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Sea-Level Rise and Its Impact on Vulnerable States: Four Examples

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Sea-Level Rise and Its Impact on Vulnerable States: Four Examples

*Ann Powers**

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I. INTRODUCTION

Of the myriad crises facing the world, none has more potential for global damage and long-term impacts as climate change. From coastal land loss in the Gulf of Mexico, to rising waters in the Netherlands, to drowning Pacific Islands, the impacts of a warming climate and rising seas are obvious. Although skeptics remain, most nations recognize the problems posed by a warming world, and many are actively working to address them. Mitigation

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measures aimed at reducing greenhouse gas emissions are being pursued, and efforts to adapt to changing conditions are debated and sometimes implemented. Few countries are more concerned with making progress in this regard than countries with low-lying coastal regions and island nations, which are directly threatened by a warming climate and concomitant rise in sea levels. Many are developing countries and small island developing states (SIDS) where tourism and fishing are usually key industries; climate change, and sea-level rise in particular, may gravely impact such areas. Unfortunately, these states also often have the least capacity, financing, or support for mitigation and adaptation initiatives.

Though the extent of sea-level rise and other consequences of climate change are uncertain, global sea level rose 16 centimeters (cm) in the twentieth century, and the rate of rise is rapidly accelerating.¹ In its 2007 report, the Intergovernmental Panel on Climate Change (IPCC) predicted sea levels to rise between 18 cm to 59 cm in the next century.² For many states, infrastructure and settlements built along coasts will become uninhabitable or even vanish, and a few nations face the real possibility of disappearance beyond the next century mark.³ Developing countries are expected to suffer the earliest and to the greatest degree because of their geographical location, low incomes, weak institutional capacities,⁴ and greater reliance on climate-sensitive sectors like agriculture.⁴

1. John A. Church & Neil J. White, *A 20th Century Acceleration in Global Sea-Level Rise*, 33 GEOPHYSICAL RES. LETTERS 1, 2 (2006), available at http://naturescapebroward.com/NaturalResources/ClimateChange/Documents/GRL_Church_White_2006_024826.pdf.

2. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: SYNTHESIS REPORT 45 (2007), available at http://www.ipcc.ch/pdf/assessment-report/ar4/syr/ar4_syr.pdf.

3. Susmita Dasgupta, Benoit Laplante, Craig Meisner, David Wheeler & Jianping Yan, *The Impact of Sea Level Rise on Developing Countries: A Comparative Analysis*, WORLD BANK, 1, 9–10 (Feb. 2007), <http://www-wds.worldbank.org/external/default/WDSContentServer/IW3P/IB/2007/02/09/00001640620070209161430/Rendered/PDF/wps4136.pdf>. A one-meter sea-level rise would affect approximately 0.3% of the territory of developing countries and approximately 56 million people, or 1.28% of the world population. Eighty-nine million people, or 2.03% of the population, would be impacted by a two-meter sea-level rise. Thus, these small increases in sea-level rise affect a significant population. Such changes not only have social and economic impacts, but also possibly security implications. See G.A. Res. 63/281, U.N. Doc. A/RES/63/281 (2009); U.N. GAOR, 63rd Sess., 85th plen. mtg., U.N. Doc. A/63/PV.85 (June 3, 2009); Press Release, General Assembly, Expressing Deep Concern, Invites Major United Nations Organs to Intensify Efforts in Addressing Security Implications of Climate Change, U.N. Press Release GA/10830 (June 3, 2009).

4. William Burns, *Potential Implications of Climate Change for the Coastal Resources of Pacific Island Developing Countries and Potential Legal*

The threat to these areas from sea-level rise is often compounded by other changing climate patterns, leading to coastal wetlands losses, groundwater salinization, loss of arable land, and increased storm activity. For the SIDS, even slight sea-level rise could be dangerous to the health of their economies, people, and environments. SIDS especially have a variety of factors that aggravate their inability to cope with the effects of rising sea levels and climate change. These factors include their limited physical size and natural resources; their often fragile economies and social and institutional structures; and their susceptibility to natural hazards, such as tsunamis and storms.⁵

Among other concerns for low-lying coastal states is the question of changing territorial boundaries caused by sea-level rise and the possible impact this will have on the cultures and economies of affected coastal nations. The United Nations Convention on the Law of the Sea (UNCLOS or the Convention)⁶ is the touchstone for establishing states' rights to maritime zones, from inland waters to the deep ocean. Most of the world's nations are parties to the Convention, and it is binding upon them. In addition, most of its provisions are regarded as customary international law and are therefore binding on all states, even nonparties. The maritime zones provided in the Convention extend specific distances from the coastal baseline established by each state, usually at mean low water marks, and encompass varying rights and duties. The economies of SIDS are often heavily dependent upon coastal resources. Thus, delimiting a country's various maritime boundaries, especially the territorial sea and exclusive economic zone, is particularly important.

Under UNCLOS, a state's territorial sea extends 12 nautical miles from the coastal baseline and is, as the name suggests, essentially sovereign territory.⁷ Beyond the territorial sea, an exclusive economic zone (EEZ) extends an additional 188 nautical

and Policy Responses, 8 HARV. ASIA-PAC. REV. 4, 7 (2006), available at http://papers.ssrn.com/sol3/papers.cfm?abstract_id=930449.

5. INTERGOVERNMENTAL PANEL ON CLIMATE CHANGE, CLIMATE CHANGE 2007: IMPACTS, ADAPTATIONS AND VULNERABILITY 692–93 (M.L. Parry et al. eds., 2007) [hereinafter IPCC CHAPTER 16], available at <http://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter16.pdf>.

6. United Nations Convention on the Law of the Sea, Dec. 10, 1982, 1833 U.N.T.S. 397 [hereinafter UNCLOS], available at <http://treaties.un.org/doc/Publication/UNTS/Volume%201833/volume-1833-A-31363-English.pdf>.

7. *Id.* art. 3, at 400. Ships of other states, however, enjoy the right of innocent passage. *Id.* art. 17, at 404.

miles, ending 200 nautical miles from the baseline.⁸ Within its EEZ, a state may “explor[e,] exploit[,], conserv[e,] and manag[e] the natural resources, whether living or non-living, of the waters superjacent to the seabed and of the seabed and its subsoil.”⁹ The coastal state also has jurisdiction over its continental shelf “throughout the natural prolongation of its land territory to the outer edge of the continental margin, or to a distance of 200 nautical miles from the baselines.”¹⁰ A state may claim an extended continental shelf if it can demonstrate actual extension beyond 200 miles. Like the EEZ, states may exploit the natural resources of the continental shelf.¹¹ Finally, the high seas are areas beyond national jurisdiction, constituting “all parts of the sea that are not included in the exclusive economic zone, in the territorial sea or in the internal waters of a State, or in the archipelagic waters of an archipelagic State.”¹² With sea-level rise, the coastal baselines from which maritime zones are measured will change. While the change might be slight in most cases, for some states it could be quite consequential.

This Article first examines the physical, cultural, and economic backgrounds of four vulnerable states—Tuvalu, Seychelles, Maldives, and Bangladesh—and discusses the extent to which each might be affected by sea-level rise. It then considers, in turn, the legal implications of the current rules on maritime delimitation under UNCLOS for the states, along with their efforts to adapt to sea-level rise.

II. FOUR VULNERABLE STATES

The four countries included in this review represent a cross-section of geographic areas, natural resources, and economic situations. The potential problems they face from sea-level rise and climate change are also representative of many coastal countries and small island states.

8. *Id.* art. 57, at 419. The Convention also provides for a contiguous zone beyond the territorial sea, extending from 12 to 24 miles from the baseline, in which the coastal state has limited authority over customs, fiscal, immigration, and sanitary matters. *Id.* art. 33, at 409.

9. *Id.* art. 56, at 418. Conservation of the living resources includes determining allowable catches of those resources within the EEZ. *Id.* art. 61(1), at 420.

10. *Id.* art. 76, at 428. The continental shelf “comprises the sea-bed and subsoil of the submarine areas that extend beyond its territorial sea.” *Id.*

11. *Id.* art. 77(1), at 429.

12. *Id.* art. 86, at 432.

A. Tuvalu

Tuvalu is a Pacific archipelago of nine coral islands with a total land area of 26.5 square kilometers.¹³ It is considered by the U.N. to be one of the world's least developed countries; in 2010 its per capita GDP was approximately \$3,400, and the state's aggregate GDP was \$36 million.¹⁴ Tuvalu is a party to UNCLOS,¹⁵ however, it lacks both the human and financial capacity to formally delineate its EEZ pursuant to UNCLOS.¹⁶ This results in significant uncertainty about the size of its EEZ, with estimates ranging from 900,000 to 1.3 million square kilometers.¹⁷ "Tuvalu is one of the most vulnerable countries in the world to sea-level rise," with an average elevation of only one meter above sea level.¹⁸ Indeed, Tuvalu's highest elevation is only 5 meters and at its widest point only 200 meters.¹⁹ Increased storm activity, sea-level rise, and intensive land use have made Tuvalu extremely susceptible to coastal erosion and, thus, to loss of territory.²⁰ Coral reefs provide Tuvalu with significant protection against coastal erosion and also

13. See generally A.J. TILLING & E. FIHAKI, TUVALU NAT'L BIODIVERSITY STRATEGY & ACTION PLAN, FOURTH NATIONAL REPORT TO THE CONVENTION ON BIOLOGICAL DIVERSITY 7 (2009), available at <http://www.sprep.org/att/IRC/eCOPIES/Countries/Tuvalu/55.pdf>; TE MAILE CONSULTANCY FOR THE ECON. & SOCIAL COMM'N FOR ASIA & THE PAC., ASSESSMENT OF THE IMPLEMENTATION OF THE BARBADOS PROGRAMME OF ACTIONS FOR SMALL ISLANDS DEVELOPING STATES, AND THE MAURITIUS STRATEGY FOR THE FURTHER IMPLEMENTATION OF THE BPOA 7 (2010) [hereinafter TE MAILE], available at http://www.sidsnet.org/msi_5/docs/nars/Pacific/Tuvalu-MSI-NAR2010.pdf; Joeli Veitayaki, Pio Manoa & Alan Resture, *Addressing Climate Change and Sea Level Rise in the Pacific Islands*, 47 KAGOSHIMA U. RES. CENTER FOR PAC. ISLANDS OCCASIONAL PAPERS 1, 16 (2007), available at http://www.spc.int/lrd/index.php?option=com_docman&task=doc_download&gid=1145&Itemid=48; MINISTRY OF NATURAL RES., ENV'T, AGRIC., & LANDS, DEP'T OF ENV'T, TUVALU'S NATIONAL ADAPTATION PROGRAMME OF ACTION 32 (2007) [hereinafter TUVALU MINISTRY], available at <http://unfccc.int/resource/docs/napa/tuv01.pdf>.

14. *Tuvalu* (03/01/11), U.S. DEP'T OF STATE (Mar. 1, 2011), <http://www.state.gov/outofdate/bgn/tuvalu/176715.htm>; *Least Developed Countries: About LDCs*, UNITED NATIONS OFFICE OF THE HIGH REPRESENTATIVE FOR THE LEAST DEVELOPED COUNTRIES, LANDLOCKED DEVELOPING COUNTRIES AND THE SMALL ISLAND DEVELOPING STATES (UN-OHRLLS), <http://www.unohrlls.org/en/ldc/25/> (last visited Oct. 9, 2012). See also Cent. Intelligence Agency, *Tuvalu*, THE WORLD FACTBOOK, <https://www.cia.gov/library/publications/the-world-factbook/geos/tv.html> (last updated Sept. 11, 2012).

15. TE MAILE, *supra* note 13, at 30.

16. *Id.* at 8.

17. TILLING & FIHAKI, *supra* note 13, at 8; Veitayaki, *supra* note 13, at 16.

18. TILLING & FIHAKI, *supra* note 13, at 7–8; TE MAILE, *supra* note 13, at 7.

19. TILLING & FIHAKI, *supra* note 13, at 7–8; TUVALU MINISTRY, *supra* note 13, at 32.

20. TUVALU MINISTRY, *supra* note 13, at 30–31.

help to build the islands.²¹ However, because Tuvalu's average temperatures are within the upper limits for most coral species, further temperature increases are likely to result in significant coral mortality.²² Therefore, the effects of sea-level rise, coastal erosion, and coral damage will likely result in significant land loss for Tuvalu, potentially shrinking its EEZ.

Fishing is a way of life in Tuvalu. Of all Tuvaluan households, 67% of them were engaged in fishing activities in 2002,²³ contributing \$1.6 million, or 8%, of Tuvalu's GDP.²⁴ Fishing provides the primary source of protein for the Tuvaluans who consume approximately 100 kilograms of fish per person each year.²⁵

Foreign fleets also fish Tuvaluan waters, bringing welcome revenue to the state. The foreign catch in 2007 was about 35,551 tons of fish, valued at \$40,924,370,²⁶ and the sale of foreign fishing licenses alone resulted in approximately \$355 of Tuvalu's per capita income.²⁷ Even though Tuvalu attains significant revenue from the sale of offshore fishing licenses, its extensive EEZ and severe lack of enforcement capacity have resulted in widespread illegal and unreported fishing²⁸ and have made it difficult to manage the ten conservation areas it established on eight of its islands.²⁹

B. Seychelles

Seychelles is an archipelago in the Indian Ocean consisting of approximately 115 islands and an aggregate land area of 455 square kilometers³⁰ and an EEZ of approximately 1.3 million

21. *Id.* at 30.

22. *Id.* at 29.

23. FOOD & AGRIC. ORG. OF THE UNITED NATIONS, NATIONAL FISHERY SECTOR OVERVIEW: TUVALU 10 (2010) [hereinafter FAO TUVALU], available at ftp://ftp.fao.org/FI/DOCUMENT/fcp/en/FI_CP_TV.pdf.

24. *Id.* at 1.

25. Veitayaki, *supra* note 13, at 8; TILLING & FIHAKI, *supra* note 13, at 9; *Fishery Country Profile: Tuvalu*, FOOD & AGRIC. ORG. OF THE UNITED NATIONS (Apr. 2002), <http://www.fao.org/fi/oldsite/FCP/en/TUV/profile.htm>.

26. FAO TUVALU, *supra* note 23, at 2.

27. ROBERT GILLET, FOOD & AGRIC. ORG. OF THE UNITED NATIONS, MARINE FISHERY RESOURCES OF THE PACIFIC ISLANDS 44 (2010), available at <http://www.fao.org/docrep/012/i1452e/i1452e00.pdf>.

28. See TILLING & FIHAKI, *supra* note 13, at 9–10.

29. TILLING & FIHAKI, *supra* note 13, at 10, 15.

30. MINISTRY OF ENV'T & TRANSP., REPUBLIC OF SEYCHELLES, INITIAL NATIONAL COMMUNICATION UNDER THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 1 (2000) [hereinafter SEYCHELLES MINISTRY], available at <http://unfccc.int/resource/docs/natc/seyncl.pdf>; *Seychelles, MANGROVES FOR THE FUTURE*, <http://www.mangrovesforthefuture.org/countries/members/seychelles/> (last visited Sept. 30, 2012) [hereinafter SEYCHELLES MANGROVES];

square kilometers.³¹ Due to its low-lying elevation and significant coastal development, the country is very susceptible to land loss as a result of sea-level rise. It is estimated that a one-meter increase in sea levels would submerge many of Seychelles' islands, resulting in a loss of 70% of its land area.³² This is especially alarming because approximately 85% of the Seychelles' development occurs along its coasts.³³ Seychelles' President captured the urgency of the threat of rising waters in his statement to the 2007 Global Island Partnership meeting in Rome; he noted that much of the country's coastlines have suffered losses in recent years, with some areas losing over 50 meters of coastal plateau.³⁴

Seychelles' coral and mangrove ecosystems have been put at significant risk by the effects of climate change and development. These ecosystems provide Seychelles with natural protections against sea-level rise, offering strong protection against erosion and serving as both a breeding ground and a habitat for fish.³⁵ Elevated sea temperatures near Seychelles have recently caused up to 95% mortality in some coral reefs, and further warming is likely to cause mass coral bleaching.³⁶ Dense coastal development will lead to the loss of mangrove forests because it impedes the mangrove forests' ability to naturally retreat shoreward as the sea level rises.³⁷

Seychelles is home to over a thousand endemic flora and fauna, and the government has made significant commitments to protecting its unique biodiversity and ecosystems, setting aside 46% of its land and an additional 226 square kilometers of ocean as national parks and reserves.³⁸ The Vallée de Mai Nature

MICHÈLE P. MARTIN, NATIONAL ASSESSMENT REPORT: REPUBLIC OF SEYCHELLES (2004–2009) 4–5 (2010), available at http://www.sidsnet.org/msi_5/docs/nars/AIMS/Seychelles-MSI-NAR2010.pdf. See also Cent. Intelligence Agency, *Seychelles*, THE WORLD FACTBOOK, <https://www.cia.gov/library/publications/the-world-factbook/geos/se.html> (last updated Sept. 24, 2012); *Seychelles* (01/20/12), U.S. DEP'T OF STATE (Jan. 1, 2012), <http://www.state.gov/outofdate/bgn/seychelles/194938.htm>.

31. SEYCHELLES MANGROVES, *supra* note 30; MARTIN, *supra* note 30, at 5.

32. United Nations Env't Programme, *Coastal Erosion and Climate Change in the Western Indian Ocean Islands*, AFRICA ENV'T OUTLOOK, <http://www.unep.org/dewa/Africa/publications/aeo-1/110.htm> (last visited Sept. 30, 2012).

33. SEYCHELLES MINISTRY, *supra* note 30, at 9.

34. *Sea Level Rise Foundation*, OFFICE OF THE PRESIDENT OF THE REPUBLIC OF SEYCHELLES, http://www.statehouse.gov.sc/index.php?option=com_content&view=article&id=85&Itemid=75 (last visited Sept. 30, 2012).

35. *Id.*; SEYCHELLES MINISTRY, *supra* note 30, at 82.

36. SEYCHELLES MINISTRY, *supra* note 30, at 97; *Sea Level Rise Foundation*, *supra* note 34.

37. SEYCHELLES MINISTRY, *supra* note 30, at 82.

38. *Id.* at 2.

Reserve has been designated as a UNESCO world heritage site,³⁹ and comprehensive sea turtle protection has been implemented through a 1994 law.⁴⁰ Seychelles has engaged local stakeholders in these conservation efforts through stakeholder reports on conservation, habitat management, and even rehabilitation efforts.⁴¹ To address shortcomings in monitoring capacity, Seychelles has established a “Greenline,” which allows citizens to report illegal activity to the applicable conservation agency.⁴²

Seychelles’ economy is primarily driven by tourism and fishing, which contribute over 40% of its GNP.⁴³ In 1996, tourism brought in over \$100 million to the Seychelles, about 17% of its GNP, and employed 18% of its workforce.⁴⁴ Fishing provides approximately 4% of the Seychelles GDP, and in 1996, licensing fees alone brought in more than \$7 million.⁴⁵ The artisanal fishing industry produces about 4,500 tons of fish for domestic consumption and approximately 370 tons, worth over \$2 million, in exports.⁴⁶ As with Tuvalu, fishing is a way of life in the Seychelles and is one of the most important local sources of protein.⁴⁷

C. Maldives

Maldives is an archipelago of coral atolls consisting of 1,192 islands in the Indian Ocean with a land area of about 300 square

39. *Id.* at 2.

40. See generally Jeanne A. Mortimer, John Collie & Charles Mbindo, *The Status of Sea Turtle Conservation in the Republic of Seychelles*, 165 UNEP REGIONAL SEAS REP. & STUD. 103 (1996), available at http://college.holycross.edu/faculty/kprestwi/chelonia/pubs/4_symposium/Mortimer_Collie_Mbindo.pdf.

41. MARINE CONSERVATION SOCIETY SEYCHELLES, STAKEHOLDERS’ STRATEGY & ACTION PLAN FOR TURTLE CONSERVATION IN SEYCHELLES 4, 6 (2004) (on file with the Louisiana Law Review).

42. *Greenline Helps Public Protect Environment*, SEYCHELLES NATION, Nov. 4, 2011, <http://www.nation.sc/index.php?art=23093>.

43. SEYCHELLES MANGROVES, *supra* note 30.

44. SEYCHELLES MINISTRY, *supra* note 30, at 26.

45. Ian Kawaley, *Implications of the Exclusive Economic Zone and EEZ Management for Seychelles, a Small Midocean Commonwealth Territory*, 29 OCEAN DEV. & INT’L L. 225, 235 (1998); SEYCHELLES MINISTRY, *supra* note 31, at 96.

46. SEYCHELLES MINISTRY, *supra* note 30, at 96. In fact in 2008, the Seychelles supplied about 2.4% of the world’s tuna production. See MAKATO PETER MIYAKE, PATRICE GUILLOTREAU, CHIN-HWA SUN & GAKUSHI ISHIMURA, FOOD & AGRIC. ORG. OF THE UNITED NATIONS, RECENT DEVELOPMENTS IN THE TUNA INDUSTRY: STOCKS, FISHERIES, MANAGEMENT, PROCESSING, TRADE AND MARKETS 96 (2010), available at <http://www.fao.org/docrep/013/i1705e/i1705e.pdf>.

47. Kawaley, *supra* note 45, at 234.

kilometers,⁴⁸ sustained through continuous coral formation.⁴⁹ Its EEZ covers more than 859,000 square kilometers.⁵⁰ Maldives has made a firm commitment to address the effects of climate change and was the first country to sign the Kyoto Protocol, calling for greenhouse gas reductions.⁵¹ It has played an active role in calling attention to the plight of SIDS and has been instrumental in the Alliance of Small Island States' (AOSIS) push for climate change action.

With over 80% of its land area less than one meter above sea level and its highest elevation no more than three meters, Maldives is another of the nations most vulnerable to sea-level rise.⁵² Due to significant beach erosion and its low-lying elevation, some studies have estimated that with a one-meter rise in sea level, Maldives may cease to exist.⁵³ Even if the physical impact is not that severe, other studies have predicted that sea-level rise could cause Maldives' GDP to drop by almost 40% due to its impact on fishing and tourism.⁵⁴

Fishing has been a way of life and a main occupation in Maldives for centuries.⁵⁵ It plays a significant role in the economy of the Maldives and accounts for about 6% of the national GDP.⁵⁶ The Maldives' fishing sector employs about 11% of the workforce and accounts for about 98% of its physical exports.⁵⁷ About 80% of the Maldives' fishery sector consists of skipjack and yellowfin tuna fishing.⁵⁸ Tuna provides the primary source of protein in the

48. MINISTRY OF HOME AFFAIRS, HOUS. & ENV'T, REPUBLIC OF MALDIVES, FIRST NATIONAL COMMUNICATION OF THE REPUBLIC OF MALDIVES TO THE UNITED NATIONS FRAMEWORK CONVENTION ON CLIMATE CHANGE 2 (2001) [hereinafter MALDIVES MINISTRY], available at <http://unfccc.int/resource/docs/natc/maldnc1.pdf>. See also Cent. Intelligence Agency, *Maldives*, THE WORLD FACTBOOK, <https://www.cia.gov/library/publications/the-world-factbook/geos/mv.html> (last updated Sept. 20, 2012); *Background Note: Maldives*, U.S. DEP'T OF STATE (Mar. 29, 2012), <http://www.state.gov/r/pa/ei/bgn/5476.htm>.

49. MALDIVES MINISTRY, *supra* note 48, at 16.

50. *Id.* at 12.

51. *Id.* at 35.

52. *Id.* at 5, 16.

53. *Id.* at 5.

54. IPCC CHAPTER 16, *supra* note 5, at 709.

55. FOOD & AGRIC. ORG. OF THE UNITED NATIONS, NATIONAL FISHERY SECTOR OVERVIEW: MALDIVES 5 (2009) [hereinafter FAO MALDIVES], available at ftp://ftp.fao.org/FI/DOCUMENT/fcp/en/FI_CP_MV.pdf. Maldivian fishermen traditionally build their own boats, and income is distributed equally among the crew, while an extra share is allocated to the master fisherman, the ship owner, and for vessel maintenance. *Id.*

56. *Id.* at 2.

57. *Id.*

58. *Id.*

Maldives, and the per capita consumption is about 137 kilograms per year.⁵⁹

Although enforcement resources are slim, foreign fleets fishing within the Maldives' EEZ are monitored with a vessel monitoring system, and there have been several cases involving the coast guard's apprehension of unlicensed vessels.⁶⁰ To further enforce their licensing regime, the Maldives has contracted with GeoEye to build a new vessel monitoring system that will track vessels with GPS signals and help keep track of fish-catch reports.⁶¹

Tourism makes up another sizable portion of the Maldives' GDP: 33%.⁶² Climate change is expected to lead to significant decreases in tourism income for the state due to factors such as loss of beaches and degradation of dive sites resulting from coral bleaching.⁶³

D. Bangladesh

Bangladesh is a low-lying coastal Asian state located along the Bay of Bengal with a land area of about 144,054 square kilometers⁶⁴ and a population of approximately 131 million people.⁶⁵ It is listed by the UN as one of the world's least developed countries with a per capita GDP of only \$351.⁶⁶ Sadly, 36% of its population lives on a dollar per day or less.⁶⁷

59. FIN. & PRIVATE SECTOR DEV. UNIT, S. ASIA REGION, THE WORLD BANK, THE MALDIVES: SUSTAINING GROWTH & IMPROVING THE INVESTMENT CLIMATE 65–66 (2006), *available at* http://www.adb.org/sites/default/files/pub/2006/ICA_MaldivesREPORT.pdf.

60. FAO MALDIVES, *supra* note 55, at 5.

61. *GeoEye Wins Contract to Build Vessel Monitoring System for Republic of Maldives*, PR NEWswire (Jan. 6, 2011), <http://www.prnewswire.com/news-releases/geoeye-wins-contract-to-build-vessel-monitoring-system-for-republic-of-maldives-113023184.html>.

62. MALDIVES MINISTRY, *supra* note 48, at 30.

63. *Id.* at 65–66.

64. INT'L UNION FOR THE CONSERVATION OF NATURE & NATURAL RES., MARINE PROTECTED AREA NEEDS IN THE SOUTH ASIAN SEAS REGION VOL. 1: BANGLADESH 1 (John C. Pernetta ed., 1993) [hereinafter IUCN], *available at* http://data.iucn.org/dbtw-wpd/edocs/MRN-007_1.pdf.

65. MINISTRY OF ENV'T & FOREST GOV'T OF THE PEOPLE'S REPUBLIC OF BANGLADESH, NATIONAL ADAPTATION PROGRAMME OF ACTION 2 (2005) [hereinafter BANGLADESH MINISTRY], *available at* <http://www.moef.gov.bd/bangladesh%20napa%20unfccc%20version.pdf>.

66. *Id.* at 2. *See generally* OFFICE OF THE HIGH REPRESENTATIVE FOR THE LEAST DEVELOPED COUNTRIES, LANDLOCKED DEVELOPING COUNTRIES & SMALL ISLAND DEVELOPING STATES, UNITED NATIONS, THE LEAST DEVELOPED COUNTRIES: THINGS TO KNOW, THINGS TO DO (2012), *available at* <http://www.unohrrls.org/UserFiles/File/LATEST%20IPoA.pdf>.

67. BANGLADESH MINISTRY, *supra* note 65, at 3. *See also* Cent. Intelligence Agency, *Bangladesh*, THE WORLD FACTBOOK, <https://www.cia.gov/library/>

Because about 80% of Bangladesh consists of coastal flood plains, sea-level rise could have potentially devastating consequences.⁶⁸ Approximately 35.1 million people live in the coastal zone, over half of whom are considered “absolute poor.”⁶⁹ The World Bank estimates that there will be a one-meter rise in sea level by 2100, which will cause Bangladesh to lose over 17% of its territory.⁷⁰

Although Bangladesh has only recently opened its deep water areas in the Bay of Bengal to energy exploration, there may be vast natural gas fields, as there are in surrounding areas controlled by India and Myanmar.⁷¹ The average estimate of undiscovered offshore natural gas controlled by Bangladesh is 18.1 trillion cubic feet,⁷² worth over \$52 billion.⁷³ For a country as poor as Bangladesh, royalties from these potential deposits could have a tremendous impact.

Bangladesh contains about 60% of the Sundarbans, an extensive mangrove forest of approximately 407,313 hectares.⁷⁴ The Sundarbans is a UNESCO World Heritage site and the largest remaining tract of habitat for the last few hundred wild Bengal

publications/the-world-factbook/geos/bg.html (last updated Sept. 13, 2012); *Background Note: Bangladesh*, U.S. DEP’T OF STATE (Mar. 6, 2012), <http://www.state.gov/r/pa/ei/bgn/3452.htm>.

68. BANGLADESH MINISTRY, *supra* note 65, at 1. *See also* Mason Inman, *Where Warming Hits Hard*, 3 NATURE REPORTS CLIMATE CHANGE 18, 19 (2009), available at <http://www.nature.com/climate/2009/0902/pdf/climate.2009.3.pdf>.

69. Golam Mahabub Sarwar & Mamunul H. Khan, *Sea Level Rise: A Threat to the Coast of Bangladesh*, 38 INTERNATIONALES ASIENFORUM 375, 380 (2007), available at http://www.undp.org.bd/library/policypapers/Asienforum_Sarwar_Khan.pdf.

70. *Id.* at 376–78.

71. Badrul Imam, Op-Ed, *Offshore: The New Gas Frontier of Bangladesh?*, DAILY STAR (Oct. 16, 2009), <http://www.thedailystar.net/newDesign/news-details.php?nid=109865>.

72. U.S. GEOLOGICAL SURVEY WORLD ENERGY ASSESSMENT TEAM, BANGLADESH: ASSESSMENT RESULTS SUMMARY—ALLOCATED RESOURCES (2000), available at <http://energy.cr.usgs.gov/WEcont/regions/reg8/r8bang.pdf>.

73. This value assumes a price of \$2.88 per million BTUs—the August 22, 2012 average price on the New York Mercantile Exchange. *See* United Nations Conference on Trade & Dev., *Info-Comm: Natural Gas—Quality*, <http://www.unctad.org/infocomm/anglais/gas/quality.htm> (last visited Sept. 30, 2012); U.S. Energy Info. Admin., *Natural Gas: Weekly Update*, <http://www.eia.doe.gov/oog/info/ngw/ngupdate.asp> (last visited Sept. 30, 2012).

74. IUCN, *supra* note 64, at 5. An aerial photo of coastal Bangladesh’s Sundarbans mangroves bears a striking resemblance to coastal Louisiana with its many fingers of water and land.

tigers.⁷⁵ According to the IPCC, a one-meter increase in sea level will likely cause the demise of this fragile ecosystem.⁷⁶ The Sundarbans serves as protection against coastal erosion, so its loss would likely lead to greater land loss.⁷⁷

As a result of climate change and rising sea levels, many vulnerable coastal and island nations may suffer severe physical, economic, and cultural impacts. Those impacts may be exacerbated by the loss of territory due to shifting maritime boundaries.

III. SHIFTING MARITIME ZONES

A. *The Effect of UNCLOS*

With sea-level rise, the baselines from which most maritime zones are measured will change. As a consequence, the outer boundary of the zone may also change, retreating landward. While the change might be slight in most cases, in others it could be quite consequential, as, for example, if a baseline point such as an exposed rock disappears.⁷⁸ Excepted from this general rule are the boundaries of a state's continental shelf because the coastal state must "deposit with the Secretary-General of the United Nations charts and relevant information, including geodetic data, permanently describing the outer limits of its continental shelf."⁷⁹ UNCLOS also appears to fix the baselines of deltas and areas where natural conditions cause the coastline to be highly unstable. Article 7 of UNCLOS provides that when "a coastline is highly unstable . . . notwithstanding subsequent regression of the low-water line, the straight baselines shall remain effective until changed by the coastal State in accordance with this Convention."⁸⁰

75. BANGLADESH MINISTRY, *supra* note 65, at 5.

76. Sarwar & Khan, *supra* note 69, at 384.

77. *Id.* at 385.

78. Charles Di Leva & Sachiko Morita, *Maritime Rights of Coastal States and Climate Change: Should States Adapt to Submerged Boundaries?*, WORLD BANK LAW & DEV. WORKING PAPER SERIES NO. 5, 15–16 (July 2008), http://siteresources.worldbank.org/INTLAWJUSTICE/Resources/L&D_number_5.pdf. See also, e.g., 3 AARON L. SHALOWITZ & MICHAEL W. REED, *SHORE AND SEA BOUNDARIES* 185 (2000), available at http://www.nauticalcharts.noaa.gov/hsd/docs/CSE_library_shalowitz_Part_two.pdf.

79. UNCLOS, *supra* note 6, art. 76(9), at 429.

80. UNCLOS *supra* note 6, art. 7(2), at 401; Di Leva & Morita, *supra* note 78, at 18. Some states have made substantial efforts to protect their existing maritime boundaries and their rights. For instance, in 2007 Canada announced it would spend CA\$3.1 billion for the purchase of new patrol ships which will be used to increase the Canadian presence in the Arctic to which it has exploration rights, with an additional expenditure of CA\$4.3 billion for their maintenance over

B. Judicial Decisions Regarding Boundaries

In some nations, such as the United States, maritime boundaries are treated as ambulatory, and thus, when sea level rises over time, the boundaries will change. In *United States v. Alaska*, the Supreme Court recognized the possibility of ambulatory boundaries, but courts in other nations may rule differently.⁸¹ Although international tribunals like the International Court of Justice (ICJ) have yet to decide cases involving sea-level rise and claims of ambulatory baselines, the ICJ has given several principles to guide the establishment of maritime boundaries. In *Cameroon v. Nigeria*, the ICJ relied upon an equidistance principle, first drawing an equidistant line based on the countries' geography, and then evaluating other factors to determine whether the line should be shifted to achieve an equitable result.⁸² Some of the relevant circumstances recognized by the ICJ and other international tribunals include: the general configuration of the coasts of the parties; general geomorphological, geological, and geographical factors; the incidence of natural resources (usually oil and natural gas) in the disputed area and the principle of equitable access to these resources; defense and security interests of the states that are party to the dispute; and consistency with the general direction of the land boundary.⁸³

The effects of shifting baselines could lead to litigation in the ICJ and other tribunals as delineation of maritime boundaries is difficult and disputes contentious. For instance, disputes between Bangladesh and its neighbors, Myanmar and India, over oil and gas deposits in the Bay of Bengal led to confrontations between Bangladeshi and Myanmar warships. In 2009, Bangladesh submitted separate boundary disputes in the Bay of Bengal against Myanmar and India to UNCLOS arbitration.⁸⁴ The controversy

the 25-year life span of the ships. Canwest News Service, *Canada to Add Arctic Patrol Vessels, Deep-Water Port*, CANADA.COM (July 9, 2007), http://www.canada.com/story_print.html?id=603a03fb-9ab0-463a-8214-bfd1c5c121ba.

81. *United States v. Alaska*, 521 U.S. 1, 31 (1997).

82. *Land and Maritime Boundary Between Cameroon and Nigeria* (Cameroon v. Nigeria: Eq. Guinea Intervening), 2002 I.C.J. 303, ¶ 288 (Oct. 10).

83. IAN BROWNLIE, *PRINCIPLES OF PUBLIC INTERNATIONAL LAW* 217–18 (7th ed. 2008).

84. Michael A. Becker & Ernesto J. Sanchez, *International Law of the Sea*, 44 INT'L LAWYER 519, 524–26 (2010). See also Letter from Dipu Moni, Minister for Foreign Affairs, Government of the People's Republic of Bangladesh, to José Luis Jesus, President, Int'l Tribunal for the Law of the Sea (Dec. 13, 2009), available at http://www.itlos.org/fileadmin/itlos/documents/cases/case_no_16/Notification_Bangladesh_14.12.09.pdf; Delimitation of the

between Bangladesh and Myanmar was subsequently submitted to the International Tribunal for the Law of the Sea, which promulgated a boundary for the continental shelves of Bangladesh and Myanmar.⁸⁵ While litigation is one route that states may take to delimit maritime boundaries, there are less confrontational alternatives, such as dispute resolution under UNCLOS. Whatever the forum chosen, clearly delineated boundaries should lessen disputes.

C. The Impact of Shifting Boundaries on Fisheries

If a coastal state's baseline, and concomitantly its maritime zones, were to shift significantly landward, the change could have adverse consequences for the state's efforts to manage coastal waters and exploit its resources. If the shift were substantial enough, large segments of waters formerly under the jurisdiction of the state might be beyond its EEZ and, thus, form part of the high seas, open to all. These areas beyond national jurisdiction may be subject to some provisions of UNCLOS⁸⁶ or other international agreements, but protections are limited.

Pursuant to UNCLOS articles 118 and 119(2), in dealing with the high seas, states must make scientific information, catch-and-fishing-effort statistics, and any additional data relevant to the conservation of fish stocks available to international organizations.⁸⁷ To implement these provisions, states are required to keep a "national record of fishing vessels authorized to fish on the high seas and provision of access to information contained in

Maritime Boundary Between Bangladesh and Myanmar in the Bay of Bengal (Bangl./Myan.), Case No. 16, Order of Jan. 28, 2010, ITLOS Rep. 2008–2010, 24, *available at* http://www.itlos.org/fileadmin/itlos/documents/cases/case_no_16/Ord.2010-1.28.01.2010.E.pdf.

85. Delimitation of the Maritime Boundary Between Bangladesh and Myanmar in the Bay of Bengal (Bangl./Myan.), Case No. 16, Judgment of Mar. 14, 2012, http://www.itlos.org/fileadmin/itlos/documents/cases/case_no_16/1-C16_Judgment_14_02_2012.pdf. *See also* Moin Ghani, Op-Ed, *A 'Great Win' for Bangladesh*, DAILY STAR (Mar. 27, 2012), <http://www.thedailystar.net/newDesign/news-details.php?nid=227828>. Boundary conflicts such as this create international friction and pose the potential for armed hostilities. Additional examples of such frictions can be found in the current disputes between China and its neighbors over island territories. *See* Martin Fackler, *Dispute over Islands Reflects Japanese Fear of China's Rise*, N.Y. TIMES, Aug. 21, 2012, http://www.nytimes.com/2012/08/22/world/asia/dispute-over-islands-reflect-japanese-fear-of-chinas-rise.html?_r=1&pagewanted=all.

86. UNCLOS, *supra* note 6, arts. 116–120, at 441–42.

87. UNCLOS, *supra* note 6, art. 118, 119(2), at 441, 442.

that record on requires by directly interested states.”⁸⁸ If enforced, these articles can help ensure not only that relevant information is gathered and transmitted, but also that transparency in the process is maintained, which is a precursor to effective international conservation efforts. Unfortunately, it can be difficult for states to track and monitor all of their flagged fishing vessels, even in their own waters, and states may have little incentive to ensure that their vessels do not misreport their catches, especially in distant waters. Additionally, transparency is required only as to other states, and there are no requirements to release this information to the public, which limits oversight.⁸⁹

Even though UNCLOS provides a framework for establishing sustainable yields for high seas fisheries, issues arise when it comes to actually enforcing allowable catches and promoting conservation efforts. Article 119(1) of UNCLOS requires that states determine allowable catches based on the best scientific evidence to maintain “populations of harvested species at levels which can produce the maximum sustainable yield as qualified by relevant environmental and economic factors.”⁹⁰ These catch requirements are often difficult to enforce, and as noted, states have little incentive to police distant high seas.

A well-known example of the problem of overfishing in international waters is the Chilean Sea Bass, or Patagonian Toothfish. Currently described as “seriously overfished,”⁹¹ the Chilean Sea Bass is regulated by the Commission for the Conservation of Antarctic Marine Living Resources, created pursuant to Article IX of the Antarctic treaty system.⁹² In 2000 it was estimated that illegal harvesting of the Chilean Sea Bass amounted to twice the 16,000 tons that were legally harvested in

88. Agreement for the Implementation of the Provisions of the United Nations Convention of the Law of the Sea of 10 December 1982, Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, Sept. 8, 1995, *available at* <http://daccess-dds-ny.un.org/doc/UNDOC/GEN/N95/274/67/PDF/N9527467.pdf?OpenElement>.

89. Yen-Chiang Chang, *International Legal Obligations in Relation to Good Ocean Governance*, 9 CHINESE J. INT’L L. 589, 596 (2010), *available at* <http://intl-chinesejil.oxfordjournals.org/content/9/3/589.full.pdf+html>.

90. UNCLOS, *supra* note 6, art. 119(1), at 441.

91. ALICE CASCORBI, MONTEREY BAY AQUARIUM, SEAFOOD WATCH: CHILEAN SEABASS 3 (2006), *available at* http://www.montereybayaquarium.org/cr/cr_seafoodwatch/content/media/MBA_SeafoodWatch_ChileanSeabassReport.pdf.

92. *About CCAMLR*, CCAMLR.ORG, <http://www.ccamlr.org/en/organisation/about-ccamlr> (last updated Sept. 7, 2012); *Fisheries*, CCAMLR.ORG, <http://www.ccamlr.org/en/fisheries/fisheries> (last updated July 13, 2012).

the Antarctic management area.⁹³ Although a shift of boundaries may not always result in greater threats to fisheries and other living resources than if they were in a state's EEZ, the possibility remains.⁹⁴

IV. WHERE IS THE FAIRNESS?

Significant fairness concerns arise in conjunction with boundary delineations, and equity traditionally plays a role in the delineation process. The ICJ has recognized the importance of delineations to the livelihood and economic well-being of the parties to a delineation dispute. We should consider, then, the equitable issues involved when addressing the current regime of ambulatory baselines for territorial seas and EEZs. Most of the countries that stand to lose substantial amounts of territory if boundaries are modified due to sea-level rise are SIDS and other developing coastal countries. They contribute little to the global threat and have little capacity for mitigation and adaptation, yet they will bear a disproportionate share of the burden. This imbalance in power and capacity to mitigate and adapt to climate change starkly demonstrates the gulf between developed and developing states.⁹⁵

None of the four countries profiled in this Article has any substantial capacity to mitigate the effects of climate change, as they each contribute such a small percentage of global greenhouse gas emissions. In 1994, Tuvalu emitted .61 tons of carbon dioxide (CO₂) per capita, compared to 22.2 tons in the United States.⁹⁶

93. *Fact Sheet: Chilean Sea Bass Frequently Asked Questions*, U.S. DEP'T OF COMMERCE & DEP'T OF STATE, 1, <http://www.nmfs.noaa.gov/trade/chile.pdf>.

94. An additional example of overexploitation of a fish stock in international waters was the Alaskan Pollock in the Bering Sea. See Allison Winter, *U.S. Bans Commercial Fishing in Warming Arctic*, N.Y. TIMES, Aug. 21, 2009, <http://www.nytimes.com/gwire/2009/08/21/21greenwire-us-bans-commercial-fishing-in-warming-arctic-33236.html>; Marine Res. Serv., *Review of the State of World Fishery Resources: Marine Fisheries*, FOOD & AGRIC. ORG. OF THE UNITED NATIONS (1997), <http://www.fao.org/docrep/003/w4248e/w4248e22.htm>.

95. ALEX G. OUDE ELFERINK, *THE LAW OF MARITIME BOUNDARY DELIMITATION: A CASE STUDY OF THE RUSSIAN FEDERATION* 103 (1994) (discussing an ICJ decision resolving the dispute between Canada and France over the delineation of the maritime borders of Saint Pierre and Miquelon).

96. *Greenhouse Gas Emissions per capita*, UNITED NATIONS STATISTICS DIV., http://unstats.un.org/unsd/environment/air_greenhouse_emissions.htm (last updated July 2010). Tuvalu has threatened to bring suit against major polluting countries in an attempt to force reductions. See Rebecca Elizabeth Jacobs, *Treading Deep Waters: Substantive Law Issues in Tuvalu's Threat to Sue the United States in the International Court of Justice*, 14 PAC. RIM. L. & POL'Y J. 103, 115 (2005).

Because 90% of the Seychelles territory is covered with vegetation, it sequesters about 4.4 times the amount that it emits.⁹⁷ In 2007 the Maldives was responsible for just .003% of the world's CO₂ emissions, and its per capita CO₂ emissions were just under three tons, while the world average was over five tons.⁹⁸ Nevertheless, the Maldives take its own responsibilities seriously, and to fulfill them while setting an example for the rest of the world, it has resolved to achieve carbon neutrality within a decade.⁹⁹ In 2007, Bangladesh, with a population estimated to exceed 150 million, the seventh largest in the world, was responsible for less than 15% of the world's CO₂ emissions, and its per capita emissions were only one-twentieth of the average global per capita CO₂ emissions.¹⁰⁰ So, in spite of the Maldives' brave attempt to reduce its emissions, these countries have no meaningful capacity to mitigate the effects of climate change.

Many developing states will face devastating economic impacts as a result of climate change.¹⁰¹ The current regime of ambulatory baselines threatens to deplete some of the most valuable resources that each of these countries possesses, making it even more difficult for these countries to build resilience to sea-level rise. Shrinking EEZs will result in lower revenues from the fishing industries of Tuvalu, Seychelles, and Maldives. Countries such as Bangladesh may be unable to produce sufficient revenue from their significant nonliving resources to fund the necessary adaptation infrastructure.

If the current ambulatory baselines regime is maintained, not only will many of the smallest contributors to climate change lose control over portions of their most valuable natural resources, but many of the largest contributors to climate change will also be positioned to reap the benefits of these resources as they become part of the "high seas." In 1999, a vast majority of the ships licensed to fish in Tuvaluan waters were from the U.S. and

97. SEYCHELLES MINISTRY, *supra* note 30, at 4.

98. United Nations Statistics Div., *Carbon dioxide emissions (CO₂), metric tons of CO₂ per capita (CDIAC)*, MILLENNIUM DEVELOPMENT GOALS INDICATORS, <http://mdgs.un.org/unsd/mdg/SeriesDetail.aspx?srid=751&crd=> (last updated July 2, 2012) [hereinafter *CO₂ emissions*].

99. *Maldives*, MANGROVES FOR THE FUTURE, <http://www.mangrovesforthe future.org/countries/members/maldives/> (last visited Sept. 30, 2012).

100. *CO₂ emissions*, *supra* note 98.

101. For a detailed discussion of the potential impacts on developing countries, see THE WORLD BANK GROUP, *THE COST TO DEVELOPING COUNTRIES OF ADAPTING TO CLIMATE CHANGE: NEW METHODS AND ESTIMATES* (2010), available at <http://siteresources.worldbank.org/EXTCC/Resources/EACC-june 2010.pdf>.

Japan.¹⁰² In 2008, only six countries were licensed to fish in Tuvaluan waters, a list that included Japan, Spain, and the U.S.¹⁰³ Japan and the U.S. ranked as the second and fifth largest current greenhouse gas (GHG) emitters in 2007 and have been the source of a substantial portion of the world's historical emissions of GHGs.¹⁰⁴ The current regime of ambulatory baselines creates a perverse system in which countries that are responsible for most of the world's GHG emissions may benefit at the cost of countries that are some of the world's lowest emitters of GHGs.

Some of these developing states most vulnerable to climate change have been proactive in protecting their ecological diversity, but the loss of territory may prevent these countries from effectively implementing their conservation efforts. Tuvalu has engaged in conservation efforts as stated above; however, limited enforcement resources have made effective implementation a challenge. Shrinking EEZs will reduce revenues, and already limited enforcement efforts will become even more scant. Seychelles' efforts to preserve almost 50% of its land territory and 226 square kilometers of ocean as natural areas to protect the flora and fauna endemic to the islands will face increasing pressure as climate costs increase and revenues shrink.¹⁰⁵ This pressure on protected areas will further increase as coastal settlement is forced to retreat from rising sea levels. Therefore, it seems that countries that have made commitments to conservation, such as Tuvalu and Seychelles, may be stymied by loss of territory and shrinking revenues.

The Rio Declaration on Environment and Development sets forth principles to guide nations as they pursue the goal of sustainable development. Principle Two provides that countries have the right to exploit their own resources, but they must do so in a fashion that does not interfere with other countries' rights to a healthy environment.¹⁰⁶ The leading GHG-emitting countries are exploiting their resources in a manner that causes damage to the environment and the areas beyond their national jurisdictions, in contradiction of Principle Two. In addition, the current regime of ambulatory baselines threatens to deprive coastal states vulnerable to sea-level rise, like those profiled above, of some of their

102. *Fishery Country Profile*, *supra* note 25.

103. FAO TUVALU, *supra* note 23, at 7.

104. *CO2 emissions*, *supra* note 98.

105. SEYCHELLES MINISTRY, *supra* note 30, at 2.

106. United Nations Conference on Env't & Dev., Rio de Janeiro, Braz., June 3–14, 1992, *Rio Declaration on Environment and Development*, U.N. Doc. A/CONF.151/26 (Vol. I), Annex I (Aug. 12, 1992), available at <http://www.un.org/documents/ga/conf151/aconf15126-1annex1.htm>.

principle sources of revenue. This will impede the ability of these countries to adapt to the effects of sea-level rise, much less pursue national development. Further, the loss of historical fishing grounds for many of these countries—the result of a climate changing process caused by GHG emissions from far more developed countries—is at odds with the concept that a right to develop should not compromise the developmental and environmental needs of present and future generations. For these reasons, the current regime for boundary specification may inequitably burden the most vulnerable states and should therefore be reconsidered.

V. ADAPTATION TO RISING SEAS

For SIDS and other vulnerable coastal states, the diminishment of their EEZs and other maritime zones, if sufficiently severe, could pose potentially severe consequences for their economies, environments, and the health and welfare of their peoples. SIDS are especially vulnerable, so an organized process to assess the problems and the development of adaptive strategies are especially critical for them. Although mitigation remains a crucial strategy for addressing climate change, and SIDS and other coastal states may benefit from their own measures to reduce GHG emissions, implementing adaptation measures to deal with the effects of rising sea level is essential for them. One appropriate way to approach adaptation is to take immediate steps to better manage their EEZs and other maritime zones.¹⁰⁷

A variety of challenges confront SIDS and other island states in implementing adaptation measures. Obviously, the cost to employ these measures could be burdensome. For instance, it has been suggested that climate change protection initiatives would amount to 34% of the Maldives' GDP.¹⁰⁸ In addition, tailoring the adaptation measures to the specific problems and local customs of

107. In this regard, one commentator, Laurance Juda, has proposed a series of steps. See Kawaley, *supra* note 45, at 226. He suggests that states should first assess the resources and ecological systems under their jurisdiction and determine the boundaries of their control. They should then attempt to establish goals and priorities for adaptive measures and should attempt to regulate EEZ activities in accordance with those goals and priorities. Finally, states must establish appropriate institutional machinery for policy making and administration.

108. R. Gommès, J. du Guerny, F. Nachtergaele & R. Brinkman, *Potential Impacts of Sea-Level Rise on Populations and Agriculture*, FOOD & AGRIC. ORG. OF THE UNITED NATIONS (Mar. 1998), <http://www.fao.org/sd/eidirect/Eire0049.htm>.

the state remains a challenge, especially if requirements imposed by funding sources are not adapted to local conditions. Local knowledge may not be reflected in the adaptation measures, which devalues the contributions of local citizens who might otherwise feel empowered to influence the manner in which their countries respond to climate change. Community knowledge is not often considered, and according to commentators, "Local strategies for dealing with climate change are sometimes dismissed as ineffective due to a lack of relevant knowledge from which to work, even when they are actually hampered by a lack of supportive institutions and financial resources to implement adaptation activities."¹⁰⁹ Furthermore, management of these adaptation measures is made difficult by the lack of experts available and willing to provide aid. Within SIDS, there is a lack of qualified scientific knowledge in the fields of marine science, oceanography, and coastal management, as well as a lack of appropriate equipment to ensure proper management of marine and coastal resources.¹¹⁰ Therefore, external aid is necessary not only in the form of financial resources, but also human capital.

Approaches to adaptation come in an array of forms, depending on the state's resources and the issues to be resolved. First, engineering solutions may be available to address problems associated with sea-level rise. Artificial barriers and sea walls are frequently employed to limit beach erosion and protect against sea-level rise. These can be successful short-term adaptation options and can be utilized to protect property at risk to the immediate problem of sea-level ingress. However, investment in such options is often high because such options involve expensive hydrodynamic studies.¹¹¹ For example, the cost of protecting 50 of the 200 inhabited islands of the Maldives with artificial structures was estimated to be over \$1.5 billion in 1998;¹¹² to protect all 200 inhabited islands would require roughly \$6 billion, or more than 30 times the country's GDP.¹¹³ Additionally, in many SIDS such as Tuvalu, sea walls have not been adequately maintained, and in some cases, these structures may have actually contributed to, rather than prevented, coastal erosion.¹¹⁴

109. Ilan Kelman & Jennifer J. West, *Climate Change and Small Island Developing States: A Critical Review*, 5 *ECOLOGICAL & ENVTL. ANTHROPOLOGY*, no. 1, 2009, available at <http://www.ilankelman.org/articles1/eea2009.pdf>.

110. MARTIN, *supra* note 30, at 19.

111. SEYCHELLES MINISTRY, *supra* note 30, at 89.

112. MALDIVES MINISTRY, *supra* note 48, at 54.

113. *Id.* at 80.

114. Sea walls cut off the landward supply of sand during storm events, resulting in waves that attack unprotected areas to a greater extent than they

In addition to sea walls, other options include mechanical or electronic tide and flood control systems, which are designed to address specific coastal characteristics, including the location of ports and other infrastructure. While they may sometimes present attractive options, costs of construction and maintenance can be prohibitive.¹¹⁵ Efforts to maintain and restore so-called soft structures like beaches, dunes, and wetlands are frequently proposed; however, they are often short term and may ultimately succumb to rising waters.¹¹⁶ Bangladesh, which would like to be a showcase for adaptation efforts, has included in its strategy ideas borrowed from the Dutch: building a network of earthen berms and embankments based on polders employed in the Netherlands.¹¹⁷ The network will be expanded, and the embankments strengthened and built higher.¹¹⁸ However, SIDS are unlikely to have the resources to implement these sorts of high-cost initiatives. Furthermore, as the recent tsunami in Japan demonstrates, even the most sophisticated and expensive coastal defenses may be no match for Mother Nature.

Another adaptation option is for states to implement ecological solutions. Preservation of natural barriers such as mangroves, coral reefs, and sandy beaches is critically important, and the natural ability of beaches to act as self-adjusting buffers in the face of rising sea levels must be maintained.¹¹⁹ States can also create soft structures, which absorb wave energy and engage in tree planting for erosion control. For instance, to help reduce erosion, the Tuvalu Council of Women, funded by the New Zealand Agency for International Development, planted trees across the archipelago; their efforts on Niutao, where they planted local species, could be utilized as a “green-belt model.”¹²⁰ The use of native plants adapted to local conditions should be promoted as an effective and ecologically beneficial means to protect coasts.¹²¹

Some states have banned certain industrial practices in an effort to curtail ecological harm. For example, coral mining, which

would have done prior to the sea-wall construction. TUVALU MINISTRY, *supra* note 13, at 32.

115. SEYCHELLES MINISTRY, *supra* note 30, at 89.

116. *Id.*

117. Mason Inman, *Hot, Flat, Crowded—And Preparing for the Worst*, 326 SCI. MAG. 662, 663 (2009), available at http://cmsdata.iucn.org/downloads/hot_flat_crowded_and_preparing_for_the_worst_mason_inman_1.pdf.

118. *Id.*

119. TILLING & FIHAKI, *supra* note 13, at 17.

120. TUVALU MINISTRY, *supra* note 13, at 32–33.

121. TILLING & FIHAKI, *supra* note 13, at 17.

is frequently practiced in the Maldives, was restricted, and a complete ban on coral mining was considered.¹²² Coastal states with greater resources have been able to implement more expansive initiatives such as coastal afforestation, which is estimated to cost Bangladesh \$23 million.¹²³

There are many land-use solutions aimed at more effective management of coastal areas. Local tourism for SIDS tends to be highly concentrated in coastal areas where activities like fishing, snorkeling, and water sports are popular. While tourism is undoubtedly a significant contributor to the local economies, it has a potentially devastating effect on the environment. For this reason, relocating tourist activities and implementing reclamation projects can be effective in dealing with sea-level rise and its consequences. This solution may provide the best long-term security for investments, but the scarcity of coastal land and its cost presents a problem.¹²⁴ Creating educational programs is also an option. For instance, Tuvalu has adopted legislation and programs aimed at increasing local knowledge of land use and coastal planning.¹²⁵

Finally, in some instances retreat may mean relocating the entire population away from the home territory. Some states refuse to consider this option due to cultural and historical ties to the geographic area itself. Prime Minister Apisai Ielemia of Tuvalu reflected this attitude at U.N. climate negotiations in Poznan, Poland (2008) by asserting that “a nation has a right to exist forever [and it] is our basic human right.”¹²⁶ For most states, retreat would be a last resort—a route to take should no other adaptation mechanism prove successful.

Despite Tuvalu’s resistance, press reports indicate that the Prime Minister held confidential talks with Australian officials in October 2008 aimed at obtaining Australia’s agreement to accept the entire Tuvaluan population if and when it is forced to evacuate.¹²⁷ In addition, Tuvalu negotiated an agreement with New Zealand (under the Pacific Access Category and the Temporary

122. MALDIVES MINISTRY, *supra* note 48, at 81.

123. BANGLADESH MINISTRY, *supra* note 65, at 24.

124. SEYCHELLES MINISTRY, *supra* note 30, at 88.

125. TILLING & FIHAKI, *supra* note 13, at 21.

126. Anna Mudeva, *Threatened Tuvalu Says Rich States Block Climate Aid*, REUTERS (Dec. 11, 2008, 8:18 AM), <http://www.reuters.com/article/2008/12/11/us-climate-tuvalu-idUSTRE4BA39P20081211>.

127. Rosemary Rayfuse, *W(h)ither Tuvalu? International Law and Disappearing States* (University of New South Wales Law Research Paper No. 9, 2009), available at <http://ssrn.com/abstract=1412028>.

Labor Scheme) for the resettlement of 75 of Tuvaluan citizens to New Zealand each year.¹²⁸

Other states have openly acknowledged their plans to relocate to another territory. Maldives' then-President announced in 2008 that the country would "begin to divert a portion of the country's billion-dollar annual tourist revenue to buying a new homeland—as an insurance policy against climate change that threatens to turn the 300,000 islanders into environmental refugees."¹²⁹

VI. CONCLUSION

There are no easy solutions for states vulnerable to sea-level rise and other manifestations of climate change. For low-lying coastal and small island states, the situation is especially acute and is aggravated by the problem of shifting maritime boundaries. Various proposals have been made to deal with the issue but little progress made.¹³⁰ States should make strenuous efforts both to delimit their continental shelves and, insofar as possible, to fix their current baselines. Because of the substantial expenses involved in such endeavors, international programs should assist with financial and technical support, both in establishing maritime boundaries, as well as in developing licensing and conservation laws and building enforcement capacity. Although sea-level rise cannot be stopped, those countries most vulnerable to its effects can be helped to meet its challenges.

128. Veitayaki, *supra* note 13, at 8.

129. Randeep Ramesh, *Paradise Almost Lost: Maldives Seek to Buy a New Homeland*, THE GUARDIAN (Nov. 9 2008), <http://www.guardian.co.uk/environment/2008/nov/10/maldives-climate-change>.

130. See generally Lilian Yamamoto & Miguel Esteban, *Atoll Island States and Climate Change: Sovereignty Implications* (UNU-IAS Working Paper No. 166, 2011) available at http://www.newday.com/resource_docs/459_Working%20Paper%20166_Lilian%20Yamamoto_Miguel%20Esteban.pdf; Rosemary Rayfuse, *International Law and Disappearing States: Utilising Maritime Entitlements to Overcome the Statehood Dilemma*, UNIVERSITY OF SOUTH WALES FACULTY OF LAW RESEARCH SERIES (2010), <http://www.austlii.edu.au/au/journals/UNSWLRS/2010/52.html>; David D. Caron, *When Law Makes Climate Change Worse: Rethinking the Law of Baselines in Light of a Rising Sea Level*, 17 ECOLOGY L.Q. 621 (1990).