ANNEX I : Resilient coastal fisheries and aquaculture, Nauru

PRE-FEASIBILITY STUDY

Developed for THE Pacific Community (spc)

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Executive summary

This document has been developed to assess the pre-feasibility and potential for a proposed Adaptation Fund (AF) project entitled "Resilient coastal fisheries and aquaculture in Nauru". This pre-feasibility study validates the potential for the aforementioned project, based on inputs gathered as part of the desk-based review, consultations with key stakeholders, and assessment of technical and financial feasibility. Additionally, the present study validates the potential for the project based on an initial Environmental and Social screening assessment of proposed project activities in accordance with both the AF's and SPC's E&S safeguards.

The proposed project structure is as follows:

- Component 1: Enhanced policy, regulatory and legislative environment for resilient coastal fisheries and aquaculture (1,013,000 USD)
- Component 2: Financing climate resilience for coastal fisheries and aquaculture sectors (6,950,000 USD)
- Component 3: Monitoring, Evaluation and Learning (558,000 USD)

The total proposed project budget, including project execution costs and Implementing Entity fees, provisionally amounts to 9,511,000 USD.

The project would result in the following project-level outcomes:

- Outcome 1: Implementation of recently enacted institutional, regulatory and legal frameworks related to coastal fisheries and aquaculture is facilitated through the provision of recommendations and technical support to enable the long-term climate, environmental and economic resilience of the sectors.
- Outcome 2: Improved food security and nutrition through increased farmed fish supply, increased adaptive capacity and income of aquaculture operators and reduced pressure on climate-vulnerable coastal and reef ecosystems.
- Outcome 3: Increased compliance with environmental recommendations and provisions under policy frameworks through enhanced capacity of local communities and NFMRA officers to collect and interpret data.

What the project aims to achieve is to provide strong incentives to GoN stakeholders to actively engage in marine resource management and conservation by supporting the development of a clear roadmap for the CFA Act and providing technical assistance for its implementation, and to communities to divert pressure away from coastal fisheries to sustainable, extensive aquaculture production. To do so, the project will utilize a combination of capacity strengthening, training, awareness-raising and financial support activities to create a paradigm shift for more climate-resilient marine resource management and planning, and domestic food supply. Learnings and data gathered as part of the project will continue to inform policy and regulatory developments by constituting a robust baseline in terms of community-based fisheries and marine resource management, climate change adaptation solutions, coastal and reef restoration, and sustainable aquaculture production.

1. Context setting

1.1 National context

The Republic of Nauru is one of the smallest and most geographically isolated countries in the world. The single, coral-capped island (21 square kilometers) is home to approximately 13,000 residents as of 2019, over 90% of whom are indigenous Nauruan. The island itself is located in the central Pacific Ocean approximately 40 kilometers south of the Equator, and can be roughly divided into two distinct topographical areas – the low-lying coastal area known as "Bottomside," and the much higher elevation interior area (up to 65 meters above sea level) known as "Topside." The vast majority of homes and critical infrastructure is located Bottomside, as shown in Figure 1 below.

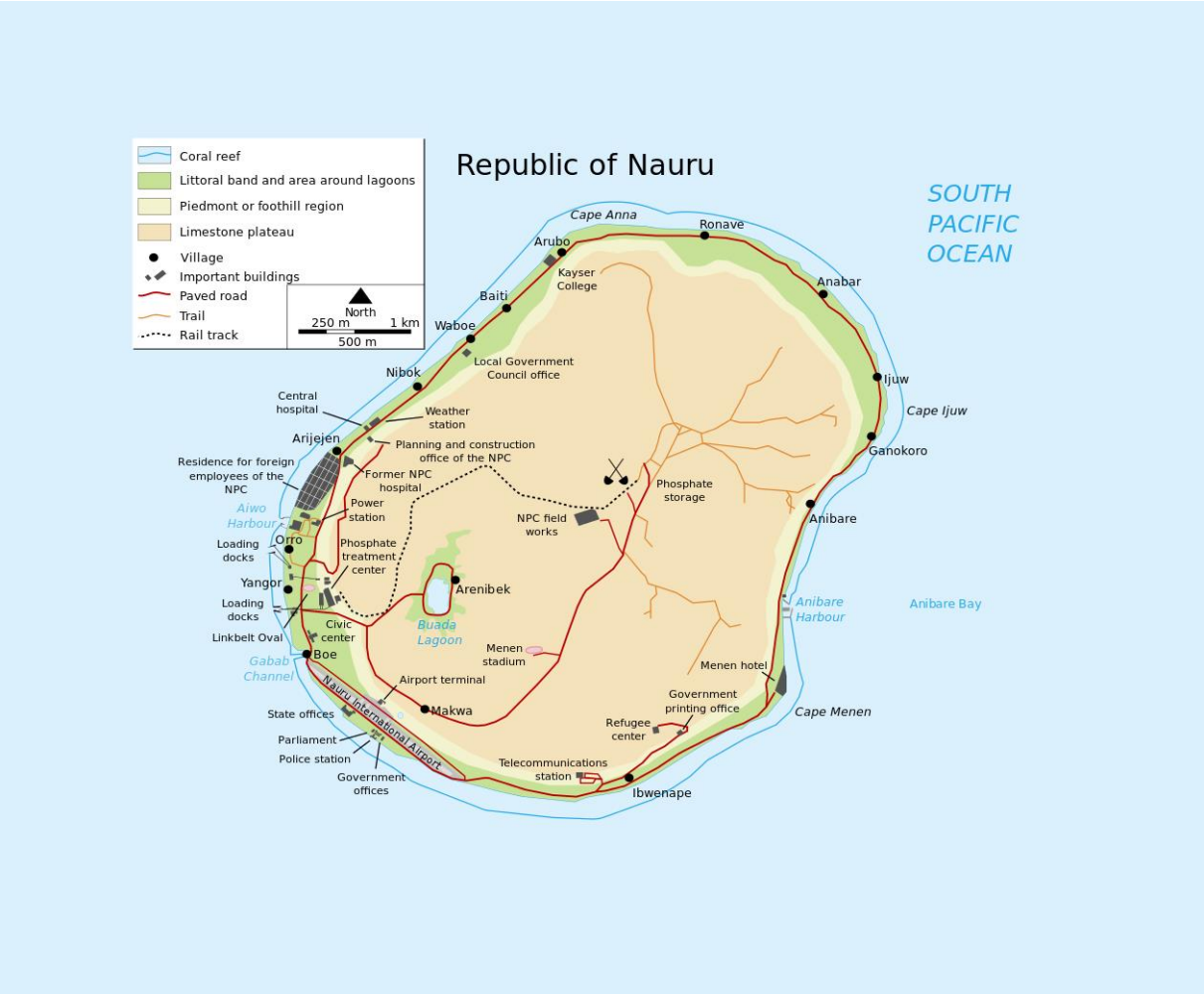

Figure 1 Map of the Republic of Nauru

Since gaining independence in 1968, the social and economic development of the Nauruan society was largely shaped by its phosphate mining industry which during its peak brought immense wealth and opportunities to the populations. Nauru is a phosphate rock island, and much of its arable land was devastated by strip mining, leaving only a narrow coast strip of four-square kilometers. Nauru's marine life has also been reduced by contamination caused by silt and phosphate runoff and in 2009 its land was estimated to be only 60% of its former productivity[1]. As a micro-state with small landmass and population, few marketable resources, and isolation from major international markets, traditional development indicators fail to provide an accurate

[1] R. Curtain and M. Dornan (2019) A pressure release valve? Migration and climate change in Kiribati, Nauru and Tuvalu, Development Policy Centre.

picture of the circumstances on the ground[2]. While income has risen in recent years, Nauru remains one of the most economically vulnerable countries in the world, while climate change adaptation is a persistent challenge.

1.1.1. Socio-economic context

In the early 1980s, Nauru was by some calculations the wealthiest nation on earth. In 2000, the economic crisis altered the living standards of the population. At the time, 95% of the workforce were public servants and mainly relied upon phosphate royalties as sources of income. During the peak years of phosphate mining, Nauruans enjoyed a high standard of living where household needs, including food and drinking water, were imported from overseas and distributed through local retail outlets. In 2000, when the large-scale commercial mining of phosphate ceased but residual mining continued, both government revenue and average household income were reduced dramatically. Those families who were once highly privileged in comparison with much of the world's population found it difficult to provide for their day-to-day needs[3].

A socio-economic assessment report by Australia highlighted the significant deterioration in the humanitarian situation in Nauru since the beginning of 2004. Food security has emerged as a serious issue as a consequence of policy failure and chronic economic decline. This resulted in a total regression of development with people resorting to basic subsistence fishing and farming for survival. Men, women and children forage daily on reefs, there is daily hunting of birds for food, and families resort to extended family systems to barter food for imported food items.

The diet of Nauru's people has deteriorated in recent years, which has led to an epidemic in diet-related disease. An estimated 25% of daily intake consists of rice and raw sugar, and only 30 food items comprise around 85% of daily calories consumed. Farming is practiced only on a very small scale on nutrient-poor land and is energy-dense. Thus, imported processed food that must come in through the country's poorly functioning port has replaced traditional food. This has pushed the national levels of obesity and diabetes (type II) to great heights, and 27% of new-borns have a reported low birthweight.

The latest Household Income and Expenditure Survey in 2013[4] demonstrated that while the incidence of food poverty was zero, about 24 % of the population and 6.8% of households were living below the basic needs' poverty line. The survey ranked 7.9% of the country's population and 6.2% of households as "extremely vulnerable." Two particularly vulnerable groups are households headed by women (which experience comparatively high levels of extreme poverty) and widows (60% of whom are classified as poor or vulnerable to varying degrees).

Nauru has the some of the lowest human development indicators in the region and the highest incidence of food poverty, with one in four people living below the basic needs poverty line. Infant, child, and adult mortality rates remain high and Nauru has the shortest life expectancy of any country in the Pacific[5]. Due to the unavailability of data, the Human Development Index (HDI) is not available for the Republic of Nauru[6]. Table 1 below provides a summary of available human development and gender indicators for Nauru.

Indicator	**Value for 2019 (unless otherwise stated)**
Expected years of schooling	**11.2**
Gross National Income (GNI) per capita (constant 2017 PPP$)	**16,237**
GDP per capita (2017 PPP$)	**11,599**

[2] Republic of Nauru (2021) Revised Nationally Determined Contribution.
[3] FAO (2017) Fishery and Aquaculture Country Profile. The Republic of Nauru.
[4] Republic of Nauru (2014) Household Income and Expenditure Survey (HIES) 2012/2013. Main analytical report.
[5] UNSDG Data website. Accessed 20/12/2021.
[6] UNDP. Human Development Index. Country webpage Nauru. Accessed 14/01/2022. Available here.

Indicator	Value for 2019 (unless otherwise stated)
Share of seats in parliament held by women (in %)	**10.5**
Violence against women ever experienced, intimate and nonintimate partner(s) (in % of total female population)	**48.1% and 47.3%**
Population living below income poverty line, PPP $1.90 a day (in %)	**0.9**
Exports and imports (% of GDP)	**99.2**
Net official development assistance received (% of GNI)	**19.0**
Foreign direct investment, net inflows (% of GDP)	**0.0**

Table 1 Key human development indicators for Nauru[7]

In Nauru, the tax-to-GDP ratio is 48.2% and income taxes increased by 13.1 p.p. in 2019[8]. This increase was due to higher tax rates for employees and service providers of the Regional Processing Centre (RPC) and higher than expected revenue from the RPC[9]. The government of Nauru is committed to a positive fiscal budget but there is uncertainty about revenues from the RPC after the contract with the Australian government expired in 2021[10]. The end of this contract coupled with the projected impacts of climate change on tuna fish stocks represent significant threats to revenue stability in the medium and longer-term.

1.1.2. Environmental context

Geology

The land area is about 22 square kilometers and has a coastline circumference of 30km long. The landscape is comprised of a narrow coastal terrace about 50 to 300 meters wide, encircling an upraised central plateau of limestone escarpment which cover about 80% of the total dry land of some 30 meters in elevation to a highest point of 71 meters. There are no rivers or surface freshwater bodies but there are: an inland brackish water lake, the Buada Lagoon, on a fertile depression at the southwest; a few anchialine ponds on the north eastern part of the island and an underground lake at a Moqua Cave in the southeast coastal portions of the island. The coastal soils of Nauru in general are of thin layers and very poor in the essential minerals for healthy plant growth and agricultural development. Soil fertility therefore is a central issue for agriculture and food security.

Flora

The flora for Nauru comprises about 56 native species and 125 naturalized species with none of the native species being endemic and many being extirpated or on the verge of being extirpated from the island. Many of the weeds found in previous assessments were absent but new weed species with a yet-to-be identified species of grass were recorded. Most of the island especially the large central plateau is covered with secondary scrub. Three plant communities present on Nauru can be classified as wetland vegetation:

1) Littoral strand;
2) Mangrove forest;
3) Freshwater marsh;

The Nauru BIORAP (2013) found that almost no native forest remains on Nauru. However, 42 native plant species were recorded and most of these are of critical importance, both ecologically and culturally.

[7] UNDP. Human Development Indicators Data. Accessed 20/12/2021.
[8] Asian Development Bank (2020) Revenue statistics in Asia and the Pacific 2021.
[9] Government of Nauru (2020), GON 2019-20 Final Budget Outcome.
[10] Ibid.

Water resources

There is very little surface water on Nauru's highly permeable terrain, much of the largest permanent water body being Buada Lagoon[11]. Buada Lagoon is a landlocked, slightly brackish freshwater lagoon in the interior of a raised coral limestone island. Its fertile perimeter is about 12 hectares in area and is actually a small lake rather than a lagoon according to several accounts[12]. The surface area of the lagoon itself is approximately 3-4 hectares. Buada Lagoon was traditionally an important site for milkfish farming and even if it has not been used so much for this anymore, it still remains the only water catchment area with the biggest potential for aquaculture production.

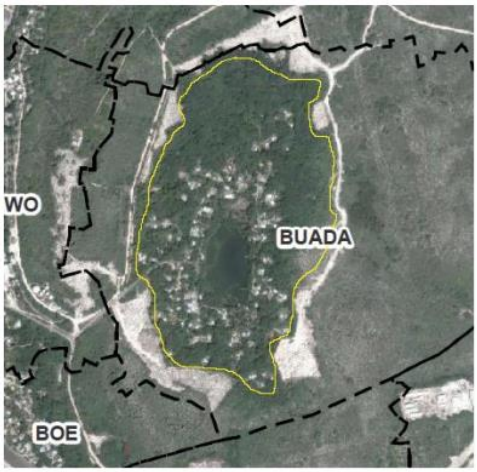

Figure 2 Satellite map of Buada Lagoon

There are two other wetland systems of note in Nauru. The first is a series of tiny wetlands (0.25-0.33 ha in extent) along the inner edge of the reef lagoon at the base of the limestone escarpment. These are small brackish marshes which sometimes dry out completely. The second system is a small patch of mangroves consisting of *Bruguiera gymnorrhiza* probably less than two hectares in extent, on the island's northeast coast.[13] The only significant water resources available for human consumption lie underground. Traditionally, the inhabitants used groundwater accessible in wells and caves in the karst. However, these supplies are dwindling, apparently as an indirect result of the pollution caused by mining activities to aquifers. During the hey-days of mining, fresh water was constantly shipped to the island in empty phosphate ships and more so during the long drought periods. More recently, desalination plants have been set up and are now the main source of freshwater for the people. Some people are also starting to collect rainwater run-offs from their roofs into big water storage tanks as their freshwater supply, but these are often used up during long drought periods.

Land use and tenure

Land use in Nauru is shared between mining areas, followed by buildings and settlements, forests and grass lands. Open lands, water bodies, coconut crops and sand bays cover smaller areas of the island (Figure 3 against).

Figure 3 Land use and land cover of Nauru

All Nauruans have certain rights to all land on the island, which is owned by individuals and family groups. Government and corporate entities do not own any land and they must enter into a lease arrangement with landowners to use land. Non-Nauruans cannot own land on the island. Due to Nauru's hierarchical and hereditary nature of customary land ownership[14], land issues and land disputes are the cause of many delays in achieving development progress and issues related to land rights also discourages foreign investment[15].

1.2 Nauru's fisheries sector

[11] Jungblut V and Dowiyogo B. (2016) Directory of Wetlands of Nauru - 2016. Report to the Secretariat of the Pacific Regional Environment Programme (SPREP).
[12] Mckenna et al. (2015) and Jungblut & Dowiyogo (2016)
[13] GFDRR (2011) Pacific Catastrophe Risk Assessment and Financing Initiative. Country Risk Profile: Nauru.
[14] Nauru Bureau of Statistics (2007)
[15] Jungblut V and Dowiyogo B. (2016) Directory of Wetlands of Nauru. Report to the Secretariat of the Pacific Regional Environment Programme (SPREP).

Nauru's fisheries sector can be divided in two distinct categories of activities:

1. The commercial oceanic fisheries sector, where the majority of government revenues is derived from fishing licenses
2. The coastal fisheries sector, characterised by subsistence, small-scale artisanal fishing

1.2.1 Fisheries sector overview

The NFMRA

NFMRA provides the institutional framework for fisheries management in Nauru. It is a statutory corporation under the Fisheries Act 1997 that has responsibility for overseeing, managing and developing the country's natural marine resources and environment resources. It is responsible for the management of offshore fisheries, coastal fisheries and aquaculture, and also owns the Nauru Fisheries Corporation, which acts as the Authority's commercial arm. The objectives and functions of the NFMRA are presented as follow in its 2014/2015 Annual Report:

- Objectives:
    - To manage, develop, conserve and protect the fisheries and marine resources of Nauru in such a way as to conserve and replenish them as a sustainable asset for future generations.
    - To promote the sustainable utilization of the fisheries and marine resources of Nauru to achieve economic growth, improved social standards, improved nutritional standards, human resource development, increased employment and a sound ecological balance.
    - To pursue effective strategies for managing the fisheries and marine resources of Nauru so as to maintain the integrity of marine ecosystems, to preserve biodiversity, to avoid adverse impacts on the marine environment and to minimize the risk of long-term or irreversible effects of resource extraction operations.
    - To enhance the administrative, legal, surveillance and enforcement capacities of the Republic for the management, development, conservation and protection of the fisheries and marine resources of Nauru.

The functions of the NFMRA relate mainly to the provision of recommendations to the Minister on matters related to the entity's objectives, to the reporting on the performance of the offshore and onshore fisheries sectors, to administer and enforce laws and regulations pertaining to coastal and offshore fisheries, and aquaculture, and to represent Nauru's fisheries interests on sub-regional, regional and international scenes.
The NFMRA is governed by the NFMRA Board of Directors, who are responsible to the Minister of Fisheries. Under the board is a Chief Executive Officer who oversees the work of the three functional units of NFMRA: Oceanic, Coastal, and Support. As of January 2022, the NFMRA had 70 staff: the CEO, 12 oceanic staff, 18 coastal fisheries staff (including 6 for aquaculture), and the remaining support staff[16]. The only non-government agency involved in Nauru fisheries is the Nauru Fishers Association.

In its last Annual Report (2014/2015), the NFMRA reinstated its goal to enhance the development and sustainable management of marine and fisheries resources to provide sustainable economic returns.

[16] Information gathered as part of stakeholder consultations conducted in January 2022.

Table 2 NFMRA strategy and objectives

Objective	Targets or milestones
1. Strengthen institutional capacity	• Corporate Plan 2009–2012 implemented • Fisheries Act updated • NFMRA effectively providing leadership, guidance and assistance on developing and managing fisheries resources • NFMRA infrastructure improved and consolidated in one site
2. Maximise sustainable economic returns	• Foreign licensing revenue per fishing day increased in real terms by 2012 from 2008 levels • Maximized sustainable economic yield from marine and fisheries resources
3. Promote private sector led development of commercial fisheries	• Potential niche, small-scale, high-quality fishing and processing export enterprises identified • Recreational use of marine resources (e.g. game fishing) investigated • Business profiles for establishing commercial fishing enterprises developed, and potential joint-venture partnerships with investors explored
4. Promote development of aquaculture	• Current 5-year national aquaculture plan reviewed and implemented • Legislative and regulatory framework for aquaculture development scoped and developed • Legislative and regulatory framework for aquaculture development adopted and implemented
5. Sustainably utilize marine resources to increase food security and alternative livelihoods	• Feasibility study conducted on new fisheries and fishing techniques, including traditional fishing methods • Business profiles/plans for development of new fisheries and fishing techniques completed and implementation started
6. Ensure sustainable practices are implemented to safeguard marine biodiversity and ecosystems	• Design, through participatory consultation, development of marine-protected area (MPA) networks • Capacity development and training on use of ecosystem approach and other conservation planning tools conducted • Develop legal and regulatory framework to support MPA • Implement ecosystem approach to coastal fisheries management
7. Minimise illegal, unregulated and unreported fishing	• Implement national plan of action for combating IUU fishing • Implement national observer programme • Substantial reduction in IUU • At least 20 observer trips conducted per annum
8. Develop sound scientific information on coastal marine resources	• Research capacity of NFMRA strengthened through partnerships with regional and international research institutions • Research plans for resources assessment capacity developed and training conducted for NFMRA

In terms of day-to-day activities, the NFMRA provides various goods and services to the local communities. According to the latest NFMRA Annual Report, these include 1) ice sales; 2) outboard motor, boat and trailer repair and maintenance; 3) rigging, deployment, repair and maintenance of anchored FADs; 4) search and rescue operations; 5) technical assistance to aquaculture operators, either directly or through the Nauru Aquaculture Association; 6) technical assistance to district communities on the community-based ecosystem approach to fisheries management; 7) technical assistance to artisanal fishers, either directly or through the Nauru Fishers Association; and 8) collection of data from communities, fishers and aquaculture operators to keep abreast of the situation on the ground and to intervene when required.

Oceanic fisheries

Estimating the share of the fisheries sector to Nauru's GDP is complicated by a number of factors. These include pending salaries, Bank of Nauru checks, the treatment of the Refugee Processing Centre, large subsidies to government-owned business enterprises, large numbers of redundancies in the public sector, and significant gaps in statistical collection[17]. As a result, the Department of Finance and Economic Planning estimates the contribution of the fisheries sector to Nauru's GDP at 2.3% in FY2014[18]. However, Gillett (2016) found a considerably lower fishing contribution to GDP for the year 2014, at AUD 1.8 million compared to the official estimate of AUD 3.2 million.

Fisheries development in Nauru is considered to be a major economic prospect for the future, particularly oceanic fishing through the sale of fishing licenses in the Exclusive Economic Zone (EEZ). Nauru's EEZ covers 431,000 km^2, and its offshore fisheries sector is overwhelmingly dominated by purse seiners from Distant Water Fishing Nations (DWFNs). Nauru's open ocean areas are frequented by an abundance of tuna and other pelagic species, but the primary target of DWFNs are skipjack and yellowfin tuna, intended for foreign canneries. The harvests of tuna in Nauru waters are substantial, but the vast majority of the catch is taken by foreign industrial fishing vessels, which are in the 1,001-1,500 gross tons size. These vessels are licensed either under bilateral access agreement with Nauru, or under a preferential regional agreement (such as the FSM Arrangement[19]) or the US Treaty[20]. In 2015, The USA had the largest numbers of vessels (purse seiners and longliners), followed by Taiwan, Japan, Korea and China (35, 33, 32, 26 and 12 vessels respectively). Vanuatu, New Zealand and the Philippines owned 1-3 vessels each, for a total of 223 vessels licensed to fish in Nauru's waters in 2015.

Over the period 2012-2016, one study estimated the average yearly total catch at 118,140 tonnes[21][22] (for tuna species at 95%, and 5% of other pelagic species). Gillett (2016) estimated the offshore foreign-based catch at 177,315 tonnes in 2014, representing a total value of 231,229,508 USD. Comparatively, the total offshore commercial catch by Nauru flagged vessels in 2016 was estimated by FAO at about 530 tonnes[23]. The access fees paid by those foreign vessels form a large portion of the government revenue, between 25-30% depending on the year[24]. There are currently no offshore fishing vessels operating from Nauru (under the Nauruan flag). The two longliners formerly owned by the Nauru Fisheries Trading Corporation (12 m and 15 m) have not operated since the mid-2000s. Table 3 below shows the total tuna catches (in tonnes) for offshore fisheries in Nauru's EEZ.

Table 3 Tuna catches in the offshore fisheries in Nauru's EEZ (tonnes)[25]

Year	Skipjack	Yellowfin	Bigeye	Total
2011	82,256	17,022	8,399	107,677
2012	42,296	8,751	3,605	54,652
2013	98,610	12,933	1,617	113,160
2014	144,175	24,599	7,505	176,279
2015	53,244	14,550	1,079	68,873

[17] R. Gillet (2016) Fisheries in the Economies of Pacific Island Countries and Territories.
[18] FAO (2017) Fisheries of the Pacific Islands. Regional and national information. FAO Fisheries and Aquaculture Technical Paper 625.
[19] The Federated States of Micronesia Arrangement for Regional Fisheries Access. Available here.
[20] Multilateral Treaty on Fisheries. Treaty on Fisheries between the Governments of certain Pacific Islands States and the Government of the United States of America. Available here.
[21] FAO (2018) Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. FAO Fisheries and Aquaculture Technical Paper 627.
[22] Calculated using the 5-year average, for total catch of DFWNs
[23] FAO (2017) Fishery and Aquaculture Country Profile. The Republic of Nauru.
[24] Republic of Nauru – Ministry of Finance (2020) 2020-2021 Budget and Estimates of Revenue and Expenditure. Budget Paper no. 1 Budget Strategy and Outlook.
[25] NFMRA, 2016

Catches from the offshore fishery are not offloaded in Nauru. Depending on the flag of the vessel, tunas are either transshipped for transport to a cannery (seiners from Taiwan and Korea), delivered directly to Pago Pago (US vessels), or delivered to a port in Japan (Japanese vessels). Some vessels may make direct deliveries to canneries in the Philippines.

Currently, there are no formal exports of fishery products from Nauru. The last export shipment of fresh tuna from the domestic longline operation was in 2001, and only seven shipments were ever made. Although the fish was of good quality and received a good price at auction in Japan, the local longline operation was unprofitable for various reasons, including frequent mechanical problems and non-incentivised wage structures. Informal exports of fish are made by passengers travelling on regular commercial flights. These shipments are often for family and friends in Australia, Fiji and Marshall Islands. Although the Nauru Quarantine Office issues certificates for fish and other marine products that are being taken out of the country, to ensure that the products are in good condition, those certificates do not indicate the weights of the shipped products.

Coastal fisheries

Coastal fishing is carried out for subsistence purposes and is sold in local markets[26]. There has been no consistent statistical system to cover all of Nauru's coastal fisheries (encompassing commercial and subsistence), catch estimates therefore vary depending on survey methods and year. The latest attempt[27] recorded coastal commercial fisheries production at 163 tonnes, and coastal subsistence fisheries production at 210 tonnes, for a total of 373 tonnes in 2016, worth 2,036,713 USD (1,071,275 USD and 965,438 USD respectively)[28]. To address this data gaps, NFMRA has set up a data collection system comprised of daily collection of landing data from artisanal fishers, creel surveys set to be done every two years and a socio-economic survey to be done every four years. The daily collection of landing data which was started in 2012 has been revised and improved recently and is ongoing, the first creel survey was conducted in 2019 and a socio-economic survey was conducted in 2020. The data from these surveys are being analyzed with some delays due to the very limited capacity of NFMRA local staff in data analysis and report writing.

Nauru's artisanal fleet comprises small (less than 6 m) powered skiffs, canoes operated by local fishers. The powered boats are mostly used for trolling and often target pelagic species. Some commercial fishing activities are practiced but mostly on a part-time scale, meaning that fish catches are sold only when there is surplus after meeting subsistence needs. In sum, there are four distinct fishing areas and methods in Nauru[29]:

- In the reef flat, crest and surf zone, prominent practices include gleaning, seine and cast nets, spearing, traditional trapping, line fishing at high tide, for both food and bait
- On the reef front and nearshore slope (25-30m), practices include seining, bottom and water column hand-line fishing from canoes and skiffs, diving and spearing, with or without scuba
- On the reef slope and in deep waters (up to 400m), practices include drop-line, other bottom fishing methods and mid-water hand-lining from canoes, skiffs and larger outboard vessels in deeper water
- Lastly, in nearshore pelagic waters within sight of the island, and adjacent to anchored Fish Aggregating Devices (FADs) and mooring buoys, practices include trolling, pole and mini long-lining, drop-stone and similar methods for deeper pelagic species; traditionally, netting for flying fish and baitfish.

The catch obtained from fishing in shallow inshore waters is landed all around Nauru wherever fishers can swim, wade, or walk ashore. Most of the catch from fishing further offshore from canoes and skiffs is landed

[26] Ibid.
[27] R. Gillet (2016) Fisheries in the Economies of Pacific Island Countries and Territories.
[28] FAO (2017) Fishery and Aquaculture Country Profile. The Republic of Nauru.
[29] FAO (2017) Fishery and Aquaculture Country Profile. The Republic of Nauru.

at a few artificial channels through the fringing reef. Grabab Channel at the southwest of the island is used during the prevailing easterly winds, while Anibare Bay is used during winds from the northwest.

Fishing area	Species
Reef flat, reef crest and surf zone	Molluscs, crustaceans, bêche-de-mer, eels, octopus, mullet, surgeonfish, scarids and other species netted in surf zone;
Reef front and nearshore slope (25-30m)	Wide range of smaller demersal and epibenthic species such as scarids, acanthurids, carangids, shallow-water serranids, lutjanids and lethrinids and ranging reef-associated pelagic species
Reef slope and deep water (up to 400m)	Deep-water snappers, lutjanids, carangids and some scombrids, deeper-water serranids, balistids, some sharks
Nearshore pelagic waters within sight of the island, and adjacent to anchored FADS and mooring buoys	Rainbow runners, some tunas, wahoo, mid-water balistids, barracuda, some sharks

Figure 4 Main species captured by coastal fishing per type of fishing area

The NFMRA with assistance from SPC carried out a survey of the reef invertebrate resources of Nauru, assessing stock of sea cucumbers, bivalves, crustaceans, gastropods, starfish and urchins[30]. The conclusion of the survey was that coastal fisheries in Nauru have operated for many years with inadequate management, and that the impacts of climate change were worsening the depletion of coastal fisheries resources. The results of the survey and previous surveys on Nauru provide evidence of significant over-exploitation of Nauru's coastal invertebrate resources.

The production from coastal and inshore fisheries and aquaculture is almost entirely for domestic consumption. The CoFish study (2005) states that local marketing of finfish is rare, and marketing of invertebrates is non-existent (apart from lobsters). The reliance on marine products for basic food needs, and the lack of transportation and outlets for marketing contribute to this. For the whole of Nauru, the annual per capita fish consumption (whole weight equivalent) was estimated to be 55.8 kg in 2016, of which 96% was fresh fish. FAO data indicates that annual per capita consumption of fish and fishery products was 52.3 kg in 2013. Almost all finfish catch is consumed or given to relatives, and only a small proportion of catches is reported to be sold. Most of the sales are from informal roadside markets. The Nauru Fisheries Corporation set up as the commercial arm of NFMRA in the late 1990's used to operate a fish market that sells fish from its own fishing operations. This only lasted for a few years before the fish market ran into some financial problems forcing it's closure. The NFC has since been dissolved.

The latest census carried out by SPC (2013) revealed that the ratio of men to women fishers in Nauru was 65% men for 35% women. The participation of women in fisheries activities differs depending on the ethnic background of the woman. The three main ethnic groups involved in fisheries are Nauruan women, I-Kiribati women and Chinese women. i) Nauruan women are mainly involved in the harvesting of resources, with less involvement in processing and marketing. I-Kiribati women are involved in harvesting, processing, and marketing of resources. Chinese women are involved in the marketing of resources. ii) Apart from the constraints imposed by society, the main restriction on women's participation in fisheries is competition for limited reef resources leading to over-exploitation of reef resources and out competition by the males dominate industry. iii) Women involved in fisheries are less aware of support services available to them as men interact in different social context and tend to seek out required support mechanisms more directly. iv) There are less women undertaking formal marine studies reducing the pool of technical expertise to be obtain technical positions in the marine public sector[31], however NFMRA has a policy of employment based solely on merit and recent years have seen an increased in women appointed to positions.

[30] Harris et al. (2016)
[31] Tuara (1998)

1.2.2 Governance of the fisheries sector

In the early 2000s, a National Tuna Fishery Strategy was prepared, and in 2005, the Nauru National Tuna Management and Development Plan was prepared. Neither document was officially adopted[32]. Although the strategy and plans cannot be relied on to provide accurate information on national management arrangements, they provide some insight. The plan has two major overall goals:

1. To promote the effective management and conservation of the tuna resources;
2. To maximise the long-term economic and social benefits for the people of Nauru from the development of tuna resources.

The draft objectives of the plan were as follows:

- Strengthening the exercise of sovereign rights by Nauru over the tuna resource
- Increasing the economic gains received by Nauru from the exercise of its rights over the tuna resource
- Ensuring effective participation by Nauru in regional tuna management activities
- Minimizing any adverse impacts of tuna fishing and related activities on non-tuna species and the marine environment
- Eliminating illegal fishing activity in the fisheries waters of Nauru
- Protecting the interests of small-scale tuna fishers, noting their contribution to food security
- Improving the nutritional standards of Nauruan people through increased availability of fish, including tuna and bycatch species taken during tuna fishing, as a source of food in Nauru.

Essentially, like most of the Pacific Island countries, Nauru's management of its offshore tuna resources follows the sub-regional and regional arrangements Nauru has signed and become a member of.. On the sub-regional level, Nauru cooperates with other member countries of the Parties to theNauru Agreement (PNA). On the regional level, Nauru is a member of the Western and Central Pacific Fisheries Commission (WCPFC) that was itself established by the Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean. There are 27 members of the Commission in total who enact tuna management measures at the annual WCPFC meeting. Of these measures, that of most relevance to Nauru was the Conservation and Management Measure for Bigeye, Yellowfin and Skipjack Tuna in the Western and Central Pacific Ocean[33]. These management arrangements are based on regular stock assessments for each species of tuna done by the Oceanic Fisheries Programme of the Pacific Community (SPC)[34]. In addition to the WCPFC, Nauru is a signatory to the UN Convention on the Law of the Sea, the UN Fish Stocks Agreement.

A central component to the management of Nauru's offshore fisheries is the PNA's Vessel Day Scheme (VDS) described in Table 4 below. According to the PNA Office and FAO, the VDS is viewed as an example of an indirectly implemented and effective economic response to climate variability. At the onset, the VDS was developed so that the parties to the Nauru Agreement had a single, coordinated – and, hence, stronger – negotiating position regarding access to their waters by distant water fishing fleets. Because the VDS covers and indirectly sets limits to the catch of fish over this vast range, it strengthens the sustainability of their fisheries, and countries are more able to provide an efficient response to increased natural variability in terms of the stock size and the location of the fish[35].

[32] Gillett (2009)
[33] FAO (2017) Fisheries of the Pacific Islands. Regional and national information. FAO Fisheries and Aquaculture Technical Paper 625.
[34] FAO (2018) Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge and recommendations.
[35] FAO (2018) Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge and recommendations.

Table 4 PNA Vessel Day Scheme[36]

In 2000, a study suggested that the PNA purse-seine management scheme that was then based on vessel numbers be replaced by a scheme based on purse-seine fishing days. The transition was actually made seven years later. In 2007, the Parties to the Nauru Agreement began implementing the Vessel Day Scheme (VDS), transitioning from permitting a total number of purse-seine vessels in the region (205) to permitting a total allowable effort (TAE) in number of purse-seine fishing days (44,703 days for 2012; 44,890 days for 2016). Given the volume, value and multi-jurisdictional nature of the fishery, it is arguably one of the most complex fishery management arrangements ever put in place. Its key features are as follows:

- System of tradable fishing effort (days) allocated to the eight Parties
- Limit on total effort (the TAE) ~ 45,000 days
- TAE is allocated to Parties based on zonal biomass and historical effort as PAEs (Party Allowable Effort)
- Fishing days are sold to fleets for fishing in each EEZ
- There is a minimum benchmark price for VDS days sold to foreign vessels
- Fishing days monitored by satellite-based Vessel Monitoring System (VMS)
- VMS monitoring supported by observers on board all vessels
- Days are tradable between Parties
- Scheme costs are financed by levies on vessels

Due to the complicated nature of the new VDS system and the various constraints of the government fisheries agencies of the region (e.g. under-funded, under-staffed), it was expected there would be problems in the introduction of the scheme. However, member countries adapted rapidly to the scheme to implement the VDS and the scheme is sustainably run by local staff that are financed by the scheme. The system is creating competition for a limited number of days, thereby increasing the value of each day. In practice, the value of a fishing day before the VDS was roughly USD 1,350, but it increased to about USD 5,000 in July 2011 and days were being sold in 2016 for over USD 12,000. Evidently, the scheme is providing substantial benefits for the PNA countries.

In terms of coastal fisheries, there has been not much active management of coastal resources in Nauru. Although coastal fisheries significantly contribute to fulfilling the food and cash needs of communities, exemplified by the revenue derived from coastal commercial and subsistence fisheries, there is little government intervention in inshore fisheries. However this has changed recently with communities calling upon the Government to do something in view of the changes they were seeing in the abundance and distribution of some fish and invertebrate resources. These views, coupled with the increasing dependence of the population on reef and inshore fisheries, improving the management of coastal fisheries in Nauru became a matter of priority in the interest of local communities. Several authors have stated that there is an urgency to develop a legal framework and effectively implement community-based fisheries management initiatives for the sustainable management of fisheries resources[37].

The NFMRA have willingly taken on the views of the communities and after reviewing its Fisheries Act 1997, it realizes that a new legal framework more specific to managing Coastal Fisheries is needed. With assistance initially from FFA and then later in collaboration with UNDP and SPC, NFMRA held many consultations with communities and other local stakeholders and was able to develop a coastal fisheries and aquaculture management legal framework that was approved by the Nauru Parliament in 2020. The new Coastal Fisheries and Aquaculture Act 2020 could allow communities to take part in decisions relating to the coastal fisheries resources, and to be custodians of their selected fisheries management areas as approved by the Government.

Table 5 Objectives and key elements of the Coastal Fisheries and Aquaculture Act

The objectives of the Coastal Fisheries and Aquaculture Act (2020) are stated as follows:

a) Preservation, protection and development of coastal fisheries waters of the Republic

[36] FAO (2017) Fisheries of the Pacific Islands. Regional and national information. FAO Fisheries and Aquaculture Technical Paper 625.
[37] FAO (2017), Gillet (2014), Profish (2007) and Harris et al. (2016).

b) Ensuring the sustainability of coastal fisheries waters and aquaculture management and development
c) Protection of livelihood and food security
d) Managing, developing and using fishery resources taking into consideration tradition knowledge, best available scientific information and in accordance with best management practices
e) Ensuring community participation in coastal fisheries and aquaculture management and
f) Co-ordinating the role of Government agencies and the community to ensure compliance with conservation and management measures for coastal fisheries waters and aquaculture.

Further, the Act enacts the establishment of the following entities and measures:

- The Coastal Fisheries Advisory Council, which shall advise the Minister on policy matters relating to coastal fisheries and aquaculture
- The Community Fisheries Stakeholder Forum, which shall work collaboratively to provide advice on the development of project outcomes, feedback on policies, plans, legislation and other conservation measures
- The National Coastal Fisheries Management Plan, which is to be prepared and reviewed as part of the Act
- The Community Fisheries Management areas, committees and plans, which are to be delineated and established as part of the Act
- The Community Fisheries Management Fund, enabling the reception of financial assistance for the purpose of supporting the implementation of community fisheries management area plans
- The National Aquaculture Plan, which is to be prepared and reviewed as part of the Act
- The Coastal Fisheries and Aquaculture Development Fund which is established to protect, conserve and manage coastal fisheries; aquaculture development and food security.

1.2.2 Challenges

As some phosphate money payouts started again in 2013, there has been a noticeable decrease in coastal fishing activities, with more people falling back to the old habits of buying food from the shops. Prior to this during the peak of Nauru's economic downturn most of the people had to go back to their coastal fisheries and marine resources to feed their family. More non-powered canoes made from aluminium roofing being used increasing to as many as up to 20 one-man canoes operated by Nauruans were going out fishing on most days of the week,. The number of people engaged in gleaning and artisanal fishing in inshore areas also increased to the tens and hundreds a day. Post 2013, when the economy started picking up again the numbers of canoes going out fishing have decreased to about six at the most, four of which are operated by men from Kiribati and Tuvalu[38]. Also, the number of people going out gleaning has dropped. The increased exploitation of the coastal fisheries resources that occurred during the economic down-turn is suspected to have had an impact especially without any management measures in place and which could contribute to the rapid deterioration of the coastal fisheries resources. . Many of the inshore fishery resources are fully or partially overexploited, creating problems for an expanding population that is reliant on marine resources for subsistence[39]. Although at the moment there is no form of fisheries management, at the district level, people have been very vocal and keen to get some management actions in place that could address the issues with many supporting the idea of districts looking after parts of the reefs themselves through the concept of community based fisheries management areas. Unlike other Pacific Island countries Nauru has yet to set up MPAs[40], and the NFMRA envisages the promotion of fisheries management areas and marine protected areas as one of its strategies for managing the coastal fisheries resources. MPAs would not solve all problems related to coastal fisheries in Nauru, but they are a useful tool in the rehabilitation of heavily impacted reef fisheries[41]. Nauru's traditional open access tenureship means that everyone is used to the idea that they are free to fish anywhere on the island. Because of the lack of traditional authority, the protocols seen in other countries are

[38] R. Gillet (2016) Fisheries in the Economies of Pacific Island Countries and Territories.
[39] FAO (2017) Fisheries of the Pacific Islands. Regional and national information. FAO Fisheries and Aquaculture Technical Paper 625.
[40] Ibid.
[41] FAO (2018) Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge and recommendations.

not practised in Nauru. There are no customary regulations, district laws or unwritten understandings on fishing activities, such as size limits, quotas, gear restrictions, use of scuba, or imports. The Coastal Fisheries and Aquaculture Act 2020 is changing this and new coastal fisheries regulations under this new Act have been prepared and are to be introduced soon.

As detailed below in the climate analysis, tuna species are expected to move northward due to the impacts of ocean warming temperatures and acidification. As a result, a significant portion of government revenues may be lost in the medium or long-term, representing at least a quarter of annual revenues generated from the sale of offshore fishing licenses. Further, as the total catch of coastal fisheries remains marginal and of subsistence nature, considering that climate change will also impact fish and invertebrates' stocks in coastal areas, opportunities to counterbalance future revenue losses are scarce. Attempts to promote the access of small-scale fishers to the large tuna resources have not been successful, mainly to due to the preference of local communities for milkfish, and to the difficulties in providing adequate infrastructure for the development of a domestic tuna market. Lastly, the NFMRA has difficulties carrying out its fisheries development functions at a time of financial stringency and lack of financial autonomy.

1.3 Nauru's Aquaculture sector

1.3.1 Aquaculture sector overview

Aquaculture has been identified by the GoN as a sector with strong potential to innovate, reap productivity gains, generate employment and contribute to national food and nutrition security and livelihood diversification. Although possessing only a very shallow lagoon (much of which dries at low tide) and a narrow fringing reef, the food produced by fishing in these inshore areas is very important in the Nauru diet.

NFMRA (2005) states there are four depressions on the Nauru plateau, the most significant one forming Buada Lagoon, with a surface area of 30,000 m^2. The other water bodies, known as ponds, are on the fringing coast, or just a few meters from the base of the escarpment. They range from about 40 m^2 to about 10,000 m^2 in area, either manufactured or naturally occurring. Anabar pond is the most significant, at 10,000 m^2. The ponds have become infested with tilapia, which is not popular as a food item[42].

Traditionally, juvenile milkfish were collected on the intertidal reef and reared in brackish water ponds. The most important areas for farming were Buada Lagoon and, to a lesser extent, the Anabar pond. Farming was divided among families, with walls and fences, and the people had an intricate social fabric intertwined with milkfish culture. The Mozambique tilapia (*Oreochromis mossambicus*) was introduced around 1961, and eventually infested all the milkfish ponds and competed for food. Many farmers abandoned their traditional practice of raising milkfish. Currently there are several milkfish grow-out ponds around Nauru. These are family owned backyard/subsistence operations. The aquaculture production is estimated below 1 tonne in 2016[43].

In 2019, 63 people (about a dozen households) reported aquaculture to be their main occupation and income source in 2019[44], primarily located in Aiwo, Buada, Anabar and Meneng. Out of those households, two-thirds were engaged in aquaculture for self-consumption purposes, while one-third was for consumption and some for sale. None were run for sale only. As of January 2016, there were 35 registered pond owners with the Nauru Fisheries and Marine Resources Authority (NFMRA)[45], demonstrating that the subsector does not display growth in the number of operators or production. The ponds are family-owned backyard milkfish ponds, and some are old swimming pools, in addition to the one-hectare Buada Lagoon. Over the past few years milkfish farming has not been active, and only a couple of family-owned ponds are known to still have milkfish from the last fry shipment from Kiribati. NFMRA has attempted to revive milkfish farming, including through the construction of an aquaculture holding facility used to receive, hold and condition milkfish fry from Kiribati before distributing and selling to local pond owners to stock their ponds. There are extension

[42] R. Gillet (2016) Fisheries in the Economies of Pacific Island Countries and Territories.
[43] FAO (2017) Fishery and Aquaculture Country Profile. The Republic of Nauru.
[44] SPC (2020) Nauru mini-survey. Population in Nauru.
[45] R. Gillet (2016) Fisheries in the Economies of Pacific Island Countries and Territories.

officers supporting owners with the preparation of their ponds and providing advice on stocking, feeding, and management of the ponds.

1.3.2 Governance of the aquaculture sector

On the national level, the NFMRA is the leading institutional body in charge of the management of aquaculture activities. Due to the limited size of the sector, there are only two non-governmental organisations in the aquaculture space, the Nauru Aquaculture Association which is comprised of fish farmer members (established to assist and enable individual fish farmers to have access to technical assistance channeled through the Association), and the Buada Lagoon Owners' Association (supports communal ownership rights and aquaculture efforts for Buada Lagoon).

On the sub-regional level, the Micronesian Association for Sustainable Aquaculture (MASA) is comprised of the Marshall Islands, the Federated States of Micronesia, Palau and Nauru. The association supports business planning information and tools, with a view to strengthen the business strategy and sustainability of this sector.

1.3.3 Challenges

The growth of the aquaculture sub-sector has been hampered by a number of factors, including:

- The operations of the NFMRA largely focus on offshore fisheries and particularly tuna resources, which make a significant contribution to government revenues compared to aquaculture.
- There is a need to strengthen local technical knowledge on aquaculture processes.
- Lack of access to commercial financing to finance infrastructure, tools for small businesses and independent aquaculture operators
- A long history of maladaptation (notably the introduction of the Mozambique tilapia, which is not favored by local communities for food and has infested existing milkfish ponds) has resulted in local communities abandoning their traditional practice of aquaculture.

1.4 Climate analysis

Overview

Nauru lies in the dry belt of the equatorial oceanic zone, with diurnal temperatures ranging from 26°C to 35°C, and nocturnal temperatures between 22°C and 28°C[46]. Typical of the Pacific region, Nauru has an extremely stable climate, with temperatures averaging 28°C all year round which are strongly tied to the surrounding ocean temperature, with humidity averages around 80%[47][48]. The wet season usually starts in November and continues to April, while drier conditions occur from May to October. Additionally, the climate of Nauru is strongly characterised by the seasonal trade winds[49], influenced by the El Niño-Southern Oscillation (ENSO).

1.4.1 Major climate hazards

The main climate change vulnerabilities in Nauru include sea level rise (SLR) and the effect of increases maximum temperatures on marine resources and already stressed water and vegetative resources[50]. Available data and information sometimes relate to Pacific Island Countries and Territories (PICTs), or Western and Central Pacific Ocean (WCPO) area due to a lack of dedicated analysis on the climate change hazards on Nauru specifically.

Sea-level rise

Observations show that climate change has increased the average sea level in the Pacific by about 15 cm in the last 100 years, with most estimates indicating an accelerated rate of change in recent decades[51]. Climate change will continue to increase sea levels, but the exact rate of increase is likely to vary across the Pacific (as is already the case) and will depend on a range of factors including rates of thermal expansion and polar ice melt.

Current estimates suggest an increase of between 20–60 cm by 2100 in the western Pacific (PACCSAP, 2014a). Given the sensitivity of many Pacific nations to relatively small increases in SLR, failure to limit global temperatures to 1.5˚C will have huge economic, social and environmental implications. Kopp et al (2014) indicate that static-equilibrium effects (differences in the Earth's gravitational field and crustal height) lead to a tendency for greater-than-global SLR in the central and western Pacific Ocean.

Ocean temperatures

Sea surface temperatures (SSTs) have increased during the 20th century and continue to rise. From 1901 to 2015 temperature rose at an average rate of 0.07°C per decade globally. Sea surface temperature has been notably higher during the past three decades than at any other time since reliable observations began in 1880 with the observed warming most pronounced at higher latitudes. The Pacific has been warming at a rate of 0.05°C per decade over the period 1950-2016; thus at a slightly slower rate than the Indian and Atlantic Oceans.

Sea surface temperatures are an important variable due to their potential impact on the productivity in the upper layers of the oceans and on atmospheric conditions. Temperatures near the surface of the ocean are influenced by heat from the atmosphere but also by the rate of upwelling and mixing of layers which are critical to the distribution of heat within oceans. The Pacific SSTs are also affected by natural factors such as the Interdecadal Pacific Oscillation (IPO) which facilitates mixing within the water column, and by El Niño events, characterized by a five consecutive 3-month running mean of

[46] Global Climate Change Alliance: Pacific Small Island States Project (2013) Climate Change Profile: Republic of Nauru.
[47] World Bank (2021) Climate change Country Profile Nauru.
[48] Pacific-Australia Climate Change Science and Adaptation Planning Program (PACC-SAP) (2014) Current and future climate of Nauru.
[49] Pacific-Australia Climate Change Science and Adaptation Planning Program (2014) Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports.
[50] Republic of Nauru (2021) Intended Nationally Determined Contribution (INDC) under the UNFCCC.
[51] Pringle, P. (2018) Effects of Climate Change on 1.5° Temperature Rise Relevant to the Pacific Islands. Pacific Marine Climate Change Report Card: Science Review 2018, pp 189-200.

SST anomalies above the +0.5°C threshold, which is known as the Oceanic Niño Index (ONI)[52]. In most regions, including in the Pacific, the average SST will continue to rise due to climate change. One of the most damaging impacts on increased ocean temperatures is the increasing propensity for coral bleaching and there is strong evidence that corals are sensitive to temperature thresholds (as illustrated later in this report). Ocean temperatures are naturally variable, and for coral reefs, peaks in SST are as significant as changes to the mean. This is illustrated by past coral beaching events which correspond with relatively short-term increases in ocean temperature. Elevated SST is also an important source of energy for the development of tropical cyclones.

Deoxygenation

Climate change is causing both ocean warming and increased stratification of the upper ocean, leading to deoxygenation of the ocean. This, in turn, is likely to have implications for ocean productivity and marine habitat. The consequences of ocean oxygen decline include decreased biodiversity, shifts in species distributions, displacement or reduction in fishery resources and expanding algal blooms. Globally, ocean oxygen levels are expected to fall on average by 3–4% by 2100 overall due to climate change and increased nutrient discharges, though the scale of effect seen will vary regionally[53]. Under warming scenarios exceeding 4°C (RCP 8.5 as per table 5), ocean oxygen levels in coastal seas could reduce by more than 40%. In contrast, limiting warming to below 1.5°C would limit this decrease to less than 10% and may allow for stabilization and eventual recovery of oxygen levels. Research shows that deoxygenation rates are regionally variable; impacts are already discernible in some parts of the world and are likely to be evident across large regions of the oceans between 2030 and 2040, however other areas may not experience detectable loss of oxygen due to climate change even by 2100. The eastern Pacific region may experience discernible changes in oxygen levels in the 2030s and 2040s while impacts in the west of the region (Melanesia) will not be evident until much later in the century or even into the 2100s[54].

Ocean acidification

The current rate and magnitude of ocean acidification is at least 10 times faster than any event within the last 65 million years[55]. This accelerating rate is caused by human-induced climate change as well as interannual variability driven by ENSO events. ENSO influences the strength and upwelling in the Pacific thereby impacting the ocean carbon content of the upper ocean. Ocean acidification appears to increase more rapidly under El Niño than la Niña conditions[56]. In 2015/16, sea levels during El Niño were depressed in most of the Western Pacific, as much as 40 cm below normal conditions in Micronesia. This exposed many coral reefs, and combined with warmer temperatures compared to normal conditions due to a drought episode, contributed to an unprecedent coral bleaching event[57]. Although there is little consensus on the projected response of ENSO with climate change, it is clear that greater emissions will increase the rate and level of ocean acidification, which in turn will have adverse impacts on ocean life by inhibiting the development of the many marine organisms that produce calcium carbonate shells or skeletons. The impacts of ocean acidification will be magnified by the vital role such organisms can play within food webs, nutrient cycling and in habitat creation (e.g. coral reefs). Anthropogenic CO^2 emissions could result in ocean pH levels being lower than at any time in the last 300 million years. It appears clear that only by limiting warming to 1.5°C can ocean acidification be halted and that in a 2°C world there is little chance of coral reef survival due to the effects of temperature-induced bleaching and ocean acidification[58].

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[52] National Centers for Environmental Information. National Oceanic and Atmospheric Administration. ENSO webpage. Accessed 16/01/2022 and available here.
[53] IUCN (2019) Ocean deoxygenation: Everyone's problem. Causes, impacts, consequences and solutions.
[54] Pringle, P. (2018) Effects of Climate Change on 1.5° Temperature Rise Relevant to the Pacific Islands. Pacific Marine Climate Change Report Card: Science Review 2018, pp 189-200.
[55]
[56] Lenton et al. (2018) Effects of Climate Change on Ocean Acidification Relevant to the Pacific Islands.
[57] SPREP (2016) Regional Statement on the Impacts of the 2015/2016 El Niño and 2016/2017 Climate and Tropical Cyclone Outlook for the Pacific Islands. Published 26 Oct 2016.
[58] Ibid

Drought

One primary type of drought affects Nauru, meteorological drought, usually associated with a precipitation deficit. Drought is the main driver of disaster risk in Nauru, contributing to water scarcity and contamination events, and can last up to 36 months[59]. Typically associated with La Niña meteorological drought is expected to decline in frequency due to projected increases in rainfall totals. However, the poorly understood interaction between climate change and ENSO means there is low confidence in this projection. This uncertainty represents a major risk as there is very high dependence on rainwater for subsistence. Drought may also impact inland aquaculture activities due to the increased risk of evapotranspiration and evaporation.

Cyclones, storm surge and floods

Nauru's proximity to the equator means that formation of cyclones is highly unlikely in its Exclusive Economic Zone. Since records began in the 1970s, no cyclone events have been recorded. Climate change is expected to interact with cyclone hazard in complex ways which are currently poorly understood. Known risks include the action of sea-level rise to enhance the damage caused by cyclone-induced storm surges, and the possibility of increased wind speed and precipitation intensity. Modelling of climate change impacts on cyclone intensity and frequency conducted across the globe points to a general trend of reduced cyclone frequency but increased intensity and frequency of the most extreme events[6061].

One study has suggested that under future climates, cyclone generation will become more frequent during El Niño events, but less frequent during La Niña events[62]. While it is unlikely that cyclone impacts will become a major feature of Nauru's risk profile, further research is required to better understand potential changes in cyclone seasonality and routes, and the potential for cyclone hazards to be experienced in unprecedented locations[63]. Despite being sheltered from cyclones Nauru is still expose to extreme rainfall events which can drive surface flooding and have been linked to prevalence of vector-borne diseases. The risk of flash flooding of this nature is expected to increase in future due both to rising temperatures and increasing average annual precipitation totals.

1.4.2 Climate Historical trends and projections

Nauru's climate varies considerably from year to year due to the ENSO. This is a natural climate pattern that occurs across the tropical Pacific Ocean and affects weather around the world. There are two extreme phases of the ENSO: El Niño and La Niña. There is also a neutral phase. In Nauru, El Niño events tend to bring warmer, wetter conditions than normal, while La Niña events are associated with a delayed onset of the wet season and drier than normal conditions, often resulting in an extended drought. In some years Nauru's climate can be affected by the West Pacific Monsoon. This occurs when the persistent monsoon westerly winds reach as far east as western Kiribati. The West Pacific Monsoon is driven by large differences in temperature between the land and the ocean. It moves north to mainland Asia during the Northern Hemisphere summer and south to Australia in the Southern Hemisphere summer. The influence of the West Pacific Monsoon on Nauru generally varies with the phase and strength of the ENSO and is usually associated with strong El Niño events[64].

HISTORICAL TRENDS

[59] Pacific-Australia Climate Change Science and Adaptation Planning Program (2014) Current and future climate of Nauru.
[60] Walsh, K., McBride, J., Klotzbach, P., Balachandran, S., Camargo, S., Holland, G., Knutson, T., Kossin, J., Lee, T., Sobel, A., Sugi, M. (2015). Tropical cyclones and climate change. WIREs Climate Change: 7: 65–89.
[61] Widlansky, M. J., Annamalai, H., Gingerich, S. B., Storlazzi, C. D., Marra, J. J., Hodges, K. I., Kitoh, A. (2019). Tropical Cyclone Projections: Changing Climate Threats for Pacific Island Defense Installations. Weather, Climate, and Society, 11(1), 3–15.
[62] Chand, S. S., Tory, K. J., Ye, H., & Walsh, K. J. E. (2016) Projected increase in El Niño-driven tropical cyclone frequency in the Pacific, in Nature Climate Change, 7, 123.
[63] World Bank (2021) Climate Change Country Profile.
64 Pacific-Australia Climate Change Science and Adaptation Planning Program (2014) Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports.

The analysis of temperature and precipitation records for Nauru proves difficult due to the unavailability of data. Meteorological observations have been taken by two automatic weather stations since July 2003 and a manual rain gauge near Yaren, the capital. There is also a sub-daily rain gauge near the centre of the island which has been operational since October 2009. Nauru data are available from 1893 to present for rainfall and 1951 to present for air temperature; however, there are significant gaps in both records. The latest NextGen projections report from the Australia-Pacific Climate Partnership (APCP) uses much of the same datasets and information from the Pacific-Australia Climate Change Science and Adaptation Planning (PACCSAP) reports from 2014, with changes in the way data is presented to be more context-specific and detailed[65].

Temperature

Nauru has consistent monthly average temperatures throughout the year which are strongly tied to the surrounding ocean temperature. The wet season usually starts in November and continues to April of the next year, while drier conditions occur from May to October. Nauru's Second National Communication to the UNFCCC[66] suggests temperatures have been rising in the region at around 0.12°C per decade since the 1970s. However, the Berkeley Earth Dataset suggests a slightly more complex picture. Up to the 1990s there was limited warming in the region, but from 1995 that warming accelerated, and temperatures between 2014 and 2018 were averaging around 0.5°C −0.6°C above the long-term average. Nauru regularly experiences high maximum temperatures, with an average monthly maximum of around 31°C[67].

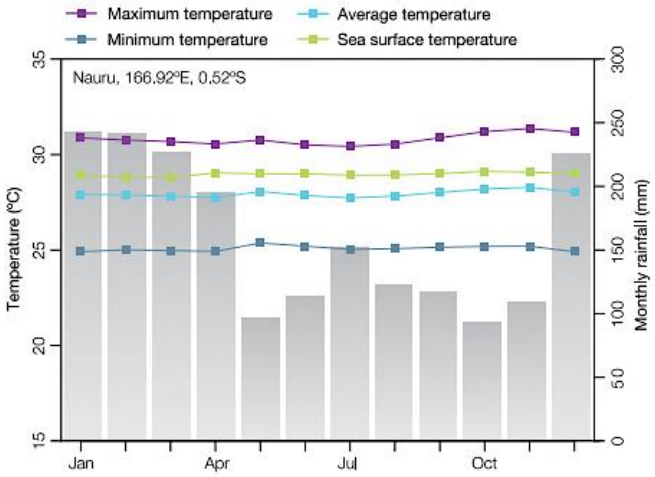

Figure 5 Seasonal rainfall and temperature in Nauru

Precipitation

Notable interannual variability associated with the ENSO has been observed in the South Pacific Convergence Zone (Nauru is situated at the Northwestern edge) since 1927. Observing records over 400 years, it shows abrupt changes of ~1800 mm can occur between wet seasons. Historical rainfall has been very strongly correlated with ENSO, peaking in El Niño years and reducing significantly during La Niña.

Rainfall peaks between December and April, averaging 200 mm per month, then falls to around 100 mm per month between June and November. However, no changes in rainfall patterns significantly outside the range of normal inter-annual variation have been documented and linked to human-

[65] CSIRO and SPREP (2021) 'NextGen' Projections for the Western Tropical Pacific: Current and Future Climate for Nauru. Final report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project.
[66] Republic of Nauru (2014) Second National Communication to UNFCCC.
[67] World Bank (2021) Climate change Country Profile Nauru.

induced climate changes. In other words, annual and half-yearly rainfall trends show little change for Nauru[68].

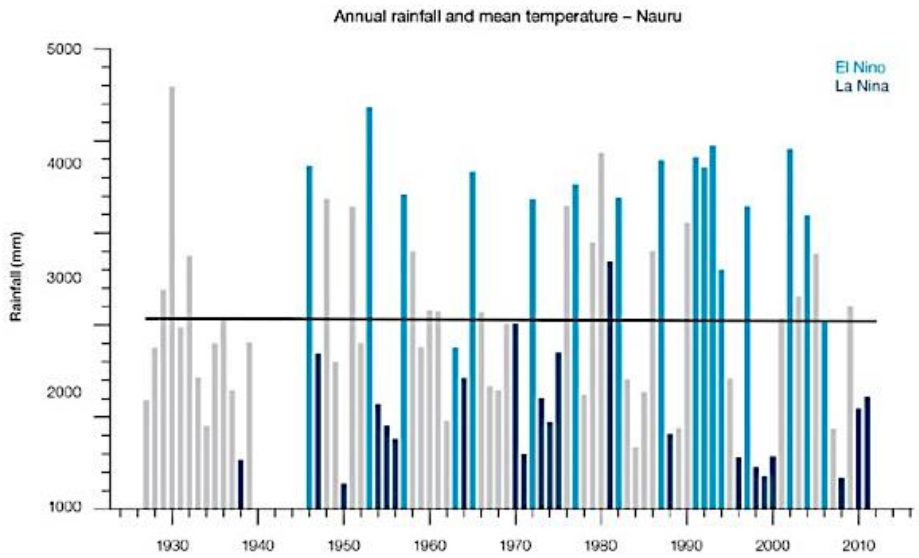

Figure 6 Observed time series of annual total rainfall for Nauru. Light blue, dark blue and grey bars indicate El Niño, La Niña and neutral years respectively. Solid black trend lines indicate least squares fit.

Wind-driven waves

No suitable dataset is available to assess long-term historical trends in the Nauru wave climate[69]. Variability of wind-waves at Nauru is characterised by trade winds seasonally, and the El Niño–Southern Oscillation from year to year. In June to September, swell waves are from the south resulting from extratropical storms, while in December to March waves are also observed from the west due to monsoon systems and from the north due to North Pacific extra-tropical storms. Wave heights are largest during the wet season period from December to April. During La Niña years, wave power is approximately 30% greater than during El Niño years in June–September, and waves are more strongly directed from the east year-round, associated with increased trade wind speeds.

		Hindcast Reference Data (1979–2009)	Climate Model Simulations (1986–2005)
Wave Height (metres)	December–March	1.5 (1.1–2.0)	1.7 (1.4–2.0)
	June–September	1.2 (0.9–1.7)	1.2 (1.1–1.4)
Wave Period (seconds)	December–March	9.3 (7.5–11.6)	8.4 (7.5–9.7)
	June–September	8.6 (7.0–10.3)	7.9 (7.1–8.6)
Wave Direction (degrees clockwise from North)	December–March	30 (320–70)	40 (20–60)
	June–September	130 (100–180)	120 (100–140)

Figure 7 Mean wave height, period and direction from which the waves are travelling near Nauru in Dec-March and June-September. Observation (hindcast) and climate model simulation mean values are given with the 5-95th percentile range in brackets. Historical model simulations are given for comparison with projections. A compass relating number of degrees to cardinal points is shown.

[68] Pacific-Australia Climate Change Science and Adaptation Planning Program (2014) Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports.
[69] Ibid.

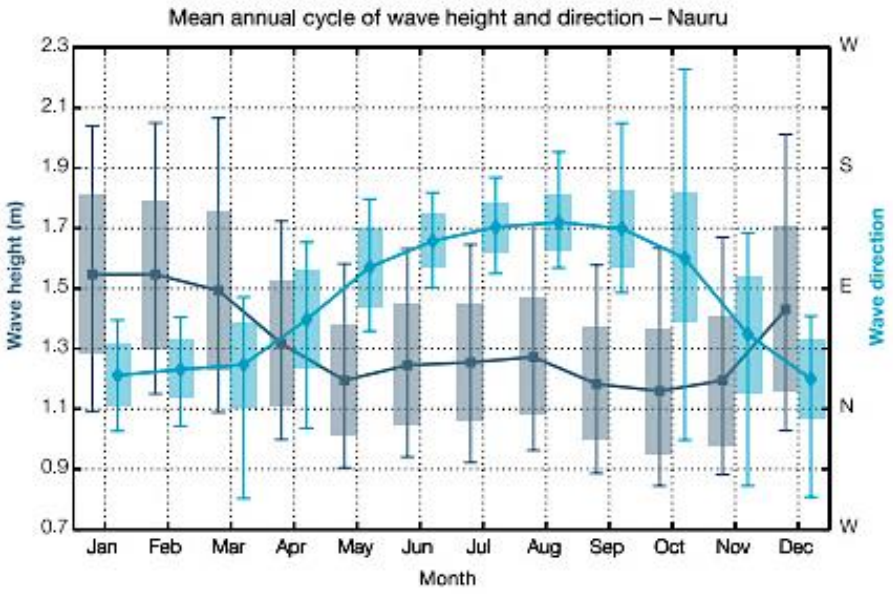

Figure 8 Annual cycle of wave height (grey) and wave direction (blue) at Nauru based on data from 1979-2009. The shaded boxes represent one standard deviation around the monthly means, and the error bars indicate the 5-95% range, showing the year-to-year variability in wave climate. The direction from which the waves are travelling is shown (not the direction towards which they are travelling).

Extreme events

The main climate extremity experienced by Nauru is drought, which can last as long as three years[70,71]. Droughts usually occur during La Niña events when the surrounding sea temperature is lower, resulting in less cloud and rainfall. Tropical cyclone formation within the Nauru EEZ is highly unlikely due to the island's proximity to the equator. There are no events on record, based on tropical cyclone data available from 1969/70 for the Southern Hemisphere and from 1977 for the Northern Hemisphere.

Sea-level rise

The sea-level rise near Nauru measured by satellite altimeters since 1993 is about 5 mm per year, slightly higher than the global average of 3.2 ± 0.4 mm per year[72].

PROJECTIONS

Temperature

Projections for all emissions scenarios show that temperatures will continue to rise in Nauru. Under the high emissions scenario the increase in temperature is projected to be in the range of between 0.3°C -1.3°C by 2030 but after 2030 there is a growing difference in warming between each RCP. For example, in Nauru by 2090, a warming of 2.0 to 4.5°C is projected for RCP8.5 while a warming of 0.6 to 1.5°C is projected for RCP2.6. See Figure 10 for ranges of projections in temperature change according to different emissions scenarios. It is worth noting that temperature increases under RCP8.5 reflect the moderating effect of large amounts of nearby ocean cover. However, this ocean cover can also distort model simulations, and the current iteration of global models does not have the spatial accuracy to reliably capture climate processes over small island states; as such these projections should be approached with caution.

The increase in temperature will result in an increase in the number of hot days and warm nights and an increase in the average annual and seasonal rainfall over the entire course of the 21st century.

[70] Republic of Nauru (2014) Second National Communication to UNFCCC.
[71] Republic of Nauru (2015) Framework for Climate Change Adaptation and Disaster Risk Reduction (RONAdapt)
[72] Pacific-Australia Climate Change Science and Adaptation Planning Program (2014) Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports.

Projections are expected to push temperatures above 33°C on a regular basis. When combined with the high levels of humidity experienced in Nauru this suggests an increased risk of temperatures which are dangerous for the human body[73]. Projected rises in maximum and minimum temperatures are of a similar magnitude. While relatively warm and cool years and decades will still occur due to natural variability, there is projected to be more warm years and decades on average in a warmer climate (Table 6).

Table 6. Nauru's temperature change projections (C°) under four emissions pathways. Projected changes over 1986-2005 baseline for 20-year periods centered on 2050 and 2090[74][75]

Scenario	Mean Surface Air Temperature (Annual)		Maximum temperature (1-in-20-year event)		Minimum temperature (1-in-20-year event)	
	2050	2090	2050	2090	2050	2090
RCP2.6	0.9 (0.6 – 1.4)	0.9 (0.6 – 1.5)	0.7 (0.2 – 1.2)	0.8 (0.4 – 1.3)	0.8 (0 – 1.6)	0.8 (0.4 – 1.2)
RCP4.5	1.1 (0.6 – 1.5)	1.5 (1.1 – 2.5)	0.9 (0.5 – 1.3)	1.4 (0.8 – 2.2)	1 (0.6 – 1.3)	1.4 (0.8 – 2.1)
RCP6.0	1 (0.7 – 1.6)	1.9 (1.1 – 3)	N/A	N/A	N/A	N/A
RCP8.5	1.5 (1 – 2.2)	3 (2 – 4.5)	1.5 (0.8 – 2.4)	3 (1.9 – 4.4)	1.5 (0.8 – 2.8)	3 (2 – 4.3)

An additional factor for consideration is the potential for marine heat waves. Research has identified the Western Tropical Pacific as a global hotspot for climate change impacts on marine heat waves. Marine heat waves are projected to extend their spatial footprint and to grow in duration and intensity. The consequences of this trend may be serious for marine ecosystems in the region (and the livelihoods dependent on them), which are adapted to survive under very stable temperature regimes[76]. In a 2°C warmer world relative to the pre-industrial baseline, Nauru is projected to be similar to or a little less than the global average: 1.4 to 2.2°C warmer compared to the pre-industrial baseline (or 0.8 to 1.5°C from the 1986-2005 baseline). The ratio is similar for other warming levels, shown in Figure 9 below.

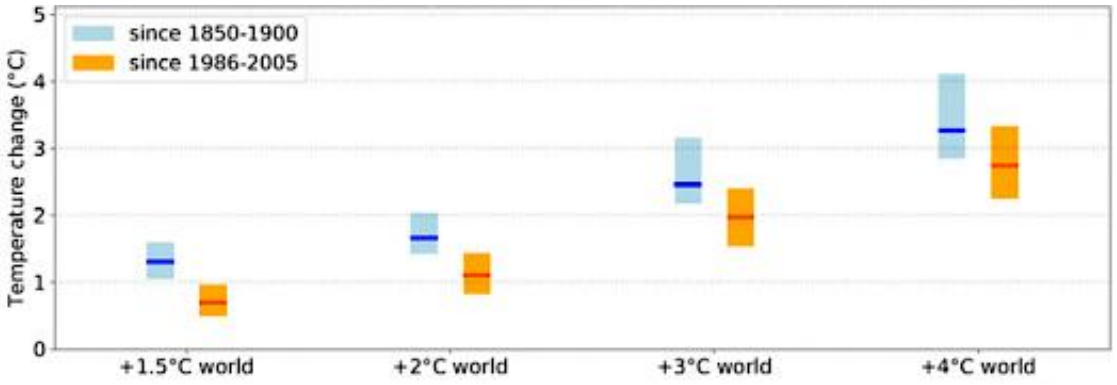

Figure 9 Change in the average annual temperature of Nauru region at different global warming levels, from the 1850-1900 baseline and from the more recent baseline 1986-2005 (10th-90th percentile range)[77]

[73] World Bank (2021) Climate Risk Country Profile Nauru.
[74] Ibid.
[75] Note: The 5th and 95th percentiles are provided in brackets.
[76] Frölicher, T. L., Fischer, E. M., & Gruber, N. (2018). Marine heatwaves under global warming. Nature, 560 (7718), 360–364.
[77] CSIRO and SPREP (2021) 'NextGen' Projections for the Western Tropical Pacific: Current and Future Climate for Nauru. Final report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project.

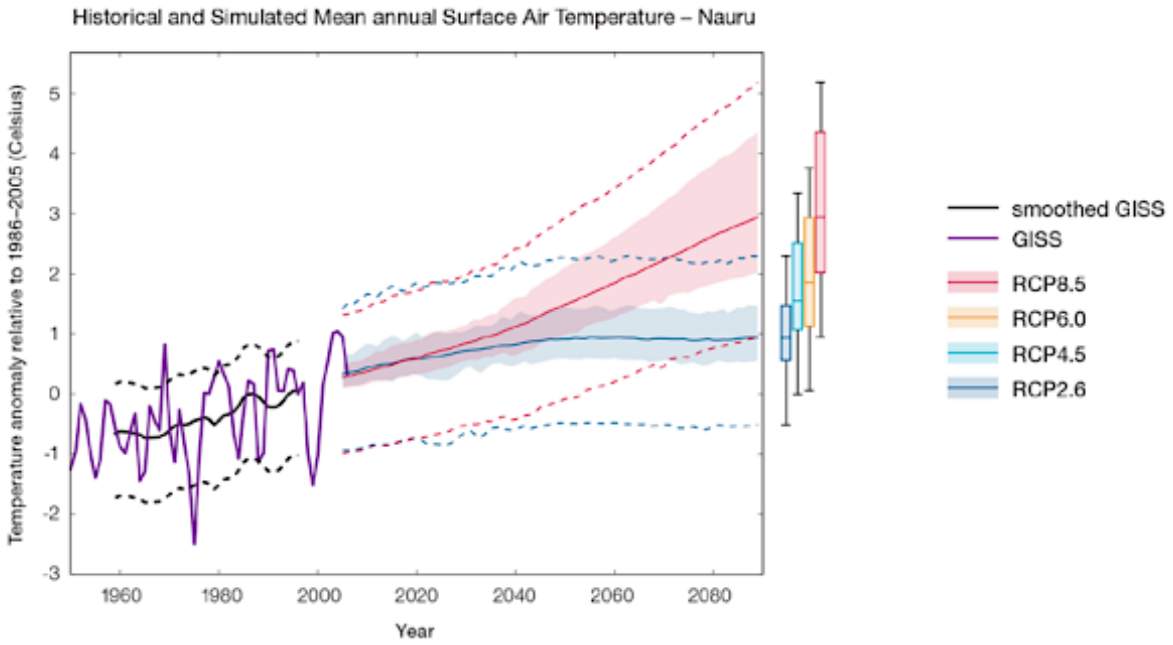

Figure 10 Historical and simulated surface air temperature time series for the region surrounding Nauru. The graph shows the anomaly (from the base period 1986–2005) in surface air temperature from observations (the GISS dataset, in purple), and for the CMIP5 models under the very high (RCP8.5, in red) and very low (RCP2.6, in blue) emissions scenarios. The solid red and blue lines show the smoothed (20-year running average) multi-model mean anomaly in surface air temperature, while shading represents the spread of model values (5–95th percentile). The dashed lines show the 5–95th percentile of the observed interannual variability for the observed period (in black) and added to the projections as a visual guide (in red and blue). This indicates that future surface air temperature could be above or below the projected long-term averages due to interannual variability. The ranges of projections for a 20-year period centered on 2090 are shown by the bars on the right for RCP8.5, 6.0, 4.5 and 2.6[78].

Precipitation

Almost all of the global climate models project an increase in average annual and seasonal rainfall over the course of the 21st century. Wet season (November-April), dry season (May-October) and annual average rainfall are projected to increase over the course of the 21st century. Projected increases in rainfall are consistent with the expected intensification of the South Pacific Convergence Zone, Inter tropical Convergence Zone and the West Pacific Monsoon. However, there is some uncertainty in the rainfall projections and not all models show consistent results. Interannual variability in rainfall over Nauru is strongly influenced by ENSO in the current climate. As there is no consistency in projections of future ENSO activity, it is not possible to determine whether interannual variability in rainfall will change in the future. Table 7 below provides a summary of projected seasonal rainfall change for Nauru under four emissions scenarios.

Table 7 Projected seasonal rainfall change for Nauru under four emissions scenarios

Scenario	2040-2059		2080-2099	
	Jun-Aug	Dec-Feb	Jun-Aug	Dec-Feb
RCP2.6	1.2 (-0.8, 3.1)	1.5 (0.1, 3.0)	1.2 (-0.8, 3.2)	1.4 (-0.2, 3.0)
RCP4.5	1.7 (-0.6, 3.4)	1.9 (0.3, 3.5)	2.3 (0.1, 4.5)	2.7 (1.2, 4.4)
RCP6.0	1.5 (-0.6, 3.2)	1.7 (0.2, 3.2)	2.9 (0.9, 5.0)	3.4 (1.7, 5.3)
RCP8.5	2.3 (0.2, 4.1)	2.5 (1.0, 4.1)	4.9 (2.2, 7.1)	5.4 (3.5, 7.3)

[78] Pacific-Australia Climate Change Science and Adaptation Planning Program (2014) Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports.

Droughts are projected to become less frequent throughout this century. The frequency of moderate drought is projected to decline from two to three times every 20 years in 2030 to once to twice every 20 years in 2090 for all emissions scenarios, while severe droughts are expected to decline from once to twice to once every 20 years over the same periods[79].

Figure 11 below illustrates the historical and simulated annual rainfall for Nauru.

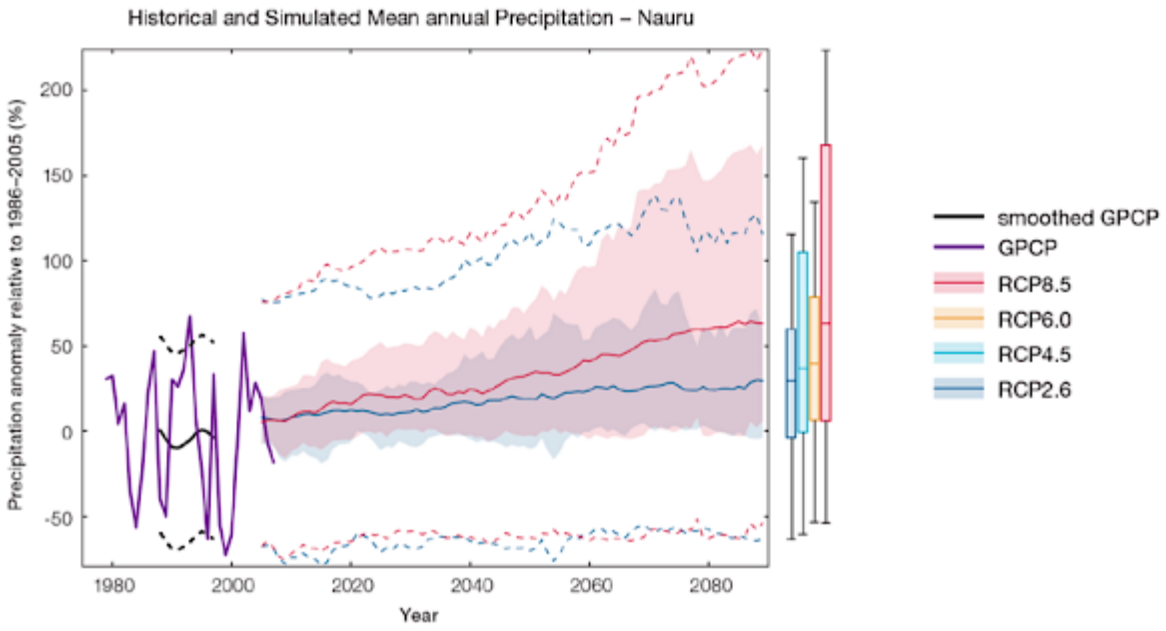

Figure 11 Historical and simulated annual average rainfall time series for the region surrounding Nauru. The graph shows the anomaly (from the base period 1986-2005) in rainfall from observations (in purple), and for the CMIP5 models under RCP8.5 (in red), RCP2.6 (in blue) emission scenarios. The solid red and blue lines show the smoothed (20-year running average- multi-model mean anomaly in rainfall, while shading represents the spread of model values (5-95th percentile). The dashed lines show the 5-95th percentile of the observed interannual variability for the observed period (in black) and added to the projections as a visual guide (in red and blue). This indicates that future rainfall could be above or below the projected long-term averages due to interannual variability. The ranges of projections for a 20-year period centered on 2090 are shown by the bars on the right for RCP8.5, 6.0, 4.5 and 2.6.

[79] PACCSAP (2013) Chapter 8. Nauru profile.

	2030	2050	2070	1.5°C global warming	2°C global warming	3°C global warming	4°C global warming
Temperature from 1986-2005 (°C)	0.7 (0.4 to 1.2)	0.9 (0.6 to 1.4)	0.9 (0.5 to 1.4)	0.7 (0.5 to 1.1)	1.1 (0.8 to 1.5)	2.0 (1.6 to 2.6)	2.7 (2.2 to 3.3)
		1.5 (1.0 to 2.2)	2.3 (1.5 to 3.5)				
Annual rainfall from 1986-2005 (%)	18 (-7 to 52)	19 (-9 to 56)	25 (5 to 72)	12 (-3 to 50)	19 (6 to 53)	23 (3 to 85)	47 (11 to 129)
		32 (-3 to 69)	52 (-2 to 142)				
May-Oct rainfall from 1986-2005 (%)	24 (-8 to 90)	24 (-4 to 63)	31 (-3 to 93)	15 (5 to 56)	24 (10 to 63)	37 (13 to 134)	61 (21 to 188)
		41 (7 to 107)	73 (2 to 212)				
Nov-Apr rainfall from 1986-2005 (%)	11 (-16 to 46)	16 (-17 to 47)	21 (-8 to 59)	9 (-10 to 35)	14 (-9 to 44)	19 (-9 to 80)	27 (-1 to 112)
		26 (-12 to 74)	35 (-12 to 105)				

Figure 12 Summary of projected changes in Nauru for average annual temperature and rainfall. Median changes are given, with the 10-90 percentile uncertainty range in brackets. Changes are for 20-year periods centered on 2030, 2050 and 2070, relative to 1986-2005, for RCP2.6 in green, and RCP8.5 in red. In 2030, changes are similar for low and high emissions.

Sea level rise

Research since 2014 was assessed in the IPCC (2019) Special Report on Oceans and Cryosphere in a Changing Climate (SROCC). Under a high global emissions pathway, the research suggested that Antarctic ice sheets may contribute to greater SLR this century than previously thought. Sea level projections that incorporate the higher Antarctic contribution have been evaluated for Nauru and show a rise of between approximately 0.09-0.18 m by 2030 (very similar values for different RCPs and also similar to the PACCSAP projections), and an increase of 0.66 to 1.22 m by 2100 under RCP8.5. Interannual variability of sea level will lead to periods of lower and higher regional sea levels. In the past, this interannual variability (after removal of the seasonal signal) has been about 0.23 m (5–95% range; see dashed lines in Figure 13) and it is likely that a similar range will continue through the 21st century[80].

[80] CSIRO and SPREP (2021) 'NextGen' Projections for the Western Tropical Pacific: Current and Future Climate for Nauru. Final report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project.

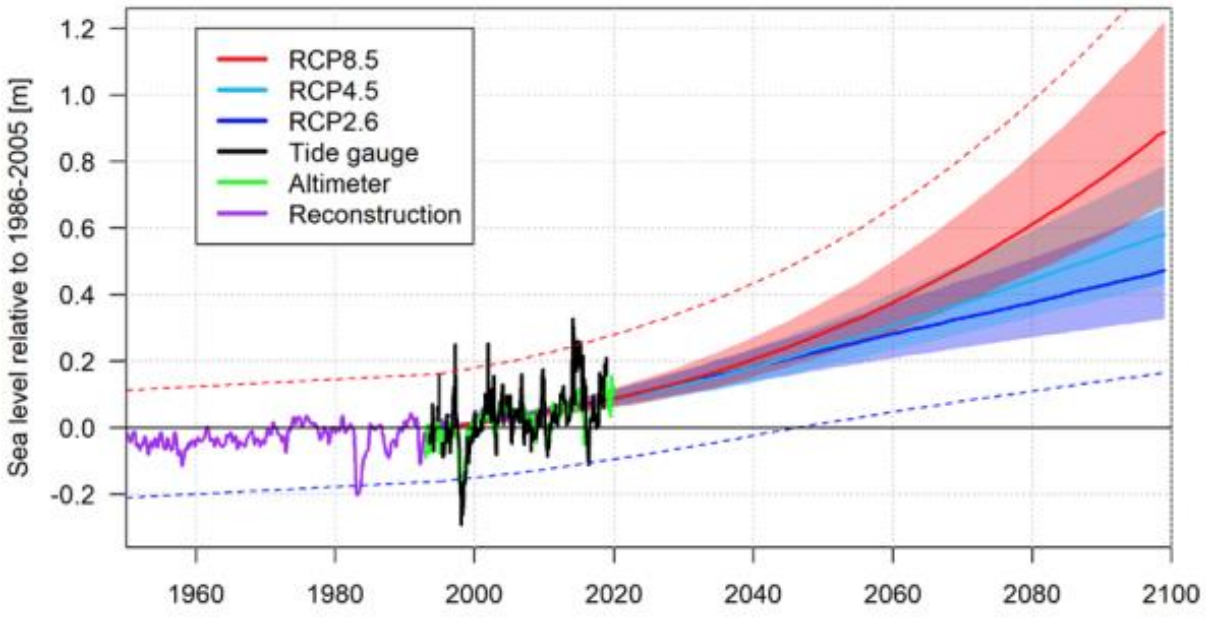

Figure 13 Sea level projections for Nauru. The tide gauge record of relative sea level at Nauru is indicated in black, the satellite record in green and reconstructed sea level data is shown in purple, all are monthly means without seasonal cycles and referenced to mean sea level between 1986-2005. Multi-model mean projections from 1995-2100 are given for the RCP8.5 (red solid line), RCP4.5 (cyan solid line) and RCP2.6 emissions scenarios (blue solid line), with the 5-95% uncertainty range for RCP8.5 and RCP2.6 shown by the red and blue shaded regions respectively. The dashed lines are an estimate of interannual variability in sea level (5-95% uncertainty range) and indicate that individual monthly averages of sea level can be above or below longer-term averages.

Year	RCP2.6	RCP4.5	RCP8.5
2030	0.13 (0.10-0.17)	0.12 (0.09-0.16)	0.13 (0.10-0.18)
2040	0.18 (0.13-0.23)	0.17 (0.13-0.23)	0.20 (0.15-0.26)
2050	0.23 (0.17-0.30)	0.24 (0.18-0.31)	0.28 (0.21-0.36)
2060	0.28 (0.21-0.37)	0.30 (0.23-0.39)	0.37 (0.28-0.49)
2070	0.32 (0.24-0.44)	0.37 (0.28-0.49)	0.47 (0.36-0.63)
2080	0.37 (0.27-0.50)	0.44 (0.33-0.58)	0.60 (0.46-0.80)
2090	0.42 (0.30-0.58)	0.51 (0.38-0.68)	0.73 (0.55-1.00)
2100	0.47 (0.33-0.66)	0.58 (0.43-0.79)	0.89 (0.66-1.22)

Table 8 Median sea level projections for Nauru with 5-95% range relative to 1986-2005 for RCPs 2.6, 4.5 and 8.5 (in meters)

Ocean acidification

Future changes in ocean pH and aragonite saturation will largely depend on the atmospheric concentration of CO2. These values are also affected, to a smaller extent, by changes in water temperature and salinity. Based on the RCP8.5 scenario, tropical Pacific pH is projected to decrease by a further 0.15 units from the historical 1986–2005 period into the 2040–2060 period (averaged between 15°S to 15°N and 120°E to 280°E). Moreover, dramatic changes in aragonite saturation are also projected to occur (Figure 15 shows aragonite saturation levels for the Pacific region, and Figure 14 for Nauru)[81]. Saturation levels greater than 4 are considered optimal for coral calcification, while

[81] J. Johnson, J. Bell & A. Sen Gupta (2015) Pacific Islands Ocean Acidification Vulnerability Assessment.

levels less than 3.5 are considered very low for a healthy reef system to continue reef-building[82]. Saturation levels less than 3 are considered extremely marginal for growth of corals, with no major reef systems currently found at locations with these levels. Model projections suggest that by mid-century, the entire tropical Pacific region will have shifted to sub-optimal conditions, with aragonite saturation levels between 3 and 3.5. This represents a drop of approximately 0.6 in the tropical region, corresponding to a decline in coral calcification rate of about 10%[83]. The projections[84] relating to aragonite saturation levels for the Pacific can be summarized as follows:

- **For 2030,** all pathways show a similar decrease in pH and aragonite saturation state, consistent with all of the emissions pathways showing similar atmospheric CO2 concentrations. By 2030, the median value of aragonite saturation state in the Central Equatorial Pacific areas has already started to shift from good to marginal conditions for corals.

- **By 2050** as atmospheric CO2 concentrations start to stabilize under the low emissions pathway (RCP2.6) the ocean acidification also starts to stabilize. In contrast under medium (RCP4.5) and high (RCP8.5) emissions, atmospheric concentrations continue to increase and the rate and magnitude of ocean acidification continues to increase. While the conditions for coral remain marginal, some areas in the Central Pacific have started to transition to values of aragonite saturation of less than 3, a value considered to be very marginal for long-term coral viability.

- **By 2100,** atmospheric CO2 concentrations have stabilized under low and medium emission pathways (RCPs 2.6 and 4.5 respectively). In the low emission scenario (RCP2.6), the surface pH and aragonite saturation state in 2100 are similar to the values projected for 2030. Under RCP4.5 scenario, pH and aragonite state values stabilized to values that are marginal for most corals across the Pacific, with very marginal conditions in the Central Pacific (where present-day values are low). In contrast, under the high emission scenario (RCP8.5) the entire Equatorial Pacific will experience conditions that are very marginal for coral and it is likely coral reefs will disappear from most of the Equatorial Pacific region.

[82] Langdon and Atkinson 2005
[83] Chan and Connolly (2013)
[84] Lenton et al. (2018) Effects of Climate Change on Ocean Acidification Relevant to the Pacific Islands, in Science Review, pp. 31-42.

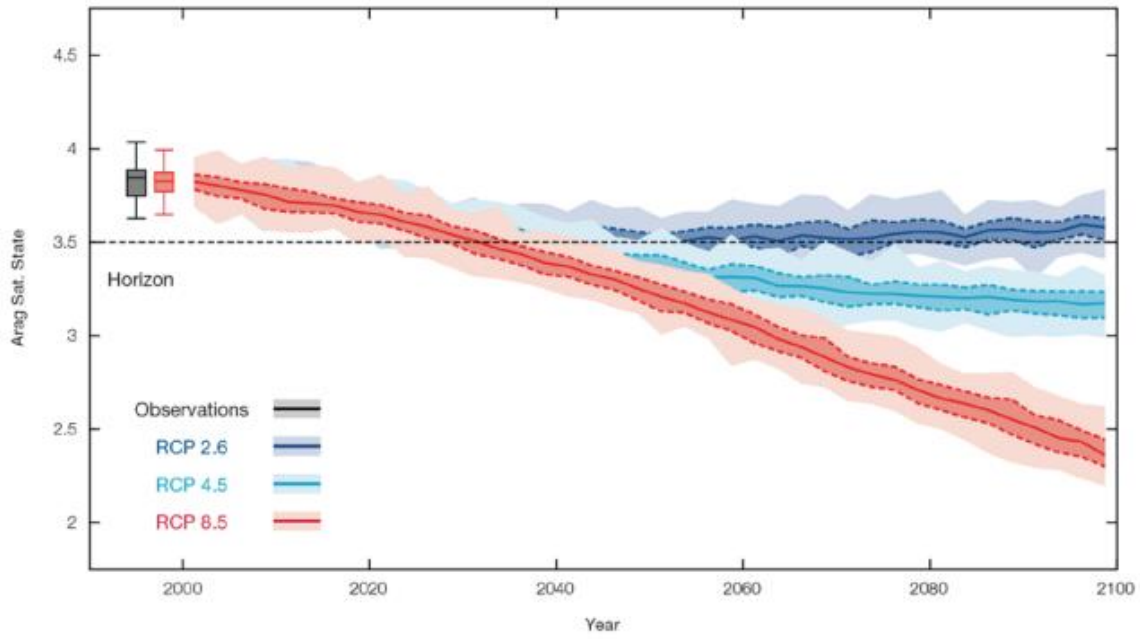

Figure 14 Projected decreases in aragonite saturation state in Nauru from CMIP5 models under RCP2.6, 4.5 and 8.5. Shown are the median values (solid lines), the interquartile range (dashed lines), and 5% and 95% percentiles (light shading). The horizontal line represents the transition to marginal conditions for coral reef health[85].

[85] Pacific-Australia Climate Change Science and Adaptation Planning Program (2014) Climate Variability, Extremes and Change in the Western Tropical Pacific: New Science and Updated Country Reports.

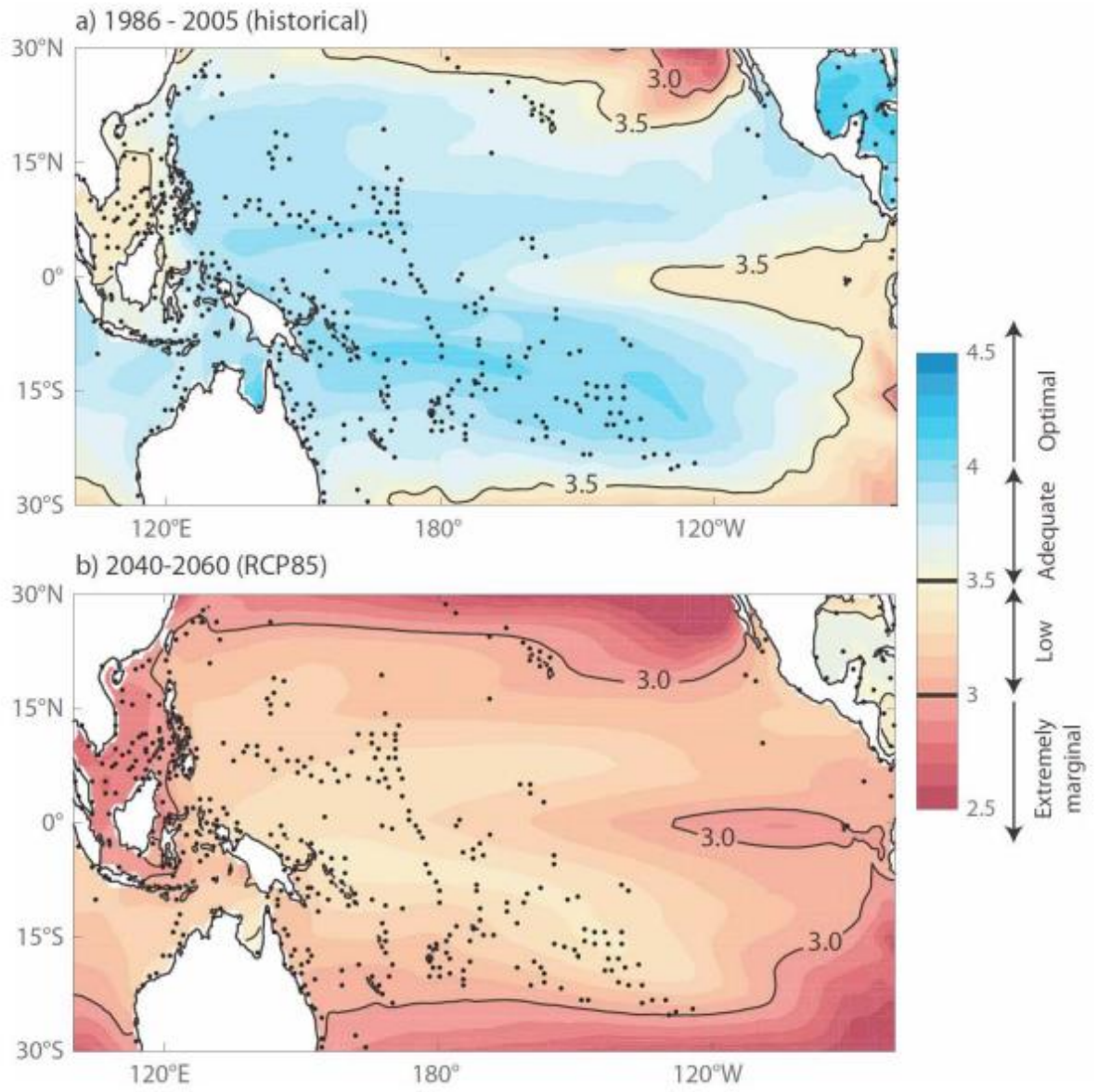

Figure 15 Aragonite saturation state for the periods (a) 1986-2005 (based on multi-model median from the CMIP5 historical simulations) and (b) 2040-2060 (based on RCP8.5 simulations). Contour lines of 3 and 3.5 are superimposed. Black dots indicate location of coral reefs.

Wind-driven Waves[86]

In Nauru, during December–March (in the wet season), projected changes in wave properties include a decrease in wave height accompanied by a decrease in wave period and a possible small anticlockwise rotation (more northerly waves) (low confidence). These features are characteristic of a decrease in strength of the north-easterly trade winds. This change is only statistically significant by the end of the century in a high emission scenario and only in March, with a projected decrease in wave height of approximately 15 cm. In June–September (the dry season), there are no statistically significant projected changes in wave properties (low confidence). Non-significant changes include a possible increase in wave height, a small decrease in period, and a clockwise rotation of direction (more southerly waves). A projected decrease in the height of larger waves is suggested (low confidence). There is low confidence in projected changes in the Nauru wind-wave climate because:

[86] Ibid.

- *Projected changes in wave climate are dependent on confidence in projected changes in ENSO, which is low*
- *The differences between simulated and observed (hindcast) wave data can be larger than the projected wave changes, which further reduces our confidence in projections.*

Conclusion

In light of the analysis provided above, the conclusion of climate change projections can be summarised as follows, with key climate variables displaying the greatest impacts ***in bold****:*

- **Annual mean temperatures and extremely high daily temperatures will continue to rise (very high confidence);**
- **Sea level will continue to rise (very high confidence);**
- **Ocean acidification is expected to continue (very high confidence); as a result, the risk of coral bleaching will increase in the future (very high confidence);**
- **Mean rainfall is projected to increase (medium confidence), along with more extreme rain events (high confidence);**
- Droughts are projected to decline in frequency (medium confidence);
- Wave height and period are projected to decrease in December–March (low confidence). No significant changes are projected in June–September (low confidence).
- El Niño and La Niña events will continue to occur in the future (very high confidence), but there is little consensus on whether these events will change in intensity or frequency.

Summarised detailed projected changes in the annual and seasonal mean climate for Nauru under four emissions scenarios can be found in Figure 16 *below.*

Variable	Season	2030	2050	2070	2090	Confidence (magnitude of change)
Surface air temperature (°C)	Annual	0.7 (0.4 to 1)	0.9 (0.6 to 1.4)	0.9 (0.5 to 1.4)	0.9 (0.6 to 1.5)	*Medium*
		0.7 (0.4 to 1.2)	1.1 (0.6 to 1.5)	1.4 (0.8 to 2.1)	1.5 (1.1 to 2.5)	
		0.7 (0.4 to 1)	1 (0.7 to 1.6)	1.5 (0.9 to 2.3)	1.9 (1.1 to 3)	
		0.9 (0.5 to 1.2)	1.5 (1 to 2.2)	2.3 (1.5 to 3.5)	3 (2 to 4.5)	
Maximum temperature (°C)	1-in-20 year event	0.6 (0.1 to 1.1)	0.7 (0.2 to 1.2)	0.8 (0.4 to 1.4)	0.8 (0.4 to 1.3)	*Medium*
		0.6 (0.2 to 0.9)	0.9 (0.5 to 1.3)	1.2 (0.6 to 1.8)	1.4 (0.8 to 2.2)	
		NA (NA to NA)	NA (NA to NA)	NA (NA to NA)	NA (NA to NA)	
		0.9 (0.4 to 1.2)	1.5 (0.8 to 2.4)	2.3 (1.4 to 3.5)	3 (1.9 to 4.4)	
Minimum temperature (°C)	1-in-20 year event	0.7 (0.3 to 1)	0.8 (0 to 1.6)	0.8 (0.2 to 1.6)	0.8 (0.4 to 1.2)	*Medium*
		0.6 (0.2 to 0.9)	1 (0.6 to 1.3)	1.2 (0.6 to 1.6)	1.4 (0.8 to 2.1)	
		NA (NA to NA)	NA (NA to NA)	NA (NA to NA)	NA (NA to NA)	
		0.8 (0.4 to 1.3)	1.5 (0.8 to 2.8)	2.4 (1.5 to 3.6)	3 (2 to 4.3)	
Total rainfall (%)	Annual	11 (-7 to 27)	19 (-9 to 56)	25 (5 to 72)	30 (-4 to 60)	*Low*
		18 (2 to 40)	24 (1 to 61)	33 (0 to 84)	37 (-1 to 105)	
		18 (-1 to 38)	26 (2 to 49)	29 (4 to 65)	40 (6 to 79)	
		21 (1 to 52)	32 (-3 to 69)	52 (-2 to 142)	63 (6 to 168)	
Total rainfall (%)	Nov-Apr	7 (-16 to 27)	16 (-17 to 47)	21 (-8 to 59)	28 (-9 to 60)	*Low*
		15 (-4 to 41)	19 (-7 to 50)	26 (-3 to 65)	27 (-7 to 90)	
		18 (-3 to 46)	24 (-11 to 50)	25 (-11 to 57)	34 (-12 to 83)	
		13 (-4 to 32)	26 (-12 to 74)	35 (-12 to 105)	45 (-7 to 139)	
Total rainfall (%)	May-Oct	16 (-1 to 51)	24 (-4 to 63)	31 (-3 to 93)	31 (-2 to 76)	*Low*
		22 (-1 to 50)	32 (3 to 108)	43 (0 to 128)	48 (10 to 143)	
		17 (-8 to 43)	28 (-7 to 73)	33 (-4 to 80)	48 (8 to 100)	
		32 (5 to 90)	41 (7 to 107)	73 (2 to 212)	86 (3 to 202)	
Aragonite saturation state (Ωar)	Annual	-0.3 (-0.6 to -0.1)	-0.4 (-0.7 to -0.1)	-0.4 (-0.6 to -0.1)	-0.3 (-0.6 to -0.1)	*Medium*
		-0.3 (-0.6 to 0.0)	-0.5 (-0.8 to -0.2)	-0.6 (-0.9 to -0.4)	-0.7 (-1.0 to -0.4)	
		NA (NA to NA)	NA (NA to NA)	NA (NA to NA)	NA (NA to NA)	
		-0.3 (-0.6 to -0.1)	-0.6 (-0.9 to -0.4)	-1.0 (-1.3 to -0.7)	-1.4 (-1.6 to -1.1)	
Mean sea level (cm)	Annual	12 (8–17)	22 (14–30)	32 (19–45)	42 (24–60)	*Medium*
		12 (7–17)	22 (14–31)	35 (22–48)	48 (29–68)	
		12 (7–16)	22 (14–30)	34 (21–48)	49 (30–69)	
		13 (8–18)	25 (17–34)	42 (28–58)	63 (41–89)	

Figure 16 Projected changes in the annual and seasonal mean climate for Nauru under four emissions scenarios; RCP 2.6 in dark blue, RCP4.5 in light blue, RCP6.0 in orange and RCP8.5 in red. Projected changes are given for four 20-year periods centered on 2030, 2050, 2070 and 2090, relative to 1995. NA indicates where data are not available.

1.4.3 Climate change risks and impacts

In light of the climate analysis above, there are five main climate change impact categories relevant to Nauru's fisheries and aquaculture sector:

- Impacts on coastal small-scale fisheries, which include declines in reef fisheries populations
- Impacts on oceanic commercial fisheries, which include changes in the distribution of large pelagic fish stocks
- Impacts on coastal and marine ecosystems, which include habitat decline due to coral bleaching and loss of biodiversity
- Impacts on aquaculture, which may be negative or positive depending on fish species and locations, include extended growing seasons for warmer water species, and increased number of available species for production
- Impacts of health and livelihoods, which include heat-related mortality, higher incidence of NCDs, and decrease in nutritional quality of food.

Climate change is expected to have profound effects on the status and distribution of coastal and oceanic habitats, the fish and invertebrates they support and, as a result, the productivity of fisheries and aquaculture, and the health and livelihoods of local communities.

impacts on coastal small-scale fisheries

In the Pacific Islands region, fish and invertebrates (specifically shellfish) fulfil important ecological roles in coastal and oceanic habitats, and provide a source of food, nutrition and income for communities.

Four prominent categories of fish and invertebrates can be identified in the Pacific Islands region:

- Demersal, or bottom-dwelling fish (including shallow- and deep-water species)
- Shellfish (crustaceans, molluscs and echinoderms (in shallow subtidal and intertidal habitats)
- Pelagic species (often dominated by tuna and tuna-like species)
- Sharks and rays.

Table 9 below provides an overview of the four main fish and invertebrates categories in the Pacific region as well as a description of their status and expected climate change impacts.

Table 9 Description and status of fish and invertebrates categories in the Pacific Island region and associated climate change impacts[87]

Fish category	Description and status	Climate change impacts
Demersal fish	There are approximately 7,000 species of fish in the Pacific islands region, and demersal fish are a key component of coastal ecosystems. They have specialised roles in reef ecosystems that include corallivores that eat corals (e.g. butterflyfish), herbivores that eat algae (e.g. rabbitfish), generalist species (e.g. damselfish), and predators (e.g. groupers). A range of families of demersal fish are harvested for subsistence and for local sale in the Pacific Islands region, the most common being parrotfish (Scaridae), surgeonfish (Acanthuridae), trevallies and scads (Carangidae), soldierfish and squirrelfish (Holocentridae), wrasse (Labridae), emperors (Lethrinidae), snappers (Lutjanidae), mullet and goatfish (Mullidae), groupers (Serranidae), and rabbitfish (Siganidae). The status of demersal fish stocks is not well known in many PICTs due to lack of regular fisheries data collection. In-water assessments at 63 sites across 17 PICTs conducted in the early to mid-2000s found that demersal fish populations at 54% of sites were in 'average-to-low' or 'poor' condition. In addition, fishing impacts are evidenced by small average sizes of key species, targeting of juveniles, and fishing down the food web (i.e. disproportionately fewer higher-order species; predators) in many PICTs.	**Increasing thermal stress** has been observed to have both indirect and direct impacts on demersal fish and invertebrates in the Pacific Islands region. Many coral reef fishes appear to be living very close to their upper thermal optimum, such that any significant increases in ocean temperature will constrain metabolic performance, with effects on movement, prey capture, reproduction and growth. Demersal fish and invertebrate species dependent on reef habitats are unlikely to occur on reefs where their thermal optima no longer overlap. Conversely, tuna and other mobile pelagic fish are expected to be able to move more easily to areas with optimal thermal conditions. Indirect impacts include **habitat declines due to coral bleaching** that have been shown to impact reef fish and invertebrate populations over time (discussed in more detail in Section "Impacts on coastal and marine ecosystems" below). Extensive coral bleaching was reported across much of the Pacific in 2015–2016, with associated bleaching of giant clams. As live coral cover declines, abundances of coral-dependent demersal fish and invertebrate species are expected to decrease. Generalist demersal fish species, such as emperors, snappers and goatfish, are not likely to be affected significantly, at least in the short-term, because they use a range of habitats. In contrast, the proportions of herbivorous demersal fish species, including surgeonfish, parrotfish and rabbitfish, are likely to increase as the cover of live coral declines and macroalgae increases. Declines in diversity and abundance of coral reef fishes due to coral bleaching have been observed elsewhere, and it is likely that these events had significant effects on local fish communities in the region. At the same time, mass fish kills were observed on the Coral Coast of Fiji and in Vanuatu. In both locations, water temperatures on reef flats were reported to be consistently over 30°C and in Fiji as high as 35°C. The influence of higher water temperatures on oxygen concentrations are thought to be responsible for this mass fish mortality. **Ocean acidification** is expected to affect calcifying invertebrates, including molluscs, crustaceans and echinoderms because, like corals, their shells, exoskeletons or skeletal elements are composed of aragonite (or high-
Invertebrates (shellfish)	Many invertebrate species are harvested in the Pacific islands for subsistence, sale at local markets and/or export. For the purpose of the analysis we consider only those that are important for coastal fisheries and aquaculture – crustaceans, molluscs and Echinoderms. Harvesting of sea cucumbers to supply the bêche-de-mer (dried sea cucumber) export trade supports livelihoods across the region. However, the ease with which sea cucumbers can be collected and their high value has led to widespread overfishing, with fisheries in many PICTs now closed. Bivalve molluscs, in particular giant clams and ark shells, are among the most commonly harvested invertebrates in PICTs. The largest of the giant clams, Tridacna gigas, is now considered rare as a result of heavy fishing pressure in the past.	

[87] Johnson et al. (2018) Effects of Climate Change on Fish and Shellfish Relevant to the Pacific Islands, the Coastal Fisheries they Support, in Science Review, pp. 74-98.

	A variety of crustaceans, e.g. mangrove crabs (*Scylla* spp.), spiny lobsters (*Panulirus* spp.), slipper lobsters (*Parribacus* spp.) and coconut crabs (*Birgus latro*) are also harvested in the region, largely for subsistence and sale at local markets. Coconut crabs, which are long-lived and slow-growing, are particularly vulnerable to over-harvesting are locally depleted on numerous Pacific islands. Some commercially important molluscs and crustaceans, such as pearl oysters, shrimp and marine ornamentals (e.g. giant clams), are vulnerable to climate change and ocean acidification. For these organisms, reductions in growth, poor shell production and quality will occur under increasing SST and lower pH conditions.	magnesium calcite in some species). Calcifying molluscs reared under lower pH form thinner shells, and have reduced growth and lower survival rates, than those reared under normal pH conditions. Lower rates of calcification are expected to result in declines in the size and growth of molluscs for export (e.g. trochus, green snail and pearl oysters), and in the abundance of bivalves and gastropods gleaned for local consumption. Shellfish important for aquaculture in the tropical Pacific that are expected to be most vulnerable to climate change and ocean acidification are pearl oysters, shrimp and marine ornamentals, while seaweed may benefit in some locations depending on the influences of increasing SST and rainfall.
Pelagic fish	A range of large and small pelagic fish species are found in Pacific waters. Although there are few data quantifying biomass or the catches of these species, it is estimated that ~30% (around 43,000 t) of the total coastal fisheries catch in the region is comprised of nearshore pelagic species, while four species of tuna are targeted by oceanic fisheries. The most common larger species are skipjack tuna *Katsuwonus pelamis*, South Pacific albacore *Thunnus alalunga*, bigeye tuna *Thunnus obesus*, yellowfin tuna *Thunnus albacares*, wahoo *Acanthocybium solandri*, mahi mahi *Coryphaena hippurus*, rainbow runner *Elegatis bipinnulata*, Spanish mackerel *Scomberomorus commerson*, billfish (Istiophoridae) and sharks (SPC 2013). The smaller pelagic species mainly comprise mackerels (Scombridae), scads (Carangidae), flying fish (Exocoetidae), pilchards and sardines (Clupeidae) and anchovies (Engraulidae).	Observations of climate change impacts on pelagic fish species have been more elusive than for demersal fish[88]. In the Pacific Islands region, this is due to the strong influence of climate variability on the distribution of tuna and billfish. For example, the locations where skipjack tuna biomass is predicted to be highest are strongly influenced by the El Niño Southern Oscillation (ENSO), varying up to 4,000 km of longitude between El Niño and La Niña events. The detailed impacts of climate change on tuna species and implications for Nauru's commercial fisheries are detailed in the section below (Impacts on oceanic commercial fisheries).
Sharks and rays	Over 130 species of sharks and rays are believed to occur in the Pacific although this is likely to be an under-estimate, especially for PICTs closer to the Indo-Pacific centre of biodiversity. For example, at least 133 species of sharks and rays occur in the Great Barrier Reef and species are still being described. Sharks and rays are mainly taken in two distinct fisheries: (i) pelagic species caught in association with tuna fisheries; and (ii) coastal species taken as target or incidental catch by small-scale coastal fishers. However, there are reports of some illegal, unreported and unregulated (IUU) fishing activity targeting sharks (oceanic and coastal) in the Pacific, primarily for their fins. The main pelagic sharks captured include silky sharks (*Carcharhinus falciformis*), blue sharks (*Prionace glauca*), ocean whitetip sharks (*C. longimanus*), as well as hammerheads (*Sphyrna* spp.), thresher sharks (*Alopias* spp.) and mako sharks	Predicting the effects of climate change on Pacific sharks and rays is challenging due to: (i) the lack of knowledge about the status and ecology of these species; (ii) the diversity of these species (e.g. they have six different modes of reproduction); and (iii) their position as higher order predators, which means that indirect impacts may depend on the impacts to – and responses of – lower trophic level species to climate change. There is limited information about the effects of climate change on sharks and rays in the Pacific, apart from a systematic risk assessment in the Great Barrier Reef. No observed changes have been reported and the lack of data on existing patterns of diversity and occurrence make it difficult to identify climate related changes in range and movements. However, experimental evidence suggests that some species may be adversely affected by rising sea temperatures and ocean acidification.

[88] Pecl et al. (2017)

	(*Isurus* spp.) (SPC Oceanic Fisheries Program 2010). Significant numbers of sharks have been caught in association with tuna fisheries that historically retained fins for the shark fin trade. However, long-term, accurate data on the catch of sharks in these fisheries are limited and there is great uncertainty about species-specific catch rates, catch fate and trade. However, there are several indications that sharks are under significant pressure in the Pacific. As a result, several species of pelagic sharks have been listed on Appendix II of the Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES), and the WCPFC has a no-retention requirement on some of these species. Some other species of conservation interest, such as whale sharks (*Rhincodon typus*) and mobulid rays (*Mobula* spp.), are also sometimes caught as bycatch by purse-seine vessels (SPC Oceanic Fisheries program 2010).	Pelagic sharks are highly dependent on food resources, and their occurrence is closely linked to that of their prey species, which in turn, respond to oceanographic factors. As such, changes in the distribution of pelagic fishes will likely result in changing distribution patterns of pelagic sharks. These changes in movement and distribution could also affect reproduction, as pelagic shark stocks are structured by sex and size, and increased unpredictability in phenology such as location and timing of upwellings could affect provisioning and survival. However, if pelagic sharks are able to respond to changing conditions and prey distribution, they may be able to adapt to climate impacts.

The socio-economic risks from climate change impacts on fish and shellfish in the Pacific region relate to changes to the coastal fisheries that they support and fall under three main areas: (i) food security, (ii) livelihoods, and (iii) economic development and government revenue (from oceanic commercial fisheries, described in the section below). These all relate to the primary goods and services and cultural significance that fish and shellfish provide to Pacific communities. In addition, given the finite amount of coastal marine resources and increasing population pressure, there is growing "competition" between subsistence fishers for food, and commercial fishers for income, leading to poaching and the undermining of management arrangements.

Additionally, non-climatic pressures on coastal and marine fish habitats, such as coastal infrastructure development, resource extraction (phosphate, fishing, sand and coral mining) and land-based pollution, are already impacting the condition of coastal and near-shore ecosystems, with indirect impacts on demersal fish and invertebrates. In particular, declines in the productivity of demersal fish and invertebrates are expected to present the greatest challenges for the use of fisheries resources by Pacific communities and economies.

Lastly, population growth and high demand for fish combined with the inadequate management of coastal fish habitats and stocks have resulted in a widening gap between the amount of fish recommended for good nutrition and sustainable catches from coastal fisheries[89]. The effects of ocean warming and acidification on coral reefs, and the effects of climate change on mangrove and seagrass habitats, are expected to widen this gap (described in relevant section further below).

The capacity of PICTs as a whole and Nauru in particular to provide the recommended 35kg of fish per person per year for good nutrition and food security is jeopardized due to direct and indirect climate change impacts on coastal fish stocks, and on their habitats (coral reefs, mangroves and sea grasses). According to an assessment conducted by Bell et al. (2017), Nauru fits into the third category of PICT where coastal fisheries cannot meet the increased demand for fish for adequate food security of their growing populations over the long-term.

Table 10 below provides estimates of the annual catch for the three main categories of coastal fisheries in Nauru.

Table 10 Estimates of annual catches (in tonnes and as a percentage of total catch) for the three main categories of coastal fisheries in Nauru[90]

Demersal fish		Nearshore pelagic		Invertebrates		Total catch (t)
Tonnes	%	Tonnes	%	Tonnes	%	373
115	30.8	252	67.6	6	1.6	

In addition to impacts on the food security and nutrition of coastal communities, climate change will impact their livelihoods and income opportunities. Within the coastal fisheries sector, the effort of small-scale fishers will need to be increasingly transferred from demersal fish associated with coastal habitats, to currently under-utilised species such as large and small pelagic species, including skipjack and yellowfin tuna and squid[91] (see below section on Impacts on oceanic commercial fisheries).

Current projections anticipate declines in reef fisheries productivity of as much as 10-20% in the western Pacific under climate change due primarily to habitat degradation[92]. Other estimates predict a decline of up to 50% of the production of coastal fisheries from coral reefs by the end of the century[93].

[89] Bell et. Al (2018) Adaptations to maintain the contributions of small-scale fisheries to food security in the Pacific Islands, in Marine Policy, vol. 88, pp. 303-314.
[90] Johnson et al. (2018) Effects of Climate Change on Fish and Shellfish Relevant to the Pacific Islands, the Coastal Fisheries they Support, in Science Review, pp. 74-98.
[91] Bell et al. (2011)
[92] (Pratchett et al. 2011, Bell et al. 2016)
[93] Bell et al (2016) Climate change and Pacific Island food systems. CCAFS and CTA.

Table 11 shows the projected changes in the production of the three categories of coastal fisheries and total coastal fisheries production by 2050 and 2100 under a high emission scenario.

Table 11 Projected changes in production of the three categories of coastal fisheries, and total coastal fisheries production, in 2050 and 2100 under a high emissions scenario[94]

Variable		Coastal fisheries category				Total coastal fisheries	
		Demersal fish	Nearshore pelagic fish		Invertebrates		
Contribution to coastal fisheries production		56%	28%		16%	West	East
			West	East			
Change in production due to climate change	2050	-20%	-10%	+20%	-5%	-10 to -20%	-5 to -10%
	2100	-20 to -50%	-15 to -20%	+10%	-10%	-20 to -35%	-10 to -30%
Main direct and indirect effects of climate change		Habitat loss, and reduced recruitment (due to increasing temperature and reduced water movement)	Reduced production of zooplankton in food webs for non-tuna species and changes in distribution of tuna		Habitat degradation, declines in aragonite saturation due to ocean acidification		

Impacts on oceanic commercial fisheries

Tuna are found throughout oceanic waters of the Pacific Ocean and are critically important for national revenue and livelihoods in many Pacific nations including Nauru, of which four species targeted by industrial fleets: albacore, bigeye, skipjack and yellowfin tuna. Nauru's revenue from fishing licenses accounted for over USD 71 million in financial year 2019-2020, representing a share of 31% of total revenue and the first revenue source[95]. The COVID-19 pandemic is thought to have had an impact as the global economic downturn resulted in lower demand for fishing licenses and fishing days compared to previous years; therefore, these factors compound the climate impact on revenue and share of government budget derived from fisheries can be expected to be even higher.

Projected warming of the tropical Pacific Ocean and decreases in the strength of major currents and in the formation of eddies, are likely to have two primary effects on the spatial distributions of the four tuna species.

- The first involves potential changes in the timing and location of spawning, and in recruitment success. The magnitude of these effects will depend on the phenological adaptation of each species. Assuming limited adaptation, spawning tuna are expected to avoid areas with temperatures above their thermal optimum to prevent overheating. The exact location of spawning areas would differ among tuna species because albacore, bigeye and yellowfin tuna spawn where SST is greater than 24-25 °C, whereas skipjack tuna prefer SST greater than 28-29 °C.

[94] Johnson et al. (2018) Effects of Climate Change on Fish and Shellfish Relevant to the Pacific Islands, the Coastal Fisheries they Support, in Science Review, pp. 74-98.
[95] Republic of Nauru – Ministry of Finance (2020) 2020-2021 Budget and Estimates of Revenue and Expenditure. Budget Paper no. 1 Budget Strategy and Outlook.

- The second potential impact relates to changes in the vertical distribution of fish. Increased stratification of the water column due to higher SST may alter the vertical distribution of tuna and affect their access to food during the diel vertical migrations of their prey (Le Borgne et al. 2011). Increases in temperature and concomitant decreases in oxygen in subsurface waters are expected to have less impact on skipjack tuna, which inhabit the surface layer. In contrast, greater impacts are expected to occur for yellowfin tuna and albacore, which swim between the surface and subsurface, and for bigeye tuna, which descend to deeper layers.

The effects of climate change on tuna have been difficult to observe because of the strong influence of climate variability on their distribution. For skipjack, the locations where the best catches of this species are made in the WCPO can vary by up to 4 000 km of longitude between strong El Niño and La Niña events. Projected responses of tuna in the WCPO to long-term climate change (Figure 17), and the combined effects of climate change and potential increased fishing effort, have been modelled using SEAPODYM. An eastward and poleward shift in distribution, and reductions in total biomass, are projected for both skipjack and yellowfin tuna under the RCP8.5 emissions scenario, driven mainly by changes in larval survival and spawning location. Decreases in biomass of these two species in most EEZs west of 170 °E, and increases in EEZs east of 170 °E, are also expected. Projected percentage decreases by 2050 and 2100 relative to 2005 are particularly marked for Papua New Guinea, the Federated States of Micronesia, Palau and Nauru.

Somewhat different responses are projected for bigeye tuna and South Pacific albacore. For bigeye tuna, strong decreases in biomass are expected to occur in the EEZs of all PICTs, with the declines exceeding 60% in several EEZs by 2100 (Figure 17). For South Pacific albacore, the distributions of larvae and juveniles are expected to shift south towards the Tasman Sea after 2050. Densities of early life stages are projected to decrease in their core area (Coral Sea) by 2050, resulting in a stabilized adult biomass approximately 30% lower than in 2000. However, the North Tasman Sea could emerge as a new spawning ground after 2080, reversing the downward trend in abundance.

Redistribution of skipjack and yellowfin tuna (Figure 17) is expected to result in lower catches across the prime fishing grounds by 2050. In both cases, a greater proportion of longline fishing is eventually expected to occur outside the EEZs of PICTs, reducing government revenue from license fees. The projected eastward redistribution of skipjack and yellowfin tuna as a result of climate change could result in opportunities for PICTs in the eastern WCPO, e.g. French Polynesia, and PICTs in the subtropics, e.g. Vanuatu and Fiji, to obtain increased economic benefits. However, although modelling indicates that the percentage increases in catch could be substantial in these EEZs, the scale of benefits is likely to be modest because present-day catches are low.

Overall, the data shows that climate change impacts causing changes in the distribution of tuna stocks will not be felt in Western Pacific countries by mid- or even end of the century and under a high emission scenario; by 2050, under a high greenhouse gas emissions scenario (RCP 8.5), the total biomass of three tuna species in the waters of ten Pacific SIDS (including Nauru) could decline by an average of 13% due to a greater proportion of fish occurring in the high seas[96]. Redistribution of tuna under a lower-emissions scenario (RCP 4.5) is projected to reduce the purse-seine catch from the waters of Pacific SIDS by an average of only 3%, indicating that even greater reductions in greenhouse gas emissions, in line with the Paris Agreement, would provide a pathway to sustainability for tuna-dependent Pacific Island economies[97].

[96] Bell et al (2021) Pathways to sustaining tuna-dependent Pacific Island economies during climate change, in Nature sustainability, 4, 900-910.
[97] Ibid.

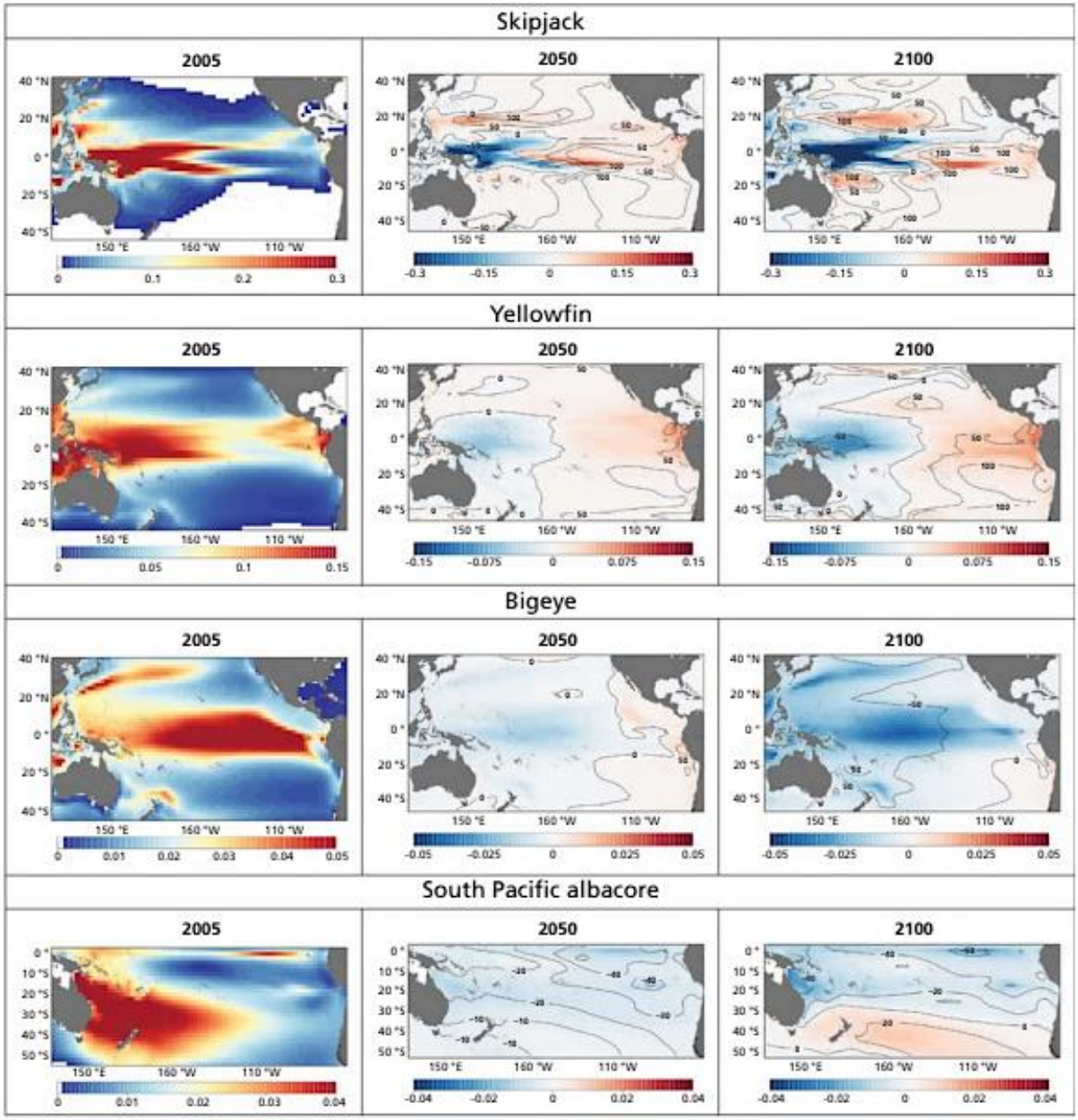

Figure 17 Average historical (2005) distributions of skipjack, yellowfin and bigeye tuna and South Pacific albacore (Mt/km2) in the tropical Pacific Ocean, and projected changes in biomass of each species relative to 2005 under the RCP8.5 emission scenario for 2050 and 2100, simulated using SEAPODYM. Isopleths in the projections for 2050 and 2100 represent the relative percentage change in biomass caused by climate change[98]

Under a high emissions scenario, catches of skipjack tuna for the western Pacific are estimated to decline by an average of more than 20%. Across the entire region, total catch is projected to decrease by 7.5% under the same scenario by 2100. For bigeye tuna, small decreases in catch (usually less than 5%) are projected by 2035. Catches are projected to decrease by 10% to 30% for many Pacific countries under the high emissions scenario in 2100[99].

The projected changes in maximum catch potential varied substantially across EEZs in different regions. Averaged across the two climate-LMR models, EEZs that show the largest decrease (more than

[98] FAO (2018) Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. Technical paper no. 627.
[99] Asian Development Bank (2013) The Economic of Climate Change in the Pacific.

-40%) by the end of the century are in tropical countries, mostly in the South Pacific regions. These tropical countries include Nauru, in addition to Kiribati, Tuvalu, Ecuador, Palau, FSM and Tokelau[100], as detailed in Table 12 below.

Table 12 Projected changes in catch potential (%) by 2050 and 2100 relative to 2000 under RCP2.6 and RCP8.5 based on outputs from the dynamic bioclimate envelope model and the dynamic size-based food web model. The table shows the average change for the Nauru EEZ, as well as the variability (range) around the average, representing the different estimates from the array of climate models used to drive the fisheries projections.

DBEM model: Mid Century RCP2.6		**DBEM model: Mid Century RCP8.5**		**DBEM model: End of Century RCP2.6**		**DBEM model: End of Century RCP8.5**	
Average	Range	Average	Range	Average	Range	Average	Range
-45.16	78.51	-98.86	1.85	-42.48	29.01	-99.81	0.13
Dynamic size-based food web model: Mid Century RCP2.6		**Dynamic size-based food web model: Mid Century RCP8.5**		**Dynamic size-based food web model: End of Century RCP2.6**		**Dynamic size-based food web model: End of Century RCP 8.5**	
Average	Range	Average	Range	Average	Range	Average	Range
-26.44	35.97	-36.53	28.98	-11.63	31.24	-55.32	41.10

At the regional level, the modelling suggests that the total catch, essentially driven by the skipjack fishery, will be maintained until 2050, even under a high emissions scenario, and will decrease later in the century[101]. The benefits generated by the redistribution of tuna stocks in eastern WCPO countries will depend on the PNA members and industrial fleets complying fully with the VDS and with the target reference points for catches of yellowfin, bigeye tuna and albacore that are still to be agreed by the WCPFC. The VDS already has mechanisms to cater for changing stock distribution that would likely need to be enhanced/reconsidered under the long-term shifts in biomass forecast to be driven by climate change. They will also depend on PNA members continuing to develop more flexible management systems to cope with the changing spatial distribution of tuna stocks and fishing effort.

Impacts on coastal and marine ecosystems

Since the 1970s, there has been a growing body of evidence showing the deterioration of coral populations around the world and in the Pacific Ocean due to both climatic and non-climatic drivers. Despite the detrimental effects of non-climate drivers on coral communities, accelerating climate change is currently the strongest driver affecting coral dynamics[102]. Anthropogenic-induced SLR, high ocean temperatures, ocean acidification and the synergistic effects that climate drivers have with one another and with non-climate drivers (such as tourism-related impacts, sedimentation and run-off of pollutants etc.) are currently causing widespread negative effects on coral reefs in PICTs.

Acidification, warming oceans and coral bleaching

Global climate projections suggest that if we follow the current emissions trajectory, by mid-century, acidification will result in coral reefs in the western tropical Pacific dissolving faster than they are built[103]. As stated above, when specific ecosystems such as coral reefs are examined, it is evident that ocean acidification combines with other climatic (e.g. sea surface temperatures) and non-climatic drivers (e.g. pollution or invasive species) to decrease resilience and magnify damage. This may play an important role in the localised impact of ocean acidification. Corals are capable of regulating pH at the point of calcification (within certain limits). However, their ability to do so in environments that

[100] FAO (2018) Impacts of climate change on fisheries and aquaculture. Synthesis of current knowledge, adaptation and mitigation options. Technical paper no. 627.
[101] Johnson et al. (2018) Effects of Climate Change on Ocean Fisheries Relevant to the Pacific Islands, and the Coastal Fisheries they Support, in Science Review, pp. 177-188.
[102] Leo et al. (2018) Effects of Climate Change on Corals Relevant to the Pacific Islands, in Science Review, 132-158.
[103] Pringle, P. (2018) Effects of Climate Change on 1.5° Temperature Rise Relevant to the Pacific Islands. Pacific Marine Climate Change Report Card: Science Review 2018, pp 189-200.

are already stressed due to elevated temperatures and high nutrient levels may be hampered, increasing the likelihood and extent of permanent coral degradation. For example, current maximum calcification rates are just 2-3°C below the maximum temperature corals can withstand before thermal bleaching.

The increase in ocean acidification is expected to impact on coral physiology (calcification rates, ability to repair tissues and growth), behaviour (feeding rate), reproduction (early life-stage survival, timing of spawning) as well as weaken calcified structures, and alter coral stress-response mechanisms[104], with impacts on population dynamics of individual species from phytoplankton to animals (medium to high confidence)[105]. The vulnerability of reef-building corals to ocean acidification has potentially detrimental consequences for fisheries and livelihoods.

As shown in Figure 14 in Section 1.4.2 Climate Historical trends and projections, for the Pacific region and Nauru projections show that under low emissions (RCP2.6) in terms of aragonite saturation state, the conditions for coral remain favourable for corals within this century. Under medium emissions (RCP4.5) and high emissions (RCP8.5) the projections for all Pacific Islands transition from good to marginal conditions in the 2030s period. However, under high emissions (RCP8.5), ocean acidification continues to increase and conditions transition from marginal to very marginal conditions by 2060s, to levels at which corals are not present by the end of this century[106].

The long-term changes in ocean acidification in the Equatorial Pacific are also associated with large interannual variability caused by the ENSO. ENSO influences the strength of upwelling in the Eastern and Central Pacific thereby impacting the ocean carbon content of the upper ocean. Ocean acidification appears to increase more rapidly under El Niño than La Niña conditions[107]. However, there is little consensus on the projected response of ENSO with climate change, and so how this may influence future rates of ocean acidification remains unknown.

The disappearance of coral reefs is likely to have profound impacts on marine ecosystems and the economies and livelihoods they support. Projected changes in pH are equally very large and would reach levels that are likely to have large impacts on the abundance and diversity of marine ecosystems. The projections shown in Section 1.4.2 Climate Historical trends and projections and in Figure 14 represent only the median values (50th percentile), if the 90th percentile were to be considered (not shown) the values of aragonite saturation state would be well below the values at which corals are normally found (2.5), and the pH values close to 7.6, considered the threshold to support marine ecosystems[108]. Such changes combined with ocean warming and other stressors are likely to be catastrophic. As the dominant coastal habitat in the tropical Pacific, corals are the fundamental structures supporting coastal and marine species of fish, invertebrates, algae and plants. Their decline or worse, their disappearance would result in an unprecedented decline of coastal fisheries activities, which would jeopardize the food and income security of the communities who depend on small-scale coastal fishing.

[104] Fabricius et al. (2015) In situ changes of tropical crustose coralline algae along carbon dioxide gradients, Sci-Rep.
[105] Fabricius et al. (2011) Losers and winners in coral reefs acclimatized to elevated carbon dioxide concentrations, in Nature Climate Change, 1: 165-169.
[106] Lenton et al. (2018) Effects of Climate Change on Ocean Acidification Relevant to the Pacific Islands, in Science Review pp. 31-42.
[107] (Sutton et al. 2014)
[108] Fabricius et al. (2011) Losers and winners in coral reefs acclimatized to elevated carbon dioxide concentrations, in Nature Climate Change, 1: 165-169.

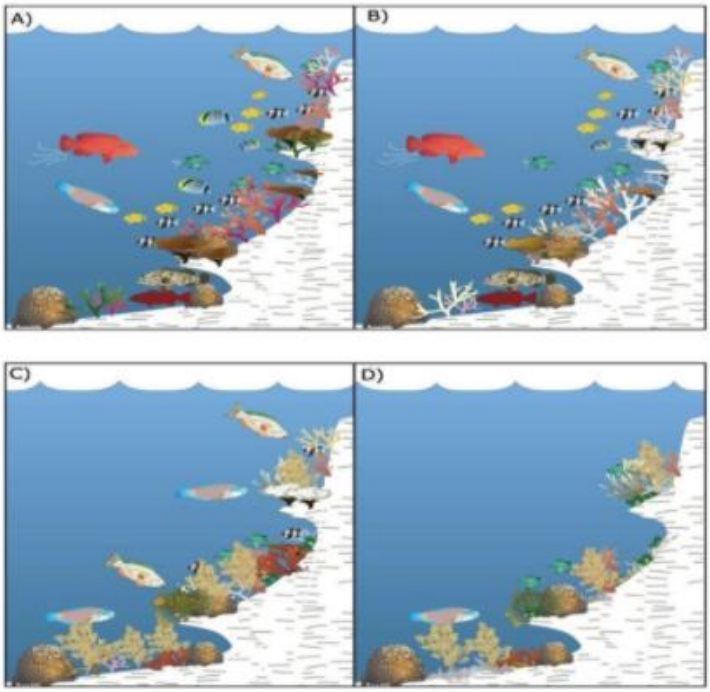

Figure 18 Changes in the state of Pacific coral reef ecosystems caused by climate change: Structurally complex coral reef habitats that support high species diversity (a) once bleached (b) become overgrown with algae, (c) and then collapse to form rubble banks, (d) leading to decline in fish diversity and abundance of coral dependent species (c and d). Predatory fish are expected to decline due to reductions in coral dependent prey species, while generalist species (e.g. herbivores) may become more abundant on algae dominated reefs due to access to more food, at least in the short- medium-term.

Sea level rise

As explained above, coral reefs form a mosaic of habitats along with mangroves and seagrasses, which sustains a diversity of organisms, greater fish productivity, and protect the coastline against erosion. Coral reefs and adjacent ecosystems such as mangroves and seagrasses are intrinsically linked through sediment capture, localised pH buffering and linked life cycles of some fish species[109]. Together, the three habitats substantially improve coastline protection than any one habitat alone[110]. Therefore, any declines in any of the three ecosystems will most likely affect the other two.

Mangrove areas in some locations are projected to decline due to sea-level rise[111],more intense cyclones, and changes in rainfall patterns[112]. Rising sea level would allow minimum shore zone for mangrove development or shore stability; with an early period of increased coastal erosion and destabilizing sedimentation as catchment streams and shorelines adjusted to new and changing base levels, thus negatively affecting corals[113]. Therefore, widespread degradation of corals is expected due to coastal erosion associated with SLR. Seagrasses have already shown sensitivity to the effects of increased turbidity due to flooding and their area is expected to decrease by 5–35% by 2050 due to increased runoff from more extreme rainfall.

Although the land area covered by mangroves is only 0.17% in Nauru (representing 0.036 km^2 covering two species)[114], the ecosystem services and functions they provide are essential for health stocks of fish and invertebrates (see Figure 19 below). Climate change impacts on mangrove and seagrasses

[109] (Albert et al., 2017; Atkinson et al., 2016)
[110] (Guannel et al., 2016)
[111] (Veitayaki et al., 2017)
[112] (Waycott, 2011)
[113] Leo et al. (2018) Effects of Climate Change on Corals Relevant to the Pacific Islands, in Science Review, 132-158.
[114] Ellison et al. (2018) Effects of Climate Change on Mangroves Relevant to the Pacific Islands, in Science Review pp. 99-111.

therefore contribute to the degradation of fish and invertebrates habitats, which in turn impact fish catch and productivity of the coastal fisheries sector.

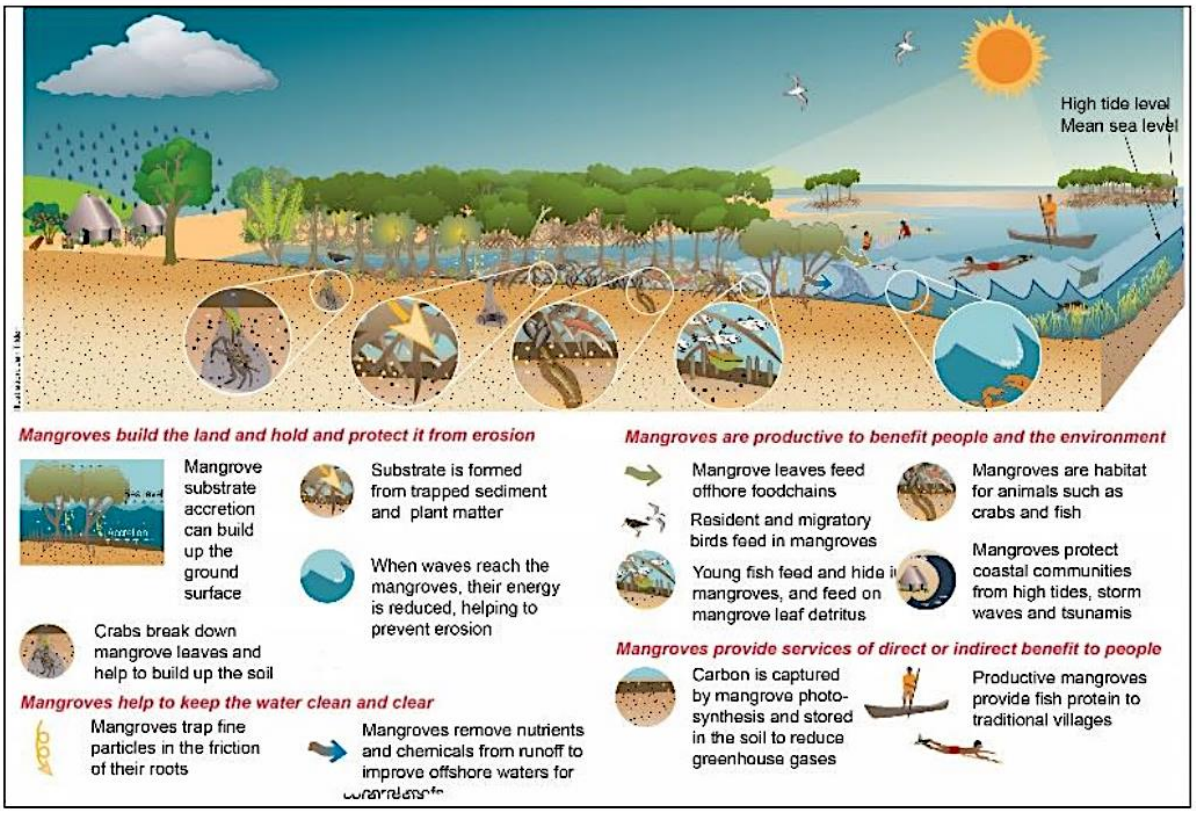

Figure 19 Value of mangrove ecosystem to coastal species and people

Impacts on aquaculture

Climate change impacts on aquaculture production are expected to be both direct and indirect. The direct effects include influencing the physical and physiology of finfish and shellfish stocks in production systems, while indirect effects may occur through altering the primary and secondary productivity, and structure of the ecosystems, input supplies or by affecting product prices, fishmeal, and fish oil costs, and other goods and services needed by fishers and aquaculture producers[115].

[115] Maulu S, Hasimuna OJ, Haambiya LH, Monde C, Musuka CG, Makorwa TH, Munganga BP, Phiri KJ and Nsekanabo JD (2021) *Climate Change Effects on Aquaculture Production: Sustainability Implications, Mitigation, and Adaptations*, in Frontiers in Sustainable Food Systems.

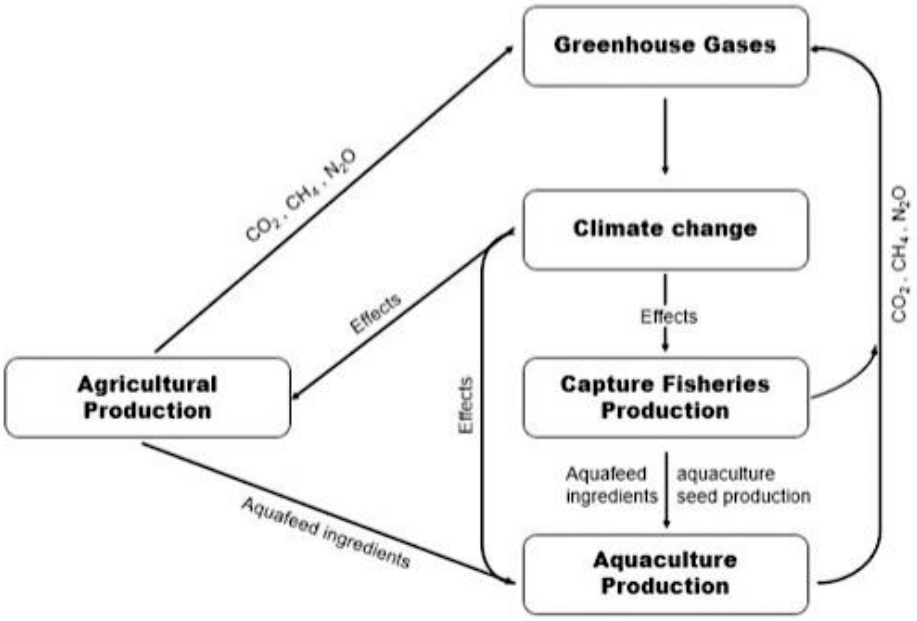

Figure 20 Illustration of the direct and indirect pathways through which climate change will affect aquaculture production

There is a large consensus in research showing that climate change impacts on aquaculture will vary widely depending on geographical areas, economy, climatic zones, production systems, cultured species and culture environments (freshwater, brackish and marine)[116]. Additionally, it is understood that small-scale farmers will be more impacted by climate change risks due to increased production costs in farm management and lack of support systems to recover from climate change impacts compared to larger-scale producers. Lastly, it is important to note that climate change will not only impact aquaculture production systems, but the entire value chain.

The main climate change drivers that threaten the production and sustainability of the aquaculture sector include rising temperature, ocean acidification, diseases and harmful algal blooms changes due to changes in rainfall and precipitation patterns, SLT, changes in sea surface salinity and extreme climate events.

Maulu et al. (2021) provided a comprehensive overview of the available literature on the negative and positive climate change impacts on aquaculture production, summarised in Table 13 below. The impacts of each climate change driver are summarised in more detail in Table 14 below.

[116] Merino et al., 2012; Bell et al., 2013; Cheung et al., 2013; Sae-Lim et al., 2017; Adhikari et al., 2018; Barange et al., 2018; IPCC, 2018; Zolnikov, 2019, cited in Maulu et al (2021)

Table 13 Summary of positive and negative impacts of climate change on aquaculture production

Effects/Element	Rising temperatures	Ocean acidification	Diseases and harmful algal blooms	Changes in rainfall and precipitation patterns	Sea level rise	External input supplies uncertainty	Sea surface salinity	Extreme climate events
Negative effects	• Poor growth and survival of cold-water species • Water quality deterioration • Weakened immune system of cold-water species • Weakened ocean carbon sink capacity • Thermal stratification • Increased virulence of warmer water pathogens	• Reduced species growth performance and survival • Poor coral skeleton development for shell-forming species • Increased water acidity levels • Increased production costs in marine areas	• Poor species growth and reduced survival • Deterioration of water quality • Increased production costs due to disease outbreaks • Increased outbreaks of exotic diseases	• Drought could increase production costs • Competing use of water during periods of drought • Flooding may increase loss of organisms in low land areas • Flooding could deteriorate water quality and pollute the environment • Destruction of production facilities	• Destruction of several coastal ecosystems • Possible intrusion of saline water into freshwater systems and culture facilities • May affect species richness, abundance and distribution, and phonological shifts	• Increased costs of production due to possible increase in the costs of inputs, such as fish feeds and seed	• Reduced ocean's heat storage capacity • Reduced carbon and nutrients circulation • Increased species mortalities	• Destruction of production systems • Increased management costs • Increased loss of culture species
Positive effects	• Extended growing seasons for warmer water species • Further developments in genetic breeding possibility	• Increased production feasibility in hatcheries • Identification of more marine species for culture	• Possible elimination of cold-water pathogens • May facilitate the development of species with better resistance to diseases • Possible identification and development of new species	• Flooding may increase suitable areas for aquaculture production in some regions • Droughts could promote developments in wastewater management	• May increase areas suitable for brackish water culture species, such as shrimps and mud crab	• Possible identification of alternative and sustainable input supplies, such as protein sources to replace conventional sources	• Possible increase in the cultivation of tolerant species	• Better mixing of water column and nutrients • May minimize rising temperature pressures by minimizing the temperature

Table 14 Impacts of climate change drivers on aquaculture production

Climate change driver	Impacts
Rising temperature	Temperature plays a critical role in the growth and development of aquatic animals. Fish, being poikilothermic, may particularly be sensitive to temperature variations resulting from climate change. With the predicted 1.5◦C rise in average global temperature this century, increased mortalities are likely to occur for most fish (and especially cold-water species). Additionally, rising ocean temperatures and consequential ocean acidification slowly weaken the ocean carbon sink capacity, giving rise to alterations in the hydrology and hydrography of water systems, and the occurrence of red tides. Environmental sustainability may also be affected by thermal stratification in deep water bodies resulting from temperature variations which may affect the distribution and abundance of nutrients in the water, and in case of upwelling occurrence, aquaculture producers operating in open waters will suffer from severe economic losses. However, information regarding the physiological response of the most economically important species to rising temperature is still limited to few species, and biased toward adult stages, leaving initial ontogenetic stages, such as embryos, larvae, and fingerlings unclear. On the other hand, warmer periods (within species' tolerance conditions) may promote longer growing seasons, especially in temperate regions, and favor the production of warmer water species, such as the Giant tiger prawn, Tilapia, Oysters, and Mussels. Larger-scale investors that run hatcheries in sheltered locations may also benefit from market opportunities emerging due to the decline of preferred specimens in the wild as a result of degrading coral reefs.
Ocean acidification	Global warming will have adverse effects on the growth, development, calcification, survival, and abundance of several aquatic species. Increased accumulation of CO2 in water could result in increased water acidity levels (pH decrease) which threatens the environmental sustainability of aquaculture production systems through water quality deterioration leading to poor productivity. Moreover, the rise in ocean acidity reduces the availability of carbonate required for the construction of coral skeletons (Calcification) in shell-forming organisms, such as shrimps, mussels, oysters, or corals, which potentially threatens marine aquaculture production. A positive impact of ocean acidification is that the partial or total dependence of large-scale aquaculture producers on hatcheries for spat production may create huge economic gains for the hatchery owners. Additionally, this may provide more employment opportunities to local communities since these hatcheries will require huge labor in response to the growing demand, thereby favoring the social and economic sustainability of aquaculture production.
Diseases and harmful algal blooms	Diseases in aquaculture, such as bacterial, parasitic, viral, and fungal diseases are likely to be affected by a changing temperature regime, but in a largely unpredictable manner. What is certain, however, is that when cultured species are exposed to thermal stress conditions, they become more susceptible to diseases and that warmer conditions may result in the establishment of exotic diseases. The vulnerability of finfish and shellfish to pathogens is a major determinant of diseases and is likely to be affected by both direct and indirect thermal stressors. Therefore, warm water disease outbreaks are predicted to occur more frequently in addition to the possibility of discovering new ones under a changing climate. Rising temperature is likely to accelerate the replication rate, virulence, life cycle longevity, and transmission of pathogens among several finfish and shellfish species. Moreover, the increasing temperature pressures may promote the emergence of epizootic diseases in aquaculture and cause serious economic challenges. Already, the outbreak of epizootic diseases remains one of the most important factors that limit the success of aquaculture production systems in many countries of the world. Overall, the increased occurrence of diseases in aquaculture production systems will lead to reduced

Climate change driver	Impacts
	profits, consequently, affecting the social and economic sustainability aspects of aquaculture production. Algal blooms are a serious threat to the environmental sustainability of aquaculture production. For example, flagellates and dinoflagellates taxonomic groups, and other harmful species have been reported to contain potentially toxic or nuisance species that can be responsible for stress or kills in finfish and shellfish. Although there is limited information on the mechanisms through which climate change will affect toxic substances in aquaculture, Farrell et al. (2015) reported that temperature variation can affect the metabolism of most widespread harmful algae.
Changes in rainfall and precipitation patterns	Changes in rainfall patterns will affect aquaculture production and sustainability in two directly opposite ways; increased rainfall (flooding) and periods of low or no rainfall (drought). According to the IPCC (2018), risks resulting from droughts events are likely to be higher at 2°C compared with 1.5°C of global warming in a given region, while flooding event patterns are difficult to predict with certainty. Increased levels of rainfall, particularly if it occurs as heavier events, will increase the production risks in lowland areas (Bell et al., 2010). These risks include losing fish from ponds during floods, invasion of ponds by unwanted species, and ponds damage resulting from infilling and washing away of walls. The mixing of pond water and fish with those in the wild could negatively affect the environmental sustainability of aquaculture production mainly through the introduction of invasive fish species and water quality deterioration. Furthermore, fish losses from ponds threaten the social and economic dimensions of aquaculture sustainability by lowering the economic gains of the producers and inducing poverty in communities. However, it should be noted that heavier rainfall may increase the areas suitable for aquaculture ponds that rely on rainwater in low-lying tropical regions, thereby favoring the social and economic sustainability in such regions. Drought events may lead to water stress, such as shortages and quality deterioration that have negative effects on aquaculture production. The predicted water shortages driven by climate change will lead to increased conflicts for water among the different user groups, such as aquaculture, agriculture, domestic, and industries. This will affect all the dimensions of aquaculture sustainability. However, there is a need to further investigate how different species and life stages of fish, especially those of economic importance will respond to changes in the precipitation pattern.
Sea level rise	The rise in sea level may destroy several coastal ecosystems, such as mangroves and salt marshes, which are considered crucial for maintaining wild fish stocks, as well as supplying seed for aquaculture production. This will negatively affect aquaculture breeding programs and the economic sustainability of the sector. Higher sea level is predicted to affect aquaculture production facilities, such as ponds, cages, tanks, and pens particularly in lowland regions through the intrusion of saline water. Salinization of groundwater is regarded as harmful to aquaculture, freshwater fisheries, and agricultural production. Therefore, salinization renders aquaculture environmentally unsuitable for production leading to higher production costs and lower economic gains. SLT is also likely to result in changes in species composition, organisms' abundance and distribution, ecosystem productivity, and phenological shifts that may threaten inland and marine aquaculture production. Besides, aquaculture activities in coastal areas bring social and environmental benefits that may be affected both directly and indirectly by rising sea levels thereby affecting the production and sustainability of the sector. On the positive side, sea-level rise may increase the areas suitable for brackish water culture of high-value species, such as shrimp and mud crab. This may favor aquaculture production sustainability by presenting new opportunities for aquaculture production particularly those in coastal areas.
Uncertainty of external input supplies	Agriculture and capture fisheries are the primary sources of external inputs for aquaculture production, suggesting a strong relationship among these systems. Aquaculture is a complementary activity to capture fisheries, and though more similar to agriculture in its practice, it has important links with capture fisheries. While agriculture is the main source of ingredients for energy requirements in aquatic animal feeds and likely to be the main supplier

Climate change driver	Impacts
	of protein sources in the future, capture fisheries are currently the principal supplier of protein sources as well as wild seed and brood stock for aquaculture. The impact of climate change on capture fisheries through alterations in the abundance and distribution of fish species will have a significant effect on fishmeal and fish oil supplies, and the sustainability of fish breeding programs due to increased scarcity of wild seeds. The ineffective management of fisheries and rising fishmeal prices are already a significant threat to aquaculture production sustainability. Moreover, the projected impacts of climate change on fishery resources are likely to accelerate the mismanagement of capture fisheries. Generally, the projected impact of climate change on agriculture and capture fisheries is expected to lower the availability and increase the cost of the inputs, such as fish seed and feed ingredients required for aquaculture production. Consequently, aquaculture production costs are expected to rise, making it more difficult, especially for small-scale producers to survive in the sector. On the other hand, the rising fishmeal and fish oil prices are likely to accelerate developments in scientific studies that seek to identify alternative protein and oil sources to replace conventional ingredients in aquafeeds.
Changes in sea surface salinity	Salinity is seen as a variable parameter reflecting the input of freshwater from precipitation, ice melting, river runoff, loss of water through evaporation, and the mixing and circulation of ocean surface water with underground water. Variations in sea salinity may occur due to increased evaporation resulting from rising temperature and ocean circulation changes or induced directly by climate change. These variations may affect oceanic circulation and stratification, and hence, the ocean's capacity to store heat, and carbon and nutrient circulation. Since climate change is expected to cause these variations, the environmental sustainability of aquaculture will be affected. Most aquatic organisms have specific salinity levels within which they can survive, any alterations may lead to mortalities and production losses. Meaning that variations in sea salinity are expected to negatively affect the economic gains for some aquaculture species which could affect the social and economic aspects of aquaculture production sustainability negatively. However, the higher salinity effect has been strongly correlated with aquaculture production systems in downstream regions of coastal areas (Nguyen et al., 2018). For example, Ahmed (2013), reported negative effects on the production performance of freshwater prawns at higher salinity. Baker et al. (2005) reported increased mortality in juvenile clams, while (Rodrick, 2008) reported increased susceptibility to bacterial invasion in oysters at lower water salinity. In general, variation in water salinity will lead to increased mortalities for several species which may affect the economic and social sustainability of the sector through increased species' losses and higher management costs.
Extreme climate events	Severe climatic events, such as cyclones, waves, and storms are expected to influence aquaculture development especially marine ornamental products, and those in coastal areas. For example, the coral and giant clam farmers in tropical villages may face the risk of increased losses as a result of bleaching, while those in sub-tropical regions are likely to suffer greater risks, such as loss of production equipment and stock due to rougher sea conditions related to stronger cyclones. The occurrence of storm surges, waves, and coastal erosion are considered the most dangerous threats to aquaculture production and other related coastal activities. On the other hand, severe climatic events, such as storms will likely play a significant role in mixing water columns and nutrients that have previously been restricted to certain columns due to thermal stratification which could promote the environmental sustainability of aquaculture production. Moreover, storms may be very crucial in decreasing water temperatures and associated risks that may harm both cultured and wild organisms.

There is a limited understanding of the impacts of climate change on aquaculture species farmed in the Pacific. Existing assessments have focused on species that are already farmed in some PICTs. Calcareous aquaculture commodities in the tropical Pacific that are expected to be most vulnerable to

ocean acidification are pearl oysters, shrimp, and marine ornamentals, while seaweed may benefit in some locations from the increased levels of CO2 depending on the influences of increasing sea surface temperatures and rainfall[117].

Species	Description of impacts
Milkfish	Effects of climate change on milkfish *Chanos chanos* production include a) flooding of fish farms during heavy rains, b) increased fish mortality and disease incidence and outbreaks in ponds, cages and pens, and c) higher temperatures adversely affecting the migration of milkfish spawners to coastal areas for spawning purposes, the hatchability of the spawned eggs and the survival of the milkfish fry. In the past Milkfish production was much more dependent on wild fisheries for the collection of wild broodstock and collection of wild fry. However, broodstock are now grown in ponds or cages until they reach the desired age or size for breeding. Also the role of wild fry collection has greatly diminished with greater availability of hatchery reared fry from foreign hatcheries. However for wild fry that is still collected, the wild Milkfish fisheries will be impacted mainly due to the direct and indirect effects of climate change on the abundance and distribution of the wild stocks with a likely increased variation in the supply of juveniles from changes to the location and suitability of inshore habitats for collection of fry driven by increasing temperatures, sea-level rise, and variation in coastal currents and salinity regimes[118]. Changes in temperature and rainfall patterns and their effects on salinity and oxygen levels can also be expected to affect the reproduction, growth and survival of milkfish as well as affect pond productivity. Additionally, the shift in phytoplankton composition negatively impacts aquaculture activities as this newer algal assemblage (e.g. *Anabaena* spp., *Prorocentrum minimu*m) may produce alkaloids toxic to fish or their prey items leading to less food available to fish and the bloom can lead to hypoxic conditions in the culture environment[119].
Pearl oysters	Despite the value of pearl farming to the tropical Pacific, there has been limited research on the effects of ocean acidification on the production of pearls from the black-lipped pearl oyster *Pinctada margaritifera.* However, research on the closely related *Pinctada fucata* (Welladsen et al. 2010) suggests that survival and growth of wild *P. margaritifera spat*, which provide the oysters for pearl farms in the tropical Pacific, are expected to decrease as shells are weakened by lower aragonite concentrations. Reduced availability of aragonite is also expected to affect pearl quality because aragonite is a key component of nacre[120].
Shrimp	Like some other crustaceans, penaeid shrimp typically exert high biological control over calcification by gradually accumulating intracellular stocks of carbonate ions to harden their chitin and protein exoskeletons, usually in the less soluble form of calcite. Therefore, formation of the exoskeleton in shrimp is not highly sensitive to the projected reductions in aragonite saturation expected to result from ocean acidification. However, the species of shrimp farmed in New Caledonia, *Litopenaeus stylirostris,* may be more sensitive to acidification of seawater than other species of penaeid shrimp because of its thinner exoskeleton[121]. Given the detrimental effects of marks such as 'black spot' on the price received for shrimp by farmers in New Caledonia, any deformities due to the effects of ocean acidification on the thinner exoskeleton of the species would be expected to reduce profits.
Seaweed	Higher projected concentrations of dissolved CO2 in seawater are likely to stimulate the growth of seaweed (*Kappaphycus alvarezii*) farmed in Kiribati, Fiji, Solomon Islands and Papua New Guinea. Like all plants, *K. alvarezii* depends on CO2 for photosynthesis and might be expected to have a faster growth rate as the

[117] Johnson et al. (2015) Pacific Islands Ocean Acidification Vulnerability Assessment.
[118] ENECA (2012) Case study on the impacts of climate change on Milkfish pond production in the Municipalities of Borotok Nueva and Dumangas, Panay Island, Philippines.
[119] Macusi et al. (2014) The Potential Impacts of Climate Change on freshwater fish, fish culture and fishing communities, in Journal of Nature Studies, 14 (2) 14-31.
[120] (Pickering et al. 2011)
[121] Ibid.

	concentrations of CO2 in the ocean increase. However, as explained by Pickering et al. (2011), other consequences of increased CO2 emissions for the tropical Pacific—increases in sea surface temperature and rainfall—are likely to retard the growth of seaweed. Thus, any potential benefits to seaweed farming from the higher levels of dissolved CO2 in seawater are unlikely to eventuate in many of the locations currently used to grow *K. alvarezii*.
Marine ornamentals	The declining pH of the tropical Pacific Ocean is expected to affect the growth and shell formation of calcifying species farmed for marine ornamental aquarium markets, primarily corals, giant clams, and more recently live-rock[122]. Corals, live-rock, and giant clams are likely to have their skeleton and shell formation affected by increased seawater acidification. These aquarium products will also be impacted by other features of climate change, such as increasing sea surface temperature, which causes bleaching, and the detrimental effects of increased runoff from changes in rainfall patterns.

[122] Ibid.

Impacts on health and livelihoods

Many countries of the Pacific region currently experience poor health status that may be further exacerbated by climate change. Nauru, like other Pacific islands, faces a triple public health burden of communicable diseases, noncommunicable diseases (NCDs) and the health impacts of climate change[123]. In Nauru, life expectancy at birth is one of the lowest in the region at 55 years, and in 2011, diabetes prevalence (as % of the total population aged 20 to 79) was 20.4%[124], a number thought to have increased in recent years due to the increased dependency on nutritionally-poor food imports for domestic food security.

NCDs are the main cause of premature mortality and morbidity, contributing to a shorter life expectancy compared to other Pacific island countries. The four key risk factors are: tobacco use, alcohol use, unhealthy diets and lack of physical activity, which are contributing to high rates of obesity, diabetes and raised blood pressure[125]. In the Pacific region, there is a very real concern that climate change may act as an additional risk factor for NCDs. It is likely that the Pacific region is—or will be—the first to experience the consequences of the interaction between climate change phenomena and other factors driving the burden of NCDs, such as physical inactivity, food insecurity, and poor nutrition. The schema in Figure 21, developed in consultation with the climate change and health team in Nauru summarizes these interactions as they are perceived in a number of countries across the region[126].

Climate change would have both direct and indirect effects on health in the region. Direct impacts would include declines in the abundance of coral reef fishes due to coral bleaching as a result of rising ocean temperatures. Ocean acidification is projected to have the greatest range of direct and indirect impacts on the distribution and abundance of demersal fish and invertebrates. Indirect impacts include changes in coastal fish habitats, which in turn result in lower reproduction and survival rates, and changes in metabolic growth rates, and therefore reduced fish stocks. The projected rise in sea-level would reduce the growth of protective mangroves along the coast. As many coral reef and coastal fish species depend on mangroves and seagrasses as nursery areas; if the mangroves and seagrass decline, so will fish populations.

These combined effects of climate change are expected to significantly reduce the productivity of coastal fisheries, especially for small-scale fishers. The repercussions of these impacts on food security and nutrition are significant for the whole WCPO region, and in particular for Nauru. Although the *availability* of food to Nauruan communities has not been identified as an issue, there is growing concern over the *quality and nutritional value* of available food on the island. As explained previously, Nauru is fully dependent on imports for its food security, although a significant share of the population engages in small-scale fisheries for subsistence purposes. The reduced availability of reef fish species will directly and negatively impact the nutrition of local communities in Nauru, as coastal fish resources will not be sufficient to meet the required quantity of fish for adequate nutrition. Unbalanced diets will, over the long-term, result in higher rates of NCDs.

[123] World Health Organization (2017) Nauru-WHO Country Cooperation Strategy 2018-2022.
[124] World Bank (2021) World Development Indicators. Diabetes prevalence (% of population ages 20-79) in 2011. Accessed 29/12/2021.
[125] World Health Organization (2017) Nauru-WHO Country Cooperation Strategy 2018-2022.
[126] McIver et al. (2016) Health impacts of climate change in Pacific Island Countries: a regional assessment of vulnerabilities and adaptation priorities, in Environmental Health Perspectives, vol. 124, no. 11, November 2016.

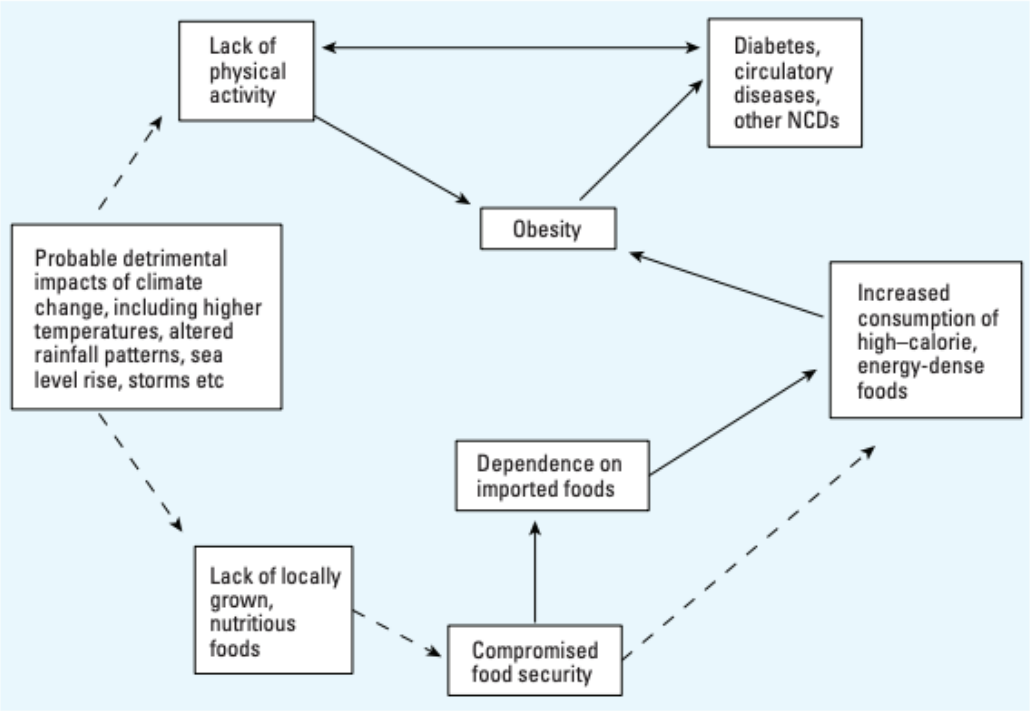

Figure 21 Model summarizing the pathways between climate change and NCDs (broken arrows represent hypothetical links)

Exposure of people and livelihoods

Nauru was ranked 62nd most ready country on ND-GAIN Index, which calculates a country's vulnerability to climate change as well as its readiness to improve resilience. However, the ND-GAIN Index for vulnerability could not be generated due to a number of missing indicators[127]. Another indicator used to determine the country's vulnerability to climate change and risk profile is the INFORM GRI (Index for Risk Management Global Risk Index), which measures the risk of humanitarian crises and disasters in 191 countries. At time of writing the INFORM Index had not been generated for Nauru.

In terms of risk profile, Nauru is located on the equator and it is outside the belt of frequent occurrence of tropical cyclones with damaging winds, rains and storm surge between the months of October and May. In the Pacific region from Taiwan to New Zealand in latitude and from Indonesia to east of Hawaii in longitude almost 2,500 tropical cyclones with hurricane-force winds spawned in the last 60 years, with an average of about 41 tropical storms per year. However, in historical times none of these cyclones affected Nauru. Significant wind speeds from local storms are possible in Nauru but the consequences of such storms are expected to be negligible.

As a result, Nauru is expected to incur, on average, less than 2 thousand USD per year in losses due to earthquakes and tropical cyclones. In the next 50 years, Nauru has a 50% chance of experiencing no economic losses and no casualties, and a 10% chance of experiencing a loss exceeding 0.2 million USD and no casualties[128]. In the event of a natural peril, It is estimated that the replacement value of all the assets in Nauru is 450 million USD, of which about 91% represents buildings and 9% represents infrastructure (Figure 22 shows building locations and nature in Nauru, and Figure 23 shows building replacement cost density per administrative district).

[127] ND-GAIN Index webpage. Accessed 21/12/2021.
[128] GFDRR (2011) Pacific Catastrophe Risk Assessment and Financing Initiative. Country Risk Profile: Nauru.

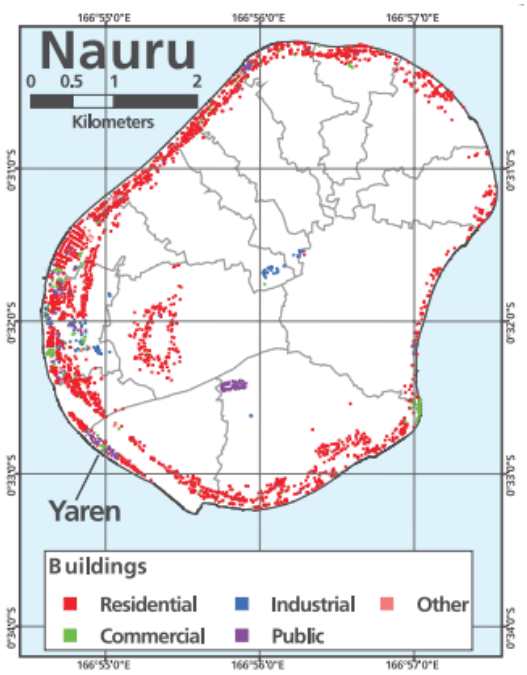

Figure 22 Building locations in Nauru

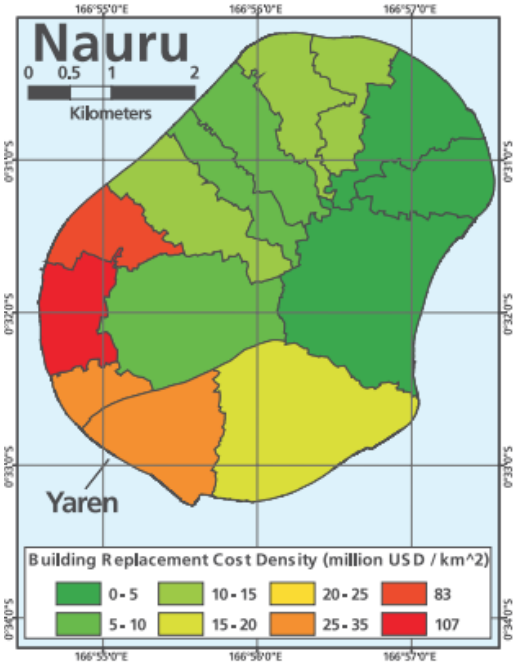

Figure 23 Building replacement cost density by district

Nauru is situated in a very quiet seismic area but is surrounded by the Pacific "ring of fire," which aligns with the boundaries of the tectonic plates. These tectonic plate boundaries are extremely active seismic zones capable of generating large earthquakes and, in some cases, major tsunamis that can travel great distances. In historical times no records of earthquake or tsunami damage in Nauru have been reported.

Vulnerability factors

For the development of the Republic of Nauru Framework for Climate Change Adaptation and Disaster Risk Reduction (RONAdapt), a comprehensive analysis of identified vulnerability factors was provided. Limiting factors to climate change adaptation in Nauru include:

- **Scarce water resources** – With small land area and very limited groundwater resources, water scarcity is a major concern. Rainwater harvesting is an important source, though is constrained by the poor condition of roofing catchments and other components (gutters and tanks). Climate variability is a contributor to drought periods that place great stress on the limited desalination and community storage capacity, and create water stress for many households. Moreover, limited groundwater resources are typically polluted from septic systems, and hence use is limited.
- **Limited land and soil resources** – Nauru is only 21 square kilometers in area, consisting of a single raised atoll. Most development is located around the narrow coastal plain. The island's elevated interior, which makes us over 70% of the land area, consists of coral-limestone pinnacles and limestone outcrops that have been the focus of intense phosphate mining since the early 1900s, with the result that most of the landscape is now unusable for settlement or agriculture. Consequently, there is very little, if any, land available for agriculture and critical infrastructure such as power stations, roads and hospitals, which are all located in low lying coastal areas which makes them highly vulnerable to flooding, storm surges and inundation.
- **Environmental degradation** – Coastal erosion and water pollution have the potential to affect coastal fisheries and reef health, as well as groundwater quality. Loss of vegetation on the

central plateau as a result of mining has left much of the landscape scarred, while rehabilitation is a long-term, and uncertain, project. The need to dispose of large volumes of waste is a major challenge to environmental sustainability since Nauru's population is currently swollen with the Regional Processing Centre (RPC).

- **High concentration of income-generating activities for state revenues** – Over recent decades earnings have been concentrated in the mining sector (which is contracting) and to a lesser extent in fisheries licenses. Revenue associated with the RPC for asylum seekers also provides an income stream, though is uncertain over the long-term. This narrow range of income-deriving activities makes Nauru's foreign earnings, which are critical for underpinning development and climate change adaptation, particularly vulnerable to market shocks and changes as well as to the productivity and abundance of these resources. In the case of fisheries, the impacts of long-term climate change will alter the productivity and/or location of key fish species, which makes Nauru's reliance on these resources for income even more precarious.
- **Dependence on imports** – The economy is reliant on a limited resource base and imports the majority of its fuel and food, making it highly vulnerable to price shocks and external forces. Changes in global markets or terms of trade (currency exchange rate, for instance) can have a devastating impact on livelihoods and the country's progress towards development objectives. This is particularly critical in the case of food, from a food security and also a health perspective, and also energy since imported oil is a major drain on revenue that could otherwise be used for tacking development and climate change adaptation priorities.
- **Geographical isolation** – The ability to access services elsewhere can be a useful coping strategy for when their delivery inside a community is constrained. Nauru's isolation, in terms of distance and the infrequency and cost of air transportation, makes accessing services in other countries very difficult. This isolation can magnify the effect of other stresses, for instance it raises the costs of imports and exports, with consequent impacts on household expenditure and purchasing power, and on government debt and budgets.
- **Low human capacity, linked to low levels of education** – Although primary school enrolment is almost universal, less than a quarter of adults have completed their secondary certificate and only 5% have a tertiary qualification. Finding staff with the appropriate qualifications and mixed skill based required to support Nauru with planning for climate change and disasters is therefore difficult. Keeping the limited capacity engaged in key sectors such as health or other government services is also a challenge. The Regional Processing Centre currently operating on Nauru also has the effect of providing an incentive for some employees to move from essential services, as young people are drawn to short term employment opportunities. Planning for longer term capacity development is thus a crucial need at this point.
- **Chronic health problems –** Nauru has one of the highest rates in the Pacific of non-communicable diseases (NCDs) such as diabetes. The National Health Strategic Plan 2010-2015 cites NCDs as the cause of 79% of deaths on the island, while obesity rates (above 70% for both males and females) are among the highest both regionally and globally. Life expectancy in Nauru is among the lowest in the Pacific region and appears to have declined over the 1-2 decades. These problems are linked to diets that are dependent on processed imported food, and to sedentary lifestyles.

- **Aid dependence –** Being heavily dependent on foreign aid means economic capacity at the national level is dependent on the behaviour of other countries, which makes Nauru vulnerable to possible future changes in the scale, type and direction of foreign aid flows.

1.5 Institutional and policy landscape

Name of climate change and development policy	Contribution of the project to achieving the policy targets
Coastal Fisheries and Aquaculture Act 2020	The proposed project specifically aims to support the effective implementation of the 2020 CFA Act, which is a central pillar to the development of Nauru's sector and to the sustainable management of coastal and marine resources using community-based approaches. The project is therefore fully aligned with the CFA Act's objectives, notably: • "preservation, protection and development of coastal fisheries • waters of the Republic; • ensuring the sustainability of coastal fisheries waters and • aquaculture management and development; • protection of livelihood and food security; • managing, developing and using fishery resources taking into • consideration traditional knowledge, best available scientific information and in accordance with best management practices; • ensuring community participation in coastal fisheries and aquaculture management; and • coordinating the role of Government agencies and the community to ensure compliance with conservation and management measures for coastal fisheries waters and aquaculture."
Nauru Fisheries and Marine Resources Authority Act 1997[129]	The proposed project will support the NFMRA in the fulfilment of its mandate (as described in Section 1.2.2 Governance of the fisheries sector) through the provision of implementation support, capacity building and training activities in relation to its objects and functions. The project will work with the NFMRA to enhance its human resource capacity with regards to biosecurity, data collection for marine resources, aquaculture production indicators and fisheries production, ecological modelling and risk assessments. These activities will strengthen the NFMRA's capacity to support coastal fishers, aquaculture operators and coastal communities to implement sustainable practices in resource management for increased resilience to climate change impacts. The project will particularly support the NFMRA in the fulfilment of the following objects and functions: • "To manage, develop, conserve and protect the fisheries and marine resources of Nauru in such a way as to conserve and replenish them as a sustainable asset for future generations; and • To promote the sustainable utilization of the fisheries and marine resources of Nauru to achieve economic growth, improved social standards, improved nutritional standards, human resource development, increased employment and a sound ecological balance; and • To pursue effective strategies for managing the fisheries and marine resources of Nauru so as to maintain the integrity of marine ecosystems, to preserve biodiversity, to avoid adverse impacts on the marine environment, and to minimise the risk

[129] Republic of Nauru (1997) Nauru Fisheries and Marine Resources Authority Act 1997, as in force from 26 November 2004.

Name of climate change and development policy	Contribution of the project to achieving the policy targets
	of long-term or irreversible effects of resource extraction operations; • To enhance the administrative, legal, surveillance and enforcement capacities of the Republic for the management, development, conservation and protection of the fisheries and marine resources of Nauru."
Environmental Management and Climate Change Act 2020	The project is in full alignment with Part 8 of the Environmental Management and Climate Change Act of 2020, which aims to address climate change, including: • "facilitate and implement projects to protect water resources, coastal areas, land, biological diversity, fisheries and public infrastructure; put in place strategies and action plans to address a global warming, rising sea level and other effects of climate change; • address the environmental impacts of climate change on water resources, coastal areas, lands and land usage, food security, biological diversity, fisheries, economic welfare, public infrastructure and its vulnerability to natural disasters; and • participate in international and regional meetings and forums with a view to obtaining the fullest possible assistance to address the implications of climate change and undertake adaptation initiatives."
Intended Nationally Determined Contribution (iNDC) [130]	The proposed project specifically aims to assist Nauru in the implementation of its iNDC objectives, which state that one of the "most pressing adaptation strategy is to improve the indigenous food supply". By facilitating and providing incentives for the development of the small-scale aquaculture sector, the project will increase access to and availability of fresh, local and nutritious food.
National Sustainable Development Strategy 2019-2030 (Revised 2019)[131]	The project is in full alignment with the key priorities identified by community stakeholders as part of the development of the National Sustainable Development Strategy, including: • "providing greater access to finance for small businesses and for homeowners • Increasing domestic food production to improve nutritional standards • Strengthening social inclusion through greater participatory processes in policy design • Providing greater recognition of the role of women in the community through better designed community programmes". In terms of key national development priorities, the project will support the implementation of the following: • "Employment and sustainable income-generating activities • Business environment "and access to finance"

[130] Republic of Nauru (2015) Intended Nationally Determined Contribution (INDC) Under the United Nations Convention on Climate Change.
[131] Republic of Nauru (2019) National Sustainable Development Strategy 2019-2030: Revised 2019.

Name of climate change and development policy	Contribution of the project to achieving the policy targets
	• Diversification of the economy (…) given the risks associated with the dependence on a narrow range of products".
First National Communication to the UNFCCC (1999)[132]	The project aligns with key priority needs identified in Nauru's first national communication such as: • "Education and training. (…) enhance of local expertise and skills • Institutional strengthening • Monitoring of Important baselines. (…) These activities should be coordinated together with the Nauru Fisheries and Marine Resources Authority (NFMRA)
Second National Communication to the UNFCCC (2014)[133]	The project directly feeds into the priority CCA actions for the fisheries and marine resources sector identified in Nauru's second NDC: • "**Fill knowledge gaps – identify and document vulnerable fisheries and marine resource:** collect and analyse fisheries and marine resources data in conjunction with assessments of climate change and disaster impacts on coastal resources. Includes establishing programs for regular monitoring of fish resources, ensuring active community participation. Development of effective monitoring, control and surveillance (MCS) capability, through national programmes and regional cooperation • **Support a community-based ecosystem approach** to fisheries management (CEAFM): Strengthen the community fisheries program of NFMRA, to support CEAFM. Develop integrated fisheries management plans, through community consultation, which integrates future changes and risks due to climate change • **Promote aquaculture as an important contributor to food security that can reduce pressure coastal fisheries**: assess the impact of drought on aquaculture develop management tools. Finalize an action plan for aquaculture development • **Strengthen the human capacity of government and community stakeholders**: Promote and facilitate human resource development through fisheries education and training programmes. Specifically, increase local capacity in aspects of marine science, including fisheries techniques, monitoring and analysis of resources and any impacts of climate change, coastal and marine resource management practices, and seafaring. Increase local capacity to support aquaculture expansion."
Framework for Climate Change Adaptation and Disaster Risk Reduction (RONAdapt)[134]	The project directly supports the RONAdapt's priority CCA actions for fisheries and marine resources, which follow those of the Second National Communication above.

[132] Republic of Nauru (1999) 1st National Communication under the United Nations Framework Convention on Climate Change.
[133] Republic of Nauru (2014) Second National Communication to the UNFCCC, December 2014
[134] Republic of Nauru (2015) Climate change: Building our resilience. Republic of Nauru Framework for Climate Change Adaptation and Disaster Risk Reduction (RONAdapt).

Name of climate change and development policy	Contribution of the project to achieving the policy targets
Updated Nationally Determined Contribution (2021)[135]	The project directly supports the achievement of objectives laid out in Nauru's updated NDC, particularly in relation to food security and SDGs 2, 3, 13, 14 and 17: • "Implementation of Coastal Fisheries and Aquaculture Act 2020 • Collect and analyze data on climate change impacts on fisheries and marine resources • Develop milkfish farming in support of the development and expansion of aquaculture" (which is the only conditional objective).

[135] Republic of Nauru (2021) Updated Nationally Determined Contribution.

1.6 Baseline projects and lessons learned

Table 15 List and description of past and ongoing initiatives relevant to the project, and description of potential synergies and complementarities

Project title and Implementing Entity	Description and lessons learned (if applicable)	How synergies and complementarities are built into the project design
Implementing a Ridge to Reef approach to protect biodiversity and ecosystem functions in Nauru (R2R Nauru) **Feb 2016 – Feb 2021** (UNDP-GEF)	The Nauru Ridge to Reef (R2R) GEF Project aimed to develop, establish and implement a government and community partnership approach to increase knowledge for better management of natural resources and ecosystem services for the entire Island of Nauru through innovative integrated land, water, biodiversity, coastal and marine management approaches thereby protecting and increasing livelihoods opportunities, food security, and enhancing climate resilience at five initial Pilot Sites (Districts) of Anabar, Ijuw, Anibare, Buada and Meneng. The total project cost of the Nauru R2R Project is US$11,051,358. The project had four components: 1. Conservation of marine biodiversity 2. Sustainable land and water management 3. Governance and institutions 4. Knowledge management The project's Terminal Evaluation was completed in November 2020. The project suffered from significant delays, with an original target end date of April 2019 (actual completion in June 2020). The TE found that although the project design seemed sound according to UNDP-GEF criteria and the needs of the country and communities, the project failed to achieve its planned targets (only 52%), and a number of key activities will never be implemented. Very little progress on the development and implementation of sustainable land use plans has been noted, while "hard" investment activities (such as kitchen gardens, canoes, FADs, water systems etc.) have already died or are missing. This is probably due to a lack of a maintenance plan, with a failure from GoN to develop a documented Sustainability Plan with clear allocation of resources, and the inclusion of these in the institutions' workplans. Therefore,	One of the key issues to have hampered the implementation of the R2R project was the lack of accountability mechanisms and monitoring of implementation milestones on the part of GoN. This has resulted in long delays, prevented the implementation of certain activities, and negatively impacted the sustainability of project outputs, notably the enactment of provisions and policies developed during the project. To this day, the roll-out of provisions under the Coastal Fisheries and Aquaculture Act has been slower than expected due to limited community awareness campaigns and understanding on the changes created by the act. To remedy this as part of the proposed project, clear accountability mechanisms and interinstitutional coordination and monitoring will be needed, so that planned initiatives do not fall short due to a lack of incentives to implement them in a timely manner. The project will build on the work initiated by UNDP to support the GoN and NFMRA to develop a roadmap for the Coastal Fisheries and Aquaculture Act of 2020 by: • Supporting the identification and enactment of designated fisheries management areas to enhance fisheries resource management • Support the implementation of the Community Fisheries Stakeholder Forum and Community Fisheries Management committees to ensure that there is sufficient capacity among members to effectively implement activities relating to the conservation, protection and monitoring of coastal and reef areas • Supporting Community Fisheries Management areas and plans together with coastal communities, to enable communities to lead the implementation of coastal protection and fisheries resource management measures

Project title and Implementing Entity	Description and lessons learned (if applicable)	How synergies and complementarities are built into the project design
	the overall rating for the sustainability of project outputs was marked as "unlikely". On the positive side, the project's governance component has directly helped to address long-standing environmental governance gaps in Nauru, including new legislation. The project directly contributed to support the drafting of the Coastal Fisheries and Aquaculture Act 2020, which paves the way for the enhanced sustainable management of Nauru's coastal and marine resources. Further, the awareness-raising activities around environmental issues, marine biodiversity and sustainable land use among the government and communities have received acclaim from the TE. Lastly, the project supported the signing of MoAs between each pilot districts and the GoN for the development of LMMAs, but at time of writing this still has not progressed passed the MoA stage.	• Providing technical support to the NFMRA for the development of national aquaculture standards in adequation with best international practice • Providing support to the GoN and NFMRA for mainstreaming climate vulnerabilities into the National Aquaculture Plan with a view to assess the aquaculture sector needs and barriers to private investment and vulnerabilities with regards to climate change • Providing support and recommendations for the preparation and review of the National Coastal Fisheries Management Plan (20-3 of the Act) in relation to mainstreaming climate change adaptation • Ensuring the development of maintenance plans with clearly allocated resources and milestones for any "hard" investment supported by the project
Aquaculture Business Investment Planning and Development to Increase Resilience and Improve Food Security Oct 2017 – Dec 2019 (FAO)	This project had a budget of USD 499,000 and targeted the Marshall Islands, FSM, Palau and Nauru. The timeframe of the project was October 2017 to December 2019 and the final report summarizing its outputs was published in May 2020. The technical assistance project aimed to benefit technical personnel from the aquaculture divisions of line ministries or authorities in MASA (Micronesian Association for Sustainable Aquaculture) member countries (in the case of Nauru, the NFMRA), and private aquaculture farmer associations. The key recommendations of the project were: i) Support the development of national legislation responding to development and investment needs in the aquaculture sector, including on aquatic biosecurity; ii) Assess the economic viability, market potential and environmental sustainability of expanding commercial production of priority species, such as milkfish and giant	The proposed project will pursue the work initiated by FAO by: • Supporting the implementation of national legislation in light of identified investment needs and climate change impacts • Demonstrate the economic viability and domestic market potential of aquaculture production • Demonstrating the contribution of the aquaculture sector to national food security and improved health through improved nutrition • Collecting data relating to the costs for the production of key species e.g. milkfish, giant clams and coral • Enhancing local capability at NFMRA and within communities to collect data in aquaculture operations • Supporting the GoN in its efforts to operationalize the MASA network in collaboration with partner countries • Finalising the risk and vulnerability assessment of the aquaculture sector and ensuring that climate change impacts are integrated.

Project title and Implementing Entity	Description and lessons learned (if applicable)	How synergies and complementarities are built into the project design
	clams, and provide guidance on facilitating access to capital, research and development and finance streams; iii) Develop loan programmes for entrepreneurs to assist in purchasing necessary equipment and supplies; iv) Evaluate applied research and development technologies to support the implementation of giant clam and milkfish production ponds for demonstration and community and farmer training purposes; and v) Collect production and/or value data of aquaculture produce to assess availability and profitability. At time of writing of the FAO report (April 2020), the prepared national aquaculture business development strategy had not been reviewed further or endorsed by the GoN.	• Providing access to finance for small businesses and homeowners to engage in small-scale aquaculture operations
Sustainable and Climate-Resilient Connectivity (formerly Port Development Project) Dec 2015 – 2022 (expected) (ADB-GCF)	The project will improve port operations in Nauru by building a wharf, breakwater, and a berth pocket at Aiwo, reconstructing port buildings and the container storage area, and strengthening the institutional capacity of Port Authority of Nauru. Although not directly related to the proposed project, the ADB Port project will enhance Nauru's access to regional and international markets by improving the port infrastructure, reducing loading and unloading times, and securing the docks. These structural improvements will facilitate exports for Nauruan businesses, enhance the nation's connectivity and may attract new shipping companies to provide shipping services.	Although not directly related, the proposed project will leverage the structural developments financed by the ADB-GCF project which will reduce costs and delivery times for the transport of materials and equipment required for the construction of small-scale aquaculture production facilities.
Ecosystem Restoration and Sustainable Land Management to improve livelihoods and protect biodiversity in Nauru Project approved in late 2021 (UNEP-GEF)	This recently approved UNEP-GEF project (implementation approved September 2021) has the objective to achieve land degradation neutrality and improve ecosystem services in Nauru through integrated landscape management and conservation and sustainable use of biodiversity. It has four components:	The project will utilize one of the UNEP-GEF's project outputs for activities under Component 2 pertaining to the planting and revegetation of coastal areas by utilizing the native vegetation nursery to be established. Other synergies may be found at the time of implementation.

Project title and Implementing Entity	Description and lessons learned (if applicable)	How synergies and complementarities are built into the project design
	1. Strengthening policy and institutional capacity for sustainable land management and biodiversity conservation 2. Rehabilitation and restoration of degraded land to protect and reinstate ecosystem services in Nauru 3. Conservation and sustainable use of Nauru's remaining forests 4. Scaling up towards land degradation neutrality and biodiversity conservation	
Support for the development of Nauru's National Adaptation Plan (NAP) project Implementation to start 2022 (SPREP-GCF)	TBD when project document is available	TBD when project document is available
Higher Ground project 2017- ongoing (Nauru Rehabilitation Corporation)	The project focuses on the preparation of a land use and restoration plan for the Topside. In the long run, it aims to rehabilitate land for use for residential, renewable energy, agriculture, aquaculture, recreation, parks, and natural reserves, etc. as dictated by the revised land use plan. The project has limited funding and is in the process of preparing a land use plan for the Topside based on analysis of remote-sensed data and so far without stakeholder consultations.	The proposed project will seek synergies with the existing work carried out for the rehabilitation of land for aquaculture purposes. In consultation with GoN stakeholders, under Component 1, the project will formulate a set of recommendations to enable the establishment of aquaculture facilities (zoning) in accordance with environmental and social management safeguards and existing sustainable land use plans.

Project title and Implementing Entity	Description and lessons learned (if applicable)	How synergies and complementarities are built into the project design
The Pacific Adaptation to Climate Change project 2009-2014 (SPREP-UNDP-GEF)	The project had a budget of US$ 13,125,000 in funding from the GEF (Special Climate Change Fund) and AusAid. The project aimed to create mechanisms for learning and knowledge sharing on climate change at national and regional level. Demonstration of adaptation options showed very little success in Nauru, as most water purifiers installed by the project were found non-functional by the terminal evaluation.	The proposed project will build on the lessons learned of the PACC project by: • Utilizing the knowledge sharing mechanisms created for disseminating information on climate change at the national and regional levels (Nauru Environmental Data Portal) • Ensuring the development of maintenance plans, with clear allocated resources and milestones, for USPs to be supported by the project under the mini-grant facility
INFORM/ Building National and Regional Capacity to Implement Multilateral Environment Agreements (MEA) by Strengthening Planning and State of Environment Assessment and Reporting in the Pacific Sept 2016 – Jan 2021 (SPREP-GEF)	This project has a total budget of US$ 4,319,635 and is due to end in 2021. The project builds a network of national and regional databases for monitoring, evaluating, and analyzing environmental information to support environmental planning, forecasting, and reporting requirements at all levels and has established the Nauru Environmental Data Portal.	The proposed project will utilize the existing regional database and the Nauru Environmental Data Portal to include the data and information generated by the environmental surveillance working group (composed of community members and NFMRA staff) to be established under Component 3. Additionally, and in alignment with the GoN's Coastal Fisheries and Aquaculture Act of 2020, a training programme will be provided to NFMRA staff in bio-oceanographic monitoring. The data generated from these observations will be added on the regional and national databases.
Biodiversity and Protected Areas Management Phase II (BIOPAMA II) **Feb 2018 – Sept 2023 (expected)** (SPREP-IUCN-EU)	This project has a total budget of US$ 1,623,865 until September 2023. The project provides tools for data and information management, services for improving the knowledge and capacity for protected area planning and decision making, and funding opportunities for specific site-based actions. It is a project that focuses on the Africa-Caribbean-Pacific (ACP) group of states and also includes Nauru. Nauru participated in the regional project inception workshop held in Samoa in June 2018. However, SPREP has had minimal engagement with Nauru on this project simply because they do have any declared or designated protected and conserved areas. However, SPREP stands ready by to assist Nauru with any requests related to the process of establishment of protected and conserved areas, and in October 2020, SPREP provided technical advice and	The project will upload all data collected as part of Component 3 relating to coastal and marine inventories onto the PIPAP Portal, in additional to the Nauru Environmental Data Portal.

Project title and Implementing Entity	Description and lessons learned (if applicable)	How synergies and complementarities are built into the project design
	additional decision support resources (upon request from the Nauru Environment Department – DCIE) to support their proposal to conserve an area of key national biodiversity importance on the western side of the island (in Anibare district) as recommended through a Biological Rapid Assessment (BIORAP) for Nauru coordinated by SPREP in 2013. The main information platform under the BIOPAMA project is the Pacific Islands Protected Area Portal (PIPAP), which is the main online source for Pacific Island protected and conserved area coverage data and other related information. The Portal can be accessed freely by the public and while there is a Nauru Country Page on the Portal, it has yet to be populated due to the absence of country data. Nevertheless, portal analytics have confirmed that 41 people in Nauru have accessed and/or used the PIPAP since the official commencement of phase II of the BIOPAMA project (June 2017). In addition, the project disseminates a weekly newsletter of which there are subscribers from Nauru.	
Integrated Islands Biodiversity project (IIBP) **2012 - 2017** (SPREP-UNEP-GEF)	The project had a total funding of US$ 4,302,720, including US$ 1,740,600 of GEF funding, of which US$ 601,660 was spent on Nauru. In 2013, a Rapid Biodiversity Assessment of Nauru (Nauru BioRAP) was carried out to improve the state of knowledge on marine and terrestrial ecosystems and provide a scientific basis for the conservation and management of nationally, regionally, and globally important ecosystems and species. The BioRAP documented the status of biodiversity, identified plant communities, described invertebrates, reptiles, and birds, as well as marine biodiversity, including species previously not reported in Nauru. The BioRAP assessment remains the most complete report on Nauru's biodiversity. The report made key conservation recommendations for immediate action to promote and establish a strong culture of conservation, protected areas, and sustainable use of biodiversity resources in the country. A particular focus of the Nauru BioRAP was to identify areas of conservation value and to investigate opportunities for establishing marine and terrestrial protected	The project will pursue efforts initiated by the IIBP project by supporting the formal establishment of community-based fisheries management areas and Designated Fisheries Management Areas to enhance biodiversity resource management and conservation.

Project title and Implementing Entity	Description and lessons learned (if applicable)	How synergies and complementarities are built into the project design
	areas. Based on Nauru's BioRAP recommended priorities for conservation action, efforts are ongoing through R2R Nauru to protect Nauru's marine and terrestrial biodiversity with a view to formalizing locally managed marine protected areas (LMMAs) covering 30% of the coastline of Nauru. The DCIE is using the BioRAP's baseline data and information to guide the development of strategies for conservation management and monitoring purposes. Although some progress has been made, the majority of the BioRAP's recommendations for conservation and sustainable use of Nauru's biodiversity remain to be implemented. To date, there are no terrestrial protected areas, declared community conserved areas or landscapes under improved practices in Nauru.	

2. Project design and rationale

2.1 Project area

Due to the nature of the proposed activities, the project will generally target Nauru as a whole, particularly for activities pertaining to Component 1 and Component 3. Nonetheless under Component 2, activities relating to the restoration of coastal areas and the management of reef resources will likely occur in designated fisheries management areas to be defined as part of the implementation of the Coastal Fisheries and Aquaculture Act under Component 1.

Additionally, under Component 2, the project will support the upgrade and rehabilitation of NFMRA aquaculture facilities, which are located in Anibare district (see Figure 24 below). The mini-grant facility to be established will finance small-scale unidentified sub-projects (USPs as per AF's terminology) in the aquaculture sector (construction of ponds, provision of equipment etc.) on a national scale. As the exact nature of the USPs is not known at this stage, and will depend on demand from local communities, and also considering the small size of the island, the project design assumes the project area to be the entire country of Nauru.

For activities under Component 2 pertaining to the rehabilitation of NFMRA's aquaculture facilities, an overview of Anibare district is provided below.

Figure 24 Map of project area (NFMRA facilities)

2.1.1 Selection of the Project Area

As a single raised coral island, with a surface area of just over 21 km^2, Nauru is one of the smallest countries in the world. Its size and remote location represent some of the main challenges, with exacerbated transport and access issues. A formerly rich country from phosphate mining, Nauru's economic situation witnessed a dramatic downturn when mining operations ceased in the mid-2000s. In recent decades, climate change impacts such as warming ocean temperatures and ocean acidification have taken a significant toll on the nation's natural resources, which include coral reefs

and an important diversity of fish and invertebrate species, on which local communities rely for subsistence, income, and cultural heritage. The analysis on climate change impacts relating to the coastal fisheries sector can be found in the Sections "impacts on coastal small-scale fisheries" and in "Impacts on coastal and marine ecosystems".
Nauru's unique characteristics and extreme climate vulnerability call for a nationwide, integrated approach to safeguard its food security and livelihoods in the face of climate change through the conservation of coastal and reef resources and the uptake of aquaculture operations.

2.1.2 Characteristics of the project area

The overview of Nauru's socio-economic structure can be found in Section "Socio-economic context" above. The overview below will relate to Anibare district, where NFMRA-managed aquaculture facilities to be upgraded under Component 2 are located.

Socio-economic structure

Anibare district is located on the Eastern coastal of Nauru. In 2019, Anibare's total population was 317 people, of which 153 males and 164 females, representing 2.7% of the total population. Anibare is the second-least populated district of Nauru, and the largest in surface area with 3.1 km^2. The average household size in Anibare is 9.6 people as of 2019, a number which has increased from 6.6 people in 2011[136]. Some households are overcrowded and count over 16 people. Almost a quarter of all dwellings in Anibare are considered in "need of replacing"[137].

environmental / ecological context

Anibare district is home to a large phosphate stockpile where secondary mining started in 2019 in the western portion of the district. Mining operations will progressively move, a few hectares at a time, in an anticlockwise manner to other districts, eventually covering the entire Topside, in a process that is estimated to last 15-20 years. RONPHOS estimates that at least 100 hectares will be mined per year.

Anibare Bay comprises the richest remaining native vegetation on the island[138]. In 2008, BirdLife International identified the Anibare Bay escarpment as an "Important Bird and Biodiversity Area" (IBA). This site is reported as the area holding the highest density of Nauru Reed-warbler on the island, although actual numbers involved are not provided. It is likely to also be a preferred site for nesting Micronesian Imperial Pigeons, if any still remain, and is also known to hold numbers of tree-nesting seabirds such as black noddies[139]. The same area had previously been proposed as a protected area. Additionally, Anibare Bay is one of the candidate areas for the establishment of a Marine Protected Area (MPA).

[136] SPC (2020) Population in Nauru. Available here.
[137] Ibid.
[138] GEF-UNEP project document "Ecosystem Restoration and Sustainable Land Management to Improve Livelihoods and protect Biodiversity in Nauru". Approved 2021.
[139] BirdLife International (2022) Important Bird Areas factsheet: Anibare Bay Escarpment. Downloaded here on 24/01/2022.

Figure 25 Anibare Bay

Contribution of fisheries to livelihoods

An analysis of the characteristics of the coastal fisheries and aquaculture sectors is provided in the Section "1.2 Coastal fisheries" and "1.3 Nauru's Aquaculture sector". The section below relates to the contribution of fisheries to livelihoods at the national level.

In terms of contribution to livelihoods and food security, the sectors of importance for Nauruan communities are the coastal fisheries and aquaculture sectors; indeed, although the industrial oceanic fisheries sector accounts for a quarter of government revenue, oceanic fisheries activities do not generate any direct benefits or co-benefits for communities, in the form of jobs or value-added. This is primarily due to the overwhelming majority of tuna fishing vessels belonging to foreign nations, which do not transit by Nauru to process their catch. Additionally, the consumption of larger pelagic fish species such as tuna is very limited on the island, due to a cultural preference for reef fish, milkfish, and seafood, and the limited tuna catch by Nauruan commercial vessels (as explained in Section "1.2 Coastal fisheries").

Although only a handful of people reported coastal fishing and gleaning to be their main occupation and source of income[140], the sector has important implications for national food security and nutrition Likewise, the aquaculture sector, once a central pillar of the economy and of Nauruan culture, has progressively shrunk to amount to a few dozens of aquaculture operators of subsistence nature (about a dozen households or 63 people)[141]. Conversely, 826 people reported to be looking for work in 2019, demonstrating the opportunity to revive the aquaculture sector to climate-proof community revenues, provide new income opportunities, and enhance food security and nutrition. The dependency of Nauru's population on food imports is therefore total, reaching 90% of the country's food needs[142], with extremely low agricultural and livestock production levels (only about 4 square km of arable land are available on Nauru, much of which is occupied by residential dwellings[143] and only

[140] 23 people as of 2019. From SPC (2020) Nauru mini-survey. Education and Economic Activity in Nauru.
[141] Ibid.
[142] FAO (2021) FAO and Nauru. Partnering to improve food security and income-earning opportunities. Available here.
[143] World Bank Development Indicators. Agricultural Land sq. km. Accessed 27/01/2022.

about 5% of households were engaged in livestock production in 2019[144]). The high cost of imported food products, limited capacity for food production and constrained economic situation constitutes the main threats to food security.

As a result, for the country to adapt to climate change and be more resilient to external shocks, the coastal fisheries and aquaculture sectors are in dire need of improved practices and management as well as financial and technical assistance, to enable a sustainable supply of fresh, nutritious food to communities.

[144] SPC (2020) Nauru mini-survey. Livestock and aquaculture in Nauru.

2.2 Barriers to adaptation

In addition to the vulnerability factors identified in Section 1, page 60, the following barriers to adaptation specifically relating to the coastal fisheries and aquaculture sectors can be identified.

Table 16 Barrier analysis and project justification

Barrier to adaptation	How the project will address the barrier(s)
Information barriers	
Inadequate information on coastal ecosystems and fisheries and impacts of climate change to inform marine planning and management. While several coastal ecosystems and fisheries surveys have been initiated or partially conducted, the NFMRA's capacity to collect, analyse and disseminate relevant data on a regular basis is limited – thus no solid baselines exist. The lack of information collection and knowledge management systems impedes the NFMRA's ability to base strategic and major projects planning based on robust and localised evidence and therefore to ensure interventions are fit for purpose and proportionate. It also impedes their ability to disseminate and communicate empirically collected, localised and up to date information to communities and stakeholders that are the evidence base for ecosystem protection and fisheries management measures. For example, it is noted that "[l]ittle data is available on the status of near shore fisheries habitats … coastal habitats, [or] links between land-based contaminants and coastal water degradation and coastal habitat status".	Under Output 1.2, the proposed project will provide technical support in the form of "hands-on" training to NFMRA officers on a number of topics related to coastal fisheries, marine ecosystems and aquaculture. Topics will include bio-oceanographic monitoring, ecological modelling and ecological risk assessments which will ensure there is sufficient national capacity to predict resource availability, to inform and adjust conservation measures in coastal and reef areas, and to enhance sectoral planification. Additionally, Output 3.1 will be dedicated to the establishment of a Knowledge Management Strategy (KMS) to enhance government-community collaboration for improved ecosystem health and productivity. The project will provide marine monitoring stations to support the NFMRA's existing data collection efforts, and support the establishment of an environmental surveillance group between NFMRA officers and community fisheries management committees, to monitor among others reef catch, compliance with quotas and coral reef health in alignment with objectives and provisions under the CFA Act.
Inadequate institutional and technical capacity of GoN stakeholders and NFMRA to assess and implement climate change adaptation solutions and planning processes in a socially inclusive manner. It is noted that overall Government capacity to manage its climate change program is limited. The Government's ability to robustly link identified climate vulnerabilities to adaptation options appraisal and project feasibility testing and detailed design is limited. As a small Pacific Island Country, with a small pool of generalist technical staff there are significant gaps in national technical expertise to develop viable interventions with a strong climate nexus, that are proportional to the changing scale of the issues and national budget capacities. National capacity to assess positive and negative project impacts in line with national environmental policy or multi-lateral safeguards policies is limited, and will be a continuing barrier to accessing external funding. While mandated to execute national coastal fisheries and aquaculture policy and legislation, the NFMRA has limited technical capacity to	The proposed project will address this barrier by providing technical support and recommendations to the GoN to develop an implementation plan for the Coastal Fisheries and Aquaculture Act of 2020 to ensure the framework fully accounts for projected climate change impacts. The CFA Act, which was supported by UNDP as part of the R2R project (see section 1.6 Baseline projects and lessons learned for more information) is delayed in its implementation due to capacity constraints, and does not include a list of potential adaptation solutions or options to increase the resilience of coastal fisheries and marine ecosystems. The support provided will enable the development of a climate change-aware roadmap for implementation, with clear resource allocation, timelines, milestones, and monitoring arrangements. Further, the national awareness campaign will include the organisation of government-community workshops to discuss the CFA Act's implementation plan, roles, responsibilities and accountability channels to ensure the successful and timely roll out of its provisions.

manage major strategic environmental and natural resource management planning processes.	
Technical barriers	
Limited natural resource base and potential of reef fisheries: Nauru's reef area is too small to support commercial development of reef fisheries, with perhaps one or two exceptions: aquarium fish for export, and invertebrate export fisheries[145]. For the latter, it is doubtful that the resource base would withstand more than a few sacks per year (for sea cucumber and surf redfish). In both cases, the economic value of these activities is unlikely to provide a sustainable income for local populations over the long-term[146].	One of the project's key objectives is to provide support and incentives to enable the sustained uptake of aquaculture production in Nauru, as a means to adapt to climate change, create income diversification opportunities, enhance food supply and quality, and relieve human pressure on climate vulnerable coastal and reef ecosystems. To do so, in addition of the capacity building support to be provided under Output 1.2. to both NFMRA officers and coastal communities, the project will establish a mini-grant facility to finance small-scale aquaculture production ponds and equipment, in order to divert pressure away from vulnerable coastal fisheries and to generate higher income opportunities through milkfish production. Lastly, under Output 3.1 the proposed project will finance the provision of marine monitoring systems and support the establishment and sustainability of a government-community collaborative environmental surveillance group which will enable the long-term monitoring of coastal resources and ensure the success of ecosystem restoration activities.
Long history of maladaptation in the fisheries and aquaculture sector: In 1961, the Mozambique tilapia was introduced to Buada lagoon as a biological control for mosquitoes. As a result, tilapia infested the lagoon to the detriment of milkfish, as it drains out the available natural food source for milkfish in the lagoon. This resulted in the slow growth of milkfish, taking them longer to grow to edible size, which led many milkfish farmers to abandon their traditional practice of raising milkfish. More recently, the FAO in 1981 launched an eradication programme but was unsuccessful, as were several other attempts. In 1991, the FAO SPADP project demonstrated that it was possible to raise milkfish in coexistence with tilapia; simultaneously a Taiwanese project achieved faster growth using more intensive methods but the capital costs were considered prohibitive, due to the import of all necessary supplies for production (fry, feed, tools, equipment etc.). Semi-intensive farming methods were introduced in Anabar pond by Taiwan in early 2001, using imported formulated feeds, nets, water pumps and aerators to enhance water quality and fish growth rates. Fish from the farm were accepted by the local communities and considered to be of high quality, however the dependence of this method on imported goods poses issues with regards to its sustainability over the long-term.	Although Buada Lagoon has been the epicenter of aquaculture production in Nauru for decades, the proposed project will aim to incentivise communities to establish aquaculture production ponds elsewhere on the island. This choice is informed by the geographical nature of Buada Lagoon, which has a limited surface area, and land ownership constraints which do not allow for further expansion of aquaculture activities at this site. Further, the costs associated with the elimination of tilapia in the lagoon and with its rehabilitation far exceed the potential adaptation benefits that would be generated. This essentially removes the risk of maladaptation or inadequate use of project resources with regard to the tilapia infestation issue at Buada Lagoon. In addition, the project will utilize a small-scale, low-cost approach to pond aquaculture production by supporting the development of a domestic supply chain for milkfish feed and fry, which will greatly reduce the reliance on imported goods, as well as the investment and operational costs to produce milkfish. This will demonstrate the economic viability of milkfish farming which is a strong argument for long-term sustainability of this initiative, with little to no potential impact on existing environmental systems, and very limited risk of maladaptation. Sustaining these results will be made possible through the

[145] Ibid., pp. 5-6
[146] Ibid.

	provision of technical support to all stakeholders involved in aquaculture production and planning, from NFMRA officers to local communities.
Disrupted value chain for aquaculture production: The majority of milkfish fry has been imported from Kiribati since the 1980s, a practice which continues to this day. A number of ponds in Buada lagoon are now used to store the imported fry until it is ready to be farmed. The Buada Lagoon Owners Association (BLOA) introduced 10,000 milkfish fry from Kiribati, but the uptake of milkfish fry farming has not followed due to both a lack of capital, and a lack of technical capacity. Additionally, climate change and environmental degradation impact the distribution and quantity of wild milkfish fry, reducing its availability for small and commercial scale aquaculture production. Lastly, the COVID-19 pandemic disrupted freight for the import of goods, including milkfish fry and feed, which has brought a halt to the supply which continues to this day, further hampering the development of the aquaculture sector.	To address this barrier, the project will support the development of a domestic supply chain for milkfish fry by financing the construction of a hatchery at NFMRA's aquaculture facilities site. Jointly, the project will provide training to NFMRA officers in production methods of milkfish fry and milkfish hatchery managment to secure the sustainability of the initiative. Additionally, the project will aim to develop a supply chain for domestic feed production, by experimenting with different milkfish feed options in ponds. This will directly increase the resilience of the aquaculture sector by removing the reliance on depleting and climate-vulnerable wild milkfish fry, and by improving the livelihoods of local aquaculture operators on the long-term by reducing costs relating to milkfish production and therefore increasing income.
Financial barriers	
Lack of finance for infrastructure and project management for resilient livelihoods development. Despite the central importance of the sector for the livelihoods of Nauruan communities, there is a lack of equipment and infrastructure for promoting and valuing fishing products and by-products. This explains the subsistence nature of fishing activities. The RoN have limited national finance to fund CAPEX construction of infrastructure and technical studies associated with aquaculture and major coastal protection measures. While operational expenditures associated with ongoing management of aquaculture and other potential infrastructure are able to be funded through enterprise revenue and national budgets, substantial capital inputs are required to establish viable aquaculture operations and value chain infrastructure. The lack of investment in aquaculture specifically, results in lower national food and income security nationally and a major lost opportunity for alternative fisheries.	The proposed project specifically aims to remove barriers relating to the access of finance for the development of small-scale aquaculture. Through the establishment of a mini-grant facility, the project will unlock access to finance for existing and new aquaculture operators, who so far have been unable to invest in infrastructure due to the risk-averse behaviour of national banks and the inability of the GoN to finance CAPEX construction of facilities. By offering a holistic approach to sectoral development through the provision of capacity building and financing, the proposed project will strengthen the resilience of livelihoods and vulnerable coastal and reef ecosystems by enabling the upscale of aquaculture operations. The sustainability of this approach will be ensured through enhanced accountability mechanisms between government, NFMRA and community stakeholders and the establishment of domestic supply chains for aquaculture production inputs.
Difficult access to climate and development finance: Small projects appropriate for Nauru are not eligible for many international and bilateral funds, as Nauru is not classified as a Least Developed Country; coupled with low credit worthiness due to existing levels of public debt and unreliable revenue streams to service debt; and high per capita cost of projects. The future of Nauru's regional processing centre is expected to determine Nauru's future economic position[147]. Adaptation and disaster risk reduction efforts are hampered by Nauru's	Nauru's economic prospects are dire considering identified climate change impacts which will result in changes in the distribution and quantity of tuna resources, as fishing licenses account for more than a quarter of annual government revenue. Additionally, the extreme dependency on imports for 90% of all food consumed on the island has directly contributed to an unprecedented drop in national food availability and quality, resulting in nutritionally poor diets and a rise in non-communicable diseases. Nauru's journey to climate change resilience as a whole must start with the creation of income diversification and generating opportunities, with a view to divert pressure away from climate-impacted coastal and oceanic fisheries resources, towards greater food

[147] R. Curtain and M. Dornan (2019) A pressure release valve? Migration and climate change in Kiribati, Nauru and Tuvalu, Development Policy Centre.

lack of economic independence and its inaccessible location. Without support, and innovative approaches, climate change threatens to drive poverty and inequality[148].	security, nutrition and sustained income. To this end, the project will utilize an integrated approach for the uptake of formerly central aquaculture sector, in particular for the production of milkfish. The need for grant financing to finance this initiative is high, as Nauru's surface area is extremely limited and its population small, which greatly limits the potential for economic development and revenue-generating activities through other commercial or industrial means and therefore results in the inability of the GoN to finance CAPEX construction costs required.
Policy / Institutional barriers	
Failure to implement an aquaculture development plan: An Aquaculture Development Plan was drafted in 2005 but the cost of implementing this plan did not appear to be outweighed by the potential benefit. There is a provision under the CFA Act to develop a National Aquaculture Plan, but implementation has yet to start more than 1 and ½ years after the enactment of the Act.	The GoN is willing to invest annually in aquaculture systems to support process and ensure sustainability and maintenance of the system. However, upfront investment costs for the development of Nauru's aquaculture sector are more extensive than be met by the needs of construction for new facilities that are needed under the National Aquaculture Development Plan. In this line AF resources are targeted to support the GoN meet the upfront costs whilst national resources will ensure sustainability in the long term. . Additionally, there has been a drop in the number of people engaging in aquaculture operations in recent years, due to barriers such as lack of access to financing instruments, lack of technical capacity and inconducive policy frameworks. Provisions to develop a National Aquaculture Plan under the CFA Act of 2020 constitute the first ever successful policy framework to be enacted, but stakeholder consultations conducted as part of this project design revealed that the implementation of provisions related to aquaculture have not started more than 1 and ½ years after the Act, made worse under the COVID-19 pandemic that restricted the importation of milkfish fry from Kiribati. This highlights the need to move away from dependence on international fry sources . To remedy this, the proposed project, under Output 1.1, will provide recommendations and support to the GoN and NFMRA to develop a roadmap for the implementation of aquaculture provisions, using lessons learned and best practices for the uptake of small-scale aquaculture production in Nauru. This will include suggestions for drafting aquaculture standards, carrying a full situational and economic assessment of the aquaculture sector, developing recommendations for the development of national supply chains for feed and milkfish fry etc. Overall, the proposed project will aim to provide the necessary tools and knowledge to GoN and NFMRA officers to enable the effective implementation of aquaculture activities under the Act. Further, under Output 2.1, the project will address barriers relating to the access of finance from communities and to support GoNs current annual investments to cover extensive upfront cost for aquaculture infrastructure development through the establishment of a community-managed mini-grant facility to finance the construction of

[148] World Bank (2021) Nauru Climate Change Risk profile.

	small-scale aquaculture infrastructure (ponds, hatcheries, grow-out ponds etc.). Taken together, these activities will directly contribute to incentivise local communities to re-engage in aquaculture production, and in doing so will increase their adaptive capacity through increased income opportunities, and increase the resilience of vulnerable coastal and reef ecosystems by alleviating fishing pressure in these areas.
Repeated failure to establish community-based management structures for coastal fisheries: "Community consultations were held, and legislation to enable the management of coastal fisheries was drafted in 2006 and 2007 with the assistance of SPC, but some of the concepts proposed in that draft, particularly the concept of giving communities rights to manage nearby reef-areas, apparently proved contentious due to land disputes and the draft legislation has not yet been laid before government"[149]. Since those failed attempts, and with the support of UNDP through the R2R project, provisions for community-based fisheries management were included in the 2020 CFA Act, but implementation was reported to be slow[150].	Over the past two decades, there have been an important number of attempts to establish community-based management structures for the management of coastal resources as well as for sustainable land management. Stakeholder consultations conducted as part of the project design shed light on the barriers hampering CBFM to take place in Nauru, which include the lack of government-community collaboration and communication channels, a lack of awareness on the part of communities of climate change impacts on coastal and reef resources and their implications on livelihoods, and insufficient technical capacity to implement adaptation solutions for more resilient fisheries management. To this end, the proposed project will, under Output 1.2, organize a nationwide awareness campaign to promote the provisions enacted under the CFA Act of 2020, which include the formation of community-based fisheries management committees and supports community-led marine resource planning and management. Simultaneously, the project will provide technical support to the NFMRA to implement workshops and field trips to coastal communities on the utilization of sustainable fishing gear and FADs for example, in addition to sharing knowledge and best practices relating to the implementation of community-based fisheries management plans. Further, under the activity the project will support he is mainstreaming of climate resilience into the workhops and activities conducted by the NFRMA. As part of Output 1.2 and onwards, the project will support frequent consultations between communities, community fisheries management committees and The Coastal Fisheries Advisory Council (incl. GoN stakeholders and NFMRA) as laid out in the CFA Act. Notably, under Output 3.1 the project will support knowledge and data generation and dissemination by establishing a government-community environmental surveillance working group to collect key data on marine resources, ecosystem health, and fisheries.
Social and gender barriers	
Open access tenureship results in a lack of regulations and framework for fishing in coastal and reef areas: The economic downturn following the collapse of the nation's phosphate mining has driven the majority of households on the island to glean and fish anywhere, including outside of residential districts. Nauru's open-access tenureship means	The project will provide continued support to the NFRMA to promote collaboration and dialogue between government and community stakeholders to establish regulations on coastal fisheries activities, including size limits and quotas in designated fisheries management areas under Output 1.1. Additionally, by promoting community-based

[149] NFMRA (2012) Corporate Plan.
[150] Insight gained in stakeholder consultations conducted as part of the project design.

that everyone is free to fish anywhere on the island. This is very different from other Pacific Island countries. Because of the lack of traditional authority, the protocols seen in other Pacific countries are not practised in Nauru. There are no customary regulations, district laws or unwritten understandings on fishing activities, such as size limits, quotas, gear restrictions, use of scuba, or imports (for coastal species).	management of fisheries resources, and by providing community fisheries management committees with adequate technical knowledge and capacity, the project will raise awareness of communities to comply with new fishing regulations to allow for the restoration of climate-impacted coastal and reef resources.

2.4 Project overview

2.4.1 Project objective and approach

The proposed project aims to utilize an integrated approach to natural resource management and utilization to address a number of long-standing barriers that have hampered the implementation of adaptation solutions with regards to Nauru's coastal fisheries and aquaculture sectors. Further, historical obstacles to the sustainability of these sectors have been exacerbated by the COVID-19 pandemic which shed light on the country's extreme reliance on exports for its food supply and aquaculture supply chain, which resulted in increased human-induced pressure on climate-vulnerable coastal and reef ecosystems. These ecosystems are increasingly vulnerable to climate change impacts such as warming ocean temperatures, resulting in extensive damage caused by coral bleaching, which in turn causes depleting fish stocks and biodiversity.

What the project aims to achieve is to provide strong incentives to GoN stakeholders to actively engage in marine resource management and conservation by supporting the development of a clear roadmap for the CFA Act and providing technical assistance for its implementation, and to communities to divert pressure away from coastal fisheries to sustainable, extensive aquaculture production. To do so, the project will utilize a combination of capacity strengthening, training, awareness-raising and financial support activities to create a paradigm shift for more climate-resilient marine resource management and planning, and domestic food supply. Learnings and data gathered as part of the project will continue to inform policy and regulatory developments by constituting a robust baseline in terms of community-based fisheries and marine resource management, climate change adaptation solutions, coastal and reef restoration, and sustainable aquaculture production.

2.4.2 Interlinkages between components

The proposed project was designed to ensure the complementarity and synergistic nature of its three components. First, under Component 1, the project aims to address long-standing capacity and organizational barriers to enable the development of a road map for the implementation of key coastal fisheries and aquaculture policy and regulatory frameworks. Using a combination of capacity building and policy recommendations, the PMU will support the GoN and the NFMRA to design an implementation plan that reflects the needs and interests of fisheries-dependent communities, and integrates best international practices and recommendations in terms of marine resource management and conservation; climate change adaptation; community-based fisheries management; coastal fisheries management and sustainable aquaculture production. This will ensure that the Coastal Fisheries and Aquaculture Act (hereafter "CFA Act") allocates sufficient technical and financial resources for its effective implementation, along with relevant monitoring, evaluation and reporting arrangements to ensure climate-resilient results are delivered in a timely and efficient manner.

Under Output 1.2, to address critical information and awareness barriers, an extensive national-scale awareness-raising campaign will be rolled out to inform local communities across all districts of climate change impacts on coastal fisheries and marine resources as well as their implications for food supply, nutrition, livelihoods and environmental sustainability. Additionally, the campaign will promote aquaculture production as an opportunity to adapt to climate change and reduce pressure on climate-impacted coastal and reef resources. The campaign will act as a catalyzer for local communities to organize into formal management structures (fisheries management committees) to create accountability mechanisms by officializing collaboration and communication channels between communities, ministries and the NFMRA. Subsequently under Component 1, technical assistance will be provided to all stakeholders involved in the implementation of the Act, to ensure that local communities and NFMRA officers have the necessary technical capacity and the resources to implement its provisions.

Once the necessary policy and organisational frameworks are in place, and gaps in technical capacity filled, Component 2 will see the establishment of a mini-grant facility to enable the financing of small-scale aquaculture production systems. One of the key identified barriers to the uptake of milkfish production is the complete lack of financing instruments and products from banking institutions to individuals and community structures, which results in the inability to rehabilitate existing infrastructure or establish new ponds to sustain production. Additionally, under Component 2, the project will support an upgrade of NFMRA-owned aquaculture facilities, which currently only comprise a holding and quarantine facility for imported milkfish fry. Lastly, to enhance market access and value-added, a community-led storage and processing facility will be established to enable aquaculture operators and coastal fishers to store, transform and sell fish products. These combined investments will provide communities with the required minimum infrastructure to incentivize local communities to re-engage in aquaculture production and more climate-aware coastal fisheries for enhanced food supply and nutrition on a national scale.

Lastly, Component 3 will address significant barriers pertaining to the collection, management and utilization of data and information for natural resource planning, which will reinforce both the accountability mechanisms and reporting requirements enacted in the CFA Act supported under Component 1. The baseline in terms of marine resources data collection primarily focuses on industrial tuna fisheries while key ecosystem health indicators are not monitored due to both a lack of technical capacity and monitoring stations. By supporting the systematic collection of data on reef health, fish populations and distribution among other factors, the proposed project will directly improve the adaptive capacity of government institutions and community organisations by enabling the availability of data for marine resource planning and conservation. Furthermore, knowledge outputs generated under Component 1 such as the training modules and data reports will be saved onto a knowledge platform, which will be leveraged from past initiatives for enhanced cost and time effectiveness.

2.4.3 Description of Project components and Activities

Component 1: Enhanced policy, regulatory and legislative environment for resilient coastal fisheries and aquaculture

Outcome 1: Implementation of recently enacted institutional, regulatory and legal frameworks related to coastal fisheries and aquaculture is facilitated through the provision of recommendations and technical support to enable the long-term climate, environmental and economic resilience of the sectors.

Rationale: Breaking a long history of unsuccessful attempts to effectively allocate sufficient technical, financial and operational resources to implement national coastal and marine resources management strategies and plans to secure and strengthen the resilience of fisheries resources and communities' livelihoods to climate change.

Output 1.1. Provision of technical assistance and recommendations to the GoN for the effective implementation of the Coastal Fisheries and Aquaculture Act of 2020

Rationale: The delayed effective implementation of provisions under the CFA Act due to a lack of organisational and technical capacity as well as interinstitutional and government-community collaboration prevents adaptation efforts from taking place[151].

The CFA Act 2020 successfully encompasses key recommended adaptation actions and represents the first successful attempt by the GoN to enact a set best practices for the management, planning and conservation of coastal and reef areas, fisheries resources, and livelihoods. However, stakeholder consultations carried out of part of the project design process evidenced that the technical capacity

[151] The latter aspect was identified as a key limitation to the development of spatial planning and management in Nauru by local stakeholders in the Nauru Training Workshop on Marine Spatial Planning conducted by SPREP in 2019.

of staff at NFMRA, the key Authority responsible for the implementation of the Act, is insufficient to implement its provisions according to best practices and recommendations.

Therefore, the proposed project, with support from SPC and SPREP[152], will provide technical assistance to the Government of Nauru, the NFMRA and the Coastal Fisheries Advisory Council[153] to ensure the following items and considerations are fully integrated in the development of the implementation plan and roadmap relating to the CFA Act 2020:

- ***Coastal Fisheries Advisory Council***, to ensure that the governance structure reflects adequate engagement and input from fisheries-dependent communities
- ***Community Fisheries Stakeholder Forum***, to ensure that communities have sufficient resources and capacity to identify issues and implement the relevant adaptation solutions
- ***Designated fisheries management areas***, to enable the identification of fisheries hotspots which require conservation measures (through either permanent or rotational or seasonal closures)
- ***National Coastal Fisheries Management Plan***, in adequation with best international practice[154], to enable a full assessment of the coastal fisheries sector, including relevant species, catch quotas, management objectives, conservation status, risk and vulnerability assessment and monitoring, reporting and surveillance requirements
- ***Community Fisheries Management committees***, to ensure that communities have sufficient capacity to register as a fisheries management committee, and to develop climate-resilient fisheries management plans
- ***Community Fisheries Management areas and plans,*** to ensure that communities have sufficient capacity to identify suitable areas to be designated as fisheries management areas in alignment with national coastal management areas to be identified
- ***Community fisheries management fund,*** to ensure that community fisheries management committees have sufficient capacity to access financial assistance for activities identified as part of the associated community fisheries management area plan and receive revenue from sustainable finance activities identified under the plans
- ***FAD management Programme –*** monitoring and evaluations, continual data collection
- ***National Aquaculture Plan,*** to provide technical support to enable a full assessment of the aquaculture sector, including priority species (from a food security and income security standpoint), objectives and milestones, barriers and associated adaptation actions, infrastructure requirements
- ***Development of national aquaculture standards,*** in adequation with best international practice[155], provision of recommendations for the development of standards pertaining to, for example:
    - Site selection and premises
    - Aquaculture farm design and maintenance

[152] SPREP has been actively involved in the provision of technical assistance to the Republic of Nauru for the identification of Marine Protected Areas (MPAs), Key Biodiversity Areas (KBAs), Locally Managed Marine Areas (LMMAs), the implementation of community-based mechanisms for natural resource management, as well as knowledge products and dissemination tools. Further, SPREP established the Pacific Islands Protected Area Portal which aims to collect and compile all relevant data and information about these topics.

[153] The Council was established as part of the Coastal Fisheries and Aquaculture Act of 2020. The function of the Council is to advise the Minister on policy matters relating to coastal fisheries and aquaculture, relating to (a) conservation and management and (b) development and sustainable use. The Composition of the Council can be found on p. 6.

[154] Such as: Code of Conduct for Responsible Fisheries (FAO 1995), the Ecosystem Approach to Fisheries and Aquaculture, the International Guidelines on Securing Sustainable Small-Scale Fisheries (FAO 2012), the Voluntary Guidelines on the Responsible Governance of Tenure (FAO 2012a) and the Voluntary Guidelines on Securing Sustainable Small-Scale Fisheries in the Context of Food Security and Poverty Eradication (FAO 2015)

[155] As above.

        - Stocking densities, farming methods,
        - Feed and feed supply
        - Biosecurity
        - Environmental and waste management
        - Water quality monitoring
    - ***Coastal Fisheries and Aquaculture development Fund,*** to develop a set of objectives and a framework for the operations of the Fund, for the purpose of "protecting, conserving and managing coastal fisheries; aquaculture development and food security"[156].
- Inclusion of climate change drivers, risks and impacts threatening the sustainability of the sectors in the implementation plan;
- Development of a list of potential adaptation options to mitigate the impacts of identified climate change risks;

Output 1.2. National awareness-raising campaign on climate change impacts on fisheries and aquaculture and provision of capacity-building to secure the uptake of provisions and measures under the Coastal Fisheries and Aquaculture Act

Rationale: Repeated attempts to implement community-based fisheries management and establish MPAs or similar mechanisms aimed at reducing pressure on overexploited and climate-impacted resources have failed primarily due to a lack of awareness of communities on the projected impacts of climate change on coastal ecosystems and their livelihoods, and a lack of technical capacity to trigger lasting behavioral change.

Lessons learned from past projects and consultations have confirmed that local communities had identified the following priority areas and objectives (i) "create awareness about food cycle and understanding marine resources; (ii) establish and enforce legislation to support the local management and marine resources; (iii) establish local community structures to manage marine resources; (iv) educate communities e.g. no-take zones and explore alternative livelihoods for communities; (v) empower communities to manage their coastal areas; empower communities to protect key marine resources; and (vi) ensure sustainable marine resources" [157].

Further, with regard to the fisheries sector and the NFMRA, key priority areas identified pertained to "(i) establishing robust information base to planning and management support (including spatial data); (ii) developing alternate livelihoods including aquaculture (iii) enforcing initiatives relating to invasive species, quarantine, biosecurity and biodiversity assessments; (iv) data collection, methods and analysis"[158].

Stakeholder consultations also revealed that people engaging in fishing activities for subsistence purposes lacked knowledge on the sustainable utilization of coastal and marine resources, including sustainable fishing techniques and gear. For example, Fish Aggregating Devices (FADs) are being deployed by the NFMRA but these often get lost or damaged due to inadequate use by small-scale fishers (currently 3 out of 6 NFMRA-managed FADs are in operation; others have been lost). Likewise, people who glean on reef areas indiscriminately catch fish of all sizes, depleting resources of juvenile fish, further damaging fragile ecosystems.

[156] Coastal Fisheries and Aquaculture Act 2020, Part 11, page 29.
[157] See the Nauru Training Workshop on Marine Spatial Planning conducted by SPREP in 2019, page 8 "What do communities want to see?".
[158] As above.

Activities under Output 1.2 will be rolled out in two subsequent phases: (i) national awareness raising campaign on projected climate change impacts and implications for coastal fisheries and aquaculture (ii) training and capacity building for fishing communities, CSOs and NFMRA officers.

- ***National awareness and dissemination campaign on the Coastal Fisheries and Aquaculture Act*** provisions in force, and on expected impacts of climate change on coastal fisheries resources and opportunities in aquaculture production:
    - Organisation of biannual government-community workshops between community fisheries management committees, NFMRA staff and the Coastal Fisheries Advisory Council to discuss implementation plan, roles, responsibilities and accountability channels
- ***Technical support in the form of workshops and field trips to coastal communities*** for:
    - Establishing community fisheries management committees
    - Identifying community fisheries management areas
    - Designing and implementing community fisheries management area plans
    - Utilizing sustainable fishing gear and FADs; sustainable fishing methods
- "***Hands-on"***[159] ***training for NFMRA officers*** in:
    - Bio-oceanographic monitoring and ecological modelling to predict changes in resource availability (in alignment with CFA Act) and inform conservation measures in fisheries management and fisheries designated areas
    - Biosecurity and best practices in small-scale aquaculture production (primarily for milkfish) i.e. pond design, stocking densities, water quality monitoring etc.[160]
    - Ecological risk assessments for integrated, informed management of coastal and reef resources
    - Milkfish feed production in ponds (algae, diatoms); hatchery and fry production.

The capacity building and training activities provided under this Output will directly contribute to increasing the adaptive capacity of local fishing communities and strengthening the resilience of vulnerable ecosystems to projected climate impacts, by enabling the implementation of the CFA Act and strengthening the awareness and ownership of adaptation and climate risk reduction processes.

Component 2: Financing climate resilience for coastal fisheries and aquaculture sectors

Outcome 2: Improved food security and nutrition through increased farmed fish supply, increased adaptive capacity and income of aquaculture operators and reduced pressure on climate-vulnerable coastal and reef ecosystems.

Output 2.1. Enhanced coastal fisheries management and biodiversity conservation

Rationale: Reducing human-induced pressure on critical ecosystem and marine resources by providing technical and financial support to fisheries-dependent communities in reef areas and applying resource conservation measures.

The economic downturn resulting from the interruption of phosphate mining activities and more recently the COVID-19 pandemic pushed a number of Nauruans to fish and glean in coastal and reef areas where ecosystems are increasingly impacted by climate change. Additionally, the high domestic demand for fish products (either reef fish or milkfish) is not met, which exacerbates the pressure on climate-impacted coastal and reef resources with local communities engaging in unsustainable fishing activities. To break the cycle of resource degradation, the project will provide a combination of

[159] The technical support will be provided in the form of in-person workshops, focus groups, training sessions and meetings as much as possible, as one of the lessons learned from past projects and stakeholder consultations revealed that virtual and/or theory-based workshops had mitigated results in terms of the capacity of training recipients to apply the knowledge gained.
[160] Leveraging best practices and lessons learned from other SPC-supported small-scale aquaculture facilities in other PICTs.

technical and financial assistance designed to restore and conserve coastal and reef areas while supporting the adoption of sustainable fishing methods and gear to divert pressure from vulnerable reef fish toward larger pelagic species. Building on existing NFMRA-supported FADs schemes, the project will install a number of additional anchored FADs, which have been shown to yield important adaptation benefits[161], with regards to relieving pressure away from reef resources towards oceanic resources, and contributing to the success of locally managed marine areas (LMMAs) and other similar schemes, such as the community fisheries management areas to be supported under Component 1.

The exact nature and potential locations for the deployment of FADs will be assessed in later stages of the project development, however both subsurface and lizard FADs seem to have adequate features for deployment in Nauru's coastal areas. Subsurface FADs, unlike other types of surface FADs, do not have a visible upper floatation section, which significantly lessens the risk of vandalism[162]. Consultation with SPC FAME Masterfisherman will be consulted on the setting of FAD locations. Additionally, subsurface can be deployed in high boat traffic areas and require little to no maintenance at all, which has proved to be an issue in Nauru. Alternatively, lizard FADs display similar features with the addition of a surface component and a specific deployment technique.

Other activities under output 2.1 include:

- ***Conditional provision of subsurface or lizard FADs*** to compensate for the establishment of the no-take community fisheries management areas as an alternative source of fish by increasing access to larger pelagic species outside of these fisheries management areas whilst reducing pressure on vulnerable reef species. This will also be very supportive in triggering behavioral change in fishers to respect the fisheries management areas and to increase compliance to management measures put in place, and thus ultimately making it easier for the appointed wardens and community fisheries management committees to manage and monitor their fisheries management areas. Estimated (USD 10,000 – 3 to 7 years, near shore 3 years)
- ***Adoption of sustainable fishing methods*** to tackle non-selective fishing gear and methods directed to target species vulnerable to climate change
- ***Restoration, re-stocking of natural banks*** in areas identified as community fisheries management areas under Component 1 by community-led committees, leveraging existing NFMRA-supported giant clam and coral production for restocking purposes
- ***Development of certification scheme*** for local artisanal sustainable coastal fisheries
- Other measures for coastal restoration and coral reef protection, identified by community committees as part of the community fisheries management area plans under Component 1.

Output 2.2. Provision of infrastructure and equipment to enable the sustained production of milkfish for increased domestic food supply and income

Rationale: Currently there is a wealth of documentation, studies and assessments on potential opportunities for the aquaculture sector, and virtual certainty around the projected climate change impacts on coastal fisheries (nearshore and offshore), although no diversification efforts have

[161] From Bell et al. (2015): "There is recognition that regular use of nearshore FADs could have two other possible benefits. First, it provides communities with the opportunity to transfer some of their fishing effort from coral reefs to oceanic fisheries resources—an intervention expected to help prevent over-exploitation of coral reef fish and maintain the normal representation of important functional groups of fish (e.g. herbivores) associated with coral reefs required to assist these ecosystems to adapt to climate change. Preliminary analyses in the Federated States of Micronesia and Vanuatu indicate that 50% to 75% of fishing effort can be transferred from reefs to FADs. Second, nearshore FADs could enhance the success of coral reef management initiatives, e.g. those by the local marine managed area (LMMA) networks and Micronesia Challenge, by providing practical ways for people to continue to catch pelagic fish when regulations are introduced to help coral reefs recover from overfishing and other local stressors, e.g. through designation of temporal or spatial fishing closures".
[162] SPC (2020) Manual on anchored fish aggregating devices.

amounted to behaviour change. That is due to a lack of incentives for local communities to change their ways, and a lack of access to financial resources to invest in adequate aquaculture facilities.

Additionally, meeting the high demand for affordable aquaculture products (particularly milkfish) on the domestic market while providing stable income opportunities for vulnerable communities. Adapting aquaculture to climate change provides a good opportunity to reduce non-climatic pressure on climate-vulnerable, overexploited coastal and marine ecosystems.

Nauru's aquaculture sector and particularly milkfish production was formerly a central economic activity for local communities. Aquaculture production was progressively abandoned, and communities resorted to coastal fishing and gleaning on reef areas as a means of subsistence and income generation. Remaining aquaculture operators face a myriad of challenges, including the current need to improve or rehabilitate small scale ponds to increase production as well as for climate-proofing, inability to access finance to develop pond infrastructure, a lack of technical capacity to sustain production, and the absence of storage and processing facilities to increase value addition and market access. The COVID-19 pandemic further weakened the aquaculture supply chain by preventing plane freight for imported fry, which exacerbated the dependency of the sector on external supplies and resulted in increased pressure on coastal and marine resources. Further, NFMRA-managed aquaculture infrastructure is in need of an upgrade and rehabilitation to provide a training facility and enable NFMRA officers to apply the knowledge gained and adequately assist aquaculture operators.

This output will aim to break the cycle of coastal and marine resource degradation by demonstrating the economic and technical viability and sustainability of milkfish production to provide incentives to local communities to resume aquaculture production for the domestic market. Strengthening the milkfish supply chain will increase the resilience of coastal and marine ecosystems to climate change through the reduction of human pressure and increase the adaptive capacity of local communities by securing the domestic food supply and creating income increasing and diversification activities. Lastly, the proposed activities will enable NFMRA officers to provide extension services and demonstrations to aquaculture operators in adequate, dedicated facilities, therefore increasing the resilience of the aquaculture sector and the adaptive capacity of vulnerable communities over the long-term.

Activities under Output 2.2 will relate to the following:

- ***Rehabilitation of existing NFMRA infrastructure for aquaculture production and piloting of innovative aquaculture production methods and channels:*** harmonization of production system and infrastructure at NFMRA's hatchery and holding tanks to achieve sustainable operationalization of fry production on Nauru;
- ***Development of sustainable feed production supply to reduce reliance on international feed imports:*** utilize bi-catch and pilot the use of *Tilapia* (an invasive in Buada Lagoon) as protein bases in the production of a local fish feed. Providing feed for other high-value species (omnivorous crustaceans such as marine shrimps, freshwater prawns, crabs) for export or growing milkfish fry;
- ***Establish a community-managed facility for storage and processing of sustainably caught reef fish and aquaculture products:*** cold room, ice plant, frozen storage etc;
- ***Establishment of mini-grant facility for disbursement of grants to community fisheries management committees and registered aquaculture operators***: to finance the construction or climate proofing of small-scale, low-tech ponds, or grow out systems, purchase of gear, fry or feed (for starting production);
- ***Physical climate enhancement of the Buada Lagoon***: construction of flood defenses to divert flood/storm waters away from the lagoon, reduce siltation of the lagoon,
    - Potential to be explored at full design stage – dredging of the Buada Lagoon. Noting that this will have a high environmental impact and a full ESS assessment of the

process should be carried out to ensure there is no environmental impact on 1) the Lagoon ecosystem or 2) benthic habitats in surrounding coastal systems or terrestrial ecosystems through waste deposits. Further, social assessments should be conducted to ensure the process will not have a negative impact on local communities or interfere with land tenure systems and equitable rights to resources.

Component 3: Monitoring, Evaluation and Learning

Outcome 3: Increased compliance with environmental recommendations and provisions under policy frameworks through enhanced capacity of local communities and NFMRA officers to collect and interpret data.

Rationale: There is insufficient data on the state of marine resources, ecosystem health, and coastal fisheries production to adequately inform marine resource planning and fisheries management processes and plans. Provisions for data collection under the CFA Act are limited and do not allow for informed marine and fisheries planning.

Output 3.1. Establishment of a knowledge management strategy (KMS) to sustain climate-resilient practices in environmental and natural resource management

Rationale: To remedy the lack of marine monitoring systems and NFMRA-community collaboration for environmental monitoring and reporting.

Stakeholder consultations and secondary research revealed that Nauruan authorities currently do not monitor key indicators to determine ecosystem (coastal, reef, marine) health and productivity. Indeed, much of the data collection effort is focused on industrial tuna fisheries and commercial domestic fisheries. Data and information pertaining to coastal subsistence fisheries and ecosystem health are not collected. This is primarily due to insufficient technical capacity in environmental monitoring (addressed under Output 1.2), and the absence of adequate marine monitoring stations around Nauru and collaborative environmental surveillance groups. Going forward, the data collected will help toward the development of a strong baseline and provide the science basis for the management of fisheries areas, coastal protection measures, FADs management, among others[163].

Activities under Output 3.1 will include:

- ***Provision of marine monitoring stations*** to collect data and information on ecosystem health, reef status, chemical indicators etc. following the training provided under Output 1.2.
- ***Establishment of an environmental surveillance working group*** between NFMRA and community fisheries management committees and compliance officers[164]:
    - Monitoring and compliance with community fisheries management areas regulations
    - Monitoring of reef fish catch and compliance with quotas; FADs surveillance and monitoring
    - Data collection: indicators of coral reef health (e.g. diversity, percentage cover and structural complexity of corals, and percentage algal cover) and reef fish stock status (e.g. abundance, diversity, size structure and mean trophic level) and ecosystem health indicators in plankton, distribution of key species, and supportive chemical variables as pH and oxygen).

[163] Provisions under the CFA Act in relation to information and statistics are limited to "(a) catches; (b) bycatches; (c) fishing methods; (d) fishing effort; (e) production; (f) production methods and (g) any other relevant information".
[164] Based on recommendation by Harris, 2016.

Output 3.2. Learning and dissemination of project results

Rationale: Consultations carried out as part of the project design process revealed that field trips for NFMRA officers were particularly useful in terms of their capacity to apply the knowledge gained compared to theory-based workshops. Additionally, lessons learned from past projects indicate insufficient integration of project results and learnings in existing information portals.

- ***Establishment of learning partnerships with other PICTs countries***: to exchange knowledge on best practices in small-scale aquaculture production e.g Kiribati (long history of producing milkfish) Tuvalu, Palau (existing SPC aquaculture facilities)
- ***Evaluate CBFM progress*** using *SPC Framework For Action*
- ***Dissemination of lessons learned through national and regional workshops*** for GoN officials, academia, CSOs in partner MASA countries. The MASA network aims to promote a strong and environmentally responsible aquaculture sector through the sharing and application of science-based and indigenous knowledge and technology.
- ***Compilation of all project learnings, data and information*** (community fisheries management area plans, workshop and training modules and reports etc.) on the Nauru Environmental Data Portal

2.5 Results framework and transformational change

Project Objective(s)[165]	Project Objective Indicator(s)	Fund Outcome	Fund Outcome Indicator	Grant Amount (USD)
Provision of technical support and recommendations to GoN and NFMRA for the implementation of national coastal and marine resources strategies and plans to increase the resilience of fisheries resources and community livelihoods to climate change	Number of staff from targeted institutions with increased technical and operational capacity to implement coastal fisheries and aquaculture plans Number of households with increased awareness of the linkages between identified climate change impacts and their livelihoods	**Outcome 7:** Improved policies and regulations that promote and enforce resilience measures	7. Climate change priorities are integrated into national development strategy	1,013,000 USD
To increase national food supply and enhance marine resource conservation through increased access to finance and technical knowledge of vulnerable fisheries-dependent communities to enable the diversification of livelihoods	Number of households with increased awareness of fisheries and marine resource conservation measures Number and type of government-owned aquaculture facilities established Number of households with new or additional diversified income source(s)	**Outcome 6:** Diversified and strengthened livelihoods and sources of income for vulnerable people in targeted areas	6.2 Percentage of targeted population with sustained climate-resilient alternative livelihoods	6,950,000 USD
Enabling long-term sectoral planning and marine resources management through the increased capacity of national and community stakeholders to collect, analyse, compile and disseminate information	Rate of compliance with CFA Act provisions by year 5 of project from population (%) Number and value of marine health indicators improved (coral health, fish stocks, size structure etc.)	**Outcome 8**: Support the development and diffusion of innovative adaptation practices, tools and technologies	8. Innovative adaptation practices are rolled out, scaled up, encouraged and/or accelerated at national level	558,000 USD
Project Outcome(s)	**Project Outcome Indicator(s)**	**Fund Output**	**Fund Output Indicator**	**Grant Amount (USD)**
Outcome 1: Implementation of recently enacted institutional, regulatory and legal frameworks related to coastal fisheries and aquaculture is facilitated through	Number of CFA Act roadmap or implementation plan developed Number of Community Fisheries Management areas established	**Output 7**. Improved integration of climate-resilience strategies into country development plans	**7.1** No. of policies introduced or adjusted to address climate change risks (by sector)	1,013,000 USD

[165] The AF utilized OECD/DAC terminology for its results framework. Project proponents may use different terminology but the overall principle should still apply

the provision of recommendations and technical support to enable the long-term climate, environmental and economic resilience of the sectors.	Number of recommendations reported for the development of the National Aquaculture Plan Number and type of national aquaculture standards developed Percentage of households with knowledge of the CFA Act, its provisions and ways to engage in its implementation Number of NFMRA staff with increased knowledge and technical capacity in environmental data modelling, ecological risks assessment (coastal fisheries) Number of NFRMA staff with increased knowledge and technical capacity in biosecurity, milkfish feed production and fry production (aquaculture)		**7.2** No. of targeted development strategies with incorporated climate change priorities enforced	
Outcome 2: Improved food security and nutrition through increased farmed fish supply, increased adaptive capacity and income of aquaculture operators and reduced pressure on climate-vulnerable coastal and reef ecosystems.	Number of FADs deployed Adoption rate of sustainable fishing methods from trainees Number of coastal fisheries certification scheme developed Number of hectares of natural banks restored and/or re-stocked Number and type of new aquaculture production facilities at NFMRA Number of community-managed postharvest and storage facilities established Number of new aquaculture operators supported through the mini-grant facility	**Output 6**. Targeted individual and community livelihood strategies strengthened in relation to climate change impacts, including variability	**6.1.1.** No. and type of adaptation assets (tangible and intangible) created or strengthened in support of individual or community livelihood strategies **6.2.2.** Type of income sources for households generated under climate change scenario	6,950,000 USD

	Number of existing aquaculture operators supported through the mini-grant facility Number of fry systems established near Buada Lagoon			
Outcome 3: Increased compliance with environmental recommendations and provisions under policy frameworks through enhanced capacity of local communities and NFMRA officers to collect and interpret data.	Number of marine monitoring stations deployed Number of environmental surveillance working groups established Number of learning partnership groups established with other PICTs countries Number of case studies developed and disseminated Number of topics and data uploaded onto the Nauru Environmental Data Portal and other regional platforms	**Output 8**. Viable innovations are rolled out, scaled up, encouraged and/or accelerated	**8.1** No. of innovative adaptation practices, tools and technologies accelerated, scaled-up and/or replicated **8.2** No. of key findings on effective, efficient adaptation practices, products and technologies generated	558,000 USD

2.6 Project Design Considerations

2.6.1 Selection of the proposed project interventions

The approach used for the selection of the proposed project interventions was informed by:

- An analysis of relevant past projects and programmes implemented in Nauru and regionally
- Stakeholder consultations with implementation partners of past and ongoing projects (UNEP, UNDP, FAO, SPREP)
- Stakeholder consultations with national counterparts (NFMRA)
- Desktop research and analysis

Additionally, the following aspects were considered in the selection of the project interventions:

- Cost effectiveness
- Innovative potential
- Alignment with national priorities and plans

2.6.2 Profiles and selection criteria of direct and indirect beneficiaries

There are four categories of direct beneficiaries under the proposed project:

1. GoN members and NFMRA staff
2. Members and representatives of community fisheries management committees
3. Coastal fishers and people who depend on coastal fisheries for their livelihoods
4. Existing and new aquaculture operators

Direct beneficiaries under Component 1 will primarily be GoN members and NFRMA staff (including the Coastal Fisheries Advisory Council) and members and representatives of community fisheries management committees. Component 2 will target community fisheries management committees as well as local coastal communities and new and existing aquaculture operators. NFMRA staff will also benefit from the training activities under Output 2.1. Lastly, all direct beneficiaries will be involved in activities to be proposed under Component 3. Overall, the proposed project will directly benefit approximately a quarter (25%) of Nauru's total population, and indirect benefit 100% of Nauru's population.

The table below provides an initial assessment of the potential number of direct beneficiaries as well as the assumptions underlying the calculations. Indirect beneficiaries are considered to be the total population of Nauru, due to the small size of the country and the project's potential to benefit all Nauruans in terms of increased resilience of coastal and reef ecosystems, increased knowledge of and capacity to address climate change impacts, and increased access to financial instruments to diversify income sources and increase the resilience of livelihoods.

A) DIRECT BENEFICIARIES

Table 17 Assumptions and calculations for potential direct beneficiaries

Component / Outputs	Total Number of beneficiaries	Comments / Methodology for estimation
Output 1.1. Provision of technical assistance and recommendations to the GoN for the effective implementation of the Coastal Fisheries and Aquaculture Act of 2020	180	18 NFMRA staff for coastal fish and aquaculture + Coastal Fisheries Advisory Council (at least 6 people as per CFA Act) + community representatives for the Community Fisheries Stakeholder Forum (1 representative for each district, 14 districts) + 2; assuming 10 people per community fisheries management committees Assuming an additional 15 people from ministries
Output 1.2. National awareness-raising campaign on climate change impacts on fisheries and aquaculture and provision of capacity-building to secure the uptake of provisions and measures under the Coastal Fisheries and Aquaculture Act	165	Total population of Nauru for awareness campaign: about 11k For capacity building / training: - 165 people (NFMRA staff + CF Advisory Council + community committees)
Output 2.1. Enhanced coastal fisheries management and biodiversity conservation	1,000	- Number of coastal fishers (commercial and subsistence) - Number of people who rely on fisheries for their livelihoods Indirect beneficiaries: all population Assuming 1,000 people (TBD)
Output 2.2. Provision of infrastructure and equipment to enable the sustained production of milkfish for increased domestic food supply and income	553	- NFMRA staff (18 people for coast and aqua) - 500 beneficiaries of mini-grant facility - beneficiaries of storage facility: 1,000 (assuming new pond owners + existing people engaged in coastal fisheries and aquaculture). Indirectly benefitting total Nauru population - 35 pond owners in Buada Lagoon
Output 3.1. Establishment of a knowledge management strategy (KMS) to sustain climate-resilient practices in environmental and natural resource management	152	Environmental surveillance groups: - NFMRA staff (12 people for coastal fisheries) + community committees (14 districts x 10 people)
Output 3.2. Learning and dissemination of project results	200	Same beneficiary group as Output 1.1 + 20 people from CSOs and regional academic institutions
TOTAL DIRECT BENEFICIARIES	2735	avoided double counting: calculated as total beneficiaries under output 3.2 + output 2.2 + 2,000 (TBD, assuming subsistence fishers share + people depending on fisheries for their livelihoods)
Share of total pop (%)	24%	Latest census pop (SPC mini survey 2020: 11,550
Women (%)	1340	Female to male ratio is 49%/51%
Male (%)	1395	
No. of households	408	average household size: 6.7 (SPC mini survey 2020)

Number of direct beneficiaries	2,735
Number of indirect beneficiaries	11,550

Estimate of cost per direct beneficiary	3,459 USD
Share of the total population	24% for direct beneficiaries, 100% for indirect beneficiaries
Share of the target area	100%

2.7 Pre-feasibility assessment

2.7.1 Technical assessment

Table 18 below provides an overview of the proposed technologies and practices to be introduced by the project, and an analysis of their expected adaptation benefits and co-benefits in light of the baseline scenario. The expected innovative potential of these technologies and practices in also presented.

Table 18 Analysis of technologies and practices to be introduced by the proposed project

Technologies/ Practices	BAU practices	Expected changes	Innovative potential
Deployment of subsurface or lizard FADs and training in utilization	• Very limited number of nearshore floating FADs • Recurring loss and/or damage of FADs • Inadequate utilization of FADs by local fishing communities	• Increased availability of larger pelagic species (i.e. tuna species) • Increased consumption of larger pelagic fish species by local communities • Increased income for Nauru-based coastal subsistence and commercial fishers • Increased technical capacity of communities to adequately utilize FADs	• Establishment of both onshore and offshore FADs
Sustainable fishing gear and fishing methods	• Utilization of resource-depleting fishing gear (fish catch of all sizes) • Impacts on coral ecosystems	• Limited damage to coral reef ecosystems • Climate-aware fishing methods	• Introduction of sustainable fishing gear and practices to Nauru
Construction of community-led storage and processing facility for fish products	• No dedicated facility for fish products and by-products storage and transformation • Fish sales occur directly from boats or in individual homes	• Development of a domestic value chain for aquaculture products • Increased year-round availability of fish products and by-products	• Ability to transform aquaculture products into higher value-added products and by-products • Ability to store fish and fish by-products off-season • Community-led organisation of domestic aquaculture market
Mini-grant facility	• No financial products for aquaculture development • Inability of GoN to allocate financial resources to aquaculture infrastructure development	• Availability of micro-finance for new and existing aquaculture operators • Construction of small-scale aquaculture infrastructure according to international best practice and standards	• Community-managed fisheries and aquaculture infrastructure • Operational and maintenance costs borne by communities (fishers and aquaculture operators)
Construction of hatchery at NFMRA site	• No hatchery at Anibare NFMRA site • Milkfish fry is imported from neighbouring countries in small quantities, to fit in the existing quarantine pond	• Year-round availability of domestic milkfish fry • Establishment of dedicated facility which can be used for training of NFMRA officers • Reduced costs of milkfish fry supply	• Climate-proofing of milkfish fry supply • Enhanced traceability of supply

Technologies/ Practices	BAU practices	Expected changes	Innovative potential
Construction of small-scale aquaculture ponds	• Limited number of extremely small ponds (some are old swimming pools) • Animal welfare concerns (high density and insufficient space for fish development) • Extremely limited production volume	• High expected ROI • Increase in production volume and quality • Increased income for aquaculture operators • Increased availability and quality of fresh produce, at a lower cost (compared to imported frozen fish) • Enhanced animal welfare	• Demonstration of economic viability of aquaculture operations
Domestic milkfish fry production	• Imported milkfish fry from neighbouring countries and/or Taiwan • High costs of supply which hurt economic viability • Vulnerability of wild milkfish fry to climate change impacts • Vulnerability of imported milkfish fry to external shocks (COVID-19 prevented freight)	• Creation of income diversification opportunities (milkfish fry for aquaculture production and to be used as tuna bait) • Sustainable, climate resilient domestic supply chain • Reduced production costs for milkfish	• Creation of a climate-resilient, community-owned domestic supply chain • Diversification of income for local communities and job creation • Climate-proofing milkfish production
Domestic milkfish feed production	• Imported milkfish feed from neighbouring countries or Asia • High costs of supply which hurt economic viability • Vulnerability of imported feed to external shocks (COVID-19 prevented freight resulting in complete halt of aquaculture production)	• Year-round availability of milkfish feed at a lower cost domestically • Decreased aquaculture production costs • Creation of diversified income-generating activities	• Creation of a climate-resilient, community-owned domestic supply chain • Diversification of income for local communities
Marine monitoring systems	• No monitoring stations to collect data on ecosystem health, reef status, chemical indicators etc.	• Availability of data relating to reef health, marine resources, fish stocks etc.	• Enhanced ability of GoN, NFMRA and community stakeholders to effectively plan for and manage marine resources, fisheries and coastal restoration efforts based on scientific evidence

2.7.2 Environmental and social assessment

The social and environmental assessment is a process that aims at reviewing a project to identify whether it is likely to cause adverse social and environmental risks and/or impacts.

What for? Make an initial assessment of risks and/or impacts based on criteria allowing to categorize them according to their significance (low – medium or high- risk project).

When? It is a desk assessment undertaken at the stage of project design, before project proposal approval, to determine if further assessment of the identified risks/impacts is necessary and if prevention or mitigation measures can be integrated within the project activities.

How? It is based on information made available for the project design and should be conducted in using the Social and Environmental assessment Questionnaire. It is the assessment Report that determines the risk category for each project on the basis of the identification and ranking of risks/potential impacts, in taking account of available information as well as comments from consulted stakeholders including affected populations.

By Whom? The Project Manager in charge of the Project Concept Note is responsible for filling in the SER Questionnaire and make recommendations for the next septs.

Next Steps:

- if the project is ranked as "**low risk**" from the screening process, no further assessment is needed, and the project can be approved after technical appraisal.

- if the project is ranked as "medium" or "**high risk**", further assessment may be needed in order to determine if it can be implemented while not triggering the social and environmental safeguards of SPC SER Policy, and under what conditions or adjustments, including mitigation measures.

Table 19 SPC SER assessment questionnaire

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	**If no answer, please shortly justify** **If Yes answer, describe potential issues, specify activities causing the risk identified.** **characterise the identified risk or impacts (likelihood, intensity, duration, reversibility)** Indicate the risk localization (local/national/global)	**Where applicable, identify the remedial actions that would mitigate the identified risk**	**Characterize the risk level:** **Low (L), Medium (M) high (H)**
1. Labour and Working Conditions	Will the project present unsafe, indecent or unhealthy working conditions for stakeholders involved?	TBD	The project activities that may bear a safety risk are related to the construction of facilities, ponds and small-scale infrastructure. Safe labour conditions for construction workers will be ensured through the development of an environmental and social management system (ESMS). Risk localization: Local		L
	Is there potential for the project to apply adverse discriminatory practices based on religious, racial, gender, disability or political considerations?	No	The project activities will follow an integrated approach which aims to mobilize and include all stakeholders involved in marine resource planning and fisheries management, from local communities to government stakeholders. Representation of all groups including minorities will be ensured in the organisation of project activities including workshops, field trips, and training sessions. Additionally, and where numbers allow, gender balance will be applied to all project activities. Risk localization: National		L

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	**If no answer, please shortly justify** **If Yes answer, describe potential issues, specify activities causing the risk identified.** **characterise the identified risk or impacts (likelihood, intensity, duration, reversibility)** Indicate the risk localization (local/national/global)	**Where applicable, identify the remedial actions that would mitigate the identified risk**	**Characterize the risk level:** **Low (L), Medium (M) high (H)**
2. Climate change	Could the project adversely contribute to climate change by generating greenhouse gas emissions including through deforestation or forest degradation?	No	The project will not support any activity, infrastructure, or investment that might directly result in an increase in GHG emissions. The only expected GHG emissions to be generated by the project are those relating to the freight of materials and supplies from abroad, and the transport of people in Nauru and regionally. Risk localization: national		L
	Could the project negatively affect the resilience to climate change?	No	The risk of maladaptation of the proposed activities is low as their implementation will be directly informed by communities.		L
3. Resource Efficiency and Pollution Prevention	Will the project generate hazardous waste? Is the project likely to lead to environmental damages due to an uncontrolled management of waste?	TBD	A waste management plan will be required for the disposal of waste and waste by-products resulting from the small-scale infrastructure construction activities (concrete, plastic packaging etc.), especially as Nauru does not have a waste management and disposal system in place. Waste generated as part of the construction activities may require to be evacuated from the island after completion.		M

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	If no answer, please shortly justify If Yes answer, describe potential issues, specify activities causing the risk identified. characterise the identified risk or impacts (likelihood, intensity, duration, reversibility) Indicate the risk localization (local/national/global)	Where applicable, identify the remedial actions that would mitigate the identified risk	Characterize the risk level: Low (L), Medium (M) high (H)
	Is the project likely to lead to pollutants release? Are chemicals (including pesticides) likely to be used during the project?	No	No chemicals such as pesticides, herbicides or similar will be used as part of this project. The use of chemicals related to the construction of small-scale aquaculture production facilities can be expected to a limited extent. Provisions for the management and disposal of pollutants will be included in the project's ESMS.		L
4. Human Rights	Is the project likely to negatively impact on the human rights of the affected populations? (e.g. their rights to water, work, health, to a healthy environment, etc.)?	No	None of the proposed project activities are likely to impeach human rights of local communities.		L
	Is the project likely to create less favourable treatment of, or discrimination against, any person or group?	No	The proposed project will promote the inclusive participation of all community members, irrespective of age, sex, ethnicity, occupation or religion, through the establishment of government-community communication channels. Special attention will be given for the inclusion of women's voices and needs in the consultations.		L
	Is the project likely to increase the risk to people with disability (physical, hearing, visual, intellectual and sensory impairments)?	No	People with sensory impairments may be exposed to temporary noise and visual pollution as a result of the construction works (for small-scale aquaculture production facilities). Sufficient notice will be given if people with disabilities live around the site, and		L

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	If no answer, please shortly justify If Yes answer, describe potential issues, specify activities causing the risk identified. characterise the identified risk or impacts (likelihood, intensity, duration, reversibility) Indicate the risk localization (local/national/global)	Where applicable, identify the remedial actions that would mitigate the identified risk	Characterize the risk level: Low (L), Medium (M) high (H)
			temporary alternative accommodation will be provided.		
	Is the project likely to increase risks to children or vulnerable adults through interaction with SPC staff and non-staff?	No	None of the proposed project activities are likely to increase risks to children or vulnerable adults. The project will have a Grievance Redress and Complaints Mechanism in accordance with both AF and SPC Policy.		L
5. Impacts on Affected communities	Any risk that populations perceive they did not receive enough opportunities to raise their concerns regarding the project?	TBD	A grievance redress mechanism will be included in the Environmental and Social Management System to be developed, and will be published in transparent and accessible places for all beneficiaries. Additionally, adequate communication channels will be established between the project management unit and all project beneficiaries and stakeholders.		M
	Is there a risk that the project would create or exacerbate conflicts with or within affected populations?	TBD	Particular attention will need to given to land tenure and ownership dynamics prevalent in Nauru. The inclusion of the baseline in terms of land use and ownership will need to be included in the project ESMS, with associated mitigation measures included. Regular and transparent consultations between community leaders, members and the project		M

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	If no answer, please shortly justify If Yes answer, describe potential issues, specify activities causing the risk identified. characterise the identified risk or impacts (likelihood, intensity, duration, reversibility) Indicate the risk localization (local/national/global)	Where applicable, identify the remedial actions that would mitigate the identified risk	Characterize the risk level: Low (L), Medium (M) high (H)
			management unit will be established throughout the implementation of the project.		
	Is the project likely to increase community exposure to disease (water borne, water based, water related and vector borne diseases as well as communicable diseases)?	No	Risks related to water-borne diseases that may occur in small-scale ponds will be mitigation through the provision of biosecurity training and adequate water quality management.		L
6. Gender	Is there a likelihood that the project would have adverse impacts on gender equality, and/or the situation of women and girls?	No	Women will have equal access and participation opportunities to benefit from project activities. In particular, a target for the number of women to benefit from financing issued by the mini-grant facility will be developed as part of the project's gender assessment and plan. Nonetheless, due to the lack of available data and information relating to the role of women in coastal fisheries and aquaculture in Nauru, a full gender assessment informed by stakeholder consultations is needed at full project preparation phase.		L
	Have community groups/leaders raised gender equality concerns regarding the project during the stakeholder engagement process?	No	A full analysis of the gender situation in Nauru will be required at full project development stage; however, at this stage no stakeholder consulted as part of this pre-feasibility assessment raised issues relating to		L

SER Screening Questionnaire	Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
	Yes, No, n/a, TBD	**If no answer, please shortly justify** **If Yes answer, describe potential issues, specify activities causing the risk identified.** **characterise the identified risk or impacts (likelihood, intensity, duration, reversibility)** Indicate the risk localization (local/national/global)	**Where applicable, identify the remedial actions that would mitigate the identified risk**	**Characterize the risk level:** **Low (L), Medium (M) high (H)**
		gender dynamics in the fisheries or aquaculture sector. Further consultations will be carried out in full design stages.		
Would the project potentially limit women's ability to access or use natural resources upon which they depend for a livelihood?	No	The project will enhance women's access to fisheries resources through the provision of recommendations for the implementation of community fisheries management areas and plans. Special attention will be given to the inclusion of women in all consultations and at all stages relating to the establishment of committees, the identification of fisheries management areas, and the development of plans. Furthermore, the project will enhance women's access to financing for aquaculture operations through the definition of a dedicated target for the disbursement of mini-grants to women beneficiaries. Effectively, the project will create additional income opportunities directly benefitting women's livelihoods.		L

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	**If no answer, please shortly justify** **If Yes answer, describe potential issues, specify activities causing the risk identified.** **characterise the identified risk or impacts (likelihood, intensity, duration, reversibility)** Indicate the risk localization (local/national/global)	**Where applicable, identify the remedial actions that would mitigate the identified risk**	**Characterize the risk level:** **Low (L), Medium (M) high (H)**
	Is the project likely to increase risks of sexual harassment or sexual exploitation?	No	None of the project activities are expected to result in an increased risk of sexual harassment or sexual exploitation. A Grievance Redress Mechanism and Complaints mechanism will be established in accordance with FPIC provisions. The baseline with regards to GBV and the role of women in fisheries and aquaculture will need to be established at full project preparation stage as there is little to no data available for Nauru.		L
7. Resettlement	Could the project involve the physical relocation of people? (encompassing displacement as well as planned relocation)	No	Considering Nauru's unique land tenure and ownership framework and dynamics, it is not expected that the project will involve the physical relocation of people. Indeed, terrestrial land is individual or family-owned, therefore the project will require extensive community consultations to ensure that local communities engage with and perceive the benefits of the project interventions.		L
8. Use of natural resources	Could the project lead to adverse impacts on biodiversity or natural habitat?	TBD	It is not expected that the planned small-scale construction works have any impacts on biodiversity or natural habitat, as most of construction site will be in existing residential areas. Criteria in the application to receive grant funding will include questions to assess the expected environmental and social impact		L

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	If no answer, please shortly justify If Yes answer, describe potential issues, specify activities causing the risk identified. characterise the identified risk or impacts (likelihood, intensity, duration, reversibility) Indicate the risk localization (local/national/global)	Where applicable, identify the remedial actions that would mitigate the identified risk	Characterize the risk level: Low (L), Medium (M) high (H)
			of the construction works based on the chosen location. Additionally, the potential impacts of FADs will need to be fully accounted for in the project ESMS with associated mitigation measures.		
	Is the project likely to negatively impact a protected area?	No	Construction of infrastructure will not occur in potential or effective terrestrial or marine protected areas. This will be ensured through the inclusion of relevant criteria and questions in the application forms for the mini-grant facility.		L
	Is the project likely to introduce invasive alien species to the project area?	No	The proposed project will not introduce any non-native species to the project site. For coastal restoration activities, if the developed community fisheries management plans choose revegetation activities, only native species will be utilized. The nursery established as part of the R2R project can be leveraged to this end. Provisions will be included in the ESMS.		
	Is the project likely to restrict People's access to natural resources and their means of livelihoods?	No	The project will advocate for rotational and seasonal closures of fisheries managed areas as part of the fisheries management plans, however these measures will be temporary and it will be ensured that fishing locations remain open.		L

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	If no answer, please shortly justify If Yes answer, describe potential issues, specify activities causing the risk identified. characterise the identified risk or impacts (likelihood, intensity, duration, reversibility) Indicate the risk localization (local/national/global)	Where applicable, identify the remedial actions that would mitigate the identified risk	Characterize the risk level: Low (L), Medium (M) high (H)
	Is the project likely to favor unsustainable exploitation of a renewable resource?	No	The proposed project aims to break the cycle of fisheries resources depletion in coastal and reef settings.		L
9. Peoples right and tenure	Is the project likely to negatively affect Peoples or communities rights: rights of affected populations, including procedural rights such as the right to be consulted or to have access to information, or substantive rights (real or personal) such as the right of access to natural resources or benefit-sharing related to these natural resources (carbon rights, benefits from access to genetic resources ...).	No	The project will contain a Grievance Redress Mechanism and Complaints Handling Mechanisms at the local and project levels to ensure that there are open communication channels (in accordance to FPIC principles).		L
	Could the project require the relocation of Peoples from their homes or lands subject to traditional ownership or customary use?	No	The construction of small-scale aquaculture infrastructure will take place a) on NFMRA's site in Anibare, and b) on individual plots as a result of the application of the landowner. As a result, none of the project activities contain a risk of relocation for communities.		L
10. Cultural heritage	Is the project likely to negatively affect cultural heritage?	No	The project aims to renew interest and facilitate the uptake of a cultural heritage that is the production of milkfish. No construction or rehabilitation activities will take place on or around an area of cultural significance. Consultations with local communities will ensure that culturally important coastal areas are		L

SER Screening Questionnaire		Risk Description		Risk assessment to be completed only if the answer is "Yes" under the risk description column	Score
		Yes, No, n/a, TBD	**If no answer, please shortly justify** **If Yes answer, describe potential issues, specify activities causing the risk identified.** **characterise the identified risk or impacts (likelihood, intensity, duration, reversibility)** Indicate the risk localization (local/national/global)	**Where applicable, identify the remedial actions that would mitigate the identified risk**	**Characterize the risk level:** **Low (L), Medium (M) high (H)**
			protected and restored in adequation with local traditional knowledge and beliefs.		
	Is the project likely to negatively affect a legally protected cultural heritage area?	No	At date of writing, there are no legally protected cultural heritage areas in Nauru.		L
Risk categorization process			• If only L on the right hand column, then the project is Low risk > no further assessment is required • If one or more M then the project is Medium risk > further assessment is required to formulate alternatives • If one of more H, > topic assessment is compulsory , including for the assessment of credible alternatives (NB: the project may have to be categorized as Medium or High risk depending on the outcome of the ESIA)		M

Conclusion:

- Risk Categorization (tick the relevant answer in the right-hand box: **Medium**

Recommendations for next steps:

- Is further assessment needed (Please specify if it is a topic or full Environmental and Social Impact Assessment, as well as in which areas or on which topic(s) any such further assessment should be conducted):

Topics/areas to be further assessed	Type of Assessment
Labour and working conditions for construction workers	Environmental and Social Impact Assessment
Hazardous waste and pollutants	Waste management plan
Land tenure and ownership dynamics	Environmental and Social Impact Assessment
Adverse impacts on biodiversity or natural habitats	Environmental and Social Impact Assessment

I, undersigned, Mr/Ms XX, hereby certify that I have answered this Questionnaire truthfully and to the best of my knowledge.

Signature:

2.7.3 Gender assessment

Assessing gender dynamics in relation to the coastal fisheries and aquaculture sector in Nauru is made difficult due to the unavailability of data. Since the 1998 SPC's Gender Assessment on the role of women in fisheries[166], only a couple of reports have been developed. The 2015 SPC Gender Stocktake identified a number of barriers and issues hampering gender mainstreaming into government mandates and organisational structures, as well as in policy frameworks. However, this analysis does not specifically cover gender dynamics and mainstreaming capacity relating to the fisheries and aquaculture sectors.

The NFMRA does not collect any data with regards to the roles and responsibilities of women in the fisheries sector, and there is little collaboration between the NFMRA and the Department for Women's Affairs.

In light of the above, a number of recommendations can be made for the development of the gender assessment at full proposal development stage:

- With regards to the fisheries sector, there is a need to identify areas where women can be better supported for greater participation, more efficiency, obtain greater higher economic returns, and how to ensure general safety at all points along the fisheries value chain. This can include but is not limited to various post-harvesting and value adding processes, packaging and retailing.
- How best to structure cooperative or associative efforts based around women and men's different needs, households needs, social and cultural obligations and labour requirements
- How best to structure the mini-grant facility criteria to ensure women's access to the facility and assess basic financial literacy
- Explore possibilities for women's perspectives to be fully integrated into fisheries management and marine conservation plans
- Include the collection of gender-disaggregated data by NFMRA and other line ministries' workplan and CFA roadmap.

As a sector-specific gender assessment is not available at this stage, the analysis provided below focuses on an overview of gender dynamics and issues in Nauru.

Policy framework

The Constitution gives equal rights to women and men. In 2009, the government prepared for Nauru to become signatory to the Convention on the Elimination of All Forms of Discrimination Against Women (CEDAW). Nauru acceded to the CEDAW in June 2011. After accession, the government is undertaking a complete review of the Criminal Code, and proposes to include in the revised Code provisions that deal specifically with domestic violence, and which afford women greater protection from threatened, apprehended and actual domestic violence.

The Department of Women's Affairs has existed since 1997. Prior to its establishment, the Department of Foreign Affairs dealt with issues concerning women, and their only formal source of representation was the Nauru National Council of Women. The Department of Women's Affairs works with the Department of Culture and NGOs to promote craft activities, employment opportunities for women and youth and to make representation on women's needs.

The National Women's Policy, which was enacted in 2014, has six goals based on the National Plan of Action for Women and the NSDS, (i) improved participation of women in decision making and

[166] SPC (1998) An Assessment of the Role of Women in Fisheries in the Republic of Nauru. Available here.

leadership on all levels, (ii) elimination of all forms of violence against women, (iv) improved women's health, (v) improved and equitable participation in education by women and girls, (vi) a strengthened Women's Affairs Department and improved capacity of government agencies to mainstream gender. The main aim is to advance and improve the quality of lives. Key actors in Nauru working in various aspects of Gender Equality and Women's Empowerment are the Ministry of Foreign Affairs, the Department for Justice, the Department for Women, the Police Domestic Violence unit, Nauru Safe House, Nauru Umbrella of NGO's and the National Council of Women.

Nauru recognizes that there still remain considerable obstacles and challenges for women in Nauru primarily based on the lack of technical expertise in the areas of great need. According to NSDS, women have equal opportunity in the public service. There is currently one woman Member of Parliament, the current Minister for Home Affairs, and there have only ever been two female MPs. Women were previously under-represented on the boards of State-Owned Enterprises and senior official positions but are now present on all SOE Boards. Apart from this policy for SOE boards, requiring at least one woman on all SOE boards, there are no affirmative action policies in Nauru.

Key gender issues

Gender-based Violence (GBV)

Violence against women is anecdotally reported to be widespread in Nauru; women who report violence may be stigmatised and they are also at risk of further violence from perpetrators. This set of social patterns makes it difficult for women to break out of abusive situations. During the stocktake[167] informants repeatedly mentioned that domestic violence is under-reported in Nauru. Despite this the majority of cases reported to police are withdrawn and few cases are actually heard in court. There are no comprehensive baseline studies on prevalence or severity of violence against women and children. In 2014 UNFPA was working with Nauru to undertake a Family Health and Safety study using WHO methodology to document intimate partner violence. At the outset of the survey, response rates were average in the first two or three communities. However, as information about the content of survey questions was shared around the island, women in other communities declined to participate despite confidentiality protocols. Of those surveyed, the findings were as followed:

- Nearly half of ever-partnered women (48.1%) who participated in the survey experienced physical and/or sexual violence by a partner at least once in their lifetime;
- Nearly half of ever-partnered women (46.6%) who participated in the survey experienced physical partner violence at least once in their lifetime and 20.6% indicated experiencing such violence in the 12 months before the interview took place;
- The most commonly mentioned act of physical partner violence was being slapped or having something thrown at them (84.1%);
- Among ever-pregnant women who reported experiences of physical and/or sexual partner violence, 25.4% experienced physical violence in at least one pregnancy.
- One-fifth of ever-partnered women (20.6%) experienced sexual violence by a partner at least once in their lifetime and 9.9% said to experience such violence in the 12 months prior to the interview.

Women in leadership and politics

[167] SPC (2015) Stocktake of the gender mainstreaming capacity of Pacific Island governments. Nauru.

Women are seriously under-represented in political leadership. Only one of the 19 members of parliament is female, and she is only the second woman ever elected. While women are represented in the public service, the majority are concentrated in lower level positions. There is no sexual harassment policy in the public sector and there are reportedly inequitable levels of pay for male and female staff doing equivalent work with equivalent qualifications. Nauru has matrilineal inheritance traditions and awareness of women's rights as landowners has had some positive influence on girls' education and has resulted in a degree of openness to women's advancement in the public sector; however, women are still in the minority at senior levels. This is despite the fact that the Department for Human Resources and Labour regularly notes in its advertisements that women are encouraged to apply. However, women face a number of barriers that also prevent them from undertaking multiple roles. The total fertility rate in Nauru is high and women are primarily responsible for work in the home and for childcare. These multiple responsibilities are not fully acknowledged or supported through government policy and consequently it is more difficult for women than men to devote the time required to high-level posts.

Economic status

The economic situation in Nauru has been difficult for both men and women since the decline of the phosphate mining industry that was the main source of revenue for landowners. There are limited sources of employment, no banks on the island and very few financial services for women who wish to become entrepreneurs. As a consequence, women have little knowledge of how to successfully generate income or start, run and manage a business. The National Women's Policy also identifies sexual harassment and discrimination in the workplace, lack of pay equity and limited social services as barriers to women's economic participation, as well as to their advancement into leadership positions. Women have identified lack of economic opportunities as a constraint to effectively supporting their families. This in turn creates an ongoing cycle of dependency and apathy. Impacts include a rise in gambling, increasing truancy among children and high rates of teen pregnancy. Parents who have themselves dropped out of school don't see value in sending children to school since there are few employment opportunities. This creates a cycle of non-attendance and perpetuates a general decrease in social cohesion and community-oriented values. There are few market opportunities for women and those that exist tend to be under-used. Handicraft, agricultural and fisheries activities are limited and most are for home use.

Health and education

Nauru has a high rate of non-communicable diseases, high incidence of sexually transmitted infections and the second highest adolescent fertility rate in the Pacific after Marshall Islands. The total fertility rate is high at 4.3 (2011 Population and Housing Census) and there is a lack of knowledge about sexual and reproductive health issues, including birth control among adolescents and prevention of sexually transmitted infections among the general population. There is a staff shortage in the health system, and this impedes delivery of health services and health promotion campaigns, making it more difficult for women of all ages to be proactive about their health. Due to the collapse of the Nauru economy, geographic isolation and social problems such as alcoholism, violence against women and high levels of disability related to non-communicable diseases, there are also serious mental health concerns for Nauruan women. In the education system there do not appear to be significant gender disparities when measured by enrolment and completion rates. Within the education system the only areas where boys and girls are segregated is in sports and for sex education classes. Girls who get pregnant are not required to leave school; however, there may be family and community pressure for them to do so. In addition, low expectations of what they can achieve in the Nauru society and economy may also undermine their motivation to continue attending school while they are pregnant and after they have given birth. According to the Secretary for Education, gender discrimination becomes clear only once students move into work experience and formal employment. There seems to be a preference for employers to want young men and women to fill traditional gender roles in employment. Because women have traditionally been in lower paid clerical and service-oriented jobs while men have held

either more profession or technical positions, stereotyping and streaming in the workplace is linked to an imbalance of earning power.

Employment

Men employed by government and private sector are slightly over-represented among the poor and vulnerable households compared to their female counterparts. Around 46% and 23% of male labour force (age 15-59), compared to 30% and 12% of female labour force (age 15-59) were employed by public and private sectors respectively. A larger number of women (15-59) was engaged in home duties as their sole economic activity, compared to males from the same age group. Engagement in home duties was the main and only economic activity for around 39% of all females age 15-59, compared to 12% of males from the same age group. This confirms that Nauru society is based on patriarchal principles of labour division of home (not remunerated, female domain) and public (remunerated, regarded as male domain).

2.7.4 Economic viability and cost effectiveness

One of the key objectives of the proposed project is to demonstrate the economic potential of aquaculture production as a tool to adapt livelihoods to climate change and support the restoration of vulnerable climate-impacted marine ecosystems. Past projects which have attempted to revive milkfish aquaculture production in Nauru display a long history of maladaptation due to both inadequate geographical focus primarily on Buada Lagoon, which is constrained by its surface area by nature and also by land ownership rules in place, which prevent the introduction of new aquaculture operators on the site.

Initially, by focusing on strengthening the enabling environment for aquaculture production and through the provision of capacity strengthening and training activities to communities and government stakeholders, the project aims to create a conducive ecosystem to attract new aquaculture operators. Then, by offering small grants through a community-led and demand-based led mini-grant facility, the project aims to incentivise aquaculture production among the most vulnerable communities by lifting barriers of accessing finance to enable investment in small-scale aquaculture facilities. With an estimated 10,000 USD for the construction of a small-scale pond, the establishment of the proposed mini-grant facility would enable one of the most cost-effective adaptation measures to secure a climate-resilient food supply and divert pressure away from Nauru's climate-impacted coastal and marine ecosystems.

The NFMRA supported a pilot project to demonstrate the technical and economic viability of milkfish production by subsidising a couple of private pond-owners to purchase milkfish fry and feed. About 2,000 USD were spent on the subsidy for each pond owner, and it was reported as part of stakeholder consultations that over 15,000 USD of gross revenue was generated within the first 6-month growing period. It was additionally reported that the demand for fresh milkfish was so high that some people placed pre-orders. The NFMRA is unable to upscale the pilot project to a larger audience due to important financial and budget constraints, however this example demonstrates the strong market potential for farmed milkfish in Nauru. Additionally, it is envisaged that the proposed project will support the creation of a domestic supply chain for milkfish feed, by experimenting with various production methods, and reinstate milkfish fry production through the construction of a hatchery in NFMRA's facilities. Securing a domestic supply of milkfish feed and fry will further reduce the initial investment costs as well as the operating costs of small-scale milkfish ponds over the longer-term.

Although the estimated cost per beneficiary is high compared to traditional benchmarks (see 2.6.2 Profiles and selection criteria of direct and indirect beneficiaries), the size of Nauru as a country, the limited number of people and their acute vulnerability to climate change call for funding to be mobilized to secure the sustainable uptake of aquaculture operations and the preservation of vulnerable ecosystems. Overall, more resilient coastal fisheries and a productive aquaculture sector represent some of the last available options for the people of Nauru to adapt their livelihoods in the

face of climate change, economic downturn and external factors as exemplified by the COVID-19 pandemic. Considering changes in the quantity and distribution of fish stocks and particularly tuna species, the progressive interruption of phosphate mining activities, and the potential closure of the Australian Regional Processing Centre, national economic prospects for Nauru are dire unless the adaptation costs for the coastal fisheries and aquaculture sectors are met.

2.8 Risk analysis and mitigation measures

Risk description	Probability	Impact	Proposed mitigation measure
Changes in political leadership at national and local level result in delays or a refocus or suspension of project activities.	Low	High	The probability of a leadership change resulting in a refocus of the project is highly unlikely given that aquaculture development is of the GoN's top priority. The project management unit and national coordination team will ensure that communication and collaboration channels are maintained regularly throughout the lifetime of the project.
COVID-19 pandemic prevents or increases the costs of transport and freight for necessary supplies and construction materials	Medium	Medium	All project activities will be able to be implemented in the event of disturbances in freight and transport with the exception of construction of small-scale aquaculture facilities, and the regional knowledge exchange with MASA countries. For the former, at the earliest stage once implementation of the mini-grant facility starts, the PMU and national coordination unit will plan and secure the necessary supplies and tools for the construction. For the latter, meetings and workshops will be held virtually.
Complex land tenure situation can cause delays or halt construction of small-scale infrastructure or coastal restoration activities	Medium	High	The project assumes sufficient buy-in and that the landowners will engage in the construction of small-scale aquaculture infrastructure. However, given the number of private lands owners involved who all need to endorse the activities relating to coastal restoration and management, this process could create delays in implementation. The process of obtaining a community endorsement will start during the initial environmental and social impact assessment. Awareness campaigns on coastal protection will improve the understanding of the proposed interventions making sure they are supported and endorsed by the community.
High staff turnover and limited national human resource base could compromise the project management unit and delay implementation	Medium	Medium	Competitive salaries and incentive packages will be offered, in addition to means of transport to get to the office. Training and other incentives should also help make the positions attractive.
Spillage of construction materials: The transport and supply of material, and any other machinery may have impacts that may arise from accidental spillage of construction materials (e.g. cement).	Low	Medium	Compliance with the project ESMS will significantly reduce both the likelihood and the impact(s) of this risk.

2.9 Project sustainability and exit strategy

Given the highly uncertain financial trajectory of Nauru, with volatile revenue sources, capacity and infrastructure constraints and climate change, Nauru is at a point of transition with a decline in phosphate mining and the activity associated with the Regional Processing Centre (RPC) for asylum seekers which prevent the financing of adaptation measures. New sources of economic growth and income are needed to support Nauru's development and climate change agenda[168]. Due to the nature and scale of climate change impacts, the GoN is not able to finance the resilience of the aquaculture sector and of the coastal fisheries sector. Impacts on tuna fisheries in the medium to longer term will result in important government revenue deficits, and the progressive depletion of coastal fisheries resources will unavoidably result in decreased income and food supply for vulnerable people of Nauru. AF funding would act as a trigger for the transformation of Nauru's economy and its sustainability will be ensured through the following ways:

1. Supporting the enabling environment for national uptake of aquaculture operations
2. Transfer or incorporation of the mini-grant facility at the end of the project from SPC to GoN
3. Knowledge transfer and dissemination of lessons learned on the national and regional levels

Under Component 1, the project will work with the GoN and NFMRA to develop a roadmap and a set of guidelines for the implementation of the CFA Act of 2020. Insufficient technical capacity and limited budget allocation have so far hampered the GoN's efforts to implement strategies pertaining to the coastal fisheries and aquaculture sectors. Through the provision of guidance, recommendations, and training, the project will seek to provide the GoN and communities with the necessary tools to effectively manage fisheries resources and contribute to the long-term resilience of ecosystems. Further, support towards the development of the National Aquaculture Plan and national aquaculture standards will be instrumental to the sustainability of a conducive environment for domestic aquaculture production.

Under Component 2, each project to be financed under the mini-grant facility will have to include a maintenance plan with clear allocated resources and responsibilities, to demonstrate how the financed infrastructure will be sustained over the long-term. The expected profits that are generated from the sale of milkfish at market will provide sustained resources to implement the maintenance plans. Additionally, the PMU and National Coordination Unit will aim to support the GoN to create an enabling environment for the uptake of the aquaculture sector, with a view to attract private finance in the future. Under Component 3, regional workshops will serve the purpose of both knowledge and information exchange, as well as platforms to engage with private sector stakeholders. The PMU will utilize the knowledge products generated throughout the project and specifically under Component 3 to disseminate the results of the sub-projects financed through the mini-grant facility.

Lastly, from the start of the project implementation, the PMU and the National Coordination Unit will seek to engage with the GoN to discuss the inclusion or incorporation of the mini-grant facility to be established under Component 2 into the Coastal Fisheries and Aquaculture Development Fund, which is a key provision of the CFA Act of 2020. Alternatively, SPC will hand over the mini-grant facility to the NFMRA. In both cases, by the end of the project implementation period, the processes and guidelines for the operation of the mini-grant facility will be effective, facilitating the transfer of the structure to national authorities.

[168] IMF (2020) IMF Country Reports 20/31. Republic of Nauru: 2019 Article IV Consultation-Press Release; Staff report, and Statement by the Executive Director for the Republic of Nauru. Available here.

2.10 Projected calendar for implementation

Milestones	Expected Dates
Start of Project/Programme Implementation	01/2023
Mid-term Review	Q3 2025
Project/Programme Closing	12/2027
Terminal Evaluation	Q4 2027

COMPONENTS/OUTPUTS	2023				2024				2025				2026				2027			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Component 1: Enhanced policy, regulatory and legislative environment for resilient coastal fisheries and aquaculture																				
Output 1.1 **Provision of technical assistance and recommendations to the GoN for the effective implementation of the Coastal Fisheries and Aquaculture Act of 2020**																				
Output 1.2 **National awareness-raising campaign on climate change impacts on fisheries and aquaculture and provision of capacity-building to secure the uptake of provisions and measures under the Coastal Fisheries and Aquaculture Act**																				
Component 2: Financing climate resilience for coastal fisheries and aquaculture sectors																				

COMPONENTS/OUTPUTS	2023				2024				2025				2026				2027			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Output 2.1 **Enhanced coastal fisheries management and biodiversity conservation**																				
Output 2.2 **Provision of infrastructure and equipment to enable the sustained production of milkfish for increased domestic food supply and income**																				
Component 3: Monitoring, Evaluation and Learning																				
Output 3.1 **Establishment of a knowledge management strategy (KMS) to sustain climate-resilient practices in environmental and natural resource management**																				
Output 3.2 **Learning and dissemination of project results**																				
Project Monitoring*					APR				APR		MTR		APR				Completion Report			Terminal Evaluation

APR = Annual Performance Report

2.11 Project indicative budget

Project/Programme Components	Expected Concrete Outputs	Expected Outcomes	Amount (US$)
Component 1: Enhanced policy, regulatory and legislative environment for resilient coastal fisheries and aquaculture	Output 1.1. Provision of technical assistance and recommendations to the GoN for the effective implementation of the Coastal Fisheries and Aquaculture Act of 2020	Outcome 1: Implementation of recently enacted institutional, regulatory and legal frameworks related to coastal fisheries and aquaculture is facilitated through the provision of recommendations and technical support to enable the long-term climate, environmental and economic resilience of the sectors.	$660,000
	Output 1.2. National awareness-raising campaign on climate change impacts on fisheries and aquaculture and provision of capacity-building to secure the uptake of provisions and measures under the Coastal Fisheries and Aquaculture Act		$353,000
Component 2: Financing climate resilience for coastal fisheries and aquaculture sectors	Output 2.1. Enhanced coastal fisheries management and biodiversity conservation	Outcome 2: Improved food security and nutrition through increased farmed fish supply, increased adaptive capacity and income of aquaculture operators and reduced pressure on climate-vulnerable coastal and reef ecosystems.	$1,400,000
	Output 2.2. Provision of infrastructure and equipment to enable the sustained production of milkfish for increased domestic food supply and income		$5,550,000
Component 3: Monitoring, Evaluation and Learning	Output 3.1. Establishment of a knowledge management strategy (KMS) to sustain climate-resilient practices in environmental and natural resource management	Outcome 3: Increased compliance with environmental recommendations and provisions under policy frameworks through enhanced capacity of local communities and NFMRA officers to collect and interpret data.	$292,000
	Output 3.2. Learning and dissemination of project results		$266,000
6. Project/Programme Execution cost			$140,000
7. Total Project/Programme Cost			$8,636,000
8. Project/Programme Cycle Management Fee charged by the Implementing Entity (if applicable)			$710,000
Amount of Financing Requested			**$9,511,000**

3. Implementation arrangements

3.1 Stakeholder consultation process

Stakeholder engagement and consultation was a key consideration in the elaboration of this initial project design. Consultations with key stakeholders and potential project partners have been conducted over the period November 2021 to February 2022. Consultations were undertaken remotely using online means of communication. The consultations aimed to:

- Gather relevant information on the technical, operational and financial capacity of the Executing Entity
- Gather missing information and data for the development of baseline and contexts sections
- Gather lessons learned and insights into past and ongoing relevant projects from other donors
- Seek feedback on the proposed project structure activities to ensure their adequacy with the context and identified climate change drivers
- Gather information for the mapping of barriers hampering the conservation of coastal areas and the uptake of the aquaculture sector
- Ensure overall alignment with national priorities and buy-in.

It is to be noted that the Nauru's Women's Affairs Department could not be consulted at this pre-project design phase, and it will be essential to engage with the Department at full project development phase as the lack of information on gender dynamics particularly pertaining to the fisheries and aquaculture sectors is a key issue and barrier. Additionally, community leaders and community members will need to be included in consultations at full project design phase, using means such as workshops and meetings to promote ownership of the project activities.

The meeting minutes of the stakeholder consultations can be found in the Stakeholder Consultations report annexed to this pre-feasibility study.

3.2 Capacity assessment of the executing entity

Stakeholder consultations conducted as part of the design process provided insights into the technical, operational, organizational and financial capacity of the NFMRA.

The governance framework of the Nauru Fisheries and Marine Resources Authority is currently that of a State-Owned Enterprise, as defined by the 1997 NFMRA Act. However, unlike many other Pacific Island government fisheries services, NFMRA generates far more income – primarily from fees paid by foreign vessels to fish in the Nauru EEZ – than its expenditure. The current financial management process through central government has ensured that the broader national interest is upheld in the disbursement of fisheries income, but has restricted NFMRA from efficiently fulfilling many of its regulatory functions. The finances of the Authority have been managed directly by Government ever since an amendment of the Act in December 2004 that required all NFMRA revenue to be received by the Ministry of Finance. The primary role of the NFMRA Board of Directors – of financial oversight and ensuring probity – has thus been more or less in abeyance since 2005, and in the hands of Government. The FY 2020-2021 budget of NFMRA was 2,349,944 USD[169] when offshore fishing licenses amassed more than 54,530,000 USD in government revenue over FY 2020-2021.

While mandated to execute national coastal fisheries and aquaculture policy and legislation, the NFMRA has limited technical capacity to manage major strategic environmental and natural resource management planning processes. The NFMRA have limited systems or skills for financial and project

[169] Republic of Nauru (2020) 2020-2021 Budget and Estimates of Revenue and Expenditures. Budget Paper no. 1. Budget Strategy and Outlook. Available here.

management, and procurement to execute the key projects envisaged by the national policy and legislative framework, despite these projects being critical to achieving national coastal marine ecosystem health and food security. The NFMRA has relatively low capacity for gender responsive and socially inclusive community engagement. This will remain an ongoing barrier to ensuring strategic climate adaptation actions and projects benefit the most vulnerable groups in Nauruan society.

It is recommended that a full assessment be conducted to determine whether the NFMRA has sufficient technical, operational and financial management capacity to manage and implement the sub-projects to be financed under the mini-grant facility.

3.3 Implementation arrangements and governance of the project

SPC, in its capacity of Implementing Entity, will have oversight on the NFMRA's execution of the project activities. Additionally, a number of entities will be established to support the implementation of the project activities on the ground as well as the operationalisation of the mini-grant facility:

- Project Steering Committee, co-chaired by the Chief Executive Officer of the NFMRA and the AF DA and constituted of representatives of DCIE, MoF, Dept. of Women's Affairs
- Project Management Unit (At SPC Regional Office), composed of a project manager, an admin & finance assistant, a procurement officer and a technical officer
- A National Project Coordinator (based in Nauru)

The potential institutional arrangements diagram is provided below.

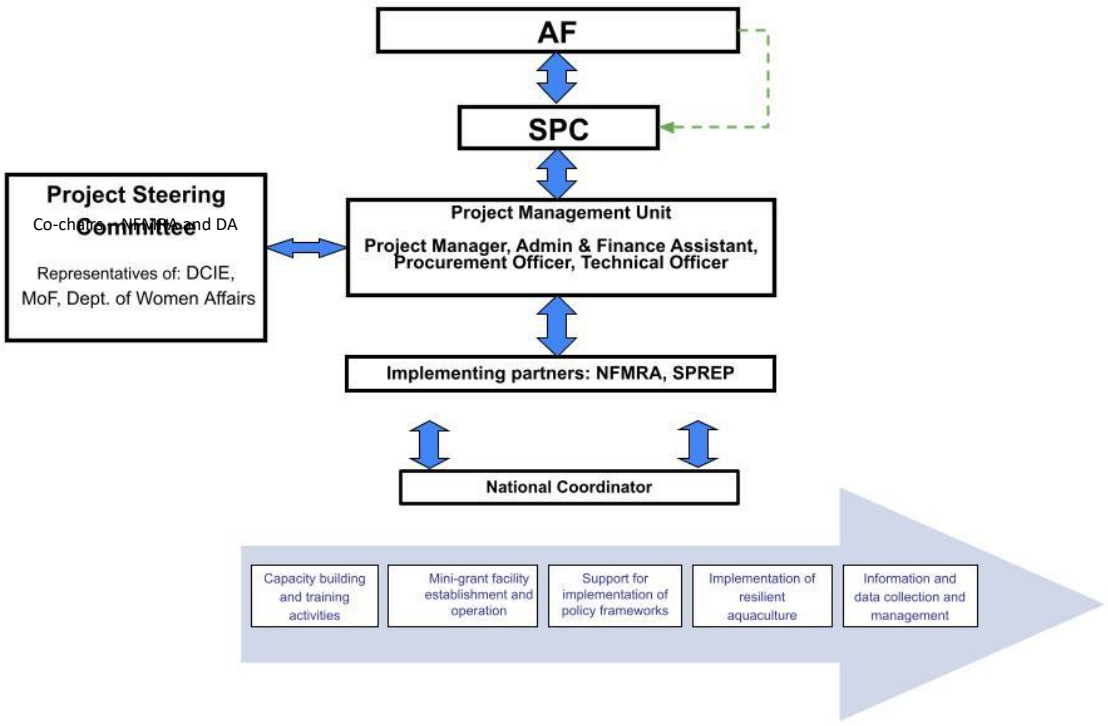

Table 20 Institutional arrangements diagram

3.4 Institutional and programme/project level grievance mechanism

A grievance is a concern or complaint raised by community members and stakeholders related to the perceived or actual impacts of the project activities. The objectives of setting up an appropriate grievance mechanism process are to:

1. Provide stakeholders with a clear process for providing comment and raising grievances.
2. Allow stakeholders the opportunity to raise comments/concerns anonymously.
3. Structure and manage the handling of comments, responses, and grievances in a timely manner.
4. Ensure that comments, responses, and grievances are handled in a fair and transparent manner and in line with local and national policies.

SPC Grievance Redress Mechanism

SPC has a Grievance and Redress Mechanism in place to ensure that complaints are being promptly reviewed and addressed by the responsible units (see https://www.spc.int/accountability). This process aims to address complaints from affected stakeholders, including communities, about the social and/or environmental performance of the project, and to take measures to redress the situation, where necessary. For the process to be efficient, project stakeholders have to be properly informed that SPC has such a mechanism established, and how they can access to it to settle their grievance.

The SPC GRM is operated through a web-hosted page on SPC site for the expression of concerns or complaints, which can be posted by email with the information in using the complaints' template (Please see Annex IV of SPC's GRM on SPC website)

Concerns expressed shall be received by the legal team who will reach out internally, primarily to the division in charge of the project or to relevant division. Grievances will be sorted out through a conflict resolution process. In case this process is not functional, other process will be used, such as a compliance system, the overall objective being to address and redress project stakeholders' grievances in the most simple and efficient manner.

Project-level Grievance Redress Mechanism

SPC is committed to receiving any concerns or grievances from an affected community about the environmental and social plans or performance of activity under the proposed project. In that direction, communities and stakeholders will be sensitised about the existing grievance process and form. AF Designated Authority will be responsible for supporting the communities with the information they need to properly submit a grievance letter. The GCF focal points are taking part into the grievance and redress mechanism through documenting grievances and coordinating with SPC the process to settle the grievances. For the proposed project, there are several processes to submit project related grievances:

1. An email can be sent to SPC through the online process: https://www.spc.int/accountability.
2. Contact the AF Designated Authority or submit a letter to the AF Designated Authority.
3. Bring up the complaint during the project update meetings or community awareness meetings. The complaint then must be directed to the AF Designated Authority who will then forward to the SPC legal team.
4. Mail can be addressed to the project institution, which will then be forwarded to SPC.

The AF Designated Authority will receive and register the grievance and will contact SPC legal team through a proactive outreach. He/she will provide an initial response within two business days to the

person who submitted the grievance to acknowledge the grievance and explain that the grievance will be logged onto the SPC GRM. As a first timeframe, a response will be provided to the complainant within a two-month period, with indication of appropriate process to address the grievance. This duration should be sufficient to screen the complaint, outline how the grievance will be processed, screen for eligibility as well as assign organisational responsibility for proposing a response. This response will propose a methodology to reach an agreement and address the complainant's concerns. This process will possibly involve engaging with other project stakeholders to resolve the issue.

SPC GRM is responsible to inform the complainant that he/she has the right to pursue other options to resolve the complaint if unsatisfied after the SPC GRM process, noting that the GRM may respond to questions from the complainant, but does not constitutes an advisor or attorney for the complainant.

All grievances will be recorded, and these records will be kept at a secure place for up to three years after the end of the project.

SPC's Social and Environmental Responsibility Grievance Mechanism Complaint Form can be found in Annex 2. Complaint form.

3.5 Monitoring and Evaluation arrangements and estimated costs

In its role as Implementing Entity, the Pacific Community (SPC) will oversee and supervise the implementation of this project in accordance with the agreement signed between SPC and the AF. SPC will be responsible for project-level monitoring and evaluation in compliance with SPC and AF policies through coordination between its Climate Finance Unit (CFU), Strategy, Performance and Learning (SPL) Team, the Designated Authority for the Republic of Nauru and Project Management Unit (PMU), implementing the necessary tools and methods to facilitate monitoring and evaluation of the project. The programme indicators described in the results framework will be jointly monitored by the DA, the PMU and SPC during program implementation via six-monthly supervision missions (or as needed) that will include results, reflection and planning meetings with project proponents and grantees. This will happen within the framework of regular monitoring and evaluation (M&E) procedures established during the project's inception phase.

The project implementation unit will include a designated MEL specialist to support the monitoring, evaluation and learning (MEL) of the overall project and of the sub-projects to be implemented under Output 2.2 as part of the mini-grant facility, by undertaking quarterly site visits to project sites. This M&E system will be aligned with the various policies and results frameworks of AF, the Nauru DA, SPC and the project itself. The MEL specialist will work with the PMU to develop MEL tools, approaches and reporting arrangements for sub-projects. This will include annual performance reports.

The CFU will be responsible for coordinating the independent interim and final evaluations, guiding SPL technical inputs to align with AF requirements. The evaluations will be conducted using a question-driven approach, and may include assessments against the criteria of relevance, effectiveness and sustainability, among others. The Mid Term Evaluation will be instrumental in contributing – through operational and strategic recommendations – to improve implementation, setting out any necessary corrective and adaptive management measures for the remaining period of the project, and identifying relevant lessons learned for stakeholders in Nauru as well as the broader Pacific region. The Terminal evaluation will assess the relevance of the intervention, its overall performance, as well as sustainability and scalability of results, differential impacts and lessons learned. Both evaluations will contribute to the evidence base for adaptation to climate change in Nauru and across the Pacific region and will be published on the SPC website and other relevant platforms.

The evaluation will draw on mixed-methods, using qualitative methods (e.g. participatory rural appraisal) in combination with counterfactual analysis, depending on the existence of reliable control group data from the project's baseline and end-line surveys. In addition to primary data collected by

the evaluators and secondary national data, both interim and final evaluations will draw on the monitoring reports and activities prepared by project staff. Careful attention will be paid to the disaggregation of data, results and outcomes by gender. The interim evaluation will be undertaken when delivery reaches 50% of the initial total budget and/or mid-point of scheduled project duration. The independent Terminal Evaluation will be launched within six months prior to the actual completion date of the project.

Indicative costs of monitoring and evaluation including Mid-Term and Terminal Evaluations are shown in the table below.

Type of Monitoring	**Responsible Party(ies)**	**Budget USD**	**Timeframe**
APRs	PMU and SPC Project Manager (review)	$5,0000	Annually
Mid-term review	IE, PMU, SPC Project Manager, External Consultants	$30,000.00	Mid-point
Terminal Evaluation	IE, PMU, SPC Project Manager, External Consultants	$45,000.00	End of project
Technical Reports	PMU and National Project Coordination Team		2 per year
TOTAL		**$100,000.00**	

Annexes

Annex 1. Pictures of the NFMRA holding facilities

NFMRA Aquaculture Holding Facility Bio-filters and overhead water tanks

NFMRA Aquaculture Holding Facility – fish conditioning tanks for milkfish fry

NFMRA Aquaculture Holding Facility – fish holding tanks for milkfish fry

NFMRA new raceways for giant clams and corals still under construction and installation

Annex 2. Complaint form

To: SPC (designate responsible Division or refer to headquarters),

- by post; - by email to:

1. We [insert name(s) and /or name of the institution] live and/or represent others who live in the project area [insert name of area, country].

_____
_____

2. The following project [insert name or description of project] implemented by SPC and [insert name of executing agency if known] is a cause for concern:

3. Description of the harm that is, or may be resulting from project activities:

_____
_____

4. Indicate the environmental and/or social safeguards of the SER Policy or related procedures you believe have been infringed and explain why they have not been complied with:

_____ _____

5. List the actions taken to solve the issue(s), including previous contacts with SPC and/or executing agency staff, describe explanations given and (if any) actions proposed, and why these are not considered satisfactory:

_____
_____

6. We request SPC to investigate these matters as part of its commitment to serve the Pacific Islands Community.

7. Signatures: _____

8. Date: _____

9. Contact address(es), telephone number(s), fax number(s) and email address(es):

_____ _____

10.List of supporting documents and attachments, as appropriate.

Important note: if the complaint is filled by a representative, please provide proof of representation.