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 Cook Islands
prepared by the Pacific Community (SPC)

14 March 2024

Acknowledgements

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I. INTRODUCTION AND EXPERTISE

The Pacific Community (SPC) supports Pacific 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 will help provide further expertise for Cook Islands' state submission.

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]

SPC is also a consultative and advisory body to participating governments and administration 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 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.

II. METHODOLOGY

Cook Islands 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

[1] 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).

[6] See note 3 at para. 6.

together this report, compiled by an international lawyer with a scientific background to ensure proper competencies.[7]

The science captured in this expert report builds upon the best available science, including the Sixth Assessment Report by the Intergovernmental Panel on Climate Change (IPCC).[8] It covers climate impacts that have already been observed as well as those currently occurring, like extreme weather events such as cyclones, changing rainfall patterns and drought, ocean warming, acidification and deoxygenation, and others.

It concludes that (i) Cook Islands has experienced significant harm as a result of anthropogenic climate change, and (ii) 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.

III. CLIMATE CHANGE–RELATED IMPACTS

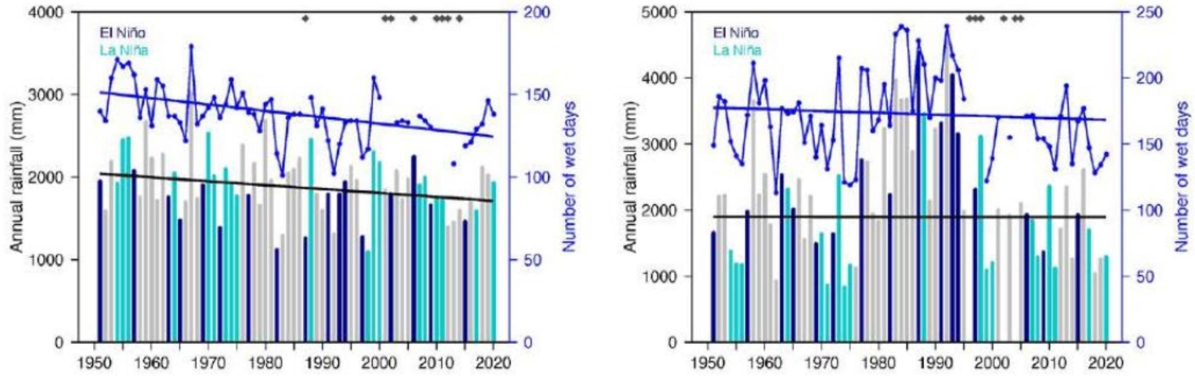
Small island developing states, due to their geographical circumstances and level of development, are specially affected and particularly vulnerable to the adverse effects of climate change. For Cook Islands, these well-documented harms include, but are not limited to, extreme weather events: sea-level 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 food security.[9] These impacts are described under the progression of time and corresponding increased temperature projections, and where possible, include 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.

Changing rainfall patterns, water security, and drought

Annual rainfall has decreased significantly in Rarotonga since 1951. This is attributed to decreases from May to October in the number of wet days and year-to-year variability associated with El Niño–Southern Oscillation (ENSO). For Penrhyn, decade-to-decade variability is evident. Annual rainfall has varied from approximately 1100 to 3000 mm at Rarotonga and from approximately 800 to 4700 mm at Penrhyn (see Figure 1).[10]

[7] SPC's relevant divisions include Human Rights and Social Development (HRSD), Geoscience Energy and Maritime (GEM), Fisheries, Aquaculture and Marine Ecosystems (FAME), Land Resources Division (LRD), and Climate Change and Environmentally Sustainability (CCES).
[8] Intergovernmental Panel on Climate Change (IPCC), *Climate Change 2022: Impacts, Adaptation, and Vulnerability*. Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, available at https://report.ipcc.ch/ar6/wg2/IPCC_AR6_WGII_FullReport.pdf.
[9] *See mainly*, McGree, Simon, Grant Smith, Elise Chandler, Nicholas Herold, Zulfikar Begg, Yuriy Kuleshov, Philip Malsale and Mathilde Rittman, SPC. *Climate Change in the Pacific 2022: Historical and recent variability, extremes and change.* Chapter 16 'Vanuatu'; and Gillett R. and Fong M. 2023. Fisheries in the economies of Pacific Island countries and territories (Benefish Study 4). Noumea, New Caledonia: Pacific Community. 704 p. https://purl.org/spc/digilib/doc/ppizh. SPC also received data on *Coral Reefs* and on *Biodiversity* from experts at the Secretariat of the Pacific Regional Environment Programme (SPREP) in consultation with the Vanuatu government.
[10] McGree et al., *Climate Change in the Pacific 2022* 'Cook Islands', Chapter 2.4 'Rainfall', 21.

Figure 1. Annual rainfall (bar graph) and number of wet days (line graph) at Rarotonga (left) and Penrhyn (right).[11]



For Cook Islands, domestic water sourced from stream catchment is limited and makes the country highly dependent on rainfall. Given this, Cook Islands is highly vulnerable to changing weather patterns and drought. Droughts have varying degrees of impact, and in general, lead to devastating water and food insecurity, fires and, in some PICTs, electricity shortages due to limited water for hydroelectricity.[12]

All water sources in Cook Islands are vulnerable to drought. Approximately 24.4% of households in Cook Islands operate land for agricultural purposes with 49% growing fruit and crop trees (e.g., bananas, taro, papaya, cassava), 43.7% growing flowers, 35.6% growing vegetables and 55% collecting coconuts.[13] The largest number of households in Cook Islands (83.4%), and especially the population in Rarotonga (90.8%), access water through the public water main, while the second most common source is water tanks. Water tanks remain the main source of water supply in outer islands—used by 98.5% of households in the northern islands and 87.2% in the southern islands.[14]

Increased frequency of high-temperature days

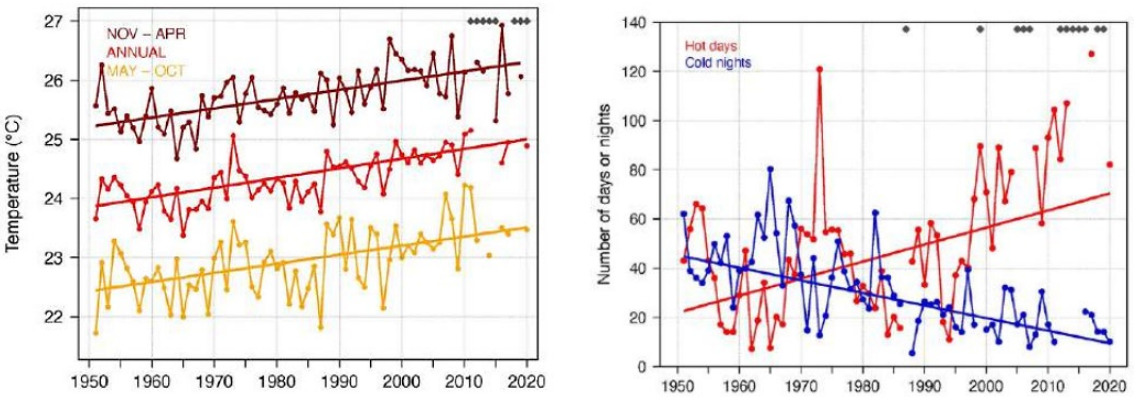
Average annual and seasonal temperatures have increased significantly in Rarotonga with November to April temperatures warming at approximately the same rate as May to October temperatures, indicating that daily minimum temperatures are warming faster than daily maximum temperatures. The number of hot days and warm nights has increased, and the number of cool days and cold nights has decreased (see Graph Comparison 1 below).

It is important to note that there is a significant difference in seasonal temperatures between the Northern and Southern Cook Islands. The position of the Northern Cook Islands (northern group) is close to the equator and results in fairly constant temperatures throughout the year, while in the Southern Cook Islands (southern group), temperatures cool off during the dry season. With all of this, scientists agree that there has been a clear shift towards warmer average monthly temperatures between the

[11] Figure from McGree et al., *Climate Change in the Pacific 2022* 'Cook Islands', Chapter 2.4 'Rainfall', 21. The 'wet days' account for rainfall that is at least 1 mm. Straight lines indicated linear trends for annual rainfall (black) and the number of wet days (blue). Diamonds indicate years with insufficient data for one or both variables.
[12] Clissold, Rachel, Karen E. McNamara, Ross Westoby, and Vaine Wichman. *Local Environment* 2023, vol. 28, no. 5, 645–661, https://doi.org/10.1080/13549839.2023.2169912.
[13] Cook Islands Statistics Office. 2018. *Cook Islands Population Census: Census of Population and Dwellings.* Rarotonga: Cook Islands Statistics Office.
[14] See note 12.

climatology periods of 1961–1990 and 1991–2020, with warmer average air temperatures occurring in all months throughout the year for Rarotonga.[15]

Graph Comparison 1. Average annual November–April and May–October temperatures for Rarotonga and the annual number of hot days and cold nights at Rarotonga.[16]



Extreme weather events

Tropical cyclones usually occur around Cook Islands during the souther hemisphere tropical cyclone season from November to April, but are increasingly occuring outside of that season. Interannual variabliity in the number of tropical cyclones in the Cook Island's exclusive economic zone (EEZ) is large, ranging from zero in some seasons to six in others (1980/81, 1997/98, and 2004/5).

Figure 2. Number of tropical cyclones passing within the Cook Islands EEZ per season with the 11-year average presented as a purple line and considering all years.

Records of tropical cyclones exist from the late 1800s in some countries in the Southwest Pacific, but trends in tropical cyclones have only been presented from 1981/82. Satellite-based observations began in the southwest Pacific in the early 1970s, but consistent coverage and reliable intensity estimates have only been available since the early 1980s. Confidence in tropical cyclone trends is moderate as the definition of a tropical cyclone has changed and satellite observation methods have continued to improve over the last 40 years.

[15] McGree et al., *Climate Change in the Pacific 2022*. 'Cook Islands', Chapter 2.4 'Air Temperature', 23.

[16] McGree et al., *Climate Change in the Pacific 2022*, 'Cook Islands', Chapter 2.5 'Air temperature: Trends', 23-24. Straight lines indicate linear trends. Diamonds indicate years with insufficient data for one or more variables.

Cyclone-related economic losses (e.g., losses to physical assets and production losses) are extremely high in the Pacific region and in Cook Islands where the highly exposed coastlines harbour the majority of the population, infrastructure, and economically important sectors.[17] This susceptibility was prominent when Tropical Cyclone Pat hit Aitutaki in February 2010 destroying 75% of homes on the island (see Picture 1).[18]

Picture 1. Example of damage caused by Tropical Cyclone Pat, February 2010.

Avarua town, the capital of Cook Islands and located on the north shores of Rarotonga island, is the densest residential area in the country and highly vulnerable to the impacts of tropical cyclones. It is the hub of Cook Islands' economy and industry, inclusive of the international airport, main fuel depot, Avatiu port and Harbour, Avarua Harbour, and the majority of government ministries.

In Maps 1–3 below, this portion of the shoreline depicts the socio-economic and environmental consequences of tropical cyclone impacts on coastal zones and nearby infrastructure when extreme wave and storm surges occur, also taking into account climate change effects over time. Blue highlighted areas are places that likely experience flooding in an average scenario; the darker the blue, the deeper the water. Yellow highlighted areas show places likely to experience wave 'overwash'.[19] Orange highlighted areas represent places likely to experience 'overtopping' wave impacts.[20] The red areas are likely to experience the heaviest surge and wave impacts, with the red blocks representing the buildings in the area that are exposed to these hazards and likely to suffer the most damage.

It is important to note when comparing these scenarios that what was once typically a 'one-in-every 20-year event' can be skewed as extreme weather events continue to be unprecedented. For example, between February and March 2005 there was an unprecedented five cyclones that hit Rarotonga within that two-month period, four of which were category 5.[21] Again, the three maps shown below depict the average recurrence intervals (ARIs) for these different scenarios, demonstrating how vulnerable Cook

[17] Clissold et al. *Local Environment* 2023, vol. 28, no. 5, 645–661.
[18] *See* 'Avarua, Rarotonga: Quantifying Asset Exposure to Extreme Events and Climate Change', 12 March 2022, available at https://storymaps.arcgis.com/stories/bbb631b99e044255838ade103e85eded. The damage from Cyclone Pat also resulted in the migration of households and a year-long reconstruction process.
[19] Overwash occurs during intense coastal storms when the combination of storm surge and storm waves overtops the beach crest and topographic high of a barrier island and deposits washover sand, causing erosion.
[20] Wave overtopping is the time-averaged amount of water that is discharged per linear metre by waves over a structure such as a breakwater, revetment or seawall, which has a crest height above still water level; it is the amount of water flowing over a coastal structure.
[21] *See* note 17.

Islands' economic and industrial hub is to extreme weather events, especially as they become more frequent.

Map 1. One-in-20-year average recurrence interval (ARI) for tropical cyclone events on the Avarua to Nikao coastline.[22]

Map 2. One-in-50-year ARI for tropical cyclone events on the Avarua to Nikao coastline.[23]

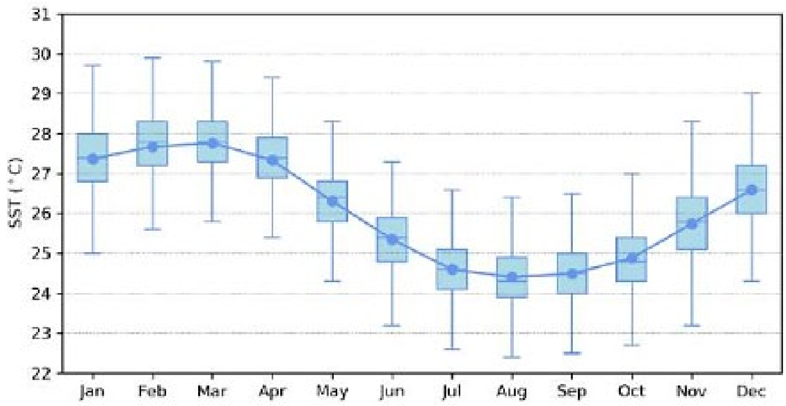
[22] An average recurrence interval (ARI) for tropical cyclone events models the vulnerability relationships that quantify and identify exposure and/or impact levels of different magnitude and intensity scenarios.
[23] This one-in-50-year ARI scenario depicts the damage from extreme wave and storm surges to the coastline for an average cyclone event that would occur once every fifty years.

Map 3. One-in-100-year ARI for tropical cyclone events on the Avarua to Nikao coastline.[24]

Ocean warming, acidification, and deoxygenation

Ocean temperature, as measured by the Rarotonga tide-gauge from 1993 to 2021, reaches on average a maximum of nearly 28°C in February/March but can get as high as 30°C (see Graph 1). Monthly average ocean temperatures in any given year can be up to ±2°C from the 24.5°C average in August and the 28°C average in February and March.

Graph 1. Annual temperatures measured at the Rarotonga tide-gauge.[25]



Sea surface temperature (SST) increased within the Cook Islands EEZ by 0.21°C per decade from 1981 to 2021. From 1981 to 2021, the SST from satellite observations averaged over the Cook Islands EEZ is shown in Graph 2. The data shows a trend of 0.21°C per decade with a 95% confidence interval of ±0.06°C. Finally, given the difference between the northern group (near the Equator) from the southern group, Figure 3 shows the observed and projected SST for the Southern Cook Islands, which shows steady warming and predicts a massive rise in SST in the near future.

[24] This one-in-100-year ARI scenario depicts the damage from extreme wave and storm surges to the coastline for an average cyclone event that would occur once every one hundred years.

[25] McGree et al., *Climate Change in the Pacific 2022,* 'Cook Islands', Chapter 2.7 'Sea surface temperature', 26. Blue dots show the monthly average, and shaded boxes show the middle 50% of hourly observations. Lines show the top and bottom 25% of hourly observations.

Graph 2. Historical sea surface temperature from satellite observations averaged across the Cook Islands EEZ.[26]

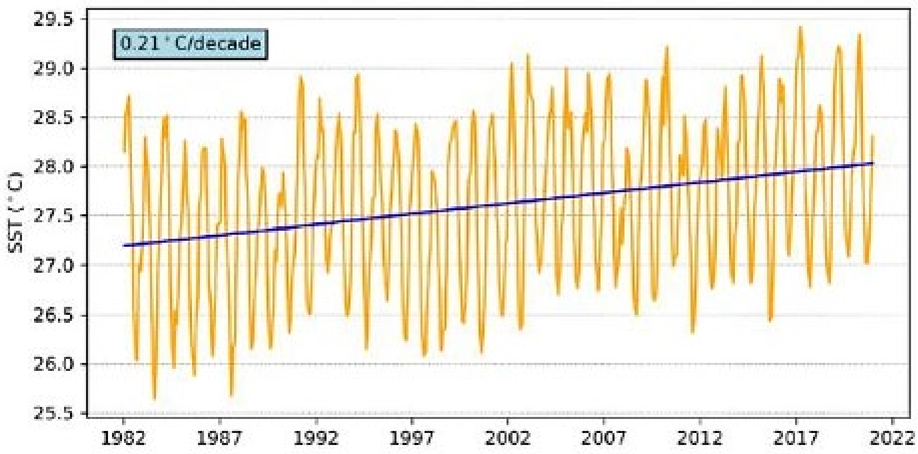
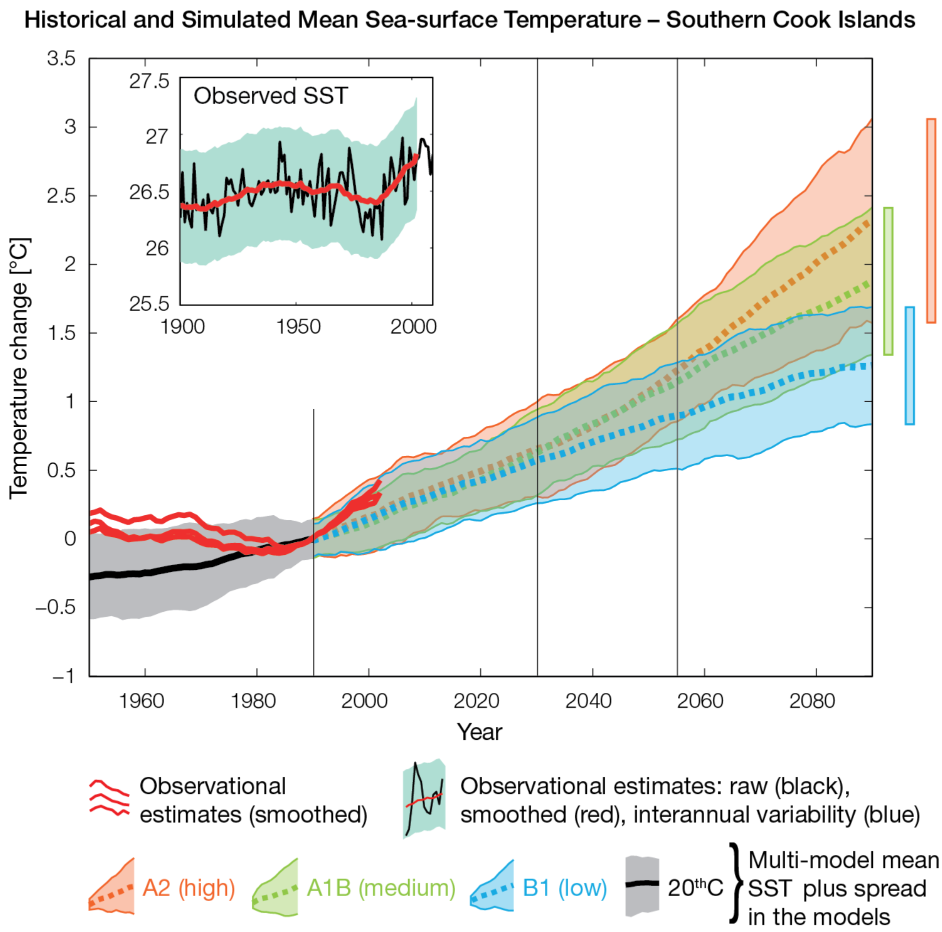


Figure 3. Sea surface temperature observed and projected in the southern Cook Islands.[27]

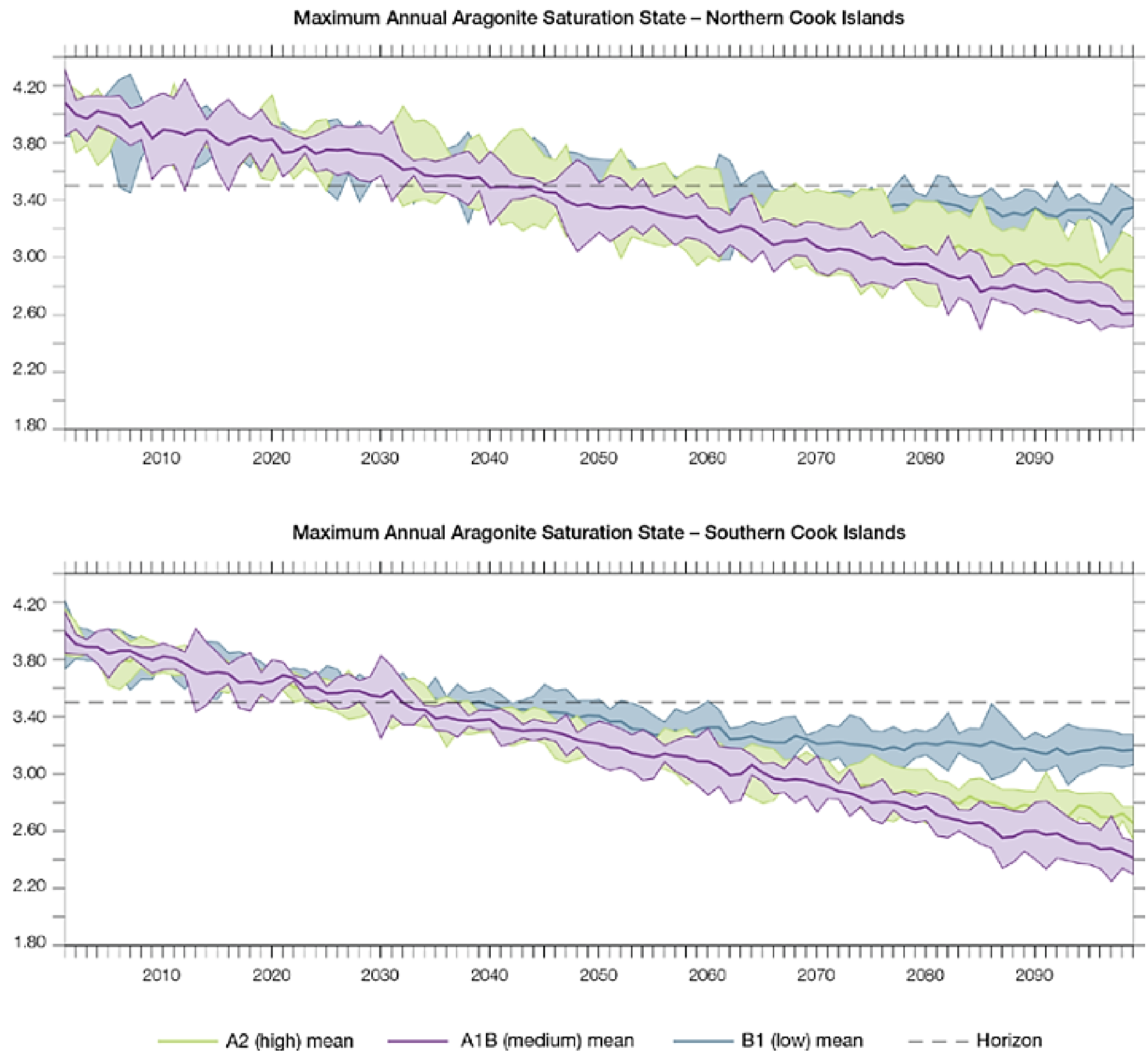


[26] *Ibid*.
[27] Figure from Pacific Climate Change Science, *Chapter 2: Cook Islands*, available at: https://www.pacificclimatechangescience.org/wp-content/uploads/2013/09/Cook-Islands.pdf, 35.

The acidification of the ocean will continue to increase and there is a 'high' confidence in this projection (see Figure 4) as the rate of ocean acidification is primarily driven by the increasing oceanic uptake of carbon dioxide in response to rising atmospheric carbon dioxide concentrations. The annual maximum aragonite saturation state is declining (i.e., getting more acidic). Aragonite saturation states above 4 are optimal for coral growth and the development of healthy reef systems, so the impact of acidification change on reef ecosystem health is likely to compound other stressors, including coral bleaching, storm damage, and fishing pressures.

These multi-model projections of the maximum annual aragonite saturation state in the sea surface waters, and their associated uncertainty (shaded area represents two standard deviations), in the Northern Cook Islands (top) and the Southern Cook Islands (bottom) shows outcomes under the different emissions scenarios. The dashed black line represents an aragonite saturation state of 3.5 (marginal state). These models indicate that the annual maximum aragonite saturation state (measure for ocean acidity) will reach values below 3.5 (extremely marginal, i.e., not ideal for coral growth and healthy marine ecosystems) by about 2050 for the Southern Cook Islands and by about 2065 for the Northern Cook Islands.

Figure 4. Ocean acidification in the Northern and Southern Cook Islands over time.[28]



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[28] *Ibid.*, 38.

Fisheries and aquaculture

In a 2020 study on the valuation of ecosystem services in Cook Islands, Brander et al. provided the values of subsistence fisheries, commercial fisheries, trochus, pearls, and others (e.g., tourism, recreation, etc.).[29] The report strives to estimate the "total economic value" of an ecosystem service, which includes all of the net benefits humans receive from that ecosystem service (see Table 1 for a data set for small-scale tuna catch). The ecosystem services study concluded that the economic value of subsistence fisheries is worth NZ$3,661,182 per year, commercial fisheries NZ$50,389,917, trochus NZ$55,690, and pearls NZ$300,000.[30]

Table 1. Small-scale tuna trolling line catch in Cook Islands waters.[31]

	Effort	Albacore	Bigeye	Yellowfin	Skipjack	Other	Total
2017	17,302 hrs	0	0	92	4	4	**100**
2018	17,651 hrs	1	1	87	5	3	**97**
2019	13,642 hrs	3	1	64	7	2	**77**
2020	10,890 hrs	0	0	69	5	4	**78**
2021	13,295 hrs	0	0	44	3	1	**48**

Source: MMR (2022); Units: tonnes

According to the Ministry of Marine Resources, a total of 61 foreign-flagged vessels were licensed and authorised to operate within the Cook Islands EEZ during 2021: 51 longliners and 10 purse seiners.[32] Using price information from the Forum Fisheries Agency (FFA) and adjusting for in-zone prices (FFA gives delivered prices), the value to fishers of the 4621 t can be determined. The catch is worth NZ$15.7 million.[33]

Pearl farming

In Cook Islands, the most significant type of aquaculture present is pearl farming. The black-lip pearl oyster (*Pinctada margaritifera*) is farmed for black pearl production in Cook Islands and is important for the local mariculture industry and for supporting local livelihoods in fisheries and tourism. Black-lip pearls are the main aquaculture commodity in Cook Islands, with the reported number of saleable pearls produced annually ranging from 37,169 [34] to 56,000 [35]. In 2014, an estimated 50,000 pearls worth US$15.63 per pearl were produced, equalling US$781,250 in value.[36] Pearl production reached a

[29] Brander, Luke, Kelvin Passfield, Kate McKessar, Kate Davey, Victoria Guisado, Florian Eppink, Nicholas Conner, and Hayley Weeks. *Cook Islands Marine Ecosystem Services Valuation* (2021) available at https://environment.gov.ck/wp-content/uploads/2022/06/25.-Cook-Islands-MESV-Report-2021.pdf
[30] Gillett and Fong. *Fisheries in the Economies of Pacific Islands Countries and Territories (Benefish Study 4)*. This study is not independent of the series of Benefish studies as it contains the statement, "The results from Gillett (2016) are used to value subsistence and commercial fisheries in this report". However, both the method of valuation and composition of categories differ between the studies, as do the focus years (2014 vs 2019).
[31] Table found in *Benefish 4*, see note 9, 34. Note the lower numbers in 2021 due to COVID-19; Cook Islands did not experience the pandemic until 2021.
[32] *Ibid.*, 35. Purse seiners are large walls of netting deployed around an entire area or school of fish. The seine has floats along the top line with a lead line threaded through rings along the bottom of the net.
[33] *Ibid*.
[34] Brown, Mark. *Cook Islands Government Budget Estimates 2015/2016: Book 1, Appropriations Bill* (2015).
[35] According to previously reported MMR data in *Fisheries in the Economies of Pacific Islands Countries and Territories*, 32.
[36] Gillett. *Fisheries in the Economies of Pacific Island Countries and Territories* (2016).

maximum in Cook Islands in 1999–2000. At its peak, there were 81 farms with two million shells in the water, accounting for more than 90% of national exports and 20% of gross domestic product.

The production of pearls is already vulnerable to marine heatwaves, ocean acidification, and tropical cyclones. Increasing SST and ocean acidification, and the high possibility of more severe cyclones, are expected to reduce the survival and growth of pearl oyster spat (larvae) in Cook Islands.[37] Ocean acidification is also expected to affect the formation of nacre by pearl oysters, and therefore pearl quality.[38] Additionally, pearl farmers have observed changes in black pearl production and quality, particularly poor spat formation, lower quality (dull) pearls, smaller pearls and a reduction in the production of rare and more valuable varieties (e.g., white pearls).

In a recent study on the historical and projected climate change impacts surrounding the Manihiki Lagoon region, the main pearl farming area in Cook Islands, situated 1200 km northwest from Rarotanga, the effects of high SST and ocean acidification have deleteriously affected spat formation. Spat collection is the process of attaching pearl oyster larvae onto artificial substrates, a common method used in the pearl industry for inexpensive, simple, and sustainable farming. The projected increase in ocean temperatures would likely result in more episodes of water surpassing the 34°C threshold by 2030, potentially affecting the productivity of Manihiki Lagoon pearl farming in the future.[39] This is particularly concerning as marine heatwaves are becoming more frequent in the region over the past decade affecting pearl production. Pearl farming on atolls is also strongly dependent on water quality and renewal, particularly controlled by the wave conditions that impact lagoon circulation, like swells, wave height, and changing ocean currents—all factors that are sensitive to climate change.[40]

Pearl farmers in Cook Islands have been noticing issues with oyster shells being thinner and deformities more common. Climate-related changes in chemistry, namely ocean acidification, can adversely affect shell growth and pearl quality. Moreover, the coral reefs protecting the atoll (lagoon island) are also adversely affected by climate change–related harms to the marine ecosystems, which would compound harms to pearl production.[41] With ocean acidification projected to increase, even under low emissions scenarios, the median aragonite saturation state never falls below 3.5, considered to be marginal conditions, so curbing ocean acidification is of special importance to preventing economic harms to Cook Islands' pearl industry.

Finally, a crude approximation of the annual volumes and values of fishery and aquaculture harvests in 2021 can be made from the MMR data (see Table 2). The Statistics Office of the Ministry of Finance and Economic Management refers to the fishing sector as "fishing and pearls". The official fishing contribution to GDP from 2017 to 2021 is given in Table 3 and demonstrates the importance of this sector to Cook Islands.

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[37] Bell, J. D., et al. (2013). "Mixed responses of tropical Pacific fisheries and aquaculture to climate change." *Nature Climate Change* 3(6): 591-599; *see also* Bell, Johann D., Johanna E. Johnson, and Alistair J. Hobday, (eds). Vulnerability of tropical Pacific fisheries and aquaculture to climate change (2011), available at https://purl.org/spc/digilib/doc/en9j3.

[38] Pickering, Timothy D., Ben Ponia, Cathy Hair, Paul C. Southgate, E. Poloczanska, L. D. Patrona, Antoine Teitelbaum et al. "Vulnerability of aquaculture in the tropical Pacific to climate change." Secretariat of the Pacific Community, 2011.

[39] CSIRO and SPREP (2022). 'NextGen' Projections for the Western Tropical Pacific: Climate change projections to inform black pearl production vulnerability in the Cook Islands. Technical report to the Australia-Pacific Climate Partnership for the Next Generation Climate Projections for the Western Tropical Pacific project. Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Secretariat of the Pacific Regional Environment Programme (SPREP), CSIRO Technical Report, Melbourne, Australia. https://doi.org/10.25919/sr2h-8282 (access restricted), 8.

[40] *Ibid*., Figure 5, 7; see also PACCSAP analysis (Australian Bureau of Meteorology and CSIRO, 2014).

[41] *Ibid.*.

Table 2. Summary of fishery and aquaculture harvests in Cook Islands for 2021.[42]

Harvest sector	Volume (t and pcs)	Value (NZ$)
Coastal commercial	150	1,600,000
Coastal subsistence	280	2,300,000
Offshore locally based	100	2,500,000
Offshore foreign-based	4,621	15,700,000
Freshwater	5	41,000
Aquaculture	81,500 pcs	330,500
Total	5,156 t and 81,500 pcs	22,471,500

Table 3. Contribution of fishing (fishing plus pearls) to Cook Islands GDP.[43]

	2017	2018	2019	2020	2021
Fishing (including pearls)	1.5	1.6	2.3	1.2	2.0
GDP at market prices	486.4	524.2	575.4	437.0	463.3
Fishing as a % of GDP	0.3%	0.3%	0.4%	0.3%	0.4%

Source: Cook Islands Statistics Office (unpublished data)

Sea-level rise

Cook Islands experiences a semidiurnal tidal cycle, meaning that two high and two low tides occur per day. The highest predicted tides of the year typically occur in the wet season months from November to April. Peak sea levels typically occur over a significant portion of the year, ranging from October to April. Since approximately 2006, increasingly more hours each year exceed the 2.0 m sea level threshold. This is due to a combination of sea-level rise and minor subsidence (land sinking) occurring at Rarotonga.[44]

Sea levels at Cook Islands, as measured by satellite altimeters since 1993, have risen 2.5–5.5 mm per year across most of the EEZ, with a 95% confidence interval of ±0.4 mm in the south and up to ±0.8 mm in the north. Trend estimates in the south are higher, ranging from 3.5 to 5.5 mm per year, which is larger than the global average of 3.1 ± 0.4 mm per year.[45] This rise is partly linked to a pattern related to climate variability from year to year and decade to decade.

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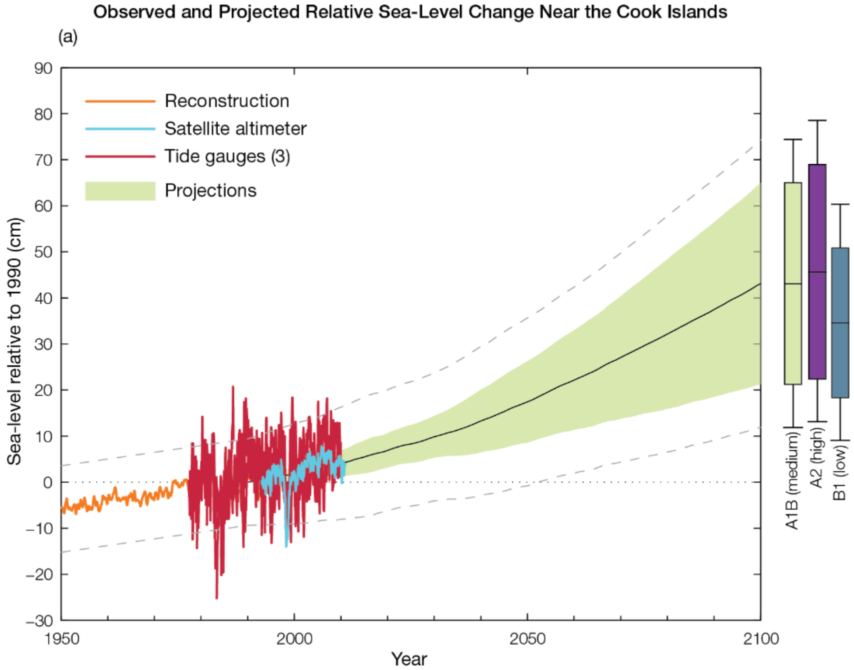
[42] Gillett and Fong, *Benefish Study 4*, 37. Aquaculture is not shown in volumes but in a mixture of units (pieces and tonnes).

[43] *Ibid*., 37.

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

[45] Karina von Schuckmann et al. (ed.), Copernicus Marine Service Ocean State Report, Issue 4, Ch 3, s77, 2020, https://doi.org/10.1080/1755876X.2020.1785097.

Figure 5. Sea-level rise observed and projected near Cook Islands.[46]



Food security and human health

Climate change affects food security, which also impacts human health. Additionally, climate change and overall climate variability will have heavy impacts on the agricultural and fishery sectors, threatening food security and the ability of Cook Islanders to produce and access safe and nutritious foods. There has been historical reductions in Cook Islands' food production index due to a decline in both area and yield of major crops like coconuts, roots, and tubers (including cassava and sweet potatoes).[47] This has far-reaching consequences.

Like many other Pacific Islands, fish consumption is high in Cook Islands, so impacts to fisheries due to climate change will also affect the nutritional uptake of healthy proteins in its population's diet. The Cook Islands 2015/16 HIES contains information relevant to fish consumption.[48] The survey indicates that 5.5% of household expenditure on food is for "fish and seafood". This is small compared to the 27.0% expenditure on "meat". In terms of the most important items consumed by households, "fresh/frozen fish" ranks ninth, behind bread/cereals, chicken, canned corned beef, taro, lamb/mutton, eggs, doughnuts and powdered milk.[49]

The increased persistence of ENSO conditions in recent decades, and the apparent intensification of tropical cyclones also wreaks havoc on agricultural sectors, impacting food security. Sea-level rise and saltwater inundation into the freshwater lens impedes crop growth, and the loss of land reduces available farmland for agricultural production, compounding the problem. Lack of rain, soil degradation, and shifting seasons also reduce productivity. Low agricultural yields increase the reliance on imported food, which can often be less nutritious and further impacts human health.

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[46] Pacific Climate Change Science, *Chapter 2: Cook Islands*, 39.
[47] Asian Development Bank, *Food Security and Climate Change in the Pacific*, available at: https://www.adb.org/sites/default/files/publication/29078/climate-change-food-security.pdf, 11.
[48] Cook Islands Statistics Office. *Cook Islands 2025–16 Household Income Expenditure Survey (HIES)*, available at https://stats.gov.ck/cook-islands-2015-16-household-income-expenditure-survey-hies/.
[49] Gillett and Fong, *Benefish Study 4*, 46.

IV. CONCLUSION

Climate change is causing significant harm to Pacific Island countries like Cook Islands. This harm materialises in the form of changing rainfall; prolonged droughts; higher air temperatures; extreme weather events; ocean warming, acidification, and deoxygenation; sea-level rise; and other impacts.[50] Cook Islands is already witnessing these impacts, and projections indicate that these impacts are bound to intensify. The extent to which this existential threat materialises will heavily depend on actions taken to curb anthropogenic greenhouse gas emissions—the vast majority of which is generated outside its borders—as well as measures to adapt to climate change and respond to the loss and damage it causes.

[50] *See also* SPC's written submission to the Tribunal for the Law of the Sea, 16 June 2023, available at https://www.itlos.org/fileadmin/itlos/documents/cases/31/written_statements/2/C31-WS-2-5-SPC.pdf.