5.1.3 New South Wales

Key findings

- Between 40,800 and 62,400 residential buildings in New South Wales may be at risk of inundation from a sea-level rise of 1.1 metres and storm tide associated with a 1-in-100 year storm.
- The current replacement value of the residential buildings at risk is between $12.4 billion and $18.7 billion.
- Local government areas (LGA) of Lake Macquarie, Wyong, Gosford, Wollongong, Shoalhaven and Rockdale represent over 50 per cent of the residential buildings at risk in New South Wales.
- New South Wales has fewer residential buildings located within 110 metres of 'soft' erodible shorelines than many other states. There are approximately 3,600 residential buildings located within 110 metres and 700 buildings within 55 metres of 'soft' coast.

The population context

New South Wales is home to almost one third of Australia's population with nearly seven million residents.[18] Over 60 per cent of the population (4.4 million) lives in Sydney[19], Australia's most populated city. The coast is also home to a large share of the population, with about 20 per cent (1.38 million people) living in coastal local government areas beyond the Sydney region. All of the coastal LGAs have continued to increase in population over recent years, with a third experiencing growth rates higher than the state average in 2007–08.[20] The LGA of Tweed on the New South Wales-Queensland border experienced both the highest rate of growth and the largest population increase of the coastal LGAs in the year to June 2008. Wollongong, Lake Macquarie and Newcastle also experienced large population increases, while high growth rates were recorded in Port Macquarie-Hastings, Coffs Harbour, Shellharbour, Byron and Ballina.[21]

Photo credit: A.D. Short

Lake Conjola.

Photo credit: A.D. Short

The nature of the coast

About a third of the state's open coast comprises hard rock coast, most of which is robust sloping rocky shores, although cliffs are present in the Sydney region and near Jervis Bay. These cliffs are subject to occasional rock falls onto their adjoining rock platforms or waters below the cliff face.[22]

Sandy coasts comprise nearly half (45 per cent) of the open coast, and the majority of these are backed by soft sediment plains which imply a potential for coastal recession and sustained frontal dune erosion with sea-level rise. Shallow flood-tidal deltas at the mouths of the numerous estuary mouths and the entrances of intermittently closed and open coastal lakes and lagoons are highly sensitive to changing wave and tidal conditions.

Muddy and soft-rock shores are only a minor feature of the state's open coast, however these types are likely to be major shoreline types within the estuaries and tidal lagoons of the coast.[23]

Existing risk

East coast lows generate severe beach and fore dune erosion, storm surges across flood-tide deltas into estuaries, as well as severe wind damage along the coast. In northern New South Wales, tropical cyclones have similar impacts. Flooding of low-lying agricultural lands and towns also occurs with these events.

The flooding event of 2007 in the Newcastle area highlights the economic and social impacts from riverine flooding, coincident with a major coastal storm (Box 5.2). In the Newcastle LGA, some 5,000 cars were written off and 10,000 properties inundated.[24] Fortunately the peak rainfall event in Newcastle in 2007 coincided with low tidal (neap) conditions[25] so there was not also the flooding impact associated with a storm surge. The same event, one week either side, would have resulted in far worse flooding throughout the low-lying suburbs around the harbour.

New South Wales is already known to have localised areas of erosion, such as in Byron Bay (Belongil Beach).

Box 5.2 Newcastle flood planning

Newcastle experienced severe flooding in 2007 when heavy rainfall caused flash flooding over vast areas of the city. Flood depths reached 1.8 metres affecting about 10,000–15,000 properties with more than 1,000 inundated above floor level. Grounding of the MV Pasha Bulker on Nobby's Beach also occurred due to this intense storm.

Newcastle City Council's research modelling and floodplain planning undertaken over a number of years was confirmed by this storm event. Some areas where flooding had not been experienced in living memory, but where computer modelling before the 2007 event predicted potential flood risks, were unfortunately profoundly affected by the 2007 flash flooding. The same modelling also predicts flash flooding could be significantly more severe than that experienced in 2007.

As well as documenting the long history of flooding in the Newcastle LGA, the models predict severe potential risk from flash flooding, riverine flooding and flooding from ocean inundation. The small and steep catchments around Newcastle mean that rainfall is channelled very quickly onto the floodplain with very little warning. Add this to a legacy of development on the floodplains, means the flood exposure of properties within the Newcastle area is high, with estimates of about 22,000 properties (or 1 in 3 lots) potentially affected by all types of flooding – including ocean flooding.

Sea level flooding is considered more manageable than flash flooding. It is estimated some 3,000 properties could be at risk of flooding from a moderate storm surge event on top of a sea-level rise of 0.9 metres. A worst case scenario from sea flooding could affect more than 4,500 properties (Figure 5.8). Risk to life is more manageable for sea level flooding, since it appears that there would be sufficient warning to evacuate people to high ground. Options being considered to manage sea level flooding include voluntary purchase and relocating properties, while recognising there may be significant inherent barriers to implementation such as community acceptance and unfavourable cost-benefit outcomes.

Concept planning for all forms of flooding has indicated that city-wide, the economic cost of retreating from high risk to life and very frequent inundation exposure could be about $2 billion. A concept flood planning approach for all the types of flooding has been developed which accepts some risks, and promotes shelter in place for flash flooding where feasible. This approach is estimated to cost about $200 million, and is being developed by Council into a city-wide Floodplain Risk Management Plan by 2011. More information can be found on Council's web site (www.newcastle.nsw.gov.au)

Source: BMT WBM 2009[26]

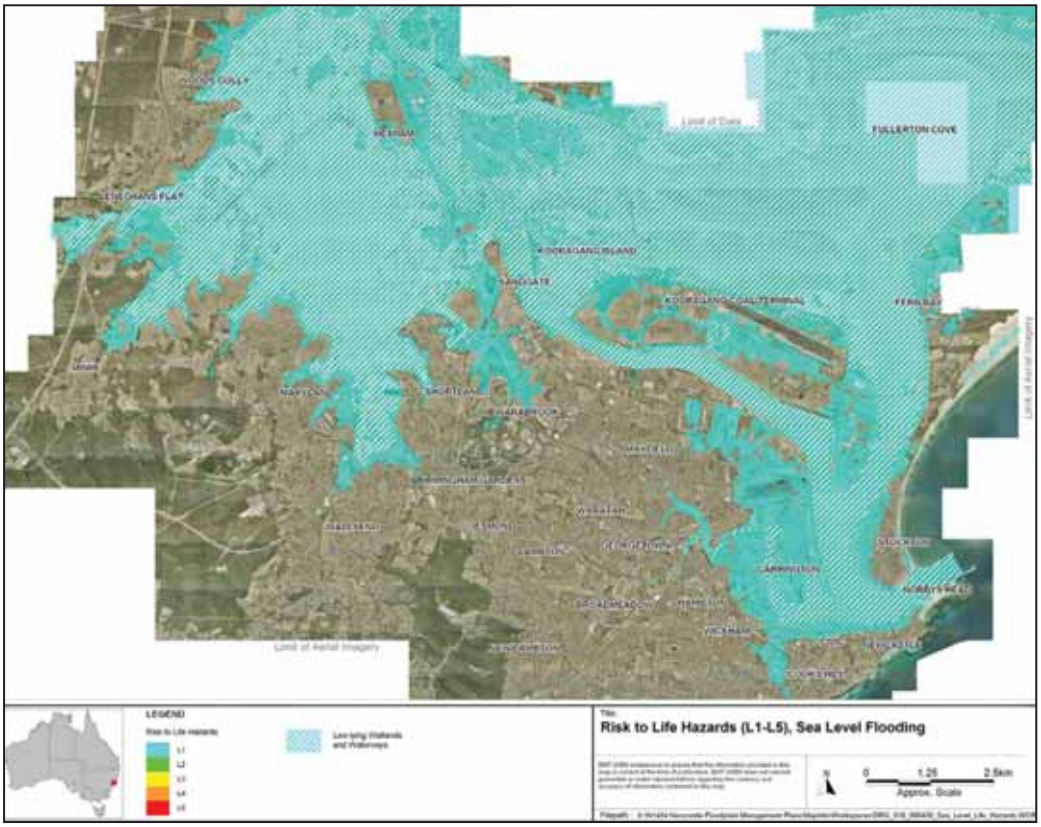


Figure 5.8 Extent of inundation from probable maximum sea flooding. Source: BMT WBM 2009.

During the 1974 storms (estimated as a 1-in-200 year event), extensive erosion occurred along the coastline. The Manly pier inside Sydney Harbour was destroyed and there was loss and damage to coastal property.[27] At Collaroy Beach in Sydney's northern suburbs, inappropriate coastal development over the last 100 years along the narrow beach has resulted in an ongoing history of erosion and property damage. Many affected properties in the area are now fronted by sea walls with the council also buying back at-risk properties.[28]

With an increasing frequency of high sea level events expected over the coming decades, the impact at localised 'hot spots' may increase in frequency and it is likely that new 'hot spot' areas will emerge over time. During 2009, Old Bar, near Taree has experienced erosion of beach front properties leading to appeals for government assistance.

Climate change risk to settlements

Inundation analysis suggests that between 40,800 and 62,400 residential buildings in New South Wales may be at risk of inundation from a sea-level rise of 1.1 metres and storm tide associated with a 1-in-100 year storm. The current replacement value of the residential buildings at risk is between $12.4 billion and $18.7 billion.

Based on this analysis, New South Wales has the highest number of residential buildings at risk of inundation around the Australian coastline. However, it should be noted that storm tide was only incorporated into the analysis for New South Wales (excluding wave setup), Victoria and Tasmania.

Photo credit: Newspix/David Clark

Severe beach erosion along Belongil Beach at Byron Bay, May 2009, where many metres of sand were washed away.

Photo credit: Newspix/Craig Greenhill

Collaroy Beach.

Methodology – key points and caveats

- Inundation analysis is based on 1.1 metres of sea-level rise using medium resolution elevation data.
- A *storm tide allowance* (1-in-100 year event) based on CSIRO modelling is included in the analysis for Tasmania, Victoria and New South Wales, although storm tide values for New South Wales are likely to be underestimates as they do not include a wave setup component.
- For the other states where the CSIRO modelling was not available (Queensland, Western Australia, Northern Territory, and South Australia) an allowance for *modelled high water level* (e.g. high tide) was included in the analysis.
- The analysis does not take account of existing coastal protection, such as seawalls, or riverine flooding associated with intense rainfall events.
- The inundation analysis is of existing residential buildings only (sourced from NEXIS database).
- More detailed analysis may change the relative order of local government areas and the magnitude and timing of projected impacts.
- Refer to Chapter 3 for further details.

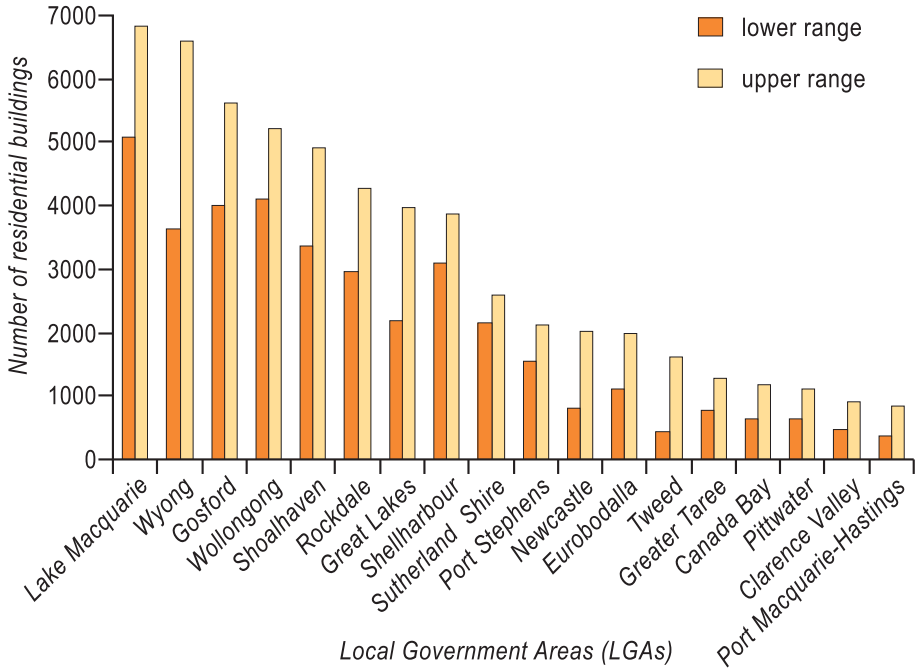


Figure 5.9 Estimated number of existing residential buildings in New South Wales at risk of inundation from a sea-level rise of 1.1 metres and a 1-in-100 year storm tide.

Local government areas that have the greatest level of risk are Lake Macquarie, Wyong, Gosford, Wollongong, Shoalhaven and Rockdale, which collectively represent over 50 per cent of residential buildings at risk in New South Wales (upper range; Figure 5.9). Inundation footprints of some regions are shown in Figures 5.10–5.12.

Between 5,100 and 6,800 buildings in the LGA of Lake Macquarie may be affected by sea-level rise and storm tide inundation by 2100, with the upper range representing around 10 per cent of the current residential building stock. This number is comparable to the results of topographical mapping of coastal and estuarine regions by the New South Wales Department of Planning[29], which found some 6,500 addresses on the Lake Macquarie waterway foreshore below 2.5 metres AHD and at risk of inundation by 2100 from the combination of sea-level rise and flood (Box 5.3).

Lake Macquarie, together with Wyong and Newcastle, was also included in an assessment in 2009 of the implications of sea-level rise and flood events for the Hunter and Central Coast region of New South Wales.[30] This study identified areas of residential, commercial and industrial assets in the Hunter and Central Coast region as at risk to sea-level rise by 2030 and 2070. The study also highlighted a threshold risk; sea-level rise combined with a storm event could potentially result in a total breach of certain sand dune areas by 2070, causing significantly higher damage to ecosystems and infrastructure (see Box 5.4).

The inundation analysis (Figure 5.9) also indicates that the LGAs of Great Lakes, Rockdale (bordering Botany Bay) and Shellharbour have a high proportion of existing residences at risk within their boundaries, with a substantial 18–20 per cent of existing buildings potentially affected by 2100 (upper range estimate).

The vulnerability of Rockdale to sea-level rise and other climate change factors was highlighted in a recent study by the Sydney Coastal Councils Group. This study *Systems approach to regional climate change strategies in metropolises* focused on the capacity of the 15 councils to adapt to climate change (see Box 5.5). The study identified spatially areas within the LGA boundaries that were vulnerable to climate change risks, including from sea-level rise and storm surge events. The Rockdale LGA, situated on the edge of Botany Bay, features as particularly vulnerable to the future impacts of sea-level rise. Sydney airport, which is located within the Botany Bay local government area, has an increased risk of inundation with climate change (see Box 5.14).

Figure 5.10 Images of Port Stephens in 2009 and with simulated inundation from a sea-level rise of 1.1 metres and a 1-in-100 year storm tide using medium resolution elevation data (not suitable for decision-making). © CNES 2009 / imagery supplied courtesy of SPOT Imaging Services and Geospatial Intelligence PTY LTD

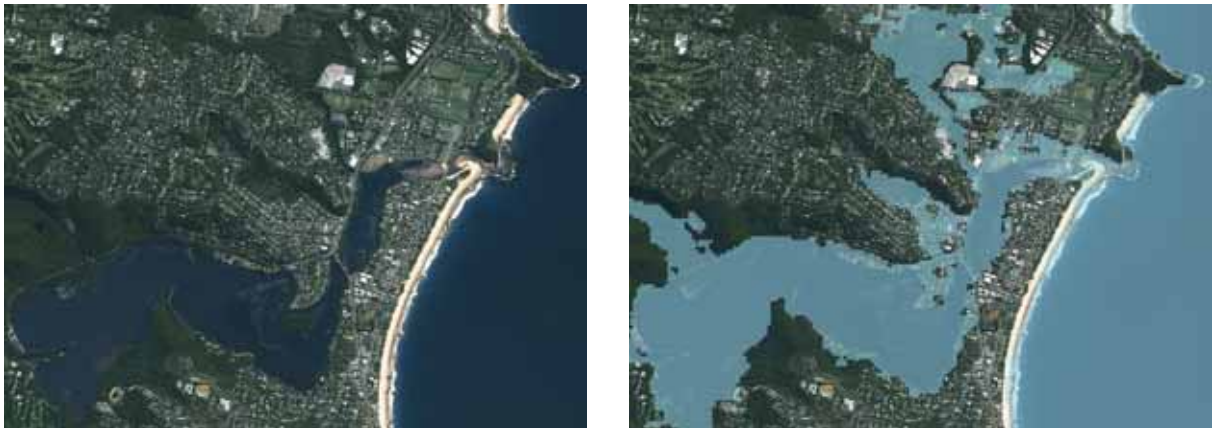


Figure 5.11 Images of Narrabeen/Collaroy (Pittwater LGA) in 2009 and with simulated inundation from a sea-level rise of 1.1 metres and a 1-in-100 year storm tide using medium resolution elevation data (not suitable for decision-making). © CNES 2009 / imagery supplied courtesy of SPOT Imaging Services and Geospatial Intelligence PTY LTD

Figure 5.12 Images of Tweed Heads in 2009 and with simulated inundation from a sea-level rise of 1.1 metres and a 1-in-100 year storm tide using medium resolution elevation data (not suitable for decision-making). © CNES 2009 / imagery supplied courtesy of SPOT Imaging Services and Geospatial Intelligence PTY LTD

Erosion due to higher sea levels is also a key risk for coastal areas. In New South Wales there are approximately 3,600 residential buildings located within 110 metres of 'soft' erodible shorelines, of which approximately 700 are located within 55 metres of 'soft' coast. Of the coastal LGAs, Sutherland and Port Stephens have the highest number, with approximately 650 residential buildings within 110 metres of 'soft' shorelines in both local government areas, and about 170 and 220 within 55 metres, respectively (Figure 5.13). Similarly, Shoalhaven (~380), Eurobodalla (~300), Rockdale (~280) and Byron (~160) have a relatively high number of residential buildings within 110 metres of 'soft' coast, with Eurobodalla also having almost 70 buildings within 55 metres. In the absence of coastal protection measures or other adaptation strategies, these buildings are likely to be at risk of increased erosion with sea-level rise and storm surge due to their location and the nature of the shoreline.

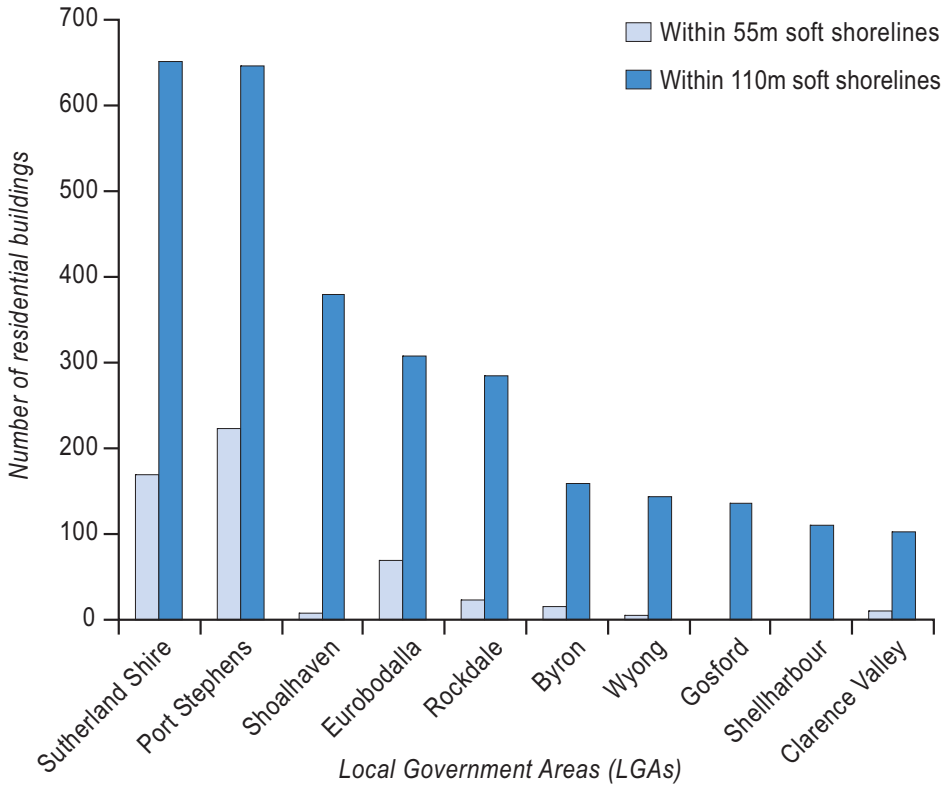


Figure 5.13 Number of residential buildings located within 55 metres and 110 metres of 'soft' shorelines in New South Wales.

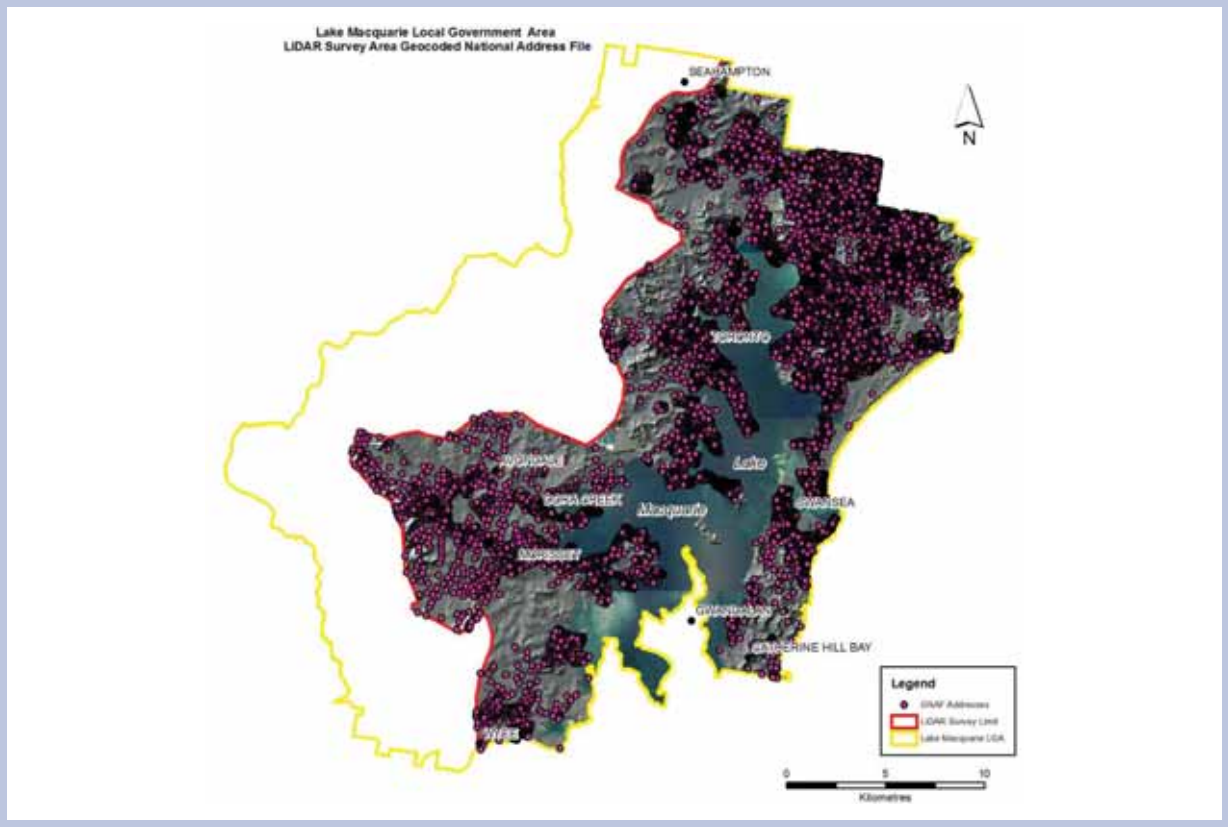
Box 5.3 Lake Macquarie – an example of sea-level rise and adaptation planning

Lake Macquarie City Council used the results of the New South Wales Department of Planning LiDAR (Light Detection and Ranging) survey of the Hunter and Central Coast region[31] to support a proactive adaptation approach to planning for sea-level rise for the City.

The LiDAR data provided highly accurate (±15 centimetres vertical accuracy) topographical mapping for coastal and estuarine areas between zero and 10 metres AHD. By overlaying topographical data with other spatial data, it was possible to make a first pass estimate of the potential impact of sea-level rise on built and natural assets. For example, it indicated that more than 6,500 addresses on the Lake Macquarie waterway foreshore were below 2.5 metres AHD (Figure 5.14), the approximate height of a 1-in-100 year flood event combined with sea-level rise by 2100. Similar overlays for infrastructure (roads and railways) and ecosystem types (including wetlands) indicated the need to plan for anticipated sea-level rise.

Council's approach to climate change has involved adopting a sea-level rise planning level of 0.91 metres by 2100, which is consistent with the figure of 0.90 metres contained in the draft state government Sea-Level Rise Policy (April 2009).

Council has adopted the 0.91 metres figure to develop decision and support tools for planning and development assessments in the City, ensuring a progressive adaptation to sea-level rise. Planning and development decisions made now will still be 'in effect' in 50 to 100 years, which places a duty of care on Council to plan for the future, based on the best available information. The proposed rate for sea-level rise allows Councillors, Council staff, and the community to develop policies, carry out more detailed studies, and make planning and development decisions that are suitable for the predicted change in conditions.



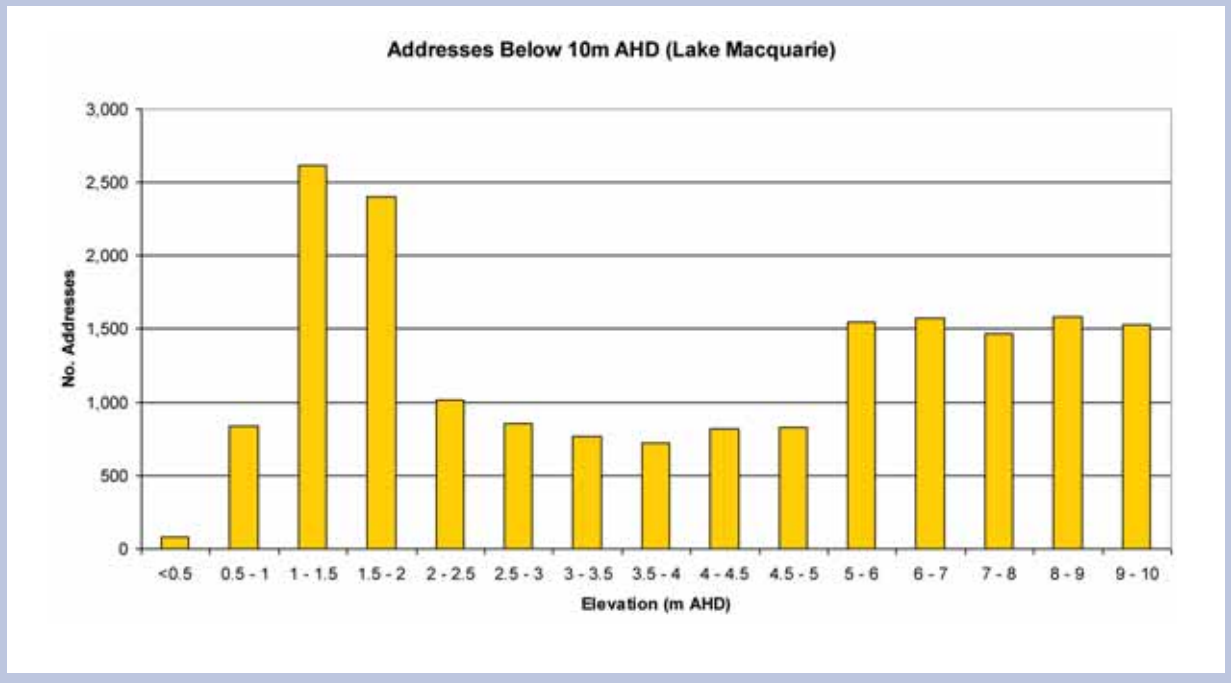


Figure 5.14 Distribution of addresses in LiDAR survey area of Lake Macquarie City LGA (above), and the number of addresses by elevation below 10m AHD for the mapped area. Source: NSW Department of Planning 2008[32]

Box 5.4 Hunter and Central Coasts – coastal vulnerability assessment

An assessment of the implications of sea-level rise and 17 flood events on human settlements, infrastructure and land use planning, as well as for estuaries, their foreshores and ecosystems, was undertaken in mid-2009 for the Hunter and Central Coast region.

The study examined climate projections for the years 2030 and 2070 (assuming a sea-level rise of 14.6 centimetres by 2030 and 47.1 centimetres by 2070) and analysed ecological, economic and social vulnerability. Each of the three areas of vulnerability were then mapped onto a spatial layer to allow an analysis of potential synergistic or cumulative effects for particular locations and regions.

Photo credit: Photolibrary

Aerial view of Newcastle.

Considerable areas of future human built environments (residential, commercial and industrial) were identified as potentially at risk of exposure to sea-level rise and increased storm rain intensity and flooding. If town planning were to continue on a business as usual basis, vulnerability would rise as follows:

Local Government Area (LGA)	2030 area vulnerable to sea-level rise and flood extremes	2070 area vulnerable to sea-level rise and flood extremes
Newcastle	4969 ha or 50% of the built area	5456 ha or 49% of the built area
Lake Macquarie	2022 ha or 11% " "	2491 ha or 11% " "
Wyong	3399 ha or 22% " "	5029 ha or 24% " "

The compounding effects of intensity of rainfall, storm events and flooding accompanying sea-level rise are likely to be responsible for most of the damage to the urban built environment, rather than sea-level rise acting alone. Gradual sea-level rise would permit adaptive responses by managers, allow the property market to price in risk and minimise the threat of serious damage. This conclusion does not hold if sea-level rise is abrupt.

Ecological communities including mangroves, coastal heaths, coastal banksia, scribbly gum and paperbark forests were also identified as vulnerable to sea-level rise combined with extreme storm events.

The coastline along the Hunter and Central Coast region is also characterised by significant stretches of sandy beaches that are exposed to wind and waves. The study noted that several coastal beach dune areas are susceptible to beach recession by 2070; with beaches such as Stockton Beach, Belmont Beach, Caves Beach, Catherine Hill Bay, Budgewoi Peninsula Beach, The Entrance, North Beach and Shelley Beach all noted as vulnerable. Additionally, a threshold risk of sea-level rise combined with a storm event potentially causing a total breach of a dune area was noted, which could cause significantly higher damage to ecosystems and infrastructure.

Major social vulnerabilities identified included nursing homes especially at Sandgate, a hospital at Morriset, relocatable home parks at Swansea, Chain Valley Bay and Bonnells Bay, housing commission neighbourhoods, new suburbs in Maryland and Woongarrah, the residential area of north Toukley and retirement villages at Canton Beach, Bonnells Bay, Wyee Point and Belmont.

Adaptive planning can reduce future settlement vulnerability. Most Councils have implemented some predictive and precautionary revisions to planning schemes and processes. Well structured adaptive planning was shown to reduce the potential for future damage to urban areas by as much as 46 per cent.

Source: Brunckhorst et al. 2009[33]

Box 5.5 Sydney Coastal Councils Group

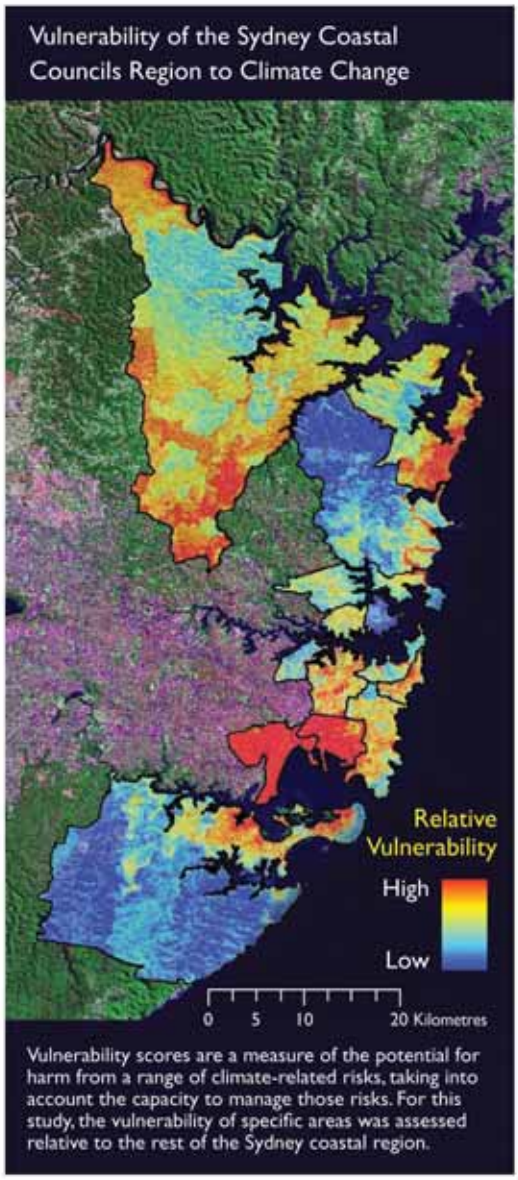
The *Systems approach to regional climate change adaptation strategies in metropolises* project focussed on the capacity of 15 Sydney coastal councils to adapt to climate change. Stage 1 of the project involved the assessment and mapping of climate change vulnerability throughout the region. The assessment was based on potential climate impacts including:

- sea-level rise and coastal hazards
- extreme rainfall and urban stormwater management
- extreme heat and human health effects
- bushfire
- natural ecosystems and assets.

These were assessed against three main groups of exposure, sensitivity and adaptive capacity indicators. The study found that overall the inner city councils of Botany Bay, Leichhardt, North Sydney, Randwick, Rockdale and Sydney, had the highest levels of climate change vulnerability. Sea-level rise was a key driver of risk for the Botany Bay, Leichhardt, Manly, Rockdale and Sydney councils, all of which were considerably more vulnerable than the average.

The vulnerability for each local government was spatially variable because of different levels of climate exposure, higher sensitivity to damage and/or a limited capacity to adapt with almost every Council having at least one impact area to which it had a high degree of vulnerability. Interestingly the study found that demographics, socio-economic conditions and response capabilities are often equally, if not more, important than biophysical hazards, in determining the level of vulnerability to climate change and the potential for harm.

The study identified that the most common barriers to managing climate change included differing levels of community social capital; perceptions of risk and knowledge; the need for infrastructure risk appraisal; planning and development; and existing decision-making processes.



This project was recently awarded the 2009 Eureka Award for 'Innovative solutions to climate change'.

Further information on the project is available at www.sydneycoastalcouncils.com.au

Source: Preston et al. 2008[34]