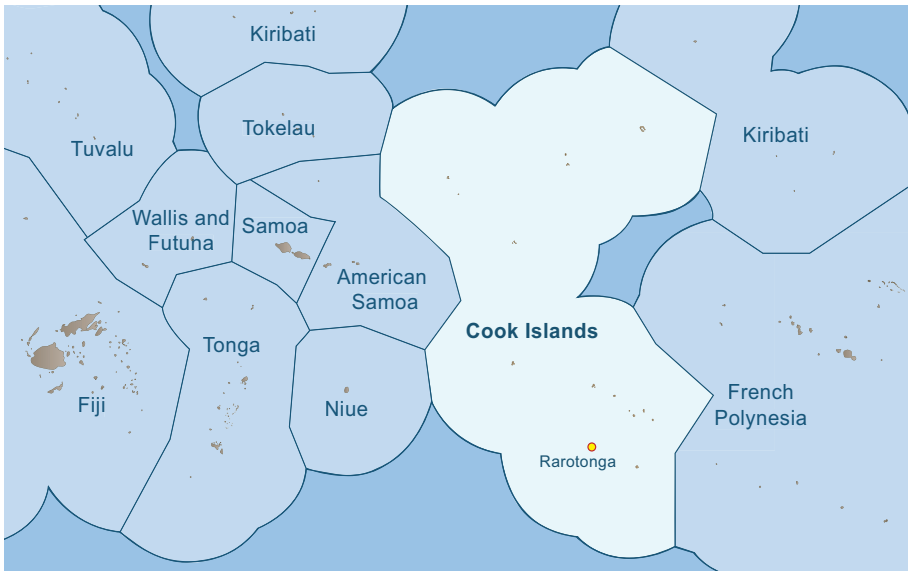
2.2 Cook Islands



Key features

Population

Year	2010	2035	2050	2100
Population (x 1000)[a]	16	17	16	16
Population growth rate[a]	0.3	0	-0.2	0

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

EEZ area (km²) 1,947,760

Land area (km²) 240

Land as % of EEZ 0.012

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

Membership of regional fisheries management arrangements: Forum Fisheries Agency; Western and Central Pacific Fisheries Commission; Te Vaka Moana Arrangement; South Pacific Regional Fisheries Management Organisation; South Pacific Tuna and Billfish subcommittee.

Surface climate and the ocean

Existing features

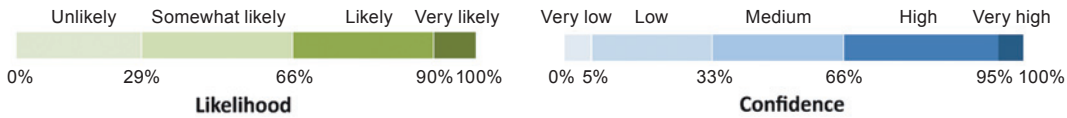
Cook Islands has a mainly tropical climate {Chapter 2}. Recent air temperatures in Rarotonga have averaged 24.4°C and average rainfall is ~ 1800 mm per year. Cook Islands lies within the South Pacific Subtropical Gyre Province (SPSG) {Chapter 4, Figure 4.6}. The SPSG Province is created by anticyclonic atmospheric circulation and rainfall in the centre of the province is low. The rotation of the gyre deepens the vertical structure of the water column, making the surface waters nutrient poor {Chapter 4}.

Projected changes to surface climate

Air temperatures and rainfall in Cook Islands 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)	24.4 (Rarotonga)	+0.5 to +1.0	+0.5 to +1.0	+1.0 to +1.5	+2.5 to +3.0
Rainfall (mm)	1802 (Rarotonga)	+5 to +15%	+5 to +20%	+10 to +20%	+10 to +20%
		More extreme wet and dry periods			
Cyclones (no. per year)	0.7 to 1.2	➢ Total number of tropical cyclones may decrease ➢ Cyclones are likely to be more intense			

* Approximates A2 in 2050; a = for more detailed projections of rainfall, air temperature and cyclones in the vicinity of Cook Islands, 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 Cook Islands 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 (increases in the South Pacific gyre) and reductions in nutrient supply 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)	26.5[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	Continued increase in strength of South Pacific gyre			
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.

Oceanic fisheries

Recent catch and value

Recent average annual catches (2004–2008) from the local longline fleet exceed 3600 tonnes, worth > USD 17 million. The local fleet mainly targets yellowfin tuna, bigeye tuna and albacore. Foreign vessels under charter also made annual average catches of 650 tonnes of tuna from the exclusive economic zone (EEZ) of Cook Islands between 1999 and 2008. See 'Coastal Fisheries' below for contributions of tuna to nearshore small-scale commercial fisheries.

Local oceanic fisheries	Average annual catch (tonnes) 2004–2008	Average annual catch value (USD million)* 2004–2008
Tuna		
Longline	3300	16.8
Other methods	128	0.3
Other oceanic fish[a]	189	0.2
Total	**3617**	**17.3**

* Calculated using market value per tonne for 2004–2008; a = billfish catch only, valued at USD 1000 per tonne.

Existing oceanic fish habitat

Cook Island's EEZ lies within the generally nutrient-poor waters of the SPSG Province {Chapter 4, Figure 4.6}. This province is characterised by downwelling and low nitrate concentrations in deeper waters. Net primary production is low, particularly in summer when there is the formation of a marked thermocline {Chapter 4, Section 4.4.3}. Local upwelling around islands can result in small areas of enriched surface productivity. In general, however, the SPSG Province does not provide prime feeding areas for tuna.

Projected changes to oceanic fish habitat

Under climate change, the surface area of the SPSG Province is projected to increase and extend poleward. Key components of the food web (net primary production and zooplankton biomass) are expected to decrease slightly in SPSG {Chapter 4, Table 4.3}.

SPSG feature	Projected change (%)			
	B1 2035	A2 2035	B1 2100*	A2 2100
Surface area[a]	+4	+7	+7	+14
Location	Poleward extension of southern limit			
Net primary production	-3	-5	-3	-6
Zooplankton biomass	-3	-4	-5	-10

* Approximates A2 in 2050; a = area derived from modelling of nutrients and salinity {Chapter 4, Table 4.3}.

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 Cook Islands are expected to increase significantly in 2035 and 2100, relative to the 20-year average (1980–2000). However, catches of bigeye tuna are projected to decrease under both scenarios in 2035 and 2100 {Chapter 8, Section 8.7}. Modelling for yellowfin tuna and albacore is now in progress. The trends for yellowfin tuna are expected to be similar to those for skipjack tuna, whereas albacore are expected to move poleward and to be more abundant at the edges of the SPSG Province.

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
+40	+50	+47	-3	-8	-15

* Approximates A2 in 2050.

Coastal fisheries

Recent catch and value

The coastal fisheries of Cook Islands are made up mainly of three components: 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}. Invertebrates targeted for export (trochus) contribute to the catch in some years. The total annual catch was estimated to be 400 tonnes in 2007, worth > USD 2.3 million. The commercial catch was 133 tonnes. Nearshore pelagic fish are estimated to make up 60% of the total catch.

Feature	Coastal fisheries category				Total	Total value (USD m)*
	Demersal fish	Nearshore pelagic fish[b]	Targeted invertebrates	Inter/subtidal invertebrates		
Catch (tonnes)*	146	240	0	14	400	2.3
Contribution (%)[a]	37	60	0	3	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 non-tuna species.

Existing coastal fish habitat

The area of coral reef habitat supporting coastal fisheries in Cook Islands is 667 km^2 {Chapter 5}. Mangroves, and most probably seagrasses, do not occur in Cook Islands. Intertidal flats do occur around the interior of atoll lagoons but the areas of these habitats have not been reported {Chapter 6}.

Habitat	Coral reef[a]	Mangrove[b]	Seagrass[b]	Intertidal flat
Area (km^2)	667	0	0	n/a

a = Includes barrier, patch and fringing reefs and reef lagoons {Chapter 5, Table 5.1}; b = values from Chapter 6, Table 6.1; n/a = data not available.

Projected changes to coastal fish habitat

Climate change is expected to add to the existing local threats to coral reefs in Cook Islands, resulting in projected declines in percentage coral cover in both the medium and long term {Chapter 5}.

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

* Approximates A2 in 2050; a = no estimates in reduction of intertidal flats available; b = assumes there is strong management of coral reefs.

Projected changes in coastal fisheries production

Fisheries for demersal fish and intertidal and subtidal invertebrates in Cook Islands 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}. On the other hand, the nearshore pelagic fishery component of coastal fisheries is projected to increase in productivity due to the redistribution of tuna to the east {Chapter 8}.

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]	+15 to +20	+20	+10	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 relatively heavy reliance on nearshore pelagic fish. As a result, potential catches from coastal fisheries in Cook Islands are projected to increase under both scenarios in 2035 and B1 in 2100, but eventually decline 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	37	-3.5	-1.3	-20	-7.4	-35	-13
Nearshore pelagic fish	60	+17.5	+10.5	+20	+12	+10	+6
Inter/subtidal invertebrates	3	0	0	-5	-0.2	-10	-0.4
Total catch[a]			**+9**		**+4**		**-7**

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

Freshwater and estuarine fisheries

Recent catch and value

The main freshwater and estuarine species caught in Cook Islands include eels, tilapia and *Macrobrachium*. The estimated annual freshwater fish catch in 2007 was ~ 5 tonnes, worth > USD 35,000 {Chapter 10}[1].

Existing freshwater and estuarine fish habitat

The relatively small rivers and lakes of Cook Islands provide only a limited range of freshwater and estuarine fish habitats, but support several fish and invertebrate species. The longest river is the Avatiu on Rarotonga {Chapter 7, Table 7.1}.

Island	Largest river	Catchment area (km^2)	River length (km)
Rarotonga	Avatiu	5.5	5

Projected changes to freshwater and estuarine fish habitat

The projected increase in rainfall for Cook Islands {Chapter 2, Section 2.5.2} is expected to result in increases in the area and quality of freshwater fish habitats {Chapter 7, Table 7.5}.

Projected changes to freshwater and estuarine fish habitat area (%)		
B1/A2 2035	B1 2100*	A2 2100
-5 to +10	-5 to +10	-5 to + > +20

* Approximates A2 in 2050.

Projected changes in freshwater and estuarine fisheries production

Higher projected rainfall and river flows are expected to result in slightly improved production from freshwater and estuarine fisheries in Cook Islands. River flow increases the availability and quality of habitats, provides cues for fish migration, and enhances reproduction and recruitment {Chapter 10, Section 10.5}.

Projected changes in freshwater and estuarine fish catch (%)		
B1/A2 2035	B1 2100*	A2 2100
+2.5	+2.5	+7.5

* Approximates A2 in 2050.

Aquaculture

Recent and potential production

The main aquaculture commodity in Cook Islands is black pearls. Other commodities produced from coastal waters include marine ornamentals (giant clams), juvenile wild milkfish, which are stocked in natural ponds on some atolls. There is also interest in evaluating the grow-out of wild-caught juvenile milkfish for tuna bait in Penrhyn Atoll, and farming *Macrobrachium* and tilapia in freshwater ponds.

Existing and projected environmental features

Higher rainfall and air temperatures are expected to have positive effects on pond aquaculture. However, increasing SST, rainfall and ocean acidification, and possibly more severe cyclones, are expected to reduce the survival and growth of pearl oyster spat and ornamental products. Acidification of the ocean may also affect the formation of nacre by pearl oysters, and therefore pearl quality {Chapter 11}.

Environmental feature	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Air temperature (°C)	24.4[a]	+0.5 to +1.0	+0.5 to +1.0	+1.0 to +1.5	+2.5 to +3.0
Annual rainfall (mm)	1802[a]	+5 to +15%	+5 to +20%	+10 to +20%	+10 to +20%
Cyclones (no. per year)	0.7 to 1.2	➢ Total number of tropical cyclones may decrease ➢ Cyclones are likely to be more intense			
Sea surface temperature (°C)	26.5	+5 to +15%	+5 to +15%	+5 to +15%	+5 to +15%
Ocean pH (units)	8.08	-0.1	-0.1	-0.2	-0.3

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

Projected changes in aquaculture production

The projected effects of climate change on aquaculture are mixed. Pond aquaculture is expected to be enhanced by increased rainfall, river flows, and warmer temperatures, provided ponds are located where they will not be affected by floods or storm surge. The commodities grown in coastal waters are likely to be affected adversely by increases in SST, rainfall, ocean acidification and stronger storm surge from more severe cyclones {Chapter 11, Table 11.5}.

Aquaculture commodity	Use	Projected change		
		B1/A2 2035	B1 2100*	A2 2100
Existing				
Pearls	Livelihoods	↓	↓	↓
Marine ornamentals	Livelihoods	↓	↓	↓
Milkfish	Food security	↑	↑	↑
Potential				
Tilapia	Food security	↑	↑	↑
Macrobrachium	Livelihoods	↑	↓	↓

* Approximates A2 in 2050.

Low Medium High
Projected increase

Low Medium High
Projected decrease

Economic and social implications

Economic development and government revenue

Current contributions

The industrial tuna longline fishery contributes only 0.1% to gross domestic product (GDP) in Cook Islands. Licence fees from foreign vessels engaged in the longline and surface fisheries for tuna are more important – they contributed 1.4% and ~ 0.3% to government revenue (GR), respectively, in 2007 {Chapter 12} and revenues have increased since then.

Industrial fishery	Contribution to GDP*		Contribution to GR**	
	USD m	GDP (%)	USD m	GR (%)
Surface	0	0	0.26	0.3
Longline	0.2	0.1	1	1.4

* Information for 2007, when national GDP was USD 211 million (Gillett 2009)[1]; ** information for 2003, when total GR was USD 86 million.

Projected effects of climate change

Although catches of tuna in the EEZ of Cook Islands are projected to increase by 40–50% due to climate change, the effects of increased catches on GDP and GR are expected to be minor due to the small contributions of oceanic fisheries to the economy.

Food security

Cook Islands is among the group of PICTs (Group 1) where the estimated sustainable production of fish and invertebrates from coastal habitats will be more than enough 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 Cook Islands is estimated to be 35 kg per person per year[2], matching the recommended level for good nutrition. Consumption is higher in rural areas, where it averages > 60 kg per person per year. At present, coral reefs in Cook Islands are estimated to be able to supply ~ 130 kg of demersal fish per person per year, although ciguatera fish poisoning prevents many species from being used for food in some locations {Chapter 9}. Rarotonga depends on fish from elsewhere to meet the demand of the local population and tourism.

Fish consumption per person (kg)			Animal protein from fish (%)		Fish provided by subsistence catch (%)	
National	Rural	Urban	Rural	Urban	Rural	Urban
35	61	25	51	27	76	27

Effects of population growth

The population of Cook Islands is predicted to remain stable over this century, and coastal fisheries are expected to continue to produce fish surplus to the demand for food {Chapter 12}.

Variable	2010	2035	2050	2100
Population (x 1000)	16	17	16	16
Fish available per person (kg/year)[a]	128	119	119	125
Surplus (kg/person/year)[b]	93	84	84	90

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 effects of climate change on coastal fisheries are likely to cause only minor reductions in the significant surplus of fish available for food. Even with the projected decreases in production of demersal fish of up to 50% by 2100 under the A2 emissions scenario, the large area of coral reef relative to population size should continue to

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

supply sufficient coastal fish for food security {Chapter 12, Table 12.10}. Projected increases in tuna catch by the nearshore fishery are expected to further increase access to fish.

Livelihoods

Current contributions

Pearl farming provides the greatest number of jobs for the sector, with up to 450 people being employed in recent years {Chapter 12}. In contrast, full-time and part-time jobs created through tuna fishing and processing represent only a low percentage of total employment. Coastal fisheries also provide important opportunities to earn income for coastal communities, with 20% of households deriving their first or second incomes by catching and selling fish.

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
50	15	12	15	15	10	12	8	20	450

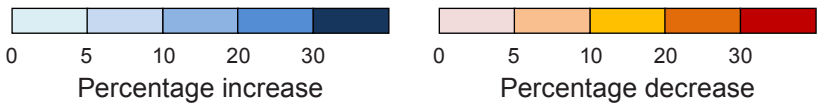
* Ponia (2010)[4]; information derived from Chapter 12, Table 12.6 and the SPC PROCFish Project.

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 oceanic fisheries, 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				
	Oceanic fisheries**	Coastal fisheries		Aquaculture	
		Nearshore pelagic fish	Other resources	Ponds	Coastal
Present*	⇧	⇧	⇩	⇧	⇧
2035	↑	↑	↓	↑	↓
2050	↑	↑	↓	↑	↓
2100	↑	↑	↓	↑	↓

* Indicates general direction of new opportunities for livelihoods based on the activity; ** based on projected changes in skipjack tuna catches; freshwater and estuarine fisheries not included due to their subsistence role.



Adaptations and suggested policies

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

1. improve access to tuna, and the efficiency of local industrial fishing operations, to increase the contributions from oceanic fisheries resources to economic development;
2. manage coastal fish habitats and fish stocks to ensure that they continue to provide fish for food security; and
3. increase the number of livelihoods that can be based on fishing, tourism and aquaculture.

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
E4	Energy efficiency programmes for industrial tuna fleets	E9
E5	Environmentally-friendly fishing operations	
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)
F1	Manage and restore vegetation in catchments	F1, F2, F18
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 for urban and rural populations	F8–F13, F18

* Adaptations for freshwater habitats and fish stocks not included due to the limited nature of these resources but see adaptations F4 and F7 (Section 3.4), and policies F4, F6, F13 and F18 (Section 3.5).

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
L3	Develop coral reef ecotourism ventures	L3
L4	Diversify production of coastal aquaculture commodities	L4, L5
L5	Modify locations and infrastructure for coastal aquaculture	L6