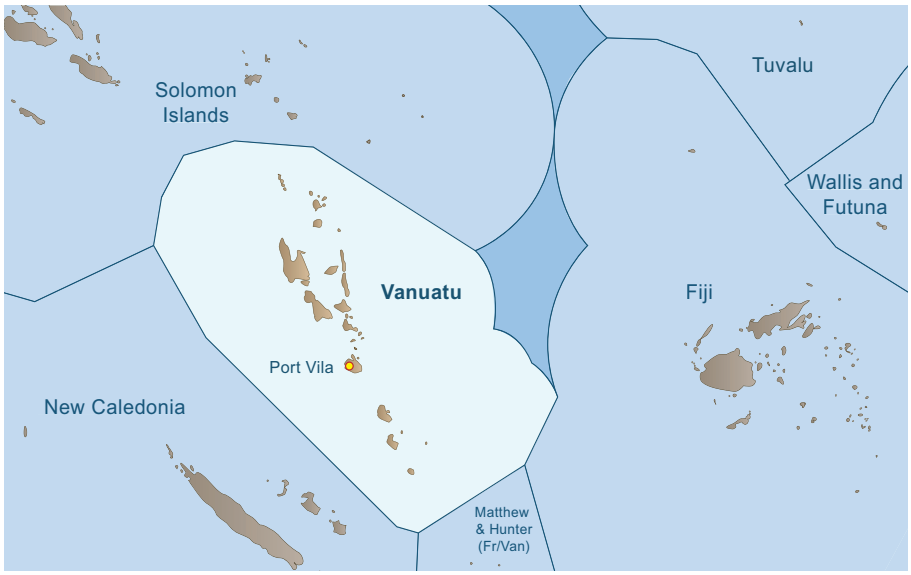
2.21 Vanuatu



Key features

Population

Year	2010	2035	2050	2100
Population (x 1000)[a]	252	400	483	695
Population growth rate[a]	2.6	1.6	1.4	0.7

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

EEZ area (km²) 668,220

Land area (km²) 11,880

Land as % of EEZ 1.7

Fisheries and aquaculture activities: Oceanic fisheries, coastal fisheries, freshwater and estuarine fisheries, coastal aquaculture and freshwater aquaculture.

Membership of regional fisheries management arrangements: Forum Fisheries Agency; Western and Central Pacific Fisheries Commission (including the Nothern Committee); South Pacific Regional Fisheries Management Organisation; Melanesian Spearhead Group; South Pacific Tuna and Billfish Subcommittee; Inter American Tropical Tuna Commission.

Surface climate and the ocean

Existing features

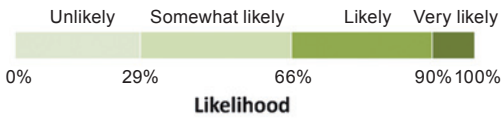
Vanuatu has a tropical climate {Chapter 2}. Recent air temperatures in Efate have averaged 24.2°C and average rainfall is > 2100 mm per year. Vanuatu lies within the Archipelagic Deep Basins Province (ARCH) {Chapter 4, Figure 4.6}. The climate and ocean within this province are influenced by a complex current regime caused by the occurrence of many islands, archipelagos and seamounts. These formations divert oceanic circulation to create eddies, resulting in upwelling, downwelling and other mesoscale processes {Chapter 3, Section 3.2.9, Figure 3.1}. ARCH Province is characterised by a patchwork of nutrient-rich and nutrient-poor water bodies that can vary over short timeframes.

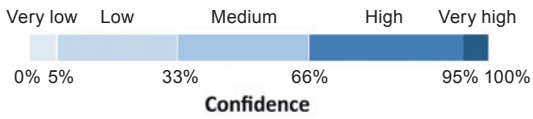
Projected changes to surface climate

Air temperatures and rainfall in Vanuatu 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)	24.2 (Efate)	+0.5 to +1.0	+0.5 to +1.0	+1.0 to +1.5	+2.5 to +3.0
Rainfall (mm)	2118 (Efate)	-5 to -10%	-5 to -20%	-5 to -20%	-5 to -20%
		More extreme wet and dry periods			
Cyclones (no. per year)	2.6	➢ 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 Vanuatu, 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 Vanuatu 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 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)	27.1[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			
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; SEC = South Equatorial Current; EUC = Equatorial Undercurrent; SECC = South Equatorial Counter Current.

Oceanic fisheries

Recent catch and value

Vanuatu has a large locally-based longline fishery for tuna that operates both within and outside its exclusive economic zone (EEZ), and a purse-seine fishery that operates only outside the EEZ. Recent average catches (2004–2008) by these fisheries totalled > 72,000 tonnes per year, worth > USD 130 million. Vanuatu also licenses foreign longline fleets to fish for tuna in its EEZ. These fleets made average annual catches of > 4200 tonnes, worth ~ USD 10 million between 1999 and 2008. 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		
Purse-seine	59,787	70.8
Longline	11,233	58.2
Other oceanic fish[a]	1265	1.3
Total	**72,285**	**130.3**

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

Existing oceanic fish habitat

The productivity of the waters surrounding Vanuatu is variable and typical of the ARCH Province {Chapter 4, Section 4.3.4}. Coasts and islands influence a broad range of mesoscale processes (e.g. local boundary currents, jets, wind-driven upwelling, internal waves and tidal mixing) which commonly bring nutrients to surface waters {Chapter 3, Section 3.2.9}. The food webs for tuna and other large pelagic fish in the EEZ of Vanuatu are based on nutrients derived from these mesoscale processes, and to a lesser extent on runoff from high islands.

Projected changes to oceanic fish habitat

The area of the ARCH Province remains the same by definition. However, key components of the food web (net primary production and the biomass of zooplankton) are expected to decrease significantly under the B1 and A2 scenarios by 2100 in ARCH {Chapter 4, Table 4.3}.

ARCH feature	Projected change (%)			
	B1 2035	A2 2035	B1 2100*	A2 2100
Net primary production	-5	-8	-20	-33
Zooplankton biomass	-5	-6	-17	-26

* Approximates A2 in 2050.

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 Vanuatu are expected to increase in 2035 and 2100, relative to the 20-year average (1980–2000). 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.

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
+18	+15	+26	-3	-6	-10

* Approximates A2 in 2050.

Coastal fisheries

Recent catch and value

The coastal fisheries of Vanuatu are made up of four components: demersal fish (bottom-dwelling fish associated with coral reef, mangrove and seagrass habitats), nearshore pelagic fish (including tuna, rainbow runner, wahoo and mahi-mahi), invertebrates targeted for export, and invertebrates gleaned from intertidal and subtidal areas {Chapter 9, Section 9.2.1}. The total annual catch was estimated to be 3368 tonnes in 2007, worth > USD 7.9 million. The commercial catch was 538 tonnes. Demersal fish are estimated to make up ~ 50% 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)*	1730	753	70	815	3368	7.9
Contribution (%)[a]	51	23	2	24	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

Vanuatu has > 1200 km^2 of coral reef {Chapter 5} that support many important coastal fisheries species. Mangroves cover 25 km^2 {Chapter 6}. The areas of seagrass and intertidal sand and mud flats have not yet been estimated.

Habitat	Coral reef[a]	Mangrove[b]	Seagrass[b]	Intertidal flat
Area (km^2)	1244	25	n/a[c]	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; c= mapping currently in progress; 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, mangroves, seagrasses and intertidal flats in Vanuatu, resulting in declines in the quality and area of all habitats {Chapters 5 and 6}.

Habitat feature[a]	Projected change (%)		
	B1/A2 2035	B1 2100*	A2 2100
Coral cover[b]	-25 to -65	-50 to -75	> -90
Mangrove area	-10	-50	-60
Seagrass area	-5 to -20	-5 to -30	-10 to -35

* 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

All categories of coastal fisheries in Vanuatu 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
Targeted invertebrates	-2 to -5	-10	-20	Habitat degradation, and declines in aragonite saturation due to ocean acidification
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 expected decrease in productivity of all components of the fishery. As a result, potential catches from coastal fisheries in Vanuatu 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	51	-3.5	-2	-20	-10	-35	-18
Nearshore pelagic fish	23	0	0	-10	-2	-17.5	-4
Targeted invertebrates	2	-3.5	-0.07	-10	-0.2	-20	-0.4
Inter/subtidal invertebrates	24	0	0	-5	-1	-10	-2
Total catch[a]			**-2**		**-14**		**-25**

* Approximates A2 in 2050; ** contribution of each component to total coastal fisheries catch in Vanuatu; *** 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 Vanuatu include flagtails (jungle perch), grunter, freshwater snappers, silver biddies, silver moonfish, scats, mullet, carp, tilapia and *Macrobrachium*. These species are taken mostly by subsistence fisheries. The estimated annual freshwater fish catch in Vanuatu in 2007 was 80 tonnes, worth USD 173,000 {Chapter 10}.

Existing freshwater and estuarine fish habitat

The larger rivers in Vanuatu provide a diversity of freshwater and estuarine fish habitats to support fish communities {Chapter 7, Table 7.1}.

Island	Largest river	Catchment area (km^2)	River length (km)
Espiritu Santo	Jourdain	369	53
Efate	Teouma	91	28

Projected changes to freshwater and estuarine fish habitat

The projected increase in rainfall for Vanuatu {Chapter 2, Section 2.5.2} is expected to result in increases in the area and quality of all freshwater fish habitats. The greatest increases in freshwater habitats are expected to occur under A2 in 2100 {Chapter 7, Table 7.5}. Sea-level rise is expected to increase the area of estuarine habitat {Chapter 7}.

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

* Approximates A2 in 2050.

Projected changes in freshwater and estuarine fisheries production

Higher projected rainfall and river flows are not expected to influence production from freshwater and estuarine fisheries in Vanuatu until 2100 under A2, when the availability and quality of habitats are estimated to increase, providing better fish migration cues, and enhancing reproduction and recruitment. These changes are expected to increase freshwater catch by ~ 7.5% {Chapter 10, Section 10.5}.

Projected changes in freshwater and estuarine fish catch (%)		
B1/A2 2035	B1 2100*	A2 2100
0 to +2.5	0	+7.5

* Approximates A2 in 2050.

Aquaculture

Recent and potential production

The main aquaculture commodities in Vanuatu include those produced for livelihoods in coastal waters such as shrimp, marine ornamentals (coral fragments and giant clams), marine fish and trochus. Tilapia and *Macrobrachium* are also produced by freshwater aquaculture for food security.

Aquaculture commodity	Annual production (tonnes)	Annual value (USD)
Shrimp	17	426,400
Tilapia[a]	80	n/a

* 2006–2008 data; a = produced in cages in a freshwater lake; n/a = data not available.

Existing and projected environmental features

Changing rainfall patterns and increasing air and sea temperatures are eventually expected to alter some of the present favourable conditions for coastal aquaculture in Vanuatu {Chapter 11}. Increasing SST, ocean acidification and the possibility of stronger cyclones are expected to reduce the survival and growth of shrimp, ornamental species, marine fish and trochus. In addition, sea-level rise is expected to affect the drainage of shrimp ponds. Higher rainfall and air temperatures are likely to improve the growth of tilapia {Chapter 11}.

Environmental feature	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Air temperature (°C)	24.2[a]	+0.5 to +1.0	+0.5 to +1.0	+1.0 to +1.5	+2.5 to +3.0
Annual rainfall (mm)	2118[a]	-5 to -10%	-5 to -20%	-5 to -20%	-5 to -20%
Cyclones (no. per year)	2.6	➢ Total number of tropical cyclones may decrease ➢ Cyclones are likely to be more intense			
Sea surface temperature (°C)	27.1	+0.6 to +0.8	+0.7 to +0.8	+1.2 to +1.6	+2.2 to +2.7
Ocean pH (units)	8.08	-0.1	-0.1	-0.2	-0.3

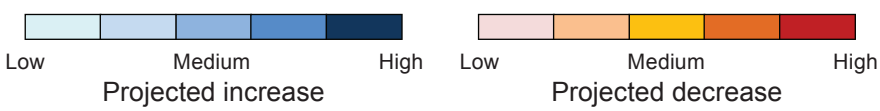
* Approximates A2 in 2050; a = data for Efate.

Projected changes in aquaculture production

In the short term, higher air temperatures are expected to improve shrimp growth and reduce cold season impacts, resulting in greater yields per hectare in the medium term. However, by 2100, increasing summer temperatures and changing rainfall patterns are likely to reduce shrimp growth rates and increase the incidence of disease. Freshwater aquaculture production is expected to be enhanced by climate change, provided ponds are located where they will not be affected by floods or storm surge {Chapter 11, Table 11.5}.

Aquaculture commodity	Use	Projected change		
		B1/A2 2035	B1 2100*	A2 2100
Tilapia	Food security	↑	↑	↑
Shrimp	Livelihoods	↑	↓	↓
Marine ornamentals	Livelihoods	↓	↓	↓
Macrobrachium	Livelihoods	↑	↓	↓
Marine fish	Livelihoods	↓	↓	↓
Trochus	Livelihoods	↓	↓	↓

* Approximates A2 in 2050.



Economic and social implications

Economic development and government revenue

Current contributions

Licence fees from foreign purse-seine and longline vessels contributed 1.7% and 0.2% to government revenue (GR), respectively, in 2007. The industrial tuna fishery in Vanuatu did not contribute to gross domestic product (GDP) in 2007 {Chapter 12}. However, on-shore activities have commenced to add value to longline catches since then.

Industrial fishery	Contribution to GR*	
	USD m	GR (%)
Surface[a]	1.4	1.7
Longline[b]	0.2	0.2

* Information for 2007, when total GR was USD 79 million; a = locally-based purse-seine; b = information from 1999.

Projected effects of climate change

The projected range of changes to government revenue due to the effects of climate change on the distribution and abundance of tuna are relatively minor due to the small contribution made by the industrial tuna fishery to the economy of Vanuatu {Chapter 12}.

Food security

Vanuatu 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 Vanuatu is estimated to be 20 kg per person per year[2], well below the recommended levels for good nutrition. At present, coral reefs in Vanuatu are estimated to be able to supply only 16 kg of fish per person per year.

Fish consumption per person (kg)			Animal protein from fish (%)		Fish provided by subsistence catch (%)	
National	Rural	Urban	Rural	Urban	Rural	Urban
20	21	19	60	43	60	17

Effects of population growth

Vanuatu will have a rapidly increasing total demand for fish for food security due to the predicted growth in population. Therefore, the current estimated shortfall between the fish needed for food security and the estimated fish production from coral reefs of 19 kg per person per year, increases to 25 kg in 2035, 27 kg in 2050 and 29 kg in 2100.

Variable	2010	2035	2050	2100
Population (x 1000)	252	400	483	695
Fish available per person (kg/year)[a]	16	10	8	6
Gap (kg/person/year)[b]	19	25	27	29

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

Vanuatu faces further declines in the fish available per person due to the combined effects of population growth and climate change. By 2050, the projected declines in production of demersal fish associated with coral reefs is expected to cause the gap

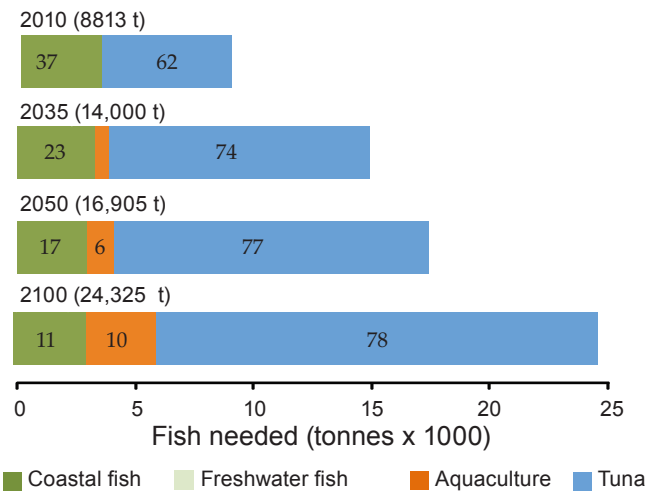
i Based on fish contributing 50% of dietary protein as recommended by the SPC Public Health Programme (SPC 2008)[25].

between the fish needed per person for good nutrition, and the fish available from coral reefs, to increase from 27 to 28 kg per person per year under the A2 emissions scenario. The gap is expected to widen from 29 to 31 kg per person per year by 2100.

Filling the gap

Tuna is the main resource available to Vanuatu for supplying the large shortfall in fish needed for food security from coastal habitats. This gap will need to be filled mostly by tuna and bycatch species because freshwater fisheries and freshwater aquaculture are only expected to be able to provide limited quantities of fish, although aquaculture could make up 11% of the fish required by 2100.

The implication is that an increasing proportion of the annual average tuna catch will need to be allocated over time to provide the quantities of fish recommended for good nutrition of Vanuatu's population. The proportion of the total amount of fish needed for food security to be provided by tuna is 74% in 2035, 77% in 2050, and 78% in 2100.



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

Livelihoods

Current contributions

Full-time and part-time jobs have been created through tuna fishing and processing in Vanuatu, although they represent only a low percentage of total employment in the nation. Coastal fisheries also provide important opportunities to earn income for coastal communities throughout the country, with > 60% of households in representative coastal communities deriving their first or second income from catching and selling fish. Aquaculture has created 30 jobs[4].

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
54	20	30	30	30	30	21	40	61	30

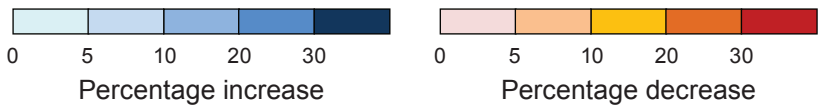
* In 2009, ~ 400 Ni-Vanuatu were employed on nationally-flagged tuna fishing vessels; ** Ponia (2010)[4]; information derived from Chapter 12, Table 12.6 and the SPC PROCFish Project.

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	↑	No effect	↓	↑	↓
2050	No effect	↓	↓	↑	↓
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 Vanuatu has to derive greater socio-economic benefits from fisheries and aquaculture will depend heavily on interventions to:

1. maximise access to tuna, and the efficiency of fishing operations, to provide fish for economic development and continued food security;
2. manage coastal fish habitats and fish stocks to minimise the gap between the fish available from coral reefs and the fish needed 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)
E3	Immediate conservation management measures for bigeye tuna	E7, 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
F3	Provide for landward migration of coastal fish habitats	F4, F5, F18
F4	Allow for expansion of freshwater habitats	F4, F18
F5	Sustain production of coastal demersal fish and invertebrates	F6, F7, F13, F18
F6	Diversify catches of coastal demersal fish	F6, F13, F18
F7	Manage freshwater and estuarine fisheries to harness opportunities	
F8	Increase access to tuna for urban and rural populations	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
L2	Rebuild populations of sea cucumbers and trochus	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