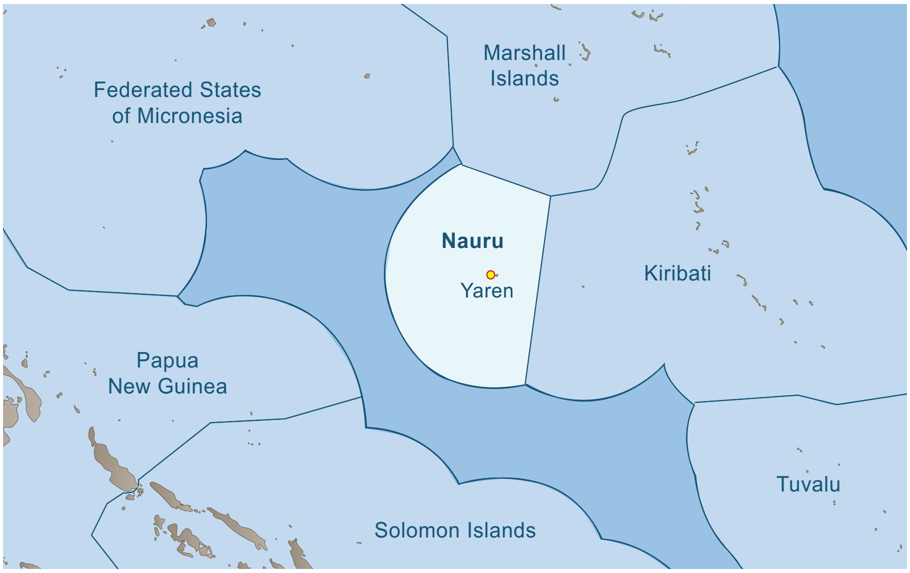
2.9 Nauru



Key features

Population

Year	2010	2035	2050	2100
Population (x 1000)[a]	10	14	16	21
Population growth rate[a]	2.1	1.2	0.8	0.2

a = Data from SPC Statistics for Development Programme (www.spc.int/sdp).

EEZ area (km^2) 293,079

Land area (km^2) 21

Land as % of EEZ 0.007

Fisheries and aquaculture activities: Oceanic fisheries and coastal fisheries, with some pond aquaculture.

Membership of regional fisheries management arrangements: Forum Fisheries Agency; Western and Central Pacific Fisheries Commission; Parties to the Nauru Agreement.

Surface climate and the ocean

Existing features

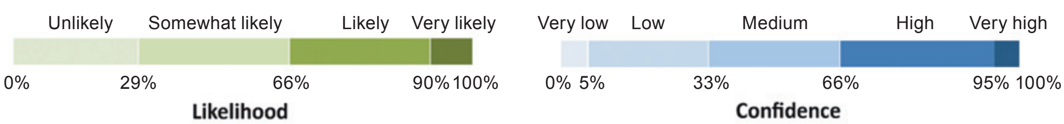
Nauru has a tropical climate {Chapter 2}. Recent air temperatures in Yaren have averaged 27.9°C and average rainfall is ~ 1950 mm per year. Nauru lies within the Pacific Equatorial Divergence (PEQD) and the Western Pacific Warm Pool (Warm Pool) provinces depending on the prevailing El Niño-Southern Oscillation (ENSO) conditions {Chapter 4, Section 4.3}. The PEQD Province is generated by the effects of the earth's rotation on the South Equatorial Current, which results in significant upwelling of nutrients {Chapter 4, Figure 4.3}. These conditions create the richest surface waters in the region.

Projected changes to surface climate

Air temperatures and rainfall in Nauru are projected to increase due to climate change under the low (B1) and high (A2) emissions scenarios in 2035 and 2100 {see Chapter 1, Section 1.3 for definition of scenarios} relative to long-term averages {Chapter 2, Section 2.5, Table 2.6}.

Climate feature[a]	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Air temperature (°C)	27.9 (Yaren)	+0.5 to +1.0	+0.5 to +1.0	+1.0 to +1.5	+2.5 to +3.0
Rainfall (mm)	1948 (Yaren)	+5 to +15%	+5 to +20%	+10 to +20%	+10 to +20%
		More extreme wet and dry periods			

* Approximates A2 in 2050; a = for more detailed projections of rainfall and air temperature in the vicinity of Nauru, see www.cawcr.gov.au/projects/PCCSP.



Projected changes to the ocean

The projected changes to the key features of the tropical Pacific Ocean surrounding Nauru relative to the long-term averages are expected to result in increases in sea surface temperature (SST), sea level and ocean acidification. Changes to ocean currents, such as the Southern Equatorial Current, and the area and location of PEQD, the Warm Pool and their convergence, are also expected to occur {Chapter 3, Sections 3.3 and 3.4, Tables 3.1 and 3.2}.

Ocean feature	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Sea surface temperature (°C)	29.3[a]	+0.6 to +0.8	+0.7 to +0.8	+1.2 to +1.6	+2.2 to +2.7
Sea level (cm)	+6 since 1960				
IPCC **		+8	+8	+18 to +38	+23 to +51
Empirical models ***		+20 to +30	+20 to +30	+70 to +110	+90 to +140
Ocean pH (units)	8.08	-0.1	-0.1	-0.2	-0.3
Currents	Increase in South Pacific gyre	SEC decreases at equator; EUC becomes shallower; SECC decreases and retracts westward			
Warm Pool area (x 10^6 km^2)[b]	7	+230% (20–26)	+250% (22–27)	+480% (36–46)	+770% (48–65)
Nutrient supply	Decreased slightly	Decrease due to increased stratification and shallower mixed layer			< -20%

* Approximates A2 in 2050; ** projections from the IPCC-AR4; *** projections from recent empirical models {Chapter 3, Section 3.3.8}; a = average for EEZ derived from the HadISST dataset; b = Warm Pool defined as area with temperature above 29°C; SEC = South Equatorial Current; EUC = Equatorial Undercurrent; SECC = South Equatorial Counter Current.

Oceanic fisheries

Recent catch and value

Nauru has only a very small local fishery for tuna within its exclusive economic zone (EEZ). Recent average catches (2004–2008) were 1.2 tonnes per year, worth USD 4500. In contrast, foreign fleets licensed to fish in Nauru's EEZ made average annual catches of 63,000 tonnes between 1999 and 2008, worth USD 52 million. See 'Coastal Fisheries' below for contributions of tuna to nearshore artisanal and small-scale commercial fisheries.

Local oceanic fisheries	Average annual catch (tonnes) 2004–2008	Average annual catch value (USD million)* 2004–2008
Tuna		
Longline	0.6	3100
Other methods	0.6	1400
Total	**1.2**	**4500**

* Calculated using market value per tonne for 2004–2008.

Existing oceanic fish habitat

The PEQD Province is characterised by high-salinity, nutrient-rich waters, and an abundance of phytoplankton {Chapter 4, Figure 4.7}. However, primary production in PEQD is limited by low iron concentrations {Chapter 4, Figure 4.9}. The convergence of PEQD and the Warm Pool creates prime feeding areas for tuna {Chapters 4 and 8}. Changes in the position of this convergence zone due to the El Niño-Southern Oscillation have a major influence on the abundance of tuna in the EEZ of Nauru.

Projected changes to oceanic fish habitat

Under climate change, the surface area of the Warm Pool Province is projected to expand, the area of PEQD is projected to contract and the convergence zone with the Warm Pool is expected to move eastward. There are likely to be only minor changes in the key components of the food web for tuna (net primary production and zooplankton biomass) in PEQD, but decreases of up to 10% by 2100 are projected for the Warm Pool {Chapter 4}.

Province feature	Projected change (%)			
	B1 2035	A2 2035	B1 2100*	A2 2100
PEQD surface area[a]	-20	-27	-30	-50
Warm Pool surface area[a]	+18	+21	+26	+48
Location of convergence	Eastwards			
PEQD net primary production	0	0	+2	+4
PEQD zooplankton biomass	-2	-2	-3	-6
Warm Pool net primary production	-7	-5	-9	-9
Warm Pool zooplankton biomass	-6	-3	-9	-10

* Approximates A2 in 2050; a = area derived from modelling of nutrients and salinity {Chapter 4, Table 4.3}; PEQD = Pacific Equatorial Divergence; Warm Pool = Western Pacific Warm Pool.

Projected changes in oceanic fisheries production

Preliminary modelling suggests that under the B1 and A2 emissions scenarios, catches of skipjack tuna in the EEZ of Nauru are projected to increase by 20–25% in 2035 and B1 in 2100, relative to the 20-year average (1980–2000). However, catches are expected to approximate the 20-year average under A2 in 2100. Catches of bigeye tuna are projected to decrease under both scenarios in 2100 {Chapter 8, Section 8.7}. Modelling for yellowfin tuna is now in progress. The trends for yellowfin tuna are expected to be similar to those for skipjack tuna.

Projected change in skipjack tuna catch (%)			Projected change in bigeye tuna catch (%)		
B1/A2 2035	B1 2100*	A2 2100	B1/A2 2035	B1 2100*	A2 2100
+25	+20	-1	-1	-7	-19

* Approximates A2 in 2050.

Coastal fisheries

Recent catch and value

The coastal fisheries of Nauru are made up mainly of three categories: demersal fish (bottom-dwelling fish associated with coral reef habitats), nearshore pelagic fish (including tuna, rainbow runner, wahoo and mahi-mahi), and invertebrates gleaned from intertidal and subtidal areas {Chapter 9, Section 9.2.1}. The total annual catch was estimated to be 650 tonnes in 2007, worth > USD 1.5 million. The commercial catch was 200 tonnes. Demersal and nearshore pelagic fish are estimated to make equally important contributions to total catch.

Feature	Coastal fisheries category				Total	Total value (USD m)*
	Demersal fish	Nearshore pelagic fish[b]	Targeted invertebrates	Inter/subtidal invertebrates		
Catch (tonnes)*	310	310	0	30	650	1.5
Contribution (%)[a]	48	48	0	4	100	

* Estimated total catch and value in 2007 (Gillett 2009)[1]; a = method for calculating disaggregated catch data for each category is outlined in Chapter 9 {Appendix 9.2, Supplementary Table 9.1}; b = catch dominated by tuna species.

Existing coastal fish habitat

Nauru has only 7 km^2 of coral reef habitat {Chapter 5} to support coastal fisheries species.

Habitat	Coral reef[a]	Mangrove[b]	Seagrass[b]	Intertidal flat
Area (km^2)	7	0.01	0	0

a = Includes mainly fringing reefs {Chapter 5}; b = values from Chapter 6, Table 6.1.

Projected changes to coastal fish habitat

Climate change is expected to add to the existing local threats to coral reefs in Nauru, resulting in declines in this important habitat {Chapters 5 and 6}.

Habitat feature	Projected change (%)		
	B1/A2 2035	B1 2100*	A2 2100
Coral cover[a]	-25 to -65	-50 to -75	> -90

* Approximates A2 in 2050; a = assumes there is strong management of coral reefs.

Projected changes in coastal fisheries production

All categories of coastal fisheries in Nauru are projected to show progressive declines in productivity due to both the direct effects (e.g. increased SST) and indirect effects (changes to fish habitats) of climate change {Chapter 9, Section 9.5}.

Coastal fisheries category	Projected change (%)			Main effects
	B1/A2 2035	B1 2100*	A2 2100	
Demersal fish	-2 to -5	-20	-20 to -50	Habitat loss and reduced recruitment (due to increasing SST and reduced currents)
Nearshore pelagic fish[a]	0	-10	-15 to -20	Reduced production of zooplankton in food webs for non-tuna species and changes in distribution of tuna
Inter/subtidal invertebrates	0	-5	-10	Declines in aragonite saturation due to ocean acidification

* Approximates A2 in 2050; a = tuna dominate the nearshore pelagic fishery {Chapter 9, Tables 9.8 and 9.10}.

The overall projected change to coastal fisheries catch reflects the projected decrease in productivity of all components. As a result, total catches from coastal fisheries in Nauru are projected to decrease slightly under both scenarios in 2035 and continue to decline under both scenarios in 2100, particularly under A2 in 2100.

Coastal fisheries category	Contrib. (%)**	Projected change in productivity (P) and catch (%)					
		B1/A2 2035		B1 2100*		A2 2100	
		P***	Catch	P***	Catch	P***	Catch
Demersal fish	48	-3.5	-2	-20	-9	-35	-17
Nearshore pelagic fish	48	0	0	-10	-5	-17.5	-8
Inter/subtidal invertebrates	4	0	0	-5	-0.2	-10	-0.4
Total catch[a]			**-2**		**-14**		**-25.4**

* Approximates A2 in 2050; ** contribution of each component to total coastal fisheries catch in Nauru; *** median projected change in productivity based on range in Chapter 9; a = assumes that proportion of each category remains constant.

Freshwater and estuarine fisheries

Nauru has no freshwater or estuarine fisheries.

Aquaculture

Recent and potential production

The main aquaculture commodity in Nauru is milkfish, which is produced in freshwater ponds. There is limited potential to culture Nile tilapia in ponds to increase access to fish for food security.

Existing and projected environmental features

Higher rainfall and air temperatures are expected to improve the conditions for pond aquaculture of milkfish and tilapia in Nauru {Chapter 11}.

Environmental feature	1980–1999 average[a]	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Air temperature (°C)	27.9	+0.5 to +1.0	+0.5 to +1.0	+1.0 to +1.5	+2.5 to +3.0
Rainfall (mm)	1948	+5 to +15%	+5 to +20%	+10 to +20%	+10 to +20%

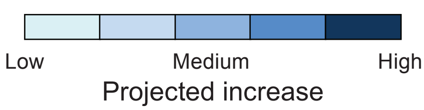
* Approximates A2 in 2050; a = data for Yaren.

Projected changes in aquaculture production

The projected effects of climate change on pond aquaculture in Nauru are expected to be positive, with enhanced production due to increased rainfall and warmer temperatures {Chapter 11, Table 11.5}.

Aquaculture commodity	Use	Projected change		
		B1/A2 2035	B1 2100*	A2 2100
Existing				
Milkfish	Food security			
Potential				
Tilapia	Food security			

* Approximates A2 in 2050.



Economic and social implications

Economic development and government revenue

Current contributions

The surface fishery by foreign purse-seine vessels in the EEZ of Nauru does not contribute to gross domestic product (GDP). However, licence fees from these fleets contributed 20% to government revenue (GR) in Nauru in 2007.

Industrial fishery	Contribution to GDP		Contribution to GR*	
	USD m	GDP (%)	USD m	GR (%)
Surface	0	0	6.1	20

* Information for 2007, when total GR was USD 30 million (Gillett 2009)[1].

Projected effects of climate change

The contribution of the surface tuna fishery in Nauru's EEZ to government revenue is projected to increase due to the effects of climate change on the distribution and abundance of tuna. Under both scenarios in 2035, and under B1 in 2100 (A2 in 2050), the contributions of licence fees to government revenue are projected to increase from 20% to ~ 25% {Chapter 12}.

Projected changes to GR (%)		
B1/A2 2035	B1 2100*	A2 2100
+2 to +6	+2 to +5	0

* Approximates A2 in 2050.

Food security

Nauru is among the group of PICTs (Group 3) where the estimated sustainable production of fish and invertebrates from coastal habitats is unable to supply the national population with the 35 kg of fish per person per year recommended for good nutrition[i] {Chapter 12, Section 12.7.1}.

Current contributions of fish to food security

Average national fish consumption in Nauru is estimated to be 56 kg per person per year[2], well above the recommended level for good nutrition. Much of this fish comes from tuna and other large species caught close to the coast, and from imported canned fish.

Fish consumption per person (kg)	Animal protein from fish (%)	Fish provided by subsistence catch (%)
56	71	66

i Based on fish contributing 50% of dietary protein as recommended by the SPC Public Health Programme (SPC 2008)[25].

Effects of population growth

Predicted population growth in Nauru will have little effect on the gap between the fish estimated to be available per person from coral reefs and the fish needed for nutrition because this gap is already very wide.

Variable	2010	2035	2050	2100
Population (x 1000)	10	14	16	21
Fish available per person (kg/year)[a]	2	1	1	1
Gap (kg/person/year)[b]	33	34	34	34

a = Based on 3 tonnes of fish per km^2 of coral reef habitat {Chapter 9}; b = relative to recommended consumption of 35 kg per person per year.

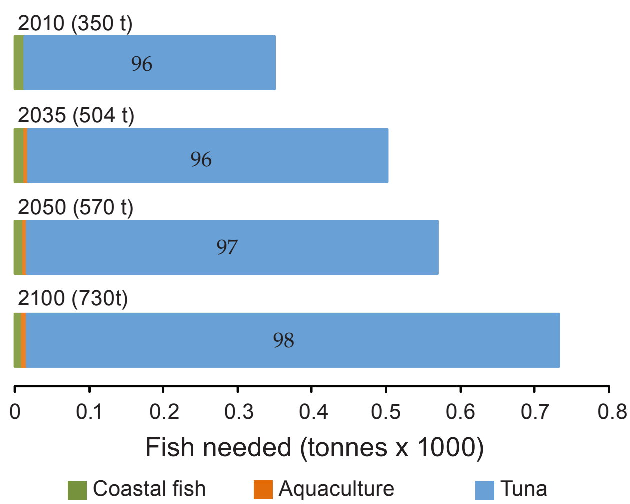
Additional effects of climate change

The projected decreases in productivity of demersal fish related to climate change {Chapter 9} are not expected to widen the gap.

Filling the gap

Tuna (and other large pelagic fish) are the only resources available to Nauru that can supply the shortfall in fish from coral reefs for food because pond aquaculture is only expected to provide minor quantities of fish.

The implication is that Nauru needs to allocate a proportion of the annual average tuna catch taken from its EEZ to provide the quantities of fish recommended for good nutrition of their population that cannot be met by purchases of imported canned fish.



Fish (in tonnes) needed for future food security in Nauru, and the recommended contributions (%) of fisheries resources and aquaculture production required to meet future needs.

Livelihoods

Current contributions

Only small numbers of jobs have been created through tuna fishing in Nauru {Chapter 12}. Coastal fisheries provide 22% of households with either their first or second source of income.

Jobs on tuna vessels			Jobs in shore-based tuna processing			Coastal households earning income from fishing (%)			Jobs in aquaculture
2002	2006	2008	2002	2006	2008	1st	2nd	Both	2007
5	0	0	10	2	0	5	17	22	n/a

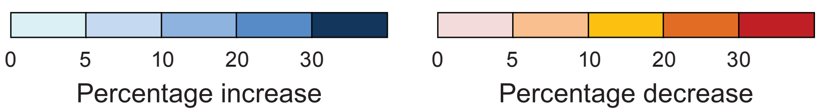
Information derived from Chapter 12, Table 12.6 and the SPC PROCFish Project; n/a = data not available.

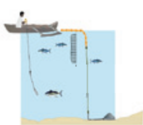
Projected effects of climate change

The effects of climate change on the potential to create more livelihoods based on fisheries and aquaculture are difficult to estimate because there is still scope to derive new jobs from the nearshore component of coastal fisheries and pond aquaculture. However, the A2 emissions scenario is expected to eventually enhance or retard these opportunities as indicated below.

Year	Projected change under A2 scenario		
	Coastal fisheries		Aquaculture
	Nearshore pelagic fish	Other resources	(ponds)
Present*	↑	↓	↑
2035	No effect	↓	↑
2050	↓	↓	↑
2100	↓	↓	↑

* Indicates general direction of new opportunities for livelihoods based on the activity.





Adaptations and suggested policies

The plans Nauru has to derive greater socio-economic benefits from fisheries and aquaculture will depend heavily on interventions to:

1. improve access to tuna to provide fish for government revenue and continued food security;

2. manage coastal fish habitats and fish stocks to optimise the use of coastal fisheries for food security; and
3. enhance sustainable livelihood opportunities in the fisheries and aquaculture sector through capacity building.

The adaptations and suggested policies to achieve these plans under a changing climate are summarised below (see Section 3 for details).

Economic development and government revenue

Adaptation no. (Section 3.2)	Summary of adaptation	Supporting policy no. (Section 3.3)
E1	Full implementation of sustainable fishing effort schemes	E1, E2, E4–E6
E3	Immediate conservation management measures for bigeye tuna	E8
E7	Safety at sea	E10
E8	Climate-proof infrastructure	E11
E9	Pan-Pacific tuna management	E2

Food security

Adaptation no. (Section 3.4)	Summary of adaptation	Supporting policy no. (Section 3.5)
F2	Foster the care of coastal fish habitats	F1–F3, F18
F5	Sustain production of coastal demersal fish and invertebrates	F6, F7, F13, F18
F6	Diversify catches of coastal demersal fish	F6, F13, F18
F8	Increase access to tuna	F8–F13, F18
F9	Develop pond aquaculture to diversify the supply of fish	F13–16, F18
F10	Develop coastal fisheries for small pelagic fish	F13, F17, F18
F11	Improve post-harvest methods	F17, F18

Sustainable livelihoods

Adaptation no. (Section 3.6)	Summary of adaptation	Supporting policy no. (Section 3.7)
L1	Improve technical and business skills of communities	L1, L2