilinus undulates*).
- State laws targeting exportation, size limits and gear ban. For example:
  - Chuuk Coastal Fisheries laws banning export of groupers and dynamite fishing.
  - Pohnpei state size limits in place for 10 species including the Humpback Snapper, Rudderfish and Pacific Longnose Parrotfish.
- Formation of fisheries councils in Pohnpei and Kosrae to empower fishermen to lead management of fisheries in their communities.
- In 2017 in Pohnpei, a local organization Menin Katengensed (MK) opened a sustainable seafood market, PMK Market. PMK Market aims to provide an alternative livelihood and fair-trade strategy for local fishermen based upon the use of sustainable harvesting techniques. The market provides a self-financing mechanism for the organization and raises awareness among fishers and consumers.

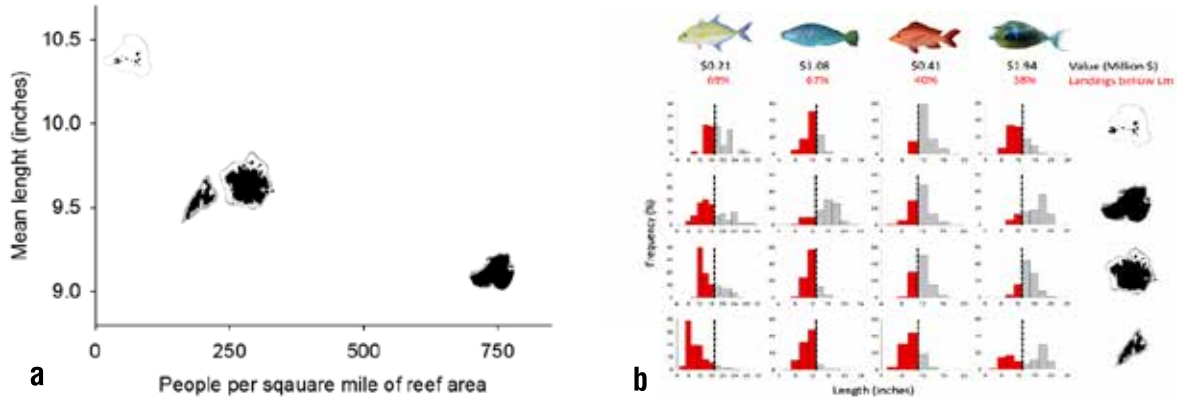

FIGURE 56. Depletion gradients in FSM can be observed at a cross-island scale, as the mean size of commercial landings decreases alongside human pressure index (people per square mile of reef area; (a) Four medium-sized target fish commonly found in FSM commercial markets (annual economic value shown in black numbers) are showing strong declines in mean body sizes. Many fish are caught before they reach optimal sizes, and often before they have a chance to reproduce (shown as red bars, and red numbers). Lm= mean length at maturity (b).

RECOMMENDATIONS

- Use an holistic approach to fisheries management that builds upon sound science and traditional knowledge.
- Develop policies that complement existing protected areas networks by protecting stocks outside these areas (Figure 57).
- Given the dynamic nature of stocks and fisheries, resources managers need to maintain an adaptive approach to fisheries management. Formalizing permanent fisheries monitoring programs/networks would be fundamental to support adaptive fisheries management that ensures healthy ecosystems alongside food and economic security.
- In addition to modern fisheries management practices, the revival of traditional management practices has the potential to provide management approaches that may have greater acceptance by society and fishers.
- Support rights-based fisheries management through capacity building, technical support and appropriate legislation where necessary.
- Alternative livelihoods to fishing could also potentially result in reduced fishing pressure by commercial fishers on compromised resources.
- Effectiveness of fisheries management policies and approaches needs to be supported by increased awareness, improved compliance, and strengthened enforcement.

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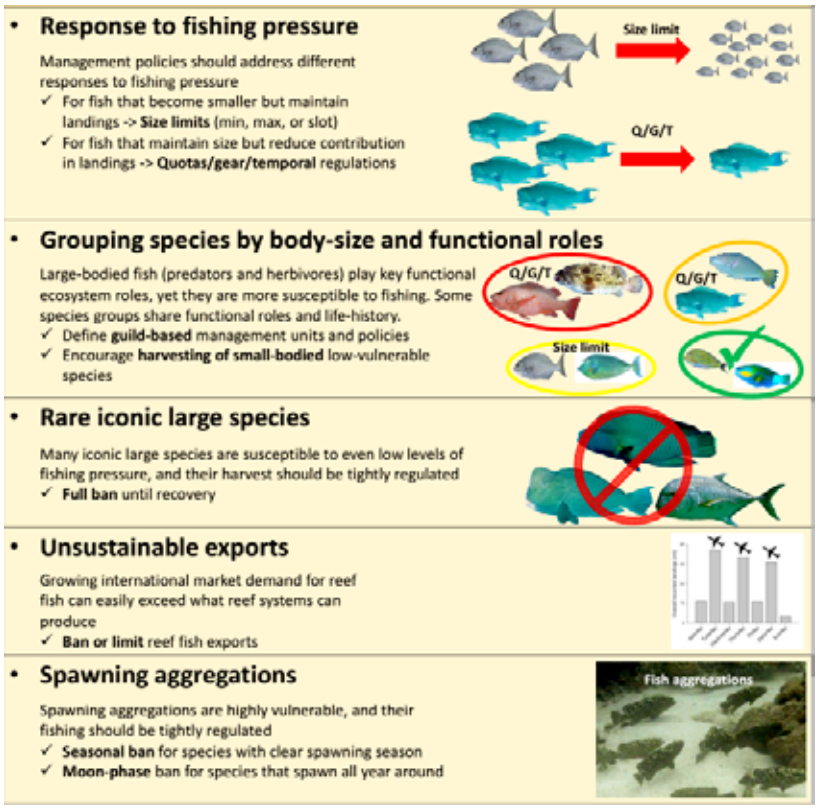

FIGURE 57. Fundamental key management principles to ensure healthy ecosystems and sustainable food and economic society (Cuetos-Bueno & Houk 2017).

INSHORE MARINE ENVIRONMENT – MARINE PROTECTED AREAS

INTRODUCTION

Government, NGO and community partners have worked closely together (through participatory processes and consultation) to establish state, municipal, and community legislated and/or traditionally declared marine protected areas covering a wide range of marine and atoll ecosystems. In 2006, five governments (the Federated States of Micronesia, the Republic of the Marshall Islands, the Republic of Palau, the U.S. Territory of Guam, and the Commonwealth of the Northern Marianas Islands) launched the Micronesia Challenge (MC), which is a shared commitment to preserve the natural resources that are crucial to the survival of their traditions, cultures and livelihoods. The goal of the MC is to "Effectively conserve at least 30% of nearshore marine resources and 20% of terrestrial resources across Micronesia by 2020." This indicator is based on a gap analysis led by The Nature Conservancy to assess the status and design of the FSM protected area networks and their progress towards achieving the goals for the MC. It looks at the percentage coverage and management status.

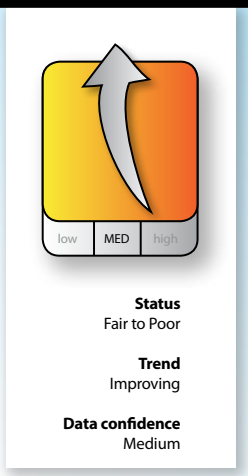

TABLE 28. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair to poor	Fair to poor	Fair	Fair
Trend	Improving	Mixed	Improving	Mixed
Data Confidence	Medium	Medium	Medium	Need improvement

The push for establishment of Marine Protected Areas (MPAs) in the FSM was formalized in 2002, when a 'blueprint' of the biological resources was created to provide a clearer picture of areas of biological significance (ABS) and a prioritization of conservation needs. The 'blueprint' contributes to the National Biodiversity Strategic Action Plan (NBSAP), the major goal of which is to protect and sustainably manage the FSM's marine, freshwater, and terrestrial ecosystems.

In 2009, a gap analysis was completed for each state using information gathered from workshops. Participants at the workshops worked together to identify conservation features ('Class') within each state and then to define an initial set of goals for each class. The results were used to guide the establishment of new protected areas.

In order for MPAs to be effective they also need appropriate legislation to support management. The national government recently passed a National Protected Areas Network Policy Framework (NPANPF) developed in 2015, this framework outlines a transparent, fair, and

efficient system governing the designation and operation of a nationwide protected areas network (PAN), inclusive of state-level protected areas networks in Yap, Chuuk, Pohnpei, and Kosrae. This PAN 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. It also outlines the benefits of membership, including access to longterm and sustained technical and financial assistance.

The FSM states of Pohnpei, Kosrae and Chuuk already have legislation in place for their state protected areas. Yap has limited jurisdiction over most terrestrial and nearshore marine resources, as most land and coastal areas are either privately or community owned. Government agencies, non-government conservation and resource management groups, and community members created a community-managed network of protected areas in 2015. Additional consultation and design is still required to establish a state-recognized network of protected areas in Yap. As is outlined above, the main incentive for the states to adopt their protected areas law is that it is a prerequisite to withdraw funds from the MC endowment fund. The FSM and the states are also keen to meet their commitments to the UN Convention on Biological Diversity (protected areas and Aichi Targets), another incentive for them to officially adopt the policies and legislation to meet those UN requirements.

The effectiveness of any protected area network also depends upon good compliance with management restrictions. In regions like Micronesia, this requires local communities and other stakeholders to support the protected area network, both in terms of the broad vision and objectives, and specific protected area boundaries and management rules. An MPA effectiveness assessment tool has been developed for Micronesia modelled after the Indonesian MPAME tool.

A second round of gap analysis and spatial prioritization analysis is currently underway for the FSM. This effort is led by TNC in partnership with state governments and local NGOs. The analysis has been completed for Pohnpei, Yap and Chuuk with the analysis for Kosrae to begin in February 2019. The analysis was conducted with respect to representation targets specified by the MC and in terms of protecting key fish species or other targets identified by stakeholders from each state. The second part of the analysis is a spatial conservation prioritization to identify indicative priority areas for conservation, accounting for community interest in undertaking management. Results from the MPAME tool allows for better understanding of the management of existing MPA sites, and whether the sites are aligned to state goals and objectives. The outputs from the analyses are a set of recommendations to establish new protected areas to achieve state and regional level objectives.

POHNPEI

Pohnpei currently achieves the targets specified in the Micronesia Challenge, with 29% of nearshore marine habitats within the protected area network. However, if we look more closely at individual habitat types, the extent to which they are represented within the PAN is highly variable. Key fishery species were identified by stakeholders at the 2014 Protected Area Network Design workshop. Many MPAs in Pohnpei are too small to protect many species of interest and lack adequate management and enforcement.

YAP

Only 11% of Yap's nearshore marine area is protected within the PAN. This falls short of the targets laid out in the MC, but it should be noted that Yap's existing protected areas have greater management effectiveness than those in the rest of the FSM (attested by ecological monitoring results). Protected area extent should not be considered as a sole (or ultimately a reliable) indicator of conservation effectiveness. Also, like Pohnpei, many MPAs in Yap are too small to protect many species of interest, but with Yap's smaller reef area, and reefs being owned by villages, expanding MPAs might not be an option.

CHUUK

Although Chuuk has the largest reef area, less than 3% of the reef habitats are within managed areas. This falls well short of the representation targets laid out in the MC and is also below that achieved by other FSM states. The small area currently under management highlights the need for conservation and fisheries management planning in Chuuk. It also indicates an opportunity to develop a protected area network that is informed by the best available science.

KOSRAE

Kosrae's marine protected areas are under various states of management with about 5% of Kosrae's reefs protected. A review found that Kosrae's MPAs fell short of the representation targets laid out in the MC and that most MPAs were inadequately sized to protect key fish species. Because of Kosrae's limited reef area, a network of well-designed smaller MPAs might be more appropriate for Kosrae. Currently Kosrae's MPAs are very isolated from each other and only cover inner reefs.

The total surface area of Marine Protected Areas (MPA) in FSM is 2135 km^2.

TABLE 29. Surface area of Marine Protected Areas in FSM.

State	MPA's surface area (km^2)	Percentage MPAs1in the context of the MC
Yap	1146	11%
Chuuk	399	3%
Pohnpei	581	29%
Kosrae	9	5%
TOTAL	2135 km^2	7%

1 Percentage of MPAs

IMPACT

Successfully managed marine protected areas benefit both the communities and the ecosystems they depend on. Effective protected areas result in more resilient ecosystems, better able to withstand the impacts of climate change, and MPAs have proven to be one of the best ways to protect diverse and healthy marine ecosystems and coral reef communities. Increased fishery resources due to better management is both nutritionally and financially better for communities.

If protected areas are poorly designed or the regulations not enforced, the expected benefits will be fewer, or may not materialize at all. MPAs cannot fully address the problems in the absence of other, supporting measures. Therefore, sound fisheries management practices, enforcement of MPA rules and regulations and community decision-making and empowerment are each fundamental to the success of MPA systems.

RESPONSE

- Declaration of the Micronesia Challenge, which has been a catalyst for creating a regional web of mutually reinforcing projects, programs, and peer-learning networks to improve the condition and management of the essential ecosystems and natural resources that the people of Micronesia rely on.
- Passing of the National Protected Areas Network Policy Framework (NPANPF) and state level PAN legislation, which allows for access to longterm and sustained technical and financial assistance. This is key to improving the management effectiveness of marine protected areas.
- Technical support through the Pacific Island Managed and Protected Area Community (PIMPAC) PIMPAC aims to provide opportunities for information expertise, practice, and experience exchange in order to enable and support site-based and ecosystem-based management capacity. It has a number of state and national partners across the FSM and provides training for capacity building in marine conservation.

RECOMMENDATIONS

- Scaling up from individual MPAs to a state/island-wide MPA network will facilitate the protection of species and habitats in addition to the maintenance of ecological processes, structure, and function.
- To achieve the 30% representation target for all marine habitat types for each state requires a substantial increase in the extent of protected areas. This might either be achieved by increasing the size of existing MPAs or by adding new MPAs to protect complementary habitat types.
- Improving protection for species with larger home ranges will require either making some MPAs larger, or alternative management measure for those species, such as catch, size, gear or effort restrictions, or seasonal catch and/or sale bans.
- While MPAs can protect against negative effects of overfishing of reef fish and invertebrates, they cannot reduce threats from poor land management practices. Degradation and destruction of forests and mangroves negatively impacts on downstream habitats and was identified as a key challenge to be addressed by all states. Reducing land-based threats will improve the effectiveness of existing MPAs.

SOURCES

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ENDANGERED MARINE SPECIES – TURTLES, CETACEANS, SHARKS AND RAYS

This section was compiled with contributions from Julie Hartup (mccjuliehartup@gmail.com).

INTRODUCTION

Cetaceans, turtles, rays and sharks are found throughout the FSM. The unknown size of populations, life history, and migration patterns of these species is particularly challenging for designing effective management regulations. This indicator looks at shark and rays trends, turtle trends and movements and the status of cetaceans in FSM waters.

Status
Fair

Trend
Mixed

Data confidence
Medium

CBD	NBSAP	CMS
12	Theme 3	Convention on the Conservation of Migratory Species of wild animals

TABLE 30. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Poor	Poor	Poor	Poor
Trend	Mixed	Mixed	Mixed	Mixed
Data Confidence	Medium	Medium	Medium	Medium

Throughout the FSM, cetaceans, turtles, rays and sharks face a wide range of threats in a rapidly changing environment. Although many turtles, cetaceans, rays and sharks are known to be vulnerable or endangered, there is limited data available to make confident assessments about the persistence of these populations. Due to their migratory nature these marine animals are prone to several threats from discarded fishing gear, fisheries bycatch, ship strikes and climate change. In addition, these taxa are an important tourism attraction, providing alternative sources of revenue and jobs to those working in the dive sector. For instance, in Yap there is a scuba diving tourist industry built around reef manta rays (*Mobula alfredi*) that has lasted over 30 years.

TURTLES

In the FSM there are four native turtle species: the Leatherback (*Dermochelys coriacea*) and Olive Ridley (*Lepidochelys olivacea*), which are considered vulnerable; the Green turtle (*Chelonia mydas*), which is considered endangered, and the Hawksbill turtle (*Eretmochelys imbricata*), which is critically endangered (NBSAP 2018).

Information on turtles in the FSM waters were collected by the FSM's Division of Resource Management and Development (DRMD) and incorporated by SPREP into the regional Turtle Research and Monitoring Database System (TREDS). Data was collected only for the green turtle, hawksbill turtle and other unidentified turtles and was obtained by tagging individuals or at nesting sites. For FSM from 1985–2013, the green turtle (*C. mydas*) has the highest number of records in TREDS with 4,192 individuals, followed by unidentified marine turtle species with 18 individuals and hawksbill turtle (*E. imbricata*) with 15 individuals. Out of the total of 4,192 green turtles recorded in TREDS for FSM, most were from surveys conducted in the outer islands of Yap.

Although the data does not reflect the real abundance of foraging and nesting turtles in FSM, they provide a proxy on turtle population structure, migration and nesting sites. The majority of nesting green turtles recorded in TREDS for FSM (Figure 58) were from surveys conducted in the atolls of Yap.

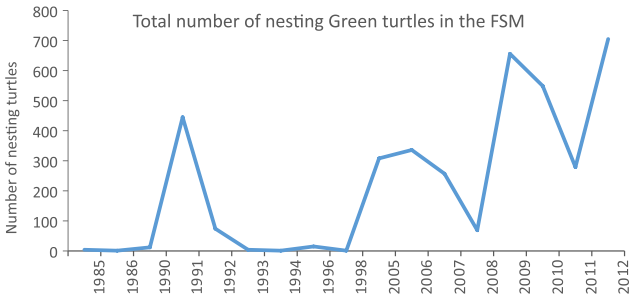


FIGURE 58. Total number of nesting green turtles (*Chelonia mydas*) in the FSM. The majority of the nesting turtles in TREDS were recorded for Yap (TREDS by SPREP).

Population structure show differences between the green turtle and the hawksbill turtle. The green turtle population was characterized over the years (1985–2013) by adults and few juveniles, while the opposite trend was observed for the few hawksbill turtles recorded in the same period. Measurements of turtle carapace, to identify their life stage, indicate that of the total 2,819 green turtles measured, 99% were adults, while of the total 16 hawksbill turtles measured, 75% were juveniles. This data suggests that FSM has an established adult green turtle population that actively reproduces in the country.

Recovered tags from 1991–2011 indicated that some tagged animals were recovered dead (34%) as part of fishing practices. Studies in Yap indicated that green turtles, which breed in Yap, range widely within the Pacific and southeast Asian region (Kolinski 1995). The migration of green turtles between nations highlights that turtles are a resource shared across political boundaries (Kolinski 1995). The susceptibility of turtles during their migrations call for transboundary cooperative management actions.

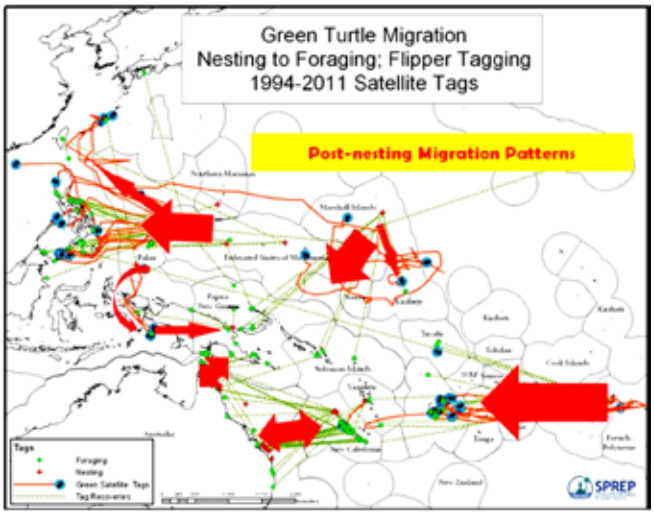


FIGURE 59. Migrations of green turtles found in the SPREP region, based on flipper tag recoveries and satellite tags (SPREP).

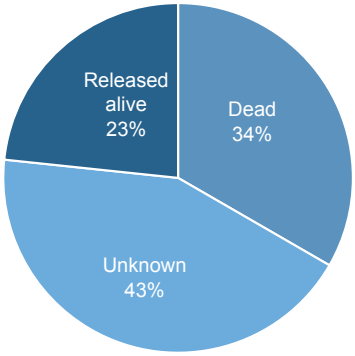


FIGURE 60. State of green turtles recovered over 10 years period in the FSM (TREDS by SPREP).

FIGURE 61. Example of education material prepared by YAP EPA for dissemination on turtle protection regulations (Yap Environmental Protection Agency).

CETACEANS

Cetaceans are important components of the marine biological diversity in the FSM. The Pacific region is known to be home for over half the world's known species of cetaceans, and for some species the region is a vital breeding area. These species are generally long-lived and have low reproductive rates making them particularly at risk from harvesting activities.

Although there has been no dedicated survey to study the marine mammal diversity within the waters of the FSM, through anecdotal reports Miller (2007) identified 14 species present in the EEZ. In the International Union for Conservation of Nature (IUCN) Red List, the sperm whale and the spinner dolphin are listed as vulnerable. For four species, listed as data deficient, there is "inadequate information to make a direct, or indirect, assessment of its risk of extinction based on its distribution and/or population status" (IUCN 2001). Therefore, it is recommended to give to these species the same degree of attention as threatened taxa, at least until their status can be assessed (IUCN 2001).

Fishers have reported sightings of tropical orca. Sightings and pictures in 1995 near the offshore island called Black-Coral (south of mainland Pohnpei), about 500 yards from the islands channel, corroborates sightings in the past. Similarly, in Yap, fisherman accounts of orca were corroborated in 2009 through sightings and pictures of a pod of tropical orca interacting with divers. Sightings seem to first occur of migrating pods near Pohnpei, Yap and then Palau. Most likely a pod is following its food source and might have a specialized diet as shown with certain pods near Washington state (Hartup J. *pers. comm.*).

SHARKS

Fishers and small tourist diving operators have accounts of whale shark (*Rhincodon typus)* sightings throughout Micronesia, but no information is known about their migration and if sightings are seasonal (Hartup J. *pers. comm.*). Whale sharks were also reported in the purse seine bycatch within FSM's EEZ corroborating their presence. Catch of other shark species has increased in recent years as shown from the above bycatch section. For instance, bycatch data for the oceanic white shark, the silky shark and the blue shark indicate that catch of these species in 2017 doubled. Some of the shark species are steadily declining and are listed as vulnerable, but are on the verge of becoming endangered.

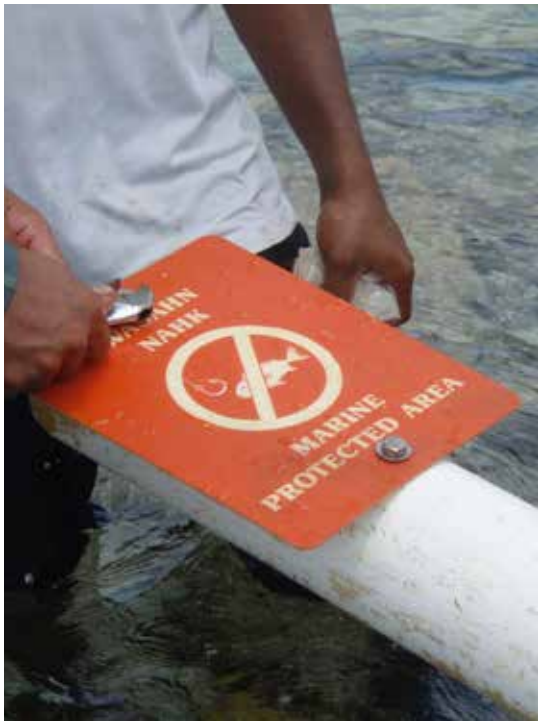
MANTAS

Manta rays are commonly sighted in FSM waters. Although populations appear to frequent lagoons and reefs, encounters have been documented starting from 2008. In 2007, DNA analysis, combining manta rays and other mobula species, brought the total species of mobula to eight (Hartup J. *pers. comm.*). Research over the past 10 years, in both the main islands of Yap and Pohnpei, helped to provide estimates of populations. In Yap manta ray population is approximately around 53 individuals. This population is considered a micro-population with new manta ray individuals that are typically juvenile, hence extremely susceptible to anthropogenic threats. In Pohnpei's coral reefs, the manta ray population is larger than Yap and currently account for more than 60 individuals (Hartup J. *pers. comm.*).

With regards to the outer islands, an aggregation of manta ray feeding was recorded in Ulithi before 2015. In addition, interviews of community members from Lamotrek

TABLE 31. Record of Cetaceans in the waters of the FSM (Miller 2007; WCPFC Record of Fishing Vessels 2018).

Common name	Scientific name	Status
Bryde's whale	*Balaenoptera edeni*	Least Concern
Short-finned pilot whale	*Globicephala macrorhynchus*	Data Deficient
Fraser's dolphin	*Lagenodelphis hosei*	Least Concern
Melon headed whale	*Peponocephala electra*	Least Concern
Striped dolphin	*Stenella coeruleoalba*	Least Concern
Spinner dolphin	*Stenella longirostris*	Vulnerable
Bottlenose dolphin	*Tursiops sp.*	Least Concern
Sperm whale	*Physeter macrocephalus*	Vulnerable
Minke whale	*Balaenoptera acutorostrata*	Least Concern
False killer whale	*Pseudorca crassidens*	Data Deficient
Long-beaked common dolphin	*Delphinus capensis*	Data Deficient
Orca	*Orcinus orca*	Data Deficient
Pantropical spotted dolphin	*Stenella attenuata*	Least Concern
Cuvier's beaked whale	*Ziphius cavirostris*	Least Concern



and Woleai indicated a presence of reef manta rays from interactions of fishermen. The presence of manta ray aggregations suggest that most island atolls are likely to have reef manta ray populations, while the presence of manta is unlikely to occur on islands that lack lagoons. Although the size of this population is unknown, they share similarities with the micro-population observed near Yap's main island (Hartup J. *pers. comm.*).

Very little is known of the population size and migration pattern of pelagic giant manta ray (*Mobula birostris*) in the FSM's waters. However, their presence in the bycatch from the FSM EEZ suggests that this species exists. There is a general lack of knowledge on pelagic Mobula spp., except that movement and migration are related to food (zooplankton). It is known that these species exist in Micronesia from bycatch data from NORMA.

Migration of coral reef manta rays throughout Micronesia is unknown, but have been reported in bycatch data by NORMA. Migration varies between regions and individuals, but is driven by increased levels of food and daily migrations of 70km (Hartup J. *pers. comm.*). NORMA bycatch data has indicated that fishing zones of purse seiners and long liners overlap with habitat of oceanic manta rays, migrating reef manta rays, and other mobula species. However, species can be easily confused by observers, indicating the need for an appropriate identification tool (Hartup J. *pers. comm.*).

IMPACT

Endangered marine species are impacted by numerous threats. These are found in pelagic fisheries bycatch because of coastal gillnets; driftnets; bottom trawls; pelagic longlines; pot and trap fisheries; discarded fishing gear; seafloor alterations and changes in the food web.

Climate change will impact migration, breeding and other parts of the life cycles. In turtles for example climate change can impact natural sex ratios of hatchlings due to beach temperature change as well as loss of nesting beaches through sealevel rise and extreme weather.

Marine pollution, including plastics, discarded fishing gear, petroleum byproducts, and other debris directly impact cetaceans, sea turtles and rays through ingestion (e.g. ingestion of plastic and Styrofoam) and entanglement.

Sea turtles play an important role in several FSM cultures. They are a prestigious ceremonial food, with cultural restrictions on take and consumption. However, changes in social practices and globalization has resulted in negative impacts on turtle populations. Several FSM states have policies protecting turtles but allow for traditional or customary uses, which are broad and make these policies difficult to enforce.

There is limited data on migration, size and structure due to lack of capacity and funding. This makes it difficult to assess populations of all species and develop appropriate management strategies and polices.

RESPONSE

- National legislation (FSM Resolution (C.R. NO. 17–110)) was implemented in 2015 to declare the entirety of the FSM's 200-mile EEZ a marine sanctuary for sharks, rays, dolphins and whales. The shark sanctuary covers nearly three million square kilometres (1.1 million square miles) in the western Pacific Ocean. This is part of the wider Micronesia regional shark sanctuary, the first of its kind in the world, which covers 6.5 million km^2 and comprises the waters of the FSM, Palau, CNMI, Marshall Islands and Guam.
- Public Law NO. 18–108 bans the taking of sharks within FSM waters "to prohibit the practice of shark finning and extend civil penalties to apply to such violations, by modifying what is considered as destruction of evidence, and for other purposes".
- Yap Act to provide for the protection of sharks, whales and dolphins (YSL 8–44). Kosrae shark sanctuary bill voted in 2012 strictly prohibits any commercial shark fishing within Kosrae waters, and also ban the sale, possession or trade of shark products on the island. Pohnpei followed suit in 2013 and passed a similar shark sanctuary law. In 2014, Chuuk passed legislation that bans shark fishing in its waters.
- FSM is signatory to the *Memorandum of Understanding for the Conservation of Cetaceans and their Habitats in the Pacific Islands Region* (12 September 2006), concluded under the auspices of the Convention on Migratory Species (CMS) in partnership with the Pacific Regional Environment Programme (SPREP). The MOU covers all populations of cetaceans in the Pacific islands region and '*aims to achieve and maintain a favourable conservation status for all cetaceans and their habitats occurring in the region*'.
- Yap *Manta Ray Sanctuary and Protection Act* of 2008 (YSL No 7–36). The Act recognises the critical value of mantas as a tourism attraction while acknowledging the exceptional abundance of this taxon as 'a rarity of nature'. This lead to the development of a Yap Manta Ray Sanctuary Conservation Action Plan in 2009. Yap State Law 7–36 Statement of findings states that there is a network of cleaning stations, sufficient plankton density, and pollution free environment that supports a population of manta ray in Yap. Both anthropogenic and natural threats have been an area of study to gain more information and assist species management.
- 26 PC 5–124. Establishment of Kisin nahmw en Nangih Stingray Sanctuary and Nahmwen Na Stingray Sanctuary. The purpose of the Kisin nahmw en Nangih Stingray Sanctuary shall be to preserve and protect the ecologically significant areas used by species of rays (Order Myliobatidiformes) in the waters of Pohnpei. The areas surrounding Kisin nahmw en Nangih and Nahmwen Na serve as sites for the aggregation and feeding of these species of rays and are of significant economic and cultural importance to the people of

Pohnpei. Protection of these sites is necessary to ensure the protection of these species and for the enhancement of the economic and cultural well-being of the people of Pohnpei. Prohibit the taking or harming of any species of ray (*Order Myliobatidiformes*) within the boundaries of the Sanctuary.

- In January 2015, the Yap State Environmental Protection Agency passed regulations to ensure the sustainable harvest of sea turtles (Reg No 2014–5). Note that the sea turtles may only be caught in season, and the turtle harvest season is from September through February. There is a catch limit of one turtle per boat per week. Turtle eggs and turtles on shore may not be disturbed at any time. Hawksbill and leatherback turtles must not be hunted at any time. Captured Olive Ridley Turtles must have a shell length of greater than 25 inches. Captured green turtles must have a shell length of greater than 40 inches. It is illegal to export or sell any turtles, turtle meat, or turtle eggs. To keep the population aware of the seasonal hunting, YAP EPA regularly puts out radio announcements for the opening and closing of turtle hunting season.
- Pohnpei State law also established a seasonal ban on turtles. No sea turtle of any size shall be taken or killed from 1 June to 31 August, nor from 1 December to 31 January.

RECOMMENDATIONS

- Develop monitoring program for species of interest.
- Provide training and tools for observers on pelagic fishing vessels to correctly identify pelagic manta rays, Mobula spp. and migrating reef manta rays in the bycatch.
- Increased resources allocated to research and identify a direct reporting agency for citizens to report and document encounters.
- Improve sharing of databases between agencies.
- Creation of national database which identifies all resources across the islands. Each state has their own database to enter data and upload to a national database, and all would be connected.

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This section was compiled by Julie Hartup (contact detail: mccjuliehartup@gmail.com)

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Weno Harbor with Tonaachau in the background, Chuuk. Photo: Ashley Meredith, KIRMA

OVERVIEW

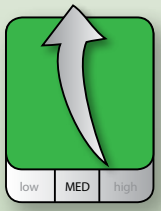
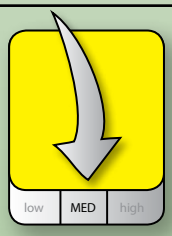
Biodiversity in the FSM "*is an intrinsic part of the country's many traditional cultures and practices, and is the foundation for a secure, sustainable and economically independent future. Biodiversity in the FSM is rich and abundant with high levels of endemism, and is a recognized part of the globally important Polynesia-Micronesia biodiversity hotspot. Biodiversity hotspots are not only biologically rich but also threatened, usually containing at least 1,500 endemic plant species and having lost at least 70% of their original surface area. In the FSM, species richness declines from east to west across the FSM, with increasing distance from landmasses"* (NBSAP 2018).

The FSM is characterised by two terrestrial and one marine ecoregion. The terrestrial ecoregions are comprised of the Yap Islands State ecoregion and the Islands of Yap, Chuuk, Pohnpei and Kosrae ecoregion (NBSAP 2018). The FSM is a Tropical Coral ecoregion, containing some of the largest coral atoll complexes in the world (WWF 2018).

The Government of FSM signed and ratified the Convention on Biological Diversity (CBD) in 1992 and became a Party to the CBD in 1994. The principal instrument for implementing the CBD at the national level is the NBSAP. The first FSM NBSAP was developed in 2002 and updated in 2018. The plan addresses the current state of the biodiversity, threats and actions to address the identified threats. The FSM's NBSAP comprises a nationwide vision, guiding principles and strategy action plans to address biodiversity challenges and opportunities in the country. Based on the NBSAP vision, the '*FSM will have more extensive, diverse, and higher quality of marine, freshwater, and terrestrial ecosystems, which meet human needs and aspirations fairly, preserve and utilize traditional knowledge and practices, and fulfil the ecosystem functions necessary for all life on Earth*' (NBSAP 2002 and 2018).

Jez O'Hare

BIODIVERSITY HIGHLIGHTS

TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
ENDEMIC, THREATENED AND NATIVE SPECIES	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium	The FSM is a country of incredible and unique biodiversity, and the importance of this biodiversity cannot be overstated. The FSM is a hotspot for endemic plants. Most of the endemic species are threatened.	• The FSM has in place numerous national and state level policies to protect endemic species. To better manage them the FSM needs to establish a list • of priority species that require further protection, increase research and • data collection on priority species, develop and enforce recovery plans for priority species and establish and enforce protected areas for these species.
INVASIVE SPECIES UNDER MANAGEMENT OR ERADICATED	 **Status** Good **Trend** Improving **Data confidence** Medium	Numerous invasive species can be found throughout the FSM with serious impacts on ecosystems and their services. There is limited capacity to eradicate or manage all invasive species.	• There are both national and state level efforts aimed at eradicating certain invasive species with moderate success. There are biosecurity measures at all ports. All efforts would benefit from increased funding, capacity and a more unified effort.
TERRESTRIAL PROTECTED AREAS	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium	Approximately 15% of the FSM's land mass is in terrestrial protected areas. Many of these areas are poorly managed and not enforced.	• Existing areas need to be declared under the new state PAN laws so they can access funding to be better managed and enforced. The blueprint should be used to guide establishment of new protected areas.

ENDEMIC, THREATENED AND NATIVE SPECIES

INTRODUCTION

Biodiversity in the FSM is crucial for the well-being of its people, who rely on the great variety of endemic and native species for subsistence, revenue, traditional medicine and persistence of customs and traditions. Loss of biodiversity is generally associated with economic loss and has the potential to severely harm traditional knowledge and their transfer to future generations. Many native and endemic species are used in various aspects of daily living and for years traditional knowledge, practices and modes of resource management have protected and conserved the FSM's biodiversity. The biodiversity contributes to the household subsistence activities as well as its income, hence contributing to the country's economy. It has been estimated that FSM's biodiversity contributes to 8% of household income in Pohnpei, 9% in Kosrae, 26% in Chuuk and 29% in Yap (NBSAP 2018). This indicator assesses the number and status of endemic, threatened and native species across the FSM.

Status
Fair

Trend
Deteriorating

Data confidence
Medium

SDG	CBD
15 LIFE ON LAND	12

TABLE 32. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Deteriorating	Deteriorating	Deteriorating	Deteriorating
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND TRENDS

Compared to the available land mass and the geography of the nation, the FSM presents high endemism. Endemic[12] plants, marine, reptile and mammal species are found across the four states and the level of endemism is considered to increase from east to west, with increasing distance from landmasses (NBSAP 2018).

The level of endemism in the FSM is based on the identified species, but it is recognized that several species have not been identified yet, hence future assessments can increase the total number of endemic species. For instance, a new species of freshwater shrimp was recently discovered in Pohnpei (Mazancourt et al. 2018), a freshwater goby *Lentipes caroline* was identified in Pohnpei rivers in 2012 (Lynch 2013), while blind snakes in the genus *Ramphotyphlops* were described for Ulithi and Ant atoll in 2012 (Wynn et al. 2012). This highlights the need for an extensive species identification assessment in the

12 Any species that occurs naturally in an area (native) and whose range is restricted to a particular geographical region. Highly endemic species, those with very restricted natural ranges, are especially vulnerable to extinction if their natural habitat is loss or significantly disturbed (IUCN, 2018).

FSM, as well as proper management of natural resources to reduce habitat fragmentation or loss that is generally accompanied by species loss.

There are a number of marine and terrestrial species in the FSM that are threatened to varying degrees. The International Union for Conservation of Nature (IUCN) identifies 325 species as being threatened to varying degrees or, in some cases, extinct. In the context of the IUCN Red List, a taxon is classified as 'Endangered' when there is very high risk of extinction in the wild in the immediate future (IUCN 2001). The IUCN Red List identifies 26 endangered and critically endangered species for the FSM (Figure 62).

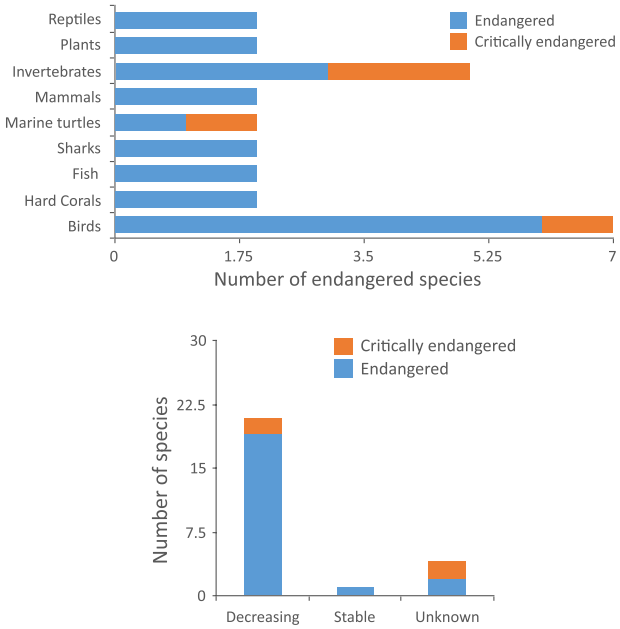


FIGURE 62. ABOVE: Status of endangered and critically endangered species in the FSM. BELOW: number of different endangered and critically endangered species in the FSM (NBSAP 2018).

Overall there are 128 native birds in Micronesia with 22 endemic species and 12 globally threatened species (Figure 63; NBSAP 2018). Much of the Yap Islands State ecoregion is open savanna with secondary tropical dry forest that contains three endemic bird species (Yap monarch – *Monarcha godeffroyi* –and two species of white-eye) and endemic plants. In Chuuk there are three endemic bird species: the Truk white-eye (*Rukia ruki*), the Truk monarch (*Metabolus rugensis*), both considered to be endangered, and the oceanic fly catcher (*Myiagra oceanica*). The high island of Pohnpei, with its native forest, is home for seven endemic species: the Pohnpei Kingfisher (*Todiramphus reichenbachii*, vulnerable), the Pohnpei Lorikeet (*Trichoglossus rubiginosus*, near threatened), the Pohnpei Fantail (*Rhipidura kubaryi*), the Pohnpei Flycatcher (*Myiagra pluto*), the long-billed white-eye (*Rukia longirostra*, near threatened), the Pohnpei white-eye (*Zosterops ponapensis*) and the Pohnpei starling (*Aplonis pelzelni*, critically endangered) (NBSAP 2018).

Similarly, Kosrae's native rainforest is home for two endemic birds: Kosrae fruit dove (*Ptilinopus hernsheimi*) and the Kosrae white-eye (*Zosterops cinereus*). In Kosrae loss of endemism occurred with the extinction of three species: the Kosrae Crake, Kosrae starling and the Mangareva Reed-warbler (Figure 63).

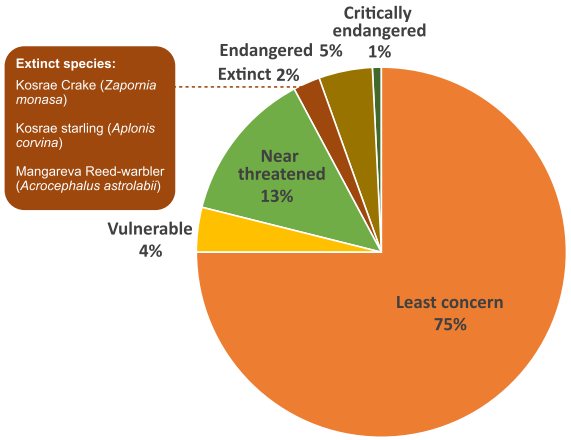


FIGURE 63. Percentage of vulnerable, near threatened, endangered and critically endangered birds in the FSM on 128 bird species classified from the IUCN Red List by Birdlife International (Birdlife International 2018).

Native mammal species in FSM are fruit bats of the genus *Pteropus* spp. and a sheath-tailed bat of the genus *Emballonura spp.* Of these, three species of fruit bats and the sheath-tailed bat are known to be endemic to the FSM, all four of which are considered to be threatened (NBSAP 2018). Other mammals listed by IUCN are introduced species: the Polynesian rat and the Philippine Deer (NBSAP 2018).

Fish endemism in the FSM accounts for six marine fish species over the 1,221 fish species recorded in the FSM waters, including the chronixis surgeonfish (*Acanthurus chronixis*) and the Caroline anchovy (*Stolephorus multibranchus*; NBSAP 2018). Most of the marine fish species recorded in the FSM are associated with extensive coral reef systems. Of the 64 freshwater fish identified in the FSM, four are endemic (NBSAP 2018).

The IUCN lists 139 marine invertebrate species for the waters around the FSM, including three species of sea cucumber that are considered endangered and four that are considered vulnerable, one vulnerable species of cockle and three conservation-dependent clam species (NBSAP 2018). In addition, of the 472 coral species identified in the FSM's waters, 100 are considered to be vulnerable and three endangered (NBSAP 2018). Among the terrestrial invertebrates, the Pohnpei tree snail (*Partula emersoni*) and the Pohnpei ground Partula snail (*Partula gaumensis*) are considered critically endangered (IUCN 2018).

The differences in ecoregion and the high degree of forest cover in the FSM are the drivers for the rich plant diversity that characterize the country. In the FSM 782 species of fern and flowering plant are described as native, while more than 457 species are introduced (NBSAP 2018). Some of these

introduced plant species became invasive and are currently threatening biodiversity. As reported by the FSM's NBSAP (2018), '*estimates of the number of plant species in the FSM remain based upon geographical checklists created in the 1970s and 1980s (Fosberg et al. 1979, 1982, and 1987), although the need for more recent data has been partly addressed through the 2010 checklist of vascular plants in Pohnpei State. This identified 935 native and non-native species and infraspecies, comprising 345 indigenous species, 52 endemic species, 360 cultivated species and 178 naturalized species. Seventeen of the 178 naturalized species are considered to be extremely aggressive and invasive (Herrera et al. 2010).*'

There are 110 species of endemic plants identified in the FSM with 15.7% endemism (species per km^2), which is higher than any other island biodiversity hotspot (NBSAP 2018). The highest plant endemism is found in Pohnpei (16%), followed by Kosrae (14%) and Chuuk (13%), while Yap presents the lowest level of plant endemism (8%) (NBSAP 2018).

There are several species of concern, which are important for the ecological role they play in maintaining ecosystems functioning, or for their cultural value. Key species of concern are both identified for marine and terrestrial environments and are defined as: "species endangered and at being at risk of being lost in a State or nationwide". Among them is the Pohnpei Mountain Starling, *Aplonis pelzelni*, that has shown a steady decrease in population and it is now estimated at being between only one and 49 individuals (NBSAP 2018). Of similar concern are some of the sea turtles living and nesting in the FSM. The Hawksbill Turtle is listed by the IUCN Red list as critically endangered, and protection of this turtle species is crucial for their survival. At the moment the FSM states have in place regulations for seasonal harvesting of turtle eggs or harvesting of adults for subsistence. However, control on species harvested and enforcement of regulations is weak.

Among the species of concern are some of the flying fox species, which have showed signs of decline due to overharvesting and habitat loss. For instance, in Yap harvesting of the flying fox was culturally regulated, with species harvested for subsistence (Falanruw 1988). However, towards the end of the 1970s, requests for export from Yap to Guam and Saipan grew, adding a dollar value to this species and consequently increasing the harvesting rate (Falanruw 1988). As a consequence of the increased harvesting pressure on the Yap flying fox populations, Yap state has put in place regulations for its protection and conservation. Flying fox species play a key role in the dispersion of seeds, helping to maintain native vegetation. Declines of this keystone species may have consequences for the survival of some of the native and endemic plants. In Kosrae, flying fox species are affected by habitat fragmentation and dislocation from their nesting sites. The Kosrae government is considering options to protect this keystone species, including the establishment of a sanctuary. In addition, flying fox populations in the outer islands (e.g. *Pteropus mariannus ulthiensis* endemic to Ulithi Atoll and one of six subspecies of *P. mariannus* recognized in Micronesia) are easy targets for hunting and a full assessment is needed to recommend appropriate management and conservation actions (Wiles et al. 1991).

IMPACT

Endemic and native species, important to FSM's biodiversity, are an intrinsic part of the many traditional cultures and practices, and are the basis for a secure, sustainable and economically independent future. A number of priority areas for economic development have been identified by the national government, including agriculture, fisheries, renewable energy and tourism (FSM Office of Budget & Economic Management 2017). Healthy biodiversity is crucial to the success of each of these priority areas, ensuring longterm food and nutrition security and economic opportunities in the face of ongoing threats to biodiversity.

The FSM's native species have evolved together and have developed interdependent relationships to help them adapt to each islands' physical conditions. The loss of certain groups will have impacts on the ecological health of the FSM's unique ecosystems.

RESPONSE

- There are several laws and regulations for protecting endemic and threatened species in all four states.
- The FSM is a signatory of the Convention of Biodiversity Aichi targets.
- All four states have resource management committees (RMCs) of some form. Formalize RMCs in all the states with funding support to help implement policy, plans and relevant resource management recommendations that come from the RMCs.
- *A Blueprint for Conserving the Biodiversity of the Federated States of Micronesia* was published in 2003. This document details the ecoregional plan developed by The Nature Conservancy in concert with experts and government and conservation agencies. Described in detail in the section above, this contributes to the implementation of the NBSAP strategic goal to protect and conserve a full representation of the FSM's marine, freshwater and terrestrial ecosystems by putting forward 24 priority areas for immediate conservation (NBSAP 2018).
- Declaration of areas of high importance for biodiversity as UNESCO biospheres. Kosrae was declared a biosphere reserve under the United Nations Educational, Scientific and Cultural Organization (UNESCO) biosphere reserves program, which is designed to

identify sites that support both biodiversity conservation and sustainable use. This was followed by the declaration of And Atoll, Pohnpei as a biosphere reserve in 2007 (UNESCO 2011).

- Nationwide Climate Change Policy was enacted in 2009, with two biodiversity-specific goals; the need to use ecosystem-based approaches to climate change adaptation where applicable, and the encouragement and strengthening of traditional knowledge application to conservation practices, also for the purposes of adaptation (FSM 2009).
- The Pohnpei Watershed Forest Reserve, established under the Watershed Forest and Mangrove Protection Act of 1987, aimed to protect the integrity of the island's watershed on public trust lands and conserve the biodiversity both in the watershed forest and mangrove forests (NBSAP 2018)
- Two Endemic Bird Areas (EBA) (Yap Islands and East Caroline Islands) and 10 Important Bird Areas (IBA) have been designated by BirdLife International. These biodiversity areas are designed to ensure the survival of viable populations of the world's threatened bird species.
- The Ridge to Reef program was launched across the Pacific in 2016 under the Global Environment Facility. This program, adopted by the FSM, seeks to ensure biodiversity protection and conservation is undertaken in a way that is integrated with sustainable land use and management. The 'ridge to reef' concept reflects the intrinsic links between the health of terrestrial and marine ecosystems, and the need to maintain essential ecosystem services to sustain livelihoods. The program supports the growing number of designated protected areas across the FSM (NBSAP 2018).
- The EIA protocol in the four states has mitigation measures to safeguard biodiversity, but implementation of EIA recommendations and control need to be more efficient.

RECOMMENDATIONS

During the recent development of the second FSM's NBSAP (2018) several recommendations have been identified. Below are the main strategy goals of conserving biodiversity that were identified by the NBSAP. A full list of recommendations and actions for implementation is available in the National Biodiversity Strategy Action Plan 2018.

- Strategy Goal 1: A full representation of the FSM's marine, freshwater and terrestrial ecosystems are protected, conserved and sustainably managed, including selected areas designated for total protection.
- Strategy Goal 2: The FSM's native, endemic, and traditionally important species are protected and used sustainably, and its threatened species protected, for the benefit of the people of the FSM and the global community.
- Strategy Goal 3: The FSM's genetic resources are accessible for use and all benefits derived are equitably shared amongst the stakeholders.
- Strategy Goal 4: The conservation and sustainable use of agrobiodiversity contributes to the nation's development and the future food security of the FSM.
- Strategy Goal 5: Economic development activities in the FSM meet the needs of the population while sustaining resources for the benefit of future generations.
- Strategy Goal 6: Border control, quarantine and eradication programs are effectively protecting the FSM's native biodiversity from the impacts of alien invasive species.
- Strategy Goal 7: All human-generated wastes are effectively managed to prevent or minimize environmental degradation, pollution and loss of the nation's biodiversity.
- Strategy Goal 8: All citizens, residents and institutions of the nation are aware of the importance of biodiversity and have the technical knowledge, skills and capability to conserve, preserve and sustainably use, manage and develop all biodiversity within the nation.
- Strategy Goal 9: Traditional resource owners and communities are fully involved in the protection, conservation, preservation and sustainable use of the nation's biodiversity.
- Strategy Goal 10: All economic and social activities of the FSM take full account of impacts on and fully consider sustainability of biodiversity.
- Strategy Goal 11: Local, regional and international financial sources provide for the longterm financial sustainability of all conservation and biodiversity-related activities.

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INVASIVE ALIEN SPECIES UNDER MANAGEMENT OR ERADICATED

INTRODUCTION

In addition to the ongoing pressures brought about by climate change, biodiversity in the FSM faces a number of other threats, including the negative impacts of invasive species. The Guidelines for Invasive Species Management in the Pacific defines invasive species as "*introduced species that become destructive to the environment or human interests; can also include some native species that proliferate and become destructive following environmental changes caused by human activities*" (Tye 2009). The indicator assessment is based on the status and trend of established invasive species within the FSM and the efforts undertaken to control invasive species.

Status
Good

Trend
Improving

Data confidence
Medium

SDG	CBD
15 LIFE ON LAND	9

TABLE 33. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Good	Poor	Fair	Fair
Trend	Improving	Deteriorating	Mixed	Mixed
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND TRENDS

The Global Register of Introduced and Invasive Species, developed by the Invasive Species Specialist Group to address Aichi Target 9, contains 592 entries for alien species in the FSM. The majority of these are plants (526 species), followed by 62 animal species and one fungus, with a small number of bacteria and virus species (GRIIS 2018). Seventeen of the 178 naturalized plant species in the FSM are considered to be extremely aggressive and invasive (Herrera et al. 2010).

Small islands are particularly vulnerable to the impacts of alien and invasive species, since with distance from the continent ecosystems tend to have fewer species that reduce their resilience to invasion (SPREP 2015). The impact of invasive species translates to impacts on human well-being, since invasive species can reduce the ability of ecosystems to provide the array of goods and services that many people rely on. Pathways of entry of invasive species into the FSM are the air and shipping services.

The Yap Invasive Species Taskforce (YIST), through its strategic action plan 2009–2012, identified 10 invasive plant species that are threatening Yap biodiversity. Among these 10 species, four were selected for eradication because of their relatively recent introductions to Yap and limited range of diffusion on the island: Cogon Grass (*Imperata cylindrica*), Chain-of-Love (*Antigonon leptopus*), African Tulip (*Spathodea campanulata*), Mile-A-Minute Vine (*Mikania micrantha*). The other six species were: Paper Rose (*Operculina ventricosa*), Bronze-Leafed Clerodendum (*Clerodendrum quadriloculare*), Pennesetum (*Pennisetum polystachion*), Merremia (*Merremia peltata*), Wedelia (*Wedelia trilobata*), Giant Sensitive Plant (*Mimosa invisa*).

In Chuuk, 15 species, the majority plants, are classified as 'invasive' based on evidence of impact or record of aggressive spread in the natural environment. The assessment conducted by Space in 2000 identified 10 species that are invasive or potentially invasive in Chuuk and eight native species that exhibited aggressive behaviour, including *Merremia peltata* that exhibit an invasive behaviour in any place there is disturbance. Among these species are African tulip (*Spathodea companulata*), Honolulu rose (*Clerodendron chinensis*), and sensitive plant (*Mimosa pudica*; Space 2000). Eradication, control and management of the spread of priority invasive plant species – African tulip tree, Honolulu Rose and sensitive plant – are conducted in Chuuk. In both Yap and Chuuk, the recent FIA survey conducted in 2017 indicated the Bronze-Leafed Clerodendum (*Clerodendrum quadriloculare*) as the invasive species most common in the FIA plots. This plant is known to invade intact or relatively intact forests.

In Pohnpei, since 2000, the invasive Species Taskforce Of Pohnpei (iSTOP), has controlled several invasive weeds targeting species as the Ivy Gourd, Chain of Love, Mile a Minute, False Sakau (*Piper auritum*) and Honolulu Rose. Through these efforts the Ivy gourd was successfully eradicated, while the other species are under continuous management and are now reduced to less than 10% of their original coverage area. In 2010, iSTOP reviewed the list of invasive species for eradication, including five additional species: Octopus Tree, Bengal Trumpet, Lolo pepper, Tree sparrow, and the Feral Pigeon.

In Kosrae, 16 invasive species, the majority plants, present evidence of impact or have spread aggressively into the natural environment affecting other species. Among these invasive species are the Giant African snail (*Achatina fulica*), crown of thorns starfish (*Acanthaster planci*) and several invasive plant species that are a priority for management action, including eradication, such as Mile-a-minute (*Mikania micrantha*), firecracker bush (*Clerodendron inerme*), *Lucanea* spp., Siam weed (*Chromoleana odorata*), *Vigna marina, and Wedelia trilobata* (Josekutty et al. 2002). In 2018, Kosrae has seen a new outbreak of crown of thorns starfish and the level of damage is expected to be extensive. The Kosrae Invasive Species Taskforce (KIST) action plan has a strong emphasis on awareness education to prevent the introduction of other alien species in the State. In addition, mammal invasive species (*Rattus* spp.) have been implicated in the extinction of two endemic bird species, the Kosrae starling (*Aplonis corvina*) and the Kosrae crake (*Zapornia monasa*).

Rats (*Rattus rattus, R. exulans, R. norvegicus*), together with the introduced flatworm *Platydemus manokwari*, are main threats also for critically endangered molluscs (*Partula emersoni, Partula guamensis* and *Partula martensiana*; Pagad 2015). On the UNESCO Biosphere Reserve of And Atoll (Pohnpei), a number of species including the Caroline Islands ground dove are threatened by invasive species such as cats and rats, while native species on Ulithi Atoll (Yap State) face threats from pigs, house rats (*Rattus tanezumi*) and the mangrove monitor lizards (*Varanus indicus*; NBSAP 2018). Successful programmes eradicated in 2007 the Polynesian rat (*Rattus exulans*) from the small island of Dekehtik, and the black rat (Rattus rattus) from the islands of Nahnkapw and Pein Mal, all located off Pohnpei (NBSAP 2018).

Caroline Islands ground dove, *Alopecoenas kubaryi,* endemic to Chuuk (Photo: Tony Morris).

Other species recognized as invasive in the FSM are *Rhinella marinus* (cane toad), *Felis catus* (feral cat), *Canis lupus* (dog) and *Sus scrofa* (pig). Pigs are an example of an introduced species that is extremely damaging to the natural environment, but that is also highly valued as a source of food and prestige. Effective management of this species (e.g. pig pens, dry-litter piggeries) has helped reduce the damage to native plants and island birds (SPREP 2009) as well as pollution of rivers. Furthermore, several other alien species established in the region can potentially arrive in the FSM and spread [e.g. Brown tree snake (*Boiga irregularis*) and melon fly (*Bractocera cucurbitae*)]. Indeed, some invasive species have recently arrived in Yap (in 2017 the little fire ant- *Wasmannia auropunctata*) and Kosrae (approximately from 2013 the coconut rhinoceros beetle- *Oryctes rhinoceros*) and other FSM states are at risk of introduction. These recent records of invasive species highlight the need for strengthening enforcement of biosecurity measures.

Invasive coconut leaf beetle.
(Photo: Conservation Society of Pohnpei).

IMPACT

Invasive species are a major threat to biodiversity loss. Invasive species can outcompete and replace native and endemic species and reduce the health and productivity of an ecosystem while altering its flow of services e.g. (1) weakening of social structures when invasive species have an impact on products used for traditional festivities; (2) loss of economic revenue when invasive species have an impact on sectors such as agriculture or fishery. Impacts from invasive species can also result in a loss of opportunities for future sustainable development of the ecosystems e.g. ecotourism, agroforestry.

RESPONSE

- Establishment of Regional, National and State level invasive species task forces.
- Formalized task forces in the states of Pohnpei (Invasive Species Taskforce of Pohnpei -iSTOP), Yap (Yap Invasive Species Taskforce- YIST) and Kosrae (Kosrae Invasive Species Taskforce- KIST).
- FSM Biosecurity Law-Public Law 16–68 (Title 22 of the FSM Code).
- Regional Micronesia Biosecurity Plan (MBP).

RECOMMENDATIONS

- Strengthen enforcement and increase capacity of border control and quarantine control.
- Develop and use standard protocols for eradication measures.
- Formalize the State IAS groups and promote access to sustainable longterm funds for the monitoring of invasive species.
- With regards to invasive species RISC have developed plans and strategies implemented by the states' invasive species task forces. However, there is a lack of proper legislation to address the invasive species problem. There is a need to develop state laws that complement the National Biosecurity Law, and to cover invasive species already established in the four states.

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TERRESTRIAL PROTECTED AREAS

INTRODUCTION

Terrestrial Protected Areas are clearly delineated areas of land or mangroves set aside for conservation. As mentioned in the section on MPAs, across the FSM, government, NGO and community partners have worked closely together (through participatory processes and consultation) to establish state, municipal, and community legislated and/or traditionally declared protected areas covering a wide range of habitats. This indicator describes the status of the FSM's current and proposed terrestrial protected areas, including their management plans and the percentage of ecosystem types protected.

Status
Fair

Trend
Deteriorating

Data confidence
Medium

TABLE 34. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Fair	Fair
Trend	Deteriorating	Deteriorating	Deteriorating	Mixed
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND TRENDS

At least 17% of FSM's land mass is in terrestrial protected areas and 27% of its mangrove forests. Each state has at least one terrestrial protected site implemented through the US Forest Service Forest Stewardship Program (FSP), which helps connect private landowners with the information and tools they need to manage their forest and woodlands. Through the FSP, a plan is developed to identify goals for the land and the management activities needed to meet them.

Other key terrestrial protected areas in the FSM were identified as Areas of Biodiversity Significance through the Blueprint for Conserving the Biodiversity undertaken in 2002. Terrestrial habitat sites struggled to meet all the criteria for ABS because of their smallness and the direct impact of human actions. A need for restoration of terrestrial habitats was identified, in order for terrestrial sites to meet the minimum target for these systems to assure their functionality and viability. In some cases, limited distribution and viability data on species conservation target populations prevented the teams from identifying enough occurrences to meet the goals (Blueprint 2002). The second round of gap analysis and spatial prioritization analysis carried out in the FSM mostly focused on marine habitat because of the lack of terrestrial data. Many species conservation targets will require further biological monitoring to determine their spatial distribution, population, and overall viability.

The number and status of terrestrial protected areas differ from state to state. In Chuuk only 13% of terrestrial resources are protected. While numerous sites were identified as ABS through the blueprint process, most are not under any type of management. Most of the sites are on private land with limited access and therefore face minimal direct threats from human activities. A forest stewardship area was recently declared on Fefan though the FSP process. There are plans to complete a watershed management plan for the municipality of Oneisomw, which will include identification of protected areas.

In Yap one per cent of terrestrial habitat is protected. The ABS sites are owned and managed under the traditional tenure system, private and community based. Only some communities have progressed to designate areas for protection and conservation. The Weloy Forest Stewardship Conservation Area is a terrestrial protected area that has been declared by the Weloy Municipality as part of the FSP carried out by the Micronesia Conservation Trust, Yap Community Action Program and US Forestry Service. Recognizing the importance of protecting and managing Yap's unique habitats from ridge to reef, the area was designated by the community and linked to the Nimpal Channel Marine Conservation Area and the Maa Mangrove Sanctuary, all located in the same municipality. The Tamil Watershed Managed Areas was also recently declared.

About 22% of Pohnpei's terrestrial habitat is considered protected. In 1987, the Watershed Forest Reserve was enacted to protect Pohnpei's upland watershed, which is public land. The reserve is still not demarcated in the municipalities of Kitti and Nett, and while the area is monitored, enforcement is limited. A site on private land, Nanwelin Rohi, was declared through the FSP process. There are several mangrove areas identified as ABS and declared as community managed areas. These include Einpein, Pwodi and Senpehn/Lehdau. There are currently two proposed sites in the municipality of Sokehs.

Twenty per cent of Kosrae's terrestrial land is protected. The Japanese Line demarcates the upland watershed, which is public land. A recent law returned some of this land to people who demonstrated that it once belonged to their family. Although there is no formal enforcement or management, the land above the Japanese Line, Kosrae residents consider the area managed because of inaccessibility and KIRMA's mandate, Title 19, which governs the use of natural and historic resources such as 100 feet buffer on each side of major rivers and no earth moving activities on slopes greater than 30 percent. As part of Title 19, the the Protected Areas Act of 2010 offers provisions for formally protecting natural and historic resources. For example, on June 6, 2018, KSL 11–156 was passed which inscribed the Mahkontowe Conservation Area (MCA) to Kosrae's Protected Areas Act of 2010. It is 15 square kilometers of Kosrae's interior land. This conservation area protects Kosrae's major watersheds, rivers, a significant portion of the ABS, as well as historic sites and landscapes. Other sites include the Olem watershed in Malem and several mangrove sites including Okat, Owane and Utwe Biosphere Reserve. The Yela forest reserve was the first site declared through the FSP in the region. It is also the first forest legacy/easement in the Pacific.

TABLE 35. Surface area of Protected Areas in FSM

State	PA surface area (km²)	Percentage PAs1 in the context of the MC
Yap	1.4	1%
Chuuk	16	13%
Pohnpei	83	22%
Kosrae	21	22%

IMPACT

The purpose of protected areas is to exclude impacts from humans in order to allow ecosystems to recover or remain intact, and facilitate cultural conservation through environmental conservation and protection. Without the environments, locals face challenges of practicing their culture. Protected areas help prevent the loss of biodiversity, replenish species populations and encourage landowners to take better care of their land. To achieve these goals protected areas must be well designed and effectively managed. Challenges to effective PA management include invasive species, poaching, enforcement and limited data. On most of the islands land is privately owned and the land parcels are small and becoming smaller. With increasing population and development projects that need to be implemented, it is becoming difficult to establish new terrestrial protected areas.

RESPONSE

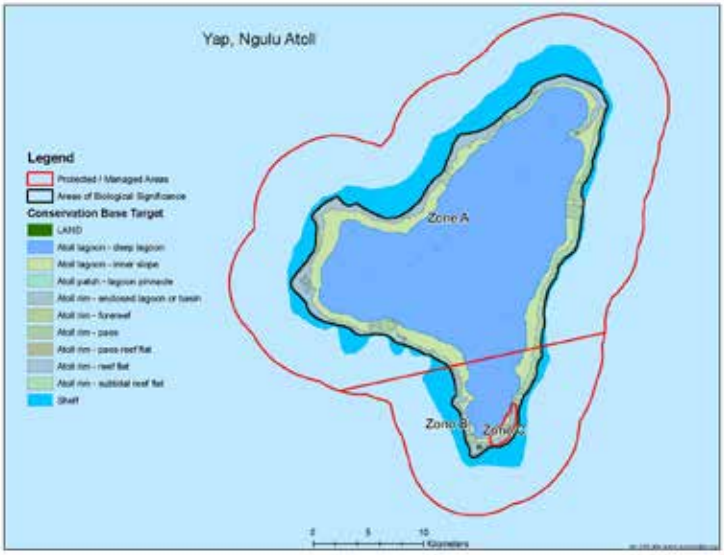
As mentioned above, the FSM national, state and municipal governments, NGOs and communities united by the MC have worked together to establish protected areas. In September 2018, the national government of the FSM endorsed the National Protected Areas Network Policy Framework (NPANPF), developed in 2015 in cooperation with a number of local partners. The NPANPF 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 Yap, Chuuk, Pohnpei and Kosrae. This national 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 national network, including access to longterm and sustained technical and financial assistance.

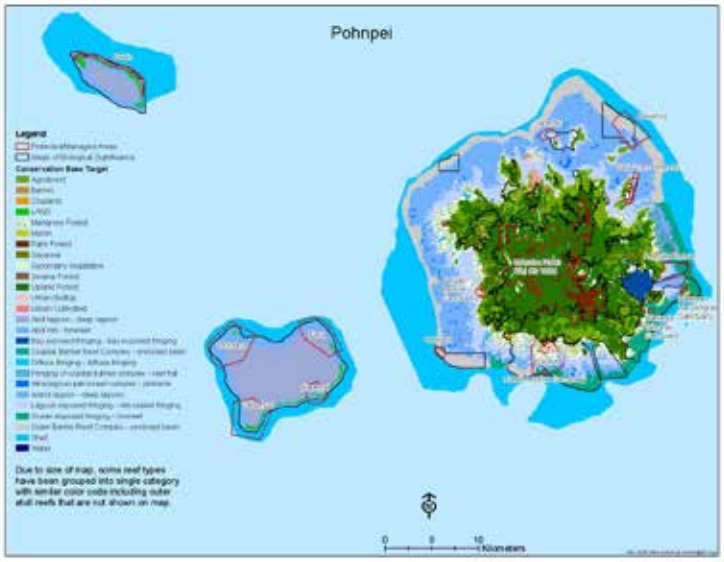
RECOMMENDATIONS

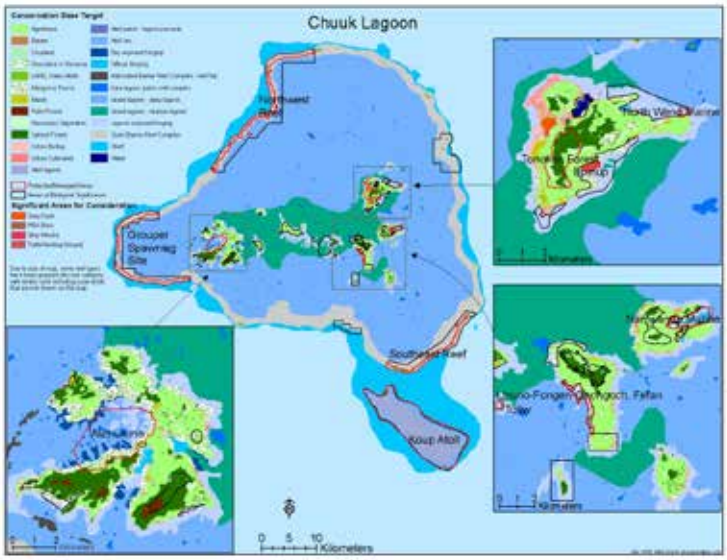
- Complete the legal demarcation of protected areas.
- Improved local knowledge with youth to increased awareness and education on importance of terrestrial areas and their existence.
- Improved enforcement.
- Revise technical assessment (including spatial assessment, gap analysis) for protected areas to create a network.
- Update the blueprint for the FSM.
- EIA for all activities happening on land.

SOURCES

Data for this section was gathered through stakeholder consultations.



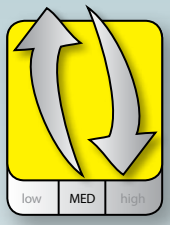
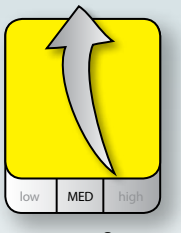
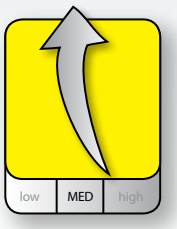




OVERVIEW

The highly dispersed geography of the FSM increases the complexity in managing and supply of energy, water and sanitation. Management of solid waste has improved over the years, due to the proper management of public disposal sites. Also, with great initiatives of EPAs and KIRMA, 3R activities such as beverage container recycling and prohibition of plastic bags have been introduced. Challenges remain in the provision of regular collection services especially by smaller municipalities with limited finances. Sewage management is still underdeveloped across the states and require efforts to improve current conditions.

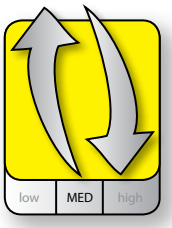
BUILT ENVIRONMENT HIGHLIGHTS

TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
ENERGY	 **Status** Fair **Trend** Mixed **Data confidence** Medium	Almost 99% of energy produced in the FSM comes from imported fuel with the remaining 1% from renewable energy. Percentage of households with access to electricity varies from state to state. The FSM's 2010 National Energy Policy sets a vision to improve the life and livelihood of all citizens with affordable, reliable and environmentally sound energy.	• To set up a fund to address the removal of 'energy' waste (LEDs, solar panels, batteries). • Assess tax levy and other economic mechanisms (e.g. subsides) on importation of batteries, etc. • Energy master plans for each state.
WASTE MANAGEMENT	 **Status** Fair **Trend** Improving **Data confidence** Medium	Public final disposal sites are managed by the public sector in Yap, Chuuk and Kosrae, and by a private company in Pohnpei. Also, 3R activities such as beverage container recycling and prohibition of plastic bags have been introduced in some states. Challenges remain in provision of regular collection services especially by smaller municipalities with limited finances.	• Improve solid waste collection and disposal especially in rural areas. • Sustainable financing for supporting the collection and disposal of solid waste.
WATER AND SANITATION	 **Status** Fair **Trend** Improving **Data confidence** Medium	In the four states, supply of freshwater differs greatly and is determined by the characteristics of rainfall, storage capacity, and infrastructure development. With numerous households, especially in the outer islands, relying on private sources of water, it is difficult to routinely monitor and test these sources and therefore ensure access to clean water.	• Support regular testing of both government and private water systems through increased funding and training. For example, the use of portable systems for water testing. • Enforce disinfection procedures. • Centralization of water system, particularly for outer islands.

ENERGY CONSUMPTION

INTRODUCTION

This indicator looks at the demand and supply of energy for the FSM. This includes electricity production and consumption, and gas, diesel and other forms of energy for both commercial and household uses. The indicator is based on access, sustainability and efficiency.



Status
Fair

Trend
Mixed

Data confidence
Medium

SDG	SAMOA Pathway
7 AFFORDABLE AND CLEAN ENERGY	Sustainable Energy [47, 48, 50] Oceans & Seas [53] Sustainable Transportation [67]

TABLE 36. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Fair	Fair
Trend	Mixed	Mixed	Mixed	Mixed
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND TRENDS

The energy sector in the FSM is highly dependent on imported fuel. In 2018, between 78–97% of the energy produced comes from diesel with some renewable energy production across the four states. Estimates from 2018 show that in the FSM the contribution of the energy sector to carbon dioxide emission is 43,490 CO_2 tonnes (Castalia, 2018). In the past, the rising cost of diesel, combined with the global economic recession severely impacted the utilities' ability to provide reliable electricity, demonstrating the volatility of this sector. In addition, rising costs of equipment and essential supplies needed by the utility providers, explains the longterm financial insolvency. The total value of energy product use in the FSM increased 25% between 2009 and 2015, from $32.4 million to $40.4 million. The increased trend in energy use recorded in 2015 was observed in all states with the exception of Yap.

As Party to the UNFCCC, the FSM submitted its nationally determined contribution, which focused on partially phasing out the use of fuel by transitioning to renewable energy alternatives, in order to reduce GHG emission by 28% by

2025. Renewable energies, particularly solar energy, have great potential. Solar energy represents an affordable solution for outer islands. Other alternative energy systems in operation in the four states are hydropower (Pohnpei), wind power (Yap) and biofuel. By 2020, the FSM is aiming to have 30% of its energy supply coming from renewable energy, as well as an increased share of renewable energy in the nation's overall supply. Climate change impacts can affect energy services and infrastructure, reducing energy access. Two typhoons that struck Yap in 2003 and 2004 damaged 80% of the conductors, and more than 90% of service was destroyed or damaged (Lenzen et al. 2013).

The percentage of households with electricity differs across states. Estimates from 2009 indicate that in Kosrae 100% of the households have access to electricity, this figure is halved for Chuuk (46%; Fig. 67). Electricity is largely used by households and commercial units (Figure 64), but 12% of the total use is energy lost by the system. In 2015, the losses in energy conversion by the electricity industry was estimated to be on average 72% at national level. In 2018, across the FSM 67% of the households had access to electricity, and renewable energy accounted for 19% of the total energy produced in the country (Castalia, 2018).

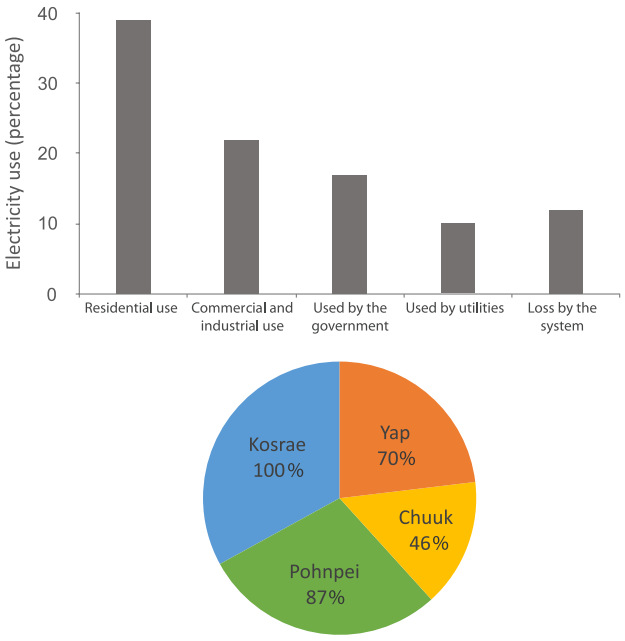


FIGURE 64. Percentage electricity use by state as estimated for 2009 (ABOVE) and energy consumption by group (BELOW) (FSM Division of Statistics, Census 2010).

The FSM's 2010 National Energy Policy sets a vision to improve the life and livelihood of all citizens with affordable, reliable and environmentally sound energy. Through cost-effective, safe, reliable and sustainable energy services, FSM intends to reduce its dependence on imported sources of energy and promote sustainable socio-economic development. The energy policy emphasizes increased renewable energy, energy conservation and efficiency standards.

The FSM's energy policy suggests that, in principle, it is possible to reduce projected fossil fuel use by 14%, with about 70% of the savings coming from renewable energy and 30% from energy efficiency measures. This indicates the considerable importance of energy efficiency for reducing costs and emissions. The four states are at different stages of addressing the commitments of the FSM's Energy policy (Figure 68). In some states, the introduction of cash power meters (pre-paid meters) have helped to develop energy saving behaviour at the customer level. In addition, utilities and states have several awareness campaigns targeting energy efficiency at household level with recommendations such as changing light bulbs and the use of energy efficient appliances.

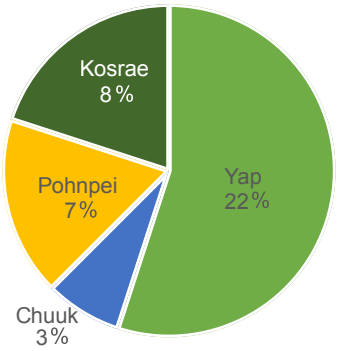


FIGURE 65. Percent distribution of energy produced through renewable energy systems (solar PV, wind turbines, hydropower) (Castalia, 2018).

IMPACT

Achieving sustainable energy consumption and efficiency are important steps for the FSM development. Renewable energies can support electrification in the outer islands reducing vulnerabilities to world market fluctuation of fuel prices. Energy diversification can be key to reduce GHG emissions and improve access to energy. However, the positive impacts associated with renewable energies may come with longterm negative impacts that should be considered at this early phase in shifting towards renewable energy systems and energy efficiency. Among these impacts are:

- Disposal of solar panels in 20–25 years when replacement is needed
- Disposal of LED and other energy saving light bulbs
- Disposal of batteries used in the renewable energy systems

RESPONSE

The FSM Government has taken several steps to improve energy efficiency and support the shift towards renewable energies. These include (1) the Energy Policy and Action Plans (2012); (2) Energy working group; (3) investigating options to recycling waste to energy – RE products, used oil, etc., (4) States JSAPs, and (5) utilities using metering options to influence consumer behaviour.

Legislation – national and state strategies are in place but do not cover outer islands, littering laws in place for all states, three of four states have recycling laws.

- Awareness -- campaigns in schools and communities on three 3Rs.
- Landfill Management – two of four states have Fukuoka method type landfill.
- Collection and Disposal – two of four states contract private companies to manage collection and disposal.
- Recycling – three of four states have Container Deposit Legislation (CDL).
- All four states ban plastic bags.

RECOMMENDATIONS

- To set up a fund to address the removal of 'energy' waste (LEDs, solar panels, batteries).
- Assess tax levy and other economic mechanisms (e.g. subsides) on importation of batteries, etc.
- Work as a nation to identify a buyer for recycling material (e.g. batteries) and revise and amend recycling law to include identification of the buyer.
- Assess alternatives for energy efficient light bulbs.
- Circular economy.

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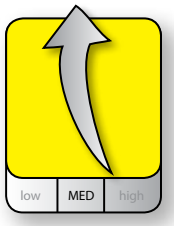
WASTE MANAGEMENT – SOLID WASTE

INTRODUCTION

Management of solid waste is an ongoing problem across the FSM due to physical, resource and human capacity limits. Challenges include siting and proper management of waste sites, access and resources for appropriate collection, management and recycling are limited, and lastly increasing consumption of waste producing goods. For this indicator we assess solid waste generation, collection and composition.



Status
Fair

Trend
Improving

Data confidence
Medium

SDG

TABLE 37. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Improving	Mixed	Deteriorating	Improving
Data Confidence	Medium	Medium	Medium	High

Entire view of the current final disposal site of Kosrae taken by a drone. The ventilation pipes in the middle of the disposal area and the leachate pond annexed are seen in the picture.

STATUS AND TRENDS

In the FSM the states and municipalities manage solid waste collection and disposal. Three states have a public final disposal site, managed by the public sector. The Department of Public Works and Transportation in Yap, Department of Transportation and Public Works (DTPW) in Chuuk, and Department of Transportation and Infrastructure in Kosrae. In Pohnpei, the Office of Transportation and Infrastructure contracted an external company for its management. In Yap, several community dumpsites, which are managed by each community, remain. Final disposal sites in Yap, Pohnpei and Kosrae employ a semi-aerobic method. In Chuuk, the interim dumpsite called the Marina Dumpsite is in use, and a new landfill site has been identified for a semi-aerobic method.

Hazardous waste in the FSM includes POPs, and electrical and electronic waste (e-waste). The management strategy for POPs is covered by the Stockholm Convention National Implementation Plan (NIP) developed in 2007. Since POPs come from burning

of domestic waste (organic and PVC), there are overlaps with the management of organic waste and related efforts in promoting composting and other ways to dispose garden and household waste.

The FSM has a legacy of scrap metal and derelict vehicles, which are abandoned at the final disposal sites, along roadsides and on vacant lots. The main sources of used oil generation are from the mechanic shops, the public utilities and boats. In Pohnpei waste oil is stockpiled at the Dekehtik dumpsite. Medical waste disposal is another problem in some of the states. Incinerators are available on hospital premises to treat medical wastes, but are not always properly maintained. There is no system for disposal of expired medicines and other products used at home for self-medication (e.g. diabetes).

TABLE 38. Available policies for waste management at state level (FSM National solid waste management plan 2010–2014).

State	Policies and legislations for solid waste management
Yap	• YSL #4–4 Yap State Public Service Corporation (Utilities Company's mandate for 'refuse collection and disposal') • Recycling Program Law (2008) • Recycling Program Regulations (Dec 2008) • Recycling Finance Law (2009)
Chuuk	• CSL Public Law 02–94–01 • Littering Law CSL- 191–33 • Recycling Law (aluminium cans)
Pohnpei	• Constitution of Pohnpei, Article 7, Section 1 on Resources and Environment which requires establishment and execution of plans for conserving natural resources and protection of the environment. • State Law No 3L-26–92, Pohnpei Environmental Protection Act • Solid Waste Regulations 3/30/95 • Pohnpei State Law No 6L-66–06 provides for litter abatement and solid waste disposal, shipping container and motor vehicle waste disposal fee, and establishes Environmental Quality Fund and Litter Reward Fund
Kosrae	• Kosrae State Constitution, Article 2: Every person has the right to a healthful, clean and stable environment, while providing for the orderly development and use of natural resources, the state government shall by law protect the states environment, ecology, and natural resources from impairment from the public interest. • Littering Law: Kosrae State Code, Title 13, Section 13.506 • Pollution: Kosrae State Code, Title 13, Section 530 • Kosrae Recycling Program: Kosrae State Code, Title 7, Chapter 22 • Bill to end the importation of non-recyclable plastic bags

13 The Fukuoka Method is a semi-aerobic landfill technology used to improve current landfill sites and to control methane emissions at landfill sites. In the Fukuoka Method, leachate (wastewater) is quickly removed from waste materials, allowing the inflow of air by installing perforated collection pipes and vertical perforated gas venting pipes at the bottom of the landfill. This allows for internal fermentation heat, which accelerates the decomposition of waste materials, improves leachate water quality and inhibits the emission of methane gas (Source: https://www.japanfs.org/en/news/archives/news_id031355.html).

The states have tried to promote 3R activities. Yap, a leader in this regard, initiated beverage container recycling targeting aluminium cans, PET bottles and glass in 2006 with technical support from UNDP. Yap adopted CDL in 2009 and the recycling rate of the target items in 2016 was as high as 96%. Also, Yap is the first state to ban plastic bags. Kosrae introduced beverage container recycling in 2007 and recycles PET bottles, glass and batteries. Kosrae's recycling rate was as high as 95% in 2015. Pohnpei only recycles aluminium beverage cans and needs to improve the system by expanding target items. In Chuuk no recycling activities are observed, but they have had programs in the past and are preparing to start up again.

Pohnpei waste oil stockpile. The operator of the final disposal site is now planning to export used oil piled up in the disposal site through the program supported by UNEP/ SPREP.

In Kosrae, where beverage container recycling is active, the people store and accumulate beverage containers separately and bring them to the recycling center to get the refunds.

Collected and pressed aluminium cans piled up in the recycling center in Yap. Through Container Deposit Legislation (CDL) in Yap, these beverage containers were brought by residents to the recycling center in exchange of five-cent refund per container.

Across the four states, households are the main contributors of solid waste (Figure 69), with larger quantities of waste generated per person per day than businesses and public institutions. Waste composition is generally consistent across states, with the largest volume of waste produced from plastic and/or biodegradable/kitchen waste, and paper/cardboard (Figure 70; J-PRISM 2016, J-PRISM 2017). Composition of waste suggests that a large volume of biodegradable/kitchen waste can be recycled for compost or as animal feed (e.g. pigs) reducing release of POPs (Figure 70).

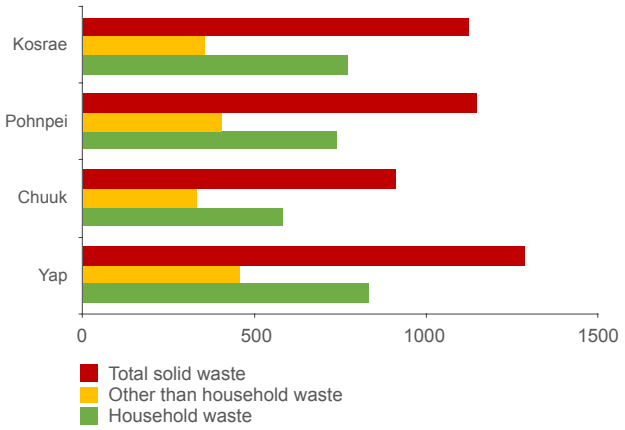


FIGURE 66. Generation of solid waste by state (g/person/day). Waste is generated from households and from business entities and public institutions. Generation rate of '*other than household waste*' is calculated by dividing waste generated from businesses and public institution by population. The total solid waste generated by each state is obtained by summing the generation rate of '*household waste*' with that of '*other than household waste'* (Kosrae SWM Plan 2018; Yap SWM Plan 2018; Chuuk SWM Plan, 2018; Pohnpei SWM, 2018).

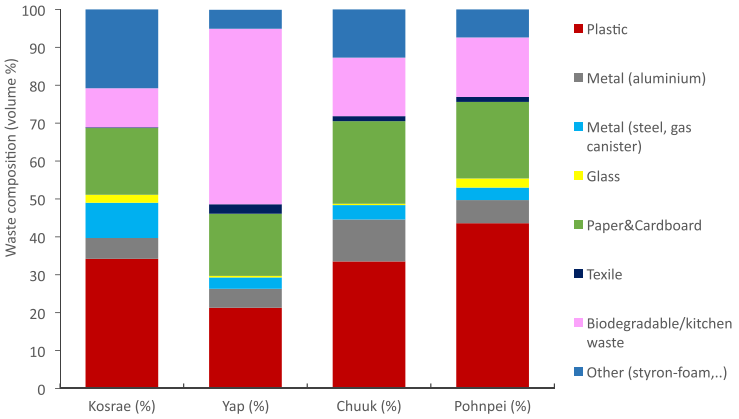


FIGURE 67. Percent waste composition across the four states (J-PRISM 2016; J-PRISM, 2017).

IMPACT

Improper waste disposal poses a significant threat to both human health and environmental health. In order to mitigate such threats, the expansion of collection services by the public private cooperation and proper final disposal will continue to be key. Accumulation of hazardous waste on private land represents a major health and environmental issues, that municipal and state governments have difficulty addressing.

RESPONSE

- National leachate monitoring guideline was developed in 2014.
- The Stockholm Convention on POPs (SC) is a global treaty "*to protect human health and the environment from chemicals that remain intact in the environment for long periods, become widely distributed geographically, and accumulate in the fatty tissue of humans and wildlife."* This convention was ratified by FSM in February 2005 and requires Parties to take measures to eliminate or reduce the release of 12 different POPs into the environment. Under Article 5 of the SC, FSM is required to implement measures to reduce and eliminate releases of dioxins and furans from unintentional sources (uPOPs), which are generally from the open burning of organic waste (kitchen and yard waste) and other materials containing chlorine (e.g. PVC plastic).
- FSM ratified the Convention for the Protection of the Natural Resources and Environment of the South Pacific Region (Noumea Convention), which prescribes that Parties "*shall take all appropriate measures to prevent, reduce and control pollution in the [South Pacific region] caused by dumping from vessels, aircraft, or man-made structures at sea, including the effective application of the relevant internationally recognized rules and procedures relating to the control of dumping of wastes and other matter*".

TABLE 39. Summary of the current solid waste services and facilities across the four states (The Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries (J-PRISM) (Solid Waste Management C, D) Project Completion Report (2016); Japanese Technical Cooperation Project for Promotion of Regional Initiative on Solid Waste Management in Pacific Island Countries Phase (J-PRISM) (Group 1) Inception Report (2017)).

	Yap	Chuuk	Pohnpei	Kosrae
Waste collection	Waste collection services, mainly in Colonia, public institutions and offices are provided by a contractor, through a contract with the Department of Public Works & Transportation (DPW&T). Other efforts are in Tamil Municipality where the municipality has developed a pilot waste collection program using the State Recycling Operator, to provide collection services for most villages within municipality.	The waste collection system rests with the Division of Public Work under the Department of Transportation and Communication (DTPW).	Collection coverage of municipalities by municipal governments except Kolonia Town Government are very low. Municipal governments collect 13.3% of waste generated, while another 9.6% of waste generated is collected by a private company.	In Kosrae, collection services are provided by each of the four municipalities. Collection of waste through collection service is only 16.6 % of the generated waste.
Final waste disposal	In Yap, the majority of generated waste (>80%) is properly discharged to the public landfill, while 14% is dumped at community sites. Yap public landfill implements the semi aerobic sanitary landfilling method called 'Fukuoka Method', consisting of gas ventilation pipes.	Majority of generated waste (> 70%) is discharged to the Marina interim dump site. The remaining 23.2 %, is discharged by uncontrolled dumping to nearby open spaces. Forty-eight percent of the incoming waste to the Marina interim dump site is collected by DTPW, while the remaining 52 % is brought directly by households and business entities.	Dekehtik landfill site (approximately 4ha) in operation since 1997. The landfill facilities of the first site were improved by adopting Fukuoka Method[13], i.e. installation of leachate collection line and treatment pond. The improved first site was full in 2018. A second site was constructed based on the Fukuoka Method experience.	Public landfill was commenced in 2009. The landfill site was constructed with Japanese funds and commenced in 2009. Kosrae's landfill implements the semi aerobic sanitary landfilling method called 'Fukuoka Method', consisting of gas ventilation pipes, leachate collection and circulation facilities, and leachate collection pond.
Container Deposit Legislation (CDL)	Yap State has a CDL Recycling Program, managed and overseen by the Yap State EPA and operated by a private company.	In Chuuk State, the CDL Law has been revised and amended awaiting passing by the Legislature.	Pohnpei State has a CDL Recycling Program.	Kosrae State has a CDL Recycling Program.
Ban on plastic bag	Yes	Yes	Yes	Yes

- The Pacific Regional waste and pollution Management Strategy 2016–2025 (Cleaner Pacific 2025), is the region's guiding document for solid and hazardous waste management. The implementation of this regional strategy is coordinated by SPREP, and it prescribes actions for SPREP as well as SPREP member countries and territories.
- All the four states formulated the State Solid Waste Management Strategy 2018 – 2027 and they are endorsed by the Governors of respective state.
- Legislation – national and state strategies are in place but do not cover outer-islands, littering laws in place for all states, three of four states have recycling laws.
- Awareness -- campaigns in schools and communities on three 3Rs.
- Landfill Management – three of four States have Fukuoka method type landfill.
- Recycling three of four states have Container Deposit Legislation (CDL).
- U Farmers association in Pohnpei now operates a plate press machine that makes recyclable plates from betel nut palms as an alternative to Styrofoam plates.

13 The Fukuoka Method is a semi-aerobic landfill technology used to improve current landfill sites and to control methane emissions at landfill sites. In the Fukuoka Method, leachate (wastewater) is quickly removed from waste materials, allowing the inflow of air by installing perforated collection pipes and vertical perforated gas venting pipes at the bottom of the landfill. This allows for internal fermentation heat, which accelerates the decomposition of waste materials, improves leachate water quality and inhibits the emission of methane gas (Source: https://www.japanfs.org/en/news/archives/news_id031355.html).

RECOMMENDATIONS

- Enforce solid waste minimization, reduction at source and recycling.
- Investigate options for alternatives to the high pollutant Styrofoam and facilitate phasing-out from Styrofoam in the four states.
- Improve solid waste collection and disposal.
- Education, awareness, and information dissemination. Enforce the 3Rs (reduce, reuse and recycle).
- Regulations for e-waste and collection of renewable energy and energy efficient equipment.
- Sustainable financing for supporting the collection and disposal of solid waste.
- Capacity building for those responsible for managing waste.

SOURCES

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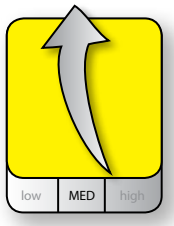
Chiara Franco

WATER AND SANITATION – WATER SYSTEMS AND CAPACITY

INTRODUCTION

As of 2010 water access in the FSM reached 88.5% of households while only 56.5% of the households had proper sanitation. The FSM National Water Resolution identifies the need to address sanitation as one of the country priorities, in line with Sustainable Development Goal (SDG) 6. The main sources of freshwater are rainfall harvesting, groundwater and surface water. Water capacity in outer islands is limited, mostly due to the inadequate storage capacity and absence of a water grid for water distribution. Most of the water in the outer islands and Chuuk lagoon islands is collected at household level and therefore quality is more difficult to control. This indicator assesses access and quality of drinking water and access and quality of sewage treatment.



Status
Fair

Trend
Improving

Data confidence
Medium

SDG		CBD	Noumea Convention
6 CLEAN WATER AND SANITATION	14 LIFE BELOW WATER	8	Dumping Protocol Emergencies Protocol

TABLE 40. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Poor	Fair
Trend	Improving	Mixed	Improving	Improving
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND TRENDS

In the four states, supply of freshwater differs greatly determined by the characteristics of rainfall, storage capacity, and infrastructure development. Assessments conducted in Pohnpei's outer islands show that in Pingilap, the majority of the water from water tanks is within recreational standards (47%), while in Mwoakilloa 27% of tank water is safe for drinking. Sapwuahfik had the highest rate of contamination (Figure 68).

In all four states there is a need to upgrade and improve the island water systems in order to ensure access to water during droughts. In urban centers, the source of water is normally from the water utilities, in rural areas residents use community water tanks, wells or surface water (e.g. rivers and streams). These water systems are not monitored routinely like those provided through the public utilities systems, therefore there is an increased health risk for users. According to the 2010 census, 43.5% of households in the FSM do not have an improved system

of sanitation. The majority of the non-improved sanitation systems (e.g. non-ventilated pits, open defecation) are in outer islands, where problems with limited water access require alternatives to flush toilets.

In Chuuk water and wastewater systems are the responsibility of Chuuk Public Utilities Corporation (CPUC), with its mandate to deliver water and wastewater utility services on a self-funding basis. These services are exclusive to the island of Weno. In Pohnpei, water and wastewater systems are the responsibility of Pohnpei Utilities Corporation (PUC). Commercial operations are centered on Pohnpei island, where there is a broad metering of water supply.

In Kosrae water and wastewater systems are the responsibility of the Department of Transportation and Infrastructure, although part of Kosrae Utility Authority's (KUA) mandate is to deliver water and wastewater utility services on a self-funding basis. Currently water distribution is managed by municipal governments.

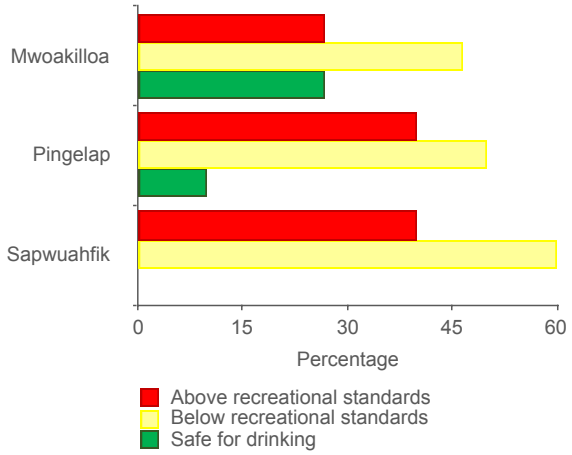


FIGURE 68. Water quality assessed in 2015 for public and private water tanks at Pingilap, Sapwuahfik and Mwoakilloa, outer islands of Pohnpei State. Drinking water standards requires concentration of E. coli to be equal to zero, for recreational standards E. coli <567 mnp 100ml-2(Source. Pohnpei EPA).

In Yap the three water utilities, the Yap State Public Service Corporation (YSPSC), the Gagil-Tomil Water Authority (GTWA) and the Southern Yap Water Authority (SYWA) are the operational entities for the management of Yap groundwater – the water quality from these systems are under the control of Yap EPA. The three water utilities are self-financed by the water bills collected directly from the customers, which are also used for maintenance and operation of the systems.

In Yap, a collective sanitation system is not widely deployed. A sewer collection system has been deployed in Colonia area, but on the rest of the island, the population discharges the sewage into private septic tanks or directly in the environment. YSPSC is in charge of supervising collection and treatment and discharge of wastewater over the entire Yap state. In Pohnpei the sewage plant is operated to treat the effluents from Kolonia before reaching coastal waters. The rest of the island households discharge wastewater into private septic tanks. Similar roles are covered by the sewage plants in Yap and Weno (Chuuk). In Kosrae most households discharge wastewater into private septic tanks.

IMPACT

Access to clean water is essential for life. Contaminated water can have numerous impacts on human health. Due to the variation in access to freshwater, and due to differences in source, abundance and infrastructure throughout the FSM, it is difficult to ensure that all have access to clean water. Therefore water supply remains a major public issue.

RESPONSE

- Revise island sewage systems.
- Improved awareness.
- Proper piping.
- Strengthened laws/regulations.
- Testing of private water systems/storage.
- Regular testing of private and government water systems.
- Marine and freshwater regulations (EPAs).
- Non-point and point source water pollution regulations water in Yap.

RECOMMENDATIONS

- Address water testing in outer island communities.
- Support regular testing of both government and private water systems through increased funding and training. For example, the use of portable systems for water testing.
- Enforce disinfection procedure.
- Centralization of water system, particularly for outer islands.

SOURCES

FSM: Federated States of Micronesia (2010). Summary analysis of key indicators from the FSM 2010 Census of Population and Housing. Division of statistics FSM Office of Statistics, Budget, Overseas Development Assistance and Compact Management (S.B.O.C), Palikir, Pohnpei.

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THEME 7 CULTURE AND HERITAGE

OVERVIEW

For more than 2,000 years, the people of the FSM have lived off the reefs and lands and these environments have shaped island lifestyles, creating strong cultural identities and attachments to the environment that persists today. The traditional cultures of the FSM differ from island to island and play vital roles in all aspects of life. While English is the official language of government and secondary and tertiary levels of education (FSM, 2004), each state has its own languages, traditional cultures and systems.

Land ownership in the FSM is limited to FSM citizens, with land lease terms varying by state to state (U.S. Department of State, 2017a). The traditional attitude toward land, one that is still commonly held by the people of the FSM, is that "*land is our strength, our life, our hope for the future*" (Hezel 1994). Land was traditionally understood to include the offshore flats and reef or fishing areas. The unique systems of land tenure that exist across the FSM are accompanied by varying traditional management practices, and these unique cultural differences therefore require unique approaches to managing natural resources that are both place and context specific. Indeed, the significant role of traditional cultures across the FSM places communities in a crucial role for resource management.

Therefore, an important aspect of the SoE report is the link between people, traditions and the environment. For this theme, two main indicators were chosen to highlight the current relationship between culture and the environment:

1. The state of historical and traditional sites, which are linked directly to the environment as either a preserved site, such as WWII battles sites, or natural sites on which myths and legends are based on.
2. The state of traditional knowledge regarding environmental management and traditional sustainable fishing and agricultural practices.

All indicators show that traditional culture forms the basis for both new and old environmental practices. The difficulties in compiling data regarding traditional knowledge highlight the need to record and document this information before it is too late.

Jez O'Hare

CULTURE AND HERITAGE HIGHLIGHTS

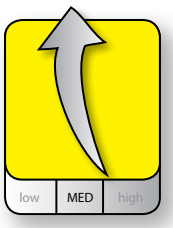
TOPIC	STATUS AND TREND	KEY FINDINGS	RESPONSE AND RECOMMENDATIONS
TRADITIONAL AND HISTORICAL SITES	 **Status** Fair **Trend** Improving **Data confidence** Medium	The FSM boasts a wealth of historical and traditional sites yet most of these sites are not under any formal management.	• Strengthen and improve existing policy to protect and manage these sites. • Support development of eco-friendly infrastructure to increase access and economic benefits. • Increase education and awareness on historical and traditional sites.
TRADITIONAL MANAGEMENT	 **Status** Fair to Poor **Trend** Mixed **Data confidence** Low	Historically, traditional knowledge, practices and modes of resource management have protected and conserved the FSM's natural resources, but sustainable management has undergone a huge shift due to the pressures of modernization.	• More research needs to be carried out on the use of traditional knowledge in preserving and interacting with ecosystems. • Increased awareness and education of youth regarding traditional knowledge and practices.


Jez O'Hare

TRADITIONAL AND HISTORICAL SITES

INTRODUCTION

The FSM boasts a wealth of historical and traditional sites. These sites are conserved for their value and significance to the people of the FSM. Historical and traditional sites refer to sites, structures, buildings, objects, and areas of significance in local history, archaeology, or culture. This indicator highlights select cultural and historical sites from each of the four states and provides a glimpse of the FSM's rich and diverse national heritage.



Status
Fair

Trend
Improving

Data confidence
Medium

SDG	CBD	WHC 1972
11 SUSTAINABLE CITIES AND COMMUNITIES	18	Convention on the protection of the World Cultural & Heritage

TABLE 41. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair	Fair	Fair	Fair
Trend	Improving	Improving	Improving	Improving
Data Confidence	Medium	Medium	Medium	Medium

STATUS AND TRENDS

The protection of the FSM's national heritage is overseen via several bodies including the FSM Office of National Archives, Culture & Historic Preservation and the four state Historical Preservation Offices. The National and State Offices of Tourism as well as the National and State Departments of Resource and Development also play a role in maintaining historical sites. There is a national policy in place to protect and preserve the diverse cultural heritage of the peoples of the FSM, and to assist in the identification and maintenance of those areas, sites, and objects of historical significance. At the state level there are also policies in place to protect these sites.

Few sites in the FSM have formal preservation or management in place, but due to community respect and land ownership there is limited access to these sites. As a result, many of these sites are not documented. Some sites are well preserved often due to scientific research values, or a unique eco-tourism value where funding is generated to assist maintenance.

YAP

The cultural and historical sites registered for Yap reflect the traditional authority structure and alliance system that connects Yap's traditional society, even in a modern-day setting. Most are still functional today and used for community purposes.

The men's houses (*faluw*) are strategically placed within villages. Most are located along the coastline with a view of the fishing grounds of the community and/or situated at entry points into the village via the sea. The traditional men's houses served as a gathering area for the men to meet, discuss and plan village arrangements, community works, prepare for fishing trips/war, etc. This was the hub for village men's decision-making and stands as a symbol of the strength of the village.

Stone money banks/traditional dance area (*malal*) are mainly situated adjacent to a village's meeting house (*pebai*). This area serves as the platform for where traditional dances are performed. It is used to display some of the village's wealth or valuables, such as stone money lining the area and serving as a backdrop to the traditional dances and landscaping around the community meeting house. This is where a village can bring out and display their community valuables such as the dances, stone money, and parading of shell money and other forms of wealth during village functions and affairs.

Maintenance, upkeep, and building of traditional community infrastructure rests solely on each village. The condition or state of the structures and/or community areas can serve as an indicator of community cohesion, strength, or capacity. Men and women of the village have clear areas of responsibility in the maintenance and upkeep of these community spaces, and each group respectively takes the lead in ensuring these community tasks are carried out.

Traditional men's house with stone money in Yap. (Photo: Greg Barbara, SPREP).

The Yap State Historical Preservation Office (YSHPO) assists communities in accessing funding to support restoration of important sites and technical assistance in documenting sites. Recently, one of the major projects implemented in the village of Makiy within Gagil municipality was to restore and rehabilitate the community meeting house, a traditional trail, and three stone platforms at the Mangyol Stone Money Cultural site, which is pending nomination with UNESCO and the World Heritage Center (WHC).

KOSRAE

There are several important cultural sites found in Kosrae. Two that are well known include Menka and Lelu. Menka is located in the Mahkontowe Conservation Area, a culturally and biologically significant mountain range which is the seat for intra-island relationships, including food collection, funeral attendance, and inhabitation (Meredith 2018). This mountain range, when viewed from Lelu Harbor, forms into the shape of a "sleeping lady" (KIRMA 2018). In the historic past and an effort towards cultural sovereignty the area is today referred to as Mahkontowe, the name of the daughter of whale in the Lelu Island origin story, as found in oral history reports produced by Meredith (2018) and KIRMA (2018). The Menka ruins are hidden within the jungles of Mahkontowe and were the sacred spot of Sinlaku, the goddess of nature and breadfruit.

The ruins are located in a large drainage, with a hundred or more compounds distributed on both sides of the river, in close proximity to one another. All the buildings are square in shape with an altar in one of the rooms. The legend is that in 1852, Sinlaku had a premonition that there would soon be big changes. Afraid her deity would be challenged and disliking change, she left Kosrae. The following day, First Congregational missionaries arrived on Kosrae. According to the tradition, Sinlaku now lives in Yap but there is widespread feeling among the locals that she is still in Menka.

Also found is Kosrae are the Lelu Ruins, a major prehistoric and historic archaeological site, encompassing the remains of a city on Lelu Island, the seat of governance including the larger island of Kosrae. The majority of the population resided on Lelu and relied on the subsistence from those residing on the bigger island of Kosrae (part of the Mahkontowe Conservation Area), historically referred to as Walung or Oualan. The remains are those of a civilization that peaked around the 14th and 15th centuries, with elements still visible at the time of European contact in the early 19th century. The rulers of Lelu gradually conquered and unified the island of Kosrae. From the capital at Lelu, they ruled the island with a monarchy that archaeologists believe was similar to the kingdoms of Tonga or Hawaii. The city itself is built of blocks of coral and basalt. It

consists of housing, royal tombs and sacred spaces. The materials used for the construction of housing depended on social class, as did the spatial situation of the people: in the center the King and the aristocracy behind high walls of basalt (similar to those at Nan Madol in Pohnpei State), to the west, the lower aristocracy in modest houses of coral, and the rest of the population in simple huts.

POHNPEI

There are historical and traditional sites scattered throughout Pohnpei, but one of the most well-known is Nan Madol. Nan Madol was the ceremonial and political seat of the Saudeleur Dynasty, which united Pohnpei's estimated 25,000 people until about 1628. Set apart between the main island of Pohnpei and Temwen Island, it was a scene of human activity as early as the first or second century AD. The huge scale of the edifices, their technical sophistication and the concentration of megalithic structures bear testimony to complex social and religious practices of the island societies of the period.

According to Pohnpeian legend, Nan Madol was constructed by twin sorcerers Olisihpa and Olosohpa from the mythical Western Katau. The brothers arrived in a large canoe seeking a place to build an altar so that they could worship Nahnisohn Sahpw, the god of agriculture. After several false starts, the two brothers successfully built an altar off Temwen Island, where they performed their rituals. In legend, these brothers levitated the huge stones that construct Nan Madol. When Olisihpa died of old age, Olosohpa became the first Saudeleur. Olosohpa married a local woman and sired twelve generations, producing sixteen other Saudeleur rulers of the Dipwilap ('Great') clan. The founders of the dynasty ruled kindly, though their successors placed increasing demands on their subjects. Their reign ended with the invasion by Isokelekel, who also resided at Nan Madol, though his successors abandoned the site.

The site was added to the list of World Heritage Sites in 2016 and is currently on the List of World Heritage in Danger due to threats, such as the siltation of waterways that is contributing to the unchecked growth of mangroves and undermining existing edifices. The current efforts are to improve accessibility and management of the site.

Nan Madol, Pohnpei (Photo: Nancy Schenk).

CHUUK

Chuuk boasts both traditional and historical sites, but most of the terrestrial sites are on private land with limited access and therefore remain undocumented. Chuuk Lagoon is best known for being considered the biggest graveyard of ships in the world, with more than 50 World War II wrecks. A significant portion of the Japanese fleet was stationed within Chuuk lagoon during WWII. During Operation Hailstone, which lasted three days in February 1944, American carrier-based planes sank 12 Japanese warships (light cruisers, destroyers, and auxiliaries), 32 merchant ships, and destroyed 275 aircraft, mainly on the ground. With its 50 plus wrecks, many still in considerably good condition and in warm, clear water, Chuuk Lagoon has become a diver's paradise. The ships and war relics, and the natural flora and fauna built up around them, provide a unique natural and cultural heritage seascape. The Chuuk government and community rely on the economic returns from tourism. The sites are also graveyards for thousands of Japanese who died during the war and are considered an open grave site by the Japanese. As a result, there is a need for a sensitive and inclusive approach to the management of these wrecks. This historic site faces both natural and man-made threats, such as corrosion, destructive fishing practices, and storms. Management is important to prevent loss of these internationally significant cultural and natural heritage sites, which play a critical role in the Chuuk economy related to dive tourism (Jefferies 2007).

IMPACTS

Historic and traditional sites are vital to the people of the FSM's cultural and natural heritage. They also provide an income through ecotourism. Unfortunately, many valuable sites are not properly managed. Many sites are on privately owned land and often there is either a dispute over ownership of the land or private landowners deny access to the sites. This provides a challenge for state governments to lead management of these sites unless landowners cooperate or agree to manage the site themselves. Economic development and urban expansion also threaten historic and cultural sites. There is a need to assign protective status to those sites of high significance for their preservation for future generations. There is concern that younger generations are not learning the myths and legends associated with many cultural sites and as a result they might not see the value in preserving them.

RESPONSE

While there are some policies in place at both the state and national level, there is a need to strengthen and improve them. In February 2018, the FSM Congress ratified the Underwater Cultural Heritage Convention. This formal consent outlines good practice in the protection and management of underwater cultural heritage in the Pacific. The FSM UCH includes traditional historical sites as well as navigation, the traditional knowledge embedded in inter-island travel, and traditional cultural knowledge of marine resources The FSM is also party to the Convention for the Safeguarding of the Intangible Cultural Heritage (2003).

RECOMMENDATIONS

- Develop rules of engagement with landowners including collaborating with landowners at an early stage of designating sites.
- Ensure clear balance between economic interest and conservation of historical sites.
- Increase transparency and partnership between states and national, local and traditional leaders.
- Strengthen and improve existing policy to protect and manage these sites.
- Support development of eco-friendly infrastructure to increase sustainable access and economic benefits.
- Increase education and awareness on historical and traditional sites.

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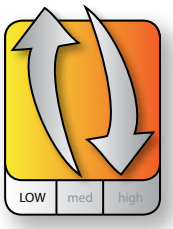
TRADITIONAL MANAGEMENT

INTRODUCTION

Traditional knowledge refers to the knowledge, skills, and practices that are developed and sustained within a cultural community and passed on from generation to generation, forming part of its cultural identity. Historically, traditional knowledge, practices and modes of resource management have protected and conserved the FSM's natural resources. Many native and endemic species are used in various aspects of daily living, including customary practices and traditional medicine.

The State of the Environment report focuses on traditional knowledge and the role it plays in connecting the people of FSM to the environment. This indicator looks at traditional management practices and traditional methods of sustainable fishing or agriculture.



Status
Fair to Poor

Trend
Mixed

Data confidence
Low

CBD

18

TABLE 42. Indicator status, trend and data confidence for each of the four FSM states.

	Yap	Chuuk	Pohnpei	Kosrae
Status	Fair to poor	Fair to poor	Fair to poor	Fair to poor
Trend	Mixed	Mixed	Mixed	Mixed
Data Confidence	Low	Low	Low	Low

STATUS AND TRENDS

Sustainable management has undergone a huge shift as the society has changed over time. Conventional western approaches to conservation such as government management and enforcement of large-scale conservation areas has proved ineffective due to land and marine ownership patterns, the difficulties of regulating activities in extremely remote locations, and the limited capacity of government natural resource agencies (FSM 2002; SPREP 1993; Micronesian Seminar 2002). Traditional knowledge and community involvement is playing an increasing role in the conservation of the environment.

CHUUK

In Chuuk resource protection customs are intertwined with ancestral and spiritual domains. The respect for the chief, made visible in the presentation of gifts and first food, is an acknowledgement of one's deep closeness and respect for the flora and fauna protected by spirits of the deep, the open ocean, the reef, the swamps, the soil, the forest,

the mountain, and the skies. Indifference to this important obligation is essentially a reprehensible defiance that can result in bad luck, soil infertility and poor harvests to the offending village or island. In Chuuk there are traditional closure mechanisms called *mechen*, which can be used for any kind of terrestrial or marine areas. *Mechen* can also be species specific, e.g. a tree can be designated under *riipopw* which means that this tree(s) is not to be harvested. The practice of *pwaau* is stricter, most often tied to the passing of a family member. These are usually strictly no entry zones. With its duration comes a certain sense of sacredness over the area – thus the no entry taboo. The *Mechen* and *Pwaau* practices are the same all over Chuuk, including the outer islands. These practices are still widely used in Chuuk -- both for marine and land family-based ownership rights and control. *Etinnuk* are traditional fishing areas that are pre-designated for certain individuals or groups – such as *Efokur*, descendants possessing "use right" over an area reserved for the children of male members or brothers in a clan; and *mwirimwir*, clan members with both ownership and use right inherited through their mothers. While reefs are still family owned, they are pretty much open to public access when not under *mechen* or *pwaau*. The practice of longterm selective and exclusive access rights (*Etinnuk*) over certain areas have been greatly diminished (or devalued) in almost all parts of Chuuk.

In Chuuk there are also several traditional methods for sustainable agroforestry. As breadfruit is the most culturally significant stable crop in Chuuk, there are two breadfruit customs of *Mwemei* and *Omwuumei*. *Mwemei* marks the readiness of the breadfruit harvest, and it requires that a thanksgiving feast is provided to the spirit of the harvest and presented to the paramount chief, or in most places, the village chief who is usually the eldest in a chiefly village *Einang* (clan). For all other crops, it is expected that a *Mwenua* is presented to the chief as well, celebrating the first fruits and acknowledging appreciation for and awareness of the 'blessings' that come with the inheritance of land and sea. For *Omwuumei*, this involves taking the last fruit of the harvest to the chief as a display of respect before everyone enters the waiting period before the next breadfruit season.

There are also traditional methods for fishing. The practice of *Punipun* involves small stone fish traps, where dead coral is piled into a makeshift fish habitat and harvested later. These traps are also designated for certain women or groups of women. Another form of larger stone traps is called *Mai*. *Takkich*, which refers to the use of pronged wooden spears to catch needlefish under fire or moon light. *Takkich* is done not only for certain fish but also for turtles. People from the island of Parem are known for *takkich* of the needlefish 'Fana' and many lagoon islands are known for *takkich* of turtles in deep sea areas. *Fouko* and *Uu* are wooden fish traps for either deep or shallow waters. The practice is still used in the Mortlocks region, but islands found within the lagoon do not use wooden fish traps – nets have replaced this practice.

POHNPEI

Traditional resources management and stewardship in Pohnpei has always been integral to Pohnpei's culture and customary practices. In Pohnpei there is a declaration/ accord (*Pilerehre*), which states that the people of Pohnpei will care for the land as if it is the last place on earth. The name itself signifies how much the people of Pohnpei care for their land – Pohnpei Sarawi, which means "Upon a Sacred Alter". The people of Pohnpei developed farming and fisheries management practices that ensured they could continue to live off the land sustainably. Some of these practices included the development of a comprehensive agroforestry system (*Pahnwel* – literally means under the forest/canopy), which allows for the cultivation of a diversity of food crops intermingled. Monoculture and large clearings were prohibited or frowned upon. In Pohnpei, fisheries management practices included a taboo on certain species, sizes and amounts of fish one could take or consume. For example, certain clans (Pohnpei has 12 major clans) do not eat certain fish. These serve as totems for those clans. Big fish are reserved for the chiefs, thus when fishing, fishermen refrain from catching them to avoid the required visit to offer the fish to the chief.

Today many people continue to practice the customary *Pahnwel*, especially on their private lands, but unfortunately this is not practiced on public lands. For example on public land monoculture of sakau has led to large forest clearings. Now that the ocean in Pohnpei is also considered public domain, people have lost the customary practices of conservation mentioned above. Some clans continue to honour their totems but have done away with the other practices.

While many traditional and customary practice of resource management have withered, the principle that guides the people of Pohnpei's consciousness in ensuring ecosystem balance remains intact. When required either by customary obligations or as a way to inform outsiders or even the younger generations of such practices, those who know about such traditional practices are always willing to share their local knowledge. Recently, in a landmark case, the FSM Supreme Court presided over a civil case involving the Pohnpei Traditional Leaders vs. the State and a foreign business. The issue involved the harvesting of sea cucumber, where the traditional leaders contend that without a management plan that takes into consideration the impact of an unmanaged harvest, the impact on the customary use of sea cucumber as well as the health of the ecosystem, the planned harvest will cause an irreparable threat to Pohnpei's marine ecosystem and sea cucumber stock. This will ultimately impact the rights of traditional leaders and community members to enjoy the traditional use of sea cucumber. In essence, the case is an example of how sustainable development must ensure balance between the use of natural resources and conservation.

KOSRAE

In Kosrae there are traditional forms of management and sustainable agroforestry and fisheries practices. Kaluk fishing uses the boat, torch and net at night, sul is night fishing at low tide in lagoon flats, with torch and net, and neklap (women's fishing using local nets, two pairs to surround the rocks and someone chases the fish inside to the net.) Sundays and the moon calendar operate as a natural conservation practice as one day gives rest to all and the other identifies each day of the moon phase as a time to do or not do something particular, including collection of trees from the forest, fish from the sea at various times, avoidance of jelly fish, collection of certain molluscs for bait, and bioluminescence.

The Kosrae State Historic Preservation Office, a unit of the Kosrae Island Resource Management Authority, recently conducted intensive ethnographic surveys and youth ethnographic field schools, of which included ethnozoology, funerals and burial practices, navigation practices, ethnobotany, subsistence practices, cultural identity, and economic planning and development in Kosraean culture. Through these ethnographic surveys, it was found Kosraean cultural practices continue to include animals and plants in their daily lives, including food, medicine, and even in navigation practices (KIRMA 2019c), with some parts from the past carried forward and other parts adapted to contemporary conditions.

On Kosrae, family and church are paramount to a Kosraean lifestyle. For many Kosraeans, the church and Sundays reflect Kosraean cultural identity as well as politeness and being well-kept; it is a tradition and custom since the mid-19th century (KIRMA 2019d). Sundays on Kosrae support Kosrae's natural and cultural conservation — legally, there is no harvesting on Sundays. Culturally, Sunday is a day of rest, giving the people, animals and plants and other natural resources a chance to rest. Giving a day of rest promotes good mental health. Saturday is the day to subsist and prepare the um (earth oven) for the family. To alter this would usurp efficacy of this conservation and cultural practice of making an um to prepare Kosraean soup for Sunday, the day of rest. Among the threats to this include tourist expectations against this tradition, private sector businesses pursuing capitalist endeavours rather than working within the cultural context, and increasingly busy lives as people use western foods more frequently as can be seen in funerals.

Funerals today support togetherness, food security, and connections with the deceased while also producing a lot of garbage (KIRMA 2019a,e). In the past, funerals were a month long affair for the whole family, partly because the family needed the support after the death of a loved one and in part the absence of roads necessitated a long arduous trip requiring many resources to invest in the process of getting there. Therefore, it was important to stay a while and support and build on relationships. On contemporary Kosrae, the funeral continues as a month but not by the same people. Family members come at different

Women practicing traditional fishing methods (Photo: Nick Hall).

times to support the family. During and after the initial funerary activities, visitors consume food and leave behind the containers in which the contents of the food were held. In the past, this included coconut bowls and banana leaf plates filled with only traditional foods, for example. Today this includes primarily styrofoam filled with variations on traditional food and much western food — foods which produce NCDs (noncommunicable diseases) such as diabetes and heart disease. It is customary to leave the containers on the ground for it is unwise to show strength after the death of a loved one for it may send the spirits away before the family is strong again and leave them in a weakened state for time to come. This is a challenge since the styrofoam containers do not biodegrade or support healthy ecosystems and whose contents pose threats to health.

Kosraeans as navigators are often written off, because the practice today is missing, as compared to other islands. However, "*Kusaians were one great mariners, ranging far to the west; every atoll in the Central Carolines has tales of Kusaian visitors, and various clans trace their origins to women from that island…*" (Riesenberg 1972 in Lewis 1994). While it is not known why Kosraeans discontinued open sea trips, a 2019 FSM National project focused on women's roles in navigation and exchange relationships during which islanders from the Central Carolines identified their ancestry to Kosrae. On contemporary Kosrae, traditional and modern navigation practices continue to be employed in everyday life. Navigation practices on Kosrae refer to both land and water, from crossing the island for hunting today to attending a funeral in the past to locating fish or finding one's way back to the island (KIRMA 2019f).

Elders and those who subsist report changes in patterns for fishing as well as related to birds (KIRMA 2019f) while others who do not know the moon calendar miss out on fish-catching opportunities. However, overfishing and human development in general may be affecting the reef which sustains reef life subsisted through Kosraean practices. There are many timbers harvested at times not on the moon calendar. This results in one of the ecological problems Kosrae experiences, such as overpopulation of crown of thorns. The firewood serves an economic

importance — culturally it is a smoking fire which signals togetherness and that there is something to eat because people come together to eat while economically it is a resource for sale which can be purchased (KIRMA 2019b). Shifts to a cash economy on a salary meant to support fewer people than it actually does, means people seek other sources of income. Some collect firewood and fish to sell for income, and in some cases, the cash is used to purchase prestige goods which may be purchased at a grocery store (Fazzino et al forthcoming).

With increased electricity and the use of iceboxes, families do not need to keep a fire going, but community members report that this discourages sharing of food and takes away from togetherness and knowing each other. Funeral practices continue to support togetherness and sharing of food, as well as food security. Busy lives on Kosrae lead to a fast-paced life which is easily consumed with community, cultural, church, and governmental obligations. Western foods do not keep as long as traditional foods and require regular cooking, also taking more time from families than cooking traditional foods which can be on the fire for a few days (KIRMA 2019a). Taro patches persist on contemporary Kosrae as to agroforestry and farming. While communities report saltwater intrusion, some families continue to maintain their taro patches and agroforests. Selection of plants include traditional foods as well as herbs such as basil, which may be added to flavour food.

There are regulations which support Kosrae's cultural and natural environments, even on privately owned land. However, the land is paramount to families that to prohibit strongly would be both culturally inappropriate and cause one to feel pakomutuh (to feel sorry for causing harm to someone or something). This perceivably creates challenges to enforcement, a practice prized in western culture, but culturally inappropriate on Kosrae. There are socio-cultural methods in place which govern more appropriately. In some ways, these traditional sustainable practices are changing as people seek to adopt and rely on a more policy-based way of living in the absence of knowledge of traditional conservation practices. However, many Kosraeans pursue Kosraean knowledge through ethnography and organizations supporting the use of traditional ecological knowledge, the State and its communities tend toward Kosraean knowledge. This can be seen with the Mahkontowe Conservation Area regulations which rely on the Kosraean moon calendar and the Utwe Biosphere which relies upon traditional ecological knowledge for its management.

YAP

In Yap, sustainability of natural resources was interwoven in the traditional practices of daily living. Conservation of these resources, which life depended on, was a key social value. The people understood that they were only stewards of the land and sea under their domain, as they pass through this life partaking of its resources but remaining mindful to pass on the benefits to the next generations for continued sustenance.

Marine and terrestrial spaces, inclusive of all resources within, are owned and managed by traditional family estates. Therefore, family estates have access to land for farming and living and some have fishing rights. Social exchanges of goods and services between families, villages and alliances is integral to Yap – resources were always astutely managed by those who have rights to use and oversee these resources to ensure that customary obligations and daily family sustenance are always met. This is how resource management is private in nature – ownership lies with traditional family estates.

Agroforestry was readily practiced by selection of trees and other plants that had functional use near the homes and in all the lands that were owned. Sustainable fishing was always practiced, catching only what was needed at home or to meet a customary obligation. Fish traps/weirs were designed to allow for fish to remain in the trap at low tide. The fish weir served a purpose similar to a refrigerator where fish was always readily available and fresh.

These traditional sustainable practices are changing as people adopt a more modern way of living. Selection of plants for replanting is shifting to more ornamental plants instead of functional plants. With electricity and access to chest freezers and iceboxes, fishers catch as much as they can to fill their freezers instead of catching just enough to prepare for daily meals. Shifting to a cash economy and preference for imported goods/services has meant that fishers are also fishing now to earn an income.

IMPACTS

There are two major constraints regarding the preservation of traditional knowledge and practices. The first is the loss and decreased sharing and use of traditional knowledge at the family level, with younger generations less engaged in learning traditional knowledge. The second issue is a cultural reticence to share knowledge outside of the family structure, which makes recording traditional knowledge a sensitive issue to address. As this knowledge and way of life is lost due to modern and external influences, and people no longer practice traditional resource management, the ecological services that people depend on from these ecosystems will be lost, thereby reducing quality of life and economic opportunities. Traditional sustainable management has already undergone a huge shift as the society has changed over time.

RESPONSE

The role of traditional knowledge is increasingly recognized in playing an essential part in the conservation of biodiversity. Most management strategies and plans now take into account the importance of traditional knowledge. The four states have Historical Preservation Offices and there have been numerous studies to record traditional knowledge. The national and state Constitutions also respect the importance of traditional knowledge and culture.

The Yap State Constitution preserves traditional management by recognizing the traditional authority structure. Under traditional authority, resource management and use is controlled by rights-based access. The work to get PAN legislation/frameworks in place across the FSM has been the most complicated in Yap. This is due in part to 90% of land and 100% of nearshore marine being held under traditional tenure.

There are several NGOs focused on preserving traditional knowledge and practices. In Pohnpei, for example, the Island Food Community of Pohnpei (ICFP) promotes the consumption of local foods by raising awareness about their benefits and sustainable methods for growing them.

The Kosrae State Constitution preserves traditional conservation and management through a bottom-up approach which begins with the mayors of each municipality, channels through the Kosrae State Historic Preservation Office which actively conducts ethnographic surveys to help inform the Kosrae Island Resource Management Authority management practices. Tradition is often saturated with ideas of never changing; however, on Kosrae, tradition refers more often to practices which continue to serve a purpose to the community, such as the moon calendar.

RECOMMENDATIONS

- More research needs to be carried out on the use of traditional knowledge in preserving and interacting with ecosystems.
- Increased awareness and education of youth regarding traditional knowledge and practices. While some school offer Micronesia Studies, traditional knowledge should be incorporated into school curricula.
- Awareness of best practices and traditional methods and the negative impacts of modern technology.
- Build capacity at the community level, so that they can continue to be stewards of their environment while the government facilitates the process.
- All policy or regulations developed should take into account or recognize traditional rights and knowledge.

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PART 4

CONCLUSION AND RECOMMENDATIONS

CONCLUSION AND RECOMMENDATIONS

Numerous regional and global drivers impact the FSM's environment. These drivers include economic and technological development, globalization, changes in values and cultural norms and global climate change. The drivers result in activities like land development, energy consumption and extraction of resources that puts pressure on FSM's ecosystems.

This report assessed the state of the FSM's environment by evaluating the impacts of these pressures on key habitats, species, infrastructure and climate variables. Table 43 gives an overview of the various indicators that were assessed in this report, with their respective status and trend. Figure 69 shows the percentage of indicators with a good, fair and poor status, as evaluated in this report.

Overall the state of the FSM's environment was assessed as fair and it is clear, many pressures on the environment are increasing. There have been numerous cases of successful conservation or management actions, but there is still a need for an increased effort to improve environmental management in the FSM.

While the FSM has many laws, polices and regulations that promote sustainable use and protection of its environment, there are still many gaps. National implementation and enforcement of policies, regulations and environmental plans and strategies are limited due to jurisdictional constraints that the national government has over coastal marine areas and terrestrial areas across the four states. Implementation and enforcement rests on state agencies, whose roles, responsibilities, and jurisdiction differs from state to state, further complicating implementation of strategies developed at the national level.

Local non-government organizations (NGOs) play a key role in implementing community-based conservation projects. These NGOs have taken the lead in supporting communities in the management of protected areas. However, activities and initiatives led by NGOs largely depend on external funding from donors and international sources, many of which are short-term and determined by current international priorities.

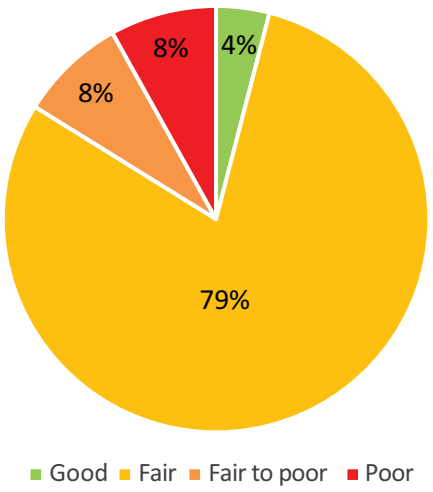


FIGURE 69. Percentage of indicators that are Good, Fair, Fair to poor and Poor.

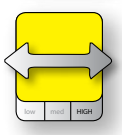
Some of the most successful conservation initiatives in the FSM are community-led, where traditional knowledge and practices are combined with the latest science and conservation recommendations. One example of this is the community managed protected area – Nimpal Channel Marine Conservation Area in Yap, which has some of the highest fish biomass within a protected area in the region.

On their own, community efforts will not be enough to protect the FSM's environment, especially from more large-scale modern-day pressures. This, along with the variation in jurisdictions across states, calls for an integrated approach to environmental management. The national and state governments, regional and local NGOs should coordinate, support and facilitate efforts for well-developed polices, regulations and plans that recognize the intricacy of implementing environmental management in the FSM.

There are already examples of the success of this integrated approach. For example, all of the FSM's waters are designated a shark sanctuary. The FSM's commitment to achieve the twin goals of the Micronesia Challenge to preserve 30% of our nearshore resources and 20% of our terrestrial resources by 2020 has led to the creation of numerous protected sites. The establishment of the first conservation easement in the region is the Yela Forest in Kosrae. The FSM endorsed the Nationwide Climate Change Policy in 2009, the Nationwide Integrated Disaster Risk Management and Climate Change Policy in 2013, the National Energy Policy in 2010, and in 2016, submitted its first Nationally Determined Contribution under the UNFCCC.

Customary and traditional land tenure systems influence how FSM and the four states establish, manage, protect and preserve protected areas. The FSM Constitution clearly recognizes the role of traditional leaders and their customary roles within their respective states. Having parallel or concurrent responsibility over the welfare of the people and the protection of their heritage which is inextricably intertwined with the environment and its natural resources, state governments and the traditional leaders have exclusive power to deal with issues such as land, the environment and conservation within their respective jurisdictions including coastal marine areas (territorial sea), lagoons and rivers. The first protected areas in the states were identified by traditional knowledge, and confirmed by science, which then supported the enactment of legislations.

TABLE 43. Overview of status and trend for all indicators

No	Indicator	Status & Trend
1	Greenhouse gas emissions (GHG)	 **Status** Fair **Trend** Improving **Data confidence** Medium
2	Ozone Depleting Substances (ODS)	 **Status** Fair **Trend** Improving **Data confidence** High
3	Physical climate	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium
4	Climate Change Adaptation	 **Status** Fair **Trend** Improving **Data confidence** Medium
5	Watershed condition	 **Status** Fair **Trend** Mixed **Data confidence** Medium
6	Surface water quality	 **Status** Poor **Trend** Mixed **Data confidence** Low
7	Groundwater	 **Status** Fair **Trend** Unknown **Data confidence** Low
8	Forests	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium
9	Mangroves	 **Status** Fair **Trend** Mixed **Data confidence** Medium
10	Agriculture	 **Status** Fair **Trend** Mixed **Data confidence** Medium
11	Soil	 **Status** Fair **Trend** Mixed **Data confidence** Medium
12	Offshore Marine Environment – Tuna and ByCatch Harvested	 **Status** Fair **Trend** Stable **Data confidence** High

No	Indicator	Status & Trend
13	Inshore Marine Environment – Live Coral Cover	 **Status** Fair **Trend** Deteriorating **Data confidence** High
14	Inshore Marine Environment – Reef Fisheries	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium
15	Inshore Marine Environment – Marine Protected Areas	 **Status** Fair to Poor **Trend** Improving **Data confidence** Medium
16	Endangered Marine Species – Turtles, Cetaceans, Sharks and Rays	 **Status** Poor **Trend** Mixed **Data confidence** Medium
17	Endemic, threatened & native species	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium
18	Invasive Alien Species Under Management or Eradicated	 **Status** Good **Trend** Improving **Data confidence** Medium
19	Terrestrial Protected Areas	 **Status** Fair **Trend** Deteriorating **Data confidence** Medium
20	Energy Consumption	 **Status** Fair **Trend** Mixed **Data confidence** Medium
21	Waste management- Solid Waste	 **Status** Fair **Trend** Improving **Data confidence** Medium
22	Water and sanitation- Water Systems and Capacity	 **Status** Fair **Trend** Improving **Data confidence** Medium
23	Traditional and historical sites	 **Status** Fair **Trend** Improving **Data confidence** Medium
24	Traditional management	 **Status** Fair to Poor **Trend** Mixed **Data confidence** Low

Recently in Chuuk, where the government does not own land, a state Protected Areas Network Law was passed allowing land or reef owners to include their respective areas into a state-wide protected areas network system. In Kosrae, another law was recently passed by the legislature setting aside the interior forest of Kosrae as a cultural, historic, and natural reserve—the Mahkontowe Conservation Area. The Kosrae legislature relied on its own history and traditional knowledge to pass this landmark legislation, despite the general view that Kosrae has lost its custom and tradition. In Yap, all existing protected areas were established by custom and tradition without the involvement of government because communities have the full jurisdiction over their resources. Most of these efforts were supported by the Yap Community Action Program (YAPCAP) Environment Program with the support of international NGOs. In Pohnpei, protected areas were already recognized by custom and tradition prior to being formally declared under municipal or state law. New protected areas also receive the blessing of traditional leaders and community members prior to their entry into law. Despite having limited jurisdiction over state owned resources, the national government still plays a significant role in the coordination of how technical and financial resource flows to the states in support of the management of protected areas.

RECOMMENDATIONS

Key recommendations from stakeholders emphasized the need to improve implementation of existing polices and initiatives as well as increased systematic environmental monitoring to provide a better understanding of the state of the FSM's resources.

One of the major challenges in developing the SoE was compiling, analysing and processing data held by the various national and state agencies. Data was difficult to access and the type of data available varied from state to state. A key recommendation for future work is to build off the baseline set in this report and develop monitoring schemes to fill the data gaps. Key data needs should be identified, and a standardized monitoring protocol should be developed for all four states as well as the necessary training and equipment to implement the protocol.

All data collected during the compilation of this report has been uploaded to the 'Federated States of Micronesia Environment Data Portal' hosted by SPREP as part of the Inform Project. This online data portal is a resource for uploading, storing and sharing environmental data in a central place. This is particularly useful in facilitating the process for compiling and analysing data for future SoE reports and other policies.

The Environment Data Portal for the FSM can be accessed via the following link: https://fsm-data.sprep.org/. To read more about the Inform Project, please visit: https://www.sprep.org/inform.

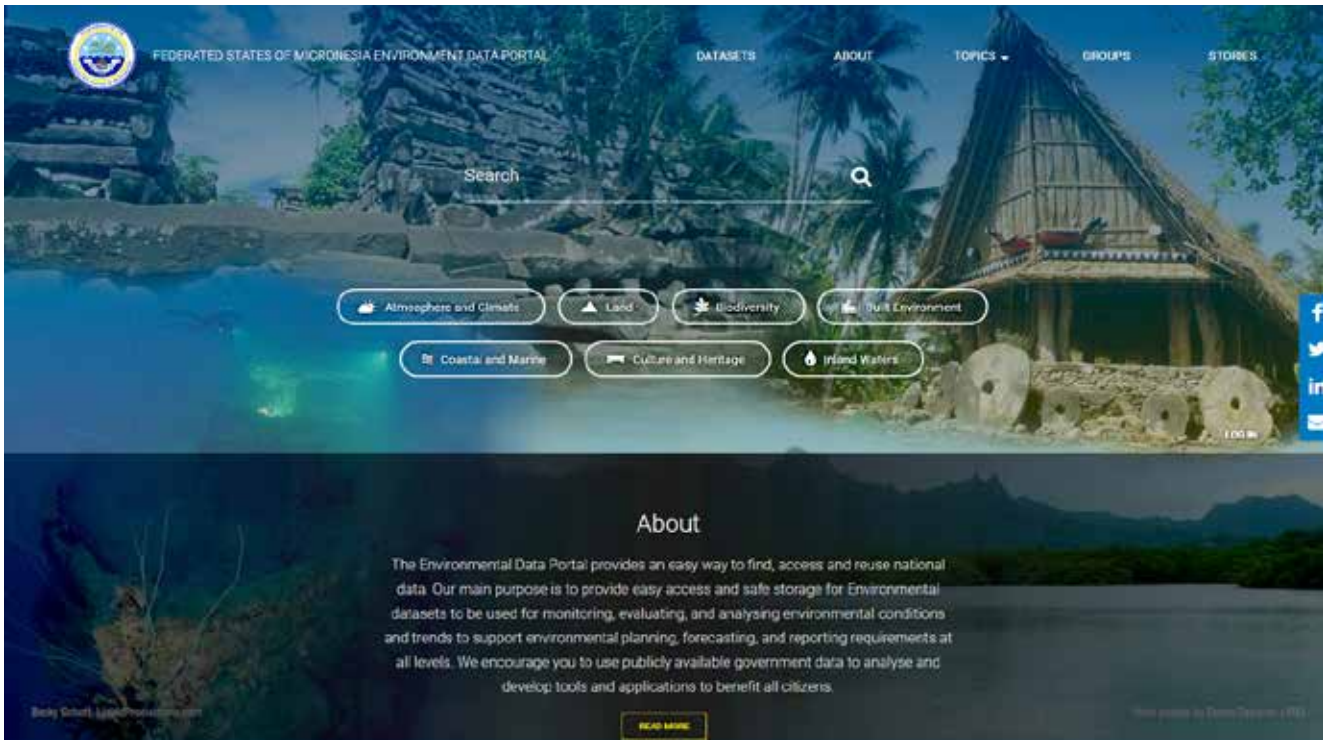


FIGURE 70. Homepage of the Federated States of Micronesia Environment Data Portal.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