Annex 13: Pre-Feasibility Study and Climate Baseline

Climate resilient food security for farming households across the Federated States of Micronesia (FSM)

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Introduction

This study presents a pre-feasibility assessment for the proposed project "Climate resilient food security for farming households across the Federated States of Micronesia." The intention of this pre-feasibility study is to document and analyse the key factors supporting project feasibility for the Green Climate Fund's Simplified Approval Process. It includes a description of the following:

- Project context (climate, socioeconomic, and policy)
- Past relevant projects
- Key barriers
- Project theory of change
- Implementation arrangements
- Stakeholder engagement plan
- Initial assessment of adaptive farming techniques
- Environmental and social impact assessments
- Financial and economic assessment
- Long-term sustainability of project outcomes

Project Context

Geography

The Federated States of Micronesia (FSM) consists of 607 small islands located in the Northern Pacific Ocean. The islands are spread over a vast region in the Pacific, between one degree south and 14 degrees north latitude, and between 135- and 166-degrees east longitude. FSM consist of 273.5 square miles of land area (708.36 km^2) with a vast exclusive economic zone (EEZ) covering over one million square miles (2.9 million km^2).

The Federation consists of four states, Yap, Chuuk, Pohnpei and Kosrae, with Yap State: being 46 Sq. miles, Chuuk State: 49 Sq. miles, Pohnpei State: 132 sq. miles and Kosrae State: 42 sq. miles. Each of the four States is centered on one or more main high islands and all of the states except Kosrae have inhabited outer-island atolls. Yap State is made up of 4 volcanic islands, 7 small islands and 130 atolls (of which 22 are inhabited). Pohnpei State is made up of one large volcanic island and 6 inhabited atolls. Chuuk is made up of 7 volcanic island groups within the Chuuk Lagoon and 24 outer-island inhabited atolls.[1] Many of the islands in FSM are extinct shield volcanoes, with steep and rugged centers that are densely vegetated and eroded. Mangroves grow around the coastal fringes. Land elevations range up to about 2,500 feet (760 m). Other islands are relatively flat, small and swampy, with low-lying, forested atoll islets, typically one to five metres above mean sea level

[1] FSM GCF Country Programme; Available at: http://www.dofa.gov.fm/wp-content/uploads/2018/12/FSM-GCF-Country-Program-Endorsed.pdf

Figure : Map of FSM Island Chains

Past and Future Climate Change Impacts

At a glance, FSM impacts/threats from climate change include an increase in annual mean temperatures and extreme maximum daily temperatures, an increase in annual precipitation, accelerated sea level rise, accelerated ocean acidification, and potentially increased severity of ENSO events. Projections of climate change impacts in a medium emissions scenario for FSM include[2]:

- Mean sea level rise – +9 cm by 2030 and +39 cm by 2050.
- Surface Air Temperature – Increase 0.8°C (+/- 0.5) by 2030 and 1.5°C (+/-0.6) by 2055
- Total Rainfall – Increase 2% (+/- 9%) by 2030 and increase 7% (+/- 14%) by 2055
- Sea Surface Temperature – Increase 0.7°C (+/- 0.5) by 2030 and 1.3°C (+/- 0.5) by 2055
- Ocean Acidification (Aragonite saturation) – 3.3 (+/- 0.2) by 2030 and 3.0 (+/- 0.2) by 2055 – dangerous levels for coral start at 3.5 and extremely dangerous start at 3

Historical observations, projections, and specific vulnerabilities for climate change in FSM are explored individually below.

[2] Federated States of Micronesia Second National Communication on Climate Change pg. 33; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

Sea Level Rise and Extreme High Tides

Since 1993 sea level in the tropical western Pacific has been rising an average of 0.2-0.4in (5-10 mm) per year. For FSM specifically the value is over 0.39 in (10 mm) per year. This is well above the global mean of about 0.12 in (3 mm) per year over the same period. [3]

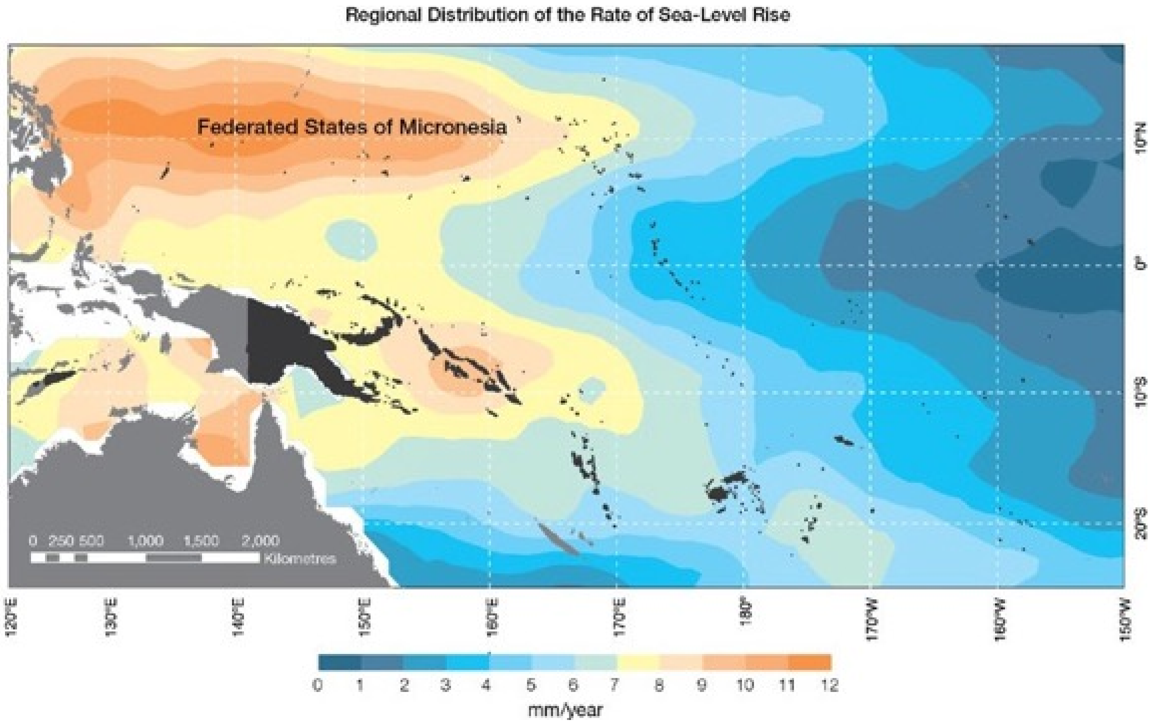

Figure 1: Sea Level Rise 1993 - 2010

By 2030, under a very high emissions scenario, this rise in sea level is projected to be in the range of 3.1-7.1 inches (8-18 cm). The sea-level rise combined with natural year-to-year changes will accentuate the impact of storm surges and coastal flooding. Frequency of extreme high sea level (tidal surges) for FSM are projected to increase dramatically as a result of climate change. [4]

Table 1: Sea Level Rise Projections for FSM

Emissions Scenario	2030	2050	2070	2090
Very low	3.1–7.1 in (8–18 cm)	5.5–11.8 in (14–30 cm)	7.9–17.7 in (20–45 cm)	9.4–23.6 in (24–60 cm)
Low	3.1–6.7 in (8–17 cm)	5.5–12.2 in (14–31 cm)	8.7–19.3 in (22–49 cm)	11.8–26.8 in (30–68 cm)
Medium	2.8–6.7 in (7–17 cm)	5.5–11.8 in (14–30 cm)	8.7–18.9 in (22–48 cm)	12.2–27.2 in (31–69 cm)
High	3.1–7.1 in (8–18 cm)	6.7–13.8 in (17–35 cm)	11.0–23.2 in (28–59 cm)	16.1–35.4 in (41–90 cm)

[3] Federated States of Micronesia Second National Communication on Climate Change pg. 28; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf
[4] Federated States of Micronesia Second National Communication on Climate Change pg. 30; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

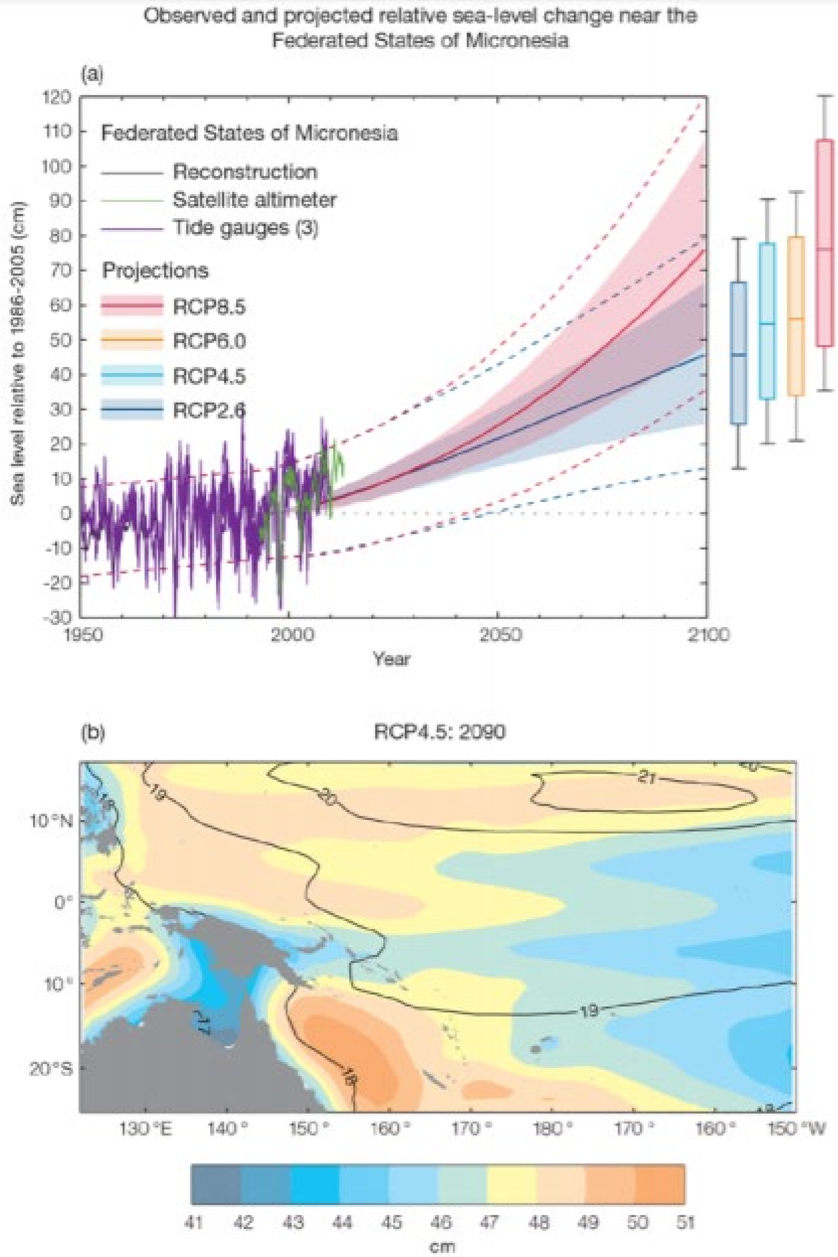

Figure 4.13: (a) The observed tide-gauge records of relative sea-level (since the late 1970s) are indicated in purple, and the satellite record (since 1993) in green. The gridded (reconstructed) sea level data at the Federated States of Micronesia (since 1950) is shown in black. Multi-model mean projections from 1995–2100 are given for the RCP8.5 (red solid line) and RCP2.6 emissions scenarios (blue solid line), with the 5–95% uncertainty range shown by the red and blue shaded regions. The ranges of projections for four emission scenarios (RCPs 2.6, 4.5, 6.0 and 8.5) by 2100 are also shown by the bars on the right. The dashed lines are an estimate of interannual variability in sea level (5–95% uncertainty range about the projections) and indicate that individual monthly averages of sea level can be above or below longer-term averages.

(b) The regional distribution of projected sea level rise under the RCP4.5 emissions scenario for 2081–2100 relative to 1986–2005. Mean projected changes are indicated by the shading, and the estimated uncertainty in the projections is indicated by the contours (in cm).

Figure 2: Sea Level Rise Projections for FSM[5]

Unfortunately, it must be noted that almost all outer island islets lie within the 2-meter zone of potential sea level rise, and all lie within a 5-meter zone of storm surge. Many of these islands already have had to abandon taro patches because of inundation in the past.[6] In urban areas on the high islands, most of the agricultural areas are located around coastal areas and are vulnerable to rising ocean waters and are already enduring increased flooding and drainage problems.[7] Further, the high islands of the FSM will need to begin now to prepare for rapid population increase in the form of climate change refugees from low-lying islands, while at the same time, enhancing and adapting their own food production systems.

The majority of agricultural production within FSM occurs in the low-lying areas of the high, volcanic islands. These areas are increasingly subject to lowland flooding as well as seawater inundation from sea level rise.[8]

Sea level rise analysis was conducted for the main islands for the states of Yap, Chuuk, Pohnpei and Kosrae. This analysis utilized projections of 0.3 meters of sea level rise by 2055 and 0.62 meters of sea level rise by 2090. The projected sea level rise for Yap indicates that there will be inundation of large parts of existing coastline and low-lying areas of the main island.[9] The main island of Pohnpei will experience coastal changes due to sea level rise by 2055 as well as salt water inundation of low-lying areas, including the Pohnpei airport.[10] The main island of Chuuk and the other islands located in the main atoll are also projected to experience coastal changes due to sea level rise by 2055 along with salt water inundation.[11] The main island of Kosrae is projected to experience sea level inundation of low-lying areas up through 2090.[12]

[5] Pacific-Australia Climate Change Science and Adaptation Planning Program; Available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2014/07/PACCSAP_CountryReports2014_WEB_140710.pdf

[6] FSSLP via FSMNC2; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[7] Statewide Assessments and Resource Strategies via FSMNC2 pg. 64; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[8] GCF Country Program – Federated States of Micronesia; Available at: https://www.greenclimate.fund/sites/default/files/document/micronesia-country-programme.pdf

[9] Department of Environment Climate Change and Emergency Management (DECEM) FSM. Yap State Vegetation Overlay Analyses Vulnerability Map (2055 – 2090 Scenarios).

[10] Department of Environment Climate Change and Emergency Management (DECEM) FSM. Pohnpei Vegetation Overlay Analysis Vulnerability Map (2055 Scenario).

[11] Department of Environment Climate Change and Emergency Management (DECEM) FSM. Chuuk State Vegetation Overlay Analyses Vulnerability Map (2055 – 2090 Scenarios)

[12] Department of Environment Climate Change and Emergency Management (DECEM) FSM. Kosrae State Vegetation Overlay Analyses Vulnerability Map 2030, 2055 and 2090 Scenarios.

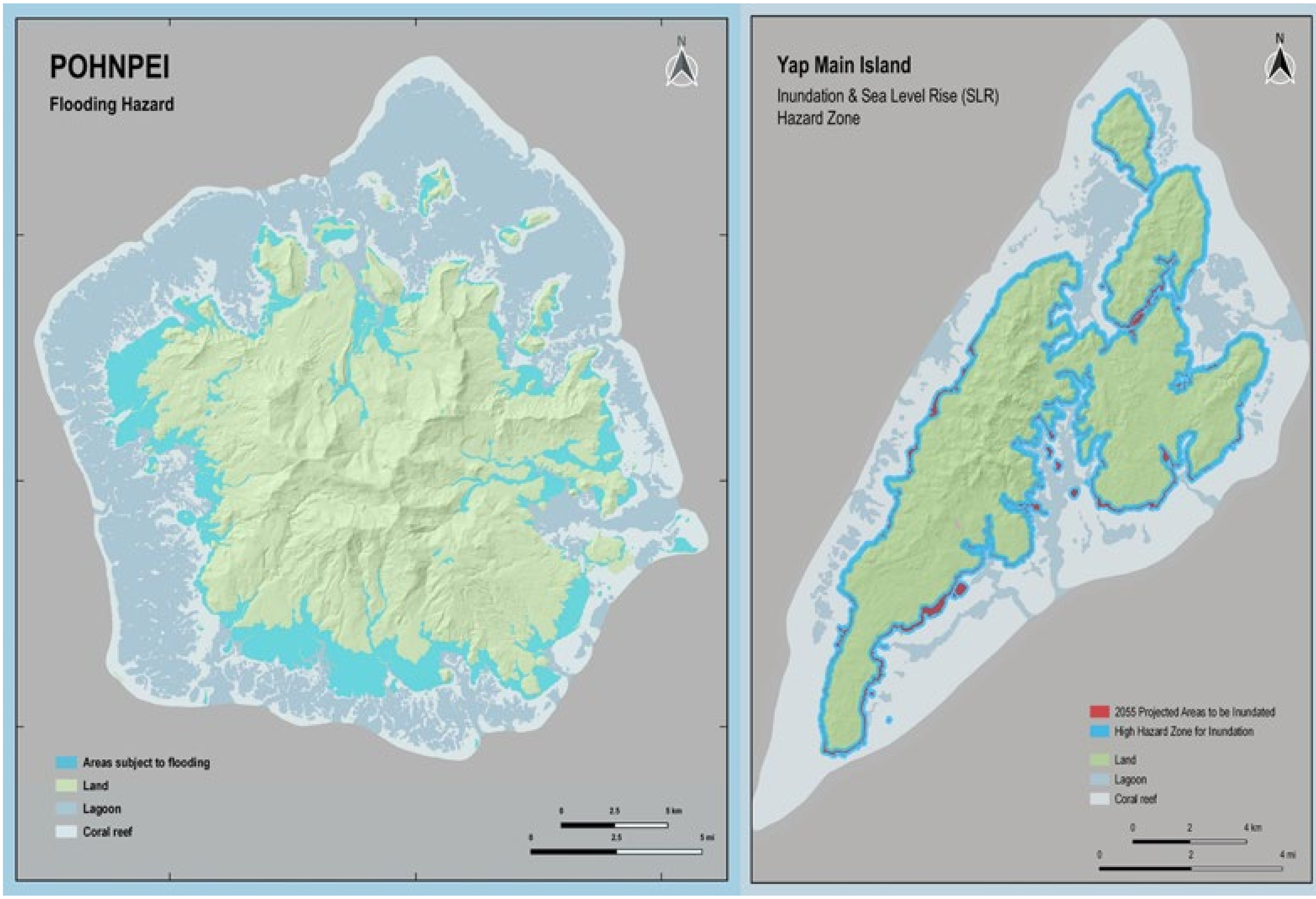

Figure 3: Sea Level Rise and Flood Hazard Maps for Pohnpei and Yap

Saltwater intrusion from coastal erosion, sea level rise, and extreme events is a critical risk for food security and agricultural production. For example, the most fertile soils in Yap state are all vulnerable to salt water intrusion. Increasing soil salinity is the greatest threat to crop productivity on the atolls of FSM. Increasing soil salinity of atoll soils to 6ds/cm kills crops like cassava, pawpaw, and yams. And when soil salinity is increased to 12ds/cm (a condition caused by sea water inundation), only coconut and the dryland giant taro (sawahn Hawaii, tannia, Xanthosoma sagittifolium) can survive.[13]

In addition to the risks outlined above, sea level rise and intensifying rainfall and storm events from climate change also exacerbate existing risks from tidal surge in FSM. Extreme tides, known as “king tides,” cause significant flooding, salinization, and erosion that ultimately damage groundwater resources, taro beds, soil, and agroforestry resources in coastal settings,

[13] Fourteen Atoll Assessment of Food Security via FSMNC2 pg. 58-59; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

especially in the low islands. [14] For example, the saltwater intrusion during tidal surges in 2007 in Yap, led to the mortality of 90% of the taro crop on the islet of Falalop, Ulithi atoll, and 75% of the taro crop on the islet of Falalop, Woleai atoll.[15] Assessment of damage following the 2008 tidal surges indicated substantial damage to four staple crops (taro, breadfruit, banana, and coconut) in the Chuuk State Islands – particularly the subsistence crops of taro and breadfruit which had severe damage or were fully destroyed.[16] Roughly half of all households surveyed reported at least a partial loss of their primary dietary staple and source of calories (taro and breadfruit). These findings are consistent with events that have been predicted to occur as a result of climate change.[17]

Air Temperature and Rainfall

Annual and seasonal maximum temperatures have increased in Pohnpei and Yap since 1951. Maximum temperatures have increased at a rate of 0.32ºF (0.18°C) per decade at Pohnpei and at a rate of 0.41ºF (0.23ºC) per decade at Yap. Also, at Pohnpei, annual and half-year trends in maximum air temperature are greater than those observed in minimum air temperature. These temperature increases are consistent with the global pattern of warming.

Annual rainfall in FSM has remained relatively constant with a slight decline across states with Yap declining an average of 0.31in (7.9mm) per decade, Pohnpei declining 3.46in (88mm) per decade, and Chuuk declining 1.93in (-48.9mm) per decade (1950 -2009).

Below are summary tables and graphs for Pohnpei (East FSM) and Yap (West FSM) pulled from the PACSAP Country Report.[18]

[14] Climate Change in the Federated States of Micronesia Food and Water Security, Climate Risk Management, and Adaptive Strategies (2010); Available at: https://pubs.er.usgs.gov/publication/70041522

[15] Perkins and Krause, Adapting to climate change impacts in Yap State, Federated States of Micronesia: the importance of environmental conditions and intangible cultural heritage, Island Studies Journal (2018); Available at: https://doi.org/10.24043/isj.51

[16] Post Disaster Assessments of FSM Outer Islands Via FSMNC2 pg. 81; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[17] Assessment of a Centennial Event for Climate Change in Chuuk via FSMNC2 pg. 91; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[18] Pacific-Australia Climate Change Science and Adaptation Planning Program; Available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2014/07/PACCSAP_CountryReports2014_WEB_140710.pdf

Table 4.2: Annual and half-year trends in air temperature (Tmax, Tmin, Tmean) and rainfall at Pohnpei (top) and Yap (bottom). The 95% confidence intervals are shown in parentheses. Values for trends significant at the 5% level are shown in **boldface**.

Pohnpei	**Tmax** **°F/10yrs** **[°C/10yrs]**	**Tmin** **°F/10yrs** **[°C/10yrs]** **1951–2011**	**Tmean** **°F/10yrs** **[°C/10yrs]**	**Total Rain** **inches/10yrs** **[mm/10yrs]** **1950–2011**
Annual	**+0.32** (+0.19, +0.46) [**+0.18** (+0.10, +0.26)]	+0.16 (-0.02, +0.35) [+0.09 (-0.01, +0.20)]	**+0.27** (+0.12, +0.38) [**+0.15** (+0.07, +0.21)]	-2.26 (-5.32, +0.61) [-57.3 (-135.1, +15.5)]
Nov–Apr	**+0.31** (+0.17, +0.48) [**+0.17** (+0.09,+0.27)]	**+0.25** (+0.03, +0.42) [**+0.14** (+0.02, +0.23)]	**+0.29** (+0.11, +0.44) [**+0.16** (+0.06, +0.25)]	-1.80 (-4.60, +1.64) [-45.8 (-116.7, +41.8)]
May–Oct	**+0.32** (+0.16, +0.46) [**+0.18** (+0.09, +0.26)]	**+0.19** (+0.03, +0.37) [**+0.11** (+0.02, +0.21)]	**+0.27** (+0.13, +0.39) [**+0.15** (+0.07, +0.22)]	**-2.23** (-4.52, -0.12) [**-56.6** (-114.9, -3.1)]

Yap	**Tmax** **°F/10yrs** **(°C/10yrs)**	**Tmin** **°F/10yrs** **(°C/10yrs)** **1951–2011**	**Tmean** **°F/10yrs** **(°C/10yrs)**	**Total Rain** **inches/10yrs** **(mm/10yrs)** **1952–2011**
Annual	**+0.41** (+0.36, +0.48) [**+0.23** (+0.20, +0.26)]	**-0.36** (-0.43, -0.27) [**-0.20** (-0.24, -0.15)]	+0.03 (-0.02, +0.07) [+0.01 (-0.01, +0.04)]	0.00 (-2.85, +3.22) [-0.1 (-72.5, +81.8)]
Nov–Apr	**+0.39** (+0.34, +0.44) [**+0.22** (+0.19, +0.25)]	**-0.27** (-0.37, -0.18) [**-0.15** (-0.21, -0.10)]	+0.04 (-0.02, +0.11) [+0.02 (-0.01, +0.06)]	+0.86 (-2.87, +1.44) [-21.9 (-72.8, +36.6)]
May–Oct	**+0.44** (+0.37, +0.51) [**+0.24** (+0.20, +0.28)]	**-0.40** (-0.48, -0.33) [**-0.22** (-0.27, +0.18)]	+0.01 (-0.04, +0.05) [0.00 (-0.02, +0.03)]	+0.93 (-1.27, +3.10) [+23.6 (-32.1,+78.8)]

Table 4.3: Annual trends in air temperature and rainfall extremes at Pohnpei (top) and Yap (bottom). The 95% confidence intervals are shown in parentheses. Values for trends significant at the 5% level are shown in **boldface**.

		Pohnpei	**Yap**
TEMPERATURE		**1952–2011**	**1952–2011**
Warm Days (days/decade)		**7.86** (+3.65, 11.70)	**12.23** (+4.60, +19.80)
Warm Nights (days/decade)		**5.12** (+1.22, +9.05)	**-16.68** (-21.57, -10.24)
Cool Days (days/decade)		**-3.98** (-5.53, -2.52)	**-8.50** (-13.66, -2.67)
Cool Nights (days/decade)		-2.73 (-8.21, +3.68)	**+8.70** (+3.71, +14.90)
RAINFALL			
Rain Days ≥ 1 mm	(days/decade)	-0.21 (-2.79, +2.48)	-1.01 (-4.20, +1.82)
Very Wet Day rainfall	(inches/decade)	**-2.63** (-5.15, -0.12)	+0.22 (-1.39, +1.97)
	(mm/decade)	**-66.88** (-130.81, -3.05)	+5.55 (-35.30, +49.95)
Consecutive Dry Days (days/decade)		0.00 (-0.43, +0.20)	**-0.37** (-0.77, 0.00)
Max 1-day rainfall	(inches/decade)	-0.015 (-0.29, 0.27)	-0.04 (-0.30, +0.21)
	(mm/decade)	-0.38 (-7.29, +6.84)	-0.88 (-7.62, +5.41)

Warm Days: Number of days with maximum temperature greater than the 90th percentile for the base period 1971–2000
Warm Nights: Number of days with minimum temperature greater than the 90th percentile for the base period 1971–2000
Cool Days: Number of days with maximum temperature less than the 10th percentile for the base period 1971–2000
Cool Nights: Number of days with minimum temperature less than the 10th percentile for the base period 1971–2000
Rain Days ≥ 1mm: Annual count of days where rainfall is greater or equal to 1mm (0.039 inches)
Very Wet Day rainfall: Amount of rain in a year where daily rainfall is greater than the 95th percentile for the reference period 1971–2000
Consecutive Dry Days: Maximum number of consecutive days in a year with rainfall less than 1mm (0.039 inches)
Max 1-day rainfall: Annual maximum 1-day rainfall

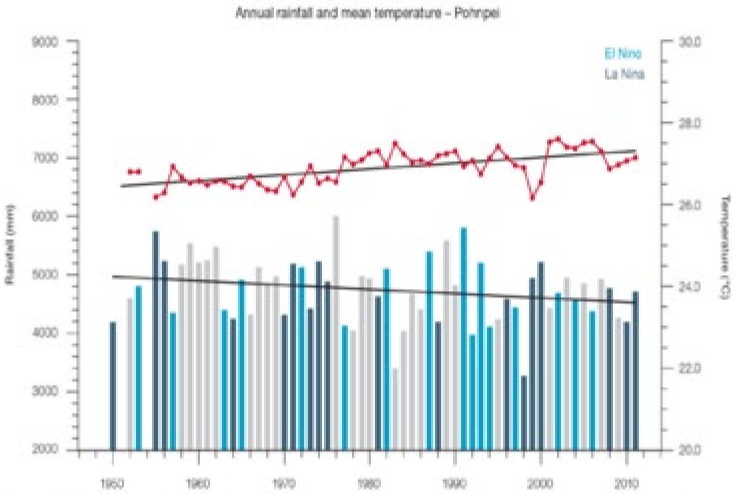

Figure 4.3: Observed time series of annual average values of mean air temperature (red dots and line) and total rainfall (bars) at Pohnpei. Light blue, dark blue and grey bars denote El Niño, La Niña and neutral years respectively. Solid black trend lines indicate a least squares fit.

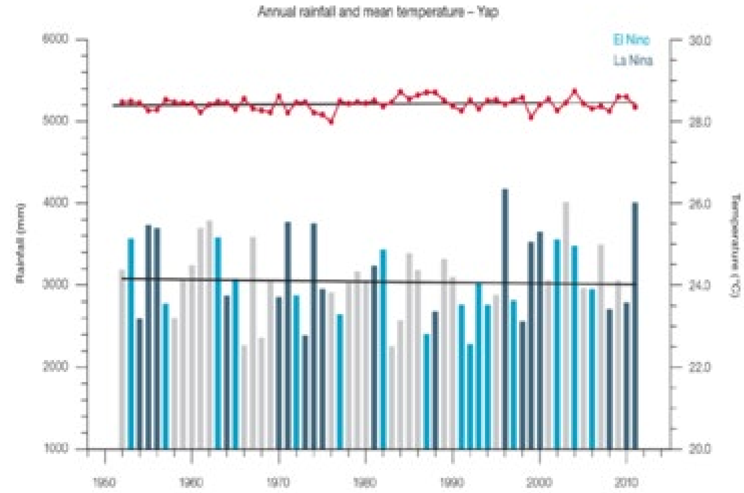

Figure 4.4: Observed time series of annual average values of mean air temperature (red dots and line) and total rainfall (bars) at Yap. Light blue, dark blue and grey bars denote El Niño, La Niña and neutral years respectively. Solid black trend lines indicate a least squares fit.

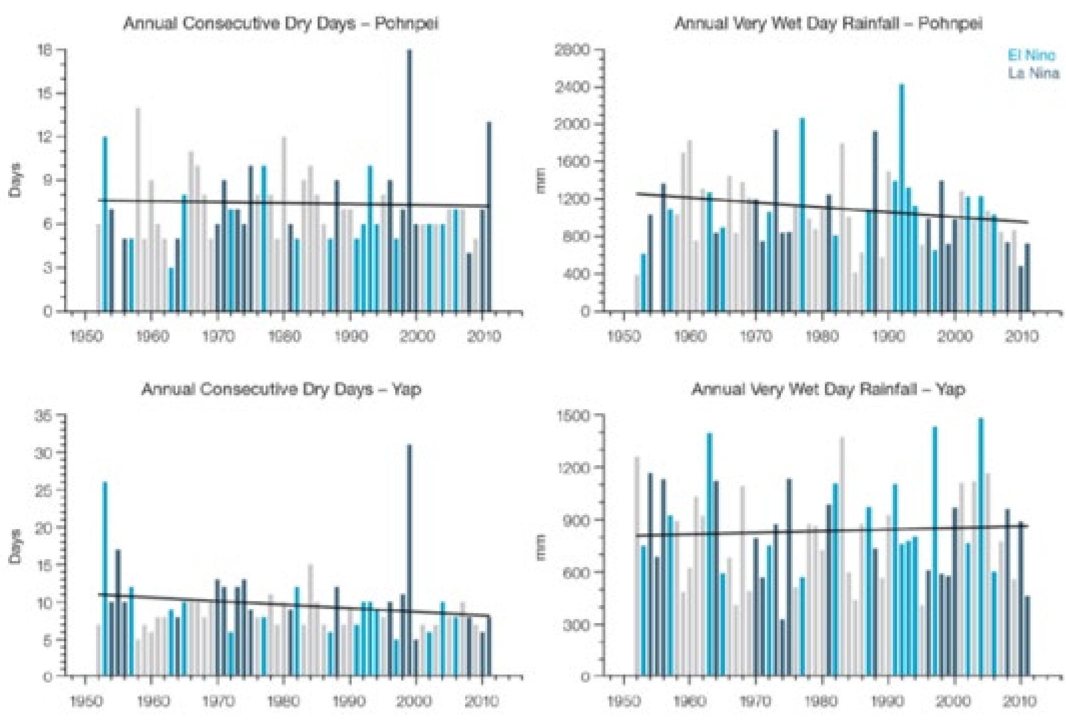

Figure 4.6: Observed time series of annual Consecutive Dry Days at Pohnpei (top left panel) and Yap (bottom left panel), and annual Very Wet Days at Pohnpei (top right panel) and Yap (bottom right panel). Solid black line indicates least squares fit.

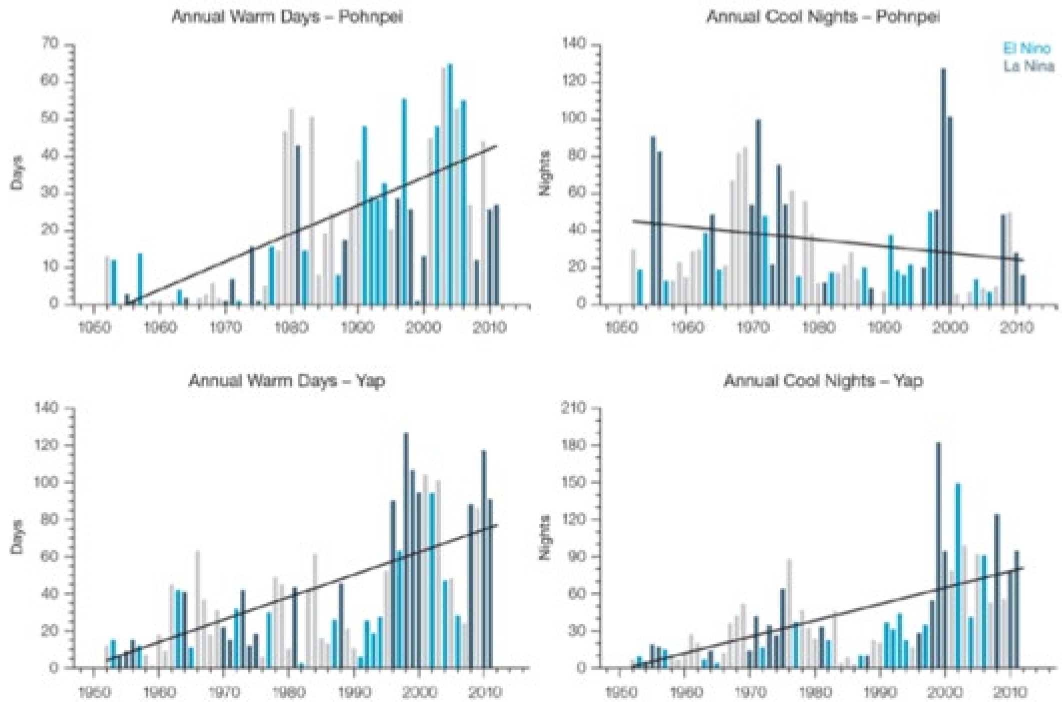

Figure 4.5: Observed time series of annual total number of Warm Days at Pohnpei (top left panel) and Yap (bottom left panel). Annual total number of Cool Nights at Pohnpei (top right panel) and Yap (bottom right panel). Solid black line indicates least squares fit.

Figure 4: FSM Historic Rainfall and Temperature

Climate projections suggest that the frequency and occurrence of higher maximum daily temperatures will dramatically increase for Pohnpei and FSM more broadly. [19] Projections for all emissions scenarios indicate that the annual average air temperature and sea-surface temperature will increase in the future in the Federated States of Micronesia (Table 1). By 2030, under a very high emissions scenario, this increase in temperature is projected to be in the range of 1.1–2.0°F (0.6–1.1°C). Increases in air temperature can cause crop damage in extreme events and decrease optimal yields from staple crops particularly sensitive crops like giant taro and fruit trees.[20]

Table 2: Projections for Increases in Air Temperature in FSM

FSM East	2030	2050	2070	2090
Very low	0.7–1.6 °F (0.4–0.9 °C)	1.1–2.2 °F (0.6–1.2 °C)	0.9–2.2 °F (0.5–1.2 °C)	0.9–2.2 °F (0.5–1.2 °C)
Low	0.9–1.8 °F (0.5–1.0 °C)	1.3–2.5 °F (0.7–1.4 °C)	1.8–3.4 °F (1.0–1.9 °C)	1.8–3.8 °F (1.0–2.1 °C)
Medium	0.7–1.6 °F (0.4–0.9 °C)	1.3–2.5 °F (0.7–1.4 °C)	1.8–3.6 °F (1.0–2.0 °C)	2.3–4.7 °F (1.3–2.6 °C)
High	1.1–2.0 °F (0.6–1.1 °C)	1.8–3.4 °F (1.0–1.9 °C)	2.9–5.6 °F (1.6–3.1 °C)	3.8–7.4 °F (2.1-4.1 °C)

[19] FSM National Communication on Climate Change pg. 20-22; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf
[20] Pacific-Australia Climate Change Science and Adaptation Planning Program; Available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2014/07/PACCSAP_CountryReports2014_WEB_140710.pdf

FSM West	2030	2050	2070	2090
Very low	0.7–1.6 in (0.5–0.9 cm)	1.1–2.0 in (0.6–1.1 cm)	0.9–2.2 in (0.5–1.2 cm)	0.7–2.2 in (0.4–1.2 cm)
Low	0.9–1.8 in (0.5–1.0 cm)	1.4–2.5 in (0.8–1.4 cm)	1.8–3.2 in (1.0–1.8 cm)	1.8–3.8 in (1.0–2.1 cm)
Medium	0.7–1.6 in (0.4–0.9 cm)	1.3–2.5 in (0.7–1.4 cm)	2.0–3.4 in (1.1–1.9 cm)	2.5–4.7 in (1.4–2.6 cm)
High	1.1–2.0 in (0.6–1.1 cm)	2.0–3.4 in (1.1–1.9 cm)	2.9–5.6 in (1.6–3.1 cm)	3.8–7.2 in (2.1–4.0 cm)

Projections of both rainfall and temperature variability for FSM East and West can be seen below. [21]

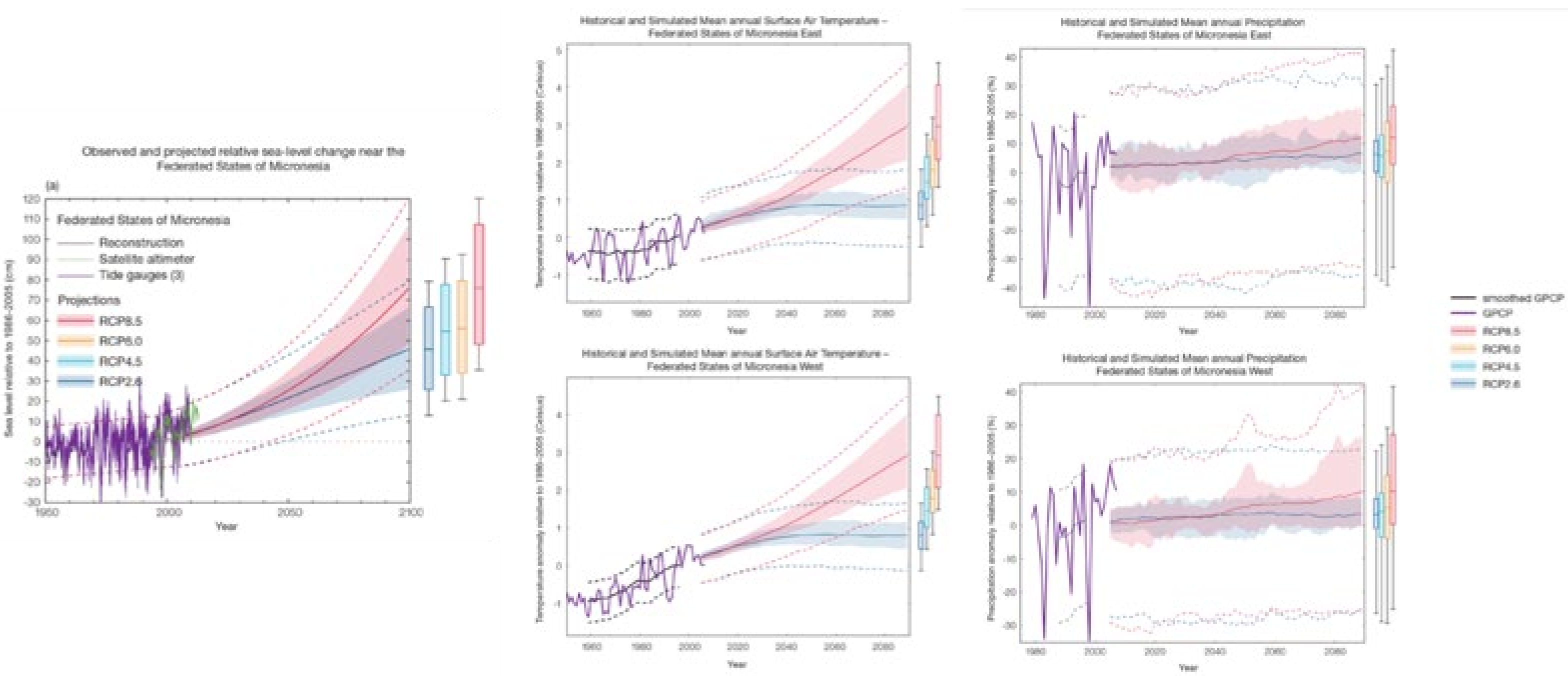

Figure 5: Projections for Sea Level Rise, Air Temperature, and Precipitation in FSM

Extreme hourly and daily rainfall events, such as Tropical Storm Chataan which resulted in massive landslides and damage across Chuuk state are also projected to increase in frequency, particularly in Pohnpei and Kosrae. [22] The incidence of drought is also expected to decrease over the 21st century (except during ENSO conditions as outlined below), consistent with an overall increase in rainfall for FSM. Recent projections suggest that:

- mild drought will occur:
    - approximately eight to nine times every 20 years in 2030
    - approximately seven to eight times every 20 years by 2090 under the B1 (low) emissions scenario,

[21] FSM National Communication on Climate Change; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[22] FSM National Communication on Climate Change pg. 23-25; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

- and six to seven times under the A1B (medium) and A2 (high) scenarios
- moderate drought will occur:
    - once to twice every 20 years in 2030
    - once every 20 years in 2090 for all emissions scenarios
- severe droughts will occur:
    - approximately once every 20 years across all time periods and scenarios

Below is the statistical spread for drought projections in FSM. [23]

Additionally, islands within FSM will also be subject to more intense precipitation events as the climate changes.[24] These precipitation events are projected to result in increased flooding in areas already prone to flooding, such as low-lying agricultural zones. For example, high hazard flood zones on the main islands of Pohnpei and Yap will experience more extreme flooding during the projected intense precipitation events.[25][26]

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[23] Pacific-Australia Climate Change Science and Adaptation Planning Program; Available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2014/07/PACCSAP_CountryReports2014_WEB_140710.pdf

[24] GCF Country Program – Federated States of Micronesia; Available at: https://www.greenclimate.fund/sites/default/files/document/micronesia-country-programme.pdf

[25] Department of Environment Climate Change and Emergency Management (DECEM) FSM. Pohnpei Flooding Hazard.

[26] Department of Environment Climate Change and Emergency Management (DECEM) FSM. Yap Main Island Inundation & Sea Level Rise (SLR) Hazard Zone.

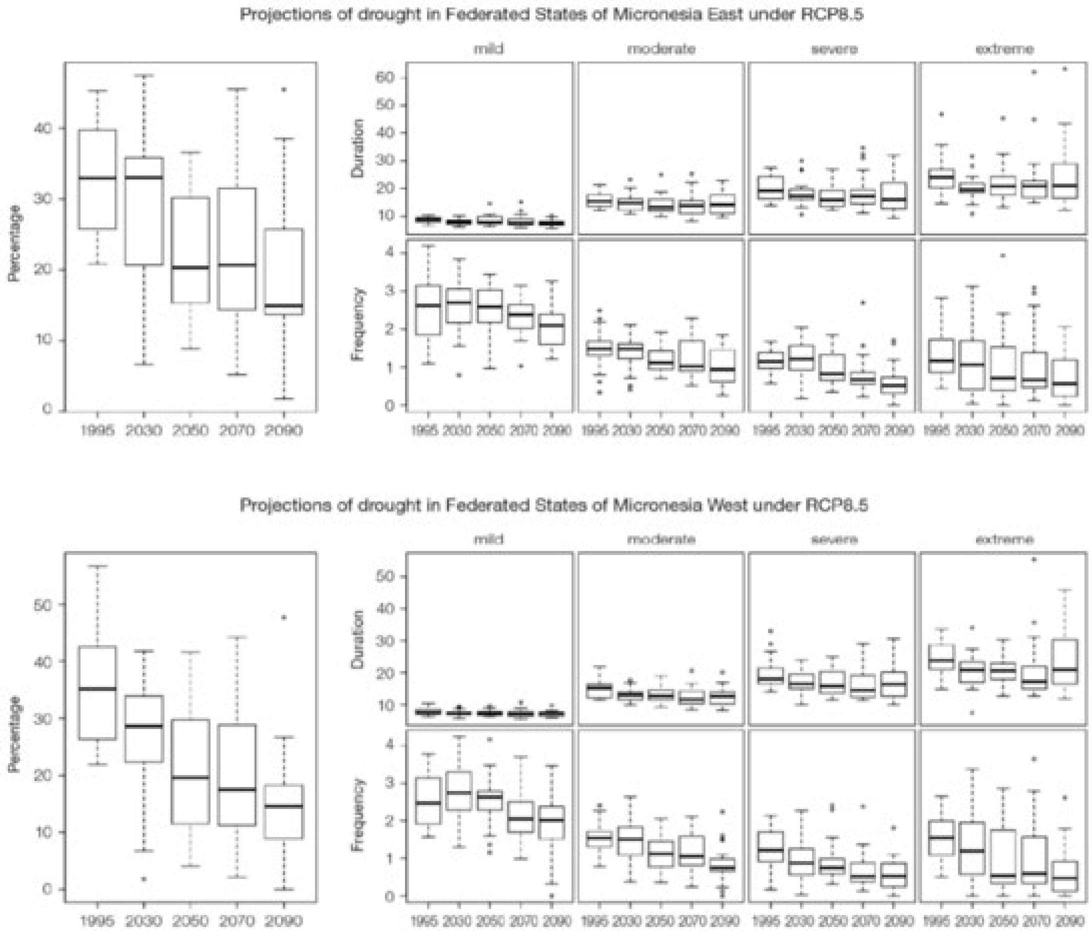

Figure 4.10: Box-plots showing percent of time in moderate, severe or extreme drought (left hand side), and average drought duration and frequency for the different categories of drought (mild, moderate, severe and extreme) for the eastern (top) and western (bottom) Federated States of Micronesia. These are shown for 20-year periods centred on 1995, 2030, 2050, 2070 and 2090 for the RCP8.5 (very high emissions) scenario. The thick dark lines show the median of all models, the box shows the interquartile (25–75%) range, the dashed lines show 1.5 times the interquartile range and circles show outlier results.

Figure 6: FSM Projections for Drought Occurrence

Sea Temperature and Ocean Acidification

Historical changes in sea surface temperatures around FSM are consistent with the broad-scale sea-surface temperature trends for the wider Pacific region. Warming was relatively weak from the 1950s to the late 1980s. This was followed by a period of more rapid warming (approximately 0.11°C per decade and approximately 0.08°C per decade from 1970 to 2009, in the eastern and western regions respectively). At these regional scales, natural variability plays a large role in determining the sea surface temperature, making it difficult to identify long-term trends. [27] However, such increases in sea temperature can substantially impact marine ecosystems and the intensity of waves and storms which can exacerbate climate change impacts on food security systems, particularly in small island states like FSM.

[27] FSM National Communication on Climate Change pg. 20; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

Climate change is also driving acidification in ocean systems. FSM has observed a decline in optimal growing chemistries for coral reefs as a result of ocean acidification, but the conditions have not yet been classified as marginal or extremely marginal for coral growth, but climate projections for acidification suggest FSM marine environment will continue to degrade and reach critical conditions by mid-century.[28]

Below are projections for ocean acidification in FSM.[29]

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[28] FSM National Communication on Climate Change pg. 26; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[29] Pacific-Australia Climate Change Science and Adaptation Planning Program; Available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2014/07/PACCSAP_CountryReports2014_WEB_140710.pdf

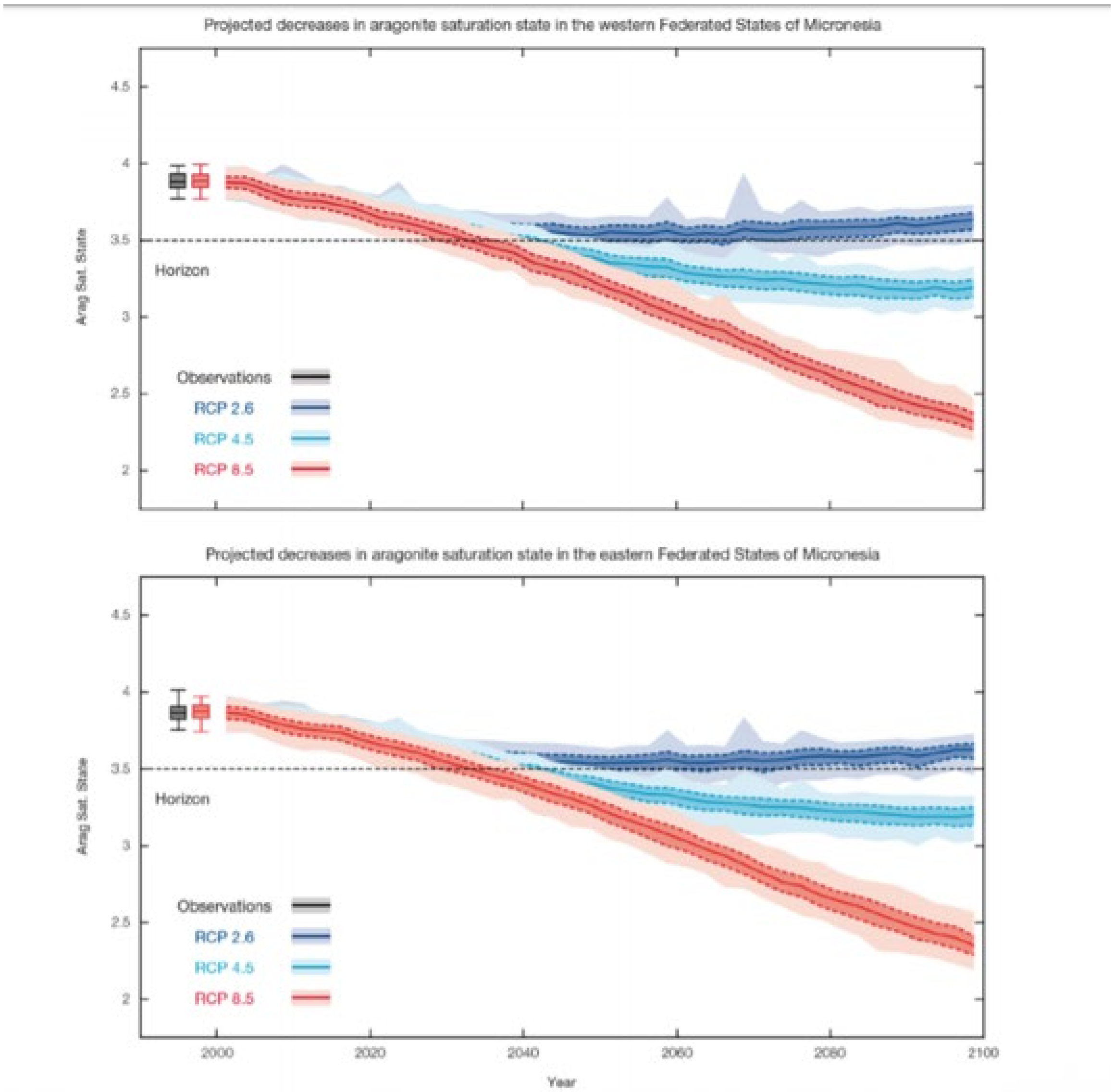

Figure 4.12: Projected decreases in aragonite saturation state in western (upper) and eastern (lower) Federated States of Micronesia from CMIP5 under RCPs 2.6, 4.5 and 8.5. Shown on this plots are the median values, the interquartile range (the dashed line), and 5% and 95% percentiles. The horizontal line represents the transition to marginal conditions for coral reef health (from Guinotte et al., 2003).

Figure 7: FSM Aragonite Saturation (Ocean Acidification) Projections

Substantial negative impacts on coastal and marine ecosystems are likely. Rising ocean temperatures and ocean acidification (via increased concentration of carbon dioxide) may have significant adverse impacts on coral reefs, coastal ecosystems, and migratory fish stocks such as tuna, which represent a substantial economic value and food source for FSM. [30][31][32][33]

Declining Agroforestry and Increased Pests and Diseases for Crops

Forests and planted trees can help local communities adapt to climate change through livelihood diversification and provision of ecosystems services, but impacts of climate change, particularly sea level rise, increased erosion and saltwater damage, and clearing of stands to compensate for lost arable land are driving a substantial decline in forestry resources, particularly barrier ecosystems in FSM. [34]

An assessment of food security in FSM identified the possibility of climate change triggering expanded opportunities for pests and disease in staple crops, particularly the expansion of fruit flies, mealybugs, scale insects, and whiteflies.[35] A further assessment highlighted uncertain impacts of climate change on pests, but noted that there was significant potential for expanded optimal conditions for pest spread, particularly for fruiting trees.[36]

Typhoons

Tropical cyclone numbers are projected to decline in the tropical North Pacific Ocean over the course of the 21st century. Consistent with this, is a projected decrease in the proportion of the most severe storms (those stronger than the current climate 90th percentile storm maximum wind speed). Most simulations project an increase in the proportion of storms occurring in the weaker categories. Associated with this is a reduction in cyclonic wind hazard. This is under normal conditions, but since typhoons in FSM are greatly influenced by ENSO variation as discussed below, the overall risk of typhoons under future climate change remains a significant unknown. [37]

El Nino and ENSO Induced Impacts

FSM's climate and sea level are both strongly modulated by the ENSO. El Nino events in FSM tend to cause droughts which have resulted in water and food shortages (including staples such as taro, coconut, breadfruit, banana, yam, sweet potato, and citrus), impacts on terrestrial

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[30] FSM Chuuk Joint State Action Plan for Disaster Risk Management and Climate Change; http://bsrp.gsd.spc.int/wp-content/uploads/2019/01/chuuk-action-plan-for-web.pdf
[31] FSM Pohnpei Joint State Action Plan for Disaster Risk Management and Climate Change; http://bsrp.gsd.spc.int/wp-content/uploads/2017/08/JSAP-report_web-1.pdf
[32] FSM Yap Joint State Action Plan for Disaster Risk Management and Climate Change; http://bsrp.gsd.spc.int/wp-content/uploads/Publications/FSM_Yap_JSAP.pdf
[33] FSM Kosrae Joint State Action Plan for Disaster Risk Management and Climate Change; Available at: http://bsrp.gsd.spc.int/wp-content/uploads/Publications/Kosrae_JSAP.pdf
[34] Fourteen Atoll Assessment of Food Security via Federated States of Micronesia Second National Communication on Climate Change pg. 57; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf
[35] Fourteen Atoll Assessment of Food Security via Federated States of Micronesia Second National Communication on Climate Change pg. 61; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf
[36] http://pubs.iclarm.net/resource_centre/2015-15.pdf
[37] Federated States of Micronesia Second National Communication on Climate Change; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

habitats, wildfires, and invasive species. [38] ENSO variations also significantly impact the mean sea level across FSM which impacts tidal surges, rainfall, and extreme events like typhoons. The ENSO cycle has a profound effect on the distribution of tropical cyclones in the FSM. During La Nina events, above average numbers of tropical storms occur in the FSM region. The formation region of cyclones is also impacted. During El Nino, typhoon formation extends eastward resulting in an increased risk of a typhoon for Pohnpei during El Nino years, and a decreased risk during the year following El Nino and during La Nina years. On Pohnpei, the risk of having typhoon force winds of 65 kt (33.4ms-1) or greater is one year in 10 for El Nino years, and approximately one year in 50 for non-El Nino years. Overall, the effect that climate change will have on ENSO incidence and severity remains a critical uncertainty, but it has the potential to dramatically shape climate and impact in FSM.

The islands of FSM were severely impacted by drought during El Niño conditions of 1997-1998. Insufficient rainfall caused water and food shortages including staples such as taro, coconut, breadfruit, banana, yam, sweet potato, citrus, sugar cane, and others. Communities among the atolls survived because bottled water, food supplies, and reverse osmosis pumps were imported. A survey undertaken in April 1999 revealed 75% of the breadfruit trees and 68% of the coconut trees were either severely stressed and/or dying as a result of the El Nino induced drought. Meanwhile, taro, the primary source of starch on the atoll, was estimated to be at 25% of its pre-drought levels, with importation from other islands needed to make up the deficit. [39]

In 2007 and again in 2008, FSM communities were flooded by a combination of large swell and spring high tides that eroded beaches, undercut and damaged roads, intruded aquifers and wetlands, and inundated communities. Once again food and drinking water were in short supply. Seawater flowed into coastal wetlands and surged up through the water table, killing taro, breadfruit, and other foods. Fresh water ponds and wetlands turned brackish and have not recovered. Crop sites in use for generations were physically and chemically damaged or destroyed on approximately 60 percent of inhabited atoll islets. A nationwide state of emergency was announced on December 30, 2008 and food security was declared the top priority in the nation.

Additional State Specific Impacts

Some additional state specific impacts and vulnerabilities from their individual adaptation plans are highlighted below.

Kosrae[40]

- Combined with natural variability, sea-level rise will enhance impacts of storm surges and flooding in Kosrae. For Kosrae, approximately 97% of all current high tides are less than 2 m high. Sea-level rise will alter these statistics as follows:

[38] Federated States of Micronesia Second National Communication on Climate Change; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[39] Post Disaster Assessments of FSM Outer Islands via Federated States of Micronesia Second National Communication on Climate Change pg. 83; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[40] FSM Kosrae Joint State Action Plan for Disaster Risk Management and Climate Change; Available at: http://bsrp.gsd.spc.int/wp-content/uploads/Publications/Kosrae_JSAP.pdf

- In the 2030s, the high-tide level of 2 m will be exceeded by 12% of all high tides.
- In the 2050s, the high-tide level of 2 m will be exceeded by 27% of all high tides.
- In the 2070s, the high-tide level of 2 m will be exceeded by 69% of all high tides.
- In the 2090s, the high-tide level of 2 m will be exceeded by 95% of all high tides.

- It is likely that sea-level rise will result in salinization of agricultural land, with coastal areas of Kosrae vulnerable to high seas and storm surge. Land loss via erosion is also likely, further reducing the availability of suitable land to grow crops.
- Climate change, and potential alterations to rainfall patterns, pose only a moderate risk to water resources through drought, except when associated with intense El Niño events such as the event that caused the 1998 drought.
- Substantial negative impacts on coastal and marine ecosystems are likely. Rising ocean temperatures and ocean acidification (via increased concentration of carbon dioxide) may have significant adverse impacts on coral reefs, coastal ecosystems, and migratory fish stocks such as tuna, which represent a substantial economic resource for Kosrae.

Yap [41]

- It is likely that sea-level rise will result in salinization of agricultural land, with outlying islands and coastal areas of Yap Proper vulnerable to high seas and storm surge. Land loss via erosion is also likely, particularly in the low-lying outlying islands, further reducing the availability of suitable land to grow crops and affecting food security.
- Climate change may have significant adverse impacts upon coral reefs, coastal ecosystems, and migratory fish stocks such as tuna, which represent a substantial economic resource for Yap.

Chuuk[42]

- Projections indicate that the air temperature and sea surface temperature will continue to increase into the future for the FSM and for Chuuk. An increase in hot days and a decrease in cool weather are also predicted.

Pohnpei[43]

- Pohnpei is vulnerable to periods of low rainfall (sometimes associated with El Nino events), with past drought events providing examples of such challenges. Climate change, and potential alterations to rainfall patterns, therefore poses a moderate risk to water resources through enhanced or prolonged drought. Pohnpei's outlying islands often have limited groundwater, thus any reduction in rainfall leaves them prone to water shortages. Pohnpei is vulnerable to projected periods of increased rain and has inadequate current drainage infrastructure to manage current water flows, let alone increased rainfall. Inadequate drainage is likely to be increased in the future.

[41] FSM Yap Joint State Action Plan for Disaster Risk Management and Climate Change; http://bsrp.gsd.spc.int/wp-content/uploads/Publications/FSM_Yap_JSAP.pdf
[42] FSM Chuuk Joint State Action Plan for Disaster Risk Management and Climate Change; http://bsrp.gsd.spc.int/wp-content/uploads/2019/01/chuuk-action-plan-for-web.pdf
[43] FSM Pohnpei Joint State Action Plan for Disaster Risk Management and Climate Change; http://bsrp.gsd.spc.int/wp-content/uploads/2017/08/JSAP-report_web-1.pdf

- It is likely that sea-level rise will result in salinization of agricultural land, with outlying islands and coastal areas of Pohnpei Island vulnerable to high seas and storm surge. Land loss via erosion is also likely, particularly in the low-lying outlying islands, further reducing the availability of suitable land to grow crops and affecting food security
- Substantial negative impacts on coastal and marine ecosystems are likely. Rising ocean temperatures and ocean acidification (via increased concentration of carbon dioxide) may have significant adverse impacts upon coral reefs, coastal ecosystems, and migratory fish stocks such as tuna, which represent a substantial economic resource for Pohnpei.

As part of the FSM Country Program development for GCF rapid vulnerability assessments were conducted for each of the four states.[44] The results are summarized below.

Figure 8: GCF Country Programme Vulnerability Assessment

			Vulnerability Assessment		
Yap	**Stressors**	**Projected Climate Change Impacts**	**Sensitivity IDEAL -LOW**	**Adaptive Capacity IDEAL -LOW**	**Vulnerability IDEAL -LOW**
Agriculture	Earthquakes, Tsunamis, Typhoons Flooding Drought Wildfires High Seas Storm Surges, Human Induced vulnerabilities	▪ Increase in air and sea temperatures up to 3.5°C ▪ Increased ocean acidity (OA) ▪ Reduced frequency of droughts ▪ Decreased typhoon frequency ▪ Decreased frequency of severe storms ▪ Rise in sea levels (SLR) up to 60cm by 2070 ▪ Land loss via erosion especially in low lying outer islands	HIGH-Agriculture production sensitive to periods of low rainfall, limited groundwater, flooding events associated with typhoons, salination of agricultural land, high sea storm surges in outer islands and coastal areas of Yap proper	MEDIUM- Can address through priority projects under JSAP but costly. Current efforts underway through 'Ridge to Reef' project focusing on sustainable land management.	HIGH-Although project priorities have been identified and endorsed, institutional efficacy to secure funds and implement adaptation and mitigation priorities are slow and challenging given the remote and dispersed islands of Yap. Agriculture Policy as well as food and farming systems do not address the impacts of climate change relating to biodiversity, skilled sufficient labour and supporting infrastructure.
Fisheries, coastal ecosystems and biodiversity	Drought, Wildfires, Human Induced vulnerabilities	▪ Increase in air and sea temperatures up to 3.5°C ▪ Increased ocean acidity ▪ Rise in sea levels up to 60cm by 2070	HIGH- Coastal ecosystem health sensitive to SLR, OA and human induced vulnerabilities.	MEDIUM- Can address through priority projects under JSAP but costly. Current efforts underway through 'Ridge to Reef 'project focusing on protected areas management, the Micronesian Challenge Trust FSM Program, TNC adaptation projects.	HIGH-Although project priorities have been identified and endorsed, institutional efficacy to secure funds and implement adaptation and mitigation priorities are slow and challenging given the remote and dispersed islands of Yap.
Kosrae	**Stressors**	**Projected Climate Change Impacts**	**Sensitivity IDEAL -LOW**	**Adaptive Capacity IDEAL -LOW**	**Vulnerability IDEAL -LOW**
Agriculture	Higher than normal tides Large Sea Swells Increased impact of storm surges	▪ Increase in air and sea temperatures up to 3.5°C	HIGH-Agriculture production sensitive to, flooding events	MEDIUM- Can address through priority projects under JSAP but costly. Current	HIGH-Although project priorities have been identified and endorsed, institutional efficacy to secure funds and

[44] FAO Climate risks, vulnerabilities and impacts of climate change on the agricultural sector in FSM: Assisting Small Island States to Integrate the Agricultural Sectors into Climate Change Priorities and Nationally Determined Contributions (2020); Draft available in Annex 5 below.

	Flooding due to SLR Tropical storms Typhoons Drought Landslides Human Induced vulnerabilities	▪ Increased ocean acidity (OA) ▪ Reduced frequency of droughts ▪ Decreased typhoon frequency ▪ Decreased frequency of severe storms ▪ Rise in sea levels (SLR) up to 60cm by 2070 ▪ Land loss via erosion	associated with typhoons, salination of agricultural land, high sea and storm surges.	efforts underway through 'Ridge to Reef' project focusing on sustainable land management.	implement adaptation and mitigation priorities are slow and challenging. Agriculture Policy as well as food and farming systems do not address the impacts of climate change relating to biodiversity, skilled sufficient labour and supporting infrastructure.
Fisheries, coastal ecosystems and biodiversity	Higher than normal tides Large Sea Swells Increased impact of storm surges and flooding due to SLR Tropical storms Typhoons Drought Landslides Human Induced vulnerabilities	▪ Increase in air and sea temperatures up to 3.5°C ▪ Rise in sea levels up to 60cm by 2070 ▪ Increased ocean acidity	HIGH- Coastal ecosystem health sensitive to SLR, OA and human induced vulnerabilities.	MEDIUM- Can address through priority projects under JSAP but costly. Current efforts underway through 'Ridge to Reef' project focusing on protected areas management, the Micronesian Challenge Trust FSM Program, under the TNC adaptation projects.	HIGH-Although project priorities have been identified and endorsed, institutional efficacy to secure funds and implement adaptation and mitigation priorities are slow and challenging.
Pohnpei State	**Stressors**	**Projected Climate Change Impacts**	**Sensitivity IDEAL -LOW**	**Adaptive Capacity IDEAL -LOW**	**Vulnerability IDEAL -LOW**
Agriculture	Droughts Variable rain patterns Typhoons during El Nino periods Tropical storms High Sea Levels during El Nina Human Induced vulnerabilities	Increase in air and sea temperatures up to 3.5°C More often extreme rainfall days Reduced frequency of droughts Decreased typhoon frequency Decreased frequency of severe storms Increased OA Rise in sea levels (SLR) up to 60cm by 207	HIGH-Agriculture production sensitive to, flooding events associated with typhoons, salination of agricultural land, high sea and storm surges on outer islands.	MEDIUM- Can upgrade system through priority projects under JSAP but costly. Current efforts including 'Ridge to Reef' project and Micronesia Challenge Terrestrial project underway. As the nation's capital state, Pohnpei has the advantage on availability and accessibility of assistance.	HIGH-Although project priorities have been identified, they are yet to be endorsed. Despite some favorable projected climate change impacts, institutional efficacy to secure funds and implement adaptation and mitigation priorities are slow and challenging especially given Pohnpei's remote and dispersed outer islands. Agriculture Policy as well as farming systems do not address the impacts of climate change sufficiently with gaps relating to biodiversity, skilled sufficient labour and supporting infrastructure.
Fisheries, coastal ecosystems and biodiversity	Droughts Variable rainfall patterns Typhoons during El Nino periods Tropical storms High Sea Levels during El Nina Human Induced vulnerabilities	▪ Increase in air and sea temperatures up to 3.5°C ▪ Rise in sea levels up to 60cm by 2090 ▪ Increased ocean acidity	HIGH- Coastal ecosystem health sensitive to SLR, OA and human induced vulnerabilities.	MEDIUM- Can address through priority projects under JSAP but costly. Current efforts underway through 'Ridge to Reef' project focusing on protected areas management, the Micronesian Challenge Trust FSM Program, under the TNC adaptation projects. As the nation's capital state, Pohnpei has the advantage on availability and accessibility of assistance.	HIGH-Although project priorities have been identified they are yet to be endorsed. Despite some favorable projected climate change impacts, institutional efficacy to secure funds and implement adaptation and mitigation priorities are slow and challenging especially given Pohnpei's remote and dispersed outer islands.

Chuuk	Stressors	Projected Climate Change Impacts	Sensitivity IDEAL -LOW	Adaptive Capacity IDEAL -LOW	Vulnerability IDEAL -LOW
Agriculture	Droughts Typhoons Tropical storms High Sea surges in outer islands Human Induced vulnerabilities	▪ Increase in air and sea temperatures ▪ More often extreme rainfall days ▪ Reduced frequency of droughts ▪ Decreased typhoon frequency ▪ Decreased frequency of severe storms ▪ Increased OA ▪ Rise in sea levels (SLR) up to 60cm by 2070	HIGH-Agriculture production sensitive to, flooding events associated with typhoons, salination of agricultural land, high sea and storm surges on outer islands.	MEDIUM- Can upgrade system through priority projects under JSAP but costly. Current efforts including 'Ridge to Reef' project focusing on SLM. However, the low capacity of the Chuuk State Agriculture Department is an issue.	HIGH-Although project priorities have been identified, they are yet to be endorsed. Despite some favorable projected climate change impacts, institutional efficacy to secure funds and implement adaptation and mitigation priorities are slow and challenging especially given the land ownership issues in Chuuk and its remote and dispersed islands. Agriculture Policy as well as farming systems do not address the impacts of climate change sufficiently with gaps relating to biodiversity, sufficient skilled labour and supporting infrastructure.
Fisheries, coastal ecosystems and biodiversity	Droughts Typhoons Tropical storms Storm-waves Flooding Landslides High Sea Levels in outer islands Human Induced vulnerabilities	▪ Increase in air and sea temperatures up to 3.5°C ▪ Rise in sea levels up to 60cm by 2090 ▪ Increased ocean acidity	HIGH- Coastal ecosystem health sensitive to SLR, OA and human induced vulnerabilities.	MEDIUM- Can address through priority projects under JSAP but costly. Current efforts underway through 'Ridge to Reef' project focusing on protected areas management, the Micronesian Challenge Trust FSM Program, under the TNC adaptation projects.	HIGH-Although project priorities have been identified they are yet to be endorsed. Despite some favorable projected climate change impacts, institutional efficacy to secure funds and implement adaptation and mitigation priorities are slow and challenging especially given the land ownership issues in Chuuk and its remote and dispersed islands

Agriculture and Poverty Baseline

State by State Agriculture Snapshot

The FAO Report "Climate risks, vulnerabilities and impacts of climate change on the agricultural sector in FSM: *Assisting Small Island States to Integrate the Agricultural Sectors into Climate Change Priorities and Nationally Determined Contributions"*[45] highlights state level agriculture snapshots below.

[45] FAO Climate risks, vulnerabilities and impacts of climate change on the agricultural sector in FSM: Assisting Small Island States to Integrate the Agricultural Sectors into Climate Change Priorities and Nationally Determined Contributions (2020); Draft available in Annex 5 below.

Yap State

- Population 11,376 (2010 Census). A little over half of the population of Yap State live on the main island, Yap Proper.
- Yap's indigenous cultures and traditions are reportedly still strong compared to neighbouring states.
- 33.6% of the population are involved in subsistence activities.
- Yap has the lowest proportion of households in FSM where expenditures are below the Food Poverty Line
- Traditional food preservation methods (Fermentation of breadfruit in pits, creating pandanus and arrowroot flour, leaving yams in the ground) provide nourishment in times of disasters when crops are likely to be destroyed or damaged.
- Food and farming systems do not address the impacts of climate change sufficiently with gaps relating to biodiversity, sufficient skilled labour and supporting infrastructure.
- Sea-level rise will result in salinization of agricultural land, with outlying islands and coastal areas of Yap Proper vulnerable to high seas and storm surge. Land loss via erosion likely, particularly in the low lying outlying islands, further reducing the availability of suitable land to grow crops and affecting food security.

Chuuk State

- Population 48,654 (approx. 47% of FSM's total population). Highest population density in FSM of 383 per square km). Also, the youngest population on average relative to other states.
- Chuuk relies heavily on subsistence base. Food from land and the ocean are a big part of their source of food.
- *Kon*, a pounded breadfruit able to be eaten for a week is a popular source of starch for many Chuukese.
- Other preservation method of food such as Epot, fermented
- breadfruit can be stored for months and prepared for consumption
- Key issues addressing the agriculture sector include: inadequate funding and resources; lack of infrastructure for projects communications and transportation; limited agriculture land for development of agriculture is not of high priority by leaders or head of states; capacity level is not high in expertise
- level for R&D and other skill such as reporting; lack of interest and participation in Youth and Women in agriculture; lack of collaboration between in CSDOA and Private Sector for commercial farming potential; lack of policies and enforcement in sustainable land management and forest use

Pohnpei State

- Population 36,196, (approx. 35% of FSM's total population).34,000 reside on Pohnpei Island (2010 Census). The outer islands make up 4% of the population.
- Indigenous agroforestry provides jobs, food security, and income. In high islands this consists of a permanent over-storey of tree crops, forest trees, fruit and multipurpose trees. Understory consists of shrubs, root crops, and herbaceous plants.
- 92% practice home agriculture with households cultivating coconuts, bananas, yams, breadfruit, sakau, swamp taro, and betel nut. Pigpens are common on riverbanks and coastal shores. Almost 86% of Pohnpeians raise livestock, with this number higher in the Outer Islands (94%). Reliance on indigenous agriculture has diminished since Compact of Free Association, with increased reliance on imported, Western food.
- Key priority issues are identified and include: Human and institutional capacity; Food and nutritional security; Limited market opportunities and lack of competitiveness of agricultural products; and Public awareness and collaboration.

Kosrae State

- Population 6,616 (2010 Census).
- While the population of Kosrae is partially dependent upon fishing and farming for their livelihoods, nonfarm activities contribute significantly to income
- Agricultural exports from Kosrae are very small compared to other states and consist mainly of citrus, bananas and root crops.
- Reliance on imported food is high in FSM and particularly so in Kosrae, which has a lower level of subsistence livelihoods (approx. 8.5%) compared to other states (up to 30% in Yap).
- The Agriculture Policy and the Pohnpei Strategic Development Plan acknowledges the importance of agriculture for food security, income and livelihoods (as well as health). Key priority issues are identified and include: Human and institutional capacity; Food and nutritional security; Limited market opportunities and lack of competitiveness of agricultural products; and Public awareness and collaboration.

Soil and Watersheds

Soil composition varies by state as well as between volcanic and atoll islands. For the state of Yap, most of the soils are considered relatively poor for agriculture production.[46] The majority of the main island consists of a rumung/weloy soil type. Soils in Chuuk are additionally overall of relatively poor quality for agriculture. Soil erosion is considered a major concern in Chuuk for areas with slopes greater than 15% and many soils require lime and/or fertilizer to increase their suitability for agricultural production.[47] Similar conditions are present on the main islands of Pohnpei and Kosrae.[48][49][50]

[46] Federated States of Micronesia State-Wide Assessment and Resource Strategy 2010 – 2015 +. Last Accessed 03 August 2020.
[47] Soil Survey of Islands of Truk (Chuuk), Federated States of Micronesia. Last Accessed 03 August 2020.
[48] Soil Survey of Island of Ponape (Pohnpei), Federated States of Micronesia. Last Accessed 03 August 2020.
[49] Although the soil surveys did not include the outer atolls, most atoll islands in this region are characterized by a sandy, coralline dominant soil type.
[50] Soil Survey of Island of Kosrae, Federated States of Micronesia. Last Accessed 03 August 2020.

Although conditions vary slightly by island, the majority of the fertile, alluvial soils that are suitable for endemic food production (breadfruit, banana, taro) are located in low-lying areas on the high, volcanic islands.[51] Outer atoll islands generally have poorer, nutrient deficient soils that are less suitable to agriculture production. Agricultural production on atoll islands occurs along the coastline, such as the cultivation of coconut trees. Both the volcanic and atoll agricultural areas are susceptible to coastal erosion and saltwater inundation from storm surges and sea level rise. Taro patches, which are generally located in low-lying areas, are especially susceptible to saltwater inundation. The coastline of many volcanic and atoll islands in FSM harbor mangrove forests, which act as a buffer from storms and reduce saltwater inundation. However, sea level rise is already affecting the ability of mangroves to shield agroforests and other agricultural areas from sea water intrusion.

Watersheds on the higher, volcanic islands generally allow for sufficient freshwater availability during non-drought years whereas low-lying atolls typically rely on a more fragile freshwater lens for their water supply. Both the mountainous watersheds and freshwater lenses are susceptible to degradation from storm surges and sea level rise. Additionally, during ENSO years drought can occur and negatively affect agricultural production, especially in the more water deficient outer atolls. Watershed health is also dependent on upland forest health and stability. Non-climatic factors including deforestation, landfills and dredging have affected watershed health in recent years and subsequently agriculture that relies on watershed resources.

Vegetation overlays with sea level rise vulnerability for each of the four states are provided below.

[51] Federated States of Micronesia State-Wide Assessment and Resource Strategy 2010 – 2015 +. Last Accessed 02 August 2020.

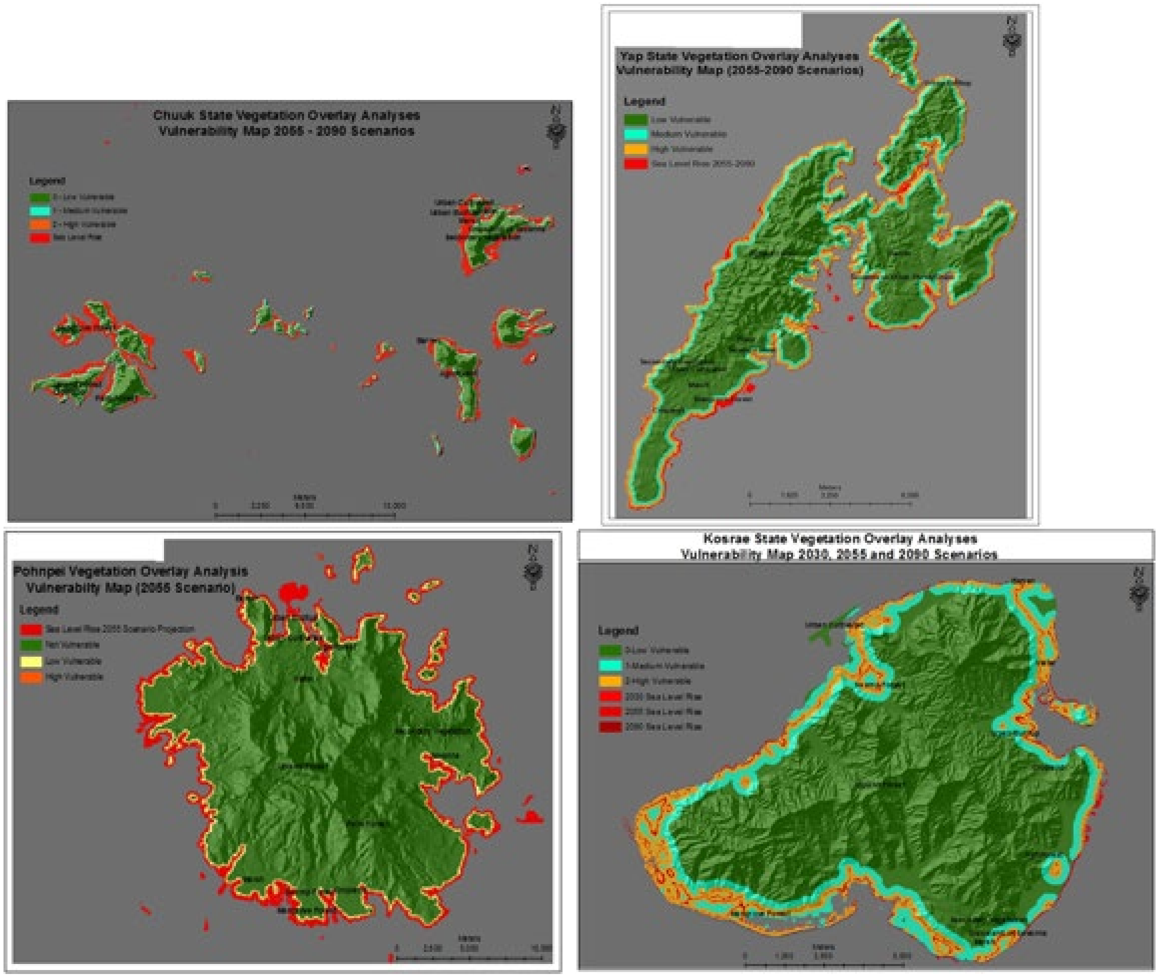

Figure 9: Vegetation Overlays for FSM States

Integrated Agriculture Census[52]

The Integrated Agriculture Census Report (2020) indicates that approximately 40% of the land in FSM is used for agricultural purposes (10% Kosrae, 40% Pohnpei, 70% Chuuk, 47% Yap) and over 90% of FSM households have access to land that can be used for agriculture. Much of the land is used for agroforestry and tree crops, with 70% of household operated (not shared) parcels and 80% of shared parcels of land mainly under tree crops or agroforestry. The primary crops grown are coconut, breadfruit and banana (about 90% of households). Additionally, about 36% of households grow root crops like yams and only 17% of households grow vegetable crops like peppers.

Over 74% of households indicated the main use of crops grown was for self-consumption. The extent of subsistence activity in agriculture is clear, with 92% of those working in agricultural occupations being unpaid. For crops that were sold, over 40% of the households that grew certain crops (sakau, cucumber, betelnut, swamp taro, coconut, and breadfruit) were selling at

[52] FSM Integrated Agriculture Census 2016 (2020); Available at: http://www.fsmrd.fm/wp-content/uploads/2020/06/200120_FSM_IAC_2016.pdf

least a portion of their yields. Across all crops and states the largest number of sales reported were directly to the consumer (38%) closely followed by sales to a public market (35%). Sales to a local shop were also significant at 19%, but sales to a restaurant or hotel were low at 2%, less than sales reported to others at 6%. Across FSM, over 50 percent of households with land for agriculture reported that they received no income from agriculture. In Yap, nearly 70 percent reported no income from agriculture while in Pohnpei less than 40 percent reported receiving no income from agriculture.

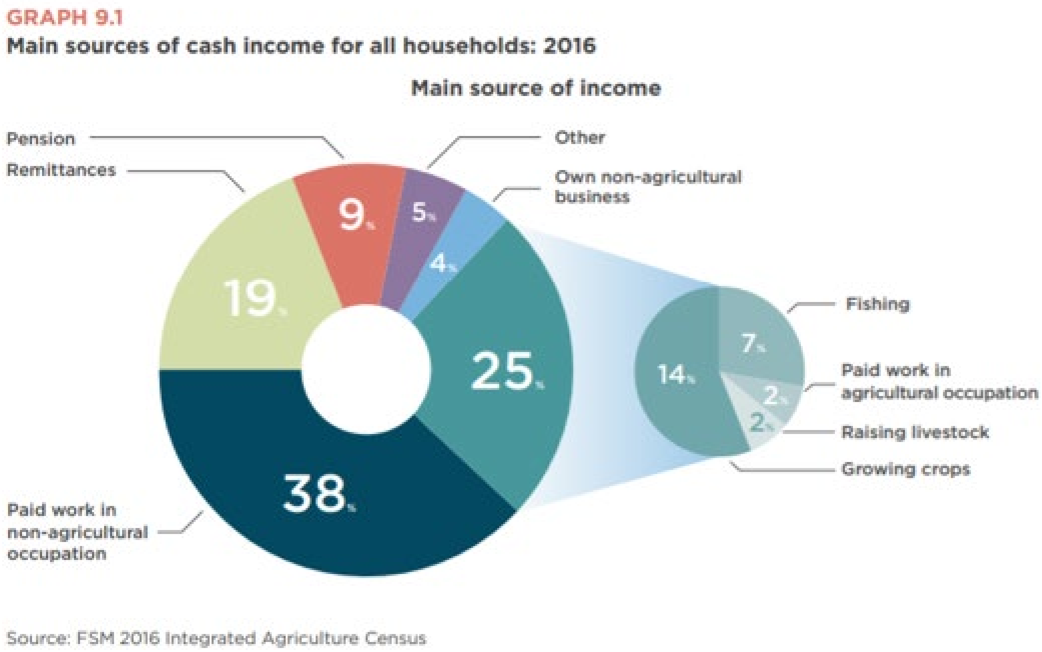

Figure 10: FSM Agriculture Census Main Sources of Cash Income

Under half (48 percent) of the households with land for agriculture reported engagement in markets for their produce. Thirty percent of farm households lived less than an hour from a market, but for 2.5 percent of households there was no market accessible or available. Around nine percent of households with land for agriculture reported participating in product organizations in the past year. This was consistent across the states with participation by 10 percent of farm households in Yap, 8 percent in Chuuk, 9 percent in Pohnpei and 11 percent in Kosrae. Agriculture extension services had visited 19 percent of households in the census year, half of them twice. Chuuk had the highest proportion of households reporting visits from an extension officer with 14 percent reporting one visit and 11 percent reporting two or more visits. However, the main sources of information about agriculture were the radio (31 percent), other farmers (24 percent), or agriculture extension services (13 percent).

Most households reported using the most basic tools. Machetes were reported used by 97% of households with land for agriculture, and shovels were reported by 91%. Nearly all of those using these tools owned their own tools. The next most commonly used equipment were wheelbarrows, weed eaters (line trimmers) and chainsaws (10-52% of households across states).

FSM has a complex system of traditional ownership that dates back centuries. Many parcels of land are held by families or clans that may have different factions, all of whom assert interest in the land. This complicates both the use of the land and the recording of tenure and use of the land. Most land used for agriculture was reported to be freehold land or held with customary titles. About eight% of the land parcels used for agriculture were leased or had other tenure. In Yap, 79% of single household operated parcels and 84% of shared parcels in customary tenure. In Yap only 15% of single household operated parcels were freehold land, while all other states reported over 70% freehold for single household operated parcels. Shared land parcels are more likely to be in customary tenure in other states, with 49% of shared parcels in customary ownership in Kosrae, 37% of shared parcels in customary ownership in Chuuk and 20% of shared parcels in customary ownership in Pohnpei.

A summary of key agricultural facts for FSM can be seen in the table below (pulled from the FSM Integrated Agricultural Census).

	NUMBER	PERCENT OF HOUSEHOLDS WITH LAND AVAILABLE FOR AGRICULTURE
Number of households with access to land for agriculture	14 031	100.0
Number *parcels* of land operated only by single household:	12 019	
Own free-hold land	7 293	
Leases free-hold land	419	
Customary land	3 818	
Leased customary land	223	
Leased government land	192	
Other	74	
Number of households with unshared land parcels	9 850	70.2
Number of households with shared land parcels	9 626	68.6
Median size of total land holding	0.2 acres[1]	
Household with land available for agriculture – *Main purpose*	14 031	100.0
Only for home consumption	10 444	74.4
Mainly for home consumption but occasionally sell	3 365	24.0
Mainly for sale but occasionally consume	211	1.5
Only for sale	11	0.1
Number of people involved in agricultural activities		
Total (aged 15 and over)	21 818	
Males	14 100	
Females	7 718	

	NUMBER	PERCENT OF HOUSEHOLDS WITH LAND AVAILABLE FOR AGRICULTURE
Top crops by number of households reporting growing:		
Coconut	13 301	94.8
Banana	13 118	93.5
Breadfruit	12 906	92.0
Lime/lemon	8 250	58.8
Swamp taro	7 561	53.9
Papaya	7 535	53.7
Mango	7 486	53.4
Betelnut	6 816	48.6
Land taro	6 666	47.5
Pineapple	5 623	40.1
Yam	5 073	36.2
Tapioca	4 989	35.6
Sakau (Kava)	3 382	24.1
Number of households with livestock	9 434	60.7
Numbers of pigs	29 916	
Number of chickens	70 828	
		PERCENTAGE OF ALL HOUSEHOLDS
Barriers to agriculture		
Lack of production inputs	9 700	62
Lack of source of finance	6 262	40
No land available	5 192	33
Lack of management skills	4 612	30
Difficulty getting to the land	3 996	26
Lack of market to see produce	2 763	18
Lack of new tech & infrastructure	1 675	11
No barrier	4 727	30
Number of households with 1 visit from an extension agent	1 298	9.3
Number of households with 2 or more visits	1 327	9.5
Main source of cash income		
Growing crops	2 160	15.4
Raising livestock	276	2.0
Fishing	935	6.7
Own non-agricultural business	483	3.4
Paid work in agricultural occupation	311	2.2
Paid work in non-agricultural occupation	5 098	36.3
Pension	1 282	9.1
Remittances	2 826	20.1
Other	659	4.7
Number of households with 50% or more income from agriculture	1 954	13.9

Source: FSM Integrated Agriculture Census 2016

Figure 11: Summary of FSM Integrated Agriculture Census

Market Assessment[53]

Pohnpei has 3 major vegetable markets, about 20 small stores selling mainly cooked food and 5 large commercial shopping centers selling imported produce from the USA. In Pohnpei there is a fluctuation on the availability of fresh produce, some of the vegetables are not always available. There is room for farmers to produce more vegetables in Pohnpei.

Yap has one Supermarket selling local produce, 8 vegetable markets and 3 Fish markets. The supply with local vegetables in Yap is very good, some farmers were complaining that there are not able to sell there produce all the time.

Chuuk has 16 Roadside Markets, some only sell Betel Nut and cooked/pounded food, other's sell vegetables and fish. In Chuuk there is often a shortage of some of the fresh vegetables like cucumber, eggplants, some vegetables like Chinese Cabbage, leafy vegetables Keng Kong), tomatoes and others are not available. There is room to produce more local vegetables. It was also noted that the prices for local vegetables are very high, sometimes more than twice as high compared to the other FSM States. The information on pounded breadfruit in Chuuk is very high, it is questionable if the seasonality was considered in the estimation. Some of the products are sold at the markets and taken (re-exported) by aircraft passengers to Guam or Hawaii.

Kosrae has 20 formally registered Local Markets. It is not known if all of them are continuing to operate, or at what level, however this number is consistent over the last 20 years and indicates a generally thriving domestic agricultural market and demand for such products. There are approximately 3-5 such markets and stores selling agricultural and marine products which are the largest in any given year, purchasing produce from other farmers as well as supplying their establishments with their own grown foods, generally with family affiliated green houses and farms. In addition, there is currently at least one monthly Farmers Market in the beachside community of Tafunsak. All of the markets generally sell packaged cook foods known as 'take outs', in particular Sunrise Market, which is situated in the government center of the island. There are four large stores selling imported produce from the USA. In Kosrae there is a fluctuation in the availability of fresh produce, and some of the vegetables are not always available. There is room for farmers to produce more locally, for both the domestic and export markets.

Household Income Survey

In 2013/2014, 63% of FSM households reported conducting some form of agricultural activity and 43% of the labor force conducted agriculture as a primary or secondary activity with agriculture contributing 14% to overall household income. However, nearly 40% of households produce goods purely for subsistence and only 24% of FSM households have sold any part of their agriculture production.[54] Agricultural engagement varies across the states. In Yap 90% of

[53] GAFSP FSM Market Study (July 2019); Available at: https://www.gafspfund.org/sites/default/files/inline-files/Note%201.%20Multi-country_GAFSP%20SIFWaP%20FSM%20Market%20Study.pdf

[54] Household Income and Employment Survey 2013/2014 Agriculture Factsheet; Available at: https://pafpnet.spc.int/attachments/article/806/FSM%20Agriculture%20fact%20sheet%20Final.pdf

households engage in agricultural activities, but only 28% have sold any of their production. In Pohnpei 69% of households engage in agriculture, and a relatively large proportion of households (36%) have sold some of their production. In Chuuk and Kosrae agricultural engagement is lower (50% and 59% respectively), as is the percentage of households that have sold their production (12% and 20%, respectively).

Of the total value of agricultural products, 24% was sold, 63% was consumed at home and 14% was gifted. The most valuable food crops sold across FSM were yam, banana, taro, cucumber, tapioca, green coconut and copra, with the remainder being predominantly a mix of vegetables and fruit.[55]

In FSM in 2013/2014, meeting essential caloric needs required an average of $US1.84 per adult per day; meeting both food and non-food basic needs required on average $US4.34 per day. At the national level, about 10% of people in FSM are below the food poverty line and 41% are below the total poverty line. The poverty gap index, which indicates the extent to which average adult equivalent expenditures fall short of the poverty lines, is estimated at 3.6% at the food poverty line and 15.1% at the total poverty line. Chuuk has the highest proportion of people below the food poverty line (16%), followed by Yap (10%), Pohnpei (2.6%), and Kosrae (<.1%). Across the four states, food expenditures make up significant portions of household spending particularly for the poorest quintiles who allocate 42-76% of their expenditures on food. Even the wealthiest quintiles, however still allocate 32-45% on food. [56]

Table 3: Food Poverty Lines by State

State	Food Poverty Line (Daily per adult equivalent)	Share of Non-food Cost in Total Poverty Line	Total Poverty Line (Daily per adult equivalent)	Food Poverty Line (Annual per adult equivalent)	Total Poverty Line (Annual per adult equivalent)
Yap	$2.46	51.95%	$5.11	$896.3	$1,865.3
Chuuk	$1.72	48.37%	$3.33	$628.1	$1,216.6
Pohnpei	$1.80	66.81%	$5.41	$655.2	$1,974.0
Kosrae	$1.80	58.92%	$4.39	$657.6	$1,600.8

The Second National Communication on Climate Change highlighted that imported food constitutes 17-43% of the households' diets in FSM and that female adults in FSM consumed only 27 percent of their energy and 30 percent of their protein from local sources, with the rest from imported foods, while children had an even greater reliance on imported foods with only 16 percent of their energy and 27 percent of their protein coming from local foods.[57] Trends in imported items in FSM clearly demonstrate an increasing dependency on imported food items such as rice/flour. Total food imports have shown a steep increase from around US$17 million in

[55] Household Income and Employment Survey 2013/2014 Agriculture Factsheet; Available at: https://pafpnet.spc.int/attachments/article/806/FSM%20Agriculture%20fact%20sheet%20Final.pdf
[56] FSM HIES Poverty Profile 2013; Available at: http://www.fsmstatistics.fm/?page_id=115
[57] FSSLP via FSMNC2; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

2000 to US$43.1 million in 2010.[58] Convenience starch foods, including rice, ramen, noodles, flour and bread are the major food items being imported. This group of imports has shown a steep rise over the last 10 years, reflecting a change in diets away from traditional staples. The soaring global prices for food and oil mean the costs of imports will continue to rise.

Food Security Baseline and the Added Threats of Climate Change

The FSM Food Security Vulnerability Assessment[59] and its follow on established a detailed baseline of the major pillars of food security (availability, access, stability, and utilization), the key considerations and driving factors from that assessment are described below.

Availability

Food availability in FSM is becoming increasingly strained from a variety of factors. First, most agricultural production in the FSM is rainfed and subsistence in nature, but production of staple food crops (taro, breadfruit, cassava, yams, banana, coconut, etc.) has been declining in favor of nonfood export items like kava, betel nut, and piper leaves. Further, there is an increasing reliance on imported food because of high prices for local foods compared to imported foods, a growing preference for imported foods in FSM diets, and importantly a loss in knowledge of traditional food systems. Unemployment is also increasing in FSM, particularly in the food production sectors which is reducing total output and raising costs. One of the biggest factors is declining soil fertility mostly from salinization of soils from inundation and coastal erosion. Where this doesn't outright fallow land, rising salinity decreases crop productivity and limits the types of crops that can be grown. Finally, there is very little established connectivity and opportunities for farmers to sell their food in local markets. This leads to declining confidence in the sector and low availability of domestic supply.

Access

Food access, particularly for lower income areas and groups is also constrained in FSM. The low consumption of local foods and reliance on imported food items has also made cash income a major factor in accessing food. Large household sizes, increased unemployment, and a decline in agricultural, livestock, and fisheries income have combined to drive more households below the national food poverty line where they are having to sacrifice other expenditures or resort to lower nutritional alternatives. With loss of arable land and population growth low income households are left with a growing issue of landlessness and an inability to grow food for subsistence. Finally, high prices for local crops further drives households to increasingly rely on imported food.

Utilization

FSM has extremely high prevalence of non-communicable diseases particularly diabetes, heart disease, and chronic obstructive pulmonary disease. The rising levels of low-nutrition imported foods as a share of FSM diets have also driven up rates of obesity and particularly vitamin A

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[58] Federated States of Micronesia Second National Communication on Climate Change pg. 17-18; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf
[59] Fourteen Atoll Assessment of Food Security via FSMNC2 pg. 58-61; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

deficiency. With a lack of institutional capacity and systems for monitoring food supply, there is increased risk of low-quality foods dominating local diets, particularly for low income households.

Stability

Extreme events, particularly droughts and tidal surges, have consistently been a threat to food security in FSM. Many agricultural areas have not recovered from past extreme events or the expanding impacts of salinization and coastal erosion and are fundamentally not resilient or adapted to potential future disasters. Further, current agricultural production, storage, and distribution institutions are ill equipped to cope with extreme events, particularly storm surge, high tides, and drought. The growing reliance on imports also increases the risks of price shocks and food shortages from volatility in global oil/commodity prices and interruptions to supply chains and distribution channels.

More detail on the adaptive context, and baselines for food security and climate change can be seen in Figure 1.

Figure 12: FSM Food Security and Climate Change Baseline

FSM Food Security Climate Baseline

Overview of Adaptive Context, Food Production, Imports, and Poverty

Adaptive Context
- FSM is the 4th most vulnerable country and the 78th least ready country in the world Subsistence agriculture (76%)
- None of the FSM States have a 'high' level of adaptive capacity
- Limited financing for food security (<$500,000/year)
- Post 2023, projected annual financing gap of about USD 41 million, or 35–45% of current national government expenditure levels

Agriculture
- 15.5% of the FSM GDP between (2008-2010)
- Nationally 63% of Households engaged in agricultural activities, particularly agroforestry
- Subsistence agriculture (76%)
- Yam, banana, taro, cucumber, tapioca, green coconut, copra, breadfruit, betel nut , cassava, etc.
- Annual household income from subsistence - $395
- Only 24% of FSM households have sold any part of their production

Imported Food
- 17-43% of household diet is imported food
- 70% of protein and calories from imports
- Total food imports have been dramatically increasing ($43.1 million in 2010)
- Convenience starch foods, including rice, ramen, flour and bread are the major food items being imported

Food and Poverty
- Total Poverty Line - $US 4.34/adult/day with 40% falling below at the national level
- Food Poverty Line - $US 1.84/adult/day with 10% falling below
- The poorest income groups allocated more than half of total expenditures on food

Food Security Status Quo

Availability
- Declining, but significant reliance on subsistence agriculture
- Increased production of export crops instead of staples
- Declining agriculture labor
- Declining soil fertility
- Loss of traditional knowledge for food systems
- Lack of farmers crop markets and connectivity between local production and opportunity
- Growing reliance on imported food

Access
- Significantly increasing unemployment
- Decline in agricultural, livestock, and fisheries income
- Lack of safety nets
- Growing number of households below food poverty lines
- High prices for local food vs. imported food
- Growing issue of landlessness and need for increased production

Utilization
- Extremely high prevalence of non-communicable diseases, particularly diabetes, heart disease, and chronic obstructive pulmonary disease
- High prevalence of obesity and vitamin A deficiency
- Physical inactivity
- Shifting preferences for imported food
- Weak monitoring of food supply

Stability
- Increased risk of flooding and drainage problems for agricultural areas
- Inability of current agricultural production, storage, and distribution to cope with extreme events, particularly storm surge, high tides, and drought
- Risks of price shocks and shortages from global oil/commodity prices due to the reliance on imports

Exacerbates Baseline

Effects of Climate Change

Sea Level Rise
+9 cm by 2030 and +39 cm by 2050.

Increased Sea Temperatures
Increase 0.7°C (+/- 0.5) by 2030 and 2.2°C (+/- 0.9) by 2050

Salinization and Erosion of Arable Land
Most FSM soils are vulnerable to saltwater intrusion and erosion under SLR

Increased Rainfall and Extreme Events
Increase 1% (+/- 7%) by 2030 and increase 9% (+/- 15%) by 2050

Increased Annual and Extreme Temperatures
Increase 1.4°C (+/- 0.8) by 2030 and 4.2°C (+/-1.6) by 2050

Increased Frequency and Intensity of Tidal Surges
In the 2030s, the high-tide level of 2 m will be exceeded by 12% of all high tides (baseline – 3%).

Expanded Opportunity for Pests and Disease
Climate change triggers temperature and rainfall conditions ideal for pest spread

Ocean Acidification
3.3 (+/- 0.1) by 2030 and 2.6 (+/- 0.2) by 2050

Impacts on Availability, Access, Utilization, and Stability

Unknown Impacts

ENSO
- Typhoons
- Tidal Surge
- Drought

Climate Change Impacts on Food Security

Availability
- Loss of arable land from inundation and coastal erosion as a result of sea level rise
- Increased crop damage and arable land loss from saltwater intrusion and salinization of soils
- Loss of groundwater resources
- Destruction of crops and arable land from tidal surges
- Destruction of crops and cropland from extreme weather (high winds, washouts, flooding, etc.)
- Changes to growing seasons and viability of certain crops
- Unknown impact on incidence and severity of ENSO impacts (typhoons, sea level rise, high winds, drought, wave action)
- Loss of coastal habitat and potential impact on subsistence fishing and aquaculture
- Potential increase in incidence of crop blight and pests, particularly for taro

Access
- Lower yield leading to high food prices, particularly for locally grown agricultural products, and lower farmer income
- Increased reliance on imports and other negative coping strategies (slash agriculture, etc.)

Utilization
- Decreased calorie availability and intake due to loss of subsistence crops
- Dietary changes and nutritional deficiencies from increased reliance on imported food and loss of subsistence crops
- Potential changes in pests and water availability

Stability
- Extreme events, particularly tidal surges and potentially typhoons and droughts from ENSO conditions, can disrupt food storage, access, and availability
- Abandonment of low-lying islands and sudden added strain on remaining food systems
- Disruption of global supply chains for food imports

Policy Context

Despite the challenges, FSM has made clear commitments to improving the resiliency of food security and the agricultural sector, most notably through its National Climate Change Strategy, FSM Strategic Development Plan, National Agriculture Policy, second national communication on climate change, and Statewide Assessment and Resource Strategies.

This project specifically aligns and supports the priorities and strategies of FSM's national planning and frameworks and has naturally embedded country ownership into the scope and concept of the project by systematically providing new pathways for increased domestic agricultural production, increased food security at the household and community level, increased uptake and utilization of traditional practices, supporting market access and development, and strengthening the adaptive capability of agriculture and households.

First, agriculture is one of the priority economic sectors identified under the FSM Strategic Development Plan 2004-2023 (SDP)[60] as a means of addressing food security and achieving development goals. The project specifically aligns with SDP's agricultural goals 1-4 (properly focused agriculture policy framework; increased production of traditional farming systems; increased volumes of saleable products in markets; and environmentally sound and sustainable production) as well as SDP's environmental goals 1 and 6 (mainstream environmental conditions including climate change into policy and planning; improve environmental awareness, education, and involvement of citizenry).

Achieving national food security, safety and nutritional health is also one of the priority goals outlined in the FSM National Agriculture Policy (2012-2016)[61][62]. Specifically, the project supports the Policy's specific goals and strategies for mainstreaming climate change and resilience into the agriculture sector, increasing production of traditional farming systems to provide for household nutrition and incomes, and increased volume of saleable agricultural products.

The project's targeted outcomes also align with the second national communication on climate change is the principle framework for responding to climate change impacts in FSM and it highlights three key adaptation strategies that the present project endeavors to support: 1) conserving and promoting island and oceanic ecosystem services; 2) Preserving and promoting traditional culture to facilitate adaptation strategies and community accord; 3) Improving food and water security with a focus on domestic production as a core strategy in the National economy.[63]

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[60] FSM Strategic Development Plan 2004-2023; Available at: http://prdrse4all.spc.int/system/files/fsm_sdp_vol_1_0.pdf

[61] FSM National Agriculture Policy; Available at: http://www.fao.org/fileadmin/user_upload/sap/docs/FSM%20Agriculture%20Policy%20DraftSR2Sept2011.pdf

[62] FSM Government is in the process of developing a new Agriculture policy however, it is unclear when this will be completed.

[63] Federated States of Micronesia Second National Communication on Climate Change pg. 17-18; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

The second communication builds on the National Climate Change Strategy (2009)[64] which among other things established national goals to develop and implement appropriate strategies to improve food production and new opportunities for communities and decision makers to access technical skills and knowledge to respond to climate change impacts.

Food security was also one of the principal issues highlighted by all four states in the FSM Statewide Assessment and Resource Strategy 2010-2015+[65]. The proposed project activities also support the objectives outlined by the four Joint State Action Plans on Disaster Risk Management and Climate Change Adaptation including principally:

- **Chuuk**[66] - Objective 2.4 "sustain productive agriculture",
- **Pohnpei**[67] **-** Objective 2.3 "school children educated on food security; Objective 4.1 "strengthen food security in Pohnpei", Objective 8.6 "strengthen early warning systems"
- **Yap**[68] **-** Objective 2.2: Develop and implement an ongoing climate change and DRM education and awareness program for communities; Objective 3.5: Address food security issues in Yap and the risks provided by climate change and other events
- **Kosrae**[69] – Activity 1.3.4 "Conduct an awareness program on the nutrition value of locally grown food"; Activity 3.2.11 "Establish and strengthen local early warning systems"; "Objective 5.2: Improve and strengthen cultural and traditional practices and knowledge in agriculture"

In addition to these national and state level plans, the project also aligns with regional frameworks including "Regional Framework for Accelerating Action on Food Security and Nutrition in Pacific SIDS"[70][71], 'Towards a Food Secure Pacific: Framework for Action on Food Security in the Pacific 2011-2015[72][73], the SAMOA Pathway[74][75] and the FAO Pacific Multi-Country

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[64] FSM Nationwide Climate Change Policy; Available at http://www.fsmpio.fm/Nationwide_Climate_Change_policy.pdf

[65] FSM State-Wide Assessment and Resource Strategy; Available at: https://fsm-data.sprep.org/system/files/FSM%20SWARS%20FINAL%20REPORT%202010-2015%2B.pdf

[66] Chuuk Joint State Action Plan http://bsrp.gsd.spc.int/wp-content/uploads/2019/01/chuuk-action-plan-for-web.pdf

[67] Pohnpei Joint State Action Plan http://bsrp.gsd.spc.int/wp-content/uploads/2017/08/JSAP-report_web-1.pdf

[68] Yap Joint State Action Plan http://bsrp.gsd.spc.int/wp-content/uploads/Publications/FSM_Yap_JSAP.pdf

[69] Kosrae Joint State Action Plan; Available at: http://bsrp.gsd.spc.int/wp-content/uploads/Publications/Kosrae_JSAP.pdf

[70] **Pacific Framework Objectives** – 1. Enabling environments for food security and nutrition; 2. Sustainable, resilient, and nutrition sensitive food systems; 3. Empowered people and communities

[71] UN Pacific Framework; https://sustainabledevelopment.un.org/content/documents/17753PacificFramework.pdf

[72] **Towards a Food Secure Pacific Expected outcomes** – 1) multisectoral coordination for food security nationally and regionally; 3) Improved production, processing and trading of safe and nutritious local food; 4) Increased well-being, reduced illnesses, disabilities and premature deaths associated with food insecurity; 5) Individuals, communities, producers and governments empowered with information about food security and the skills to make informed decisions and healthy choices

[73] SPC Towards a Food Secure Pacific; Available at: http://lrd.spc.int/pubs/doc_download/1055-towards-a-food-secure-pacific-2011-2015-

[74] SAMOA Pathway; http://www.sids2014.org/index.php?menu=1537

[75] **SAMOA Pathway Priority Areas** – 2) Climate Change; 4) Disaster Risk Reduction; 6) Food Security and Nutrition; 9) Sustainable Consumption and Production; 11) Health and Noncommunicable Diseases; 14) Biodiversity

Programming Framework 2013-2017.[76][77] These frameworks are intended as a regional and national policy guide, and seek to guide countries in determining relevant, specific country-level activities.

Barriers

In the face of such dramatic potential impacts, FSM's adaptive capabilities are currently constrained. According to the Notre Dame Global Adaptation Initiative (ND GAIN) FSM is the fourth most vulnerable country to climate change and the 78th least ready country in the world (FSM scored 0.640 on the vulnerability scale and 0.360 on the readiness scale). [78] The FSM GCF Country Program[79] concluded that at present, none of the FSM States have a 'high' level of adaptive capacity required to ensure adaptation to the effects of climate change. Despite some variation in their adaptive capacities, all States are highly vulnerable due mainly to a combination of capacity issues to respond to climate impacts in a timely manner and the wide dispersion of the islands in the FSM which poses transportation, communication and development challenges for the nation, particularly for costs of goods and services, costs of energy and transportation, and scalability and connectivity of markets. [80] Further, institutional capacity to secure sufficient funds and implement coordinated adaptation and mitigation projects is also inadequate, making progress slow and challenging. This makes those living in rural areas, outer islands, and coastal communities especially vulnerable, given the long distances, at times unfavorable weather, logistics and challenges with the high cost of inter-island transportation making it particularly difficult to deliver assistance and implement projects. Given this there is a great need for investment and innovation to improve readiness and a great urgency for adaptation action.

In addition to the risks outlined above, the Second National Communication on Climate Change highlights insufficient investment in agriculture, lack of relevant policy, weak data, limited market information systems and infrastructure, the high cost and low status of local food compared with imported food, and limited interest of youth in agriculture as significant barriers undermining food security and the resiliency of the agriculture sector. [81] Climate change will affect and exacerbate these factors to further erode food security. Additionally, the Second National Communication for FSM also identified 3 key gaps in vulnerability assessment and adaptation planning in FSM:

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[76] **FAO Framework Priority Areas** – 1) Evidence-based Policy and Strategic Planning 2) Food and Nutrition Security Resilient to the Impacts of Disasters and Climate Change; 3) Value/Supply Chain Efficiency and Market Linkages; 4) Environmental Management and Resilience

[77] FAO Pacific Multi-Country CPF Document; Available at: http://www.fao.org/3/a-az134e.pdf

[78] ND GAIN Country Index; Available at: https://gain.nd.edu/our-work/country-index/

[79] GCF Country Programme for FSM; Available at: http://www.dofa.gov.fm/wp-content/uploads/2018/12/FSM-GCF-Country-Program-Endorsed.pdf

[80] Pacific Possible: Long-term Economic Opportunities and Challenges for Pacific Island Countries. World Bank, Washington, DC. Available at: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/168951503668157320/pacific-possible-long-term-economic-opportunities-and-challenges-for-pacific-island-countries

[81] Federated States of Micronesia Second National Communication on Climate Change; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

1. No comprehensive understanding of vulnerability to climate change at National, State, island or community levels;
2. Assessments are not being informed by the results of formal analyses of current let alone future risks; and
3. Identification of appropriate adaptation measures remains at a very generic level.

USAID also recently published a Financial Assessment of Climate Change and Disaster Risk for FSM and identified several key barriers and challenges[82]:

- Lack of government coordination, strategic direction, and priorities for adaptation integrated into FSM's current national policy framework
- Lack of true mainstreaming for climate change considerations into national policy. The national agriculture policy was specifically highlighted as an area that is due to be updated
- Estimated costing for operationalizing climate change policies and action at the state and local level currently far outweighs department budgets
- One off projects not formalized or monitored through state and national governments leading to fragmented climate financing
- FSM does not have a central mechanism for the collection and dissemination of climate change related information, particularly for localized and state level information
- Limited private sector engagement in climate change planning
- Lack of capacity in national and state governments to effectively coordinate climate finance and adaptation priorities
- Limited ability to build and sustain local capacity in a manner that is consistent and builds corporate knowledge

The vulnerability assessments summarize in the FAO report[83] highlight that all states are vulnerable to climate change impacts in the agriculture and fisheries sector as they are exposed to a number of climate related stressors and are sensitive to these stressors and projected climate impacts. Their vulnerability ranges from medium to high as none of the four States have the required 'high' level of adaptive capacity to ensure adaptation to the effects of climate change. Despite some variation in their adaptive capacities, all States are highly vulnerable due mainly to a combination of capacity issues to respond to climate impacts in a timely manner and to isolated and dispersed geographies. Institutional capacity to secure sufficient funds and implement coordinated adaptation and mitigation projects is inadequate, making progress slow and challenging. This makes those living in rural areas, outer islands, and coastal communities especially vulnerable, given the long distances, at times unfavorable weather, logistics and challenges with the high cost of inter-island transportation making it particularly difficult to deliver assistance and implement projects.

The main barriers and challenges the proposal will address in this space can be summarized as follows:

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[82] FSM Climate Change and Disaster Risk Finance Assessment (2019); Available at: https://fsm-data.sprep.org/dataset/fsm-climate-change-and-disaster-risk-finance-assessment-%E2%80%93-2019

[83] FAO Climate risks, vulnerabilities and impacts of climate change on the agricultural sector in FSM: Assisting Small Island States to Integrate the Agricultural Sectors into Climate Change Priorities and Nationally Determined Contributions (2020); Draft available in Annex 5 below.

1. Lack of de-scaled and locally available data on risks and impacts of climate change constrains opportunities for effective targeting and uptake of climate adaptation in local communities
2. Significant lack of technical knowledge and capacity in climate-smart agriculture (CSA)[84] policy, planning, and techniques for both government actors and vulnerable households
3. Weak enabling environment for government and community uptake of CSA and planning
4. Instability of food supply due to extreme events and the growing effects of climate change, particularly sea level rise and the salinization of arable land
5. Underdeveloped market opportunities and value streams for households
6. Declining availability of local agriculture due to declining soil fertility (i.e. salinization and flooding), agricultural labour, and a growing reliance on imported food

Project Overview

The proposed project would be the first comprehensive national effort to focus on increasing the resilience of FSM's most vulnerable communities to food insecurity in the face of climate change. Specifically, the proposed project will work to:

1. Establish an enabling environment for adaptive action and investment including strengthening the evidence base for adaptation, mainstreaming climate risk into development planning, and disseminating actionable climate information to community and state decision makers.
2. Enhance the food security of vulnerable households by introducing CSA practices
3. Strengthen climate-resilient value-chains and market linkages across the agriculture sector

Theory of Change

The agriculture and food security sectors in FSM are currently characterized by massive participation in subsistence agriculture (63% of the population engaging in agriculture), limited to no market development for local agriculture products (Only 24% of FSM producers have ever sold their goods), high and growing proportions of income spent on food purchases (32-76% of incomes spent on food), increasing reliance/preference for imported food (17-43% of household diets from imported food), and growing food and overall poverty (40% live below national poverty line and 10% live below food poverty line). The status quo for FSM suggests major risks for the four pillars of food security availability (declining agriculture labor, lack of markets, declining soil fertility), access (unemployment, high prices for local food compared to imports), utilization (high prevalence of NCDs, shifting preferences for imported food), and stability (increased flooding risk, lack of storage or buffer capacity).

Compounding this, FSM's economy, particularly the agriculture sector, is acutely vulnerable to the impacts of climate change, particularly loss of arable land, crop loss, and overall food insecurity stemming from saltwater intrusion from sea level rise and tidal surges, extreme

[84] CSA is an approach that helps to guide actions needed to transform and reorient agricultural systems to effectively support development and ensure food security in a changing climate

rainfall and flooding, extreme heat, loss of agroforestry resources, and increased intensity of extreme events. To make matters worse, the governments in FSM lack both capacity and financial resources to effectively address both the growing issue of food security (access, availability, stability, and utilization) as well as the impending impacts of climate change. As well, previous one-off projects have ended up short of creating lasting impact at the national level. Finally, given the vulnerabilities of the recent COVID-19 pandemic has exposed, the need for stronger domestic food supplies will be needed to build the resilience of FSM against future infectious disease outbreaks.

This project is working to combat the underlying challenges and drive progress towards a more climate resilient future by:

1. Establishing an enabling environment for adaptive action and investment (institutional coordination, state/local vulnerability assessments, integration of climate change into state and national planning and policy, developing a network of farmer associations, and disseminating tailored communications for informed decision-making). This specifically will help to better target adaptation investments based on local vulnerabilities, improve technical capacity for climate smart planning and policy, cement political commitment and accountability for CSA, and drive informed decision-making for farmers, all of which will increase the adaptive and anticipatory capacity of FSM and lay the foundation for improved strategic planning for food security and climate resiliency.

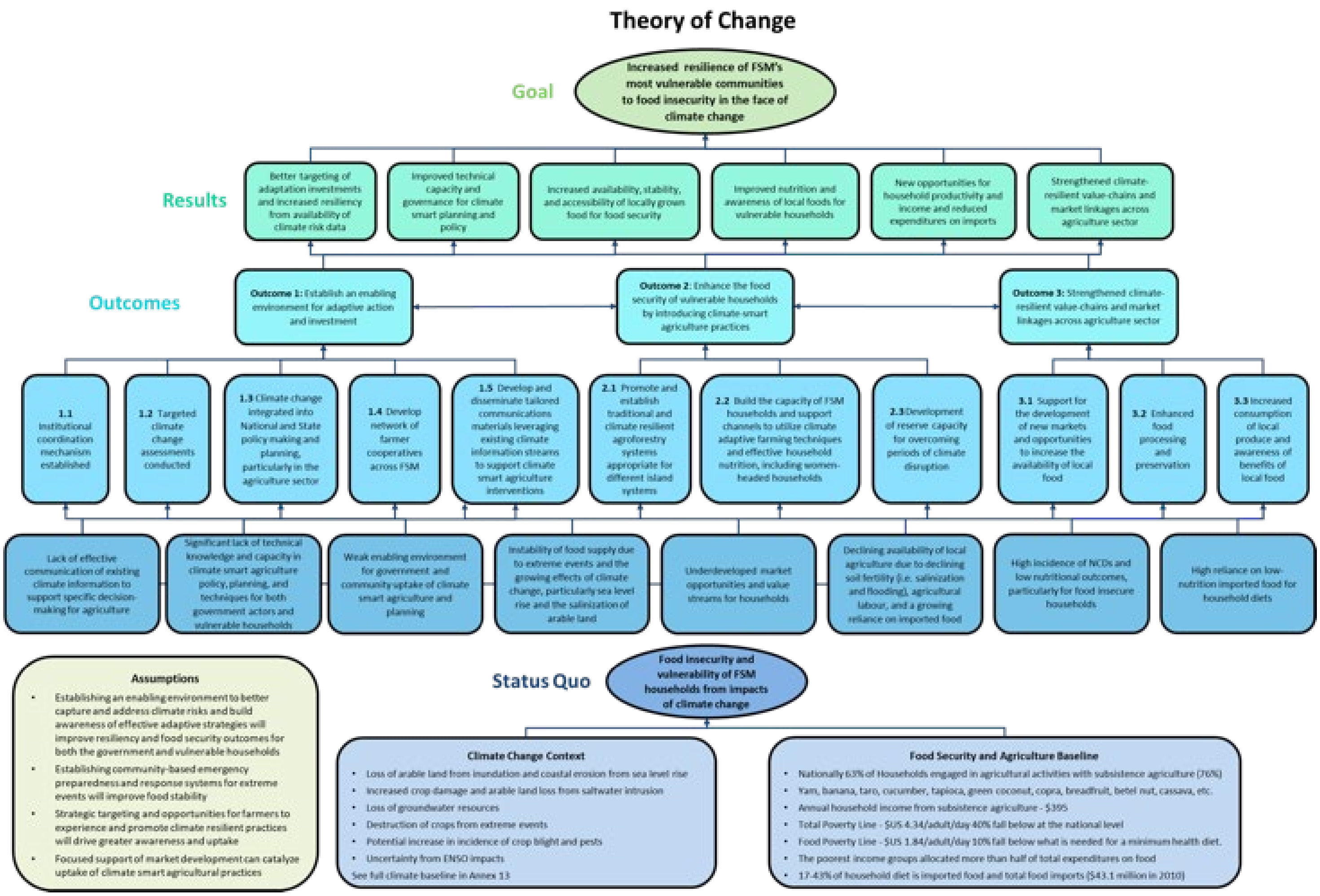
2. Enhancing the food security of vulnerable households by introducing CSA practices (establishing agroforestry systems, capacity building for extension agents, awareness building and training for FSM households, and developing reserve capacity for climate disruption). This will increase availability, stability, and accessibility of locally grown food for food security, improve nutritional outcomes for vulnerable households, develop new opportunities for income and household productivity, and drive a national change in awareness and utilization of CSA for improved resiliency.

3. Strengthening climate-resilient value-chains and market linkages across the agriculture sector (development of new markets for local agriculture, enhanced food processing and preservation, and increasing awareness and consumption of local food). This will strengthen climate resilient value chains across the agriculture sector, improve food security gaps through storage and processing, significantly transform opportunities for improved livelihoods thereby driving increased adaptive capacity, and create a strong incentive framework for local farmers to leverage CSA packages beyond the life of the project to secure a long-term shift towards improved climate resiliency with regards to food security.

Overall, the project is expected to become the critical foundation for sustained efforts on food security as part of the national response to climate change. This project will especially build the political framework and commitment through state/national agriculture policies, social and market structures for CSA, as well as capacity for farmers, advisors, and others throughout the agricultural value chain that will enable future initiatives for food security to build off, particularly for other sectors like fisheries and livestock.

All of this is directly working to overcome the current barriers and increase the resilience of FSM's most vulnerable communities to food insecurity in the face of climate change.

Figure 13: Expanded Theory of Change



Climate Rationale for Project Components and Activities

To address the identified barriers, the current project, "Climate resilient food security for farming households across the Federated States of Micronesia (FSM)" is specifically working to better target adaptation investments utilizing climate risk data, improve technical capacity for climate smart planning and policy, increase availability, stability, and accessibility of locally grown food for food security, improve nutritional outcomes for vulnerable households, develop new opportunities for income and household productivity, and strengthen climate resilient value chains across the agriculture. Table 2 below provides a description of the climate rationale for each of the project's components and activities.

Table 2: Climate Rationale for Project Components and Activities

Project Components, Outputs, and Activities	Climate Rationale
Component 1: Establish an enabling environment for adaptive action and investment	Component 1 works to address some of the principal gaps and barriers for climate adaptation in the agricultural sector identified for FSM including the lack of capacity at the state and national level, lack of integration of climate change in national strategy and development priorities, and the lack of descaled climate information for government and household decision makers. Component 1 will build on several assessments and studies already undertaken to complement and build upon the evidence base for introducing appropriate adaptation measures. **Specific Activities** **Establishment of Institutional Coordination Mechanisms –** Collaboration with planners, policymakers, and researchers to establish protocol for integrating climate change considerations and climate information into the National Agriculture Policy and the equivalent policies at the state level. The resulting output will facilitate coordinated national decision making on agriculture that effectively incorporates the risks and opportunities of climate change on the agriculture sector. **Integrated Vulnerability Assessments –** Collaboration with researchers, state level institutions and policymakers, and local communities to undertake and publish integrated vulnerability assessments for agriculture and climate change across the four FSM states. The assessments will identify and map potential impacts from climate change including arable land loss, saltwater intrusion, tidal surge risk, and the use of traditional agricultural practices. This information will then be leveraged to develop descaled assessments for specific communities and decision-makers to guide the development and deployment of appropriate climate interventions are

introduced. Additionally, currently, baseline crop data does not exist across FSM or most PICs, which prohibits the modelling of climate change impacts on future crop yields. This output will develop the baseline for the countries staple crops and enable the projection of climate change impacts on future crop yields. These results will help inform future food security planning in FSM and the region.

Policy Guidance for Agricultural Policy – Develop specific recommendations for ensuring that climate change and adaptation considerations are mainstreamed into the National Agriculture Policy and State Agricultural Policies. This activity will develop the overall program for increasing the awareness of climate change risks in the agricultural sector including: (i) development of training curriculum for national and State-level policymakers and agencies and (ii) establishment of mechanisms for facilitated knowledge and information exchange. In so doing, this activity will ensure effective incorporation of climate risk and adaptation into policy decisions in agriculture.

Establish Farmer Cooperatives – Farmer cooperatives enable better connectivity with producers which amplifies the uptake and utilization of CSA packages[85] envisioned in the project and will not only provide a means to disseminate available information but will create channels whereby other activities and training can be conducted and will build networks across States. Creating greater connections across the States is a major part of the strategy to build resilience through cooperation and relying on domestic food sources in cases of disaster or prolonged drought, etc.

Tailored Communications for Agricultural Decision-making – This activity utilizes the integrated vulnerability assessments from Output 1.2, CSA communications (2.1) and existing weather/climate information streams currently relayed to DECEM (NOAA Regional Weather Service, Pacific Tsunami Center), to inform development of targeted communications materials for CSA and farmers including parameters like seasonal rainfall, drought events, etc. tailored to the needs and priorities of local operational areas. This will help support improved agricultural decision-making and specific agricultural practices for climate adaptation.

[85] Please see Annex 8 for an example of a CSA package.

Component 2. Enhance the food security of vulnerable households by introducing climate-smart agriculture practices	Component 2 develops specific tailored measures for climate adaptation mostly through the development of CSApackages (technology, adapted seeds, practices) and creates effective pathways for deployment in local communities. Further, this component builds capacity for government agencies and institutions to actually promote, leverage, and support climate adaptation and CSA at the local level. Finally, Component 2 provides new opportunities for communities to improve agricultural production and household food security (access, availability, and stability) **Specific Activities** **Promote and Establish Climate Resilient AgroForestry –** Developing an inventory of climate resilient agroforestry practices and technologies that can be effectively adapted and utilized in FSM provides the foundation for climate resiliency in individual communities and households. This will include specific training and demonstrations that will provide for greater uptake and utilization of climate adaptive practices by the individual producers. **Capacity Building for Extension Agents** – Increasing the capacity of agricultural advisors to utilize and in turn train producers and households on new climate technology packages and agroforestry practices helps to amplify the adoption and effectiveness of climate resilient practices both for project participants, as well as future participants beyond the scope of the initial project. **Training on Agroforestry Practices –** Adoption of climate resilient agroforestry practices by the individual household producers enables climate resilient livelihoods and supports improved food-security for households while also providing for long-term adaptation of agricultural systems to climate change. **Development of Reserve Capacity for Climate Disruption –** By establishing locally managed seed banks and nurseries at the State and Community Levels, the project is providing for additional bridging capacity for periods of climate disruption which improves the overall resiliency of the targeted communities to climate change.
Component 3. Strengthened climate-resilient value-chains and market linkages across agriculture sector	Component 3 seeks to develop new opportunities for market access thereby increasing farmer incomes and consumption of local food, engaging private sector models for adaptive agriculture practices, creating new pathways and reserve

	capacity for severe climate disruptions, and strengthening awareness of the benefits of local food. **Specific Activities** **Market Development and Value Chains –** Targeted marketing support for producers helps to improve market access and catalyze opportunities for sustaining new climate adapted livelihoods. It further increases availability and affordability of local food and helps to upscale existing food-security business models. **Food Processing and Preservation –** Food processing support and training for individual household producers and communities helps to enable long term adaptation to climate change, new income streams, and importantly an additional measure of bridging resiliency for climate disruptions to food supply. **Awareness Building for Local Agriculture** – Targeted outreach and community engagement on the issue of local agriculture can further build opportunities for producers and help to secure long-term food security and nutrition outcomes.

Climate Adaptation Benefits

The project is principally focused on adaptation outcomes, particularly those related to food and income security for household farmers in FSM. Specifically, the project targets several key indicators detailed in the GCF Performance Evaluation Framework:

- **A1.0** Increased resilience and enhanced livelihoods of the most vulnerable people, communities and regions
  - Change in expected losses of lives and economic assets (US$) due to the impact of extreme climate-related disasters in the geographic area of the GCF intervention
  - Number of males and females benefiting from the adoption of diversified, climate resilient livelihood options (including fisheries, agriculture, tourism, etc.)
- **A2.0** Increased resilience of health and well-being, and food and water security
  - 2.2 Number of food secure households (in areas/periods at risk of climate change impacts)
- **A5.0** Strengthened institutional and regulatory systems for climate-responsive planning and development
  - 5.1 Institutional and regulatory systems that improve incentives for climate resilience and their effective implementation.

- 5.2 Number and level of effective coordination mechanisms
- **A6.0** Increased generation and use of climate information in decision-making
    - Use of climate information products/services in decision-making in climate-sensitive sectors
- **A7.0** Strengthened adaptive capacity and reduced exposure to climate risks
    - 7.1: Use by vulnerable households, communities, businesses and public-sector services of Fund supported tools, instruments, strategies and activities to respond to climate change and variability
- **A8.0** Strengthened awareness of climate threats and risk-reduction processes
    - 8.1: Number of males and females made aware of climate threats and related appropriate responses

Given these indicators, the project will mostly focus on strengthening the adaptive capacity[86] of the communities and households mostly through improving food security for household farmers, deploying new climate adapted technology, practices, and varieties, creating new value chains and linkages for market access for local produce, preventing acute and sustained loss of crops and arable land, and providing for improved income availability and stability. In total, the project will directly improve the adaptive capacity of an estimated 68,250 individuals. In addition to the adaptive capacity benefits, the project will also be improving anticipatory and absorptive capacity for communities and households by 1) providing descaled vulnerability assessments to advise agricultural and other decision making; 2) developing new climate-resilient agricultural packages for communities and households; 3) improving national capacity and strategic consideration of climate change in agricultural policymaking; and 4) increasing savings, efficiency, and net income through production and marketing support, cooperatives, and improved support and advisor networks.

Implementation Arrangements

Implementing Arrangements and Capacity Assessment of Entities

The government of FSM has undergone a broad capacity assessment the *Regional Assessment Capacity Report* (included as a separate annex, Annex 16 of the Funding Proposal). The United States Agency for International Development (USAID) funded 'Institutional Strengthening in Pacific Island Countries to Adapt to Climate Change' (ISACC) project seeks to respond to some of the key challenges that limit the ability of PICTs to effectively implement national climate change priorities. The goal of the regional project is to strengthen the national institutional capacity of PICTs to effectively plan, coordinate and respond to the adverse impacts of climate change. The regional institutional mapping exercise identified both the human capacity and policy gaps that currently exist for each of the eight Pacific Island countries (including FSM) involved in the project through a desktop study of relevant national policies and strategy documents, national development plans, existing national financial assessments, previous project reports, regional agency experiences, climate change portals and government websites. The assessment included key sectors such as agriculture, forestry, water, education, finance, health, development planning, finance and social development, by identifying both policy and human capacity gaps that impede multi-sectoral approaches to mainstreaming climate change adaptation.

[86] Based on ODI's BRACED Portfolio's 3As framework: adaptive capacity, anticipatory capacity, and absorptive capacity; Available at: https://www.odi.org/sites/odi.org.uk/files/odi-assets/publications-opinion-files/9812.pdf

Through the country assessment of FSM, the report has identified financial management and human resources as weaknesses in the government system. MCT through previous work with R&D has also specifically targeted weaknesses in procurement and financial management. As such, the main recommendation is to structure implementation arrangements in such a way as to minimize the risk of any mismanagement and project implementation delays. Specifically, MCT should handle procurement for the government outputs/activities. MCT is in the process of obtaining a HACT assessment done recently by UNDP to further expand its capacity assessment for DECEM and R&D and to support the structure of the project agreement/MOU that will be developed between MCT and the projects executing entities.

For COM-FSM, MCT has utilized the Financial standing of the COM-FSM that is embedded within Standard II of ACCJC's accreditation standards (https://accjc.org/wp-content/uploads/Accreditation-Standards_-Adopted-June-2014.pdf). Standard II: Human, physical, technology, and financial resources (section D) enable these programs and services to function and improve. Every year COM-FSM submits a Financial report (http://www.comfsm.fm/accreditation/archive/ACCJC_Annual_Fiscal_Report_3-31-2020.pdf). All of COM-FSM's historical Accreditation reports are publicly available (http://www.comfsm.fm/?q=reports-archive). Procurement policies, procedures fall within these standards. From these assessments COM-FSM has the full capabilities, financial resources, appropriate experience to implement component 2 and parts of component 3 of the project.

The AE and EEs are separate legal entities, but for the purpose of this project MCT as AE is developing a Memorandum of Understanding (MOU) with R&D as the main EE and the entity which will house the PMU. This agreement operates as the legal contract for the implementation of the project and includes specific obligations, arbitration, and liability.

Taking into account the limited human resource and financial capacity of R&D the implementation arrangements have been set-up to mitigate these risk.

The Micronesia Conservation Trust (MCT) will be the AE designated by the FSM. The AE will be responsible for supervising the implementation, financial management, evaluation, reporting and closure of the project, as well as having overall fiduciary responsibility for the project.

The FSM national government, acting through the Department of Resources and Development (R&D) and the Department of Environment, Climate Change & Emergency (DECEM), as well as the College of Micronesia (COM-FSM) will serve as the Executing Entities (EE). The FSM government and COM-FSM will assume overall responsibility for the effective delivery of required inputs in order to achieve the expected project outputs. The FSM government will be responsible for Component 1 and COM-FSM will be responsible for Components 2 and 3.

Disbursement of funds will be from the Green Climate Fund to the Micronesia Conservation Trust (MCT), which will be responsible for budgeting, procurement, and expenditure. The project funds will be deposited in a designated account managed by MCT. It is envisaged that expenses will be paid directly by MCT to the project partners in order to enhance accountability and oversight. The FSM government has indicated its wishes to escalate efficient and effective project management and delivery, and thus has agreed for MCT to procure certain services directly.

MCT will enter into appropriate agreements (Project Cooperation Agreement or Memorandum of Understanding) with R&D and COM-FSM, as the EEs, for the execution of the project. The Project Cooperation Agreements (PCA) establish clear roles and include terms of reference (ToRs) for both parties for the delivery of the proposed activities, the schedule and conditions for instalments, the determination of the prevailing fiduciary standards and the terms and conditions for arbitrations and termination of contract. The PCA also includes specific obligations for the EEs on project execution, financial management, personnel administration and reporting, as well as on arbitration and liability terms.

Roles and responsibilities

Accredited Entity: MCT, as the Accredited Entity, will manage the funds for the implementation of the project. In addition, MCT will co- chair the Project Steering Committee (PSC) to ensure that appropriate project management milestones are managed and completed. As an Accredited Entity to the GCF, MCT is required to deliver GCF-specific oversight and quality assurance services including: i) day-to-day project oversight and supervision; ii) oversight of project completion; and iii) oversight of project reporting. MCT will be responsible for overseeing the implementation of the proposed project in coordination with the Executing Entity, PSC and the PMU. In addition, an MCT representative will fulfil the role of Task Manager (TM), taking responsibility for project oversight and supervision. The TM will also ensure consistency with GCF and MCT policies and procedures, including: i) participating in the annual PSC meetings; ii) facilitating the project's mid-term and final evaluations; iii) clearing the Progress Reports and Project Implementation Reviews; iv) undertaking the technical review of project deliverables; v) providing input to the annual portfolio reporting to GCF; and vi) preparing requests for disbursements.

Executing Entities:

FSM National Government (R&D and DECEM)

The FSM national government will be an Executing Entity, represented by two of its national departments: the Department of Resources and Development (R&D) and the Department of Environment, Climate Change and Emergency Management (DECEM). R&D, as the lead government entity for the agriculture sector, will be in charge of Component 1 as well as the day-to-day execution of the project through the establishment of a Project Management Unit (PMU). Overall coordination with other GCF projects and climate change initiatives will be undertaken by FSM's Department of Finance and Administration, as FSM's NDA for the GCF. DECEM serves as the lead government agency on issues related to emergency, environment and sustainable development, and climate change. DECEM is responsible for disseminating information related to early warning information to mitigate damages from disasters. DECEM will take the lead on output 1.5: Disseminate weather and climate information for climate-risk informed, adaptive management of resilient agriculture".*COM FSM*

The College of Micronesia-FSM (COM-FSM) is a multi-campus institution with the National Campus located in Pohnpei, and a State Campus in each state. COM-FSM runs the Small Island Agricultural program which addresses sustainable plant and animal production and marketing including potential adverse effects on the environment and ecosystems due to improper practices. As the main institution on FSM with experience training farmers across the four states and leading research on food security within the local context, COM-FSM is the legal entity for Components 2 and 3.

In 1999, through a memorandum of understanding with the national government, COM-FSM accepted management of the FSM Fisheries and Maritime Institute in Yap. The purposes of the college are mandated by national law PL 7-79 "College of Micronesia-FSM Act of 1992"

The college is accredited by the Accrediting Commission for Community and Junior Colleges of the Western Association of Schools and Colleges, an institutional accrediting body recognized by the Commission on Recognition of Postsecondary Accreditation and the U.S. Department of Education. Accreditation was awarded in 1978 and reaffirmed in 1982, 1987, 1992, 1998, 2005, 2013, 2016 and 2018. The college is currently preparing its self-evaluation report to maintain its accredited status beyond 2023.

All work at COM-FSM is guided by its mission statement:

> *The College of Micronesia-FSM is a learner-centered institution of higher education that is committed to the success of the Federated States of Micronesia by providing academic and career & technical educational programs characterized by continuous improvement and best practices.*

COM-FSM assesses its effectiveness in achieving its mission through mission fulfillment indicators. The mission guides COM-FSM's Strategic Plan which has two strategic directions between 2018 and 2023:

i) Innovate academic quality to ensure student success
ii) Strengthen resources to meet current and future needs.

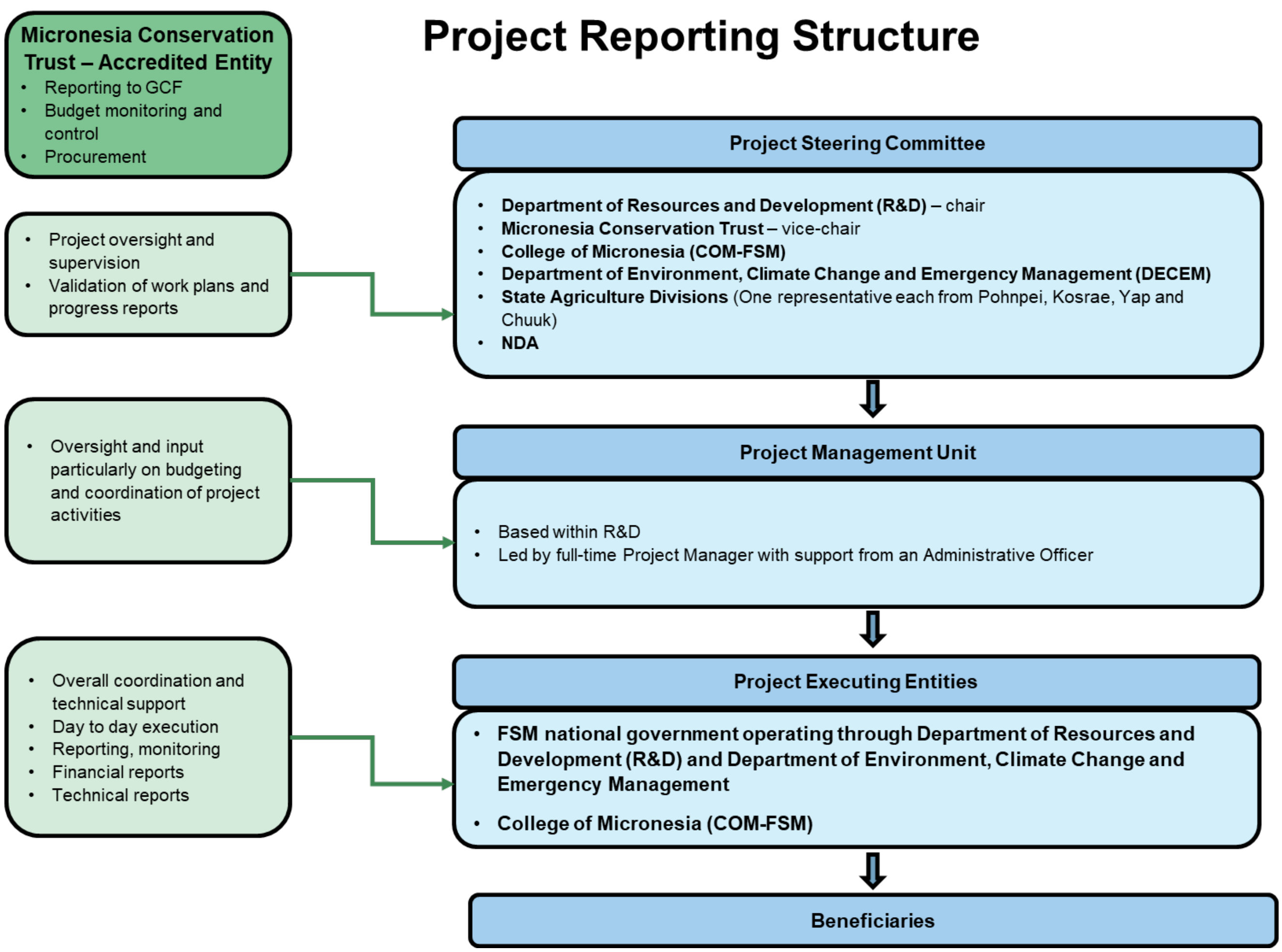
The Center For Entrepreneurship promotes student success by providing programs, services, and training that allow students to explore avenues and opportunities for entrepreneurship. To achieve this, the Center focuses on four goals: 1) Facilitating local industry growth through research and development. 2) Creation of innovative and sustainable student operated start-up businesses. 3) Specialized business services to existing SMEs and startups, and 4) Encourage and support local entrepreneurship. In the last academic year, the Center expanded its services to include Small Business Development Center activities in Pohnpei by providing business support to small business owners. The Center For Entrepreneurship is under the departmental oversight of the Vice President for Enrollment Management and Student Services.

The Cooperative Research and Extension (CRE) is an affiliate of the College of Micronesia Land Grant Program. The CRE focuses on developing and assisting a well-informed populace to ensure wise and judicious management of the limited human and natural resources needed to support a viable FSM economy. Its mission and activities are centered on a 5-Year Plan of Work which is an integrated approach to critical issues of strategic importance to the entire Micronesian region. The objectives are addressed through interdisciplinary community level research, extension and education programs embodied in the Plan of Work. Interdisciplinary efforts in research, extension and education require not only input of researchers but also extension agents, stakeholders, and community members. In the current plan, CRE identified 6 Critical Issues of national and regional importance, including Lack of Local Crop

Production and Food Insecurity (Critical Issue #1) and Climate Change Challenges in Micronesia (Critical Issue #4). Within COM-FSM, CRE is under the departmental oversight of the Vice President for Instructional Affairs.

Project Steering Committee (PSC): R&D will convene and chair the Project Steering Committee (PSC), while MCT will assume the role of vice-chair. The two implementing partners COM-FSM and DECEM, along with, one representative from each of the State Agriculture Divisions (Pohnpei, Korsae, Yap and Chuuk); and the GCF's NDA. A gender balance will be ensured in the PSC. The mandate of the PSC will include: i) overseeing project implementation; and ii) reviewing annual workplans and project reports. The PSC will meet at least twice a year – with *ad hoc* meetings held as and when necessary – to discuss the project's main performance indicators and provide strategic guidance.

Project Management Unit (PMU): The PSC will be supported by the Project Management Unit (PMU), that will be based within the R&D. It will be led by a Project Manager (PM) and will include an Administrative Officer. The PMU will coordinate activities between MCT and R&D as well as the implementing partners to oversee the implementation of the project's activities. The Project Manager will: i) lead and direct the PMU; ii) provide administrative and technical expertise; iii) be responsible for the day-to-day implementation and management of the project, iv) serve as the focal point for interactions between the project stakeholders and partner organizations (e.g. government departments, NGOs, civil society groups); and v) meet regularly with project managers of closely-related ongoing projects operating in the target areas to ensure synergy.



Stakeholder Analysis and Engagement Plan

This project is one of 14 selected priority projects under the Green Climate Fund Country Program (CP) for the FSM. The Country Program was prepared under the direction of the NDA for the GCF in consultation with the States of Chuuk, Kosrae, Pohnpei and Yap. The Readiness program team developed the country program using a four-part series workshop over a nine-month period: introductory, validation, confirmation and endorsement. Consultations were undertaken with a whole-of-society approach, including stakeholders from civil society, non-governmental and intergovernmental organizations and the private sector. This process was implemented from late 2016 to mid 2017. As this proposal was developed based on the ambitions of FSM stakeholders from its inception.

MCT has continuously consulted to ensure that the proposal meets the needs of said agencies, NGO's, communities, women's groups and other organizations. Through MCT's ongoing engagement across the country, the Executive Director and other program staff have been engaging with identified stakeholders over many years, and therefore were already well aware of the food security and resources management needs of the communities around the FSM and this informed the development of the project concept paper. Moreover, this consultation has included discussions with the highest-level officials in the municipal, states and national governments, including discussions with Governors, legislatures, Secretaries and Directors of relevant Departments.

After the NDA requested MCT take the lead and develop the project proposal for the GCF, MCT met with the NDA and National Government authorities on July 3, 2018 to begin consultations. This was followed by four state wide consultations in Pohnpei (July 5th), Yap (July 9th), Chuuk (July 12th) and Kosrae (July 16th) with a total of 129 participants across the four meetings. All meetings were jointly held as inception for the MCT Adaptation Fund project and consultation for this GCF Concept. Those in attendance included: National, State and Municipal government authorities representing all areas of governance, NGO's, women's organizations, farmers organizations, resource managers, community members, regional organizations and more.

Additional stakeholder meetings have taken place during the full development of the SAP. As part of stakeholder engagement during the formulation of the project concept and this project proposal, the project engaged and collaborated with the following entities:

- Ministry of Finance (NDA)
- Micronesia Conservation Trust (AE)
- College of Micronesia (COM-FSM)/Cooperative Research Extension Service (CRE)
- Ministry of Agriculture
- Pohnpei Weather Services
- Pohnpei State level Agriculture Services

- Pohnpei state level EPA (Environmental Protection)
- National Department of Resources and Development (NDRD)
- Private Sector/Market Actors
- Pohnpei Farmers' Cooperative
- SPC/Other aid organizations

Building from this, the project will work to engage other stakeholders to secure buy-in and work to tailor and implement activities and outcomes. A summary of the different stakeholders and how they will be engaged is provided in Table 1 below.

Table 4: Stakeholder Engagement Plan

Stakeholder Group	Description	Method of Engagement	Overview of engagement and key issues	Notes
National Government Institutions (Ministries and relevant Departments)	National agencies and policymakers responsible for designing national policy and programmes, particularly those related to agriculture and climate change. Includes for example the Ministry of Finance, Ministry of Environment, Ministry of Agriculture, National Department of Resources and Development	Direct meetings; Capacity building and awareness building workshops; advocacy through policy recommendations and other communications from project activities.	Various ministry representatives have been consulted as part of the project development process laying the groundwork for further engagement during project implementation. **Key Issues:** • Building awareness of climate change and the need to integrate it into national policy, particularly for agriculture • Preserve key budget line items for ongoing food-security and agriculture projects	
State Government Institutions (Ministries and relevant Departments)	State-level policy makers responsible for state-level programming and policy. Includes for example Pohnpei Weather Services, Pohnpei State level Agriculture Services, Pohnpei EPA, etc.	Direct meetings; Capacity building and awareness building workshops; advocacy through policy recommendations and other communications from project activities.	Various ministry representatives have been consulted as part of the project development process laying the groundwork for further engagement during project implementation. **Key Issues:** • Building awareness of climate change and the need to integrate it into national policy, particularly for agriculture • Preserve key budget line items for ongoing food-	

			security and agriculture projects • Identify and leverage existing data streams to better support project interventions • Work to scale-up or complement existing food security and agriculture efforts
College of Micronesia (COM-FSM)/Cooperative Research Extension Service (CRE)	Research institution that also oversees the agriculture extension for FSM. COM-FSM has been an executing partner on past food-security projects and has valuable experience to leverage for project success.	Direct meetings; engagement through extension agents; field research; collaboration on policy documents and communication; community capacity building workshops	COM-FSM representatives have been engaged as part of project development. **Key issues:** • Past project experience • Research into CSA practices and seed-varieties • Agricultural extension service and capacity building for households • Policy research
Extension Agents	Primary information and support service for household farmers, which consequently makes them the primary touch point and pathway for integrating agroforestry techniques into farming households and providing ongoing training and support of project activities.	Field research; capacity building workshops; community engagement	Extension agents will be critical for siting and ongoing implementation of project activities. **Key Issues** • Training and awareness on the CSA techniques and technology identified by project activities • Producer outreach and training • Ongoing support of agroforestry activities
Women's Organizations	Key social institutions for empowering women in FSM and providing opportunities for gender mainstreaming and social advancement.	Community meetings; workshops; direct meetings; surveys	These institutions will be key partners in engaging households and will be the primary targets for some of the technical and business model trainings envisioned as part of Component 3 (i.e. food processing and storage, local nutrition, school curriculums, etc.).

			Key Issues • Gender mainstreaming of project activities • Creating new opportunities for income streams and livelihood advancement for vulnerable groups particularly women • Beneficiary selection • Policy advocacy • Program design • Community outreach and engagement
Existing Farmer Groups/Cooperatives	Existing organizations both formal and informal supporting or coordinating farmers, particularly household farmers in FSM.	Surveys; direct meetings; workshops and trainings; interviews	For many farmers these groups are a key source of information, technology, and best practices. Accordingly, they will need to be engaged throughout the project to ensure connectivity and dissemination of promoted CSA measures. **Key issues** • Awareness and training for CSA techniques • Buy-in for importance of adapted livelihoods • Training for market connectivity and support • Dissemination of information to farmers
Private Sector/Market Actors	Operators within the agriculture value chain, particularly those already engaging in established and informal markets for the selling of local produce in FSM. These groups will be partners for the market access and linkages components of the project.	Surveys; workshops and trainings; interviews; direct meetings	With limited market availability and operation in FSM, these existing institutions will be key sources of best practices and lessons learned for scaling up agriculture markets and the private sector in FSM. **Key Issues** • Market access and value chain linkages • Training and awareness building • Leveraging and scaling up existing operations

Individual Households	Individual households and farmers/producers in FSM. These are the primary beneficiaries targeted by the project.	Surveys; in home interviews; demonstrations; workshops/trainings; outreach material; climate information dissemination	Project activities will need to be tailored to the needs and priorities of these households in order to ensure uptake and long-term sustainability of food security and adaptation outcomes. **Key issues** • Acceptance of CSA techniques and practices • Interest and engagement in project • Awareness of value of local produce and nutrition • Livelihoods and opportunity
USAID/SPC/Other Donors	International/multi-lateral donors and other operators. These institutions are funding other food security projects and could also be critical partners for both co-financing and technical lessons learned	Direct meetings; workshops; lessons learned and best practices reporting;	Engagement with these groups will help to inform the design and implementation of project activities and will ultimately be crucial for dissemination of project success over time. **Key Issues** • Avoiding duplication and finding opportunities for collaboration and scaling up • Sharing lessons learned and best practices

Redress Mechanism

Grievance Mechanism

MCT's Whistle Blowing Policy provides people affected by any projects with an accessible, transparent, fair and effective process for raising complaints about environmental or social harms caused by any such project.

Stakeholders can lodge a complaint via MCT's website (www.ourmicronesia.org). Formal complaints can also be forwarded to the Executive Director (director@ourmicronesia.org) who shall handle as appropriate.

Appropriate authority levels as specified in MCT's governance structure will handle all complaints, in a professional and timely way.

Pre-feasibility Assessment

Technical Assessments

Per SAP guidelines[87] this project leverages past projects and assessments as evidence of feasibility for specific project activities. There are a few past and ongoing projects related to food security in FSM that the project will work to leverage and build upon. A more complete list of relevant projects is included in Annex 1, but a few main projects are discussed below:

- **Climate Adaptive Agriculture and Resilience Project (CAAR)** - Under a USAID funded program, Pacific American Climate Fund (PACAM), the Climate Adaptive Agriculture and Resilience Project (CAAR) ($556,264) was undertaken in Yap. The project deployed a three-pronged adaptation model to enhance the adaptive capacity and climate resilience of coastal communities in Yap. The project's concurrent focus on enhancing food security through traditional crops coupled with nutrient-rich vegetables, promotion of rainwater-harvesting systems and water conservation, and promoting resilient household livelihood opportunities, demonstrated success in bringing together crucial elements needed to reduce vulnerabilities and cope with disasters and climate extremes while embracing the traditional culture. The CAAR project found that restoration agroforestry has great potential for regreening degraded lands in a less expensive and participatory way, creating a basis for improved livelihoods, water provision and sustainable food production. Realizing this potential, the current GCF proposal will leverage the model established by the CAAR project to scale-up the multiple benefits of CSA across FSM refining the exact intervention through targeted research that will be conducted through Component 2. Please see Annex 2 for CAAR's final report.
- **Enhancing the Climate Resilience of Vulnerable Island Communities in Federated States of Micronesia** – The Adaptation Fund has an ongoing project ($USD 9 million) in FSM working to build social, ecological and economic resilience of the target island communities of the Federated States of Micronesia and reduce their vulnerabilities to extreme drought, sea level rise and other climate risks through water resource management, coastal resource and development planning, and by promoting gender perspectives and ecologically sound climate resilient livelihoods. The project aims at reducing the vulnerability of the selected communities to risks of water shortage and increase adaptive capacity of communities living in Woleai, Eauripik, Satawan, Lukunor, Kapingamarangi, Nukuoro, Utwe, Malem to drought and flood-related climate and disaster risks. The present project proposal will work to leverage the lessons learned and best practices on community engagement and beneficiary selection as well as synergize the food security and agriculture approaches with the technology and practices for water security, particularly through the water resource protection zones. Project documents for this project are available in Annex 3.
- **Pacific Adaptation Strategy Assistance Program (PASAP)** – Australia and the Secretariat of the Pacific Community (SPC) supported a two-year research project in FSM to help secure the nation's food resources against the impacts of climate change. The key relevant outcome from this project is that it developed an extensive evidence base for appropriate adaptation measures

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[87] GCF Pre-Feasibility Study Guidelines; Available at: https://www.greenclimate.fund/documents/20182/574766/Guidance_for_preparing_a_pre-feasibility_study_under_the_Simplified_Approval_Process.pdf/6ff63481-8569-75c7-f69e-1037989b4e86

in FSM which can be utilized to inform the activities in the current project. Alongside this, PASAP also identified key next steps (integrate climate change risk considerations into coastal management policies; include community-based adaptation activities in land-use policies; conduct further research into the impacts of climate change on food systems; include atoll and rural communities in climate-action projects; protect agroforestry and mangrove areas; develop climate-change and food-security awareness and education campaigns; collate and update geographic data to allow for better informed environmental and developmental management decisions) which the project also acts upon in the design of its activities. Project documents for PASAP are included in Annex 4.

For market development, one successful initiative the project will be leveraging is the Island Food Community of Pohnpei (IFCP). Prior to IFCP's establishment, very little local food was sold in restaurants and takeaway shops. Local produce was sold whole in the local markets and prepared at home. Most of the buyers (Pohnpeians in town with no access to land, and Yapese, Chuukese, Kosraean's and other expats working for the governments) of the local produce sold in the local markets were residents of town who did not have access to land and almost all local produce markets were located in town. Those who owned or had access to land, would grow their own local produce for consumption and cultural events, and would sell the excess to local markets in town. As a result of IFCP's efforts, local people's behavior towards local foods has improved dramatically due to research and outreach that showed the high nutritional values in local foods such as taros, breadfruits, yams, bananas, etc. and also the increased awareness that diabetes and other diseases were linked to the consumption of rice, bread and other imports. Today, IFCP and other partners continue to promote the production and consumption of local foods, which has increased the amount of local foods produced and sold to takeaway shops and restaurants. IFCP has also started to help farmers find ways to preserve their local produce for longer shelf life. This includes making preserved breadfruits and making flower or dried products from bananas, taro, breadfruit, etc. The present GCF project, will build upon the initial success of the IFCP model in Pohnpei and continue to scale these efforts in Pohnpei and in the three other states. [88]

In addition to the IFCP model for market outlets for local produce, the project will also build upon existing school feeding programs funded through the FSM government. Currently, only early education and high school students participate in the food programs. All other students attending both public and private schools, except for boarding schools like Xavier High School and the College of Micronesia - FSM's main campus, do not have access to specific school feeding programs. Specifically, the project will be partnering with the FSM and State departments of education to increase availability of local foods in these food programs as well as working with private school boards and managers, and PTAs to require vendors that sell meals to students to include local foods in their meals. Some public and private schools are already doing some of this voluntarily (i.e. requiring vendors who sell on their school properties to only sell healthy meals), so this project can formalize this and help link farmers to the different schools and vendors who prepare the meals. Further, Memos of Understanding can be developed among the schools interested in implementing feeding programs and IFCP for sustained supplies of seeds and plants for school gardens in which the harvests are to be used for the feeding programs and for IFCP for development of value-added products for selected crops.

The project will also be leveraging the Participatory Guarantee Schemes (PGS) model established through the Coconuts for Life program. [89] In this model. A PGS model is founded on an agreement

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[88] Island Food Community of Pohnpei; Available at: http://www.islandfood.org/

[89] Coconuts-for-Life (C4L) Program Proposal. MCT. September 2017.; Document included in Annex 6

regarding quantity, quality, price etc. between a purchaser and a producer of an agricultural good. The producers of the good are organized into cooperatives, which jointly work to meet the purchasers demand. PGS groups set up in Pohnpei and Chuuk include farmers who are for the most part from the most vulnerable groups. While these farmers own and/or have access to land to grow, harvest and sell coconuts, they are mostly those with very low income and with very little alternative means to make money.

In 2017, MCT in partnership with Vital Group (the dominant energy provider in FSM) set up the Coconuts-for-Life (C4L) PGS program. C4L was designed to rehabilitate the coconut agroforestry and processing industry across FSM. The initial phases of the program involved stakeholder engagement and setting up the coconut farmers groups throughout FSM. Once established, these farmers groups agreed to provide a pre-determined amount of coconuts to Vital Group at regularly scheduled intervals. Vital Group then uses these coconuts to produce crude coconut oil, virgin coconut oil and copra meal for sale in the domestic market. Initially the program is being managed and financially supported by MCT. However, once firmly established, profits from the program will be used to establish a PGS trust account that will then be used to fund the continuation of the program. Although the C4L program is a beneficial program in FSM, there is still the need for farmers groups/associations that cover a wide range of crops and sustainably feed into local food markets. Some local associations have been developed (such as the Awak Farmer's Association) that allow farmers a forum and have implemented local agricultural projects as part of other small grants programs. [90] However, these associations are not widespread and are not designed to sustainably feed into the local food markets throughout the country. This component will work to create new PSGs for a variety of crops to support all of the farmers in the main FSM islands. The creation of regional farmers associations under Output 1.4 will also support the consistent and sustainable production of locally grown food to local and domestic markets by providing greater coordination across states, PSGs, and crop value chains.

Assessment of Appropriate Climate Resilient Agriculture Practices

Developing climate resilient agriculture systems in FSM will necessarily require close coordination of multiple strategies tailored to specific socioeconomic and geographic conditions. In general, there has been strong research across FSM and the Pacific supporting strategy development and validation for climate resiliency in agriculture. Specific strategies include:

Introduction of climate resilient species and varieties – There are a number of projects both ongoing and completed in FSM and similarly situated Pacific Island countries that have developed, isolated, and identified appropriate traditional crop varieties and species that are more resistant to changing climatic conditions including characteristics like higher salt-tolerance, higher drought tolerance, resistance to water logging, resistance to pests, etc. For example, three varieties of adaptive taro, cassava, and kumala were developed as part of the PACC project in Fiji and three varieties of Colocasia taro, namely Dungersuul, Dirrubong, Kirang, were identified as salt tolerant in a PACC project in Palau joining a total of sixteen climate resilient crop varieties identified by that project – Colocasia taro (8), swamp taro (6) and Xanthosoma (2). Other examples include species such as shade tolerant yam (dioscorea spp), wetland taro (colocasia spp), ngali nut (canarium indica), leafy vegetable shrubs, banana (musa) varieties tolerant to wet conditions, cut-nut (barringtonia spp, terminalia spp), mukuna beans (mukuna bractiyata). The

[90] SGP Final Project Report – Awak River and Piggery Clean-up Project. Awak Youth Organization. January 2017; ; Document included in Annex 6

Secretariat for the Pacific Community plays a central coordinating role for identification and distribution of climate smart crop species particularly through the Centre for Pacific Crops and Trees (CePaCT).[91][92][93][94]

The Pacific Adaptation Strategy Assistance Program in FSM trialed different types of sweet potato (provided by SPC) with climate resilient properties for their applicability in FSM and soft taro (provided by the Micronesia Plant Propagation Research Centre - MPPRC). The aim of the project was to provide fully acclimatized plants of sweet potato (1,600) and soft taro (400) to four states for field trials.[95]

In Pohnpei research is testing the resilience of varieties of cassava and taro to climate change, and also testing the resilience of taro varieties to Taro Leaf Blight (TLB). SPC's Pacific Agriculture Policy Project (PAPP), College of Micronesia – FSM, COM-Land Grant, and the FSM and Pohnpei Agriculture Departments, and other partners are collaborating in these research activities. Nine varieties of cassava and 11 varieties of taro currently growing in Pohnpei are being tested in the trial agriculture plot. The collaboration is also conducting ongoing demonstrations of cassava to highlight drought resistant varieties and showcase effective crop management. [96] Other research into climate smart varieties in FSM includes the Micronesia land grant research stations[97]

Enhanced farming and land use techniques facilitating soil and water conservation – Depending on crop type and location, different strategies have proven effective at preventing land degradation and loss of soil fertility, improving productivity, and building resilience to climate change. Improving soil health management through use of cover crops and improved fallow (i.e. mucuna), legumes, composting and agroforestry systems. Other strategies include mulching, minimum tillage, and contour farming as well as altering production practices (planting time, spacing, fertilizers, pest and disease, harvesting time). Organic fertilizer can also be leveraged particularly soil amendments like fish meal and rock phosphorus have been shown to be effective increasing taro yields. [98][99]

In FSM, a strong example of this is the research undertaken by the College of Micronesia on enhancing the climate resilience of atoll communities on Yap island. The project adopted a three-pronged adaptation model consisting of soil management, water conservation and management, and livelihood enhancement. The college started by teaching the communities to improve the soil through techniques such as composting, liming and mulching, among others. [100]

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[91] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

[92] Land Use Planning and Climate Resilient Agriculture Capacity Workshop (2016); Available at: https://www.unescap.org/sites/default/files/Land%20Use%20Planning%20and%20Climate%20Resilient%20Agriculture%20by%20SPC.pdf

[93] SPC Land Resources Division; Available at: https://lrd.spc.int/

[94] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf

[95] Pacific Adaptation Strategy Assistance Program – Impact of Climate Change on Food Security in FSM; Available at: https://www.preventionweb.net/files/27083_110318pasapfoodsecurityproject%5B1%5D.pdf

[96] Climate-Ready Crop Research Factsheet (2016); Available at: https://pafpnet.spc.int/attachments/article/764/Factsheet02_Final_ecopy.pdf

[97] Kosrae Agriculture Experimentation Station; Available at: http://www.micronesialandgrant.org/research/college-of-micronesia-fsm/kosrae-agricultural-experiment-station/

[98] Land Use Planning and Climate Resilient Agriculture Capacity Workshop (2016); Available at: https://www.unescap.org/sites/default/files/Land%20Use%20Planning%20and%20Climate%20Resilient%20Agriculture%20by%20SPC.pdf

[99] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

[100] https://www.climatelinks.org/blog/enhancing-climate-resilience-atoll-communities-yap-island-fsm

Promote traditional farming systems and agroforestry – Traditional farming systems and agroforestry techniques that match the carrying capacity of the land can improve long-term productivity and resilience.[101] Strategies include integration of native trees, fruit trees, coconuts, and nitrogen fixing trees with taro, yaqona and vegetables. Development of community woodlots to improve ecological resilience in terms of watershed function and avoiding reduced fallow periods or repeated cropping of high-value crops on the same land, especially without rotations or sufficient replenishment of soil nutrients. Agroforestry and tree crops increase the resilience of local communities by providing diversity of fruits, nuts, medicines, fuel and timber and reducing soil erosion.[102][103]

Restoration of barrier species - Protect and replant littoral forest to help build resilience of coastal agroforestry farming systems and maintain coastal forest integrity. Forest species, particularly barrier species like mangroves, can help protect crops and crop patches like taro from wind/seawater damage and provide a measure of resiliency to storm surges and inundation. [104]

Leveraging organic farming techniques – Organic farm management can help to prevent soil and water degradation while building increased resiliency and yields for small scale farmers. A number of different techniques including mulching, composting, crop spacing and mixing, etc. have been developed and demonstrated as part of the organic pasifika project (SPC) and other initiatives around the region.[105][106][107][108]

Introduce integrated management approaches - Integrated Pest Management (IPM), Integrated Crop Management (ICM) and Integrated Vector Management (IVM) practices to help combat pests and improve yields. This includes strategies like intercropping, reservoirs, and crop cycling. Further, enhancing quarantine capabilities, sentinel monitoring programs, and commitment to identification and management of pests, weeds and disease threats to counteract those pathogens and pests likely to be favored by climate change. The recent development of plant health clinics and the release of an app for Pacific Pests and Pathogens illustrate the approaches that can be applied. [109] [110]

Enhanced food storage and processing techniques – Particularly for root crops like taro, yams, and cassava which traditionally have a short shelf life, utilizing established techniques like solar drying, processing into products like flour and chips, etc. have been shown to improve opportunities for food

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[101] Please see Annex 7 for further articulation of traditional agriculture activities in FSM.
[102] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf
[103] https://www.unescap.org/sites/default/files/Land%20Use%20Planning%20and%20Climate%20Resilient%20Agriculture%20by%20SPC.pdf
[104] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf
[105] Pacific Organic and Ethical Trade Community Farmer Resources for Organic Farm Management; Available at: http://www.organicpasifika.com/poetcom/for-farmers-and-growers/resources/organic-farm-management/
[106] Pacific Organic and Ethical Trade Community Organics Simplified; Available at: http://www.organicpasifika.com/poetcom/wp-content/uploads/sites/2/2018/05/Friends-FIji-4pg.pdf
[107] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf
[108] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf
[109] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf
[110] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

availability during times of shortage. Improve processing and storage of staples to offset production losses due to climate change.[111] [112]

Exit Strategy and Sustainability

The project proposal is designed with the explicit purpose of ensuring the sustainability and replicability of results. Past attempts at one-off pilot projects have failed to provide a system-wide solution to increasing the resilience of FSMs most vulnerable communities to food insecurity in the face of climate change. The opportunity provided through GCF support will allow for targeting multiple barriers at one time, which will include strengthening the enabling environment, providing an evidence-base for specific interventions, developing new opportunities for market access and development, and targeting new CSA techniques and opportunities for income and food security to a substantive portion (63%) of the FSM population. Specific project activities and structural components that enable long-term sustainability of project outcomes include:

- **Mainstreaming of climate change into national policies** – By integrating climate change adaptation more deliberately into national policies and planning, particularly the national and state agriculture policies, the project can ensure focused institutional attention for maintaining momentum built by project interventions.
- **Nurseries and seedbanks** – Developing nurseries and seed banks ensures longevity of project impact by creating a self-sustaining supply of climate resilient seed varieties that can be distributed to communities and households both proactively and post-disaster. These systems provide an additional measure of resiliency that can support and sustain project outcomes for food security even if there are larger shocks to a specific state or community.
- **Establishment of farmers cooperatives and agricultural networks** – These institutions provide a forum for adaptive management and long-term knowledge and innovation sharing across States as well as a vehicle for directly reaching communities and households.
- **Development of business models for sustainable financing** – By leveraging structure and elements of existing business models and initiatives for local food production the project will work to develop sustainable financing models to help sustain project impacts beyond initial GCF investment.
- **Market awareness and access** – By developing new awareness and opportunities for market participation for household farmers, the project is creating new structures (both formal and informal) and a positive feedback loop that will provide financial incentives to replicate results. Additionally, the success of these markets and structures creates best practices that can be leverage to drive additional market development beyond the initial project impact.
- **Tailored trainings for households** – The project includes a wide variety of targeted trainings, most notably on use of climate information, utilization of climate-smart agroforestry practices, water resource management, household food processing, market access and valorization, etc. all of which are skills that can and will be utilized by the communities and households to sustain food-security outcomes beyond project life.
- **Training and capacity building for communities and governments** – The project also targets trainings and capacity building specifically for cooperatives and government actors to manage and operate the project outcomes beyond initial GCF involvement including training on the climate data systems, nursery management and care, and agroforestry.

[111] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf
[112] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

Summary

Overall the envisioned project, “Climate resilient food security for farming households across the Federated States of Micronesia (FSM)” has strong potential to provide long term sustainable outcomes for climate resiliency for small-scale producers in FSM by increasing food and income security through climate adapted practices, livelihoods and value chains. Coupled with its very small risk profile and proactive mainstreaming of gender considerations throughout the project components, the project should be poised for favorable appraisal and funding by the GCF Board.

Annex 1: Relevant Projects and Programmes

Project	Location	Organization/ Donor	Overview	Opportunities to be leveraged for the Present GCF Project
Climate Resilient Adaptation and Mainstreaming	FSM	USAID	With a grant from the Pacific-American Climate Fund (PACAM), the College of Micronesia-FSM (COM-FSM) will educate community members on CSA strategies, including crop diversification, to provide livelihood and ensure food security; and on water harvesting techniques and water conservation. Using a model successfully developed in Gargey Village in Yap, communities will be trained in small-plot intensive farming, microgardening, container home gardening, agroforestry, and integrated farming with livestock. Expected outcomes include: 1. Improved soil management for CSA. 2. Increased livelihood opportunities and gender focused CSA practices. 3. Reduced risks from form climate variability and change through local capacity building and promoting appropriate diverse crop production practices. 4. Increased awareness on sustainable water use and conservation.	Inventory of CSA techniques Capacity building and training techniques Seed varieties
Climate Change Adaptation through Family, Gardens, Food, and Health, Federated States of Micronesia	FSM	USAID	This project mitigates the impacts of climate change by strengthening the capacity of families and school communities to grow nutritious food. This will be achieved through the establishment of community nurseries, as well as home and school gardens. In addition, a new school curriculum will focus on gardening, food production, and nutrition. This curriculum complements the community and home gardens, while providing students, teachers, and their families with new tools for adapting to climate change. Food security is further improved through the project's focus on food systems (i.e., the knowledge, production, processing, distribution, preparation, and consumption of food). The project incorporates traditional gardening and food production knowledge, with community liaisons serving as mentors for the home and school garden program.	Communications and outreach material on food security Connectivity to school programs for awareness building activities.
Climate Change Adaptation and Income Diversification in Pohnpei,	FSM	USAID	With a grant from USAID's Pacific-American Climate Fund (PACAM), the Marine and Environmental Research Institute of Pohnpei (MERIP) is increasing the resilience of communities to the impacts of climate change by working with coastal rural communities that support protected areas to start small-scale aquaculture ventures. These include the	Climate vulnerability information for Pohnpei Capacity built for training and engagement of local FSM communities

Federated States of Micronesia			farming of giant clams, sponges and coral-- highly sustainable activities, well-established within the region-- and the farming of rabbitfish as a new source of income for Pohnpei and an alternative food supply. The PACAM-funded project also strengthens local fishery management capacity through workshops and community meetings that focus on key management issues such as the catching of undersized or immature fish, Marine Protected Area (MPA) compliance, and climate change impacts. Pilot projects will be implemented in coastal communities to improve knowledge of sustainable mangrove management and of the effects of land-based activities on water quality and coral health.	
Let's Go Local	FSM	Island Food Community of Pohnpei	The Pohnpei community intervention programme took place in Mand community, Pohnpei, Federated States of Micronesia (FSM) from September 2005 to June 2007. The programme aimed at increasing the production and consumption of locally grown foods and improving health. The programme had two phases: phase 1 involved documenting the traditional food system and imported foods, and assessing health status, using the Centre for Indigenous Peoples' Nutrition and Environment methodology; phase 2 involved two sub-phases. In phase 2a, promotion and intervention activities focused on building awareness through workshops, competitions (weight loss, planting and cooking), mass media, posters, billboards, postage stamps, postcards and other materials; the conservation of rare crop varieties; and small-scale food processing. In phase 2b, the impact of promotion and intervention activities carried out in phase 2a was evaluated.	Assessment of traditional food systems vs imported foods to better inform project activities on local produce Communications and outreach material for local nutrition Value chains and linkages for local produce activities
Enhancing Livelihood Recovery through Food Security in the Aftermath of Natural Disasters in Fiji	Fiji	UNDP	The project focuses on two key areas: i) Assisting in livelihoods recovery by focusing on improvement in food security methods for vulnerable communities affected by natural disasters and ii) Enhancing capacity in the Dept. of Agriculture to address disaster risk mitigation and providing support to vulnerable communities to improve resilience to climate change and natural disasters.	Potential methods for improvement of food security in the face of natural disasters.

Samoa 50 villages Project	Samoa	USAID	With a grant from the Pacific-American Climate Fund (PACAM), Matuaileoo Environment Trust, Inc. (METI) will assist 50 Samoan villages to adapt to the impacts of climate change. Its multi-faceted project will include integrated training in CSA and healthy living through whole foods and plant-based nutrition. This will be implemented through a culturally sensitive program that includes training for taiala (Samoan for “path-breakers”), who are village residents enlisted to serve as frontline health, education, and sustainable development workers.	Potential methods for capacity building, CSA, and local nutrition
Foundation for Rural Integrated Enterprises and Development (FRIEND)	Fiji	USAID	This project focuses on adaptation measures that improve food security, particularly through good agricultural practices and organic farming methods. Project interventions revive traditional methods of farming, harvesting, and storing food to ensure supply of healthy meals even during extreme weather conditions. The project will also include production and marketing incentives to expand the market for organic produce. Climate resilience of vulnerable communities will be strengthened through improved livelihood, healthier food options, improved governance practices, and improved social cohesion.	Inventory of potential adaptation measures related to food security, particularly agricultural practices and market/value chain support
Yumi Redi long Klaemet Jenis (We're Ready for Climate Change): Increasing Small Islands' Resilience to Climate Change Vanuatu	Vanuatu	USAID	With a grant from the Pacific-American Climate Fund (PACAM), CARE International in Vanuatu, in partnership with Save the Children, will support climate change adaptation activities to improve the resilience of selected districts in two provinces in Vanuatu to climate impacts. This project will leverage the community-based adaptation projects that CARE had implemented in the past, including: the empowerment of women and youth in climate change planning; increased rural community access to climate and weather information; rural community adoption of climate-sensitive agricultural practices; and natural resources management. These inputs resulted in the introduction of home gardens, crop diversification, water harvesting, seed saving practices, and piloting of climate-resilient and disease-resistant crops. This PACAM-supported project will further advance climate change awareness and innovation, and improve the ability of communities, local civil society, and the government, to plan and take long-term action in response to climate risks affecting Vanuatu.	Potential community-based adaptation initiatives and CSA practices

Enhancing resilience of communities in Solomon Islands to the adverse effects of climate change in agriculture and food security	Solomon Islands	UNDP/AF	The Solomon Islands National Adaptation Program of Action (NAPA) to address the effects of climate change (2009) identified agriculture and food security as one of the most vulnerable sectors requiring urgent attention. This project addresses the NAPA priority and will contribute to enhancing resilience of the agriculture sector to maintain and improve food security in the country. The objective of the project is to strengthen ability of communities in Solomon Islands to make informed decisions and manage likely climate change driven pressures on food production and management systems. In particular, the project will lead to the following key results (outcomes); 1) Promote and pilot community - adaptation activities enhancing food security and livelihood resilience in pilot communities in at least 3 selected regions; 2) Strengthen institutions and adjusted national and sub-national policies related to governing agriculture in the context of a range of climate change futures; and 3) Foster the generation and spread of relevant knowledge for assisting decision-making at the community and policy-formulation level.	Inventory of potential food security and community engagement methods
Outer Island Food and Water Project	Kiribati	IFAD/IFAD	The Outer Island Food and Water Project (OIFWP) came into force in September 2014. Targeting the four outer islands of Abebama, Beru, North Tabiteuea and Nonouti, OIFWP promotes improved household food security and nutrition as well as clean water through rainwater harvesting and community planning and action activities. OIFWP aims to reach the entire population with a specific focus on women and young people. Outcome 1: Communities know how to plan and prioritise activities in a participatory and inclusive way Outcome 2: Households in the OIs are growing and eating more nutritious local foods Outcome 3: Households have secure access to a basic minimum quantity of clean drinking water	
Enhancing national food security in the context of global climate change	Kiribati	UNDP/GEF	The project objective is to build the adaptive capacity of vulnerable Kiribati communities to ensure food security under conditions of climate change. To address these challenges and reach the project's objective, the LDCF investment will support the realization of two components and related activities. Both components will be closely aligned so that national and site-based activities are designed to build synergies, increase awareness, and generate much more informed and strategic use of natural resources so that ecosystem integrity is able to continue to function as the foundation of food security needs.	

Pacific Adaptation to Climate Change	Pacific	UNDP/GEF	The objective of the PACC project is to enhance the capacity of participating countries to adapt to climate change in key development sectors: food production and food security, coastal management and water resource management. Supporting improvements in these sectors the PACC project is working to build resilience to climate change in PICT. Adaptation projects are now being implemented nationally, after an intensive consultative process with the implementing agencies and government counterparts. Under the project, Fiji, Palau, Papua New Guinea and the Solomon Islands are focusing on food production and food security. The Cook Islands, Federated States of Micronesia, Samoa, Tokelau and Vanuatu are developing coastal management capacity and Nauru, Niue, Republic of Marshall Islands, Tonga and Tuvalu are working to strengthen their water resource management. More specifically, the project is working to deliver outcomes and outputs that include improved technical capacity to formulate and implement national and sub-national policies, legislation, and costing/assessment exercises. Climate change risks will be incorporated into relevant governance policies and strategies for achieving food security, water management, and coastal development.	Lessons learned and best practices for developing and implementing adaptation projects and policies
USAID CC and Food Security Project	Pacific	SPC/USAID	SPC and the United States Agency for International Development (USAID), in collaboration with partner agencies, are supporting the governments of six Pacific countries – Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu – in their efforts to adapt to the adverse effects of climate change on food security. The support includes updating vegetation and land cover maps at the national level for Fiji, Kiribati and Solomon Islands, as well as working with local communities to implement appropriate adaptation measures to build their resilience to climate change. Successful models will inform sectoral and national policies in PICTs.	Climate resilient agriculture practices, policy development, and community engagement strategies
Readiness for El Nino Project	Pacific	SPC/EU	The RENI project is about communities working to secure food and water resources ahead of drought. The project is funded with € 4.5 million from the European Union and implemented by the Pacific Community (SPC) in collaboration with the governments and peoples of Federated States of Micronesia (FSM), Republic of Marshall Islands (RMI) and Palau.	Methods for proactively planning for El Nino impacts in the context of food security for Pacific Islands

Vegetation and land cover mapping and improving food security for building resilience to a changing climate in Pacific island communities	Pacific	SPC/USAID	The goal of this regional project is to evaluate and implement innovative techniques and management approaches to increasing the climate change resilience of terrestrial food production systems for communities in selected PICTS (Fiji, Kiribati, Samoa, Solomon Islands, Tonga and Vanuatu). The project will do this through the introduction of integrated agricultural production systems based on assessments of the climate resilience of existing systems at selected sites. This will be supported by improved land-system data and analysis tools, such as vegetation and land use mapping and the application of GIS. It will build the capacity of participating countries to utilise GIS tools and techniques to help identify key areas of food supply vulnerability, monitor vegetation and land cover change overtime. These assessments will be based on the most up-to-date country level climate change projections available. The project outputs will also be used to help inform the development and national and agriculture sector climate change adaptation response strategies in the recipient countries and other PICTs.	Potential techniques and management approaches for providing climate and weather information for localized decision-makers
Reviving Traditional Croplands to Improve Community Climate Resilience, Palau	Palau	USAID	This project works to revive traditional croplands and promote sustainable watershed management in order to increase the food, environmental, and economic security of rural communities in Babeldaob, the largest island in Palau. The Palau Conservation Society will partner with communities and the government in restoring neglected taro patches. Taro cultivation utilizes traditional soil conservation practices, including mulching and planting vegetation around farm boundaries, which helps control erosion and sedimentation. Functioning taro patches will not only benefit the ecosystem, they will also provide a readily available source of taro for consumption, ceremonial gift exchanges and other social obligations, and sale in local markets.	Specific methods for taro cultivation and development of community taro patches in the face of climate change

Annex 2: CAAR Final Report

CAAR PROJECT FINAL
REPORT_06252018.pd

The final CAAR project report has been uploaded as Annex 11a.

Annex 3: AF Enhancing Climate Resiliency Project Documents

AF - Enhancing the
Climate Resilience of '

Project document can be found here: https://www.adaptation-fund.org/wp-content/uploads/2017/01/5194COMPLETEMASTERclean06022017-1.pdf

Additional project documents avaialbe on the AF website here: https://www.adaptation-fund.org/project/enhancing-climate-change-resilience-vulnerable-island-communities-federated-states-micronesia/

Annex 4: PASAP Project Documents

FoodSecuirtyPASAP.pdf PASAP-foodsecurityproject[1].pdf

The PASAP documents are included as Annex 11b and 11c

Annex 5: FAO Draft Agriculture and Climate Change Vulnerability Report

FAO FINAL FSM VA with comments from COM_FSM and AV.pdf

Annex 6: Coconuts for Life and Other PGS Models

MCT Coconuts for Life.docx

Lenger home garden project report final.dc

SGP 2nd Progress Report Awak Commur

Annex 7: Expanded Description of Climate Smart Agriculture (CSA) Packages

Context for CSA Packages

The envisioned climate-smart agriculture (CSA) packages will be deployed on the main higher islands in each of the four states (Yap, Chuuk, Pohnpei, Kosrae) in FSM where both population and agricultural activity are more concentrated (the project will not be directly targeting the low-lying outlying atoll communities). The project will focus on deployments for smallholder farmers (generally <2 acres plot). Given the widespread geography of the FSM states, with islands spread across 2.7million km2 of ocean, the context for agriculture (including soils, erosion, rainfall, crop varieties, temperature, etc.) varies significantly across the four States, so the climate-smart agriculture packages will be tailored (Activity 2.1.1) to the specific vulnerabilities and needs of the target communities as identified through the project's downscaled vulnerability assessments (Output 1.2).

Given the above, an overarching discussion of current and future climate change and vulnerabilities, their specific impacts on agriculture and food security for smallholder farmers in FSM, and how the proposed measures in the envisioned CSA packages work to mitigate these impacts and provide key adaptation benefits is included in Table 1 below. It should be noted that the soil conservation efforts as well as some of the traditional agriculture practices will also generate mitigation impacts for climate change, but the main focus of this project is the adaptation outcomes, so the relatively small GHG reductions are considered to be a project co-benefit. Following, this the general description in the table is then more specifically explored in the context of the Yap high island communities (where the CAAR project piloted some of the proposed measures) to highlight an example of how CSA measures will be applied to different island geographies and challenges.

All of the CSA measures have been developed based on the FAO Sourcebook for CSA[113] as well as specific applied CSA projects in the Pacific, notably the USAID CAAR project and the Adaptation Fund "Enhancing the Climate Resilience of Vulnerable Island Communities in Federated States of Micronesia" project. Additional details on the proposed measures can be found in Appendix 1 and additional crop specific climate risks can be found in Appendix 2.

[113] FAO Sourcebook for Climate Smart Agriculture; http://www.fao.org/climate-smart-agriculture-sourcebook/concept/module-a1-introducing-csa/a1-overview/en/?type=111

Table 5: Overview of Climate Change Impacts on Agriculture and CSA Measures to Mitigate Potential Impacts

Ongoing Climate Change in FSM	Ongoing Climate Change Impacts to Food Security	Future Projections for Climate Change	Specific Challenges for Agriculture	Proposed Measures in Envisioned CSA Packages and Climate Change Adaptation Logic
Sea Level Rise and Tidal Surges				
Since 1993 sea level in the tropical western Pacific has been rising an average of 0.2-0.4in (5-10 mm) per year. For FSM specifically the value is over 0.39 in (10 mm) per year. This is ***well above*** the global mean of about 0.12 in (3 mm) per year over the same period. [114] Currently about 97% of high tides are less than 2 meters.	• Increasing soil salinity is the greatest threat to crop productivity on the atolls of FSM. • The majority of agricultural production within FSM occurs in the low-lying areas of the high, volcanic islands (approx. 21,700 ha of land). These areas are increasingly subject to lowland flooding as well as seawater inundation from sea level rise.[115] • Agricultural lands degraded or washed out due to SLR, soil salinity, tidal surges and the like cover an estimated area of 6,500 ha and affect over 3,300 farmers.[116] • Close to 100% of the nearly 35 inhabited outer islands in FSM lie within the 2-meter zone of potential sea level rise and within a 5-meter zone of storm surge, and have had to abandon taro	By 2030, under a high emissions scenario, the rise in sea level is projected to be in the range of 3.1-7.1 inches (8-18 cm). [122] Under a medium emissions scenario, sea level rise is projected to increase by 9 cm by 2030 and 39 cm by 2050. This amount of sea level rise is expected to inundate many low-lying coastal areas on all islands in FSM. By 2030 and 2050 dangerous high tide events are expected to exceed the 2-meter threshold 12% and 27% of the time respectively due to sea level rise creating significant potential risks	Sea level rise and increased tidal surges due to climate change results in the salinization and erosion of arable land in FSM and exacerbates existing tidal surges and acute flooding events. This results in specific challenges for agriculture in FSM including: • Salinization of soils from gradual SLR and flooding from tidal surges made worse by SLR. • Increased crop damage/loss from salt spray, tidal surges, etc. • Degradation/Loss of soils and arable land • Declining agricultural productivity	• **Introduction of climate resilient species and varieties –** Selecting salt-resistant/inundation resistant varieties of crops will help to mitigate potential crop damage and loss and improve agricultural productivity from declining soils and damaged water sources. The project will mostly focus on key staple crops that have been proven effective in FSM and other locations in the Pacific as discussed below. The project will enable access to and planting of salt-resistant varieties of key crops, which will result in the increased resilience of communities to current and future inundation events. • **Water conservation** – Specific water conservation practices that farmers will be trained to utilize will help to reduce strain on water resources, particularly in constrained periods when certain water resources have been contaminated by tidal surge. Therefore, through dissemination of water conservation practices, farmers will have increased capacity and knowledge to effectively respond to periods of water uncertainty.

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[114] Federated States of Micronesia Second National Communication on Climate Change pg. 28; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[115] GCF Country Program – Federated States of Micronesia; Available at: https://www.greenclimate.fund/sites/default/files/document/micronesia-country-programme.pdf

[116] FSM Integrated Agricultural Census 2016; Available at: https://spccfpstore1.blob.core.windows.net/digitallibrary-docs/files/a0/a08150f6a7805b5adc38fe751b1dfe16.pdf?sv=2015-12-11&sr=b&sig=nUBxA%2BAX6uUl5cZMfsm993a0L2qAbgW1BSCxxiiQ9Ys%3D&se=2021-07-26T14%3A48%3A28Z&sp=r&rscc=public%2C%20max-age%3D864000%2C%20max-stale%3D86400&rsct=application%2Fpdf&rscd=inline%3B%20filename%3D%22FSM_2016_IAC_200120.pdf%22

[122] Federated States of Micronesia Second National Communication on Climate Change pg. 30; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

	patches because of inundation in the past.[117] Examples: ○ Saltwater intrusion during tidal surges in 2007 in Yap, led to the mortality of 90% of the taro crop on the islet of Falalop, Ulithi atoll, and 75% of the taro crop on the islet of Falalop, Woleai atoll.[118] ○ In that same year, approximately 90% of all taro was destroyed in the outer islands of Chuuk, where an estimated 25% of the State's population resides.[119] • Assessment of damage following tidal surges that occurred in 2008 indicated substantial damage to four staple crops (taro, breadfruit, banana, and coconut) in the Chuuk State Islands – particularly the subsistence crops of taro and breadfruit which had severe damage or were fully destroyed.[120] Roughly half of all households surveyed reported at least a 15-40% loss of their primary dietary staple and source of calories (taro and breadfruit). Additionally, 15% of households reported a complete loss of taro and 10% reported a complete loss of breadfruit.[121]	for food security and agriculture in FSM.	• Damage to water resources	• **Soil conservation** – Leveraging various soil conservation techniques including but not limited to improving soil health management through use of cover crops and improved fallow (i.e. mucuna), legumes, composting and agroforestry systems, mulching, minimum tillage, and contour farming as well as altering production practices (planting time, spacing, pest and disease, harvesting time) all can work to directly combat loss in agricultural productivity from degraded soils as a result of SLR. These improved soil conservation techniques will empower communities to respond to current and future salt-water inundation events. • **Traditional agriculture practices** – Certain traditional agriculture practices like mulching and composting as highlighted above can directly improve degraded soils resulting from SLR. Additionally, as discussed above, the project will empower communities and farmers in particular to utilize traditional agricultural practices in response to and in preparation of salt-water inundation. • **Restoration of barrier species** – Strategic planting and refortifying of barrier crop species like mangroves which are or used to be present in the high islands of FSM can help to protect water resources from damaging salt water and protect against crop damaging salt spray, SLR, tidal surges, etc. Restoration of mangrove species will increase community resilience to sea level rise and current and future salt-water

[117] FSSLP via FSMNC2; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[118] Perkins and Krause, Adapting to climate change impacts in Yap State, Federated States of Micronesia: the importance of environmental conditions and intangible cultural heritage, Island Studies Journal (2018); Available at: https://doi.org/10.24043/isj.51

[119] Hezel, F. (2009). High water in low atolls. Micronesian Counselor, 15 March.

[120] Post Disaster Assessments of FSM Outer Islands Via FSMNC2 pg. 81; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[121] Sea-Level-Rise Disaster in Micronesia: Sentinel Event for Climate Change?; Available at: https://www.researchgate.net/publication/304554278_Sea-Level-Rise_Disaster_in_Micronesia_Sentinel_Event_for_Climate_Change

	• 3-22% of households across the four States are already reported issues with sea water as the key factor driving declining agricultural productivity and an additional 5-15% of households highlighted flooding impacts (including from tidal surges).			inundation events that impact crop production throughout FSM. • **Organic farming techniques** – Leveraging organic fertilizer from composting in coordination with other organic farming techniques works directly to improve productivity from degraded soils and arable land. These techniques will increase the capacity of farmers to utilize local resources to sustainably increase resilience to salt-water inundation. • **Enhanced food processing and storage techniques** – Improving bridging capacity through enhanced food storage and processing can help to offset potential crop losses from acute events like tidal surge made worse by sea level rise. These food processing techniques will increase household capacity for farmers and community members to weather ongoing and future salt-water inundation events that damage and destroy local crops.
		Typhoons and Tropical Storms		
The ENSO cycle has a profound effect on the distribution of tropical cyclones in the FSM. During El Nino years, typhoons and tropical storms are 2.7 times more likely to occur in the FSM region compared to non-El Nino years.[123] The formation region of cyclones is also impacted. As is currently observed, during El Nino years, typhoon	• One of the most comprehensive reviews of climate change and agriculture in the Pacific[124] highlighted that for most staple food crops (taro, breadfruit, yam, banana, and coconuts), extreme weather events including storm surges and king tides (and the resulting salinization) are already damaging these crops. • According to the FSM Integrated Agricultural Census, in 2016 weather damage was reported as resulting in ten percent (6,903 acres) or more land parcels with	Overall, the effect that climate change will have on ENSO incidence and severity remains a critical uncertainty, but it has the potential to dramatically shape climate and impact in FSM, particularly through the occurrence of tropical storms and typhoons. An increase in the magnitude and/or frequency of El Nino conditions (coupled with increased sea surface and atmospheric temperatures)	Like SLR and tidal surge discussed above, typhoons and tropical storms and their resulting storm surges (exacerbated by climate change) can result in a number of challenges for agriculture in FSM including: • Salinization of soils from storm surges • Increased crop damage/loss from storm surges and flooding events	• **Introduction of climate resilient species and varieties –** Selecting salt-resistant/inundation resistant varieties of crops will help to mitigate potential crop damage and loss from storm surge events by improving resilience to salinized/inundated soils. The project will enable access to and planting of salt-resistant varieties of key crops, which will result in the increased resilience of communities to current and future inundation events from typhoon and other storm events. • **Soil conservation** – Leveraging various soil conservation techniques including but not limited to improving soil health management through use of cover crops and improved

[123] Typhoons in Micronesia – A History of Tropical Cyclones and their Effects until 1914; Available at: https://www.researchgate.net/publication/277964781_Typhoons_in_Micronesia_A_history_of_tropical_cyclones_and_their_effects_until_1914

[124] Vulnerability of Pacific Island agriculture and forestry to climate change (2016); Available at: https://www.spc.int/sites/default/files/wordpresscontent/wp-content/uploads/2016/12/Vulnerability-of-Pacific-Island-agriculture-and-forestry-to-climate-change.pdf

formation extends eastward resulting in an increased risk of a typhoon for Pohnpei during El Nino years, and a decreased risk during the year following El Nino and during La Nina years.	losses of crops. The highest reported rates of damage were to betelnut, breadfruit, piper leaves, banana, coconut, swamp taro, tapioca and sakau all of which had reported weather damage of between 20 and 30 percent (13,808 acres and 20,711 acres) of parcels of land with the crop. • In 2015, a preliminary damage assessment (PDA) by USAID evaluating the impact of Typhoon Maysak in FSM found that Typhoon Maysak destroyed at least 90 percent of crops and fruit trees, including staple foods such as breadfruit and taro, in affected areas across both Chuuk and Yap. As a result, approximately 29,000 people in FSM required temporary food assistance. Communities also required assistance with agricultural inputs—seeds, cuttings, and limited hand tools—to facilitate quick replanting. • 5-15% of households already highlight flooding impacts (including from storm surges) as a key factor limiting agricultural productivity.	could cause more severe tropical storms and typhoons in the future.	• Degradation/loss of soils and arable land due to storm surges, landslides, and other washout events • Declining agricultural productivity • Damage to water resources	fallow (i.e. mucuna), legumes, composting and agroforestry systems, mulching, minimum tillage, and contour farming as well as altering production practices (planting time, spacing, pest and disease, harvesting time) all can work to directly combat loss in agricultural productivity from degraded soils as a result of storm surge and importantly following landslide and other washout events (i.e. 1991, 1997, 2002, 2004, 2007, 2008 typhoon/hightides induced landslides in Pohnpei). Dissemination of improved soil conservation techniques will empower communities to be more resilient to current and future storm events, as well as recover crop production following these events. • **Water conservation** – Specific water conservation practices that farmers will be trained to utilize will help to reduce strain on water resources, particularly in constrained periods when certain water resources have been contaminated by storm surge. Therefore, farmers will have increased capacity and knowledge to effectively respond to periods of water uncertainty due to storm events and conditions. • **Traditional agriculture practices, particularly agroforestry** – Certain traditional agriculture practices like mulching and composting as highlighted above can directly improve degraded soils resulting from storm surge, and importantly by specifically expanding traditional agroforestry systems, the packages can help to mitigate landslide/washout risks and impacts. Additionally, as discussed above, the project will empower communities and farmers in particular to utilize traditional agricultural practices in preparation, in response to and following major storm events. • **Restoration of barrier species** – Strategic planting and refortifying of barrier crop species like mangroves can help to protect

				water resources and crops from storm surge. Restoration of mangrove species will increase community resilience to storm events and their acute (e.g storm surge) and ongoing impacts on crop production. • **Organic farming techniques** – Leveraging organic fertilizer from composting in coordination with other organic farming techniques works directly to improve productivity from degraded soils and arable land. These techniques will empower farmers to utilize local resources to sustainably increase resilience to degraded soils and salt-water inundation from storm events. • **Enhanced food processing and storage techniques** – Improving bridging capacity through enhanced food storage and processing can help to offset potential crop losses from acute events like storm surges and landslides. These food processing techniques will increase household capacity for farmers and community members to weather crop production loses from ongoing storm events that damage and destroy local crops.
Precipitation and Drought				
Annual rainfall in FSM has remained relatively constant with a slight decline across states, with Yap declining an average of 0.31 in (7.9mm) per decade, Pohnpei declining 3.46in (88mm) per decade, and Chuuk declining 1.93in (-48.9mm) per decade (1950 -2009). [125]	• Tropical Storm Chataan struck the islands of Chuuk in 2002. The storm resulted in 500 mm of rainfall in a 24-hour period, which triggered 265 documented landslides. The landslides caused the destruction or damage of 231 structures, including homes, schools, community centers and medical dispensaries. These landslides also buried roads and damaged crops and water supplies. In 1997, two major	An increase in annual precipitation over large parts of the tropical Pacific is predicted for a warmer climate, with impact prior to 2030 being minimal. After 2030, more distinctive patterns emerge, which will become progressively stronger with time and for higher emission scenarios (RCP6 and 8.5). An increase of 25% in mean	Increased precipitation, particularly extreme precipitation events coupled with exacerbated drought conditions and severity during El Nino conditions can cause significant challenges for agriculture in FSM: • Crop damage and loss from droughts,	• **Introduction of climate resilient species and varieties** – Some of the salt-resistant/inundation resistant varietals of crops selected for the CSA packages can also be drought resilient as well/instead, so depending on the crop and location drought resistant varietals can be included as well to reduce the impact of crop loss/damage from droughts. The project will enable access to and planting of drought resistant varieties of key crops (as applicable per community), which will result in the increased resilience of

[125] Pacific-Australia Climate Change Science and Adaptation Planning Program; Available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2014/07/PACCSAP_CountryReports2014_WEB_140710.pdf

El Nino events in FSM tend to cause droughts. The islands of FSM were severely impacted by drought during El Niño conditions of 1997-1998.	tropical storms struck the main island of Pohnpei within a small timeframe. These storms triggered more than 30 documented landslides, which caused property damage, including to crops.[126] • Drought impacts in FSM tend to be severe when they occur. For example, during El Niño conditions of 1997-1998, insufficient rainfall caused water and food shortages including staples such as taro, coconut, breadfruit, banana, yam, sweet potato, citrus, sugar cane, and others. Communities among the atolls survived because bottled water, food supplies, and reverse osmosis pumps were imported. • A survey undertaken in April 1999 revealed 75% of the breadfruit trees and 68% of the coconut trees were either severely stressed and/or dying as a result of the El Nino induced drought. Meanwhile, taro, the primary source of starch on the affected atoll, was estimated to be at 25% of its pre-drought levels, with importation from other islands needed to make up the deficit. [127] • 2-47% of households already report issues with drought as a key negative driver for agriculture productivity.[128]	annual rainfall would have a significant damaging effect on crop production in locations where rainfall is already high to very high.[129] Further increased rainfall can also contribute to washout events, particularly landslides which have been common in FSM during extreme precipitation events Although drought frequency is expected to decrease in FSM due to climate change, the effects of climate change on ENSO conditions is relatively uncertain. An increase in the magnitude of El Nino conditions (coupled with increase atmospheric temperatures) could cause more severe droughts in the future.	washouts, water logging, etc. • Reduced yields for certain crops that are less moisture tolerant • Degradation of soils and arable land	communities to drought conditions and their impact on local food security. • **Water conservation –** Specific water conservation practices that farmers will be trained to utilize will help to reduce strain on water resources and proactively manage for drought situations. Therefore, through dissemination of water conservation practices, farmers will have increased capacity and knowledge to effectively respond to shifting precipitation patterns in FSM. • **Soil conservation** – Leveraging various soil conservation techniques including but not limited to improving soil health management through use of cover crops and improved fallow (i.e. mucuna), legumes, composting and agroforestry systems, mulching, minimum tillage, and contour farming as well as altering production practices (planting time, spacing, pest and disease, harvesting time) all can work to directly combat loss in agricultural productivity from degraded soils following landslide and other washout events (i.e. 1991, 1997, 2002, 2004, 2007, 2008 typhoon/hightides induced landslides in Pohnpei). These improved soil conservation techniques will empower communities to be more resilient to current and future acute precipitation events and shifting precipitation patterns that impact local crop production. • **Traditional agriculture practices, particularly agroforestry –** Agroforestry in particular can help to mitigate the impact of landslide and other washout events and other practices like mulching can help to

[126] Federated States of Micronesia Second National Communication on Climate Change; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[127] Post Disaster Assessments of FSM Outer Islands via Federated States of Micronesia Second National Communication on Climate Change pg. 83; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[128] FSM Integrated Agriculture Census 2016 (2020); Available at: http://www.fsmrd.fm/wp-content/uploads/2020/06/200120_FSM_IAC_2016.pdf

[129] IBID.

				reinvigorate degraded soils following washout events. The project will empower communities and farmers in particular to utilize traditional agricultural practices, which will enable them the tools and knowledge to more resiliently grow crops in the context of shifting precipitation patterns. • **Integrated management approaches including proactive drought management** - The CSA packages also include certain proactive drought management measures like joint-planning at the national level, participatory planning through farmer cooperatives, location-specific short term and medium-term response to drought, etc. that help to reduce the crop loss and impact on farmers from drought events. The project will, therefore, increase the capacity of national and local level planners and farmers to effectively respond to droughts and their impacts on crop production in localized areas. • **Enhanced food processing and storage techniques –** Improving bridging capacity through enhanced food storage and processing can help to offset potential crop losses from acute events like landslides and drought. These food processing techniques will increase household capacity for farmers and community members to weather crop production loses from acute, climate-driven events.
Temperature				
Annual and seasonal maximum temperatures have increased in Pohnpei and Yap since 1951. Maximum temperatures have increased at a rate of 0.32ºF (0.18°C) per	• Although FSM has experienced a trend of ambient temperature increases and is projected to continue to experience temperature increases due to climate change, to date, there have been no comprehensive studies or evidence gathered that	Climate projections suggest that the frequency and occurrence of higher maximum daily temperatures will dramatically increase for Pohnpei and FSM more broadly. [131] Projections for	Atmospheric temperature increases due to climate change will result in a number of challenges for agriculture in FSM including:	• **Introduction of climate resilient species and varieties** – Many of salt-resistant/inundation resistant varietals of crops selected for the CSA packages also tend to have more resiliency to heat stress as well. For certain crops that are more sensitive to heat stress like sweet potatoes,

[131] FSM National Communication on Climate Change pg. 20-22; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

decade at Pohnpei and at a rate of 0.41ºF (0.23ºC) per decade at Yap. Also, at Pohnpei, annual and half-year trends in maximum air temperature are greater than those observed in minimum air temperature. These temperature increases are consistent with the global pattern of warming. With less than 1.5°C between its hottest and coldest months, FSM experiences very little seasonal variation in mean air temperatures[130].	identifies the impacts of ambient temperature increases on crop production in FSM. • This SAP project is focused on addressing the observed climatic impacts on crop production from sea level rise, storm surge and saltwater intrusion, as well as damage from changing precipitation patterns. It is, however, acknowledged that the continued increase in ambient temperature will result in impacts to crops in FSM at a future date.	all emissions scenarios indicate that the annual average air temperature and sea-surface temperature will increase in the future in FSM. By 2030, under a very high emissions scenario, this increase in temperature is projected to be in the range of 1.1–2.0°F (0.6–1.1°C). Generally, the projected temperature increases up to 2030 will not affect production, based on what is currently known for optimum crop production conditions. Between 2030 and 2050, temperatures will be influenced by the emission scenario with projections of 0.5°– 1°C (very low scenario) to 1°–2°C (very high scenario) increases by 2050, and beyond 2050, the temperatures again vary significantly depending on the emission scenario. Specific impacts are difficult to predict based on current knowledge, but obviously temperatures approaching 2°C and beyond will create significant physiological stress for many of the staple crops in FSM.[132]	• Crop damage and loss due to extreme heat events • Changes in growing seasons and potential yields/productivity due to changes to average/max temperature • Increased evapotranspiration and severity of droughts	the project will work to identify potential alternative varietals that more specifically focus on heat impacts. The project will enable access to and planting of heat resistant varieties of key crops (as applicable per community), which will result in the increased resilience of communities to increasing ambient temperatures and extreme heat events, and their impact on local food security. • **Traditional agriculture practices, particularly agroforestry** – Expanding traditional agroforestry systems, particularly for shade tolerant crops like taro, will help to reduce some heat-related crop damages. The project will empower communities and farmers in particular to utilize traditional agricultural practices, which will enable them the tools and knowledge to more resiliently grow crops in the context of increasing ambient temperatures and more extreme heat events. • **Enhanced food processing and storage techniques** – Improving bridging capacity through enhanced food storage and processing can help to offset potential crop losses from acute events like extreme heat. These food processing techniques will, therefore, increase household capacity for farmers and community members to weather crop production loses from acute, climate-driven events such as extreme heat.

[130] https://climateknowledgeportal.worldbank.org/country/federated-states-micronesia/climate-data-historical
[132] Vulnerability of Pacific Island agriculture and forestry to climate change (2016); Available at: https://www.spc.int/sites/default/files/wordpresscontent/wp-content/uploads/2016/12/Vulnerability-of-Pacific-Island-agriculture-and-forestry-to-climate-change.pdf

Expansion of Vectors/Pests				
FSM currently experiences some challenges with pests due to changing climate conditions, particularly taro leaf blight, mealybugs, fruit flies, and whiteflies, but the full attribution to climate change is not fully known.	• 5-12% of households across the four States do report issues with invasive species and pests expected to be exacerbated by climate change. However, the information and data for the link between climate change and an increase of invasive species and pests has as of yet not been investigated systematically.	There is very limited information regarding how climate change will influence pest and disease incidence and distribution, so projections are difficult. However, projections for changing climate in the Pacific generally improves conditions for pest growth and spread.[133] An assessment of food security in FSM specifically also identified the possibility of climate change triggering expanded opportunities for pests and disease in staple crops. specifically, fruit flies, mealybugs, scale insects, and whiteflies.[134] A further assessment highlighted uncertain impacts of climate change on pests, but noted that there was significant potential for expanded optimal conditions for pest spread, particularly for fruiting trees.[135]	• Extreme events, and changing precipitation and temperature are expected to create more ideal growing and spreading conditions for pests. The increase in pests and vectors for staple crops can potentially increase the magnitude and rate of crop loss and damage.	• **Integrated crop/pest management approaches** – Integrated Pest Management (IPM), Integrated Crop Management (ICM) and Integrated Vector Management (IVM) practices to help combat pests and improve yields. This includes strategies like intercropping, reservoirs, and crop cycling. Further, enhancin quarantine capabilities, sentinel monitoring programs, and commitment to identification an management of pests, weeds and disease threats to counteract those pathogens and pests likely to be favored by climate change.[136] [137] • **Introduction of climate resilient species and varieties** – Some introduced varietals are more resistant to fungal spread and other pests. For example, climate resilient taro varieties have also been found to be more resilient to Taro Leaf Blight. The mitigation impact from the introduction of new varietals is expected to be secondary and limited if available.

[133] IBID

[134] Fourteen Atoll Assessment of Food Security via FSMNC2 pg. 61; Available at: https://www.fsmstatistics.fm/wp-content/uploads/2019/10/2-2nd-National-Communiation-to-the-UNFCCC.pdf

[135] http://pubs.iclarm.net/resource_centre/2015-15.pdf

[136] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf

[137] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

Appendix 1: Assessment of Appropriate Climate Resilient Agriculture Practices

Developing climate resilient agriculture systems in FSM will necessarily require close coordination of multiple strategies tailored to specific socioeconomic and geographic conditions. In general, there has been strong research across FSM and the Pacific supporting strategy development and validation for climate resiliency in agriculture. Specific strategies include:

Introduction of climate resilient species and varieties – There are a number of projects both ongoing and completed in FSM and similarly situated Pacific Island countries that have developed, isolated, and identified appropriate traditional crop varieties and species that are more resistant to changing climatic conditions including characteristics like higher salt-tolerance, higher drought tolerance, resistance to water logging, resistance to pests, etc. For example, three varieties of adaptive taro, cassava, and kumala were developed as part of the PACC project in Fiji and three varieties of Colocasia taro, namely Dungersuul, Dirrubong, Kirang, were identified as salt tolerant in a PACC project in Palau joining a total of sixteen climate resilient crop varieties identified by that project – Colocasia taro (8), swamp taro (6) and Xanthosoma (2). Other examples include species such as shade tolerant yam (dioscorea spp), wetland taro (colocasia spp), ngali nut (canarium indica), leafy vegetable shrubs, banana (musa) varieties tolerant to wet conditions, cut-nut (barringtonia spp, terminalia spp), mukuna beans (mukuna bractiyata). The Secretariat for the Pacific Community plays a central coordinating role for identification and distribution of climate smart crop species particularly through the Centre for Pacific Crops and Trees (CePaCT).[138][139][140][141]

The Pacific Adaptation Strategy Assistance Program in FSM trialed different types of sweet potato (provided by SPC) with climate resilient properties for their applicability in FSM and soft taro (provided by the Micronesia Plant Propagation Research Centre - MPPRC). The aim of the project was to provide fully acclimatized plants of sweet potato (1,600) and soft taro (400) to four states for field trials.[142]

In Pohnpei research is testing the resilience of varieties of cassava and taro to climate change, and also testing the resilience of taro varieties to Taro Leaf Blight (TLB). SPC's Pacific Agriculture Policy Project (PAPP), College of Micronesia – FSM, COM-Land Grant, and the FSM and Pohnpei Agriculture Departments, and other partners are collaborating in these research activities. Nine varieties of cassava and 11 varieties of taro currently growing in Pohnpei are being tested in the trial agriculture plot. The collaboration is also conducting ongoing demonstrations of cassava to highlight drought resistant varieties and showcase effective crop management. [143] Other research into climate smart varieties in FSM includes the Micronesia land grant research stations[144]

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[138] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

[139] Land Use Planning and Climate Resilient Agriculture Capacity Workshop (2016); Available at: https://www.unescap.org/sites/default/files/Land%20Use%20Planning%20and%20Climate%20Resilient%20Agriculture%20by%20SPC.pdf

[140] SPC Land Resources Division; Available at: https://lrd.spc.int/

[141] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf

[142] Pacific Adaptation Strategy Assistance Program – Impact of Climate Change on Food Security in FSM; Available at: https://www.preventionweb.net/files/27083_110318pasapfoodsecurityproject%5B1%5D.pdf

[143] Climate-Ready Crop Research Factsheet (2016); Available at: https://pafpnet.spc.int/attachments/article/764/Factsheet02_Final_ecopy.pdf

[144] Kosrae Agriculture Experimentation Station; Available at: http://www.micronesialandgrant.org/research/college-of-micronesia-fsm/kosrae-agricultural-experiment-station/

Enhanced farming and land use techniques facilitating soil and water conservation – Depending on crop type and location, different strategies have proven effective at preventing land degradation and loss of soil fertility, improving productivity, and building resilience to climate change. Improving soil health management through use of cover crops and improved fallow (i.e. mucuna), legumes, composting and agroforestry systems. Other strategies include mulching, minimum tillage, and contour farming as well as altering production practices (planting time, spacing, fertilizers, pest and disease, harvesting time). Organic fertilizer can also be leveraged particularly soil amendments like fish meal and rock phosphorus have been shown to be effective increasing taro yields. [145][146]

In FSM, a strong example of this is the research undertaken by the College of Micronesia on enhancing the climate resilience of atoll communities on Yap island. The project adopted a three-pronged adaptation model consisting of soil management, water conservation and management, and livelihood enhancement. The college started by teaching the communities to improve the soil through techniques such as composting, liming and mulching, among others. [147]

Volcanic soil health management through composting, mulching, and incorporation of traditional crops and agroforestry systems gradually improves soil properties, making conditions more favorable for crop growth. Mulching protects soils from excessive heat, exposure to wind, and moisture loss. Potential rates of carbon sequestration in response to improved soil management vary widely as a function of land use, climate, soil, and many other factors. With land (where displaced atoll community settlements are situated) being severely degraded, it is perhaps unreasonable to expect a higher rate in the beginning. The very low carbon levels in the Gagil and Yap Series of soils (1–2% of organic matter) mean that a 1% increase in carbon content of soil mass is feasible. Maintaining an appropriate level of soil organic matter and biological cycling of nutrients is challenging in humid tropical conditions. In practice, however, the land is expected to be used for agriculture before that rate of C sequestration would apply.

Promote traditional farming systems and agroforestry – Traditional farming systems and agroforestry techniques that match the carrying capacity of the land can improve long-term productivity and resilience.[148] Strategies include integration of native trees, fruit trees, coconuts, and nitrogen fixing trees with taro, yaqona and vegetables. Development of community woodlots to improve ecological resilience in terms of watershed function and avoiding reduced fallow periods or repeated cropping of high-value crops on the same land, especially without rotations or sufficient replenishment of soil nutrients. Agroforestry and tree crops increase the resilience of local communities by providing diversity of fruits, nuts, medicines, fuel and timber and reducing soil erosion.[149][150] Traditional agroforestry practices are the bases for most agriculture production in the FSM. The project will work to enhance and/or improve on existing agroforestry practices and systems by incorporating CSA-based research. When done correctly, these systems are resilient

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[145] Land Use Planning and Climate Resilient Agriculture Capacity Workshop (2016); Available at: https://www.unescap.org/sites/default/files/Land%20Use%20Planning%20and%20Climate%20Resilient%20Agriculture%20by%20SPC.pdf

[146] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

[147] https://www.climatelinks.org/blog/enhancing-climate-resilience-atoll-communities-yap-island-fsm

[148] Please see Appendix 7 for further articulation of traditional agriculture activities in FSM.

[149] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

[150] https://www.unescap.org/sites/default/files/Land%20Use%20Planning%20and%20Climate%20Resilient%20Agriculture%20by%20SPC.pdf

and can be better tailored to the changing conditions by utilizing science and other modern technologies and resilient crops to enhance these techniques.

Additional details on traditional farming techniques can be seen in the Feasibility study.

Restoration of barrier species - Protect and replant littoral forest to help build resilience of coastal agroforestry farming systems and maintain coastal forest integrity. Forest species, particularly barrier species like mangroves, can help protect crops and crop patches like taro from wind/seawater damage and provide a measure of resiliency to storm surges and inundation. [151]

Leveraging organic farming techniques – Organic farm management can help to prevent soil and water degradation while building increased resiliency and yields for small scale farmers. A number of different techniques including mulching, composting, crop spacing and mixing, etc. have been developed and demonstrated as part of the organic pasifika project (SPC) and other initiatives around the region.[152][153][154][155]

Introduce integrated management approaches - Integrated Pest Management (IPM), Integrated Crop Management (ICM) and Integrated Vector Management (IVM) practices to help combat pests and improve yields. This includes strategies like intercropping, reservoirs, and crop cycling. Further, enhancing quarantine capabilities, sentinel monitoring programs, and commitment to identification and management of pests, weeds and disease threats to counteract those pathogens and pests likely to be favored by climate change. The recent development of plant health clinics and the release of an app for Pacific Pests and Pathogens illustrate the approaches that can be applied. [156] [157]

Enhanced food storage and processing techniques – Particularly for root crops like taro, yams, and cassava which traditionally have a short shelf life, utilizing established techniques like solar drying, processing into products like flour and chips, etc. have been shown to improve opportunities for food availability during times of shortage. Improve processing and storage of staples to offset production losses due to climate change.[158] [159]

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[151] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf
[152] Pacific Organic and Ethical Trade Community Farmer Resources for Organic Farm Management; Available at: http://www.organicpasifika.com/poetcom/for-farmers-and-growers/resources/organic-farm-management/
[153] Pacific Organic and Ethical Trade Community Organics Simplified; Available at: http://www.organicpasifika.com/poetcom/wp-content/uploads/sites/2/2018/05/Friends-FIji-4pg.pdf
[154] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf
[155] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf
[156] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf
[157] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf
[158] SPREP Adapting to Climate Change in the Pacific PACC Programme; Available at: https://www.sprep.org/attachments/Publications/CC/PACC_Programme.pdf
[159] Building climate-resilient food systems for Pacific Islands; Available at: http://pubs.iclarm.net/resource_centre/2015-15.pdf

Appendix 2: Crop Specific Climate Change Impacts for Temperature, Precipitation and Pests

Crop	General Summary	Temperature	Precipitation	Pests
Sweet Potato	**2030 – 2050:** Impact on tuberisation and yield will be greatest in those countries where rainfall is already high, and where temperature is currently around 32°C. Impact on pests and diseases is unclear — possibly increased pressure from sweet potato scab. **Overall production assessment impact: moderate** **Beyond 2050:** Increasingly serious impact for those countries where there is currently high rainfall and temperatures, especially with high emissions scenario. The impact on pests and diseases is unclear. **Overall production assessment impact: moderate to high**	An increase of 1°–2°C (very high emission scenario) by 2050 would affect production in countries where temperatures are currently around 32°C (e.g. the Federated States of Micronesia), within one or two generations, which would have major food security implications. Beyond 2050, the food security implications under all emission scenarios except RCP2.6 could be serious. Extreme heat events would also be expected to have impacts in countries with temperatures around 32°C. The impact would depend on the timing and duration of the event, as well as soil moisture levels.	An increase in mean annual rainfall might cause some reductions in tuber yield, particularly on heavy clay soils. Excessively high soil moisture, however, particularly during initiation (6–10 weeks after planting) reduces tuber yield. Where rainfall is already very high, most growers will find it difficult to counter a significant rainfall increase — an increase in rainfall, particularly between October and March, would result in yield reductions in many locations.	A wetter climate could increase problems with sweet potato scab.
Cassava and Yams	**2030 – 2050:** Cassava impact is expected to be minimal, but extreme rainfall events could cause problems with waterlogging. Cyclone intensity could cause lodging problems which would affect growth. Possible yield benefits from eCO2. For yam production, impact from increased intensity of cyclones would be expected and increased rainfall likely to increase incidence and spread of anthracnose. **Overall production assessment impact: cassava (insignificant to low) wild yam (insignificant) domesticated yams (moderate to high)**	While the optimum temperature for cassava tuber growth is 25°–29°C, it will tolerate a wide temperature range of 12°–40°C. Thus, increases in average temperature, even up to 2°C and beyond, are not expected to have a significant impact on cassava production. Extreme heat days would also be expected to have little impact, but as with all crops the ability to manage heat stress will be influenced by precipitation.	Overall, it could be expected that a wetter environment would favour cassava and yam production compared with other root crops. However, Cassava is particularly susceptible to waterlogging. Based on simulations in Fiji using three different future climate change scenarios (warmer through to warmer/drier conditions), tuber yields were projected to decline by up to 9% by 2030, and up to 18% by 2050. In addition to declines in yield, the year-to-year variability was shown to	Higher rainfall will increase the incidence and intensity of yam anthracnose disease, possibly resulting in epidemic developments with serious implications for yam production.

	Beyond 2050: Extreme rainfall and cyclone events would be likely to increase lodging and waterlogging problems. It is unclear how cassava pests and diseases will be impacted. Possible yield benefits from eCO2. For yams, projected temperature rise could affect bulking and therefore yield. Damage from cyclones would occur and increasing rainfall levels would intensify anthracnose problems. **Overall production assessment impact: cassava (Low to moderate), wild yams (low) and domesticated yams (high)**		increase by up to 19% by 2030 and up to 28% by 2050 (the increase in variability is driven by more frequent lower yielding years).	
Taro and other Aroids	**2030 – 2050:** Countries where rainfall levels are currently a constraint could be more able to grow taro. Increased intensity of cyclones could cause damage depending on stage of crop growth. For cocoyam and giant taro — impact is expected to be minimal. For swamp taro — increasing losses from saltwater intrusion are likely. Taro — possible yield benefits from eCO2. **Overall production assessment impact: taro (low to moderate), cocoyam (insignificant), swamp taro (moderate to high), giant taro (insignificant)** **Beyond 2050:** Very high temperature increases (>2°C) could affect production especially in countries where temperatures are currently high. Cyclones will continue to cause damage. A continued spread and increase of TLB and other taro pests and diseases would also be expected. For cocoyam and giant taro — temperature (>2°C) would be a constraint to productivity. Swamp taro could disappear from atoll environments.	Modelling studies suggest that projected changes in mean climate conditions will have little effect on taro production, with the exception of extremely low rainfall. Extreme heat days are likely to pose a threat in this regard. In the long term, as 30°C is the optimum temperature for taro, temperature increases of 2°C and beyond could impact on production, and similarly with the other aroids, possibly with the exception of swamp taro. It is likely that cocoyam production will remain unaffected by changes in temperature in the short term. However, as a marked reduction in mean temperature is required for tuber bulking, the projected temperature increases in the long term and extreme heat events, depending on timing and duration, could be significant.	Overall wetter conditions would generally favour taro production and extend the areas available for successful cultivation. Taro can be highly tolerant of waterlogging, depending on the variety. Taro cannot survive prolonged moisture stress, which seldom poses a problem in traditional food gardens	A rise in minimum night-time temperature increases the likelihood of TLB spreading to locations currently free of the disease. The vulnerability of susceptible taro varieties to TLB will be increased if higher levels of humidity are associated with higher night temperatures. Increased rainfall would also favour the spread of Pythium (which would affect both taro and cocoyam) and probably taro armyworm or caterpillar.

	Taro — possible yield benefits from eCO_2. **Overall production assessment impact: taro (moderate to high), cocoyam(low), swamp taro (high), giant taro (low)**			
Bananas	**2030 – 2050:** Favour cultivation in currently sub-optimal locations and at higher altitudes. Higher temperatures could affect flowering and fruit filling. Higher temperatures could increase pest and disease. Increase in cyclone damage. **Overall production assessment impact: low** **Beyond 2050:** Increased pest and disease pressure (Fusarium wilt, nematode and weevil) is likely though the enhancing impact of rainfall on BLDS could be lessened by higher temperature. The heat stress effect on flowering and fruit filling would increase, as would cyclone damage. **Overall production assessment impact: low to moderate**	Up to 2030 the projected mean temperature rise of 0.5°–1°C is not likely to result in any significant reduction in banana yields at low altitudes, and could in fact support banana cultivation at higher altitudes. However, temperatures in excess of 35°C (heatwaves) are likely to affect flowering and bunch filling. By 2050 and beyond, temperature could be a significant constraint on banana production at low altitudes, especially if warming proceeds according to the very high emissions scenario (RCP8.5), where 1°–2°C will be reached by 2050, and 2°–4°C by 2090.	The impact of changes in rainfall on bananas is harder to project, but greater irregularity and decreasing rainfall will increase the length of the crop cycle and the seasonality of bunch production. Some banana production areas could have problems with waterlogging. Bananas will grow within a reasonably wide range of rainfall, and therefore in the short to medium term, projected increases in rainfall are unlikely to affect production. In the longer term, beyond 2050, and especially with countries lying between latitudes 5°N and 5°S, the projected rainfall increases could affect production, assuming that 4000 mm rainfall per year is the threshold for the banana varieties cultivated in the Pacific. As with temperature, the projected increase in number of heavy rain days is more a cause for concern in the short to medium term, with the potential for waterlogging to affect bunch yield.	Optimum temperature for development of black leaf streak disease (BLSD) is 27°C and the disease is reduced by very high temperatures (>36°C). Higher rainfall is also likely to increase pressure from BLSD and from Fusarium wilt.
Breadfruit and Aibika	**2030 – 2050:** Expected to be minimal though cyclone damage likely to increase. **Overall production**	Increasing temperatures are unlikely to have much impact on breadfruit at least to a 2°C increase, although fruit drop	A study on the cultivation potential of breadfruit (a key staple crop for FSM) under	Drought will reduce growth of aibika and drier weather, will

	assessment impact: insignificant to low **Beyond 2050:** Expected to be minimal though higher temperatures could reduce fruiting and fruit quality. Cyclone damage will worsen with increased intensity of cyclones. Possible increase in pest and disease problems. **Overall production assessment impact: low to moderate**	and smaller fruit are likely to be a problem if heat stress is accompanied by low rainfall. Increasing temperatures are unlikely to affect aibika unless accompanied by low rainfall, in which case growth would be affected, as would pest and disease incidence and severity. A study on the cultivation potential of breadfruit (a key staple crop for FSM) under different climate change scenarios in Hawaii and the broader Pacific highlights that using average annual temperature and rainfall projection data to 2070 (CMIP5 model using RCP 4.5 and RCP 8.5) breadfruit suitability increases in area and quality with larger increases under RCP 8.5. The study also highlights that current producing regions (i.e. FSM) largely remain unchanged in both projections, indicating relative stability of production potential in current growing regions.[160]	different climate change scenarios in Hawaii and the broader Pacific highlights that using average annual temperature and rainfall projection data to 2070 (CMIP5 model using RCP 4.5 and RCP 8.5) breadfruit suitability increases in area and quality with larger increases under RCP 8.5. The study also highlights that current producing regions (i.e. FSM) largely remain unchanged in both projections, indicating relative stability of production potential in current growing regions.[161]	generally increase attack from the Nisotra beetle, jassid and leaf roller. Extremes of rainfall are likely to provide conditions that will encourage increased incidence and severity of pests and diseases of aibika. Increased rainfall will favour collar rot, and stem and tip rot. Increased rainfall is likely to exacerbate damage by Phytophthora palmivora, affecting fruit quality.
Papaya	**2030 – 2050:** Severity of some diseases such as Phytophthora and anthracnose likely to increase because of a wetter climate. Increase of 1°C could affect fruit set. Although cyclone frequency is expected to decrease, papaya production will be negatively impacted by likely increasing intensity of cyclones. **Overall production and economic impact assessment: low to moderate** **Beyond 2050:** Impacts of increased temperature, increased high rainfall	An increase in mean temperature of 0.5°–1°C (projected for 2030, regardless of emission scenario) could increase the occurrence of 'female sterility', in which normally hermaphroditic papaya plants produce male flowers, resulting in poor fruit set and production. However, this increase in temperature during the winter months might also result in better ripening during these normally 'slow' months of the year.	Extreme rainfall events can cause damage to tree stands and contribute to waterlogging and washout.	Any increase in rainfall will exacerbate the severity of fungal diseases such as Phytophthora and anthracnose which are already causing production problems.

[160] Cultivation potential projections of breadfruit (Artocarpus altilis) under climate change scenarios using an empirically validated suitability model calibrated in Hawaii (2020); Available at: https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0228552
[161] IBID.

	events and intensity of cyclones likely to be significant. It is expected that the competitive position of the Australian papaya industry relative to Fiji and other potential Pacific Island producers will improve. **Overall production and economic impact assessment: moderate to high**			
Mango	**2030 – 2050:** Fruit set will continue to be adversely affected by unpredictable rains and temperature fluctuations during winter months. Reduction of fruit quality would result from frequent pre-wet season rains. Increasing problems with anthracnose possible. **Overall production and economic impact assessment: low to moderate** **Beyond 2050:** High temperatures could affect flowering. Mango production will be negatively impacted by increasing intensity of cyclones. Unpredictable rains could also have a significant impact. Possible increasing mango fly and anthracnose problems. **Overall production and economic impact assessment: moderate**	Mango, being a perennial fruit crop, will respond differently to increases in temperature than annual crops. A perennial crop such as mango may survive desiccating conditions, which could be highly beneficial for yield in succeeding growth seasons. An increase of 0.5°–1°C by 2030 will have little or no impact on mango production in the region. However, an increase in mean annual temperature of at least 1.5°C (projected for 2050 under RCP8.5) may adversely impact the flowering of mango trees, because floral induction occurs in response to cool temperatures.	Extreme rainfall events can cause damage to tree stands and contribute to waterlogging and washout.	The impact of climate change on the incidence and severity of Bactrocera frauenfeldi (mango fly) is unclear. Higher rainfall is expected to cause an increase in the pest, but excessive rainfall could also decrease populations (Jackson pers. comm.)
Citrus	**2030 – 2050:** Minimal impact on pests and diseases of citrus as a result of a warmer and generally wetter environment. **Overall production and economic impact assessment: insignificant to low** **Beyond 2050:** Increasing temperature and wetter environment can be expected to increase the incidence of pests and diseases. The likelihood of more intense cyclone events could accentuate the spread of diseases. **Overall production and economic impact assessment: low**	Citrus trees of the various species and cultivars are widely adapted, and will survive and grow (although sometimes with difficulty) in nearly any climate that does not kill them	Extreme rainfall events can cause damage to tree stands and contribute to waterlogging and washout.	A warming temperature and a wetter environment can be expected to increase the incidence of pests and diseases. More intense cyclone events could accentuate the spread of diseases.

Pineapple	**2030 – 2050:** Expected to be minimal. **Overall production and economic impact assessment: insignificant** **Beyond 2050:** No apparent adverse impact from increasing temperature. Severe rain events and subsequent waterlogging would impact production. An increase in drought events could increase pineapple wilt disease. **Overall production and economic assessment impact: low to moderate**	No apparent adverse impact from an increase in mean annual temperature is likely for pineapple production	Any increase in severe rain events could negatively impact pineapple because of its susceptibility to waterlogging.	Diseases like pineapple wilt disease, a serious disease of pineapples vectored by Dysmicoccus brevipes, are likely to increase with a reduction in rainfall (Jackson pers. comm.).
Kava and Betel nut	**2030 – 2050:** More intensive cyclones likely to have significant impact, particularly for plantings not in agroforestry food gardens. Unlikely any significant impact on betel nut in existing production areas. **Overall production impact assessment: insignificant (kava), betel nut (low).** **Beyond 2050:** More intense cyclones expected to have a major impact. Significant increases in rainfall could cause problems with water-logging. How climate projections will affect kava dieback is not known. An increase in rainfall levels in currently dry areas could favour production for betel nut. **Overall production impact assessment: moderate (kava), low (betel nut)**	A 1.5°C increase in mean annual temperature (projected for 2050 under RCP8.5) is unlikely to have an adverse impact on kava and betel nut production.	Any overall increase in rainfall levels is unlikely to be damaging to either kava or betel nut production; if rainfall increased in currently drier areas, then the impact could be positive.	The impact of the projected climate conditions on kava dieback is not clear, except that an increase in environmental stress could mean the plant is more susceptible to the disease.
Coconuts	**2030 – 2050:** No major effect is expected until at least 2050. The main impact will be from the expected increased intensity of cyclones on the increasingly senile population of coconut palms. **Overall production and economic impact assessment: Low** **Beyond 2050:** The likelihood of increasingly severe cyclones could have a severe impact on coconut production.	Research indicates that rising temperatures and rainfall changes could reduce coconut yields by reducing pollen quality and/or germination, thereby affecting fruit formation and nut development, leading to a smaller number of nuts or empty nuts. An increase in average annual temperature of 1.5°C would enable a further increase in the altitude at which palms	Coconuts are unlikely to be significantly impacted by climate change (changes in mean annual temperature and precipitation) until beyond 2050 when, depending on the emissions scenario, rainfall could be a factor affecting production, particularly in those areas where rainfall and cloud	Rising temperatures and lower rainfall could reduce the effectiveness of the fungus, Metarhizium anisopliae, which is still used in the control of rhinoceros beetle. As little is known about Bogia coconut

	Rainfall could reduce production especially in areas where rainfall and cloud cover are already relatively high. The impact of major pests and diseases is unclear; effectiveness of biocontrol agents for rhinoceros beetle could be reduced. **Overall production and economic assessment impact: Low to Moderate**	bear. In areas where there is a large increase in rainfall, with a concurrent increase in cloud cover, nut production is likely to decline.	cover are already relatively high. Extremes of temperature and periods of drought could lead to reduced yield.	syndrome, it is impossible to predict how this disease will respond to the projected conditions.

Appendix 3: Additional Details on Traditional Agriculture Approaches

Decades of sharing indigenous experiences and refining approaches have produced many local adaptive solutions and traditional practices as potential responses to adapt for site-specific circumstances. Some of the examples are as follows:

Mulching

Mulching is the process of covering the soil surface with organic matter to create conditions that are more favorable for plant growth, improving the decomposition and mineralization of organic material in the soil, and protecting the soil from erosion. Mulching is extensively used in the islands in staple crops production.

How is it helpful for livelihoods? Mulching improves the productivity of the land (crop yields) by making conditions more favorable for plant growth by conserving soil moisture, improving soil fertility and reducing soil erosion.

How is it helpful for adaptation to climate change?

- Mulching helps prevent erosion and increase soil fertility.
- Mulching helps protect the soil from excessive heat, exposure to wind, and moisture loss.

How is it helpful for climate change mitigation?

By retaining crop residues, mulching increases the carbon in the soil because these residues are the precursors for soil organic matter, the main store of carbon in the soil. Estimates show that GHG mulching practice can sequester 0.02 to 1.42 tons of carbon dioxide (or the equivalent of other greenhouse gases) per hectare over the course of one year.

Composting

Composting is the controlled biological and chemical decomposition and conversion of animal and plant wastes with the aim of producing humus.

How is it helpful for livelihoods?

- Compost functions as a form of organic fertilizer made from leaves, weeds, manure, household waste and other organic materials, thus it can reduce the cost of fertilizer from other sources.
- Proper compost management leads to an increased proportion of humus in the soil due to high microorganic activity, and therefore applying compost leads to quantitative and qualitative improvements of the humus content of the soil, which leads to an increase in crop yields.

How is it helpful for adaptation to climate change?

- Composting helps to improve soil fertility which is helpful in reducing the impacts of climate change.
- Composting helps increase soil moisture and soil cover, as well as reduce soil loss.

How is it helpful for climate change mitigation?
Composting helps reduce the need for fertilizer which decreases greenhouse gas emissions. GHG mitigation potential of composting is estimated to be **0.02-1.42 tCO2-eq/ha/yr**.

Manure management
Manure management activities involve the handling of animal dung (pig waste) predominately in the solid form (dry litter) when applying it to agroforestry settings.

How is it helpful for livelihoods?
Applications of manure in the agroforestry settings and other crop lands enable achieving and
maintaining a fertile soil, which can increase crop yields.

How is it helpful for adaptation to climate change?
The application of manure improves productivity and produce greater crop yield which is important for adapting to climate change.

How is it helpful for climate change mitigation?
Methane emissions from swine waste depend on the specific manure management system and on the conditions and manner in which the system operates. However, generally
handling manure in the solid form instead of the liquid form will suppress CH4 emissions. GHG mitigation potential of manure management is about **0.02-1.42 tCO2-eq/ha/yr**.

Residue management
Residue management is the sound handling and utilization of plant and crop residues. It combines mulching, composting, integrative livestock (swine, poultry) and manure management and ideally leaves 30% or more of the soil covered with crop residues after harvest.

How is it helpful for livelihoods?
- Plant residues converted into organic matter are the major source of carbon in soil.
- In an integrated system, crops and livestock interact to create a synergy, with recycling allowing the maximum use of available resources. Crop residues are used for animal feed, while livestock and livestock by-products enhance agricultural productivity by intensifying nutrients that improve soil fertility, reducing the use of chemical fertilizers.

How is it helpful for adaptation to climate change?
Crop residues placed along the contour lines can slow down surface runoff, reduce soil erosion and improve water infiltration.

How is it helpful for climate change mitigation?
Avoiding burning of residues avoids emissions of aerosols and GHGs generated from fire. GHG mitigation potential of residue management is estimated to be **0.44-1.89 tCO2-eq/ha/yr**.

Water management
Water management involves improving water use efficiency and minimizing losses of water from runoff or drainage. This includes various techniques, such as storing water in reservoirs to allow it to sink into the soil and increase soil moisture levels. It also includes using a protective cover of vegetation on the soil surface to slow down the flow of running water and spread the water over a large area. Agroforestry practices such as mulching, composting, residue management also help to conserve soil and water. In the traditional taro production systems and intermittent gardens in Yap, communities make specialized zigzag channels and direct rainwater run through to provide enough water for the crops.

How is it helpful for livelihoods?
- Conserving water helps prevent water scarcity and makes it available for crops, livestock, and domestic use over a longer period.
- Soil and water management increases soil organic matter, improves soil fertility and controls soil erosion, improving crop and pasture yields.
- Soil and water management measures improve the supply of fuel and forest products.
- Soil and water management measures increase the value of land
- Water management helps increasing productivity by improving soil fertility, preventing soil erosion, and increasing water infiltration into the soil.

How is it helpful for adaptation to climate change?
- Climate change may impact the distribution of water resources. Water management helps control excess water runoff, making them important strategies for adapting to climate change.
- Conservation and collection of rainwater help to reduce risks associated from rainfall shortage.
- Water diversion structures can help to reduce risks from extreme weather events like floods by controlling excess water.
- Soil and water management helps rehabilitating degraded land and enhance biodiversity.

How is it helpful for climate change mitigation?
Effective soil and water management increases the productivity of land, increasing plants, trees, and organic matter in the soil, and pulling carbon dioxide out of the atmosphere. GHG mitigation potential of soil and water management is about **0.55-2.82 tCO2-eq/ha/yr**.

Restoration of degraded lands
Degraded lands that were set aside for many years in Yap have been restored and rehabilitated since 2004 after resettling displaced atoll communities through a variety of agricultural practices. Assisted natural regeneration speeds up the restoration of the land by helping the natural processes of regeneration. This includes planting a large number of economically important trees and crops and protecting the area from fire and exploitation (Read our publication here).

Why is restoration beneficial?
- Allowing land to regenerate often increases the amount of land covered with vegetation, which increases the amount of carbon stored above and below ground. Also, reducing the frequency and intensity of fires allows more vegetation to remain in the landscape and store carbon.
- Rehabilitating degraded land improves yields over the long-term due to reduced soil and water erosion. GHG mitigation potential of restoration and rehabilitation of degraded land is about **1.17-9.51 tCO2-eq/ha/yr**.

Annex 8: CSA Package Examples

Saltwater inundation CSA package example – Oneisomw Municipality

Below is an example of a Climate-smart Agriculture (CSA) package that could be deployed to areas in Chuuk State and FSM that exhibit the same or similar impacted conditions due to saltwater inundation. As such, this example is only one of various CSA packages that will tailored to the specific needs and geographic constraints of a specific site (Output 2.1 and 2.2 of proposed project). Although the below example is scientifically accurate, the specific quantitative data in relation to the size of the areas impacted has been estimated to convey how the CSA package will be implemented in a similar situation or setting.

Territory for Implementation: Oneisomw Municipality, Chuuk State (main lagoon). Please see Figure 1 for a map of Oneisomw Municipality and its vegetation cover.

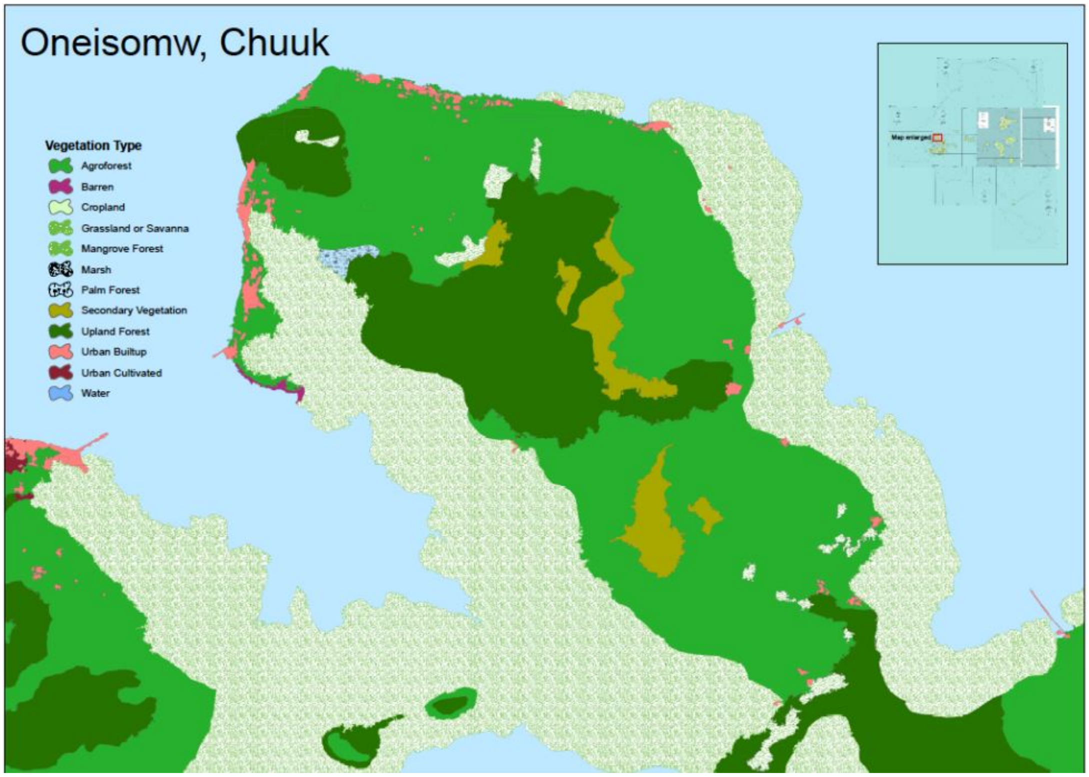

Figure 1: Oneisomw Municipality Vegetation Cover

Trend and Severity:

The communities of Oneisomw Municipality are predominantly located along the coastal areas of Oneisomw island and have been subject to **saltwater inundation during king tide events as well as via storm surges**.[162] These events, including Typhoon Maysak in 2015, have resulted in approximately 2 hectares of low-lying, giant swamp taro patches to be repeatedly inundated by saltwater, which are critical for food production for the community. The hectares of giant swamp taro have an average soil salinity level of approximately 12 decisiemens per cm (ds/cm). This level of soil salinity is detrimental to the health of giant swamp taro plants. Since Typhoon Maysak in 2015, cultivation of giant swamp taro in Oneisom municipality fell approximately 90%. Additionally, the 2015 **typhoon and other recent storm events have damaged approximately 0.75 hectares of mangrove forest** (specifically *Bruguiera gymnorrhiza*) located on the coastal fringe of the community.

Adaptation Logic:

As the Oneisomw Municipality case demonstrates, increased storm surges and king tide events brought about by **climate change** propels salinization of waters and soils along coastlines – saltwater intrusion. Driving massive changes in coastal ecosystems, increased salinity combined with more frequent inundation causes tree die-off in coastal forests, the loss of freshwater wetlands, and severely diminished agricultural productivity. The quality corm will be reduced if they survive inundation or die completely, unless salt tolerant varieties are introduced.

In the face of these and other climate change processes, farmers in coastal areas across FSM need to implement adaptation interventions to increase the resilience of agricultural production and food security. To both support the well-being of coastal communities and maintain key services provided by these ecosystems, this project will provide two main interventions through Component 2 of the proposed SAP: (i) introduction of salt-tolerant varieties of crops; and (ii) restoring damaged forest.[163] The combination of these two adaptation strategies will work to increase farmer's ability to combat climate threats and support longer-term resilience through improvement of their agroforest ecosystem and ability to withstand climate shocks (storm surges, increased king tide vents). This specifically targets the second causal pathway outlined under the theory of change for this project – appropriate climate change adaptation measures for farmers identified and deployed (see figure 2 and Annex 14- Theory of Change)

[162] Oneisomw Municipality, Faichuuk Management Plan. 2017.

[163] Please note that these interventions have been provided as an example of what would be provided through CSA packages under Component 2 of the project. These interventions are not an exhaustive set of what can and will be used across the 140 sites that will be targeted through this project.

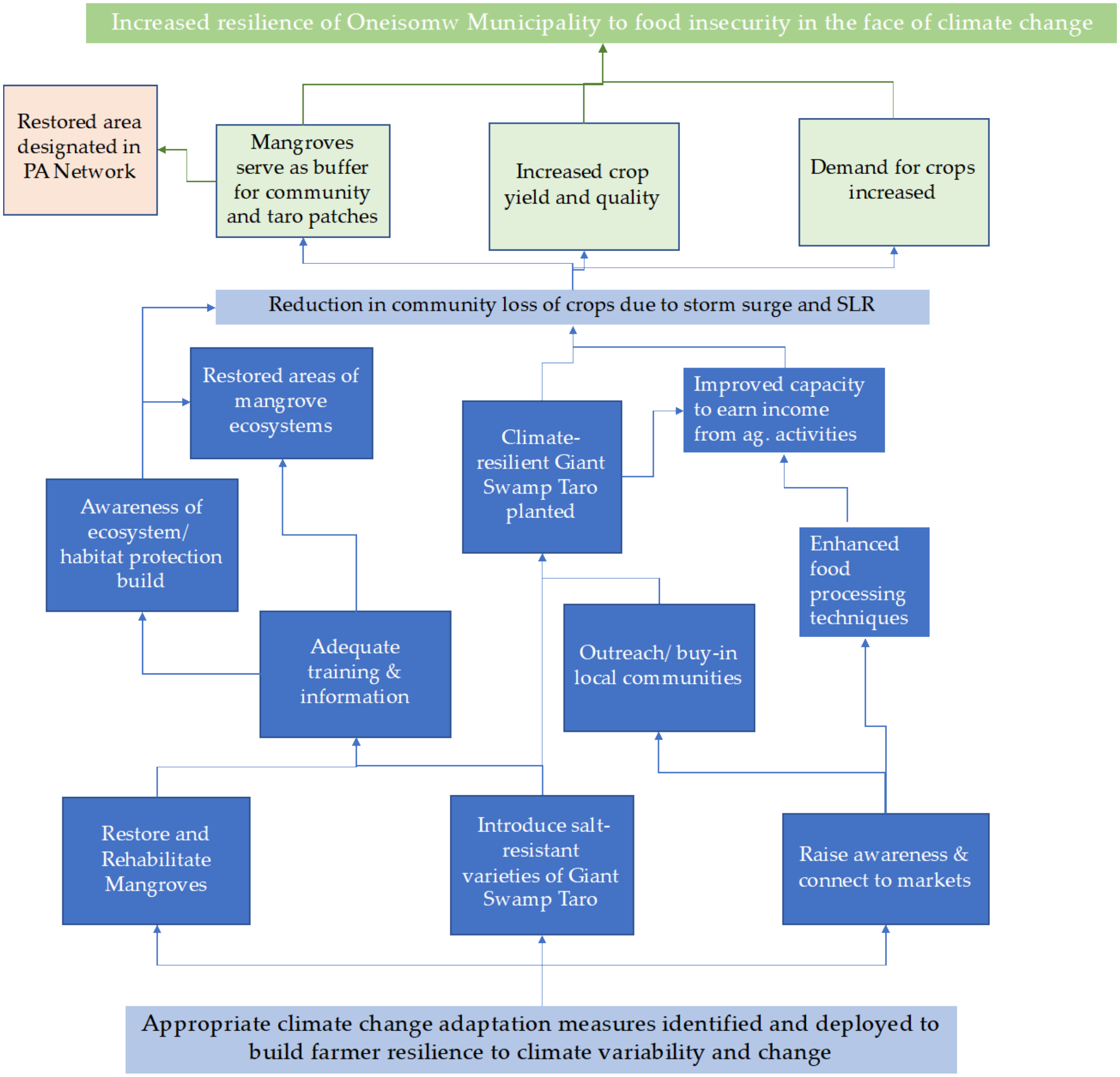

Figure 2. Causal Pathway: Appropriate climate change adaptation measures for farmers identified and deployed

Measures implemented to mitigate climate change threat: The following two strategies have been designed to mitigate crop production losses due to ongoing and future climate change for the 2 hectares of giant swamp taro.

1. **Introduction of salt-resilient varieties of giant swamp taro**

The COM-FSM Chuuk campus has identified a variety of giant swamp taro that is resistant to soil salinity levels of approximately 14 ds/cm.[164] Additionally, this variety does not have any other observed vulnerabilities that are unique compared to other giant swamp taro varieties grown in Chuuk. Due to a lack of financial resources, COM-FSM has not been able to as of yet grow a sufficient number of this variety for use by farmers in Oneisomw Municipality. With additional funding, introduction of the salt-resilient variety to Oneisomw Municipality will include the following steps:

i. A small nursery will be established in Peniata village, which will grow the salt-tolerant variety until the plants reach 2 months of age. The nursery will grow approximately 2,000 plants per 2-month cycle.
ii. Farmers in Oneisomw Municipality (~250 individual farmers) will be contacted by COM-FSM extension agents to receive their salt-resilient varieties once they have reached 2 months of age (approximately 8 plants per farmer per rotation).[165] Farmers will then plant the taro themselves (the variety has no special requirements for planting in comparison to the giant swamp taro currently used by farmers in Oneisomw).
iii. In total individual farmers will receive approximately 48 individual salt-resistant giant swamp taro plants (12 months of nursery operation), which equates to a total of 12,000 individual plants.
iv. Once these plants reach maturity, **the mother plants will later produce cormlets in large numbers** that can be separated and planted in other locations.

2. **Restoration of damaged mangrove forests**

As previously indicated, **approximately 0.75 hectares of fringe mangrove forests have been damaged by recent storm events**. A lack of funding has precluded Oneisomw Municipality from restoring these mangrove forests and educating local residents on why mangroves are most important to conserve and would make them more resilient to storms and storm surge and allow them to continue to function as buffers for the community and their taro patches.[166] With additional funding, restoration efforts will include the following:

i. Extension agents will be used to conduct education sessions targeted at the entire population of Oneisomw Municipality (~600 individuals) to explain the importance of mangrove forests on the coastal fringe for conservation and adaptation benefits.[167]
ii. *Bruguiera gymnorrhiza* seeds and seedlings will be sourced from COM-FSM Chuuk and grown in a mangrove nursery near the giant swamp taro nursery, on the coastal edges of Peniata village. The nursery will plant approximately 9,000 seedlings.
iii. Once the seedlings have fully germinated and reached a stage suitable for planting (between 8 and 9 months), they will be planted by the community with support from the

[164] COM-FSM – Chuuk Campus/Cooperative Research and Extension.
[165] Seasonal changes in the Northern Pacific are small and giant swamp taro can be grown year-round.
[166] Mangroves also provide significant socioeconomic benefits, such as fishing, tourism opportunities, and environmental services (e.g., coastal protection, water regulation, carbon sequestration, and nursery habitat for a wide-ranging diversity of species (e.g., mangrove crabs).

[167] The target area for this site is the 0.75 ha of mangroves damaged and/or lost due to the 2015 typhoon and other recent storm events. While the deforestation in this area was the result of storm events rather than any widespread collection of firewood, training will nonetheless be targeted to emphasize the importance of the mangrove ecosystem and how it connects to improved crop yields and improved resiliency for the community. The community will be directed to continue to utilize more inland forests within the community that can renewably provide the minimal firewood needs of the community. In addition, the project will support designating the rehabilitated area as a PA – whereby the community is eligible for ongoing technical and financial assistance.

extension agents within the damaged 0.75 hectares of coastal fringe mangrove forests. Plantings will be done in a manner so as to reinforce the existing coastal mangrove forests so that they are more resilient to future storms. The community, including women and youth, will be involved in every step of the process to reinforce community commitment and ownership of the mangrove.

iv. 12 months following the plantings, the area will be assessed to determine if additional plantings are necessary.

v. As the restoration of mangroves takes place, MCT will work with the Mayor and Local Council to enact an ordinance that will put the rehabilitated area under permanent protection through official registration as part of FSM's Nationwide Protected Areas Network . As part of the Network the mangrove forested area will receive annual technical and financial assistance from the FSM National and Chuuk State Governments.

Other measures: The focus on this case is to provide an example of the type of CSA packages that could be deployed through outputs 2.1 and 2.2 of the project. It is important to note that the overall project also includes other interconnected components that contribute to an overarching strategy for improving food security across FSM.

For this particular case, households in Oneisomw Municipality will be trained on food processing and storage techniques specifically around the giant swamp taro for this example community (output 3.2). By improving the bridging capacity between storm or severe weather events through enhanced food storage and processing, the project can provide a means for farmers to offset potential crop losses from acute storm events like tidal surge made worse by ongoing sea level rise. These food processing techniques will increase household capacity for farmers and community members to weather ongoing and future salt-water inundation events that damage and destroy local crops.

Through Component 3 the project will also improve the overall supply chain for food/crops – in this example connecting farmers to local markets and engaging the government to buy swamp taro to include in school feeding programs (output 3.1). It will also build awareness for eating local thereby shifting consumption towards healthier and more environmentally friendly diets foods (output 3.3).

Intended Adaptation Benefits: This CSA package is designed to rehabilitate approximately 2 hectares of giant swamp taro by introducing salt tolerant varieties and restore approximately 0.75 hectares of coastal fringe mangrove forests. Through these efforts, giant swamp taro production is expected to increase by approximately 40% within the first two years of implementation. As a staple crop, enhanced production of the giant swamp taro will strengthen food security for both those directly trained (250 individual farmers) as well as for the entire population of the municipality. Further, coupling the increased production with improved storage and processing as well as specific market linkages and value chains will help to make livelihoods more resilient and improve adaptive capacity for these communities.

GCF Investment Criteria:

In combination with **140 other sites**[168] to be analyzed and assessed for appropriate CSA packages across the entire FSM, through de-scaled vulnerability assessments (Output 1.2) and provided with targeted adaptation solutions to improve farmers' adaptive capacity to handle climate threats (Output 2.1 and 2.2) – particularly those of sea level rise, increased storm surges, and king tides – this specific example case will provide long-lasting impact for the community as outlined below in table 1.

Table 1. Impact, Innovation and Sustainability Parameters

Promoting Resilient Agriculture in Oneisomw Municipality	
Impact	At this particular site: • Climate resilient practices, technologies, and crop breeds adopted by 250 farmers across 2 ha • Demonstration of improved soil, water, and ecosystem health • 1 new value chain created to sell giant swamp taro, preserve and process (in combination with activities included in Component 3) • 12-18 tons produced annually that meet quality standards • Restoration of mangrove species will increase community resilience to storm events and their acute (e.g storm surge) and ongoing impacts on giant swamp taro production • 60% of HHs in Oneisomw Municipality with access to locally processed foods
Innovation	• Opportunity to provide technological advancement of a staple/traditional crop to better withstand ongoing and projected climate change impacts and variability • Strong potential for replication across similar ecosystems, not just in FSM, but more broadly in the Pacific • Extension agents trained to understand climate impacts and given tools to deploy adaptation solutions to farmers
Sustainability	• Additional revenue generated from the sale of giant swamp taro will increase farmer livelihood • Extension agents assigned to Oneisomw municipality will have capacity to train farmers on linkages with climate change[169] • Connection of farmers to broader farmers groups (Component 1) will facilitate a community of learning and connections to markets across the State and Nationally • Steady supply of staple crops along with increased knowledge of processing techniques will increase demand

[168] These sites will be spread across the 4 States to cover over 15,000 HHs (68% of total FSM population)
[169] One of the main roles of extension agents in FSM is to work with farming communities, however, currently they are not trained on how to deal with climate risk as it relates to farming

	• Taro farmers connected to supermarkets, restaurants, and school feeding programs to increase demand (Component 3) • Farmers provided with salt-tolerant giant swamp taro in Oneisomw Municipality will be able to propagate future rotations of these crops through seeds and tubers • Awareness raised of local community on benefits of eating local produce to increase demand (Component 3)

Soil degradation and erosion CSA package example – Gargey Village

Below is an example that is based on a Climate-smart Agriculture (CSA) package deployed in Yap State starting in 2006 to rehabilitate a landscape that was degraded due to heavy rainfall and precipitation events expected to increase due to climate change. These events subsequently caused soil erosion and impacted crop production and local livelihoods. ***The project itself has achieved a great deal of success and the community continues to use the tools and climate resilient methods deployed over 15 years later.*** *The project has also been successfully replicated at two nearby communities however, FSM has never had substantive funding to upscale and replicate these types of interventions across the entire country. This particular case is based off of a CSA package tailored for the conditions at Gargey Village; however, this type of CSA package could be deployed in other areas of Yap or other States in FSM that exhibit the same or similar impacted conditions.*

The diversity of Micronesian islands and atolls in both physical and human attributes, and their response to climate-related drivers means that climate change impacts, vulnerability, and adaptation are variable from one island to the other and among islands in each state. On small islands and remote atolls where resources are often limited, recognizing the starting point for action is critical to maximizing benefits from adaptation. They do not have uniform climate risk profiles (high confidence) and not all adaptations are equally appropriate in all contexts (Nurse et al. 2014). This should therefore be treated as an example with an understanding that the assessments to be undertaken under output 1.2 of the SAP are critically important to ensure that tailored climate change adaptation interventions will be deployed across the 140 sties targeted through this project.

Territory for Implementation: Gargey Village, Yap State.

Trend and Severity: Gargey Village is located in Yap State, in the western FSM. Rainfall levels are expected to occur in more intense events, and evaporation and transpiration rates are projected to increase. These changes will reduce the availability of soil moisture for plant growth. In Gargey Village, climate change and climate variability have and are affecting soil health for plant growth though **mostly through more intense rainfall and storms due to climate change that increase the risk of soil erosion by water and wind (through rain splash, accelerated runoff, strong winds).** Heavy precipitation events particularly from typhoons and extreme storm events (i.e. Typhoon Sudal in 2004) have degraded soils within the village, resulting in approximately **258 hectares of degraded soils**. Observed soil degradation in the village include increased soil erosion exposing the subsoil and a low soil pH, which negatively affected vegetation including crop quality and production.

Adaptation Logic: Of prime importance for Gargey Village is the ability to increase soils buffering capacity in the face of more variable supplies of rainwater. In addition, salinization is one of the progressive causes of soil degradation that threatens to limit plant growth and reduce yields on productive agricultural lands. This necessitates an increased capacity to store water in the soil and improve water management as well as ensuring better land management combined with the use of more salt-tolerant species to increase resilience to climate variability. Figure 1 below provides the basic soil principles for climate change adaptation.[170]

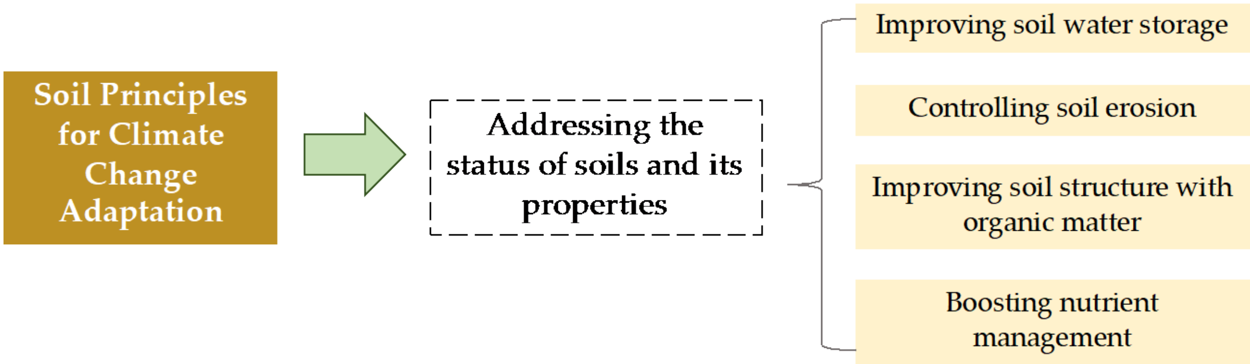

Figure 1: Soil principles for climate change adaptation and enhancing resilience[171]

Soils that have been degraded are at much greater risk from the damaging impacts of climate change. Degraded soils are vulnerable due to serious losses of soil organic matter (SOM) and soil biodiversity, greater soil compaction and increased rates of soil erosion and landslides. Leveraging various soil conservation techniques including but not limited to improving soil health management through use of cover crops and improved fallow (i.e. mucuna), legumes, composting and agroforestry systems, mulching, minimum tillage, and contour farming as well as altering production practices (planting time, spacing, pest and disease, harvesting time) all can work to directly combat loss in agricultural productivity from degraded soils as a result of storm surge and importantly following landslide and other washout events (i.e. 1991, 1997, 2002, 2004, 2007, 2008 typhoon/hightides induced landslides in Pohnpei). Furthermore, dissemination of improved soil conservation techniques and targeted trainings for farmers will empower communities to be more resilient to current and future storm events, as well as recover crop production following these events which are expected to accelerate and intensify with future climate change.

Measures implemented to mitigate climate change threat: The following three strategies were designed to mitigate crop production losses and increase soil resilience to climate damaging events within the 258 hectares of degraded soils in Gargey Village.

3. **Gender-focused capacity development on soil health management**

The first focus of the intervention is on increasing capacity development for 1,100 residents of Gargey Village, including specific focus and opportunities for women and youth, in order to create a base of

[170]Adapted from FAO's Climate-Smart Agriculture Sourcebook (2017)
[171] IBID.

community knowledge for soil health management.[172] Training on soil health management including the following (i) use of cover crops and improved fallow (i.e. mucuna), legumes, composting and agroforestry systems, mulching, minimum tillage, and contour farming as well as altering production practices (planting time, spacing, pest and disease, harvesting time). Alternative crop production methods (container gardening, raised bed gardening, small plot intensive farming), hands on training on compost preparation, and seed germination. The gender-focus was critical to ensuring equitable deployment of solutions and empowerment of women farmers and households in the community.

This gender focus and the specific soil resiliency/soil health trainings will be replicated and upscaled significantly in the envisioned GCF project's CSA packages and trainings.

4. **Dissemination and use of good practices in Sustainable Land Management (SLM)**

Following capacity building, the project trained villagers on the use of SLM practices to further soil resilience to ongoing and acute precipitation events. The SLM practices focused on volcanic soil management, compost preparation and use, along with the planting of native trees and crops. Improved protective soil cover through cover crops, crop residues or mulch; and crop diversification through rotations. Local salt-tolerant and drought tolerant crop varieties introduced included: sweet potato, land taro, tapioca, and sugarcane. Additional crops introduced included: breadfruit, mango, chestnut, soursop, sweet potato, sugarcane, pineapple, squash, banana, garden beans, eggplant, okra and leafy vegetables such as Chinese cabbage, local spinach and pak choy.

Seed packets and seedlings of self-pollinated crops. Traditionally extended family systems prevail in Yap, so communities frequently exchange planting materials such as taro, sweet potato, tapioca, swamp taro etc. The project will also support the establishment of a community nursery and seed bank under output 2.3 of the envisioned GCF project. This will ensure a continuous supply of resilient traditional plants and to provide for sustainable post-disaster recovery.

5. **Income generation activities**

The project also included training to increase incomes of households by training households in the cultivation of vegetables including Chinese cabbage, eggplant, okra, spinach, lettuce and garden beans using raised bed gardening methods. Households were then able to sell their excess vegetables in the local markets. With the help of Yap Small Business Development Center, a number of small business development trainings were conducted. This enables them to buy seeds and other assets they need to build successful ventures. Replicating this resilient livelihood development will be the primary focus of both

[172] The residents in the actual case migrated from their atoll communities due to SLR making their islands uninhabitable. Back in their atolls, communities were exclusively dependent on taro, banana and coconuts and their traditional growing methods. They did not have any scientific basis on vegetables, other crops, or how to handle degraded soils caused by severe weather. During the awareness training, the focus was on educating them about the importance of soils, different soil types, soil management methods, importance of compost, mulching etc.

the CSA trainings/packages and the market linkages/value chains works envisioned by Component 2 and 3, respectively for the prospective GCF project.

Other Measures: The focus of this case is to provide an example of a type of CSA package that could be deployed through outputs 2.1 and 2.2 of the project. It is important to note that the overall project also includes other interconnected components that contribute to an overarching strategy for improving climate resiliency and food security across FSM.

For this particular case, farmers from Gargey Village will also be provided with training to improve the fundamental business skills of farmers, such as bookkeeping, financial management, and business management. Through the trainings, farmers will be able to see how their farms can be a sustainable source of income. Upon realizing the value of their farms, the objective is that they will pass these practices to the next generation as a viable supplement to the traditional way of sustaining life in the islands which is fishing. The project also includes market demand created through the promotion of locally grown produce (output 3.1). See figure 2 below.

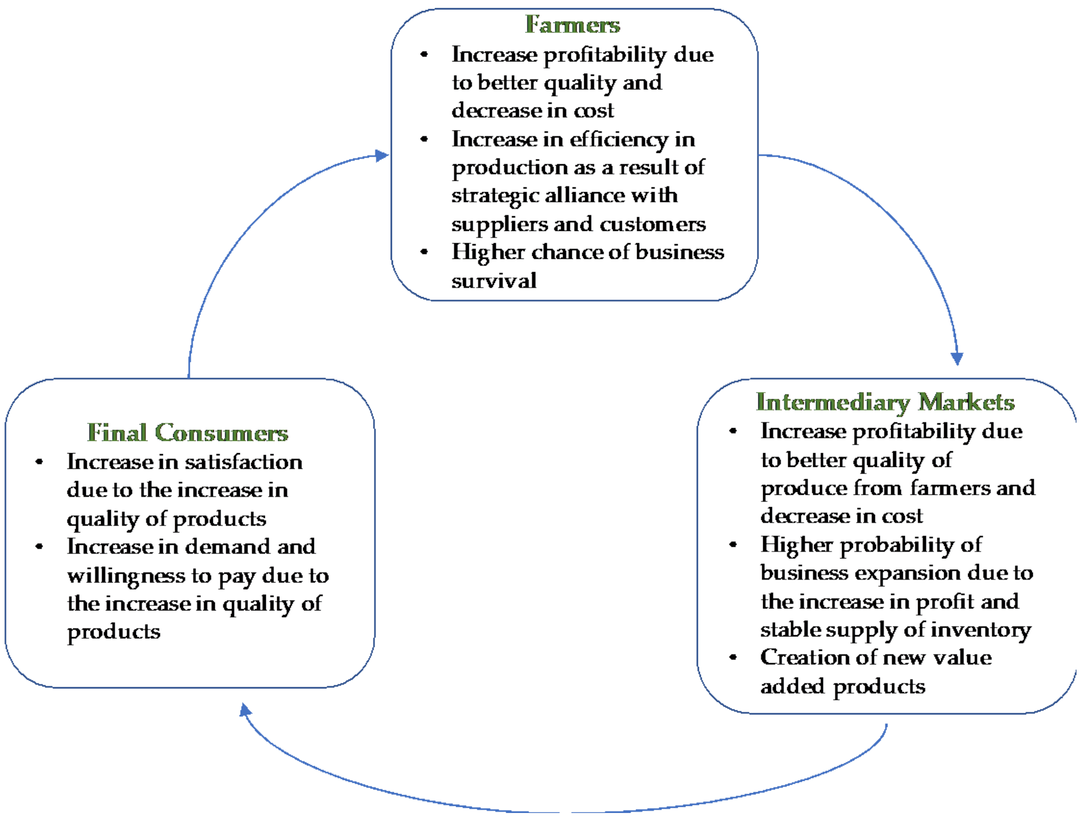

Figure 2. Increase Supply and Demand for Crops through Component 3 of Project

Introducing and educating organization such as schools, and other government offices will create a substantial number of consumers for the farmers (output 3.1 and 3.3). One of the reasons schools, markets, restaurants and other businesses or customers stop buying or lose interest in buying local produce is because of the inconsistency of local produce from farmers. Through the targeted CSA packages this project will allow farmers to produce higher quality crops more consistently thereby increasing business and consumer confidence. Connecting farmers to businesses and consumers as well as promoting the consumption of local groups will shift from much more expensive imported products. The project will also focus on securing government mandates that only locally grown food will be provided to students and patients at the hospitals as part of FSM's efforts to ensure sustainability of demand (output 1.3). See figure 3 below for a depiction of the connection between supporting sustainable farming systems that are resilient to the effects of climate change and the market.

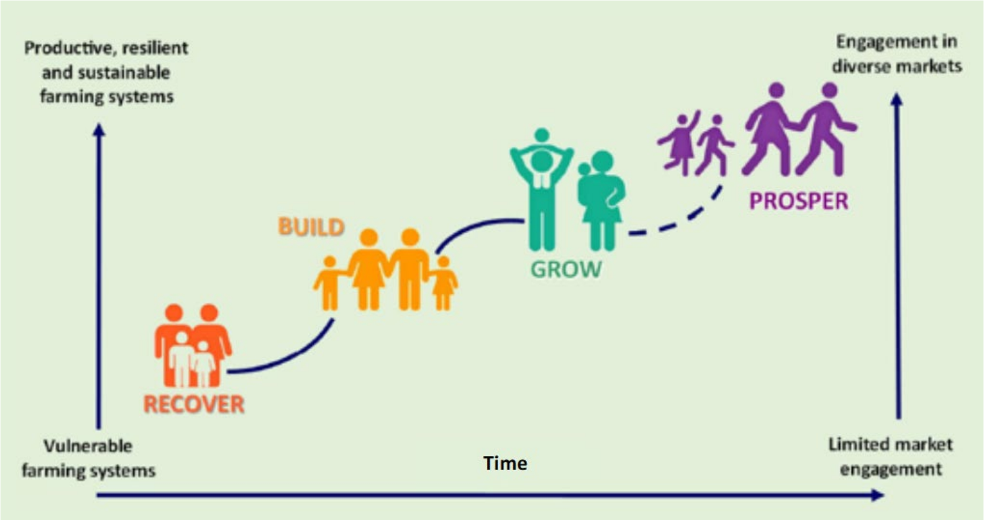

Figure 3. Linking Farmers to the Market for Improved Resilience

Observed Adaptation Benefits:

The CSA package increased arable land cover over 50% within Gargey Village. This included the planting of 42 varieties of native trees and crops. Current major crops that are being successfully grown at this location include coconut, breadfruit, mango, noni, chestnut, pineapple, sugarcane, land taro, tapioca, local oranges, mountain apple, banana and sweet potato, among others. There have been additional benefits in terms of improvement in water availability. These activities directly benefited the resilience and food security of more than 1,000 residents in Gargey Village and lessons learned from this project have helped to scale up similar projects at 3 locations in Yap that have experienced equivalent climate damaging processes.

Please see Figure 4 for a picture of Gargey Village before the start of CSA package implementation in 2007, and a present-day picture of the village illustrating the effects of the restoration. Additionally, please see Figure 5 for pictures of restoration efforts in Gargey Village between 2006 and 2013.

Figure 4: Aerial photo of Gargey Village at the start of the CSA project (panel A); Aerial photo of Gargey Village following restoration efforts as of 2021 (panel B)

Figure 5: Gargey landscape during early stages of restoration in 2006 (panel A); Gargey landscape in 2009 (panel B); Gargey landscape in 2013 (panel C).

GCF Investment Criteria:

In combination with **140 other sites**[173] to be analyzed and assessed for appropriate CSA packages across the entire FSM, through de-scaled vulnerability assessments (Output 1.2) and provided with targeted

[173] These sites will be spread across the 4 States to cover over 15,000 HHs (68% of total FSM population)

adaptation solutions to improve farmers' adaptive capacity to handle climate threats (Output 2.1 and 2.2) – particularly those related to soil degradation due to more intense rainfall and storms due to climate change – this specific example case will provide long-lasting impact for the community as outlined below in table 1.

Table 1. Impact, Innovation and Sustainability Parameters

Promoting Resilient Agriculture in Gargey Village	
Impact	At this particular site: • Climate resilient practices, technologies, and crop breeds adopted by 1,000 farmers across 258 ha • At least 5% increase in income due to sale of quality produce • 500 kg of crop varieties produced annually that meet quality standards • Improved soil health and 30% decrease in rate of soil erosion • 10% Increase in Individual Dietary Diversity Score (IDDS) for 1,100 population at Gargey Village [174] • 80% of 1,100 population with acceptable Food Consumption Score (FCS)[175]
Innovation	• Opportunity to provide technological advancement of staple/traditional crops to better withstand ongoing and projected climate change impacts and variability • Strong potential for replication across similar ecosystems, not just in FSM, but more broadly in the Pacific • Extension agents trained to understand climate impacts and given tools to deploy adaptation solutions to farmers
Sustainability	• Additional revenue generated from the sale of a wider range of crops increase farmer livelihood • Extension agents assigned to Gargey municipality will have capacity to train farmers on linkages with climate change[176] • Connection of farmers to broader farmers groups (Component 1) will facilitate a community of learning and connections to markets across the State and Nationally • Steady supply of staple crops along with increased knowledge of processing techniques will increase demand • Farmers connected to supermarkets, restaurants, and school feeding programs to increase demand (Component 3)

174 The indicator assesses the number of (pre-determined) food groups which were eaten by a specific target group the previous day or night. It is an indicator of a diet's micronutrient adequacy, an important dimension of its quality.

175 The household Food Consumption Score (FCS) is used as a proxy for household food security and is the core indicator for consumption recommended by WFP. It is a measure of dietary diversity, food frequency and the relative nutritional importance of the food consumed. FCS is calculated using a weighted frequency of consumption of different food groups consumed by a household during the 7 days before the survey. https://fscluster.org/handbook/Section_two_fcs.html

176 One of the main roles of extension agents in FSM is to work with farming communities, however, currently they are not trained on how to deal with climate risk as it relates to farming

	• Awareness raised of local community on benefits of eating local produce to increase demand (Component 3) • Leadership skills of key stakeholders built so they educate others about the project