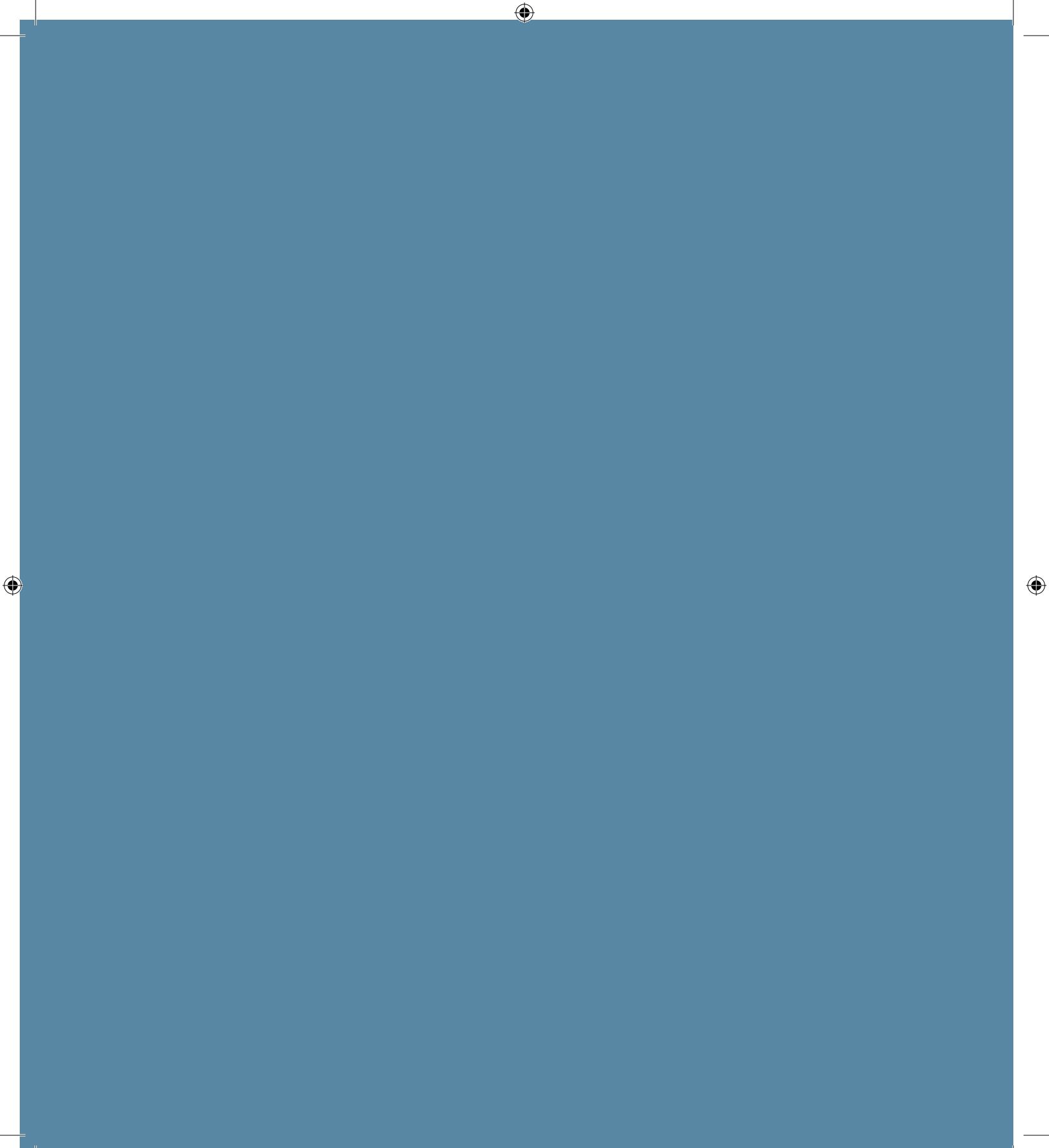


Sea Change



Sea Change

An Atlas of Islands
in a Rising Ocean

CHRISTINA GERHARDT

FOREWORDS

BILL McKIBBEN

HILDA HEINE

DESSIMA WILLIAMS

MAPS

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DESIGN

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Foreword

BILL MCKIBBEN

Planet Earth is a big, sprawling place, except when it isn't. Some of the world's most remarkable cultures have risen on small islands, as this fine atlas makes clear; having had the pleasure of visiting many of these places, I can testify to the distinctive ways-of-being that come when people must learn to live with their neighbors because there is literally nowhere to go. The "island spirit" that outsiders often notice is a great gift to the rest of humanity.

And of course these places are now under the most severe threat, and through no fault of their own. To sit on an atoll, able to see the ocean on all sides, knowing that the highest place within reach is just a few meters above sea level—in the twenty-first century that's a truly vulnerable position.

The people of these islands are not giving up. "We are not drowning! We are fighting!" has become a rallying cry across the Pacific and Indian Oceans. This volume lets them speak, and reminds all of us precisely what is at stake. We should have this information close to head and heart: the geography, the history, the particular humanity of these places that in our carelessness we in the rich continents are on the edge of wrecking.

Author Christina Gerhardt and her many collaborators deserve our thanks. The worlds they describe are among the oldest, richest, and most dense with meaning that can be found here on our planet. We should know them, honor them, and let them live on far into the future.

Forewords

HILDA HEINE

Republic of the Marshall Islands

Ocean waters regularly flood over a temporary seawall shielding my property from the sea. If left unchecked, the ocean that has sustained us for so long will take my home. For many, the stakes are even higher. They say we will be underwater in the next twenty to fifty years. What of the survival of an entire culture? What of a home for my grandchildren? And while my island nation may be on the front lines, no country is immune.

The science tells us that climate change impacts will continue to worsen. At only 2 meters (6.56 feet) above sea level, the Republic of the Marshall Islands is at a severe risk. Current predictions run between 0.3 (1 foot) and 2.4 meters (8 feet) of sea level rise by 2100. The inundation of seawater gets into our wells and renders our water undrinkable. It gets into the soil and makes it a challenge to grow foods. The water floods into homes. Seawalls have

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DESSIMA WILLIAMS

Grenada

Men, women, youth, and children from Small Island Developing States (SIDS) and low-lying countries face the imperative to present our own island realities and perspectives to the world. That is, to undertake the necessary movement of the needle on islands from where it was started centuries ago, mostly by early Europeans, who saw islands as *vacans terram*, empty of civilization but full of native cannibals and opportunities for the European (male) to carve out wealth. More recently, as islands settle into the psyche of the global public, they are seen as exotic or endangered, as sites for foreign investment or for a raft of illegal activities from human trafficking to drug smuggling and more. The universal agenda of human beings conducting the diversity of activities that constitutes human existence seems to escape common consciousness when it comes to islands.

been demolished. The inundation has washed away graves. Unlike continental land dwellers, we have no higher ground to run to.

Sea Change: An Atlas of Islands in a Rising Ocean presents islands globally that are at risk of sea level rise. Poems and texts of various genres foreground islanders' voices. In essays the book shares the islands' histories and stories. Maps show the impacts of sea level rise. This atlas shares not only the science related to climate change impacts and sea level rise but also the lived experience of islanders. Throughout the book the impact of colonialism and imperialism is a thread. Both the ongoing military occupation of islands and the tourism industry continue to challenge political and economic independence. These issues compound climate change effects.

As this atlas underscores, the view from the continent and from the islands differs starkly. While the islands may seem distant or remote to continental residents, as Christina Gerhardt writes, citing Epeli Hau'ofa, "islanders dispersed among an ocean . . . , reading it as the center, deem themselves to be connected." Epeli Hau'ofa has pointed out that "there is a gulf of difference between viewing the Pacific as 'islands in a far sea' and as a 'sea of islands.'" This atlas centers islands and tells the story about the connections among islanders.

Moreover, *Sea Change: An Atlas of Islands in a Rising Ocean* shares not only the histories and stories of islands and islanders but also the work being undertaken by islanders to address sea level rise. The Marshall Islands is currently

But the corpus of materials that helps to reverse or erase negatives on islands is indeed increasing, as positive voices on islands continue to spring to the fore worldwide. This is why *Sea Change: An Atlas of Islands in a Rising Ocean* is so welcome and critical. It presents an important shifting of the gaze toward truth-telling of islands. In poetry and prose, critical voices of and from around the world of islands give valuable messages and praises and issue calls. And sea level rise in and on islands requires more truth-telling. Indeed, in large measure, this book is about resetting the "narrative vantage point" in favor of a triple movement: celebrating islandness, confronting multiple and increasing vulnerabilities, and becoming reacquainted with a global community of island storytellers, including prize-winning intellectuals of various genres.

In his text *Globalised. Climatized. Stigmatised*, Camillo M. Gonsalves of Saint Vincent and the Grenadines in the eastern Caribbean writes of "small island exceptionalism . . . shaped by the practical realities of smallness, of islandness, and of the delicate dance of alternatively accommodating, resisting and adapting to tremendous exogenous pressures. Through this dance, small island states have forged a personality and development outlook without parallel in any other group of countries in the world" (12).

In this atlas, worldwide island exceptionalism jumps out at the reader, making the collection compelling as it combines

developing its National Adaptation Plan, a strategic plan that considers various responses to climate change, including the elevation of land, internal migration, or even the extreme option of building new islands. Islanders are actively working to bring awareness to and alleviate the impacts of climate change. The atlas highlights this work. Throughout the Pacific a battle cry can be heard: “We are not drowning! We are fighting!”

short essays and maps to focus on the impacts of sea level rise. Naturally then, the book provides insight into the painful nexus of the threats islands face and the resources they need to be themselves and, of course, to survive and thrive.

Author Christina Gerhardt reminds us that “Roman Pliny the Elder wrote of the Fortunate Islands in *Natural History* that they ‘abound in fruit and birds of every kind.’” This atlas presents island words (fruits) of every kind from island writers (birds) of every kind; therein lies its appeal to all who value an island exceptionalism of author and of subject that is anchored in the responsibility of all to do everything they can to ensure that islands stay alive and thrive.

Introduction

OF OCEANS AND ISLANDS

There is a gulf of difference between viewing . . . “islands in a far sea” and as a “sea of islands.” **EPELI HAU’OFA**

ATLASES

Atlases are being redrawn as islands are disappearing. Yet many on continents are not even aware of where these islands are located, what their names are, or how climate change impacts them, despite the fact that continental land dwellers are often more responsible for producing carbon dioxide (CO₂) emissions and sea level rise. According to the Intergovernmental Panel on Climate Change (IPCC), Pacific Island nations are responsible for 0.03 percent of global emissions. Figures for islands in the Caribbean Sea are in a similar range. Island nations are among the nations that have contributed the least to CO₂ emissions and global warming; they are, however, suffering its impacts already, severely and disproportionately. Entire nations, their histories, cultures, and languages are at risk of being lost.

These low-lying islands are a harbinger of the future that awaits the residents of coastal cities and shorelines. Internationally, the cities projected to be most affected include but are not limited to Guangzhou and Shanghai, China; Hong Kong; Mumbai, India; Amsterdam, Netherlands; Lagos, Nigeria; Manila, Philippines; Dakar, Senegal; and Ho Chi Minh City, Vietnam.¹ Almost half of the US’s population, about 40 percent, lives in coastal states and cities. In other words, or numbers, it is estimated about 13 million US residents would be affected, in particular, in order of impact, in the states of Florida, Louisiana, California, New York, and New Jersey. A study published in *Nature*

1. Jonathan Watts, “From Miami to Shanghai: Three Degrees of Warming Will Leave World Cities under Water,” *The Guardian*, November 3, 2017; Josh Holder, Niko Kommenda, and Jonathan Watts, “The Three Degree World: Cities Drowned by Global Warming,” *The Guardian*, November 3, 2017.

in 2016 estimated that by 2100 as many as 13 million US residents could be affected by sea level rise. So-called “hundred-year floods” will happen every year in New England and mid-Atlantic regions and every one to thirty years along the Southeast Atlantic and Gulf of Mexico.² All states along the Eastern Seaboard will be affected. The difference? Residents on continents can retreat inland. For many islands, sea level rise may spell the end of their nation’s very existence.

How to make visible what might be geographically remote to some? How to render visible the climate science? How to encourage thinking with? How to encourage a thinking that is mindful of how we are all connected, as humans and with nonhumans? Spatially, actions in one place have an effect in another place. Temporally, actions in one era (the history of burning fossil fuels) have an effect in another era (the present). How to encourage a perspective that weaves together our past history and actions, including the legacy of colonialism, with a thinking about our present actions that works toward a livable future? How to activate a concept of living with? Is this about a world that structures its relations to land, people, animals, and ecosystems for profit and accumulation? Or is this about a way of living that is based on an acknowledgment of the interconnectedness of the ecosystems, of humans and nonhumans, and thinks those relations through to prioritize an equitable present and a livable future?

Atlases exist that map sea level rise impacts on cities in the US but no atlas exists that maps where the most impacted islands lie, that tells what the effects of sea level rise will be on these islands and that shares the islanders’ strategies to address and resolve them. *Sea Change: An Atlas of Islands in a Rising Ocean*, through its texts and maps, allows us to understand the dramatic changes taking place and activates imaginings of possible futures.

ISLANDS—IN THE COLONIAL IMAGINATION

Every island has a story. There are, of course, many more stories than there are islands. Spanning the globe. Which is another way of saying: (Narrative) vantage point is everything.

Islands are deemed to be paradisiacal. The blue ocean. The beaches. Palm trees gently swaying in a balmy breeze. Soft white sand underfoot. The temperate clime. Do an internet search for “paradisiacal” and the first example of its use in a sentence features an island: “a paradisiacal island in the Bahamas.” *Merriam-Webster’s* definition of “paradisiacal” features an island: “The 15-day, round-trip cruise, . . . includes visits to some of French Polynesia’s most *paradisiacal* islands.” Islands are paradisiacal. Paradise is an island.

2. Reza Marsooli, et al. “Climate Change Exacerbates Hurricane Flood Hazards along US Atlantic and Gulf Coasts in Spatially Varying Patterns,” *Nature Communications* 10.1 (2019). DOI: 10.1038/s41467-019-11755-z.

The Western imagination often casts islands as utopias—or dystopias. Early on, in *Timaeus* and *Critias*, Plato wrote about the lost island of Atlantis that would threaten to conquer Ancient Greece.³ Greece, the cradle of Western civilization, encompasses thousands of islands dispersed throughout the Aegean and Ionian seas. Of course, these islands are intimately tied to maps. In the sixteenth century, German–Flemish geographer Gerardus Mercator, who created the famous or perhaps infamous Mercator map, is credited with coining the term *atlas*, referring to a collection of maps in a book. Mercator named his *Atlas Sive Cosmographicae Meditationes de Fabrica Mundi et Fabricati Figura* (Atlas or Cosmographical Meditations upon the Creation of the Universe and the Universe as Created) after the Greek god Atlas. The Atlantic Ocean, literally translated, is the sea of Atlas. Atlantis, translated from the Ancient Greek, means Atlas’s island. Thomas More revisited the mythical place Atlantis in *Utopia* (1516) and Francis Bacon in *New Atlantis* (1627),⁴ but More set his Atlantis in the Pacific between Sri Lanka and the Americas and Bacon locates it in the South Seas.⁵

For a long stretch, to Europeans, islands often rested in the fantastical realm of uncharted (to them) oceans accompanied by gods or sea monsters. In Ptolemy’s *Geography*, which introduced latitude and longitude, the Fortunate Islands (or Isles of the Blessed) where the Greek gods lived was the westernmost land known at the time. Roman Pliny the Elder wrote of the Fortunate Islands in *Natural History* that they “abound in fruit and birds of every kind.” Pliny the Elder put forward the notion that all land animals had an equivalent in the sea. If there were dogs and pigs, so the thinking went, there had to be sea dogs and sea pigs. Aside from these benevolent creatures, malevolent sea monsters were believed to lurk in the sea.

Monsters continued to adorn medieval *mappa mundi*.⁶ Sea unicorns. Giant worms. Enormous lobsters. And, of course, those dangerous sirens, who since Odysseus’s return have lured sailors to shipwreck with their beautiful voices. All of these fantastical creatures appeared on maps from the tenth to the sixteenth century. Then, as European navigators explored and charted the oceans, the sea monsters disappeared from their maps.

Narratives of disappeared islands—referred to as lost lands—took their place.⁷ Lemuria might be the most famous example.⁸ Also known as Kumari Kandam, this cradle of ancient Tamil

3. Plato, *Timaeus and Critias*, trans. Desmond Lee (Penguin, 2008).

4. Thomas More, *Utopia* (Penguin, 2012); Francis Bacon, *New Atlantis* (New Atlantis, 1952).

5. L. Sprague de Camp, *Lost Continents: Atlantis Theme in History, Science and Literature* (1954; Dover, 2012). Ignatius Donnelly, *Atlantis: The Antediluvian World* (Dover, 2011).

6. Chet Van Duzer, *Monsters on Medieval and Renaissance Maps* (British Library, 2014); Joseph Nigg, *Sea Monsters: A Voyage around the World’s Most Beguiling Map* (University of Chicago Press, 2013); Ptolemy’s *Geography*, 150; and Pliny the Elder, *Natural History*, 79.

7. Edward Brooke-Hitching, *The Phantom Atlas: The Greatest Myths, Lies and Blunders on Maps* (Chronicle Books, 2018).

8. Wishar S. Cerve, *Lemuria: The Lost Continent of the Pacific* (Rosicrucian Press, 1935); Sumathi Ramaswamy, *The Lost Land of Lemuria: Fabulous Geographies, Catastrophic Histories* (University of California Press, 2004).

civilization was believed to have rested in the Indian Ocean and to have bridged the African island of Madagascar to the west, India to the north, and Australia to the east in a theory proposed in 1864 by British zoologist and geographer Philip Sclater. Similarly, in the early twentieth century, the British engineer, inventor, and occult writer James Churchward argued that a lost continent of Mu once sat in the central Pacific Ocean, occupying a space that spanned from the Marianas (see Northern Mariana Islands (16) in this atlas) in the west to Rapa Nui (Easter Island) in the east, from Hawai'i in the north to the Kūki 'Āirani (see Cook Islands (31)) in the south.⁹

But the monsters lingered in the Western literary imagination. In Jules Verne's *Twenty Thousand Leagues under the Sea* (1870), Captain Nemo aims to find a mysterious sea monster that has sunk numerous ships.¹⁰ In Daniel Defoe's *Robinson Crusoe* (1719), the eponymous protagonist is a castaway who spends twenty-eight years on an island near Trinidad.¹¹ He encounters cannibals and mutineers. So popular was the book that it launched a new genre about castaways marooned on islands: the Robinsonade.¹² Islands were framed as remote and thus dangerous. William Golding's *Lord of the Flies* (1954) tells of a group of British boys stranded on a desert island. Their attempt to survive does not end well.

In these tales the focus so often is on the explorers. Those who seek gold. Those who hunt whales. Those who mutinied. Those who are marooned. Those who die of thirst, of disease, on tropical islands. Those who freeze to death on Arctic islands. Those who look for the Northwest Passage and never return from the icy terrain. Most characters and protagonists in these tales are men. Few are women. Moreover, when islanders appear at all, they are cast from a colonizer's point of view. The islands are cast as remote. Desolate. Deserted. Too hot. Too cold. Islands empty due to volcanic eruptions. Islands empty because of nuclear testing. Islands that held prisoners. Islands whose creatures have been hunted to extinction.

But there is another vantage point, which follows after a brief excursus into the science.

THE SCIENCE

In 2009, I attended the Copenhagen climate conference, formally the fifteenth meeting of the Conference of the Parties (or COP 15) convened by the United Nations Framework Convention on Climate Change (UNFCCC). While some media coverage concentrated overly on the US-China

9. James Churchward, *The Lost Continent of Mu* (The Brotherhood of Life, 1987).

10. Jules Verne, *Twenty Thousand Leagues under the Sea* (Penguin, 2018).

11. Daniel Defoe, *Robinson Crusoe* (Penguin, 2014).

12. Rebecca Weaver-Hightower, *Empire Islands: Castaways, Cannibals and Fantasies of Conquest* (University of Minnesota Press, 2007).

relationship—that is, the question of whether either nation, as the largest emitters, would take the lead in emissions reductions—the stories shared inside the conference told another story. As nations stood up one by one, individually, and also as part of the UN cluster groups to which they belonged—in UN parlance, the Alliance of Small Island States (AOSIS), the Africa Group, the Least Developed Countries (LDCs), and the Small Island Developing States (SIDS)—they shared information about the ongoing situation in their home countries. Since the UNFCCC takes place annually toward the end of the year, many nations have just weathered the season when cyclones, hurricanes, or typhoons have been most active. After the annual UN climate negotiations, if one is listening to what is being presented by representatives of individual nations and UN cluster groups, one comes away with a visceral sense of climate change impacts worldwide. But one would never know about this larger context if one read the papers.

As to the US and China, many nations believe that the US, given its historical responsibility for producing CO₂ emissions and given its current per capita rates at more than twice China's amount (in 2021: US, 15.53 tons; China, 6.59 tons), should lead the way.¹³ The US thinks China, which is currently the biggest producer of CO₂ emissions, should do so (in 2021: US, 5.00 billion tons; China, 9.04 billion tons).¹⁴ China and other nations often counter that China's CO₂ emissions are high because of the products it produces and ships to the US (per capita rates). That debate continues.¹⁵

So, too, does the increase in CO₂ emissions and thus of global warming and therefore of sea level rise and, in turn, the impacts on low-lying island nations. Climate models take into account both air and water temperature, but much of the discourse on global warming tends to focus on air temperature and on keeping it from increasing more than 2.0°C (3.6°F). Yet Tony De Brum, the late former foreign minister for the Republic of the Marshall Islands, and other island nations advocate “1.5 to Stay Alive” or “1.5 to Thrive.” For many Pacific Island nations—such as the Marshall Islands, which on average sit no more than 2 meters (6.56 feet) above sea level—a 2.0°C (3.6°F) increase would be what they refer to as a “death warrant,” so they advocate a maximum increase of 1.5°C (2.7°F).

Sea levels rise mainly as a result of two factors, each created by global warming. First, increased ocean temperatures lead to thermal expansion: that is, when water heats up, it expands. Warmer

13. Kindest thanks to Lucia Green-Weiskel for helpful exchanges about the US and China with regard to the UN climate negotiations that help inform this paragraph.

14. “Emissions Database for Global Atmospheric Research,” European Commission; “CO₂ Emissions from Fuel Combustion,” IEA Atlas of Energy; “Statistical Review of World Energy 2021,” BP; “Each Country’s Share of CO₂ Emissions,” Union of Concerned Scientists; and “Fossil CO₂ Emissions for All World Countries,” European Commission Joint Research Centre, 2020.

15. See Tina Gerhardt and Lucia Green-Weiskel, “Obama Admin Takes Aim at China’s Renewable Energy Subsidies,” *Grist.org*, December 29, 2010; and Tina Gerhardt and Lucia Green-Weiskel, “Sputnik Moment: Historic Meetings between US and China May Spur a Clean Energy Race,” *Grist.org*, January 17, 2011.

oceans take up more space. Second, melting land ice creates higher sea levels. Land ice includes ice sheets (or glaciers) and ice caps in Antarctica and Greenland. Melting in the cryosphere will add intensely to sea level rise. Greenland alone is estimated to contribute about 20 percent of sea level rise.

The most reliable scientific research to forecast climate change and related global effects, such as sea level rise, comes from the United Nations IPCC. Established in 1988 by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO), the IPCC gathers and reports the science related to climate change and its effects. This science is intended to provide a basis for what in UN speak are called mitigation and adaptation plans. In other words, how does a nation plan to mitigate? That is, to limit climate change impacts? Reduce CO₂ emissions? How does it plan to adapt, for example, to sea level rise? Managed retreat?

The current IPCC report is the Sixth Assessment Report (AR6) published in 2021.¹⁶ The report puts together four different scenarios, ranging from a very low greenhouse gas (GHG) emissions scenario, to a low, to an intermediate, to a very high GHG emissions scenario. On a very high GHG emissions scenario, the IPCC predicts 0.63–1.01 meters (2.06–3.31 feet) of sea level rise by 2100. Under the most extreme emissions scenario, sea level rise could reach 2 meters (6.56 feet) by the century’s end. The IPCC estimates are known to be quite conservative.

In February of 2018, the *Proceedings of the National Academy of Sciences* released a report stating that the melting in Greenland is accelerating and could lead to twice as much sea level rise as previously thought—that is, up from 1 meter (3 feet) by the century’s end to over 2 meters (6.56 feet) by the century’s end. In December 2018, a report published in *Nature* revealed that runoff from Greenland’s ice sheets is about 50 percent higher than preindustrial levels. Also in 2018, a study published in *Nature Geoscience* found that ice sheets in Antarctica are melting away at their base, which had not been detected because it is below the sea surface, and could soon overtake Greenland to become the biggest source of sea level rise.¹⁷ Research conducted by the Institute for Climate Impact Research and published in the *Proceedings of the National Academy of Sciences* in June 2019 stated: “We find that a global total SLR [sea level rise] exceeding 2 m by 2100 lies within the 90% uncertainty bounds for a high emission scenario. This is more than twice the upper value put forward by the Intergovernmental Panel on Climate Change in the Fifth Assessment Report.”¹⁸

Moreover, sea level rise varies by location.¹⁹ For example, according to the California Coastal Commission and its 2018 update *State of California Sea-Level Rise Guidance*, “California will be

16. Intergovernmental Panel on Climate Change, Sixth Assessment Report, August 7, 2021. www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_Full_Report.pdf. Information about the results of the high emissions scenario appears on page 29 of the report.

17. Hannes Konrad, et al., “Net Retreat of Antarctic Glacier Grounding Lines,” *Nature Geoscience* (2018). DOI:10.1038/s41561-018-0082-z.

18. Jonathan L. Bamber, et al., “Contributions to Future Sea-Level Rise from Structured Expert Judgment,” *Proceedings of the National Academy of Sciences* 116.23 (June 4, 2019): 11195–11200.

19. Rebecca Hersher, “Why Sea Level Rise Varies across the World,” *All Things Considered*, NPR, August 20, 2019.

greatly impacted by sea level rise. San Francisco is projected to see a rise between 1.1 [0.33 meter] and 2.7 feet [0.85 meter] by 2050. By 2100, San Francisco could experience between 2.4 and 6.9 feet [0.073 and 2.1 meters] of sea level rise, depending on how strongly we curtail our use of fossil fuels, with a potential for more than 10 feet [3.04 meters] of rise if there is extreme melting of the West Antarctic ice sheet.” As California Coastal Commissioner Donne Brownsey said in an interview, “We don’t have as much time as we think.” Sea level rise is “accelerating. Every year we find out our estimates were too conservative.”²⁰

Tools for checking predicted sea level rise for different locations are available online through Climate Central’s Surging Seas site and the Sea Level Rise Viewer of the US’s National Oceanic and Atmospheric Administration (NOAA). The latter only covers the US and its territories. For that reason, this book generalizes the IPCC data to say 1 foot (0.3 meter) by 2050 and 3 feet (0.91 meter) of sea level rise predicted by 2100. For a handful of islands (particularly those nearest the equator in the western Pacific Ocean), the numbers predicted in the IPCC report are slightly higher due to a combination of factors that will be discussed throughout the atlas. It is important to note that all of the numbers used in this book rest on the conservative end of possible predictions, so the reality of sea level rise could in fact be a lot more grave than what is shown on these maps (for more, see “Mapping Choices” in this introduction).

Climate change is, of course, not merely an issue. It is a framework that encompasses all else. It is the lens through which to see all else. That is, it is food (fish, produce). It is housing. It is health care. It is education. It is employment. It is transportation. Each one of these issues interfaces with global warming. Underpinning this atlas is a question: If climate change necessitates a radical retooling of our economies and infrastructures, why not do so in a way that deals not only with the climate threat but also with social justice, economic justice, and racial justice, in a way that ensures environmental justice. Opportunities to do so appear throughout the atlas.

ISLANDS—WHAT’S YOUR CENTER?

Narrative vantage point is everything. Vacation on an island and you will have one experience. Live on an island and you will have another experience. Being from and living on an island is yet an altogether different thing. And being from an island and being diasporic is yet another thing.

A vacation on the island will doubtless conjure up and confirm the images mentioned at the outset. These are images created and stoked by centuries of travel writing, films, and the tourism industry. “Oh my god! It must be *so* great to live there!” exclaim those who have never visited but have an image fully formed or quickly forming in their head.

20. Anne C. Mulkern, “Local and States Officials Clash on ‘Managed Retreat,’” *E&E News*, July 15, 2019.

Live on an island and you will have another impression. The high cost of food. Why? Because most of it has to be shipped in. On some islands much of the land has been given over to the use of military bases or to tourism, often the two main industries or employers. One realizes the food insecurity when shipments only come in twice a week. Or the island might rely on subsistence agriculture and fishing. What happens to it when the land for the agriculture decreases? When sea surge salinizes the soil, challenging agriculture? When ocean temperatures rise and together with overfishing deplete fish stocks? What happens to food security when a hurricane, typhoon, or tropical storm passes through the ocean?

The high cost of housing. Why? Because housing often sits empty for seasonal tourists either as second homes or as timeshares. Because the occupying military on some islands, such as Hawai'i has run out of housing for its troops and now cuts into and competes on the local real estate market.²¹ But the hourly wage of the locals cannot compete with the housing allowances members of the military receive. The higher cost also results from a limited amount of land on which housing can be built given an island space, compounded by land gobbled up by the aforementioned two industries: the military and tourism.

The high cost of energy bills. Why? Because often the energy source is oil. Even for electricity. Again, it is shipped in. Because the use of fossil fuels tethers an island more to an occupying force. Because many islands do not have the economic resources to transition to renewable energy. The challenge for a just energy transition is often not the technology but the capital. One realizes the energy insecurity.

Being from an island is yet another altogether different thing. It is the aforementioned and more. In terms of housing, in overpriced housing markets, such as Hawai'i, Native Hawaiians and Pacific Islanders constitute a disproportionate number of the homeless.²² In terms of food, one realizes that the food that is shipped in is not as healthy as eating the local fish and produce one's grandparents once did, which would also reduce CO₂ emissions. Obesity rates run high for Pacific Islanders. According to the World Health Organization, of the top ten most obese countries or territories globally, nine are Pacific Islands.²³ Consequently, rates of diabetes are also high among Pacific Islanders.²⁴ One reason: instead of traditional diets of fresh fish, vegetables, and fruits, the diet now consists of canned foods, highly processed meat, and sugary soft drinks.²⁵

21. Brenton Awa, "How the Military Impacts Rent Prices in Hawai'i," KITV, February 23, 2017.

22. Mahealani Richardson, "Count Shows Homelessness Down, but the Number of Unsheltered Homeless Swells," *Hawaii News Now*, May 25, 2019.

23. Meera Senthilingam, "How Paradise Became Fat," *CNN*, May 1, 2015.

24. See the article by Samoan poet Sia Figiel, "Diabetes Took My Teeth but Not My Life," *CNN*, February 21, 2014.

25. See Craig Santos Perez, "Spam's Carbon Footprint," *Prairie Schooner* 90.4 (Winter 2016): 12–16.

One has contributed the least to CO₂ emissions but is disproportionately experiencing its effects. The ten nations globally with the lowest CO₂ emissions are all island nations. An occupying colonial or imperial military power has often decimated the islands. France, the UK, and the US carried out nuclear testing over decades in the Pacific.²⁶ The US conducted a series of nuclear tests on Bikini Atoll in the Marshall Islands (20). The US military used the Hawaiian island of Kaho'olawe and the Puerto Rican island of Vieques as bombing ranges and is currently considering setting one up on Tinian in the Northern Mariana Islands (16).

Islands function as key geopolitical sites for colonial and imperial powers. Currently, the US has more military bases and in more countries than any other nation. According to the Pentagon, the US has an estimated five thousand military bases, of which six hundred are overseas. Many of them are located on (colonized) islands (see the list in the following paragraph). For this reason, the US military has a disproportionate number of Pacific Islanders in it. A high percentage of foreign-born service members are from the Philippines and the Caribbean. Data artist, filmmaker, and app developer Josh Begley sought to map the global distribution of US military bases and to gather satellite imagery of them using Google and Bing Maps.²⁷ Begley's project was inspired by Trevor Paglen's *Blank Spots on the Map: The Dark Geography of the Pentagon's Secret World*, which maps the US government's black holes, secret military facilities, and prisons from Area 51 to Afghanistan, to render visible the previously invisible.²⁸ Begley mapped 650 bases and gathered satellite images for 644 of them.²⁹

The US has at least fifty-two bases or installations on islands: Alaska Aleutian Islands (Eareckson Air Station); the Azores (Lajes Air Base); The Bahamas (Naval Undersea Warfare Center, Detachment AUTEK); Bahrain (Naval Support Activity Bahrain, Naval Regional Contracting Center Bahrain); Diego Garcia (Naval Support Facility Diego Garcia); Cuba (Guantanamo Bay Naval Base); Guåhan (Andersen Air Force Base, Andersen Base, Naval Base Guam); Greece (Naval Support Activity Souda Bay, Crete); Greenland (Thule Air Base); Hawai'i (Joint Base Pearl Harbor Hickam, Pacific Missile Range Facility Barking Sands, Fort DeRussy, Fort Shafter, Kunia Field Station, Pōhakuloa Training Area, Schofield Barracks, Tripler Army Medical Center, Wheeler Army Airfield, Marine Corps Base Hawai'i); Iceland (Naval Air Station Keflavík, NRTF Grindavik); Italy (NAS Sigonella, Sicily; NSA La Maddalena, Sardinia); Japan (Naval Air

26. See Japanese artist Isao Hashimoto's "A Time Lapse of Every Nuclear Explosion since 1945" (www.youtube.com/watch?v=LLCF7vPanrY), which maps 2053 nuclear explosions that have taken place between 1945 and 1998.

27. <http://joshbegley.com/>.

28. Trevor Paglen, *Blank Spots on the Map: The Dark Geography of the Pentagon's Secret World* (Dutton, 2010).

29. Josh Begley, "Mapping United States: How Do You Map a Military Footprint?," 2013. <http://empire.is/>.

Facility Agsugi, Naval Forces Japan, Okinawa; US Fleet Activities Yokosuka; US Fleet Activities Sasebo; Marine Corps Base Camp Smedley D. Butler, Okinawa and nine camps distributed throughout Okinawa; Marine Corps Air Station Futenma, Okinawa; Marine Corps Air Station Iwakuni, Yamaguchi Prefecture; Kadena Air Base, Okinawa Prefecture; Misawa Air Base; Yokota Air Base, Tokyo); the Marshall Islands (Bucholz Army Airfield, Kwajalein Island); Northern Mariana Islands (US Navy plans to build a live-fire range on Tinian); Philippines (Western Mindanao Command, Zamboanga); Puerto Rico (Fort Buchanan, Army National Guard Aviation Support Facility, Camp Santiago, Fort Allen, Roosevelt Roads Army Reserve Base); Seychelles (US Drone Base); Singapore (Logistics Group, Western Pacific); United Kingdom (RAF Alconbury; RAF Croughton, CIA communications hub; RAF Fairford; RAF Lakenheath; RAF Menwith Hill; RAF Mildenhall); and Wake Island (Wake Island Airfield).

In sum, military bases on islands worldwide are pivotal to the US security interests. The US military is well aware of the impact of sea level rise on its navy bases, especially but not exclusively in the Pacific.³⁰ The US Department of Defense (DoD) commissioned a study published in *Science Advances* on April 25, 2018, which found that “more than a thousand low-lying islands risk becoming uninhabitable by the middle of the century—or possibly sooner—because of rising sea levels, upending the populations of some island nations . . . most atolls will be uninhabitable by the mid-21st century because of sea level rise.”³¹

Soaring average air temperatures, rising sea levels, bleached coral reefs, and salinized drinking water will all make it increasingly difficult to conduct military exercises. The US DoD is very concerned about climate change. Since January 2017, twenty-one senior officials at the US DoD have publicly raised concerns about climate change. According to a 2019 brief from the Congressional Research Service, “The Department of Defense (DOD) manages more than 1,700 military installations in worldwide coastal areas that may be affected by sea-level rise.”³² In a nutshell, many islands are impacted not only by sea level rise but also by the legacy of colonialism and by contemporary competing geopolitical interests. This thread runs through *Sea Change: An Atlas of Islands in a Rising Ocean* and applies to most islands discussed.

30. Edward Hunt, “In the Pacific Islands, the Trump Administration Sees Empire, Ignores Climate Change,” *The Progressive*, September 13, 2019.

31. Chris Mooney and Brady Dennis, “The Military Paid for a Study on Sea Level Rise. The Results Were Scary,” *Washington Post*, April 25, 2018; C. D. Storlazzi, et al., “Most Atolls Will Be Uninhabitable by the Mid-21st Century Because of Sea Level Rise Exacerbating Wave Driven Flooding,” *Science Advances* 4.4 (April 25, 2018).

32. See Congressional Research Service, “Military Installations and Sea-Level Rise,” CRS In Focus, July 26, 2019.

OF ISLANDS: UNDOING THE CONTINENTAL GAZE AND RECENTERING ISLANDS

The islands, from their vantage point, share very different stories. What follows aims to decenter colonial discourses, and how they structured notions of place, space, time, and relation, and to recenter islander conceptions of space, time, and relation, following what interdisciplinary scholar Vicente Diaz has called “Archipelagic Rethinking.”³³

Colonizers, whose centers of gravity were continental landmasses, read islands as remote. Islanders dispersed among an ocean or a sea, reading it as the center, deem themselves to be connected. As anthropologist Epeli Hau’ofa, who was born to Tongan parents in what was then the Territory of Papua and who taught in Fiji, has pointed out: “There is a gulf of difference between viewing the Pacific as ‘islands in a far sea’ and as a ‘sea of islands.’ The first emphasises dry surfaces in a vast ocean far from the centres of power. When you focus this way you stress the smallness and remoteness of islands. The second is a more holistic perspective in which things are seen in the totality of their relationships.”³⁴ As historian Paul D’Arcy has argued, colonization—and its territorial carving up of the Pacific and replacement of existing structures with new institutions—often defined islands as isolated spaces.³⁵ Yet this reading erases from view, as Hau’ofa has pointed out, the relations *among* Pacific Islanders that inform both the real and the imaginary.³⁶ These relations are evidenced, as literary scholar Teresa Shewry has underscored, in “myths and legends,” shared linguistic roots, and “material histories[,] such as exploration, migration, kinship and tracing.”³⁷ “Theorists, such as Epeli Hau’ofa and Albert Wendt,” Shewry writes, flip or undo “the European tendency to isolate the land from the sea, using the term *Oceania* to connect the sea, islands and all their life.”³⁸

Given colonialism’s hegemony, in discourses that shaped historical, cultural, and geographic narratives, this framing of islands as remote and isolated versus connected across an ocean has had lasting impacts. So *Sea Change: An Atlas of Islands in a Rising Ocean* aims to make visible not only the impacts of sea level rise on islands but also the relations evidenced by material histories of ocean voyaging, shared histories, linguistic roots, myths and legends, stories and poems, thereby (re)connecting the sea, the islands and all their life, human and nonhuman.

33. Vicente Diaz, “Voyaging for Anti-colonial Recovery: Austronesian Seafaring, Archipelagic Rethinking and Remapping of Indigeneity,” *Pacific Asia Inquiry* 2.1 (Fall 2011): 21–32.

34. Epeli Hau’ofa, “Our Sea of Islands,” *We Are the Ocean: Selected Works* (University of Hawai’i Press, 2008), 27–40, 31.

35. Paul D’Arcy, *The People of the Sea: Environment, Identity, and History in Oceania* (University of Hawai’i Press, 2006), 168.

36. Hau’ofa, 31.

37. Teresa Shewry, “Hope in the Poetry of a Fractured Ocean,” *Hope at Sea: Possible Ecologies in Oceanic Literature* (University of Minnesota Press, 2015), 84–113, 98.

38. Shewry, 203fn21. See also Albert Wendt, “Towards a New Oceania,” *Writers in East-West Counter: New Cultural Bearings*, ed. Guy Amirthanayagam (Macmillan, 1982), 202–215.

Additionally, a low proportion of the world population lives in the vast region of the Pacific Ocean. As Henry Kissinger famously quipped about the forced relocation of residents of Bikini Atoll in the Republic of the Marshall Islands to make room for the US military's nuclear testing on their home island: "There are only 90,000 people out there? Who gives a damn?"³⁹ Charles de Gaulle had similarly once derided the size of the Antilles in the Caribbean Sea when viewed from a plane above as "dust-specks on the sea." Population density or size therefore becomes a way of creating hierarchies between regions, be they continents and islands, or, on continents, between urban and rural regions.

In American Studies, scholars have worked to undo what I call the "continental gaze." As scholars Brian Russell Roberts and Michelle Ann Stephens have pointed out in "Decontinentalizing the Study of American Culture," their introduction to *Archipelagic American Studies*, "every grade-schooler in the United States is taught to view President Thomas Jefferson's 1803 Louisiana Purchase as a landmark event in 'US history' one that, as the narrative goes, doubled the size of the United States." But this commonplace knowledge, they argue, pales in comparison to the "seldom discussed Cold War instigation of a US trusteeship in Micronesia, which more than doubled the size of the United States in terms of total land and water area, thereby constituting a massive geographical grounding for it [the US] as the dominant Pacific power."⁴⁰ Too often on the mainland, the US's borders are thought to end at the western edge of the continent, or, to take an ocean perspective, the eastern edge of the Pacific Ocean, which overlooks the territories that stand in different relationships to the US and that are located in the Pacific Ocean, such as Guåhan/Guam, the Northern Mariana Islands, Hawai'i, the Marshall Islands, and American Samoa. The cover of Daniel Immerwahr's *How to Hide an Empire: A History of the Greater United States* shows well how US territories—the islands and archipelagos that the US is currently occupying—are hidden from consciousness. (See the terms *territory* and *terripelago* in the glossary.)

In their introduction Roberts and Stephens also call into question the standard reading of both continents and oceans. Drawing on Martin W. Lewis and Kären E. Wigen's *The Myth of Continents: A Critique of Metageography*, they write:

In this study, Lewis and Wigen unsettle readers' easy acceptance of "the standard seven-part continental scheme employed in the United States," convincingly arguing that "a sophisticated understanding of global geography [can] be reached" only after abandoning traditional geographical models and recognizing, at the most basic level, that "the division between Europe and Asia is entirely arbitrary," that in common parlance the area referred

39. W. J. Hickel, *Who Owns America?* (Prentice-Hall, 1971), 208.

40. Brian Russell Roberts and Michelle Anne Stephens, "Introduction: Archipelagic American Studies: Decontinentalizing the Study of American Culture," *Archipelagic American Studies* (Duke University Press, 2017), 1–56, 1.

to as “Africa begins south of the Sahara Desert,” and that North and South America’s separation has been only putative, with “little importance for either social history or the animal and plant kingdoms.”⁴¹

Roberts and Stephens highlight not only that Lewis and Wigen unsettle the division of the globe into seven continents and the focus on them but also that Lewis “[i]n his essay ‘Dividing the Ocean Sea,’ further demonstrates that how we see the oceans—organized as discrete units into separate ocean basins in relation to their adjacent continents—is also culturally constructed and historically contingent.”⁴² The separation of the oceans and the focus on their relation to nearby continents are constructs, historically and culturally.

Shifting from the continents and the oceans to discuss islands, Roberts and Stephens argue that islands, too, are historically and culturally contingent. That is, they write, “what we are describing is a push and pull between *the metaphoric and the material*, in which the concept of the archipelago serves to mediate . . . humans’ cultural relation to the solid and liquid materiality of geography.” Parallel to the argument made by Roberts and Stephens that the archipelago exists somewhere in the push and the pull between the metaphoric and the material, Elizabeth DeLoughrey, among others, has argued that islands upend the artificial Western dichotomy between nature (material) and culture (metaphoric).⁴³ Indigenous worldviews undo this artificial division. For this reason, the texts that follow in this atlas weave together the material and the metaphoric.

The continental gaze not only blocks islands from view (think of the islands, such as Hawai‘i, when it is included, seated at the side table of the US continental map) and thus impedes a more robust knowledge about islands but also about the push-pull between their repetition and differentiation. “Continentalism,” as Roberts and Stephens put it, “has also stymied general acknowledgment of the Caribbean as an archipelago of jolting geopolitical diversity, with multiple political affiliations (in addition to independent nation-states, we see affiliations with the Netherlands, the United States, Britain, France, the European Union, etc.)” and “mediated,” they add, by a range of governmental forms, including “territory, department, protectorate, municipality, commonwealth, and others.”⁴⁴ Similarly, in the Pacific, affiliations, if you will, exist with France, New Zealand, and the United States. To undo the focus on the continent and to acknowledge *the relations among* while recognizing *the diversity between* seems to be the challenge.

41. Roberts and Stephens, 6. Martin W. Lewis and Kären E. Wigen, *The Myth of Continents: A Critique of Metageography* (University of California Press, 1997), 3.

42. Roberts and Stephens, 6–7 (emphasis added), citing Martin W. Lewis, “Dividing the Ocean Sea,” *Geographical Review* 89.2 (1999): 188–214.

43. Elizabeth DeLoughrey, Renée K. Gosson, and George B. Handley, eds., *Caribbean Literature and the Environment: Between Nature and Culture* (University of Virginia Press, 2005).

44. Roberts and Stephens, 39.

In the Caribbean, Martinique poet, writer, and literary critic Édouard Glissant in an opening epithet to his volume *Poetics of Relation*, touches on this issue of the differences between but commonalities among islands, creating the term “unity-diversity” to describe it: “Evolving cultures infer Relation, the overstepping that grounds their unity-diversity.” Importantly, Glissant put forward the concept of “relationality” or interdependence to think through the connected sense *among* islanders, while attendant to the differences. Furthermore, Glissant highlights three forms of relation, which he states are also forms of resistance, actively being engaged in Martinique: “relationship with the natural surroundings, the Caribbean; defense of people’s language, Creole; protection of the land, by mobilizing everyone. Three modes of existence that challenge the establishment . . . , that do . . . link . . . to an ecological vision of Relation.” Cuban novelist and literary critic Antonio Benítez-Rojo suggests a very different notion of this push-pull between shared affinities and differences among Caribbean islands when he proposes the term “repeating islands.” He argues that while islands in the Caribbean have different colonial histories, ethnic groups, languages, cultures, and so on, out of this discontinuous range emerges “an island” that repeats itself: one marked by paradoxes.⁴⁵

An island-focused perspective—that is, one centered on an island and radiating out from it—differs dramatically, historically, politically, culturally, linguistically, and environmentally. Oceanic voyagers navigated the great Pacific Ocean, the *moana nui*, without the use of magnetic compasses to determine direction; without the use of sextants to measure the distance between a celestial body and the horizon; and without longitude, which presupposes the Greenwich Meridian. Instead, they steered by the stars and kept course by reading the sun, the swells, and the shifts in the wind patterns.⁴⁶ The Marshallese created stick charts to map ocean swells. They used the presence of birds (such as terns and noddies, boobies and frigatebirds) and clouds (their color, brightness, and shape) to determine their proximity to archipelagos and islands.⁴⁷ They designed a sidereal compass to divide the horizon into points and map where the stars rise and set. So it is not only about decentering the “continental gaze” and recentering islands but also about decentering the human and recentering the relationships among the human, the nonhuman or more than human, the animals on land, in the sky, and in the waters, and the land, air, and waters themselves.

What I have missed most in atlases of islands are the voices of islanders. They share stories every day in a variety of media about their history and culture, and how it is imperiled by sea level

45. Édouard Glissant, *Poetics of Relation*, trans. Betsy Wing (University of Michigan Press, 1997), xxi, 145–146. Antonio Benítez-Rojo, *The Repeating Island: The Caribbean and the Postmodern Perspective* (Duke University Press, 1997).

46. David Lewis, *We, the Navigators: The Ancient Art of Landfinding in the Pacific* (University of Hawai‘i Press, 1972), 82–136.

47. Lewis, 195–223.

rise. In Kathy Jetñil-Kijiner’s poem “Tell Them” (at the end of this introduction), she speaks of a package she sends from the Marshall Islands to the US. The poem navigates, as Jetñil-Kijiner and diasporic islanders so often do, the distance, journey, and path from the islands to the continent and back. It also opens the eyes of continental land dwellers to the plight of the Marshall Islands.

MAPPING CHOICES

Sea level rise is not a line on a map. Neither the sea level nor the land is static. Moreover, it is better to think of the zone of their interface as one of inundation. That is, even what seems like a small amount of sea level rise and an island that does not show up as underwater on, say, the “Risk Zone Map” of Surging Seas or other online mapping sites might mean that an island has been rendered uninhabitable. When storm surges flood, they often salinize freshwater aquifer lenses. Many islands rely on rainwater and freshwater lenses for their drinking water. For example, Majuro, the main atoll of the Marshall Islands, relies on a freshwater lens for 60 percent of its freshwater. Storm surge impedes access to freshwater, rendering the water undrinkable and useless for crop irrigation.⁴⁸ Storm surges can also be life-threatening, and for this reason hurricane public advisory bulletins include not only hurricane warnings and watches and tropical storm warnings and watches but also storm surge warnings and watches.

If one envisions a simple line rising, one is using a bathtub model, which is a passive model.⁴⁹ This model overlooks active changes in ocean dynamics. For example, it does not take into account inland flooding (flooding because the mean level of the water table echoes that of sea level—e.g., at high tide or due to sea level rise), seasonal wave inundation (from swells, a series of long period waves that are generated from distant storms and that impact Hawaiian shores on a seasonal basis), coastal erosion, storm surge, and wind. Higher waves coupled with storms, king tides, or winds can reach further inland, which is called overwash. Wave overwash can inundate the freshwater supplies. In 2012 scientists explaining the model stated that “some islands will become uninhabitable long before they are submerged. Some islands will be destroyed up to 10 times faster than current models project.”⁵⁰ The reason? The passive or bathtub model.

King tides are a good way to get a sense of possible future sea levels and their impacts. King tides take place during a full moon in the spring months and during a perigee when the moon is

48. This issue is also cropping up on the continental US: see Sarah Kaplan, “Saltwater Intrusion: Rising Seas Are Poisoning North Carolina’s Farmland,” *Washington Post*, March 1, 2019.

49. I thank Chip Fletcher, School of Ocean and Earth Science and Technology, University of Hawai’i at Mānoa, for exchanges about the bathtub model and its pitfalls.

50. Jessica Shugart, “New Model of Sea Level Rise Accounts for Splash in the Bath,” AGU Blog, December 5, 2012.

closest to the earth, so that the tides are highest. During king tides we can get an idea of what a rise in sea level of a few inches to about one foot might look like in our communities. If this rise were coupled with a hurricane, tropical storm, or cyclone, with floods or storms, the higher water level could inundate further than models predict. In 2010–2012, the California King Tides Project was launched through a partnership of federal and state agencies and nonprofit organizations. It encourages citizen science. That is, during king tides, people are encouraged to document the rising tide along the shoreline through photographs and upload them to a site that aggregates the information.⁵¹ Now, a global network of king tides exists.

Not only is the water more dynamic, the islands are dynamic, too. There are vanishing islands, which appear at low tide and vanish at high tide. There are tidal islands, which are connected to the mainland by a natural or human-made causeway that is submerged at high tide. There are also ephemeral islands, which include floating objects, such as a “multi-species floating seaweed clump.” The floating objects can range from small entities, such as plastic micro-litter, plant seeds, and volcanic pumice, to large items, such as whale carcasses and tree limbs and trunks.

Sea level rise is not only a story of oceans but also one of geology.⁵² The geologic matter of the island is key. There are high, volcanic islands and low, coralline atolls. The coralline atolls and limestone islands, such as the Florida Keys, will be, by and large, much more impacted than volcanic islands. In the case of atolls, they are low-lying. In the case of limestone, it is porous. Nevertheless, volcanic or high islands will also be impacted. If, due to the mountains, there is a higher population density along the shoreline, it and infrastructure (such as power plants, water treatment facilities, roads and airports) will be affected. If the economy is highly reliant on tourism, and the beaches erode, it will be impacted.

Natural barriers, also referred to as soft engineering, to protect the shoreline exist. Oyster reefs, coral reefs, and mangroves provide protection against storm surge, but each one is affected by global warming. Coral reefs form a crucial barrier around islands against sea level rise: they break waves as they reach the island, thus reducing waves’ impact. Additionally, they form a pivotal habitat for fish and other marine life. The ocean’s absorption of CO₂ emissions and ocean temperature increase lead to the bleaching of coral reefs. While they can, if given the opportunity, recover, consistent and increasing CO₂ emissions lead the reefs to die off. Oyster reefs are to the temperate zone what coral reefs are to the tropical regions: they protect shorelines. Globally, 85 percent of oyster reefs have been lost. Mangroves grow in dense thickets along tidal estuaries, salt marshes, and on muddy coasts. They are extremely important to coastal ecosystems. Physically,

51. California King Tides Project, 2010–12. www.coastal.ca.gov/kingtides/.

52. Rosemary Gillespie and David A. Clague, *Encyclopedia of Islands* (University of California Press, 2009), 258–259. Thanks to Chip Fletcher for discussing geology with regard to sea level rise with me.

they serve as a buffer between the land and the ocean, protecting shorelines from damaging winds, waves, and floods and also reduce coastal erosion. An increase in coastal development, altered land use, and saltwater intrusion has led to a decline in global populations of mangroves. (See glossary.)

Artificial strategies, also referred to as hard engineering, for addressing sea level rise range from building seawalls or revetments to constructing artificial islands or floating cities.⁵³ Seawalls are a strategy for addressing sea level rise by building an armor to defend against the water's incursion. But seawalls cannot stem sea level rise, which can go over or around or, in the case of porous geologies, under. Furthermore, studies have shown that when the saltwater goes around the walls, it intensifies erosion. Revetments are walls built parallel to a shore to catch or break the impact of waves and protect the shoreline from erosion. Most recently, plans to build artificial islands that raise an island above predicted sea level rise have been put forward. They are under discussion in the Maldives (12), the Marshall Islands (20), and Kiribati (21).⁵⁴

Managed retreat has been discussed as a strategy for addressing sea level rise by moving infrastructure and humans inland from areas threatened by or already experiencing inundation. "Managed retreat—the purposeful, coordinated movement of people and assets out of harm's way—is a controversial and often overlooked adaptation tool but also a potentially transformative one," writes climate change adaptation scholar AR Siders. "In the United States," Siders continues, "managed retreat has occurred primarily through federally funded property acquisition programs that are unlikely to be able to scale to meet the future demands of climate change."⁵⁵ US federal agencies include the Federal Emergency Management Agency (FEMA) as well as state and local government administered or funded programs.⁵⁶ At the state level this approach is being explored by, among other state programs, the California Coastal Commission, by the State of Hawai'i Office of Planning, and in New Jersey by the Blue Acres Buyout Program.⁵⁷ When "managed retreat" is suggested, it is often a contentious proposition and questions about it abound. Will private property be seized? Who has the decision-making power? Who will foot the bill? Will private property owners be bought out? By a federal agency? Or the state? Or cities? That is, by other taxpayers? Aside from the institutional, bureaucratic, financial, and practical concerns, what are the social and cultural impacts of managed retreat? In the US the residents of Sarichef Island (2) in Alaska have voted to relocate. The residents of Lennox Island (3) are making plans to move from

53. Wade Shepard, "Waterworld? Floating Cities Turn Hollywood Sci-Fi into Reality as Sea Levels Rise," *Forbes*, October 23, 2019.

54. Giff Johnson, "Marshall Islands President Says Atolls Must Raise Islands to Survive Sea Level Rise," *Marianas Variety*, February 25, 2019.

55. AR Siders, "Managed Retreat in the United States," *One Earth* 1.2 (October 25, 2019): 216–225.

56. Katharine J. Mach, Caroline M. Kraan, Miyuki Hino, AR Siders, Erica M. Johnston, and Christopher Field, "Managed Retreat through Voluntary Buyouts of Flood-Prone Properties," *Science Advances* 5.10 (October 2019).

57. Andrew S. Lewis, *The Drowning of Money: A Forgotten Community's Fight against the Rising Seas Forever Changing Coastal America* (Beacon Press, 2019).

the island. In the Pacific, residents of Lateu, a village in Vanuatu (23), were relocated. In Kiribati (21) the village of Tebunginako on Abaiang was abandoned and relocated. In 2012 when Anote Tong was president of Kiribati, he bought land on Vanua Levu, Fiji (26), in case his people need to migrate in the future, coining the phrase “migration with dignity.” But this decision is fraught, as Fiji itself is relocating communities due to sea level rise.

In 2012, Ioane Teitiota, a Kiribati national, applied for asylum in New Zealand as a climate refugee, citing specifically sea level rise. His application was denied. He appealed the decision. The Supreme Court of New Zealand denied his appeal on the grounds that although climate change is impacting Kiribati, these changes did not qualify him for status as a refugee. Climate change conditions are not included in the 1951 United Nations Convention Relating to the Status of Refugees. Discussions are afoot, however, to have it included.

When it came to mapping sea level rise, cartographer Molly Roy and I considered a couple of approaches. Does one show the impact best by stacking on top of one another the layers of changing island outlines over time, differentiated by colors? Or does sea level rise show up more vividly by separating the coastline in the present, in 2050, and in 2100 into three distinct panels, revealing an island’s shrinking size over time (see map, p. 19)? The answer depends on the nature of the island: its geography and topography, its geology, and its impacted infrastructure. A lower-lying island will be more fully inundated than a mountainous island, so the impact across the whole island can be seen visually when split out into separate panels. For mountainous islands, where less area will be inundated but coastal infrastructure will be heavily affected, we’ve stacked the separate layers on top of one another.

To find the most up-to-date data for all islands proved to be a challenge in many cases. LiDAR (3-D laser scanning) and drone technology are currently the most state-of-the-art ways to collect information to produce a digital elevation model (DEM), which is the basic model from which we derive sea level rise maps. These technologies have been implemented only more recently in the wealthier, data-rich nations (the United States and Canada being two examples), which, however, leaves smaller, poorer island nations in need of quality data. This information gap between the so-called first and third world nations, or the Global North and the Global South, pushed us to figure out how best to map sea level rise for this atlas. Where high-quality LiDAR and drone models were lacking, we turned to a combination of the most current close-up satellite imagery we could find, local island government reports, printed topographic maps, older satellite-based DEM data, and academic science articles on particular islands.⁵⁸

58. Please note that the maps shown within this atlas are not intended to provide local regions and policy makers with the tailored information they need to understand and respond to the risks of sea level rise and coastal flooding. As is general best practice, local detail should be verified by consulting additional sources tailored to specific regions.