Pacific Community
Communauté du Pacifique

INTERNATIONAL COURT OF JUSTICE

Request for an Advisory Opinion on Obligations of States in respect of Climate Change

Expert Report for the Government of Kiribati prepared by the Pacific Community (SPC)

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12 March 2024

Acknowledgements

We acknowledge the scientific and technical support from Pacific Community (SPC) staff, including teams within SPC's Human Rights and Social Development Division (HRSD), Geoscience Energy and Maritime Division (GEM), Land and Resources Division (LRD) and Fisheries, Aquaculture and Marine Ecosystems (FAME) Division.

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INTRODUCTION AND EXPERTISE

1. The Pacific Community (SPC) supports Pacific Island countries and territories with scientific and technical solutions to address the region's greatest challenge, climate change. SPC is one of the Pacific region's scientific and technical intergovernmental organisations working alongside its Pacific Island country and territory (PICT) Members[1] to understand and develop effective solutions to the challenges they face. In this case, SPC's core technical abilities to provide the objective science behind observed impacts of the adverse effects of climate change experienced by Kiribati will help provide further substantiation of its state submission.

2. SPC's mandate and work programme addresses the many facets of climate change and its impacts on the region, including but not limited to marine ecosystems, fisheries,[2] coastal hazards, and human rights protections.[3] Additionally, SPC is the regional lead for the implementation of many climate change mitigation and adaptation programmes, including on sea level rise as well as loss and damage, and it sustainably manages Pacific maritime zones, ecosystems, and resources from 'ridge to reef' for current and future generations.[4] Its expertise in global and regional analyses of the impacts of climate change on the marine environment led to its inclusion in the advisory opinion proceedings at the International Tribunal for the Law of the Sea in Case No. 31.[5]

3. Finally, SPC is a consultative and advisory body to participating governments and administrations in matters affecting the economic and social development of its members within its scope, and the welfare and advancement of their peoples.[6] SPC sustainably manages social and environmental

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[1] The Pacific Community (SPC) has 27 members, including 22 PICTs: American Samoa, Cook Islands, Federated States of Micronesia, Fiji, French Polynesia, Guam, Kiribati, Marshall Islands, Nauru, New Caledonia, Niue, Northern Mariana Islands, Palau, Papua New Guinea, Pitcairn Islands, Samoa, Solomon Islands, Tokelau, Tonga, Tuvalu, Vanuatu and Wallis and Futuna.

[2] Note that, under the United Nations Convention on the Law of the Sea (UNCLOS), fishing is singled out among the legitimate uses of the sea that are negatively affected by pollution ('pollution of the marine environment means the introduction by man, directly or indirectly, of substances or energy into the marine environment, including estuaries, which results or is likely to result in such deleterious effects as harm to living resources and marine life, hazards to human health, hindrance to marine activities, including fishing and other legitimate uses of the sea, impairment of quality for use of sea water and reduction of amenities'*)*, UNCLOS, 10 December 1982, 1833 United Nations Treaties Series (U.N.T.S.) 397 (entered into force 1 November 1994) at Article 1(1)(4).

[3] Article IV, §§ 6-10, of the Canberra Agreement establishing the South Pacific Commission (U.N.T.S., vol. 97, 227).

[4] For the full range of SPC's implementation for mitigation and adaptation programming, *see* Pacific Community Strategic Plan 2022–2031 (available at: https://purl.org/spc/digilib/doc/uzzya).

[5] *See* Request for an Advisory Opinion submitted by the Commission of Small Island States on Climate Change and International Law (Request for an Advisory Opinion submitted to the Tribunal), Intergovernmental Organizations invited to submit written statements pursuant to the Rules of the Tribunal.

[6] Article IV, §§ 6-10, of the Canberra Agreement establishing the South Pacific Commission (U.N.T.S., vol. 97, p. 227) at para. 6.

risks and impacts of all its activities in an inclusive manner, with a people-centred approach to maximise whole-of-society benefits. SPC is committed to openness and transparency, maintaining the highest ethical standards, and as such, the statements contained in this report are factually correct and materially complete.

METHODOLOGY

4. Kiribati requested this expert report to include the full scope of climate-related losses and damages experienced, including environmental, human health, socio-economic, and cultural impacts. From this request, several of SPC's largest and most relevant divisions provided the necessary science to put together this report, compiled by an international lawyer with a scientific background to ensure proper competencies.[7]

5. The science captured in this expert report is based on and built upon the best available science, including the Sixth Assessment Report of the United Nations Intergovernmental Panel on Climate Change (IPCC).[8] It covers climate impacts that have already been observed as well as those currently occurring, like temperature rise, wave inundation, flooding, marine environment degradation, and others.

6. It concludes that (i) reef islands (atolls) like Kiribati are highly vulnerable to the impacts of anthropogenic climate change; (ii) Kiribati has experienced significant harm as a result of anthropogenic climate change; and (iii) future losses and damages are bound to occur, with the extent of future harm depending on actions taken to avert, minimise, and address such losses and damages.

CLIMATE CHANGE–RELATED IMPACTS

7. Small island developing states, due to their geographical circumstances and level of development, are specially affected and particularly vulnerable to the adverse effects of climate change. For Kiribati, these well-documented harms include, but are not limited to, sea-level rise; coastal erosion; ocean warming, acidification, and deoxygenation; and adverse effects on pelagic and coastal fisheries; coral reefs and biodiversity; temperature rise; drought and water security; agriculture; and

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[7] SPC's relevant divisions include Geoscience, Energy and Maritime (GEM), Fisheries, Aquaculture and Marine Ecosystems (FAME), Land Resources Division (LRD), Human Rights and Social Development (HRSD) and Climate Change and Environmental Sustainability (CCES). The profiles of these divisional directors as well as the author's curriculum vitae for this expert compilation can be found packaged at the end of this report.

[8] Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 2022 (also available at: https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf).

food security.[9] These impacts are described under the progression of time and corresponding increased temperature projections, and where possible, including climate impacts likely to occur at 2.8°C, the level of warming projected to occur if nationally determined contributions (NDCs) submitted under the Paris Agreement are fully implemented.[10]

Sea-level rise

8. Climate change–induced sea level rise is an existential threat to Kiribati. This low-lying country, composed of 33 atolls and reef islands, stands on average just two metres above sea level, rendering it particularly vulnerable to rises in sea level. Rising sea levels have caused increased coastal erosion and saltwater intrusion into the freshwater lens.

9. The highest sea levels in Kiribati typically occur between January and March and in August/September with El Niño years typically having higher levels. Sea-level rise in the Kiribati exclusive economic zone (EEZ), as measured by satellite altimeters from 1993 to mid-2020, ranges from about 3–4 mm per year in the vicinity of the Gilbert and Phoenix Islands, and up to 4.5 mm per year in the vicinity of the Line Islands.[11] Kiribati experiences a semidiurnal tidal cycle, meaning two high and two low tides per day. The highest predicted tides of the year at Tarawa typically occur in August/September as well as December to February. For Kiritimati, the highest predicted tides are around August, and also from November to January. Since approximately 2009, the number of hours that exceed the 99th percentile threshold has been increasing. This is due to a combination of sea-level rise and subsidence occurring in Kiribati.[12]

10. Sea level across the three Kiribati island groups, measured by satellite altimeters (see Figure 1) since 1993, has risen between three and four millimetres (mm) per year. This rise is partly linked to a pattern related to climate variability from year to year and decade to decade. For Tarawa, the sea level trend is reported at 4.4 mm per year, slightly higher than the altimetry trends for the rest of Kiribati and this difference is likely attributed to subsidence occurring at Tarawa.[13]

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[9] *See mainly*, McGree, S., Smith, G., Chandler, E., Herold, N., Begg, Z., Kuleshov, Y., Malsale, P., and Rittman, M. SPC. *Climate Change in the Pacific 2022: Historical and recent variability, extremes and change.* Chapter 5 'Kiribati'; Gillett, R. and Fong, M. 2023. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Chapter 9: 'Kiribati', Noumea, New Caledonia: Pacific Community. SPC also received further data from experts at the Secretariat of the Pacific Regional Environment Programme (SPREP) in consultation with the Kiribati government.

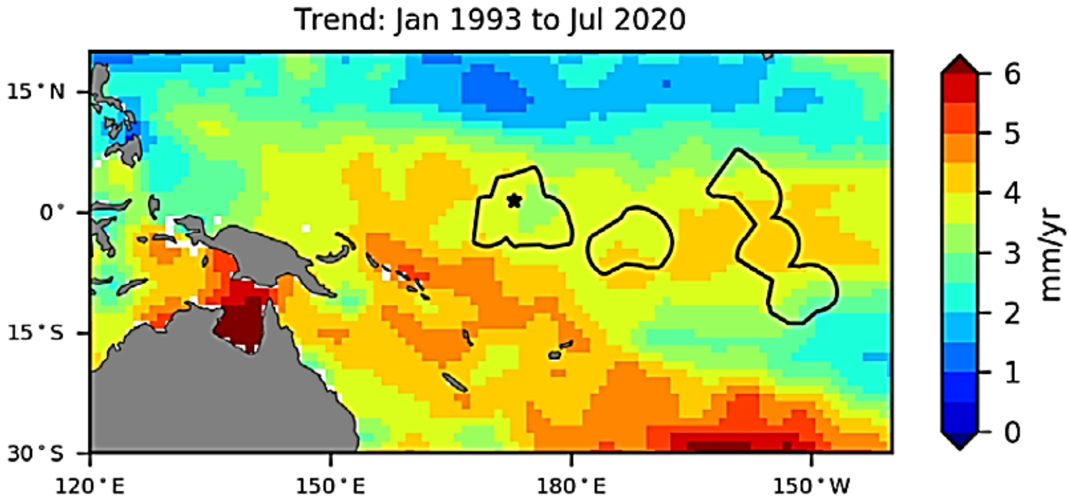
[10] Additional information on historical climate trends for Kiribati can be found in the Pacific Climate Change Data Portal available at http://www.bom.gov.au/climate/pccsp.

[11] McGree, S. et al., *Climate Change in the Pacific 2022*, 60.

[12] Brown, N. J., Lal, A., Thomas, B., McClusky, S., Dawson, J., Hu, G., and Jia, M. 2020. Vertical motion of Pacific Island tide gauges: combined analysis from GNSS and levelling. Record 2020/03. Geoscience Australia, Canberra. http://dx.doi.org/10.11636/Record.2020.003.

[13] *Ibid*.

Figure 1. Satellite altimetry annual trend for the Pacific from 1993 to 2020 with Kiribati EEZ highlighted in black.[14]



11. By the end of the century, sea level is likely to increase by 0.73 cm under intermediate climate change scenarios (SSP 2–4.5) in Kiribati (see Table 1)—a scenario where temperatures rise by 2.7°C in the 'shared socioeconomic pathway' (SSP). To understand the impacts of climate change better, there is an urgent need to invest in baseline data and strengthen monitoring efforts for informed decision-making on adaptation and mitigation as harm is already being observed in Kiribati.

Table 1. Decadal increments for projections of sea level rise in metres for Kiribati relative to the 1995–2014 mean sea level.[15]

Year	*Low* SSP1-2.6	*Intermediate* SSP2-4.5	*High* SSP3-7.0	*Very High* SSP5-8.5	*Very High - Low* SSP5-8.5 H+
1995-2014	0.00	0.00	0.00	0.00	0.00
2020	0.07 (0.05–0.10)	0.07 (0.05–0.09)	0.07 (0.05–0.09)	0.08 (0.06–0.10)	0.08 (0.06–0.11)
2030	0.13 (0.10–0.17)	0.13 (0.10–0.16)	0.13 (0.10–0.16)	0.14 (0.11–0.18)	0.14 (0.11–0.21)
2040	0.19 (0.14–0.24)	0.19 (0.15–0.25)	0.20 (0.15–0.26)	0.21 (0.16–0.27)	0.21 (0.16–0.34)
2050	0.26 (0.20–0.34)	0.28 (0.22–0.36)	0.29 (0.23–0.37)	0.30 (0.24–0.39)	0.31 (0.24–0.50)
2060	0.32 (0.25–0.42)	0.35 (0.28–0.46)	0.37 (0.29–0.48)	0.39 (0.32–0.51)	0.42 (0.31–0.71)
2070	0.40 (0.31–0.53)	0.44 (0.35–0.58)	0.47 (0.37–0.61)	0.51 (0.41–0.67)	0.55 (0.41–0.97)
2080	0.47 (0.36–0.64)	0.54 (0.42–0.71)	0.58 (0.46–0.77)	0.64 (0.50–0.84)	0.70 (0.50–1.27)
2090	0.54 (0.41–0.74)	0.63 (0.49–0.85)	0.71 (0.56–0.94)	0.79 (0.62–1.04)	0.88 (0.62–1.61)
2100	0.62 (0.43–0.86)	0.73 (0.56–1.00)	0.85 (0.64–1.14)	0.93 (0.69–1.28)	1.08 (0.69–1.96)
2110	0.71 (0.47–1.00)	0.83 (0.61–1.15)	0.95 (0.66–1.31)	1.05 (0.71–1.49)	1.28 (0.71–2.32)
2120	0.78 (0.51–1.11)	0.93 (0.67–1.30)	1.08 (0.75–1.50)	1.19 (0.82–1.71)	1.52 (0.82–2.65)
2130	0.85 (0.55–1.23)	1.02 (0.74–1.44)	1.21 (0.83–1.69)	1.33 (0.91–1.92)	1.78 (0.91–3.46)
2140	0.92 (0.58–1.33)	1.12 (0.80–1.58)	1.34 (0.92–1.87)	1.47 (1.00–2.12)	2.07 (1.00–4.58)
2150	0.98 (0.62–1.44)	1.21 (0.86–1.71)	1.46 (1.00–2.06)	1.59 (1.08–2.32)	2.39 (1.08–5.82)

[14] Figure from McGree, S. et al., *Climate Change in the Pacific 2022.* Chapter 5.8.2 'Trends' at 69. The star symbol indicates the location of the tide gauge at Tarawa.
[15] Graphic taken from PRIF: *Guidance for managing Sea Level Rise Infrastructure Risk in Pacific Island Countries*, Published: December 2021. Projections based on IPCC (2021) sourced from AR6 and interpolated to nearest decade and adjusted for the upper bound of the most likely vertical land movement defined by Fox-Kemper et al. (2021).

Shoreline change, coastal inundation (waves), and flooding

12. Studies have shown shoreline changes of reef islands in historical areas around the Tarawa atoll in Kiribati. Low-lying reef islands on atolls are threatened by the observed and anticipated effects of sea-level rise.[16] In the short term, the reef-island area and shoreline change over 30 years shows a substantial increase in size (driven largely by reclamations in urban South Tarawa), yet widespread erosion and high average accretion rates[17] are also observed that appear to be related to reclamations.

13. In rural North Tarawa, most reef islands show stability with localised changes in areas such as embayments,[18] sand spits, and beaches adjacent to, or facing, inter-island channels. Shoreline changes in North Tarawa are largely influenced by natural factors, whereas those in South Tarawa are predominantly caused by human factors and seasonal variability associated with El Niño–Southern Oscillation (ENSO). However, there are serious concerns for the future of South Tarawa reef islands as evidence shows widespread erosion along the ocean and lagoon shorelines and further encroachment onto active beach areas. This will disrupt the longshore sediment transport, intensify erosion, and increase the susceptibility of reef islands to the adverse impacts of sea-level rise.[19]

14. For Kiribati, the average sea state is dominated by swells from the south. The annual mean wave height is 0.78 m, the annual mean wave direction is 209° and the annual mean wave period is 12.17 seconds (s). In the Pacific, waves often come from multiple directions and for different periods.[20] In Betio, there are often more than seven different wave direction/period components with the majority coming from between south to southeast (see Figure 2). The significant wave height shows little change between the seasons at Betio. However, wave period is significantly higher from March to June with wave height peaks in winter, and wave period peaks in May. Typically, these changes are small but can be important during phenomena such as ENSO where extreme wave events[21] are likely to occur more frequently and can have significant negative impacts on coastal infrastructure and affect coastal hazard and adaptation planning, particularly in the face of sea-level rise.

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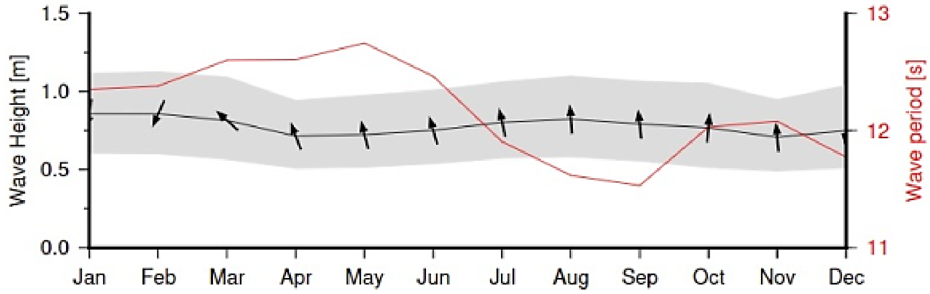
[16] Biribo, N. and Woodroffe, C.D., *Historical area and shoreline change of reef islands around Tarawa Atoll, Kiribati*, Sustainability Science 8 'Special Feature: Understanding and Managing Global Change in Small Islands, 345–362 (2013).
[17] Vertical accretion refers to the build-up of deposits or sediment in flood areas from periodic flooding of its banks and occurs in successive layers measured over time. The ability of land to sequester sediments and expand its volume is directly related to the pace of rising sea levels.
[18] This refers to a recess in a coastline forming bay-like formations often linked to irregular corrosion or modification of groundmass.
[19] See note 17 above.
[20] McGree, S. et al., *Climate Change in the Pacific 2022.* Chapter 5.9 'Waves', 70.
[21] Extreme waves are characterised as waves that are greater than twice the size of surrounding waves, are very unpredictable, and often come unexpectedly from directions other than prevailing wind and waves.

Figure 2. Monthly wave height (black line), wave period (red line) and wave direction (arrows).



Ocean warming, acidification, and deoxygenation

15. The projected changes to the key features of the tropical Pacific Ocean surrounding Kiribati relative to the long-term averages are expected to result in increases in sea surface temperature (SST) and ocean acidification (see Table 2). Under climate change, the surface area of the Pacific Equatorial Divergence Province (PEQD)—the part of the Pacific where Kiribati lies—is projected to contract and the convergence zone with the Warm Pool is expected to move eastward.[22] Changes in the position of this convergence zone due to ENSO will have a major influence on the abundance of tuna in the EEZ of Kiribati, which will result in significant losses of GDP and threaten food security.[23]

Table 2. Projected changes to the ocean surrounding Kiribati.[24]

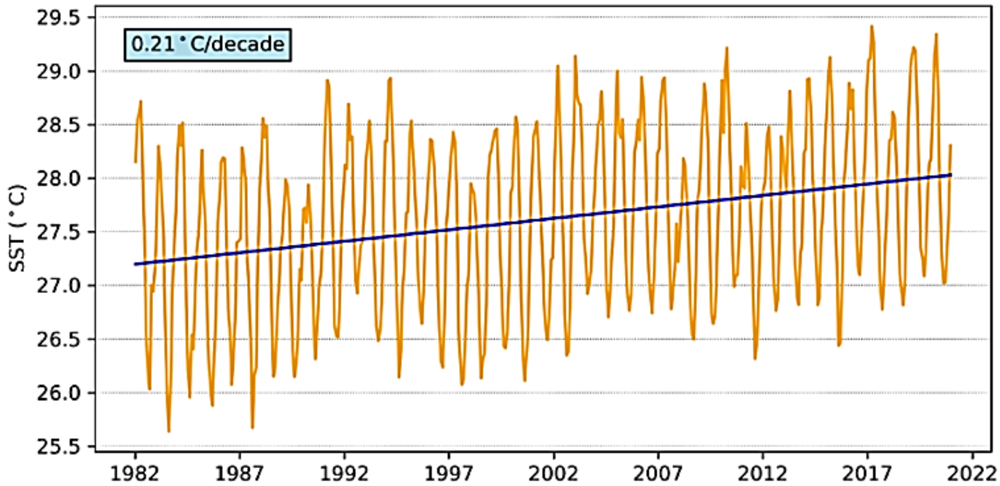
Ocean feature	1980–1999 average	Projected change			
		B1 2035	A2 2035	B1 2100*	A2 2100
Sea surface temperature (°C)	29.2[a]	+0.6 to +0.8	+0.7 to +0.8	+1.2 to +1.6	+2.2 to +2.7
Sea level (cm)	+6 since 1960				
IPCC **		+8	+8	+18 to +38	+23 to +51
Empirical models ***		+20 to +30	+20 to +30	+70 to +110	+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.

[22] Bell J.D., Johnson J.E., Ganachaud A.S., Gehrke P.C., Hobday A.J., Hoegh-Guldberg O., Le Borgne R., Lehodey P., Lough J.M., Pickering T., Pratchett, M.S. and Waycott M. (2011), *Vulnerability of Tropical Pacific Fisheries and Aquaculture to Climate Change, Summary for Pacific Island Countries and Territories*. Secretariat of the Pacific Community, Noumea, New Caledonia.
[23] *Ibid.*, 92. Modelling for yellowfin tuna is now in progress and the trends for bigeye tuna are projected to decrease progressively under moderate emissions scenarios.
[24] Table from *Ibid*., 91.

16. Ocean temperature, as measured by the Tarawa tide-gauge, reaches on average a maximum of approximately 30°C from June to October, but individual months can get as high as above 32°C from September to November; minimum average temperature is 29°C in February.[25] Equatorial locations typically have little average variation but can drastically change in a given year depending on the ENSO cycle. The variability in temperatures between September and February is reflective of the peak months of ENSO.[26] The 1981–2021 sea surface temperature (SST) averaged over the EEZ regions is shown in Figure 3.

Figure 3. Sea surface temperature from satellite observations averaged across the Kiribati EEZ (orange line) overlaid by the linear regression trend (blue line).[27]



Coastal fisheries, pelagic fisheries and tuna stock

17. For an atoll island country like Kiribati, the significance of its fishery sector cannot be understated. Two sources of data were used to estimate the value of subsistence fishing in Kiribati: Ministry of Fisheries data and the 2006 Household Income and Expenditure Survey (HIES). Estimates of the economic value of subsistence fishing using these two sources differed significantly, probably because the scope, coverage and timing of the data sources are different. The gross value of subsistence fishing, estimated from multiple data sources, was between A$3.7 million and A$38.5 million per year. The lower estimate of A$3.7 million per year is unlikely to be a true reflection of actual subsistence value. Instead, the Ministry of Fisheries estimate of net value of A$9.6 million

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[25] McGree, S. et al. *Climate Change in the Pacific 2022.* Chapter 5.7 'Sea surface temperature', 66.
[26] El Niño and La Niña have perhaps the strongest influence on year-to-year climate variability in the Pacific. These phenomena are a part of a natural cycle known as El Niño–Southern Oscillation (ENSO) and are associated with a sustained period (many months) of warming (El Niño) or cooling (La Niña) in the central and/or eastern tropical Pacific. The ENSO cycle operates over timescales from two to seven years. *Ibid*., 10.
[27] Figure from *Climate Change in the Pacific 2022,* 67. The data show a trend of 0.21°C per decade with a 95% confidence interval of ±0.06°C.

to A$19.2 million per year is used. Subsistence fishing costs are minimal, so the value added was similar to the gross value, approximately A$9.6 million to A$34.5 million per year.[28]

18. The analysis of commercial fishing was done for two categories: small-scale (household-level) commercial fishing and industrial fishing. The economic value of commercial fishing was estimated from various data sources. The gross value of small-scale commercial fishing ranged from A$7 million to A$25 million per year. This estimate included small-scale tuna fishing, with a gross value of about A$4 million per year. Small-scale inshore commercial fishers generally use outboard engines and therefore their operational costs are higher than those of subsistence fishers. In this analysis, fuel costs were assumed to be 60% of the gross output, leaving a value added of A$2.8 million to A$10 million.[29]

19. It is estimated that the production from coastal subsistence fisheries in Kiribati in 2021 was 11,000 tonnes, worth A$30 million to fishers. The HEIS 2019–2020 indicates that 44% of households in Kiribati participate in fisheries activities. In 2021 the tuna catch by the locally based longliners was 2,686 t, with an in-zone value of A$17.6 million (see Table 3).

Table 3. Locally based offshore catches in Kiribati waters.[30]

	2017	2018	2019	2020	2021
Volume (t)	1,393	998	3,429	4,768	2,686
Delivered value (US$)	7,411,113	6,844,765	21,406,374	32,539,382	16,965,033
In-zone value (US$)	5,558,335	5,133,574	16,054,781	24,404,537	12,723,775
In-zone value (A$)	7,170,252	7,289,675	23,118,884	32,213,988	17,558,809

Source: FFA (2022b), with modifications

20. Tuna is the largest source of revenue for Kiribati. The latest *Fishing License Revenues in Kiribati* gives the fishing license revenue for 2017 as A$169.0 million, for 2016 as A$143.3 million, and for 2015 as A$197.8 million.[31] The fishing license revenue is given in the 2023 Recurrent Budget, which shows that in 2021 it was A$161,445,289; so with the total government revenue of A$246,458,807, the fishing license revenue equates to 65.5% of total government revenue.[32]

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[28] Gillett R. and Fong M. 2023. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community, available at https://www.spc.int/DigitalLibrary/Doc/FAME/Manuals/Gillett_23_Benefish4.html.
[29] *Ibid*., 95.
[30] Table from *Ibid*., 98.
[31] MFMRD 2019. Fishing License Revenues in Kiribati, 2018 Report. Ministry of Fisheries and Marine Resource Development and Ministry of Finance and Economic Development, Tarawa.
[32] NEPO. 2022. Recurrent Budget: Building Back Better and Stronger. National Economic Planning Office, Ministry of Finance and Economic Development, Tarawa.

21. The improved fishing revenue was responsible for a significant turnaround in national finances. Before 2012, the budget was regularly in deficit, and there was an ongoing reliance on drawdowns on Kiribati's sovereign wealth fund, the Revenue Equalisation Revenue Fund, or RERF. However, from 2013, there were significant surpluses and contributions to the RERF. Examination of the government revenue estimates between 2012 and 2015 reveals a strong conservative bias in fishing license forecasts, with actual revenue exceeding estimates by $318.4 million over this period. By contrast, budget documents estimated that the net financing need was $91.8 million in deficits across the four years. As a result, there was a significant surplus of cash flowing onto the government balance sheet. Non-RERF cash balances increased from $11.3 million in January 2013 to an estimated $173.5 million by the end of 2018 (Ministry of Finance and Economic Development [MFED], 2018), and the RERF balance grew from $613.9 million to $994.4 million over that same period—just short of the government's $1 billion target. State-owned enterprise commercial debts with ANZ were also eliminated within this timeframe, and the government invested $10 million in a land purchase in Fiji.[33]

22. Of all the PICTs, tuna dominates the nearshore pelagic catch in Kiribati. These coastal fisheries take only a tiny fraction of the regional catch of skipjack and yellowfin tuna, the vast majority of which are targeted by offshore industrial fishing, and which do not contribute to the domestic fish supply of PICTs. Further, fish and invertebrates from reefs, mangroves, and other nearshore habitats dominate the catch targeted for subsistence fishing, the true value of which is likely underestimated for Kiribati. Further, Kiribati's location in the middle of the Pacific Ocean is a breeding and feeding ground for tuna, which contributes to the health of the oceans and global food security, not just that of Kiribati. This means there could be longer-term economic and environmental costs for Kiribati, the region and beyond as climate changes impacts worsen.

Food security

23. Kiribati has the highest per capita consumption of fish of any country in the world.[34] Kiribati's dependence on its fisheries resources, in particular tuna, has serious implications for its economic development and food security. For example, tuna access fees contribute to approximately 50% of government revenue and 25% of its GDP (see Table 4 in conjunction with above analyses). A significant medium- to long-term challenge in Kiribati is ensuring future food security without compromising lagoon fishery sustainability. Unsustainable fishing practices exacerbate climate-driven economic, environmental, and social impacts on the country, and climate change affects habitat availability and quality. Additionally, coastal and lagoon fisheries play a significant role in

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[33] Benefish Study 4, *supra* note 28, 106.
[34] Food and Agriculture Organization (FAO), *The Republic of Kiribati*, Country Brief (2018).

generating local employment and livelihoods, further affecting food security for Kiribati in the face of global climate change.[35]

Table 4. Fishing contributions to gross domestic product (GDP) in A$ thousands.[36]

	2017	2018 r	2019 r	2020 r	2021 p
Informal sector fishing for cash sales	5,678	6,183	5,924	6,403	5,959
Seaweed growers	75	75	75	75	75
Informal sector fishing for subsistence	9,464	10,305	9,874	10,672	9,932
Formal sector fishing	4,973	10,229	9,306	6,223	8,226
Total fishing contribution	22,207	26,792	25,179	23,373	24,192
Kiribati GDP at market prices	245,532	262,640	252,344	258,139	302,793
Fishing as a % of GDP	9.0%	10.2%	10.0%	9.1%	8.0%

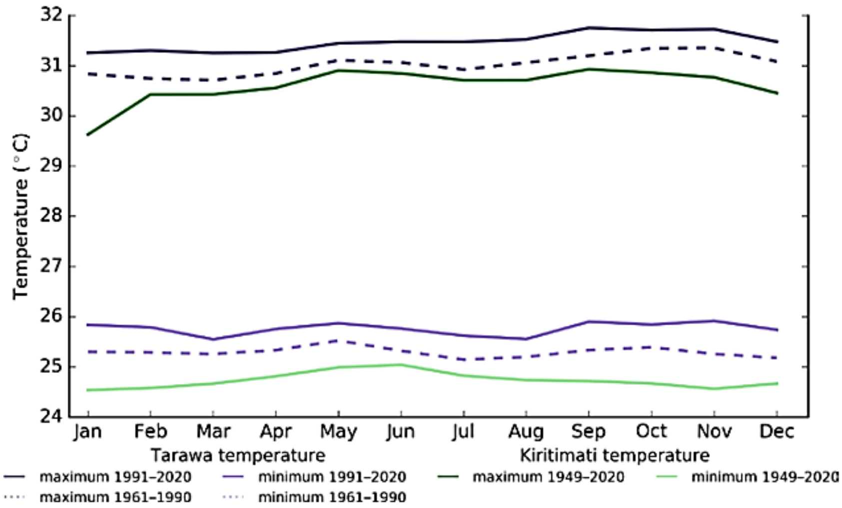
Source: NSO (unpublished data); r = revised; p = provisional

Temperature rise

24. Kiribati has a hot, humid tropical climate, with air temperatures very closely related to the temperature of the oceans surrounding the small islands and atolls. There has been a clear shift towards warmer average monthly temperatures during 1961–1990 and 1991–2020, with warmer average air temperatures occurring in all months throughout the year for Tarawa (see Figure 4).[37] Average annual and seasonal temperatures have increased significantly in Tarawa such that a relatively small size of year-to-year fluctuations in temperature can be attributed to its equatorial location.

[35] WorldFish, *Fish for the Future: Fisheries development and food security for Kiribati in an era of global climate change*, CGIAR Consortium (2014).
[36] Table from *Ibid*., 103. Only limited information is available on the method used by the National Statistics Office (NSO) to estimate the fishing contribution to GDP, and the NSO website was not functional during late 2022 and early 2023. HIES data is used to determine the value added to the informal fishing sector. The yearly exchange rates to the United States dollar between 2014–2022 are as follows: 1.22, 1.37, 1.37, 1.29, 1.42, 1.44, 1.32, 1.38, and 1.53, respectively.
[37] McGree, S. et al. *Climate Change in the Pacific 2022.* Chapter 5.5 'Air Temperature', 64.

Figure 4. Maximum and minimum air temperature seasonal cycle for Tarawa (purple) and Kiritimati (green) and for the period of 1961–1990 (dotted lines) and 1991–2020 (solid lines).[38]



Drought and water security

25. Kiribati is experiencing acute water shortages resulting from a prolonged La Niña weather pattern and low rainfall. Prolonged episodes of this result in drought and can lead to significant water security issues. Already in 2022, Kiribati experienced a state of emergency due to severe drought. As drought in Kiribati worsens, so do the challenges and threats to water via contamination, brackishness, inaccessibility, and freshwater availability to large portions of the population. For example, water assessments covering 1875 households in Betio, the largest township of Kiribati's capital city of South Tarawa, show that the water for 73% of tested households showed levels of contaminants, indicating that contamination of drinking water in Betio is widespread.[39] Reports from the majority of island councils on the outer islands point to the fact that accessing freshwater is becoming increasingly difficult and that the prolonged drought has already taken a toll on livelihoods and food security of communities in these islands.[40] This situation of high water stress due to low rainfall and dry conditions is expected to persist, especially in La Niña seasons.

Agriculture

26. Access to sufficient clean water resources, coastal defences, and adequate food crop development is limited on atolls like Kiribati. To address these development issues, the Government of Kiribati is engaged in numerous programmes and projects to enhance its resilience, especially with regard agriculture and climate change impacts. Among these is the Kiribati Livestock Production Concept

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[38] SPC notes that there is a high amount of missing temperature data for Kiritimati. The average 1949–2020 temperature cycle is available.
[39] *See* Pacific Drought Report – May 2022, available at https://reliefweb.int/disaster/dr-2002-000244-kir.
[40] *Ibid.*

to support Climate Change Adaptation and Food Security. Under the concept, the Kiribati Government seeks to address food security by increasing national capacity in the pig and chicken production sectors.[41]

27. In 2011, the Government of Kiribati requested new regional climate change programmes to support communities on outer islands in their efforts to adapt to the adverse impacts of climatic changes and variability, and to strengthen the island's response capacities to man-made and natural hazards with a holistic and integrated approach. Instead of focusing on only selected villages or sectors, this Whole-of-Island Approach targets the whole island ecosystem, communities and government structures while also considering its relationships with the national government, partners, communities and their land.[42]

Coral reefs and biodiversity

28. Ocean acidification has been increasing in Kiribati's waters and will continue to increase, which threatens coral reef ecosystems. Biodiversity and the natural environment in Kiribati face extreme pressures due to climate change, and loss of some species of coral, fish, bird, and terrestrial species is likely without proper and effective conservation measures.

29. Additionally, ocean acidification can play a large role in coral reef health. For example, calcium carbonate is used for the creation of external skeletons for multiple marine organisms such as plankton, coral reefs, and shellfish. Increases in atmospheric carbon dioxide (anthropogenic) are understood to lead to reduced levels of calcium carbonate saturation on the ocean's surface via an increase in ocean acidification thereby decreasing carbonate ion concentrations. As a result, there are serious concerns that if carbonate minerals, such as aragonite, become undersaturated, it could undermine that already fragile state of current ocean ecosystems.[43]

30. Kiribati has a large area of coral reefs as well as small areas of mangroves, deepwater, and intertidal seagrasses as well as intertidal flats that support many important fisheries species. Climate change is expected to add to the existing local threats that these areas already face, resulting in declines in the quality and area of all habitats (see Table 5).[44]

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[41] This concept is supported by SPC's Land Resources Division and the SPC, USAID and GIZ climate change programmes, which began in 2013.
[42] Learn more about this initiative at https://ccprojects.gsd.spc.int/kiribati-video.
[43] World Bank Group, *Climate Risk Country Profile Kiribati* (2021), available at https://climateknowledgeportal.worldbank.org/sites/default/files/country-profiles/15816-WB_Kiribati%20Country%20Profile-WEB.pdf
[44] McGree, S. et al. *Climate Change in the Pacific 2022.* Chapter 9 'Kiribati', 93.

Table 5. Projected changes to coastal habitats in Kiribati.[45]

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

* Approximates A2 in 2050; a = no estimates in reduction of intertidal flats available; b = assumes there is strong management of coral reefs; c = indicative estimates from Fiji and French Polynesia {Chapter 6}.

CONCLUSION

31. Climate change is causing significant harm to Pacific Island countries and territories, with atoll nations like Kiribati being injured and/or specially affected due to reef islands' extra vulnerability to the adverse effects of climate change. This harm materialises in the form of increasing sea level rise, ocean temperatures and ocean acidification, coastal erosion, extreme wave events, prolonged drought, and other impacts.[46] Projections indicate that these impacts are bound to intensify with climate change, threatening to render some or all land territory of these countries uninhabitable. The extent to which this existential threat materializes will heavily depend on actions taken to curb anthropogenic greenhouse gas emissions—the vast majority of which is generated outside of its borders—as well as measures to adapt to climate change and respond to the loss and damage it causes.

[45] Table from *Ibid*.
[46] *See generally*, McGree, S. et al., *Climate Change in the Pacific 2022.* Chapter 9 'Kiribati'; and Bell et al., *Vulnerability of Tropical Pacific Fisheries and Aquaculture*.