



In Anticipation of Extirpation

How Ancient Peoples Rationalized and Responded to Postglacial Sea Level Rise

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Abstract As concern about sea level rise grows and optimal solutions are sought to address its causes and effects, little attention has been given to past analogs. This article argues that valuable insights into contemporary discussions about future sea level rise can be gained from understanding those of the past, specifically the ways in which coastal peoples and societies reacted during the period of postglacial sea level rise. For much of the Holocene, most continental people eschewed coastal living in favor of inland areas. In many places large coastal settlements appeared only after the development of polities and associated crosswater networks. Postglacial sea level rise affected coastal living in ways about which we remain largely ignorant. Yet, millennia-old stories from Australia and northwest Europe show how people responded, from which we can plausibly infer their motivations. Stories from Australia say the people have succeeded in halting sea level rise, whereas those from northwest Europe indicate that people have failed, leading to the drowning of coastal cities such as Ys (Brittany) and Cantre'r Gwaelod (Wales). This distinction is explained by the contrasting duration of postglacial sea level rise in these regions; around Australia, sea level stopped rising 7,000 years ago, while along many coasts of northwest Europe it has risen unceasingly since the last ice age ended. The nature of past human and societal responses to postglacial sea level rise holds important insights for the future.

Keywords ancient stories, oral traditions, traditional knowledge, sea level rise, postglacial period, risk response, climate risk

Along many of the world's coasts today, people struggle to rationalize and cope with the effects of rising sea level. For some such people, the investment of time and resources that they and their ancestors have put into establishing a home on the coast even appears to justify denial of sea level rise.¹ For others, unable to deny the evidence of their eyes, rationalizing what is happening often leads to indignation and appeal, be

1. Connor, "Natural cycles" in lay understandings of climate change; Jacob, *Sea level rise, storm risk, denial, and the future of coastal cities*.

it to God or the state or the global community of nations, to annul this inconvenient problem.² In all cases, anxiety is increasing about the future among many coastal dwellers, especially those who either do not understand climate change and sea level rise or resist localizing their understanding.

Sea level rise is of course not unprecedented in human history, although sometimes this is popularly implied, nor too are its profound impacts on human societies. Yet discussions about how humanity might today and in the future respond to the effects of recent and future sea level rise are often implicitly premised on the idea that there is nothing valuable to be learned from the study of past analogs.³ This article argues otherwise.

At the end of the last ice age (Last Glacial Maximum), land ice began melting and forced a rise in global sea level by a net 120 meters on average between about fifteen thousand years ago and the present that led to changes to coastal geography to which many human groups had no choice but to adapt. At times, sea level rise was much faster than its long-term postglacial average, something that may have required accelerated (perhaps truly transformational) human adaptation in places.⁴

Adaptation is a term that has entered the global lexicon of environmental exigency, an idea often portrayed as a novel response to a novel challenge. Of course it is neither. In the same vein, climate scientists today talk about various grades of adaptation, the ultimate being transformational that requires a fundamental realignment of the way in which a particular group of people live. Again, transformational adaptation is far from unprecedented in human history but often spoken about as though it is.⁵

While much research has focused on the effects of postglacial sea level rise on human systems, very little has addressed the issue of what the people affected thought about it. How did they rationalize what was happening? How did they respond? Were they simply reactive or did they respond to it in ways that might today be described as proactive or anticipatory? Did they seek to mitigate what they understood as the causes of sea level rise, much like humanity strives to do today, or were they passive in their acceptance of the situation?

In some places, there is now sufficient information to be able to answer these questions, something that gives us insights into how we as a species view our place in the world. Such knowledge could be helpful to understanding how we might rationalize and respond to contemporary and future climate changes, especially as these affect the world's coasts during the next few decades.

2. Ambrosio-Albala, *Understanding climate change perception*; Levin, *Overcoming the tragedy of super-wicked problems*.

3. Church and Woodworth, *Understanding Sea level Rise and Variability*; Mengel et al., "Future Sea Level Rise."

4. Berger and Guilaine, "The 8200 Cal Bp Abrupt Environmental Change and the Neolithic Transition."

5. Fazey et al., "Transformation in a Changing Climate"; Saxena, Qui, and Robinson, "Knowledge, Attitudes, and Practices of Climate Adaptation Actors."

Ancient Coastal Living

Coastlines have not always have been in such great demand as places to live as they are in many parts of the world today. In the ages before the aesthetic and recreational attributes associated with coastal living became widely acknowledged, coastal settlements were so located for largely functional reasons. In situations where over-water trade was important, it made sense to locate major markets and, by default, their supporting urban contexts, as close as possible to navigable water: a tendency that explains why many coastal megacities with ancient foundations are today disproportionately exposed to climate change. Even further back in the histories of particular places, once people realized the potential for relatively easy food acquisition and production along coasts, it was understandable that population densities increased there. On many coasts today, the legacy of this has been coastal-resource depletion and overpopulation, both of which are demonstrably liable to be accelerated by future climate-driven sea level rise.

In most parts of the world for much of the postglacial period, coastal living was not a sustainable long-term option owing to the effects of sea level rise. It is not to say that this was not repeatedly attempted in many places but only that humans generally shunned coastal living, often adapting during this period (as earlier) with livelihoods involving nomadism in largely inland (or coastal-hinterland) contexts. For example, for most of the sixty-five thousand years or so that people have been in Australia, they have been mobile, most practicing circumscribed nomadism, and sustained almost exclusively by inland (nonshoreline) environments.⁶

In places where nomadism first gave way to sedentism—for example in Eurasia, Central America, and East Asia four thousand to eight thousand years ago—few of the earliest settlements were coastal, in terms of either their location or as defined by routine interactions between their inhabitants and coastal food-producing systems. Most such villages (or towns and cities) were located in areas of nascent agriculture, where food production had become sufficient to sustain nonproducers. Only later, when cross-water trade networks and alliances became essential to the development and maintenance of polities did coastal settlements of equivalent size and importance start to appear.⁷ In many nonurban contexts at the time, the coast was not embraced by inland societies to the extent it is today. For example, as Barry Cunliffe demonstrated, along the Atlantic façade of northwest Europe, until even a millennium or so ago, coastal peoples often kept themselves apart from their inland neighbors, developing a community of coast that straddled national and land borders and which was bound by shared experience.⁸

6. Williams et al., “A Continental Narrative”; Williams et al., “Sea Level Change and Demography.”

7. Pennington, Bunbury, and Hovius, “Emergence of Civilization.”

8. Cunliffe, *Facing the Ocean*.

The situation was different on islands, where size and accessibility often limit opportunities for livelihood diversification compared to larger landmasses. Certainly on smaller islands, there was little alternative to coastal settlement. Indeed it is plausible to suppose that the drive by people to settle larger islands, especially those considerable distances off continental coasts, may itself have been driven by the effects of postglacial sea level rise along continental fringes and the resulting coastal squeeze.⁹

In summary, during the early Holocene (six thousand to ten thousand years ago), many people interacted with coasts but few groups established coastal-tethered sedentary communities in near-shoreline locations. Later, perhaps 6,000 years ago in many places, such communities did become established along coasts and within a few millennia had become key to the networks that underpinned the development of complex societies (civilizations) in most parts of the world.¹⁰

Postglacial Sea Level Rise and Its Impacts on Coastal Peoples

Along most of the world's coasts, postglacial sea level rise (totaling 120–125 meters on average) lasted from about fifteen thousand to six thousand years ago, since which time sea level has varied only within 1–2 meters of its present level. The situation is quite distinct—something key to the arguments in this article—along many coasts in northwest Europe where sea level *continued* rising after six thousand years ago up to the present. These coasts have thus experienced unbroken submergence since the last ice age whereas almost everywhere else this ended some 6,000 years ago.

While the overall rate of postglacial sea level rise during the late Pleistocene and early Holocene averaged perhaps ten millimeters per year, there were short-lived periods of both reversal (sea level fall) and accelerated rise. Among the latter, the best-studied is probably the effects of the rapid emptying of Lake Agassiz-Ojibway into Hudson Bay eighty-two hundred years ago, which, as an example, is thought to have led to an almost-instantaneous sea level rise of as much as 1.2 meters along the coasts of the Gulf of Mexico, notably the Mississippi Delta.¹¹

Yet even average rates of postglacial sea level rise during the early Holocene had significant impacts on coasts. For example, it has been estimated that during this period along the lowest-lying coastal margins of northern Australia, the shoreline moved landward by as much as 1.5 kilometers a year or more.¹² Not only would this have been noticed by people living in the area at the time, it also is likely to have caused them

9. Nunn, *Climate, Environment, and Society*, 46.

10. Gillis, *The Human Shore*.

11. Tornqvist, "Tracking the Sea Level Signature," 1.

12. The 1.5 kilometers per year figure would apply to a coastline sloping at two degrees along the fringes of northern ice age Australia during the period of rapid sea level rise linked to Meltwater Pulse 1A, when sea level is calculated to have risen sixteen meters in three hundred years; Hanebuth, Stattegger, and Grootes, *Rapid Flooding of the Sunda Shelf*, 1033. A more rapid rate of inundation of five kilometers per year was noted by Flood, *The Original Australians*, 194.

concern. And in the eastern Mediterranean as postglacial sea levels rose, finally overtopping the Bosphorus Sill to pour into the Black Sea Basin, its lowest-lying parts would have been quickly inundated, something that may have prompted rapid widespread out-migration and perhaps even led to the Neolithic Transition across Europe.¹³ It is plausible to suppose that the dramatic flood stories in the Epic of Gilgamesh, the Christian Bible, their antecedents and contemporaries contain echoes of such catastrophic events.

During the early Holocene, huge numbers of (near-) coastal-dwelling peoples would have been displaced by sea level rise, although the evidence—being largely underwater—has proved difficult to isolate and quantify.¹⁴ Two Mediterranean exceptions, from the Carmel Coast and Venice, show how such people's settlements migrated slowly landward in response to sea level rise.¹⁵ Coastal food-producing systems were also incrementally affected by sea level rise during the early Holocene, ranging from evidence for landward migration provided by the pattern of giant shell middens at Muge in Portugal¹⁶ to the backward and forward shifts in East Asian deltaic rice cultivation in response to comparatively minor sea level fluctuations following delta stabilization about seven thousand years ago.¹⁷

All such studies make cogent inferences about the impacts of postglacial sea level changes on humans but are silent about their attitudes toward sea level rise, specifically—to use modern terms—how vulnerable or how resilient these people and their societies may have been. The following section answers these questions.

Anticipating and Avoiding Extirpation: How Ancient Coastal Dwellers Rationalized and Responded to Postglacial Sea Level Rise

Sea level is rising today; it has been for a century or more and will likely do so for the foreseeable future. This knowledge has inevitably created anxiety, particularly for many of today's coastal dwellers, about how they might sustain their lifestyle preferences into the future.¹⁸ For some, sea level rise may even foreshadow the end of the world.¹⁹ During the early Holocene, people could not project future sea level rise as climate modelers do today, but memories of the long multi-millennial history of observed sea level rise—passed on orally—would likely have led to speculation about what might happen in the future. It is plausible to suppose that concern about the continued loss of coastal lands, even the possibility that an entire landmass on which people lived might be

13. Turney and Brown, "Catastrophic Early Holocene Sea Level Rise," 2040.

14. Bailey and King, "Dynamic Landscapes and Human Dispersal Patterns."

15. Benjamin et al., "Late Quaternary Sea Level Changes."

16. Bicho, *The Emergence of Muge Mesolithic Shell Middens in Central Portugal*.

17. Zheng, Sun, and Chen, "Response of Rice Cultivation to Fluctuating Sea Level."

18. Bourque and Willox, "Climate Change."

19. Barker and Bearce, "End-Times Theology."

submerged, created anxiety and spawned discussions about what people could do to prevent such imagined scenarios unfolding. Like today.

Moving beyond conjecture about this ideally requires more tangible data. In recent years, it has become clear that many ancient stories, previously regarded only as legends or myths, may be based on observations of natural phenomena by preliterate peoples.²⁰ Examples come from stories about meteorite falls, about abrupt disappearances of coastal lands, about volcanic eruptions, and about coastal submergence attributable to postglacial sea level rise.²¹ It seems likely that in the right cultural contexts, it is possible for memories of such events to reach us today from as much as ten thousand years ago.²²

Through comparatively rigid systems of transferring a body of knowledge essential to group survival and identity from one generation to the next, Aboriginal Australian societies have preserved memories for millennia, including from the period when Australia was affected by postglacial sea level rise, which ended here about seven thousand years ago. Most of the associated twenty-three groups of stories recount (or can be interpreted as recalling) changes in coastal geography and terrestrial resources forced by rising sea level.²³ Two groups of stories also clearly identify resistance to sea level rise.

Stories from Northeast Australia (Great Barrier Reef Coasts)

The first comes from the Gungganyji Aboriginal people of the Cairns district in northeast Australia where “many tribes . . . have stories recounting how the shore-line was once some miles further out . . . where the barrier reef now stands.”²⁴ The story recalls how the misbehavior of a man named Goonyah caused the ocean surface to start rising but also that he organized efforts to stop this. One version of the story recalls that Goonyah led his people up a mountain where a huge fire was lit in which boulders were heated. These heated rocks were then rolled down the mountainside into the face of the rising waters that “succeeded in checking the flood.”²⁵

Another version of this story was collected by anthropologist Ursula McConnel, who stayed with the Djabuganydji people in the 1930s and reported their story recalling a time when the coral reef was all scrubland and people would hunt and roam all the way out to the edge of the barrier reef.²⁶ Its subsequent inundation was attributed

20. Barber and Barber, *When They Severed Earth from Sky*.

21. Meteorites: Hamacher, “Comet and Meteorite Traditions”; land disappearances: Nunn, *Vanished Islands*; volcanic eruptions: Vitaliano, *Legends of the Earth*; coastal: Nunn and Reid, “Aboriginal Memories of Inundation.”

22. Nunn, *The Edge of Memory*.

23. Nunn, *The Edge of Memory*, chapter 3.

24. Dixon, *The Languages of Australia*, 46.

25. Gribble, *The Australian Aboriginal*, 56–57.

26. McConnel, “The Rainbow-Serpent,” 348.

to the actions of a blue-tongued lizard, an ancestor spirit, but this process was stopped when a man “threw a hot stone into the sea to stop it coming up any further.”²⁷

Yet another version of this story, collected directly by linguist Robert Dixon from indigenous informants in the 1970s, explains the sea level rose across the coast because Gunya (Goonyah) had speared a forbidden fish; the rising sea level displaced people from many different tribes who congregated on the shore. Gunya ascended a hill with some women.

“You two make a big fire! Put *kapamari* stones to heat in the fire, big stones! Heat as many stones as you can in the fire!” Gunya ordered the women. . . . Soon they bombarded the rising sea water with hot stones. . . . The water moved away. . . . The water started to subside, and now lay there peacefully.²⁸

A final published version of this story was collected more recently and recalls that an individual named Damarri “is said to have stemmed the sea level [rise] by getting his off-siders to build many fires along the coast and put *bayngga* (hot rocks) along the water’s edge.”²⁹

The four versions of this story belong to different Aboriginal groups in this part of Australia and plausibly signal a memory of the time when sea level rose slowly across what is now the Great Barrier Reef and its enclosed reef-lagoon complex, a process that halted around seven thousand years ago. The three stories that report the success of the human interventions in halting sea level rise here are therefore likely to date from around this time, when success could indeed be claimed and promulgated through oral traditions.

Stories from Southern Australia (Nullarbor Desert Coasts)

A second group of stories comes from the fringe of the Nullarbor Desert in southern Australia, a coastline marked by a series of high cliffs (fig. 1). One version tells how a wicked old man went through the desert systematically uprooting all the mallee eucalypt trees—on which the Aboriginal peoples occupying the area invariably depended for water—which led to the water contained in their roots pouring into the ocean, causing the sea level to rise: a punishment for the old man’s perversity. Seeing what was happening, the Wati Nyiinyii people rushed to the water’s edge at the base of the cliffs and began “bundling thousands of [wooden] spears to stop the encroaching water . . . these bundles were stacked very high and managed to contain the water.”³⁰

A similar story from the Nullarbor explains that it was feared that the sea flood would spread over the whole country but that it was prevented from doing so by

27. McConnel, “Inspiration and Design,” 53.

28. Dixon, *Words of Our Country*, 94.

29. Willmott and Stephenson, *Rocks and Landscapes*, 21.

30. Cane, *Pila Nguru*, 91.

Figure 1. View of the Bunda Cliffs west of Ceduna along the seaward side of the Nullarbor Desert in southern Australia. Photograph by Bob Brown; used with permission.



interventions from various “bird women” who gathered masses of the dense intertwined roots of the *ngalda kurrajong* tree (probably *Brachychiton gregorii*). They arranged these along the foot of the Nullarbor cliffs to create a barrier that is said to have restrained the oncoming waters, a story told by Sugar Billy Rindjana, Jimmy Moore and Win-gari (Andingari people) and by Tommy Nedabi (Wiranggu-Kokatato people) to Ronald Berndt in 1941.³¹ A third version of this story recalls that only the “prompt action of the birds stopped it [the ocean] from inundating the country completely,” noting that “the rocky coastline and cliffs are the metamorphosed *kurrajong* roots, piled one on top of the other to stop the oncoming waters.”³²

The Nullarbor stories also recall the success of these interventions in stopping sea level rise here. These stories are also explicit about the urgency of people’s responses, whether it is how the Wati Nyiinyii rushed to the drowning coastline or how the situation was saved only through prompt action. The notion that, had these interventions not been undertaken, the land would have been completely inundated belies the anxiety behind the actions articulated in these stories, many more of which are likely to have existed until comparatively recently.

Resisting Ancient Coastal Inundation: Practical and Spiritual Responses

Both groups of Aboriginal stories (above) report that interventions were able to halt sea level rise, which suggests they likely date from the terminal period of postglacial sea level rise in Australia around seven thousand years ago. What they also might show is that the people of the time were alarmed by their (multigenerational) observations of coastal drowning and land loss (from sea level rise) and did indeed fear that the land they occupied and which sustained them might be submerged. They also show that

31. Berndt and Berndt, *The Speaking Land*, 58–59.

32. Berndt and Berndt, *The World of the First Australians*, 401.

people decided to do something practical in response, ranging from burning the sea with heated rocks or building coastal barriers to halt its ingress onto the land. While we have no information about the discussions that led to such practical responses, it seems likely that this was complemented by what might be called spiritual action. These might have been appeals to deities to spare their people or something altogether more difficult for us to readily decipher with hindsight. Yet we have a few clues.

In northern Australia, stone arrangements along the coast that are visible only at low tide may be “associated with ritual control of extreme tidal regimes.”³³ Similar ancient features elsewhere along the Australian coast “imply a recognition and significance of water’s fluidity to the meaningfulness of the sea in past ontologies.”³⁴ They may be legacies from similar spiritually informed efforts to stop sea level rise in earlier times. A comparable interpretation is currently favored for some of the unusually long Neolithic stone rows in northwest France, notably at and around Carnac. Rather than having any practical functionality, as once thought, these stone rows are believed to represent a cognitive barrier that sought to prevent movement between the physical and metaphysical world, specifically (continued) interference with the ocean surface by the divine.³⁵ It is proposed that these stone rows were built around 6500 years ago when the rate of sea level rise accelerated locally.³⁶

The Dilemma of Prospective Island Peoples

For coastal people in the early Holocene, one of the most disruptive effects of postglacial sea level rise would have been the selective drowning of coastal areas, creating islands from what were once mainland promontories. There are many stories that apparently recall this happening in Australia; for example, the Yidiḿḿj Aboriginal name for Fitzroy Island, off the northeast Queensland coast, is *gabar*, meaning the lower arm of a mainland promontory, something interpreted as a memory of a time when sea level was lower and Fitzroy was indeed joined to the mainland.³⁷ Insights are also possible from the behavior of people on offshore islands that were being both reduced in size and having their distance from the closest mainland gradually increased as a result of sea level rise. Examples from Australia are provided by mystery islands, such as 4,405-square-kilometer Kangaroo Island 13.5 kilometers off the coast of South Australia, which were devoid of people when first discovered by Europeans yet which contain numerous indications of having once been home to large numbers of human inhabitants.³⁸

Archaeological research on such islands suggests that their inhabitants were forced to make a difficult choice as postglacial sea level rise was about to cut off their

33. McNiven, “Sentient Sea,” 155.

34. McNiven, “Saltwater People,” 344.

35. Cassen, *Exercice de Stèle*.

36. Baltzer, “Variations du Niveau Marin,” 114.

37. Nunn, *The Edge of Memory*, 86.

38. Tindale, Barnett, and Maegraith, “Traces of an Extinct Aboriginal Population,” 285; Lampert, *The Great Kartan Mystery*.

access to mainland networks.³⁹ Some people evidently chose to leave, abandoning their island homes, while others elected to remain, perhaps unable to survive more than a few generations; a prolonged drought has been invoked to explain this situation on Kangaroo Island.

Where Postglacial Submergence Continued: The Special Case of Northwest Europe

The fact that postglacial sea level rise ended in almost every part of the world by the time cities began to be built in (near-) coastal locations means that there are no records of such cities being affected, even submerged, by rising sea level *except* along those (comparatively few) coasts where sea level continued rising after about six thousand years ago. It is surely no coincidence that these places—effectively only coasts in northwest Europe—are only those from which there are stories about submerged cities (fig. 2). Most such stories come from the coasts of Brittany (northwest France) and the Channel Islands, Cornwall and Wales (UK), all regions where cultural continuity during the last few millennia has been greater than most other parts of Europe where migration and displacement led to repeated cultural turnovers and an associated loss through syncretism of ancient tradition (including stories).

In Breton traditions, stories about the drowned city of Ys, home to King Gradlon, are well known.⁴⁰ Usually associated with the Baie de Douarnenez, the story is that of a city on the coast that was protected from drowning only by a series of sea defences that required gates to be opened at low tide (never at high tide) to allow excess water to drain off the land. One day, the king's daughter, Dahut, possessed by a demon (or otherwise persuaded) opened these gates at high tide, allowing the ocean to flood the city, an event that led to its permanent abandonment. One key detail in this narrative, which otherwise adds nothing to it, is that the city of Ys was already under threat from the sea, given that it had—for its time—probably quite an elaborately engineered system of sea defenses.

Elsewhere along the Brittany coast, there is a number of reported submerged cities and towns, as shown in figure 2. The sheer number of these and the contrasting details of their historical submergence suggest that most refer to places other than Ys. In other words, there are memories of a number of submerged cities along this coast. Memories of submergence also come from that area of the English Channel (La Manche) where the Channel Islands are located. For example, an 1899 book noted how “au temps jadis la Manche n'était pas si grande que maintenant; l'on pouvait aller à Jersey sans rencontrer d'autre obstacle qu'un ruisseau qui n'était pas tres large.”⁴¹

39. Bowdler, “The Bass Strait Islands Revisited”; Rowland, Wright, and Baker, “The Timing and Use of Offshore Islands.”

40. Guyot, *La Légende de La Ville d'Ys*.

41. Translation: “In past times, the [English] Channel was not as broad as it is now; one could go to Jersey [from mainland France] without encountering any obstacle other than a stream which was not very wide”; Sébilot, *Légendes Locales de la Haute-Bretagne*, 23.



Figure 2. Map of part of northwest Europe showing possible locations of submerged cities.

On the northern side of the English Channel, stories about the lost land of Lyonesse abound. Plausibly a distant memory of the submergence of the Scilly Isles by postglacial sea level rise, most stories about Lyonesse place it within the much-deeper area of ocean between the Scillies and the Cornwall mainland where once “there had been woods and meadows, and arable lands, and a hundred and forty parish churches which . . . were submerged by the ocean.”⁴²

Some of the most persistent stories about drowned cities in the United Kingdom come from the coasts of Wales, especially Cardigan Bay where the cities of Cantre'r Gwaelod (and others) are said to have once existed. Similarities in the contemporary renderings of the stories about the appearance and fate of Cantre'r Gwaelod and those of Ys (see above) make it almost certain that details were interchanged at some point(s) during their journeys to us today; in this regard, a key Breton scholar is Hersart de la Villemarqué, who in 1838–1839 was explicitly charged by the French Government to visit Wales “pour étudier la langue et la littérature galloise.”⁴³ Notwithstanding this, Cantre'r Gwaelod and Ys are likely to have been different places. In the same region, stories exist about people having once crossed the Irish Sea from Wales to Ireland, something which would have been possible some 9600 years or more ago. While there is considerable published scepticism about the veracity of these stories, it is here suggested that “the legends of the great inundations” in Brythonic (Breton-Celtic) cultures are indeed ancient stories—far earlier than the culture heroes who feature in them today—and

42. Warner, *A Tour through Cornwall in the Autumn of 1808*, 162–63.

43. “Translation: “To study Welsh language and literature”; Villemarqué, *La Villemarqué*, 40. Also Bromwich, “Cantre'r Gwaelod and Ker-Is,” 234.

plausibly recollections of the impacts of the unusually long postglacial sea level rise in this part of Europe.⁴⁴

Based on this proposition, what can the details in these European stories tell us about what the peoples of these areas thought about sea level rise and how this thinking informed their responses? In many ways, their attitudes and responses seem exactly the same as for Aboriginal Australians (discussed above) in that people in northwest Europe appear to have resisted sea level rise by building—at least at Ys and Cantre'r Gwaelod—structures intended to manage the threat of inundation by the sea. It is reasonable to suppose, by analogy with the history of modern coastal engineering, that such comparatively complex structures (with gates that required to be opened and closed with the tides) were not the earliest responses. It seems more likely that these structures represented the culmination of efforts to address the challenges of rising sea level, implying that by the time the cities were overrun by the ocean, decades (even centuries) had elapsed since sea level rise first became a problem for these cities. It has been estimated that the stories of Ys and Cantre'r Gwaelod are at least 8,750 to 9,000 years old,⁴⁵ and, although there are many uncertainties behind these estimates that make them inherently questionable, they are similar to the ages inferred for Australian drowning stories.

Implications: Contemporary Adaptation and Mitigation through the Lens of the Distant Past

By understanding how peoples in ancient times responded to postglacial sea level rise, whether by building wooden fences or stone walls, we can plausibly infer something about what motivated them to do so. It seems likely that people had observed postglacial sea level rise for some time (across many generations) and that they anticipated and feared this would continue, reducing the amount of land they (coastal tribes) could access. So they decided to respond. In Australia, where sea level rise ended about seven thousand years ago, the stories tell that the responses succeeded. In northwest Europe, where sea level has been rising effectively continuously since the last ice age, these responses did not succeed and entire cities are reported as lost to the rising ocean.

Along many of the world's coasts during the past few decades, the rate of sea level rise has accelerated, something likely to continue for the next few decades. If today we lacked science-informed projections of future sea level rise, it is still likely that humanity—globally and locally—would understand the likelihood of future sea level rise (given our observations during the past two hundred years or so) and would plan for this accordingly. Such a situation can be inferred as having happened during the

44. Bromwich, "Cantre'r Gwaelod and Ker-Is," 241. The essence of her argument is that in such cultures, memories of postglacial sea level rise and its effects on coastal peoples are kept alive by being transferred again and again to new groups of culture heroes.

45. Nunn, *The Edge of Memory*, 151.

flooding of (part of) a populous coastal city such as Manila or Shanghai that spurs national authorities and international bodies into appropriate action. Not to say that action is not being taken, only that—as most climate scientists agree—the action is inadequate.⁴⁶

An analogous situation in the past may be that of the lost city of Dwaraka which existed on the coastal margins of the Saurashtra Peninsula (India) during late Harappan times, perhaps around four thousand years ago. Under the leadership of Lord Krishna, Dwaraka prospered, but according to accounts in the *Mahabharata* it also had an ongoing battle with the ocean that ended with its permanent inundation. A forerunner to Dwaraka was Kusasthali, the drowning of which—a trigger event—may have prompted Lord Krishna to rebuild it as Dwaraka, a place with an engineered (artificial) coastline better able to withstand sea level rise.⁴⁷

In this context, it should be noted that climate change is today a global (trans-boundary) issue that requires, by definition, a united global response. During the early Holocene, perhaps eight thousand years ago, sea level rise (driven by climate change) was also a global issue, but because no one could recognize it as such, it was only ever responded to locally. And the fact that responses were made locally—it is irrelevant whether or not they succeeded—gives us an important lesson for coping with climate change today. This lesson is that the effects of climate change are best responded to locally, something that ensures these responses are optimally effective (because they are based on understanding of local contexts) and sustainable (because it is in local people's interests to sustain these).

To take this argument further, imagine eight thousand years ago that people were dependent—as is the case in most parts of the world today—on permission or assistance from others some distance away before responding to local sea level rise. Imagine too that, so accustomed were such people to waiting for outside assistance that they did nothing to help themselves—at least until it was too late to avoid major impacts. Of course, this did not happen. By default, coastal peoples in the past responded autonomously to sea level rise, yet there are parallels today. Many poorer nations deem themselves dependent on assistance from richer ones for adaptation to climate change. Within the former, many more peripheral areas receive no (or insufficient) help and struggle to rationalize and respond to the problems they are witnessing. This is why encouraging poorer countries to own the issue of climate change is important, as is the empowerment of local communities to autonomously respond effectively and sustainably to the local challenges it poses.

Studying ancient responses to sea level rise can also inform the design of optimal strategies for responding to future sea level rise. Today, coastal communities are often told they can either accommodate the effects of sea level rise, perhaps by building upward; protect vulnerable coasts by constructing artificial structures such as seawalls; or

46. Hinkel et al., “The Ability of Societies to Adapt.”

47. Nunn, *The Edge of Memory*, 163.

retreat. The latter would have been the most common response by nomadic peoples affected by sea level rise during the early Holocene, but later, when coastal cities such as Cantre'r Gwaelod and Ys were threatened by sea level rise, responses shifted to protection. As a long-term strategy, protection failed, as in many places it inevitably will in the future if sea level rises this century and beyond as projected. This underscores the opportunity we have now to develop long-term plans for transformational adaptation rather than continue to design and implement short-term fixes.

Conclusion

This study shows that the situation in which coastal dwellers in most parts of the world find themselves today has ancient precedents—and that the fragmented stories from those times to have reached us today allow insights that could help us adapt. The study's novel use of ancient stories to understand how people in the past may have rationalized and responded to sea level rise is one way around the difficulties of establishing “the extent of impact the rising sea levels had on past societies when much of the archaeological record has been lost, or remains underwater, undiscovered.”⁴⁸

Practical lessons from ancient stories also point toward the potential utility of these in other ways. In reference to sea level change, for example, it is clear that the contemporary desirability of coastal living in many parts of the world is not something that was shared by our distant ancestors, who understood the tenuousness of the practice. Studies from the Pacific Islands, for example, document both the regret associated with the involuntary postcontact movement of settlements from inland to coasts⁴⁹ as well as acknowledgment that people have moved there repeatedly only after memories of the attendant dangers have been lost.⁵⁰

This study shows that future transformational adaptation may be triggered by particular events, how adaptation is optimal when localized and (largely) autonomous, and how long-term plans are preferable to shorter-term ones. The idea that responding to climate-change impacts is something that can be effectively done locally and autonomously is not novel, although no one appears to have appealed to (ancient) precedent to justify its efficacy. Yet, the use of precedent as a way of persuading reluctant decision-makers, especially in poorer-country contexts, to undertake appropriate local adaptation has been increasingly advocated recently.⁵¹ In a similar way, appealing to (ancient) stories to design future ecological adaptive strategies has also been proposed recently.⁵² Such efforts to incorporate lessons from history into plans for the future are likely to improve their efficacy and sustainability.

48. Benjamin et al., “Late Quaternary Sea Level Changes,” 44.

49. Siméoni and Ballu, “Le Mythe des Premiers Réfugiés Climatiques.”

50. Walshe and Nunn, “Integration of Indigenous Knowledge,” 191.

51. Janif et al., “Value of Traditional Oral Narratives in Building Climate-Change Resilience”; Nunn, “Geohazards and Myths.”

52. Smith, “Copying Ancient Woodlands”; Pinkard et al., “A History of Forestry Management Responses to Climate Variability.”

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