CoastAdapt

Case Study

Adapting to sea-level rise in the Torres Strait

Summary

The Torres Strait is a region of national and international significance for its cultural and environmental values. The region faces a number of climate change risks, most notably the impacts of progressive sea-level rise. Coastal erosion and inundation have been pressing issues for a number of communities for many years. This case study examines the process led by the Torres Strait Regional Authority (TSRA) in partnership with state agencies, the Torres Strait Island Regional Council (TSIRC), and researchers to examine coastal risks and develop adaptation responses. Sea-level rise impacts in the Torres Strait extend beyond considerations of infrastructure and planning. For some communities their entire island is at risk with implications for their identity, culture and rights as Traditional Owners.

Keywords

Torres Strait, sea-level rise, erosion, inundation

Context

This case study examines the process led by the Torres Strait Regional Authority (TSRA) in partnership with state agencies, the Torres Strait Island Regional Council (TSIRC), and researchers to examine coastal risks and develop adaptation responses.

The Torres Strait is home to 18 island communities situated on 17 islands in the strait between Cape York and Papua New Guinea (PNG) (see Figure 1). Approximately 7000 people live in the region; the majority of these are Torres Strait Islanders, the Traditional Owners of much of the land and sea territory, and Kaurareg Aboriginal people, the Traditional Owners of the inner islands just north of Cape York.

The region is of national importance for a number of reasons. It is home to a unique Indigenous island culture, it is the only part of Australian territory to border another nation (PNG), it is on an international shipping route, and it plays a strategic role in state and national biosecurity operations. The Torres Strait is of national and international significance in relation to its environmental values: the largest dugong population in the world, largest continuous seagrass meadows in the world, significant population of green turtles, highly diverse and pristine coral reefs that are the northern extreme of the Great Barrier Reef ecosystem, and extensive and diverse mangrove communities.

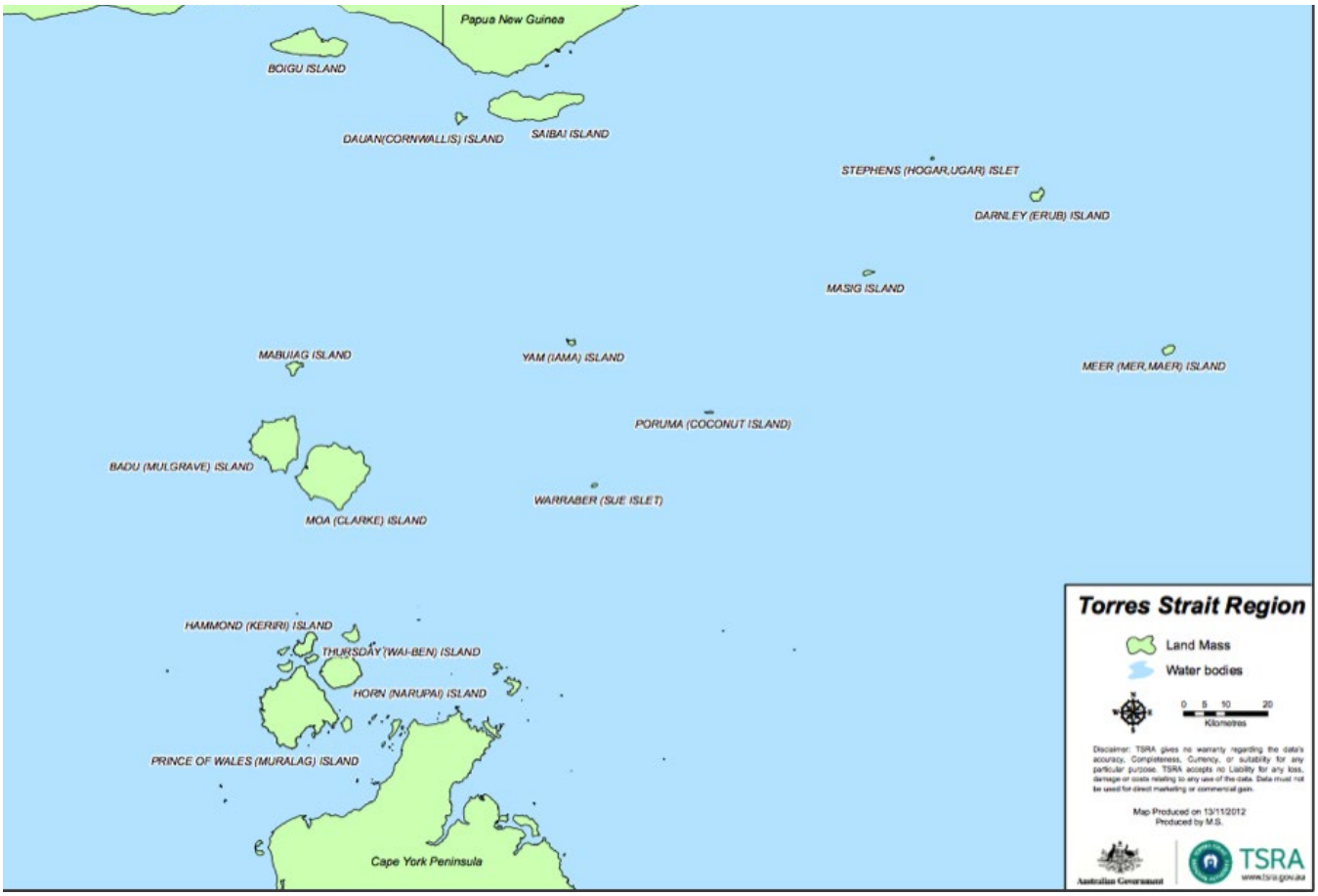

Figure 1: Map of the Torres Strait region. Source: © Torres Strait Regional Authority.

Most of the inhabited islands are fairly small and are divided into four types based on their geomorphology. The western islands are continental remnants of the Great Dividing Range that comprised the land-bridge to PNG. The central islands are mostly coral cays. The eastern islands are volcanic in origin, and the two most northerly islands, Boigu and Saibai, are deltaic alluvial mud deposits over old coral bases.

The region faces a number of significant climate challenges exacerbated by issues of remoteness, Indigenous disadvantage, proximity to impoverished communities in PNG's western province, the low elevation of the cay and mud islands, high coast-to-land-mass ratios for most islands, and many communities being settled in coastal hazard zones.

The region's strengths include, that the local community framework is generally strong and the traditional cultural practices and language are maintained as part of daily life, the region has a very healthy environment and rich marine resources, and cyclones directly impacting the region are rare due to the area's proximity to the equator.

Adapting to coastal hazards

Coastal erosion and inundation have been pressing issues for a number of communities for many years, and rising sea levels are making this situation progressively worse. This case study examines the process led by the TSRA in partnership with state agencies, the TSIRC, and researchers to examine the coastal risks and develop adaptation responses. In 2005 the Land and Sea Management Unit was formed to deliver the Environmental Management Program with the TSRA. The unit was tasked with progressing the work needed to build an understanding of the coastal issues impacting vulnerable low lying communities, and to compile the evidence needed to build a case for government investment in coastal defence options.

In responding to coastal impacts, a community normally has several options available, loosely categorised as accommodate, defend or retreat. However, if a community is situated just above sea level, on a very small footprint of habitable land, on a small island, options are very limited.

These communities do not have the option to move further away from the coast or to higher ground. Given sea levels are estimated to continue to rise over coming decades and centuries, *defend* is essentially an option to buy some time, but is not a permanent solution.

Torres Strait Islander culture (Ailan Kastom), like many Indigenous cultures, is deeply rooted in the connection to land and sea country where that culture developed. Who they are as a people is inherently tied to their island home. Many islanders have over time relocated to mainland Australia, but they maintain their connection to country through their language, cultural practices, and family and friends who still live in the region. Their ancestors are buried on the island and their cultural stories are about the island and their relationship to it. So for everyone to leave the island means that their identity as a people and their unique culture is forever transformed. A second important consideration is that each island through the region has its traditional owners. For people from one community to relocate to another island means they essentially become refugees on someone else's land. So, dealing with coastal impacts in the Torres Strait is not just about adaptation options, it's about cultural identity and survival.

Understanding coastal risks

Following on from the call of local community leaders for assistance to help address ongoing coastal issues, the Torres Strait Coastal Management Committee was established in 2006 to drive research and decision making in relation to local coastal impacts. The then State Department of Environment and Resource Management's (DERM) senior coastal scientist, Sel Sultmann, led a rapid assessment study on coastal dynamics and issues for what were considered to be the six communities most at risk: Saibai, Boigu, Warraber, Poruma and Masig (coral cays), and Iama (continental island).

These reports formed an important foundation for the understanding of coastal issues in the region. Importantly they highlighted the need to address high priority sites and areas where management options were essentially restricted to hard engineering solutions. The DERM officers discussed their results with communities, and community concerns and priorities were included in the summary report.

To provide a more detailed understanding of erosion dynamics on Iama, Warraber, Poruma and Masig, Dr Kevin Parnell (James Cook University) was engaged to assess the movement of sediments and inshore coastal processes on these islands. As part of his work, Dr Parnell held meetings with communities to discuss his findings and explain the consequences of the various potential management options. In collaboration with the community, management plans were drafted which outlined priority sites and preferred management options. An important part of this process was assisting communities to appreciate that hard engineering options, whilst helping to deal with one problem, often result in other impacts elsewhere along the shore, and may have significant impacts on coastal amenity. Dr Parnell's work included sea level mapping to illustrate which areas were most at risk from sea-level rise impacts (see examples in Figures 2-5).

Figure 2: Iama Island: makeshift dwellings located in the path of storm surge events. Photo: © John Rainbird.

Figure 3: Erosion and flooding have been impacting graves such as these on Saibai. A wall has now been built around this cemetery. Photo: © John Rainbird.

Figure 4: Saibai community is sandwiched between swamps and the ocean. Photo: © John Rainbird.

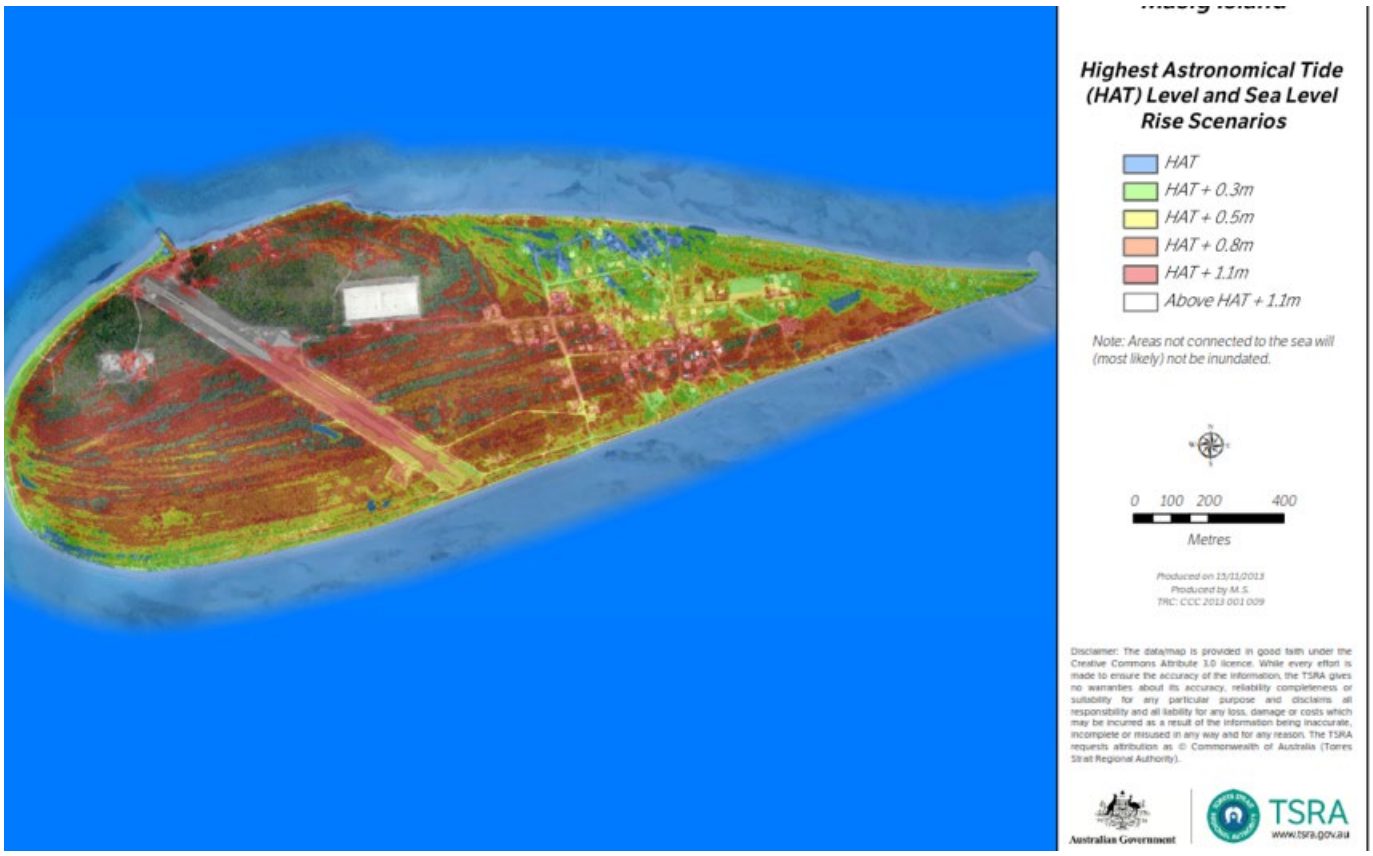

Figure 5: Coastal inundation mapping for Masig illustrates that the community is mostly settled in parts of the island exposed to even the lower end of predicted sea-level rise. Source: © Torres Strait Regional Authority.

Living with tides - Inundation

The two mud islands of Saibai and Boigu are particularly low-lying and flat, and as a result, already deal with tidal inundation on an annual basis (Figure 6). To compound this issue further, the islands are predominantly swampy in nature, with communities restricted to small areas of habitable land on the islands' northern shores. Each year during the spring tides, sea water washes through the communities. Rising tides pump up the water levels in the swamps, leading to still water flooding in from behind communities while tides wash in from the front. This means flood defences are needed behind the community as well. However, this leads to new drainage risks where communities are walled in on all sides, potentially creating a pond for torrential rain events that coincide with spring tides. Depending on the weather conditions at the time, flooding ranges from still water creeping through people's gardens and across roads, through to battering waves and water a meter deep. However one thing is guaranteed, with every spring tide the water comes into the community.

Salt water flooding has a range of consequences for communities. Besides its corrosive impacts on people's homes and possessions, the salt water infiltrates waste treatment plants through the sewerage system, disrupting the microbial processes and requiring the plant operators to reboot the system. Through this process raw sewage is discharged into the waters just off the community. This poses an immediate health risk to communities, has potential impacts on local marine systems and reduces the lifespan of the treatment plant. Flood waters wash refuse out of the community waste dump and spread it across the community, creating a health risk. The salt water impacts on people's gardens, an important local source of supplementary fresh food. Salt water crocodiles inhabit the water around these communities and large floods increase the risk of these animals finding their way into the community. Even more disconcerting for locals however, is the impact the waters have on the graves of family and ancestors, with many headstones and graves washed out, and in some case remains have been disturbed and moved by erosion. This is a source of considerable distress for the community.

Communities have not sat idly by, and have put considerable effort into building their own seawalls in past years. These walls have helped to hold back the tides to some degree. However, without the correct materials or design, they have progressively failed and are now mostly in a state of extreme disrepair, offering little immunity to flooding.

Figure 6: Inundation of Boigu island in year 2007. Photo: © Queensland Fire & Emergency Services.

Erosion

In contrast to the top western mud islands, the main challenge currently for the coral cays is erosion rather than inundation. Poruma is a small narrow cay approximately 51 ha in size. Also known as Coconut Island, Poruma has suffered extensive erosion along part of the southern section of its western shore over recent years. A tall erosion scarp has developed, and many tall coconut palms, planted by parents as important food and cultural trees for their children, have been washed out to sea (Figure 7).

Cays tend to form at the convergence of currents, accumulating coralline sand formed from the erosion of a reef platform. Plants colonise the cay and eventually an island is formed. The coasts remain highly dynamic, with sand moving around the shoreline, and with seasonal fluctuations relating to prevailing winds and currents. Traditionally islanders could relocate their dwellings to accommodate the dynamic nature of coral cays. Modern development means the buildings and infrastructure on these communities have lost the flexibility of traditional structures in their capacity to be easily and cheaply relocated to accommodate a changing shoreline. Traditional land boundaries within communities are now mapped, and while some parts of the cay are eroding, other areas are accreting. These changes are not necessarily accounted for in the mapping.

Erosion at Poruma has exceeded the trigger point for action identified by Kevin Parnell, and efforts are being made to try to fortify the eroding site with a wall of geotextile bags. Whilst coral cays can grow in response to sea-level rise, in the longer term how well they fair will be determined by the rate of increase in sea levels. Modern developments, such as barge ramps, also often interfere with the natural movement of sand around the cay and can lead to the permanent loss of sand from the reef platform. This could have long term consequences for erosion and the capacity of the cays to keep up with changes in sea level.

Figure 7: Coastal erosion at Poruma has left a large erosion scarp with a loss of many important coconut palms. Photo: © John Rainbird.

Protecting the communities

Community leaders from the most impacted islands have for many years been calling on government to help them address coastal impacts. However, any changes to the coastal zone need careful consideration; securing investment requires detailed investigation that assesses the problems, possible options and the costs and likely impacts of any proposed solutions.

Hard engineering solutions are the only feasible coastal management option for many of the sites at risk. A specialist coastal engineer was engaged to assess each site and to provide a set of options and indicative construction costs as well as preliminary designs. The indicative costs underpinned funding submissions to the state and federal governments.

Getting our levels right

The Torres Strait is considered by many tidal experts to have the most complex tides anywhere on earth. Situated between the influences of the Arafura Sea in the west and the Coral Sea in the east, the resultant influences on local tides create some interesting and complex tidal activity. High tides on Boigu can be several days out of sync with high tides on Saibai, just 35 km away.

For many years, the only tide gauges in the region were those situated in the shipping channel, a long way from Boigu and Saibai. Local tidal datums, the values used to calculate mean sea level, were based on estimates. The datum values are used by engineers to establish relative height above sea level for building sites. In the 1990s, funds were made available for the construction of a seebee (hexagonal blocks) revetment wall for Boigu. Engineers used the existing datum values and constructed the wall along the Boigu foreshore. The wall, although halting erosion, only comes up to the surface of the island. A short-term study by Griffith University to measure tides in the region enabled the datum value to be revised; the value for Boigu was found to be over one metre too low. Therefore the Boigu seawall was too low to do the job of keeping the seawater out. In 2009, TSRA initiated a project to install four tide gauges across the region to improve the tidal data for the region and help to improve the accuracy of the datum values.

As sea levels rise around the planet, the rate and level of rise varies regionally due to a range of complicating factors. Data from the Booby Island tide gauge and sea level readings from the Papua New Guinea region indicate sea-level rise in the Torres Strait area is happening at somewhere between 6-8 mm per year; this is significantly faster than the global average rate of increase of 3.2 mm per year. To ensure there are good quality local data on this critical variable, TSRA worked with the Bureau of Meteorology to install a dedicated sea level gauge on Thursday Island. The region now has the instruments in place to track real time and long-term changes in tides and sea-level, which will provide key information to inform future coastal adaptation planning.

Securing investment

An estimated $26 million dollars was required to address the critical coastal works in the six communities. Due to the remoteness of the Torres Strait, and the cost of freight and travel, the cost of installing infrastructure is significantly greater than on the mainland. This, coupled with the relatively small size of most communities, does not help in terms of securing the funding needed for such projects.

Securing the funds took several years of building a coherent case for investment. Funding submissions highlighted the impacts of flooding and erosion on culture and wellbeing, the strategic importance of the region, and built an economic case focused on how the investment would extend the life of existing investments in critical infrastructure on these communities. Boigu and Saibai alone each have over $100 million of infrastructure in the hazardous coastal zone, and the seawalls should significantly extend the lifespan of most of these buildings and structures. Bringing home the reality of king tides and their impacts on communities through images and through communities telling their stories directly through the media was an important part of building awareness of the issue amongst the broader community and the decision makers. SBS TV played a key role in this process through its long term interest in the Torres Strait, following the story over many years.

In 2013, $5 million was secured through a grant from Regional Development Australia (RDA), with help from the local RDA Far North Queensland Torres Strait office which supported council's submission. This initial funding helped to leverage additional

dollars from other Commonwealth agencies and the Queensland Government. Management and implementation of such projects in remote locations is complex, and this is further complicated by their location in the active tidal zone. Project delivery is being managed by the TSIRC. A governance structure is in place to help streamline reporting to the multi-party funding arrangements. The governance committee includes the Department of the Prime Minister and Cabinet, Regional Development Australia, the Queensland Department of Infrastructure and Planning, TSRA and TSIRC. Initial work has commenced on Saibai, and major seawall works began in late 2015.

The bigger picture

While good progress is now underway to initiate well designed and engineered coastal defences for highly exposed communities, climate science is telling us unequivocally that sea-level rise is going to continue for many centuries and probably to at least several metres above current levels. We now have no choice but to invest heavily in how we deal with this pervasive threat to the coastal zone. The big unknown is the rate of change, but for very low lying communities even small increases in sea level can be devastating. Critically, seawalls buy time, but do not solve this problem.

This is a thorny challenge for low-lying Torres Strait communities given the limited long term options available to them. How long can they stay and still lead good quality lives on their island homes? Will there be investment available to assist communities to respond to these challenges over time when many other coastal communities around Australia start to feel the impacts as well? How will rising seas progressively impact their lives and interrupt key activities? What are the triggers and thresholds for action? Unpacking these issues is a painful discussion for affected communities and needs to be done sensitively and by the communities themselves. It is critical, however, that these conversations occur and that communities develop a deep understanding of the risks, options, and what is involved in mapping out a plan that will enable them to navigate the changes that are being imposed upon them.

A regional Adaptation and Resilience Plan is being developed for the Torres Strait that considers these issues and seeks to provide a useful platform for community conversations. The Plan also provides a proactive considered response to these challenges that will help to ensure the region continues to thrive through good planning and adaptive management.

An adaptation pathways map has been compiled that helps to communicate some of the key considerations in responding to sea-level rise. The pathways map lays out the options ranging from do nothing, to accommodate, to defend through to retreat/relocate. It indicates the relative investment over time of each option, possible trigger and threshold points, and generic timing to shift from one pathway to another as sea levels rise. It provides an overall framework for pragmatic responses, but cannot fully recognise the underlying human, social and cultural challenges that accompany such a journey.

Continued refinement in decision making

Without more detailed understanding of when sea-level rise will result in critical impacts, or the cost implications of defend or retreat options, it is difficult for both community and government to properly plan and respond to the challenge. A model has been developed that considers the economic costs and benefits of retreat versus defend strategies based on cost impacts on coastal infrastructure. This model is yet to be fully tested, but does provide a useful decision support tool for agencies responsible for funding, operating and maintaining infrastructure in coastal hazard zones. The model uses the detailed site specific data on storm surge and sea level rise developed as part of a separate study into probabilistic extreme water levels in the region. It will help agencies and councils consider the relative merits and costs of defending versus retreating in the light of uncertain rates of change, and at which point of sea-level rise particular investments need to be made.

A second refinement has been to estimate at what sea level value communities could expect to be inundated by normal astronomical tides approximately 20 times per year. This is a nominal value to provide a basis for conversation. This approach is a refinement of the bathtub inundation map approach, which only really illustrates what areas will be inundated without

providing any indication of duration or frequency. For example, Boigu and Saibai are already quite regularly inundated, but the water is only there for a couple of hours before it is gone again. The bathtub modelling however, makes it look like these communities are already permanently inundated, which is of limited use in informing a more considered adaptive response.

To address inundation, we used the average height of village areas on the islands (referred to as Lowest Habitable Level - LHL). Assuming that there won't be any significant change in the tidal regime over coming decades, the high tides for 2014 and 2015 have been extracted from the tidal data and sea levels incrementally increased until they exceed LHL. The sea level value at which LHL is exceeded more than 20 times varies enormously across the region, highlighting the regional variability in exposure to risk from sea-level rise. The threshold value for each community is likely to vary based on a mix of hard and soft considerations. Hard considerations include at what point critical services and infrastructure are compromised or fail – such as waste treatment plants, or access to the airfield. Soft considerations include the coping capacity of the community and their tolerance to inundation, and this is something that may change over time.

Concluding comments

Despite the uncertainties, lessons from similarly affected areas above the Arctic Circle and in the Pacific— where Indigenous communities are facing comparable challenges watching their traditional country disappear — highlight the need to be proactive in planning for these changes. It is imperative both to build a case for the investment required to support a chosen adaptation pathway as well as to give communities the time to consider these critical issues, to digest their implications, and be ready to take the next steps on their journey into an uncertain future. As planning and coordinating agencies, our role is to provide communities with the best information so that they can make the best choices to ensure the future of their people and their culture in these changing times. Torres Strait likely has many decades before some of these difficult decisions need to be implemented. But if nature and history teach us one thing, it is that those who are adaptable and prepared for change will fare better than those who are not when the changes come.

Further reading

(all links accessed 25 May 2017).

Torres State Climate Change Strategy 2014-2018: http://www.tsra.gov.au/__data/assets/pdf_file/0003/6393/TSRA-Climate-Change-Strategy-2014-2018-Upload.pdf.

Torres Strait Extreme Water Level Study – Final Report: http://www.tsra.gov.au/__data/assets/pdf_file/0009/3996/Torres-Strait-Extreme-Water-Level-Study-Dec.pdf.

Observed and Future Climates of the Torres Strait Region: http://www.tsra.gov.au/__data/assets/pdf_file/0007/2005/Current-and-Future-Climates-of-the-Torres-Strait-web.pdf.

Inundation Management on Saibai, Boigu and Iama Islands – Drainage and Seawalls: http://www.tsra.gov.au/__data/assets/pdf_file/0016/2491/Inundation-Managment-on-Saibai-Boigu-and-Iama-Islands.pdf.

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