Australian Planner
Publication details, including instructions for authors and subscription information:
http://www.tandfonline.com/loi/rapl20

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Published online: 03 Jul 2013.

To cite this article: Jon Kellett, Jacqueline Balston & Mark Western (2014) Sea-level rise and planning: retrospect and prospect, Australian Planner, 51:3, 203-211, DOI: 10.1080/07293682.2013.808681

To link to this article: http://dx.doi.org/10.1080/07293682.2013.808681

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Sea-level rise and planning: retrospect and prospect
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(Received 27 November 2012; accepted 21 May 2013)

Twenty-five years on from Graeme Pearman’s review of coastal planning issues arising from climate change-induced sea-level rise, this article reviews the progress of our understanding of the scientific and geomorphological processes that are beginning to impact upon coastal communities. We outline legal and policy developments and specifically address perhaps the thorniest question facing governments – namely, how to address existing coastal developments threatened by rising sea levels. A Decision Mapping approach designed to assist local councils in analysing threats and developing policy initiatives is described.

Keywords: sea-level rise; defend; retreat; adapt; Decision Mapping

Introduction
The June 2012 edition of Australian Planner reprinted two 1987 articles on coastal planning and management arising from sea-level rise. The first, by Graeme Pearman, was clearly designed as an agenda-setting discussion of the likely issues arising from climate-induced sea-level rise (SLR). With the hindsight of 25 years, it becomes clear how far research on this issue has progressed in the interim. The New South Wales (NSW) Government, for example, lists 15 coastal hotspots threatened by erosion on its website (Government of New South Wales 2012). Pearman begins by condemning the more extreme scenarios of several metres of SLR possible over the subsequent 50 years. He concludes by calling for more disciplined scientific study to reduce uncertainties, particularly to develop finer-grained regional predictions and for other experts to use the resultant predictions to develop impact assessment guidelines to assist future planning (Pearman 2012). Our initial aim is to comment on this agenda. Writing in the same 1987 edition on coastal resource management, the late Peter Cullen pointed to a range of Australian urban developments that appear to have ignored the potential threat of coastal flooding and erosion that accompany rising sea levels, specifically the Gold Coast and Gippsland Lakes, thereby highlighting both the low priority granted to this issue at the time and, presaging our second concern, the problem of existing developments (Cullen 2012). Twenty-five years on from first publication, it is possible to add some flesh to the bones of the argument presented by these two authors. From a scientific perspective, climate change is no longer hedged by doubt. Recent Intergovernmental Panel on Climate Change (IPCC) reports make it abundantly clear that anthropocentric global climate change is a reality. Regional climate modelling is beginning to produce valuable data on the future for localised areas to assist adaptation planning. While Cullen could only point to South Australia (SA) as having introduced comprehensive coastal planning and management legislation in 1987, NSW, Victoria, Western Australia and Queensland adopted SLR planning levels against which to assess development proposals by 2010 (Harvey, Clarke, and Nursey-Bray 2012).

We begin with a brief review of the progress in understanding the various dimensions of this issue over the ensuing time period, before turning to perhaps the most intractable problem posed by SLR. How can governments and land owners address the issue of existing developments, which are or will, during their lifetime, be threatened by rising sea levels? Are there any answers and how might they
be arrived at? We report on recent research, which seeks to address these questions through the development of an assessment methodology and its application to two case studies in SA.

The science

In 2007, the IPCC Fourth Assessment Report (AR4) provided a review of the latest findings on climate change science and its impact. Since then, there has been further research on many of the key aspects of climate change that are crucial to our understandings of global warming. These aspects include recent trends, uncertainties, SLR, abrupt changes associated with climate thresholds and feedbacks – natural processes that can increase or decrease the effects of global warming.

The global mean temperature has been above average every year for the past 25 years (1986–2010), and 2010 was ranked by the World Meteorological Organisation as the equal warmest year on record, along with 2005 and 1998 (Bureau of Meteorology 2011). Both maximum and minimum temperatures have increased equally. The rate of warming over the last 50 years is almost double that for the last 100 years (IPCC 2007). Short-term changes (less than ten years) in the temperature trend show natural variation and do not change the long-term observed global warming trend. There is now no credible explanation (for example, solar activity, volcanos) for the level of observed warming, other than the release of greenhouse gases (GHG) through human activity (Allison et al. 2009).

The global oceans have warmed approximately 0.7 °C since 1870, mostly in the top 1000 m (Roemmich and Gilson 2011), and sea levels have risen as a result of thermal expansion. Analysis by many groups around the world now confirms that the oceans have so far absorbed more than 90% of the increased heat associated with global warming (Church 2011). The combination of thermal expansion from a warming ocean and melting ice sheets and glaciers has resulted in an increase in global sea levels since 1970 of about 1.7 mm per year or 17 cm over the past century, as recorded by tidal gauges and satellite altimeter data (Church 2011). The most rapid increase (3.1 mm per year) has occurred since 1993 and was the result of thermal expansion (about 45%) and land-based ice contributions (about 40%) (Steffen 2006; Church 2011). SLR is currently tracking at, or near, the upper limit of the IPCC worst-case projections.

As with most large coastlines, the measured increases in sea level along the Australian coast vary by location as a result of tectonic movement, climatic influences, including the El Niño Southern Oscillation (ENSO), and anthropogenic changes, such as subsidence, due to the draining of wetlands and other modifications. On average, sea levels around Australia rose by about 17 cm over the period 1920–2000 or 1.2 mm per year – a change close to that recorded globally (CSIRO and BoM 2007). Data from the early 1990s to June 2011 show increases in sea level around Australia of between 2.9–9.0 mm per year (Figure 1). All measurements are adjusted for tectonic movement, seasonal climate variations and anthropogenic land changes (National Tidal Centre 2011). In SA, there has been a SLR at the Thevenard tidal gauge (considered the most accurate and with the longest record) of 4.3 mm per year between 1992 and 2010 (National Tidal Centre 2011).

Extreme events

Wind and wave actions associated with extreme weather events, including cyclones, intense low pressure systems and storms, induce the greatest short-term erosive and flood impacts on the coastal strip. In conjunction with eustatic SLR and tidal components, wind-driven waves cause coastal erosion and resultant infrastructure and ecosystem damage. The frequency, intensity and distribution of wind, wave and storm surge events are associated with cyclones in the north of the continent, thunderstorms nationally and intense lows (‘cut-off’ low pressure systems) in the south. An extreme coastal erosion or flood event is a function of a number of different factors: global and regional sea levels, regional land movements, regional sea-level variability and tidal ranges constitute the oceanic component of the event, while storm surge and storm tide events are isolated events that are driven by the climatic variables of wind and atmospheric low pressure. Thus, in the short term, it is the increasing incidence of such extreme events that poses the greatest threat to development in coastal regions. Over the longer term, these events, allied to a rising mean sea level, combine to threaten existing and future development on the coast.

Since the release of the AR4 report, SLR has increased at a rate higher than the worst case scenario predicted by the IPCC AR4 and has roughly tripled in response to the 0.8 °C warming observed during the twentieth century (Rahmstorf 2007). The range of estimates for SLR to the end of the century now indicates an increase between 0.5 m to over 2 m. As a result, it is now agreed that there is a ‘considerable body of evidence that points towards a SLR of 0.5 – 1.0 m by 2100’ and that ‘sea level rise . . . towards 1.5 m cannot be ruled out’ (Steffen 2009, 58).
Along with our understanding of the physics and rate of climate change, flood mapping of potential inundation on the Australian coast has advanced since Pearman and Cullen presented their commentaries in 1987. In its simplest form, the most common approach is a ‘bathtub’ or ‘bucket fill’ Geographic Information System (GIS) model that uses a medium- or high-resolution digital elevation map (DEM), which can then be ‘flooded’ by entering a selected sea level. The resulting inundation map shows the areas of current foreshore that will be flooded. Additional sea-level allocations may be added to include storm surge and wind-driven wave set-up. However, these models do not take into account whether the flooding will exacerbate erosion along the coast and so do not consider a possible breach of existing flood protections, such as barrier dunes. This approach also does not include interactions between riverine and oceanic flooding, should the two occur together (for example, during a cyclone that causes both a storm surge and localised flooding at the same time).

To date, flood-risk mapping for SLR has been undertaken for numerous locations around the continent by state and local government or funded contractors for specific high-interest sites. The Department of Climate Change and Energy Efficiency’s ‘Climate Change Risks to Australia’s Coast First Pass Assessment’ provided the first national assessment of coastal climate-change hazards and included flood mapping of the entire coastline (except Cape York) using the high resolution stereoscopic reference 3D (SPOT) satellite-derived mid-resolution DEM. The SPOT DEM has a horizontal resolution of approximately 30 m and a vertical height resolution of 1 m (in other words, the vertical slope of the coastline steps up in 1 m intervals). Absolute elevation accuracy of the DEM is around 10 m, and it has a standard deviation of approximately 6 m. The product was considered accurate enough for a first-pass assessment of the Australian coast. A projected SLR of 1.1 m was overlaid on the DEM to indicate areas subject to inundation, and it was then overlaid on the National Exposure Information System (NEXIS) infrastructure database, which was developed by Geosciences Australia. The NEXIS database categorises information into residential, business (commercial and industrial), institution and infrastructure components, on the basis of data from the best available national address dataset from the Geocoded National Address File (GNAF), and also provides the approximate total replacement cost for residential buildings.
Erosion

Even a moderate increase in SLR can result in a significant increase in the Annual Return Interval (ARI) of an extreme sea-level event associated with high tides, storm surges and the associated erosion of the coast. As an example, an event that now occurs once every 100 years could be expected to occur two or three times every year by the end of the century. Erosion (or accretion) of a coastline is dependent on the combined effects of four factors (DCC 2009, 34):

- changes in the mean sea level;
- changes in the frequency and magnitude of transient storm erosion events;
- realignment of shorelines, due to changes in wave direction; and
- extent of supply and loss of sediments in nearby sources and sinks.

Assuming a static sea level and climatic drivers of extreme events (the first two factors), the potential rate of erosion will still vary significantly in response to wave energy and direction (factor three); erosion on an open, exposed coast is often greater than that on a more sheltered coast, as the larger wave climate is capable of shifting more sediment from the top of the beach into deeper water, compared with calmer, shallower environments. Finally, the substrate along the coast determines the actual erosion rates in response to the combination of the other three factors; a sandy shoreline will erode much faster than hard rock substrates. The substrates most vulnerable to coastal erosion are those made up of 'unconsolidated sediments, such as beaches, dunes and sand cliffs on the open coast of leaky embayments and on the shores of coastal lakes and lagoons... soft sedimentary and weathered cliffs, especially those formed in calcarenite' (DCC 2009, 34). SLR is not expected to increase the erosion of most hard coasts above current rates.

The geomorphic attributes (landform and stability) of the Australian coast were compiled into a national line map as part of the DCC ‘First Pass National Assessment’ of climate change risks to the Australian coast. Known as ‘Smartline’, the database is available on the OzCoasts website (www.ozcoasts.org.au) (DCC 2009). Each segment of the Smartline map contains multiple data layers describing the landform types at that point of the coast, extending from the high water mark (500 m) both inland and offshore, and this can be queried through the web browser or using GIS software. As a ‘geomorphic’ map, it represents not just the topography of the coast – the planform, elevation and shape of the coastal landforms, which a contour map or digital elevation model may represent – but it also indicates what the differing coastal landforms are made of: varying rock types, laterite, coral, sand, mud, laterite, boulders, beach rock and so on.

The policy

The Australian Federal Government has not introduced any new legislation with respect to climate change adaptation, but, rather, relies on each state to develop an individual response. Thus, the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 remains the umbrella legislation to deal with climate change adaptation at the federal level, whereas current policy is best observed in the Australian Government Position Paper, Adapting to Climate Change in Australia (Australian Government 2010). During the 1990s, the Australian states developed a range of approaches to assessing coastal vulnerability, including coastal engineering studies, inundation mapping and storm surge analysis in different locations (Harvey and Woodroffe 2008). As an alternative to the Common Methodology for vulnerability assessment, which had been established by the IPCC in 1991, Kay and Hay (1993) developed an assessment approach incorporating socio-economic and cultural factors, which was applied in both SA and Victoria with mixed results. Meanwhile, the federal government published a policy document, Living on the Coast (DEST 1995), and funded a number of coastal management and vulnerability studies (Harvey and Woodroffe 2008). Such contributions, along with Harvey, Clouston, and Carvalho’s (1999) studies of SA coastal locations, extended the debate to other, human-induced problems, such as increased coastal development, waste disposal and groundwater withdrawal, alongside climate change. A growing literature echoes this theme, arguing that coastal policy concerns are complex and interlocking (Nicholls et al. 2008; Huppertz 2005; Shepherd 2005). While consideration of coastal issues, including climate change, was initially characterised by action at both state and local level, by the mid-2000s, the need for coordinated national assessment had become more apparent, particularly as a result of the increased migration to coastal areas – a trend that, in turn, provoked concern from the insurance industry. As a result, the federal government published its First Pass National Assessment of Australia’s Coasts (DCC 2009) and instituted further position papers and mechanisms, such as the introduction of the Coast and Climate Change Council in 2009. A comprehensive overview of coastal planning, sea-level change and planning was provided by Harvey and Caton (2003), and the details of policy developments since
the early 1990s are set out in detail by Harvey and Woodroffe (2008) and Harvey, Clarke, and Nursey-Bray (2012). More recently, the Council of Australian Government (COAG) called for cooperative action on climate adaptation, and the federal government has funded the National Climate Change Adaptation Research Facility. This latter initiative has been active in commissioning a wide range of research on adaptation to climate threats, including coasts.

A common experience in a number of coastal areas has been community backlash towards policies of managed retreat, which has stimulated concern in respect to council liability for property damage or loss (Abel et al. 2011). As a result, several Australian states have sought to amend their legislation to protect councils from liability resulting from coastal inundation and erosion as sea levels rise. A detailed discussion of these amendments is included in the report Local Council Risk and Liability in the Face of Climate Change (Australian Local Government Association 2011b). NSW was the first state to attempt to clarify its liability in respect to SLR via amendments to the Coastal Protection Act 1979 in the Coastal Protection and Other Legislation Amendment Act 2010. Subsequently, other states have followed suit. The acceptance, on the part of most Australian states, that sea levels are likely to rise by at least 0.8 m by 2100 has prompted concern about the protection of vulnerable coastal areas. A common debate concerns the relative merits of hard versus soft defence, with a general recognition that different situations demand a range of solutions. Soft defences are broadly seen as preferable, in that they work with nature, rather than seek to resist it, and are less likely to have unwanted repercussions, such as changes to longshore drift or erosion elsewhere along the coastline (Macintosh 2012). However, the issue of who has the right to protect coastal assets has proved to be a contested area, which has produced a number of legal challenges. Most notable amongst these is the case of Byron Bay in NSW, which is discussed below. In addition, a spectrum of community concerns, ranging from economic impacts to health and emergency response provisions, have been identified by Gurran et al. (2011).

There are three potential strategies available to councils addressing communities threatened by SLR – namely, defend, adapt or retreat (IPCC 1992; Hennessy et al. 2007). Seeking to protect development in the face of rising sea levels may, in the long term, prove futile, but the current pace of SLR suggests that, in many instances, it is a viable approach in the short term, given suitable safeguards. Construction of defences, such as sea walls, groynes, levees, dune and beach replenishment, can protect vulnerable and valuable developments. Additional safeguards may include development consents for new structures in the coastal zone, which are time-limited or have express provisions stating that the owners have made all reasonable provisions to protect their property against extreme events. Such provisions might include raised floor levels, transportable structures or building designs that allow for periodic inundation of the lower floors, while living spaces are situated on upper levels. All of these approaches are typical of a number of local development plans published in recent years and can be best summarised as seeking to accommodate SLR. The third approach is managed retreat. This policy recognises that inexorable SLR will cause the loss of coastal land and, therefore, an organised withdrawal is required. Strategies might include physically shifting buildings and structures that are transportable back from the coast, the rezoning of coastal fringe areas, for example, to allow the gradual landward movement of mangrove areas and land swaps to allow coastal residents to relocate further inland.

Harvey, Clarke, and Nursey-Bray (2012) suggest that climate change will have an increasing impact on coastal management regulations in the future. Their argument rests on the increasing demand for coastal residential development and the risks to local councils arising from liability concerning existing developments and coastal protection works. They cite four recent cases in Tasmania, SA, Victoria and NSW in support of this position. However, their conclusion that the history of coastal management in Australia has been characterised by fragmented approaches and failure suggests a sea change in political will is required for progress to be made. In recent years, the federal government has demonstrated that it has the will to take a national overview. Recent legislative amendments also suggest a general movement by the states to deal with liability concerns (Australian Local Government Association 2011b). However, the inability of the Tasmanian Government to reach an agreement on benchmarks, the cancellation of the NSW planning benchmark and the withdrawal of Queensland’s State Planning Policy 3/11 all cast doubt on the commitment of these states to prioritise the issue.

Existing development

While all of the above strategies represent viable approaches to addressing coastal land-use change in respect to the regulation of future development, as Cullen noted in 1987, ill-considered existing developments in vulnerable coastal zones remain an intractable problem. The Australian Federal Government favours insurance as an approach to dealing with this issue. However, in relation to general insurance, the
Garnaut *Climate Change Review* and associated submissions explain that there is a trend for insurance companies to price risk at the individual-address level, based on information from flood-map data and other similar resources (Garnaut 2011; Institute of Actuaries of Australia 2011, 15). This trend means that risks will be increasingly less subsidised across regions, and premiums will increase for areas deemed to be high risk. Those who choose to live or carry out business activities in high-risk areas will face greater insurance costs. Furthermore, insurers may exit certain areas of the market, where they believe that the level of risk and costs are excessive. The 2009 report *Climate Change Risk to Australia’s Coast* highlights that, at present, insurers generally exclude ‘storm surge’, ‘action of the sea’ and ‘erosion and subsidence’ from their policies. The report also notes that the insurance industry recommends that people with low-lying land pay into a fund that can be drawn upon when compensation is required (DCC 2009, 144). However, this recommendation may only refer to land as an asset class, which is not presently covered by any insurance policies. With the exception of a few assets, publically owned infrastructure assets are largely uninsured, despite that fact that infrastructure is, by far, the largest class of assets by dollar value for most councils (Australian Local Government Association 2011a). At present, federal disaster relief funds are allocated after insurance payouts have been taken into account, so there is little incentive for councils to pay high insurance premiums to cover infrastructure from the threat of natural disaster. It is recognised that Commonwealth funds are only available in the event of a natural disaster, as defined by the Commonwealth, and they are only available once expenditure on reconstruction has exceeded certain annual thresholds. So it follows that federal funds would not be available for infrastructure under threat by gradual erosion, but only for damage resulting from extreme events.

Partly as a result of the rising costs of insurance, some private property owners have turned to their local councils, arguing that they are ultimately responsible for protecting or otherwise compensating them for loss or damage to their property resulting from SLR-induced loss or damage. Baker and McKenzie give a summary of the type of legal actions that have already been brought against various councils:

- claims by private property owners to challenge the refusal of development approval in the coastal zone by Councils on the basis of the anticipated risks of flooding and erosion or because planned retreat strategies had not been fully considered;
- claims by third parties against decisions to approve development where it was argued that the Council did not take into account potential climate change impacts;
- challenges to the adoption of planning scheme amendments that sought to impose standards to guide development in the coastal zone;
- proceedings where a Council sought to prevent a private landowner constructing coastal protection works; and
- proceedings initiated by a private landowner seeking to compel a Council to construct coastal protection works. (Australian Local Government Association 2011b, 3)

While the first three of these relate to future development in the coastal zone, the latter two derive from concerns in respect to protecting existing developments. The Byron Bay case – a longstanding dispute between Vaughan and Byron Shire Council – provides a pertinent example. The council granted itself consent for the construction of a geobag erosion control wall on the coastline of private beachfront property. The private owners brought an action against the council, alleging a breach of the development consent, following a storm that caused erosion of the beach, including about 10 m of private property. It was held that the terms of the consent obliged the council to monitor, maintain and repair the beach’s stabilisation works that it had erected. The council was ordered to restore the interim protection wall to its full height and shape that it held before the storm event. In addition, the court found that the private owners had the option of bringing action in negligence or nuisance in the Supreme Court, in order to seek damages for the loss of their property (Australian Local Government Association 2011b, 60). In this instance, therefore, the action of the council, in attempting to protect private beachfront property, had placed a legal liability on itself. Subsequent to this case, the NSW Government introduced the *Coastal Protection and Other Legislation Amendment Act 2010*, which sets limits on liability for councils, including:

- the preparation of coastal zone management plans that set out matters such as: protection of the beach environment and amenity; what emergency actions are permitted; how councils will ensure continued public access to the coast; the impacts of climate change and coastal hazards; and arrangements relating to long-term protection works;
- acts of omission regarding beach erosion or shoreline recession on Crown land or land owned and controlled by the council;
the failure to upgrade flood mitigation works or coastal management works in response to projected or actual impacts of climate change; and
- the failure to remove or enforce the removal of illegal or unauthorised structures on Crown land or land controlled by the council, which results in beach erosion.

In relation to emergency coastal protection works, landowners within 12 coastal erosion hotspots in NSW whose homes are at imminent risk from coastal erosion will now be able to place sandbags or sand on beaches to protect their homes for up to 12 months. The works may only be placed once for each landowner, and they must obtain a certificate to do so. In relation to long-term coastal protection works, landowners will be allowed to build long-term coastal protection works to protect their properties, provided that the consent authority is satisfied that the works will not unreasonably limit public access to the coast and satisfactory arrangements have been made for maintenance. Councils will have the power to levy an annual charge on landowners, where there is a need for council to manage off-site impacts of the works. Future owners will also be liable for the charge (Smith 2010, 3).

The Decision Map

Our recent research set out to develop a tool that might assist councils in setting policy in respect to existing developments threatened by SLR. A literature review revealed how difficult it can be for councils to make decisions in the face of political and financial liability. Key uncertainties related to precisely how and when to act. The research approach used two contrasting case study sites—one facing regular inundation and the other facing erosion. Site visits, consultation with the council and investigation of available data sources were used to define the steps involved and, critically, the order of these. The purpose of the resulting Decision Map is to set out a systematic process, whereby a council might proceed to collect data, assess liability and, finally, evaluate options for dealing with potential impacts from SLR. One of the key rules applied to the Decision Map is that data should not need to be collected, unless it is necessary for the subsequent step. A key learning from this process was that understanding legal liability for damage or loss is central to the process, with several subsequent steps relying on a good understanding of this stage in the process. The Decision Map does not provide an answer to the problems of inundation or coastal erosion as a result of climate change, but progressively refines the definition of the problem and provides quantifiable data in the form of financial costs, which can be used to inform decision-making.

The Decision Map has six stages:

1. analyse the climate impact;
2. analyse existing protection structures and strategies;
3. establish the profile of assets at risk;
4. determine council liability;
5. identify existing coastal protection structures and strategies;
6. evaluate options for dealing with potential impacts from SLR.

Figure 2. Stage 2. Identifying existing protection structures and strategies, as an example of the Decision Map process.
(5) determine monetary value of assets at risk; and (6) analyse actions.

An example of the steps and data requirements for stage 2 is shown in Figure 2.

The Decision Map provides a universal tool that can be applied anywhere in Australia. It relies on various data inputs in respect to flood or erosion risk, the condition of sea defences and ownership of land and property. The outcomes may vary and depend critically on the legal interpretation of liability and political sensitivity of the specific situation. As in the case of Byron Bay, the council’s position may be as much determined by political pressure from residents as it is by legal or financial aspects. Byron Bay amply demonstrated that rational decision-making based on a sound risk assessment and financial cost evaluation of different solutions does not constitute the only factor in the decision to defend, retreat or adapt to changing sea levels. Nevertheless, a sound evaluation of these aspects can assist in informing subsequent decisions, particularly by providing costing for different policy positions. It is anticipated that the Decision Map will prove a useful tool in this process.

Conclusion

Compared to 25 years ago, our understanding of the science of climate change, though still imperfect, is sufficiently robust to demonstrate that a 1 m rise in sea levels around Australia’s coast by 2100 is highly likely and should be planned for. Understanding of measurement, physical mechanisms of erosion and coastal modelling expertise has also improved substantially, partly due to technological progress in aerial and satellite imagery and computing power. It is important to recognise that the rise will not stop at 1 m, as sea levels will continue to rise for the next several hundred years, though the actual rate and extent of this rise is less well understood, since it partly depends on decisions yet to be taken in respect of future GHG emissions. New developments in coastal zones should therefore be carefully assessed with this backdrop in mind. Mechanisms such as the physical ability to adapt buildings to cope with more frequent inundation should be considered, and time-limited consents should be employed. In every case, the three policy options available – namely, resist, adapt or retreat – need to be rationally assessed. Where development already exists, information, consultation and adherence to due process appears key to successful outcomes, though, as yet, there appear to be few, if any, examples of effective action in Australia. High resolution data and clear vulnerability assessments, along with realistic and enforceable planning benchmarks driven by national policy, are generally seen as necessary for effective action. From the perspective of local councils, a clear understanding of legal and financial liabilities and the recognition that these are extremely sensitive issues, which touch upon residents’ financial positions, sense of security, place and home, suggests careful handling of timing and policy solutions. Over the next half-century, the approaches outlined in this article may be sufficient to deal with new developments and some, though perhaps not all, existing developments, which are threatened by rising sea levels. However, it is important to recognise that, for the next few centuries, Australia’s coasts will represent a moving target, and planning policy will need to stay ahead of the inexorable changes, which will gradually threaten valuable infrastructure and urban centres.

Acknowledgements

The authors are grateful to the reviewers for their valuable comments and to the Australian Department of Climate Change and Energy Efficiency and the SA Local Government Association for supporting the research from which this paper is derived. The Decision Map tool is available from the author and the SA LGA.

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