CHAPTER 7

Archipelagic Atoll States and Sea Level Rise

Clive Schofield and David Freestone

1 Introduction

This chapter outlines scientific projections for sea level rise and highlights the potential implications of this especially for low-elevation atoll and reef island features. It builds on the earlier work of the authors on the legal implications of the impacts of sea level rise on coasts and islands, in particular a recent preliminary risk assessment of the threats that sea level rise poses to all archipelagic States.[1] This chapter narrows the focus of the previous work to concentrate on the threats that sea level rise poses to low-elevation States and territories wholly or predominantly comprised of coral atolls. This group of States includes the Maldives in the Indian Ocean and Kiribati, the Marshall Islands, Tokelau and Tuvalu in the Pacific Ocean. Additionally, a number of other archipelagic States possess low-elevation atoll and reef island features as do a number of dependent island territories.

Following discussion of recent sea level rise estimates, a brief summary of the legal regime relating to archipelagos is provided. The connection and relationship between atolls and sea level rise is then discussed and competing scientific theories on this critical issue explored. What becomes clear is that sea level rise not only has the potential to threaten coastal areas of these States and territories, their infrastructure and their associated populations, but also the very validity of their archipelagic baselines and potentially even their ability to maintain their archipelagic status. This could lead to major reductions in the scope of their maritime jurisdiction defined adjacent to their threatened territories. The chapter closes with some considerations on the response options open to archipelagic island States in light of the foregoing discussion and some concluding thoughts.

1 D. Freestone and C.H. Schofield, 'Sea Level Rise and Archipelagic States: A Preliminary Risk Assessment', *Ocean Yearbook*, 35, 2021, 340–387. See also David Freestone and Duygu Çiçek, *Legal Dimensions of Sea Level Rise: Pacific Perspectives,* The World Bank and Global Facility for Disaster Reduction and Recovery (GFDRR), 2021, VIII + 71 pp.

 | DOI:10.1163/9789004518629_008

2 Sea Level Rise Projections

There is broad consensus in the scientific community that global climate change has already had and is continuing to have multiple impacts on the oceans. Substantial impacts on marine environments are predicted to result from increasing water temperatures,[2] changes to the chemistry of seawater including ocean acidification[3] and expected increases in the geographical range, frequency and intensity of extreme weather events.[4] It is also clear that, as a direct result of anthropogenic emissions of greenhouse gases, (GHG) global sea levels are rising at unprecedented rates and that they seem likely to continue to rise for the next millennia. The ultimate scale and rates of sea level rise is, however, dependent on the degree to which the international community is able to constrain GHG emissions.[5]

The factors contributing to sea level rise are multifaceted and complex, but the climate change-related ocean warming and the melting of grounded ice such as from glaciers and ice sheets are considered to be key drivers. For example, in its 2013 Fifth Assessment Report (AR5) the Intergovernmental Panel on Climate Change (IPCC) estimated mean sea level will rise between 0.52 m and 0.92 m by 2100. Subsequently, in its 2019 *Special Report on Oceans and the Cryosphere* it raised the upper end of the estimates to 1.1 m, whilst observing that this projection was conservative.[6] IPCC AR5 also concluded, with high

2 The IPCC's Fifth Assessment Report (AR5) of 2013 concluded unequivocally that the Earth's system as a whole is warming and that the global ocean will continue to warm in the 21st century. See, *Inter-governmental Panel on Climate Change* (IPCC), *Climate Change 2013: The Physical Science Basis, Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (Cambridge, United Kingdom and New York, NY, USA: Cambridge University Press, 2013), 4; and IPCC, *Climate Change 2014, Synthesis Report, Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change* (IPCC, 2015), pp. 11 and 60.

3 Ocean waters interact with the atmosphere so that increasing levels of atmospheric carbon dioxide result in solution in sea water and consequently increase acidification of the oceans. See, *Climate Change 2014, Synthesis Report*, 41.

4 The IPCC suggests that it is likely that extreme sea levels such as those experienced during storm surges have increased since 1970 mainly as a result of rising mean sea level. *Ibid*., 8 and 53.

5 IPCC, *Climate Change 2021: The Physical Science Basis*, Working Group I contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, (Cambridge, Cambridge University Press, 2021) available at https://www.ipcc.ch/report/ar6/wg1/. See also, IPCC, *Climate Change 2022: Impacts, Adaption and Vulnerability*, Working Group II contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change, (Cambridge, Cambridge University Press, 2022).

6 IPCC, *Special Report on the Ocean and Cryosphere in a Changing Climate* [IPCC Special Report], approved at its 51st Session, 20–23 September 2019.

confidence, that there are strong indications that the rate of sea level rise has accelerated, with the rate of sea level rise since the mid-19th century being larger than the mean rate during the previous two millennia.[7] Moreover, in its 2019 Special Report, the IPCC indicated that that global mean sea level rise in the period 2006–2015 has been two and a half times the rate for the period 1901–1990.[8]

Additionally, the IPCC report concerning the physical science basis for its Sixth Assessment Report (AR6), issued in August 2021, strongly reinforces this message.[9] AR6 found that the average rate of sea level rise had increased almost three-fold from 1.3 mm per year in the period 1901–1971 to 3.7 mm per year in 2006–2018 with human influence considered 'very likely' to be the main driver for these changes.[10] This report also indicated that not only is it 'virtually certain' that, with high confidence, global mean sea level will continue to rise over the 21st century, but that 'sea level is committed to rise for centuries to millennia … and that it will remain elevated for thousands of years'.[11] Further, the IPCC warned that under continued high GHG emission scenarios, significantly higher sea level rise, approaching 2 metres by 2100 and 5 metres by 2150 "cannot be ruled out, due to deep uncertainty in ice sheet processes."[12] These projections have led to serious concerns that low-elevation coasts and islands, including those of archipelagic atoll island States will be inundated and/or could be rendered uninhabitable.

In the present context it is also important to note that in the Pacific Ocean region, where the majority of archipelagic atoll States are located, the rate of sea level rise is highest in the tropics and the maximum predictions already suggest they could exceed 2 meters by 2100.[13] In 2018, the Pacific Marine Climate Change Report Card suggested that the Pacific Islands experienced sea level rise of 3–6 mm per year in the period 1993–2017 but with "some notable differences" across the region with sea level rise experienced by islands in the

7 See, *Climate Change 2014, Synthesis Report*, 42.

8 See, Ocean and Cryosphere in a Changing Climate.

9 IPCC, 2021.

10 *Ibid*., at TS-44.

11 *Ibid.*

12 *Ibid*., at SPM-28. The emissions scenarios related to this projection are Shared Socioeconomic Pathways (SSPs) 5 to 8.5, corresponding to very high emission scenarios. This projection was made with low confidence due to the deep uncertainties involved.

13 J.A. Hall *et al*., *Regional Sea Level Scenarios for Coastal Risk Management: Managing the Uncertainty of Future Sea Level Change and Extreme Water Levels for Department of Defense Coastal Sites Worldwide* (U.S. Department of Defense, Strategic Environmental Research and Development Program, 2016).

Western Pacific[14] being markedly higher than in the Eastern Pacific.[15] Further, studies taking into account observed sea level change between 1950 and 2009 in the West Pacific region coupled with assessment of variations in vertical uplift/subsidence have suggested that sea level rise in this region is of the order of three times the global average.[16]

3 The Legal Regime of Archipelagos

As the authors have discussed in detail elsewhere,[17] the codification of the concept of archipelagic status is essentially a creature of the Third UN Conference on the Law of the Sea, 1973–1982 (UNCLOS III). There had been a long history of discussion of the issue – stretching back even before the famous 1930 Hague Codification Conference,[18] to a proposal in 1924 by Professor Alvarez to the International Law Association,[19] although no agreement on the issue was possible in 1930, principally because the breadth of the territorial sea was still in dispute.[20] At the Second Conference on the Law of the Sea in 1960 (UNCLOS II), the two leading proponents of the archipelagic concept made the case for the special position of mid-ocean archipelagos, but the issue was deferred for further study.[21] Concerns over archipelagic status for mid-ocean archipelagos

14 For example, the Solomon Islands, Papua New Guinea and Marshall Islands.

15 For example, Samoa and Kiribati. See, Commonwealth Marine Economies Programme (CMEP), *Pacific Marine Climate Change Report Card 2018*, Townhill, B. *et al.* (eds), (CMEP, 2018).

16 Becker, M., Meyssignac, B., Letetral, C., Llovel, W., Cazenave., & Delcroix. T., 'Sea level variations at tropical Pacific Islands since 1950', *Global and Planetary Change,* 2012, 80–81, 85–98.

17 Freestone and Schofield, 'Sea Level Rise and Archipelagic States: A Preliminary Risk Assessment' 2021, 340, 354–367.

18 D.P. O'Connell, *The International Law of the Sea*. Ed., I.A. Shearer (Oxford, 1982) at pp. 237–8. See also generally O'Connell's seminal paper: 'Mid Ocean Archipelagos in International Law', *British Yearbook of International Law*, 45, 1971, 1–78.

19 Cited in A/CONF. 13/18 (1957), Part 1, section 1, UNCLOS I, I Off. Rec 289, 291 and in *UN Convention on the Law of the Sea: A Commentary.* S. Nandan and S. Rosenne, eds. (Martinus Nijhoff, 1993) Vol II, p. 423 (hereinafter *Virginia Commentary*). See also O'Connell, (1971), p. 5, citing *Report of 33rd Conference of ILA* (Stockholm, 1924) pp. 259 et seq. Alvarez was chair of the Committee on Neutrality.

20 Although there was some support at that point by Japan and Germany, *Ibid*. p. 239.

21 Namely Philippines and Indonesia. The delay was in large part because the Philippines based its case on an argument of historic waters – an issue that the UN General Assembly had already decided to study. UNCLOS II *Official Records* 51, cited O'Connell, n. 3 above, p. 246.

were addressed at UNCLOS III leading to the drafting of Article 46 of LOSC which provides that:

> For the purposes of this Convention:
> (a) "archipelagic State" means a State constituted wholly by one or more archipelagos and may include other islands; and
> (b) "archipelago" means a group of islands, including parts of islands, interconnecting waters and other natural features which are so closely interrelated that such islands, waters and other natural features form an intrinsic geographical, economic and political entity, or which historically have been regarded as such.

The most important aspect of this negotiated compromise definition is that these special rules may only be applied to States composed entirely of islands or parts of islands and the interconnecting water between them.[22] The requirements for the drawing of archipelagic baselines are laid out in Article 47 that can be summarised as follows:

1. that archipelagic States "may draw straight archipelagic baselines joining the outermost points of the outermost islands and drying reefs of the archipelago" provided that the "main islands" of the archipelagic State are included within the archipelagic baseline system;[23]
2. that the ratio of water to land within the baselines must be between 1:1 and 9:1;[24]
3. that the length of any single baseline segment must not exceed 125 M;[25]
4. that no more than three per cent of the total number of baseline segments enclosing an archipelago may exceed 100 M;[26] and,

---

22 It has been noted that the term 'other natural features' in art. 46(b) is somewhat obscure. However, this terminology can be taken to be a reference to drying reefs as mentioned in art. 47(1). See, J.R.V. Prescott and C.H. Schofield, *The Maritime Political Boundaries of the World*, (Leiden/Boston: Martinus Nijhoff Publishers, 2005), pp. 167–168.

23 Art. 47(1) LOSC. This represents the critical test of the validity of a system of archipelagic baselines. The intent of this provision appears to be to exclude both coastal States dominated by a few large islands and those whose islands are particularly dispersed, such as the United Kingdom and the Federated States of Micronesia (FSM) respectively.

24 Art. 47(1) LOSC.

25 Art. 47(2) LOSC.

26 *Ibid*. The requirement that no more than three per cent of baseline segments may exceed 100 M in length appears restrictive. However, this is misleading. *Handbook on*

5. that such baselines "shall not depart to any appreciable extent from the general configuration of the archipelago."

Of particular note for present purposes is the stipulation in Article 47(1) that, in defining the State's system of archipelagic baselines, these baselines should link "the outermost points of the outermost islands and drying reefs of the archipelago." Fundamentally, a system of archipelagic baselines comprises a series of base points located on or above the normal baseline along the coast of a number of insular features. Consequently, archipelagic baselines are reliant on potentially ambulatory low-water lines along the coast to ensure that the baseline system is "closed".[27]

The insular features involved may include low-tide elevations both falling within the breadth of the territorial sea measured from an above high-tide coast and low-tide elevations lying beyond that distance so long as such features have a lighthouse or similar installation located on them.[28] While this may mean that the maximum amount of area may be enclosed, the incentive to increase the area enclosed also arguably encourages the use of features that are inherently peripheral and also possibly insubstantial and therefore potentially especially vulnerable to sea level rise.

The loss of features that constitute key basepoints or turning points in the archipelagic baselines system may mean that the remaining basepoints are further apart than the Convention permits or it may mean that the resulting water to land ratio proportions no longer meet the necessary ratio requirements.[29] Leaving aside for the present the impact such changes might have on the State's maritime zone claims, such changes might actually compromise the State's ability to maintain valid archipelagic baselines. Although the group of islands would still remain an archipelago geographically and politically, it would lose all the special advantages of archipelagic status that the LOSC confers.

---

the Delimitation of Maritime Boundaries, (New York: United Nations, 2000), p. 8; and, Freestone and Schofield, 'Sea Level Rise and Archipelagic States: A Preliminary Risk Assessment' (2021) 361.

27 See, United Nations, *Baselines: An Examination of the Relevant Provisions of the United Nations Convention on the Law of the Sea* (UN Office for Ocean Affairs and the Law of the Sea, New York, 1989), p. 23.

28 *Ibid.*, p. 36. The United Nations Group of Technical Experts on Baselines indicated that this rule combines the provisions of arts. 13(1) and 7(4) of the LOSC and "so differs from the rules for applying the method of straight baselines."

29 Art. 47(1) and (2).

4 Archipelagic Atoll States

A number of island States are entirely or predominantly composed of low-elevation coral atolls and related reef islands which gives rise to particular concerns in the context of sea level rise related threats. These include the Maldives, Marshall Islands, Tokelau and Tuvalu.[30]

The Maldives comprises 1,190 islands, of which around 200 are inhabited, spread across 26 distinct atolls stretching 822 km from 7° N. to just south of the Equator.[31] The largest atoll is Bodu Thiladhunmathi while Huvadhu atoll has the greatest number of islands. The Marshall Islands consists of 29 atolls and five isolated reef island features as well as the feature termed Enenkio by the Marshall Islands but known as Wake Island to the United States, which also claims sovereignty over the feature and administers it in practice.[32] Tokelau, which is non-self-governing territory of New Zealand, comprises three low-lying atoll island features,[33] whilst the independent State of Tuvalu consists of nine low-lying atolls and 101 reef island features.[34]

Additionally, the State of Kiribati consists of 32 atolls and reef island features together with one raised island feature, Banaba (Ocean) Island, of higher elevation. There are also a number of other States and territories, which possess some higher elevation islands, but are also partially composed of low-lying reef features. While these jurisdictions are not in danger of complete inundation, they can still be considered to be subject to high levels of vulnerability to sea level rise impacts. These include the Cook Islands and the Federated States of Micronesia (FSM). The Cook Islands are a self-governing State in

30 L. Bernard, S. Kaye, M. Petterson and C.H. Schofield, C.H., 'Securing the Limits of Large Ocean States in the Pacific: Defining Baselines amidst Changing Coastlines and Sea Level Rise', 11 (2021) *Geosciences*, no.9, 394–404, at pp. 406–408.

31 See, Embassy of the Maldives, 'Maldives: Geography and location', available at https://www.maldivesembassy.be/en/about-maldives/geography-location.

32 D. Freestone and C.H. Schofield, 'Current Legal Developments: The Marshall Islands', 31 *International Journal of Marine and Coastal Law*, 2016: 720–746; and, United Kingdom Hydrographic Office (UKHO), *Pacific Islands Pilot*, Volume I, NP60 (11th edition, Taunton, 2007).

33 Tokelau does, however, have its own political institutions whereby, for example, the Head of Government rotates between the leaders of the three atolls. Tokelau also has its own judiciary, public services and full control over its budget. See. New Zealand, Foreign Affairs and Trade, "About Tokelau", available at, https://www.mfat.govt.nz/mi/aid-and-development/our-aid-partnerships-in-the-pacific/tokelau/about-tokelau/.

34 P.S. Kench, M.R. Ford and S.D. Owen, 'Patterns of island change and persistence offer alternative adaption pathways for atoll nations', *Nature Communications*, 9, 605 (2018), https://doi.org/10.1038/s41467-018-02954-1.

Free Association with New Zealand. They consist of 15 islands, nine are low-lying atoll or reef island features with the remaining six being higher elevation features.[35] Of particular note in the present context is that around two-thirds of the Cook Islands extensive EEZ claims are dependent on low-lying atoll island features, namely, Penrhyn Atoll, Manihiki Atoll, Pukapuka Atoll, Suwarrow Atoll and Palmerston Atoll, all located in the northern part of the Cook Islands.[36] Although FSM includes high elevation features among each of the four major island groups making up the federation, Kosrae, Pohnpei, Chuuk and Yap, multiple outlying and intervening low-elevation atolls and reef islands are likely to be vulnerable to sea level rise. These include, from west to east, Ulithi Atoll, Eauripik Atoll, Pulusuk Atoll, Sapwuahfik Atoll, Minto Reef and Kapingamarangi Atoll.[37]

Further, there are a number of outlying atolls and reef island features associated with the States of Fiji, Palau, Papua New Guinea (PNG), and the Solomon Islands. The maritime claims associated with the Pacific territories of extra-regional States, including French Polynesia, New Caledonia, the United Kingdom's overseas territory of the Pitcairn Islands as well as the Northwestern Hawaiian Islands and a number of U.S. remote Pacific island territories including Howland and Baker Islands, Jarvis Atoll, Johnston Atoll, Kingman Reef, Palmyra Island, and the aforementioned Enenkio/Wake Island can also be viewed as being particularly vulnerable to sea level rise impacts.[38]

Higher elevation island groups, often of volcanic origin, such as Nauru, Niue, Samoa, Tonga and Vanuatu can be considered to be subject to more limited risks from sea level rise. That said, such higher elevation islands are by no means immune to sea level rise impacts, as the majority of the population and the infrastructure on such islands is concentrated on the low-lying coastal fringes rather than the higher elevation core. Moreover, it can be anticipated

35 UKHO (United Kingdom Hydrographic Office), *Pacific Islands Pilot*, Volume I, NP60 (11th edition, 2007).

36 N. Biribo and C.D, Woodroffe, 'Historical area and shoreline change of reef islands around Tarawa Atoll, Kiribati', 8 *Sustainability Science,* 2013:345. https://doi.org/10.1007/s11625-013-0210-z. See also, Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at p. 407.

37 C.H. Schofield and R, Van de Poll, 'Treaty between the Federated States of Micronesia and the Independent State of Papua New Guinea concerning maritime boundaries between the Federated States of Micronesia and the Independent State of Papua New Guinea and co-operation on related matters', in *The International Maritime Boundaries of the World*, Vol. IX, (Leiden/Boston: American Society of International Law (ASIL)/Martinus Nijhoff, 2021). Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at p. 407.

38 Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at pp. 407–408.

that ecosystem services associated with coastal ecosystems will be negatively impacted under such a scenario.[39]

5 Persistent or in Peril?

The first model for the formation of atolls is attributed to Charles Darwin who suggested that atolls form as ocean seamounts subside. Darwin's theory suggested that as ocean volcanoes become extinct, they cool and subside and a ring of coral reefs forms on top of the extinct volcano and that over time corals and eroded coral sands become the dominant deposits overlaying volcanic rock.[40] Consequently, atolls tend to comprise coralline rock and rubble, cemented to a volcanic rock foundation and often feature low-lying (1–4 m elevation) islands surrounding a shallow lagoon. A fresh-water lens often forms under such features which is linked to the habitability of these islands. How saline this lens of fresh water is depends on levels of rainfall and the degree of saltwater intrusion.[41]

The IPCC Report of 2021 suggests that it is "very likely" that sea level rise will occur around small islands and that this, coupled with storm surges and waves that are likely to "exacerbate coastal inundation with potential to increase saltwater intrusion into aquifers in small islands."[42] This report further projects, with high confidence, shoreline retreat "along sandy coasts of most small islands."[43] These findings appear to align with the concerns of States wholly or partially composed of atolls and reef islands. There is, however, some uncertainty concerning the capacity of coral features to respond to changing sea levels, especially in the context of a warming and more acidic ocean, with

39 Coastal ecosystems provide diverse services of environmental, economic, socio-cultural value to humans including, for example, in relation to fisheries, tourism, recreation and coastal protection.

40 See, C.R. Darwin, *Journal of researches into the natural history and geology of the countries visited during the voyage of H.M.S. Beagle round the world, under the command of Captain Fitz Roy, R.N.*, (2d edition, London, John Murray, 1860); and, Darwin, C.R., *The Structure and Distribution of Coral Reefs*, (2d edition, London: Smith Elder and Co, 1874). Other atoll islands formation theories relate to sea level changes across different geological epochs with the formation of atoll islands resulting from sediment deposition controlled by tidal, wave, wind and current factors as well as sea level.

41 Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at pp. 401–402.

42 IPCC, *Climate Change 2021*, TS-97.

43 *Ibid*.

implications both for the habitability of such features and their persistence above sea level.

Much of the commentary on sea level rise and low-elevation coral islands, including atoll island features, characterizes these features as fragile and threatened environments, which will increasingly and inevitably become less and less habitable and will progressively be inundated. There are, however, competing views on the persistence of atolls in the context of climate change impacts. The critical consideration in this context relates to sediment supply and whether this will enable the island-building processes to continue to occur, on reefs. There is support in the scientific literature for the view that they will not be able to stay above water, for instance on the basis of the analysis of wave and storm dynamics.[44] These findings suggest that even if sea level rises only relatively moderately, the reefs surrounding and protecting island features will increasingly be overwhelmed leading to the islands themselves bearing the brunt of wave and storm action leading to enhanced erosion, inundation and salt water intrusion into freshwater aquifers, thereby reducing the capacity of reef islands to support human habitation.[45]

The counterpoint to these perspectives are the scientific studies that demonstrate that coral reefs and islands can be remarkably robust and enduring features, capable of natural adaptation to sea level rise over time.[46] For example, Webb and Kench have provided a particularly instructive paper in which they reviewed and analyzed 27 atoll islands in the central Pacific, comparing historical aerial photography with modern satellite imagery in order to assess whether these features had in fact, been subject to erosion – as might have been anticipated were conventional wisdom regarding the influence of sea level rise on coral islands correct. Despite the fact that the period covered by the survey coincided with sea level records for the central Pacific

44 See, C.D. Storlazzi, E.P.L. Elias and P. Berkowitz, 'Many atolls will become uninhabitable within decades due to climate change', *Scientific Reports* 2015, 5:14546, doi: 10.1038/srep14546; and, C.D. Storlazzi, S.B. Gingerich and A. van Dongeren, 'Most atolls will be uninhabitable by mid-21st century because of sea level rise exacerbating wave-driven flooding', *Scientific Advances*, 2018, 4, 1–9. See also, Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at pp. 413–414.

45 *Ibid*.

46 P.S. Kench, 'Understanding Small Island Dynamics: A Basis to Underpin Island Management', pp. 24–28 in 38 in H. Terashima (ed.), *Proceedings of The International Symposium of Islands and Oceans*, (Tokyo: Ocean Policy Research Foundation, 2009). See also, A.P. Webb, 'Coastal Vulnerability and Monitoring in the Central Pacific Atolls', pp. 33–38 in Terashima, *ibid.*; and, Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at pp. 415–416.

establishing sea level change of the order of 2.0mm yr-[1], fully 86 per cent of the islands analyzed were as large as (43 per cent) or larger than (43 per cent) they had been previously.[47] Indeed, multiple studies by Kench and colleagues suggest that atoll islands are capable of dynamic evolution in the face of sea level rise, whereby coastlines may change so that individual features may well change shape but the islands themselves are persistent over time.[48] Further, as Webb has observed, there exist examples of net-island growth which run counter to "established thought, non-scientific reports in the popular media and modelling" and are suggestive of the complexity of shoreline responses to sea level rise.[49]

This line of scientific thinking runs contrary to traditional concerns that coral reef and atoll islands are likely to be imperiled in the face of significantly accelerated sea level rise, especially against the backdrop of warming and acidifying oceans which may seriously impair the ability of natural systems such as coral reefs to autonomously adapt to changing sea levels. The work of Kench and others suggests that sea level rise will actually enhance the likelihood that such islands remain above sea level. This hypothesis is based on research suggesting that sediment transport between islands will be enhanced as sea levels rise, with positive implications for the persistence of reef features.[50] A further dimension to this thinking is that increased frequency and intensity in extreme weather events, whilst resulting in the erosion of parts of islands, simultaneously results in major supplements to sediment supply, essentially building islands up.[51]

It must be noted, however, that the observations of island changes differ between urbanized atoll islands and those features which are more natural and undisturbed. Urban atolls such as South Tarawa in Kiribati, are home to

47 A.P. Webb and P.S. Kench, 'The Dynamic Response of Reef Islands to Sea-level Rise: Evidence from Multi-decadal Analysis of Island Change in the Central Pacific', *Global and Planetary Change*, 72 (2010) (3): 234–246.

48 See, for example, P.S. Kench, R.F. McLean and S.L. Nichol, 'New model of reef-island evolution: Maldives, Indian Ocean', *Geology,* 33(2), 2005, 145–148; P.S. Kench, R.F. McClean, R.W. Brander, S.L. Nichol, S.G. Smithers, M.R. Ford and M. Aslam, M., 'The Maldives before and after the Sumatran tsunami*;' Geology*, 34, 2006, No.3; P.S. Kench, M.R. Ford and S.O. Owen, 'Patterns of island change and persistence offer alternate adaptation pathways for atoll nations', *Nature Communications,*9, 2018, 1–7.; and, R. McLean and P.S. Kench, 'Destruction or persistence of coral atoll islands in the face of 20th and 21st century sea-level rise?', 6, *Wiley Interdisciplinary In 2018 Reviews-Climate Change,* 2015, no.5), 445–463.

49 Webb, 'Coastal Vulnerability and Monitoring in the Central Pacific Atolls', at p. 37.

50 Kench et.al., 'Patterns of island change and persistence'. See also, Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at p. 405.

51 Bernard, et. al., 'Securing the Limits of Large Ocean States in the Pacific', at p. 405.

substantial populations and feature numerous man-made interventions on the coast such as sea defenses and land reclamation projects. Such interventions on the coast tend to disrupt sediment supply and transport, impairing the dynamic island-building system and causing 'knock-on' impacts elsewhere along the coast or on the coasts of other islands.

Although the scientific debate regarding the persistence of atoll island features remains unsettled, it is reasonable to conclude that numerous low-elevation atoll islands are at risk from sea level rise impacts, including substantial changes to features and associated ecosystem services, if not inundation and disappearance. This is especially the case for heavily urbanized features and with respect to the degree of sea level envisaged by the IPCC under high GHG emissions scenarios. For archipelagic atoll island States this necessarily has the potential to impact the validity of archipelagic baseline system and even the ability of such States to maintain archipelagic status.

6 Response Options Open to Archipelagic Atoll Island States

As noted above, especially in the context of urbanized atolls, man-made interventions aimed at stabilizing atoll and reef islands or, alternatively, land-reclamation and island-building activities aimed at enhancing the spatial scope of islands or creating new artificial islands have become commonplace. Such interventions are not without considerable economic and environmental costs. Singapore, for example has substantially extended its land territory over time – by approximately 25 percent over the past two centuries with most of this expansion occurring since independence in 1964.[52] While this expansion came at great expense, it has taken place to meet the needs of a growing city where land values are high.[53] In a small developing State context, this approach has also been taken in the Maldives, that has built a large artificial island, Hulhumalé, close to the capital, Malé, on which a new city is being

52 See, Tanya Ong, "S'pore's land area expanded by 25% in past 200 years", *Mothership*, 27 September 2018 available at, https://mothership.sg/2018/09/singapore-land-reclamation-increase-size/. See also, "Total Land Area of Singapore", available at, https://data.gov.sg/dataset/total-land-area-of-singapore.

53 See, Singapore Urban Redevelopment Authority, "Creating Spaces for Our Growing Needs", available at, https://www.ura.gov.sg/Corporate/Planning/Master-Plan/Themes/A-Sustainable-and-Resilient-City-of-the-Future/Creating-Spaces. See also, Samanth Subramanian, "How Singapore is Creating More Land for Itself", *New York Times*, 20 April 2017, available at, https://www.nytimes.com/2017/04/20/magazine/how-singapore-is-creating-more-land-for-itself.html.

constructed.[54] It is reported to cover four hundred hectares, rising to a height of three metres above current sea level, to house a hospital, schools, government buildings and housing for 40,000 people, with a projected future population of 240,000 people and to have cost "hundreds of millions of dollars."[55] The objective of this development is to provide more land area for safe human habitation. These initiatives are, of course, understandable when set against what is often perceived to be an existential threat to these vulnerable States, but not likely to be affordable for many small threatened States.

An additional or alternative option relates to the fixing and declaring of the location of baselines along the coast, delineated outer limits to maritime claims and delimited maritime boundaries. As the authors have explored elsewhere,[56] there is substantial emerging State practice on this issue as well as significant moves to address these issues at the international legal level.

The International Law Association (ILA) Committee on International Law and Sea Level Rise has been looking at the legal implications of sea level rise since 2014 and issued its first full report in Sydney in 2018.[57] It is due to report again in June 2022 at the ILA Conference in Lisbon. In 2018 in response to the

54 See Nenad J. Dauenhauer, "On the front line of climate change as Maldives fights rising seas", *New Scientist,* 20 March 2017.

55 See Emma Allen, "Climate Change and Disappearing Island States: Pursuing Remedial Territory" Brill Open Law (2018), pp. 1–23, at 5. In 2012, the Maldives were reported to have commissioned a Dutch engineer to design floating islands as "life-boats" for the population in the case of extreme events. See, D. Black, "Floating islands to the rescue in the Maldives", *The Star*, 23 August 2012, available at, https://www.thestar.com/news/world/2012/08/23/floating_islands_to_the_rescue_in_the_maldives.html; and, Housing Development Corporation "Hulhumalé", available at, https://hdc.com.mv/hulhumale/. See further Freestone and Çiçek (2021).

56 D. Freestone and C.H. Schofield, 'Republic of the Marshall Islands: 2016 Maritime Zones Declaration Act: Drawing lines in the sea' (2016) 31 *International Journal of Marine and Coastal Law* (*IJMCL*) 720–746; 'Securing ocean spaces for the future? The initiative of the Pacific SIDS to develop regional practice concerning baselines and maritime zone limits' (2019) 33 *Ocean Yearbook* 58–89; 'Islands awash amidst rising seas: Sea level rise and insular status under the law of the sea' in Proceedings of the 2018 Singapore Conference on Climate Change (2019) 34 *IJMCL* 391–414; 'Sea level rise and archipelagic States: A preliminary risk assessment' (2021) 35 *Ocean Yearbook* 340–387.

57 See Davor Vidas, David Freestone and Jane McAdam, "International Law and Sea Level Rise: The New ILA Committee" (2015) 21 (2) *International Law Students' Association* (*ILSA*) *Journal of International and Comparative Law* pp. 397–408. After an interim report to the ILA Johannesburg meeting in 2016, the 2018 Report is published as Davor Vidas, David Freestone and Jane McAdam, *International Law and Sea Level Rise.* Brill Research Perspectives in the Law of the Sea (Davor Vidas and Donald R Rothwell, eds.) Brill Nijhoff, 2019, ix +87 pp.

Committee's proposal the International Law Association 78th Conference in Sydney passed a Resolution endorsing the Committee's proposal that:

> … on the grounds of legal certainty and stability, provided that the baselines and the outer limits of maritime zones of a coastal or an archipelagic State have been properly determined in accordance with the 1982 Law of the Sea Convention, these baselines and limits should not be required to be recalculated should sea level change affect the geographical reality of the coastline.[58]

Since then, in 2019 International Law Commission (ILC) established a Study Group on "Sea-level rise in relation to international law."[59] The debates in the UN Sixth Committee on the two reports issued to date by the ILC Study group indicated widespread support among UN Members for the position taken by the ILA.[60]

There is now considerable evidence of emerging State practice among the South Pacific Island States, and indeed elsewhere,[61] in support for the view that once maritime baselines and limits have been notified to the UN Secretary General in accordance with the requirements of LOSC that they are not required to be recalculated even if there are coastline changes as a result of sea level rise. This State practice reached its clearest articulation on 6 August 2021, when the leaders of the eighteen Members of the South Pacific Forum at their virtual 51st Annual Meeting issued the *Declaration on Preserving Maritime Zones in the Face of Climate Change related Sea-Level Rise*.[62] This Declaration is the culmination of a long process but also arguably marks a significant change. In particular, rather than indicating that the States concerned seek to change

58 ILA, 'Resolution 5/2018: Committee on International Law and Sea Level Rise', 2018, available at, http://www.ila-hq.org/images/ILA/Resolutions/ILAResolution_5_2018_SeaLevelRise.pdf.

59 Freestone and Schofield, 'Sea Level Rise and Archipelagic States: A Preliminary Risk Assessment' (2021) 350–351.

60 Ibid.

61 See n 58 below.

62 Communiqué, attached as Annex 1 to Freestone and Schofield (2021), pp. 693-695. Available at https://www.forumsec.org/2021/08/11/declaration-on-preserving-maritime-zones-in-the-face-of-climate-change-related-sea-level-rise.The eighteen Member States are: Australia, the Cook Islands, the Federated States of Micronesia, Fiji, French Polynesia, Kiribati, Nauru, New Caledonia, New Zealand, Niue, Palau, Papua New Guinea, the Republic of the Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu.

international law in the future, they clearly articulate their understanding of the obligations imposed by the Convention in this regard and firmly declare the way in which they—as a group—intend to interpret them in the future.[63]

Very shortly after the Pacific Island countries issued their August 2021 Declaration, the Heads of State and Government of the Alliance of Small Island States (AOSIS)[64] issued a complementary Leaders' Declaration.[65] AOSIS is a global alliance established in 1990 in the run-up to the 1992 Rio Conference on Environment and Development and now has 39 members – composed of island States and also low-lying States – like Suriname. Their Declaration therefore represents the agreed position of States from all over the globe. It is clear that the AOSIS Declaration is the result of close co-ordination with the Pacific Island Forum Members. In relation to the issue of maritime zones the September Declaration states that the Heads of State and Government of AOSIS:

> *Affirm* that there is no obligation under the United Nations Convention on the Law of the Sea to keep baselines and outer limits of maritime zones under review nor to update charts or lists of geographical coordinates once deposited with the Secretary-General of the United Nations,

and that,

> such maritime zones and the rights and entitlements that flow from them shall continue to apply without reduction, notwithstanding any physical changes connected to climate change-related sea-level rise.[66]

These declarations, coupled with growing State practice regarding the fixing of baselines, limits and boundaries presage a substantial evolution in the interpretation of the international law of the sea on these matters.

---

63 D. Freestone and C.H. Schofield, 'Pacific Islands Countries Declare Permanent Maritime Baselines, Limits and Boundaries', Current Legal Developments: The South Pacific, *International Journal of Marine and Coastal Law* (2021).

64 The Declaration highlights SIDS challenges and issues guidance on Climate Change, Sustainable Development, and Ocean issues. It is dated 21 September 2021. The authors are grateful to Professor Davor Vidas (chair of the ILA Committee) for bringing this Declaration to their attention.

65 The Declaration is published at AOSIS webpage, at https://www.aosis.org/launch-of-the-alliance-of-small-island-states-leaders-declaration/.

66 Ibid.

7 Conclusions

It is abundantly clear from the scientific literature that global mean sea levels are rising and the rate of sea level rise has escalated. Further, IPCC projected *likely* sea level rise projections do not to date factor in the potential disintegration of marine ice sheets and ice cliffs around Antarctica and the faster than currently projected dynamic ice loss from the Greenland ice sheet due to the deep uncertainties relating to these processes.[67] This means that even more substantial increases in the scale and speed of sea level rise cannot be ruled out. Moreover, even if the scientific debate regarding the long-term persistence of atoll island features is, as yet, unsettled, there is little doubt that the impacts of climate change including sea level rise are likely to be most keenly felt by low-elevation atoll island archipelagic States for whom these are perceived as existential threats.

The level of threat was highlighted vividly during the COP26 negotiations in Glasgow in November 2021 when the Foreign Minister of Tuvalu, Simon Kofe, delivered an address whilst standing knee deep in the ocean of an area that had previously been land and is now submerged. During his address he commented that "We are actually looking at legal avenues where we can retain our ownership of our maritime zones [and] retain our recognition as a state under international law."[68] This statement is consistent with the clear and consistent practice the Pacific Island States as well as other threatened island States. It is clear from this practice as well as high-level diplomatic statements such as the Pacific Islands Leaders Declaration, that island States, including atoll island archipelagic States, are intent on retaining their maritime entitlements.

This is an area where the progressive development of the international law of the sea is very much a 'work-in-progress'. There is now therefore a substantial body of declared practice regarding the interpretation of the obligations contained in the LOSC regarding maritime zones. in large part driven by the practice of small island developing States that are most vulnerable to the impacts of sea level rise This includes low-lying atoll island archipelagic States whose archipelagic status, maritime entitlement and, indeed, statehood are in peril. But the reactions of the general international community to these developments will be crucial.

While the majority of other States appear sympathetic to the plight of low-lying small island developing States in particular, there remains some diversity

67 IPCC, 2021, at TS-45.

68 "Tuvalu seeks to retain statehood if it sinks completely as sea levels rise", *The Guardian*, 11 November 2021.

in views.[69] Further, there is growing realization that there are very few coastal States whose coastline and coastal infrastructure will not be adversely affected over the next few decades by the impacts of the levels of sea level rise that the IPCC is now predicting. It remains to be seen whether these perspectives will shift as the climate crisis becomes ever more apparent, yielding broad acceptance of the interpretation advocated by the Pacific Island States and others, and thus securing the archipelagic status and entitlements of atoll island States.

69 See 2020 UN Sixth Committee Debates referenced above at n 53.