Coastal hazards under sea-level rise

Coastal Erosion Snapshot

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Acknowledgement of Country

Department of Climate Change, Energy, the Environment and Water acknowledges the Traditional Custodians of the lands where we work and live. We pay our respects to Elders past and present and emerging.

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About this snapshot

This snapshot summarises projected changes in coastal erosion hazards and associated exposure along the New South Wales coastline, based on the latest sea-level rise trajectories.

Future changes in coastal erosion are assessed using historical satellite imagery and beach morphology data. These inputs inform probabilistic hazard models that simulate storm-driven erosion, natural beach variability and the effects of sea-level rise, providing a consistent state-wide assessment for the New South Wales (NSW) coast. The projected impacts are presented through an exposure assessment of built assets and cultural heritage sites.

Information is provided for 368 beaches, representing approximately 90% of NSW sandy shorelines. In this snapshot, the exposure of buildings to coastal erosion is presented for the baseline year 2020 and the future time horizons of 2050, 2100, and 2150, under sea-level rise projections aligned with Shared Socioeconomic Pathways (SSPs).

This snapshot provides a high-level overview, with more detailed findings available in a technical report (NSW Coastal Erosion and Inundation Hazards and Exposure Assessment – Technical Report, 2025[i]) and through the Future Climate and Adaptation Hub on the SEED Data Portal. This assessment provides the foundation for coordinated, strategic action, helping to prioritise investment, plan infrastructure resilience, or protect cultural heritage and communities at risk. It supports councils, agencies, and planners in identifying vulnerable assets, assessing future exposure, and designing targeted climate adaptation and disaster risk responses.

Dataset includes ~90% of the sandy shorelines in NSW potentially subject to coastal erosion now and into the future.

Understanding coastal erosion

Coastal erosion occurs when sand is removed from beaches, resulting in a landward movement of the shoreline and/or a reduction in beach volume. This typically happens during storm events. Beaches naturally fluctuate between eroded and recovered states over time, and the width of this natural variation is known as the beach fluctuation zone (Figure 1).

Erosion is driven by multiple interacting coastal processes, including wave action, tides, sea-level change, wind, coastal currents and the movement of sand along and across the beach profile.

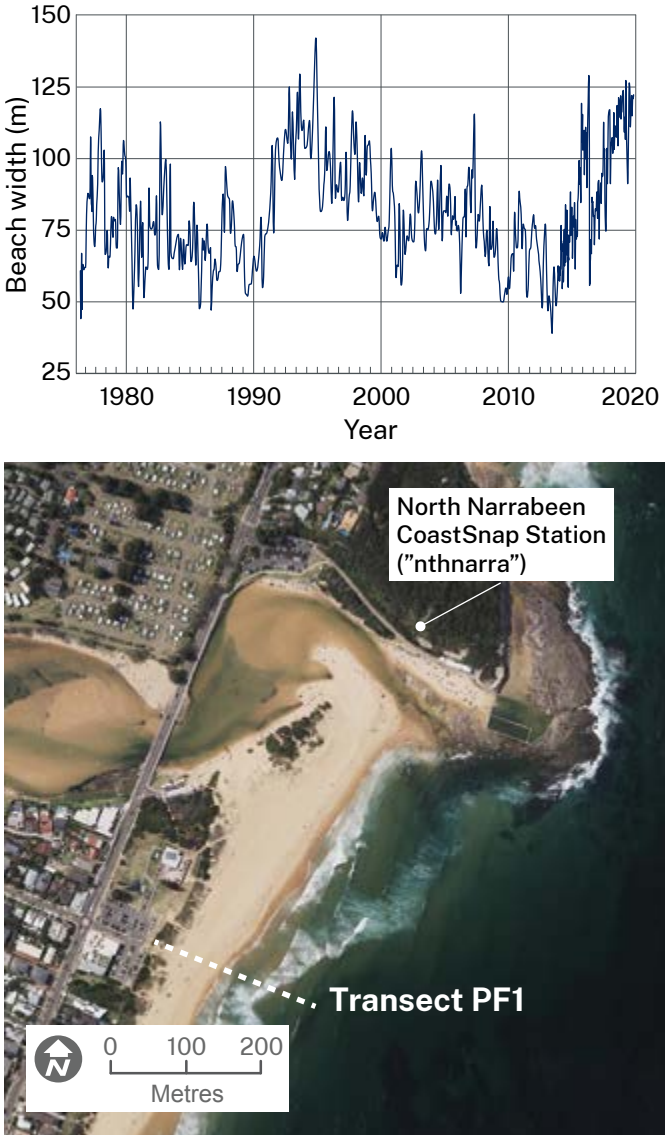


Figure 1: *Beach width over time at Transect PF1 of North Narrabeen Beach, together with an aerial photograph showing the location of Transect PF1*[ii].

Erosion may occur from a single intense storm event or through the cumulative impact of clustered storm systems over weeks or months.

Coastal storms generating large waves, elevated sea levels (storm surge) and strong winds are the primary drivers of coastal erosion. Erosion may result from a single intense storm event or the cumulative impact of multiple storm systems occurring over weeks or months. Post-storm beach recovery can take from several weeks to years, and in severe cases full recovery may take a decade or longer.

Coastal erosion can be broadly categorised into two types. The first is beach fluctuation, where beaches erode during storms and then gradually recover in the following weeks or months.

The second is long-term shoreline recession, where the shoreline progressively moves landward over decades to centuries as a result of cumulative erosion. Shoreline recession occurs when there is insufficient sand being transported to the beach from offshore or neighbouring beaches to offset ongoing losses, a situation known as a sediment budget deficit.

Storm-driven beach fluctuations occur naturally across NSW and will continue into the future. However, sea-level rise is projected to drive shoreline recession, altering the spatial extent of coastal erosion hazards. Sea-level rise may also contribute to sediment budget deficits for many beaches in NSW, as offshore sand sources become less connected to the active beach system and more eroded sand is deposited in deeper water. This shift is likely to intensify erosion where it is already occurring and cause shoreline recession in areas not currently affected.

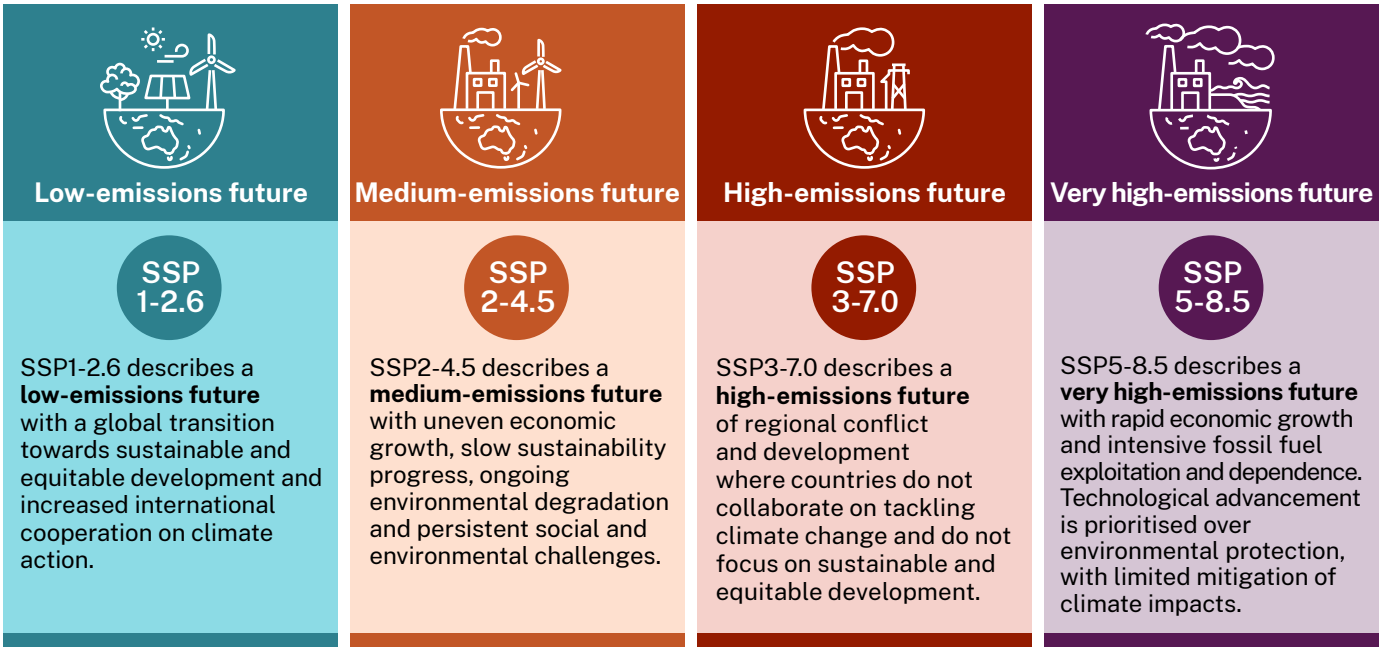
Observed coastal erosion impacts in NSW range from nuisance effects, such as sand being deposited across roads and car parks or reduced beach amenity, through to severe outcomes including dune collapse and the loss of buildings and other structures to the surf (Figure 2).

Figure 2: *Coastal erosion of the dune at the Entrance North (left) and loss of structures at Wamberal (right).*

Shared Socioeconomic Pathways

The coastal erosion modelling in this snapshot is based on the latest emissions and SSP scenarios adopted in the Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report (2021).

The SSPs describe plausible future trajectories of greenhouse gas emissions and associated socioeconomic factors such as population growth, economic development, education, urbanisation, and land use change.



Sea-level rise

Sea levels are rising and are projected to have a major impact on coastal communities in NSW over coming decades. At the State's baseline sea level monitoring station at Port Kembla[iii], average sea level has been rising at a rate of approximately 3.7 mm/year, with approximately 12 cm of sea-level rise since 1991[iv]. Regardless of future emissions trajectories, sea-level rise will continue for centuries to millennia due to the long-term response of the deep ocean and ice sheets to past and ongoing warming[v,vi].

Sea level along the NSW coastline is projected to continue rising under all emissions scenarios, with only minor spatial variation. Slightly higher rates of rise are projected toward the north.

This assessment presents modelled projections under low-, medium-, and high-emissions scenarios, with an additional very high-emissions scenario (SSP5-8.5) included to capture high-consequence futures.

Further information on emissions scenarios is available on AdaptNSW.

Port Kembla is projected to experience increases in sea level of 0.23–0.56 m under SSP1-2.6, 0.37–0.73 m under SSP2-4.5, 0.50–0.91 m under SSP3-7.0, and 0.59–1.04 m under SSP5-8.5 by 2100, relative to the 1995–2014 baseline period (Figure 3).

The 'likely' range of sea-level rise projected for Port Kembla relative to a 1995-2014 baseline (Table 1 and Figure 3) is presented for context to the coastal hazard modelling. The IPCC defines the 'likely' range as the 17th to 83rd percentile of modelled outcomes, representing a 66% confidence interval – meaning there is a two thirds chance that sea-level rise will fall within this range, based on current knowledge.

Table 1: *Projected increase in sea-level rise at Port Kembla (in cm) as per NASA Sea Level Projection Tool*[vii].

Year	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
2050	**17** (11–24)	**19** (13–26)	**21** (16–28)	**23** (17–30)
2100	**37** (23–56)	**52** (37–73)	**67** (50–91)	**77** (59–104)
2150	**58** (33–93)	**87** (58–129)	**118** (83–165)	**134** (94–192)

The bold number is the median. Underneath the median is the 'likely' (17th-83rd percentile) range of sea-level rise

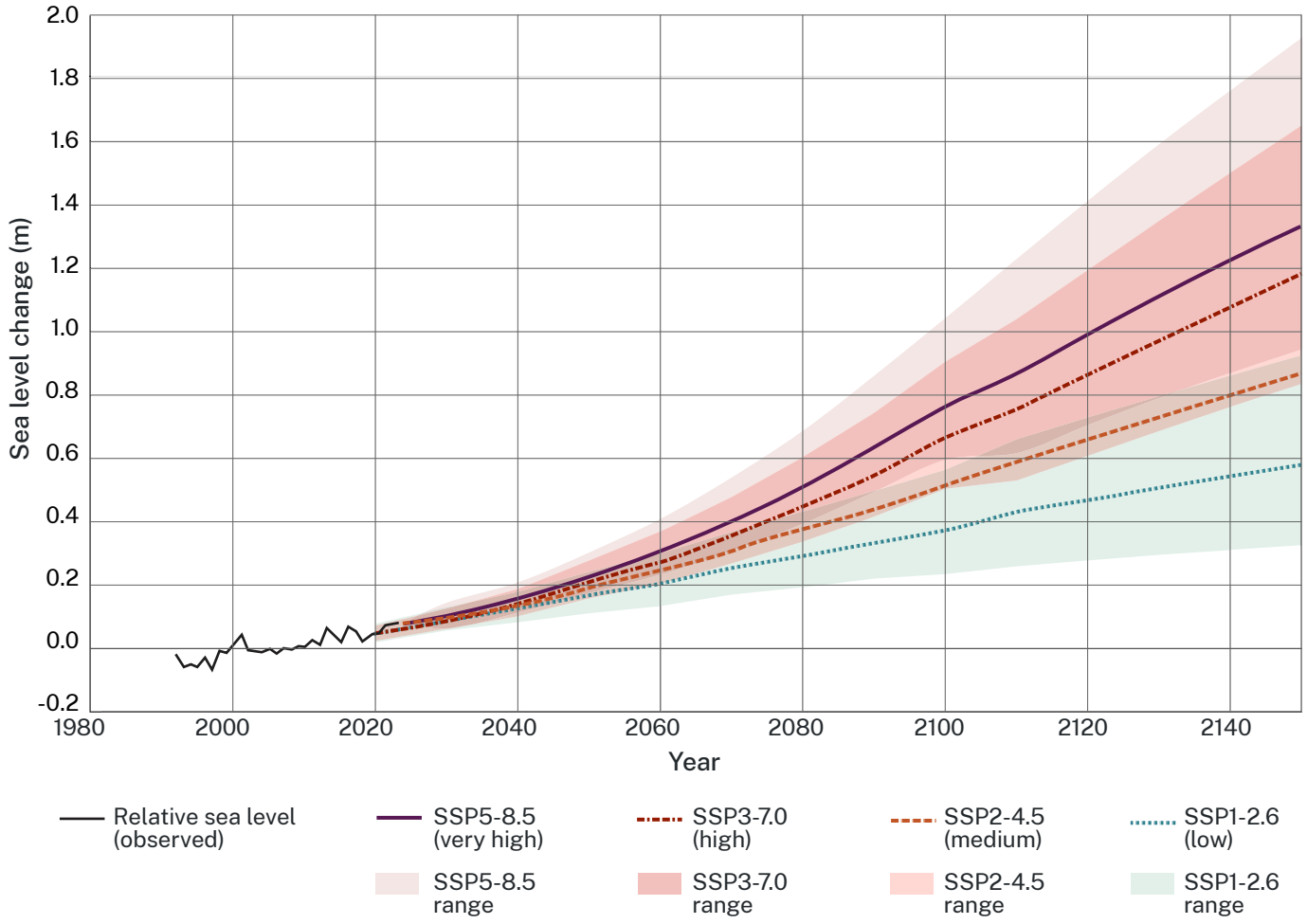


Figure 3: *Median sea-level rise trajectories for Port Kembla out to 2150 (solid lines) and their associated likely ranges (shading) representing the 17th-83rd percentile for the low-emissions scenario SSP1-2.6, medium-emissions scenario SSP2-4.5, high-emissions scenario SSP3-7.0, and very high-emissions scenario SSP5-8.5. Projected increases are relative to a 1995-2014 baseline*[vii].

Modelling coastal erosion

Coastal erosion modelling was undertaken using a probabilistic approach that simulates storm-driven erosion, natural beach fluctuation and the effects of sea-level rise at decadal intervals from 2020 to 2150, under a range of SSPs.

This produces a distribution of projected erosion extents for each decade and scenario. From this distribution, projections were extracted at selected exceedance probability levels that are relevant for planning and risk assessment.

The year 2020 was chosen as the reference baseline to optimise the use of the extensive measured water level and beach morphology data available in NSW and to align with the IPCC's Sixth Assessment Report sea-level rise data.

The probabilistic approach allows the likelihood of different erosion extents to be estimated under a range of future sea-level rise scenarios and timeframes, providing a more robust basis for decision-making.

What are exceedance probabilities from the distribution of hazard model outputs?

For each future sea-level rise scenario and each decade, the hazard modelling was repeated many thousands of times with different input values, producing a distribution of erosion hazard projections that reflects the combined range of uncertainty for each scenario. This distribution can be analysed in several ways. Key hazard projections of interest were extracted and expressed as exceedance probabilities (Figure 4). For example, a 10% exceedance probability indicates that 10% of the model projections exceed that value for the given decade and sea-level rise scenario.

The data and information presented in this snapshot are primarily based on the 1% exceedance probability. Additional projections can be explored through the Future Climate and Adaptation Hub on the SEED Data Portal and the technical report[i] to support tailored decision-making aligned with specific risk tolerances and planning needs.

There are inherent uncertainties in modelling coastal erosion hazards associated with sea-level rise. Beach sectors were modelled using reduced-complexity approaches. Localised variability within sectors may not be fully captured, and interactions between erosion and inundation under high sea-level rise scenarios may differ from forecasts. Modelling excludes bedrock areas, and erodible backshore materials were simplified, with detailed local studies needed for greater resolution.

Figure 4 *Coastal erosion mapping for Wooli Beach at present (2020 baseline) and for the SSP3-7.0 scenario in 2050, 2100, and 2150 at 1% probability level.*

Assessing asset exposure

Exposure statistics are based on the spatial extent of projected coastal erosion intersecting with the existing distribution of built assets and recorded Aboriginal cultural heritage sites along the NSW coast. The exposure assessment does not account for potential future development, current or future adaptation measures to protect assets, or changes to land use.

Exposure statistics are grouped by coastal regions following the Australian Sediment Compartments framework[viii], which delineates nine distinct compartments characterised by regionally linked coastal processes and geomorphology: North Coast, Northern Rivers, Mid-North Coast, Port Stephens, Central Coast, Sydney, Illawarra, Shoalhaven, and South Coast. These compartments are separated by major geomorphic features such as headlands, rivers, or significant changes in coastline orientation.

Regarding buildings exposure, structures without an assigned address were excluded to reduce false positives, although secondary structures (e.g., sheds, water tanks, and carports) at locations with an assigned address remain in the dataset. Several building categories (e.g., residential, commercial) were considered; therefore, the building exposure results presented herein do not represent a single building class only.

Exposure statistics for buildings are presented in this snapshot. Additional information on the exposure of roads, critical infrastructure (such as hospitals, schools, emergency services and judicial facilities), paths, railways, Aboriginal cultural heritage sites, electricity transmission lines, airports, and runway lengths can be explored through the technical report[i].

Coastal erosion extent

Coastal erosion is projected to increase

The landward extent of erosion hazards is projected to increase progressively over time, with greater impacts under higher emissions scenarios. Currently, approximately, 51 km^2 of NSW coastal areas are potentially exposed to erosion at 1% annual exceedance probability. By 2100, for a 1% probability level from the distribution of hazard projections, this is projected to increase to approximately 76 km^2 under a low-emissions scenario (SSP1-2.6), to 82 km^2 under a medium-emissions scenario (SSP2-4.5), to 94 km^2 under a high-emissions scenario (SSP3-7.0), and to 101 km^2 under a very high-emissions scenario (SSP5-8.5) (Table 2 and Figure 5).

Table 2: *Projected coastal erosion extent (km^2) for NSW sandy beaches at 1% probability level.*

Year	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
2050	56.1	56.6	57.0	57.4
2100	76.2	82.3	93.6	101.1
2150	119.1	142.4	177.8	204.9

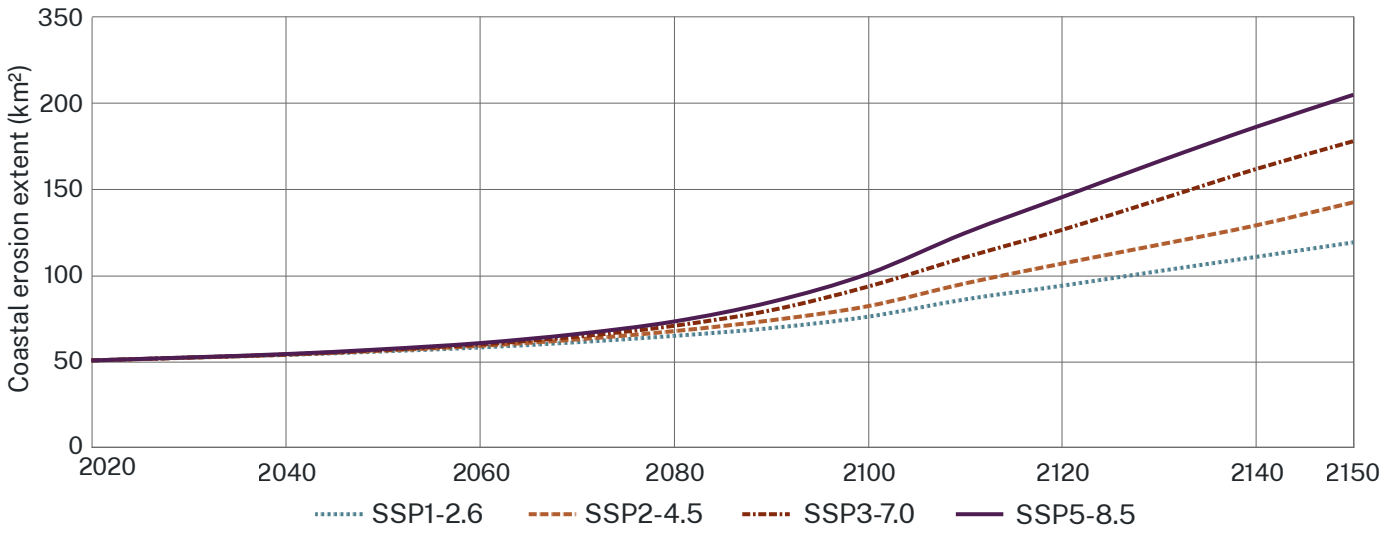


Figure 5: *Projected increase in state-wide coastal erosion extent at 1% probability level for NSW out to 2150 under different emissions scenarios.*

Exposure to coastal erosion

Exposure of buildings to coastal erosion will increase over time, with higher emissions scenarios and sea-level rise resulting in greater impacts. Currently, approximately 660 buildings are exposed to erosion at a 1% annual exceedance probability storm erosion volume. By 2100, at 1% exceedance probability in the hazard projections distribution, exposure increases to around 2,460 buildings under a low-emissions scenario, to 3,100 buildings under a medium-emissions scenario, to 4,530 buildings under a high-emissions scenario, and to more than 5,300 buildings under a very high-emissions scenario (Table 3 and Figure 6).

Table 3: *Projected number of buildings exposed to coastal erosion at a 1% probability level in 2050, 2100, and 2150 under different SSP scenarios.*

Year	SSP1-2.6	SSP2-4.5	SSP3-7.0	SSP5-8.5
2050	910	938	959	973
2100	2462	3093	4529	5305
2150	7499	10712	17741	22124

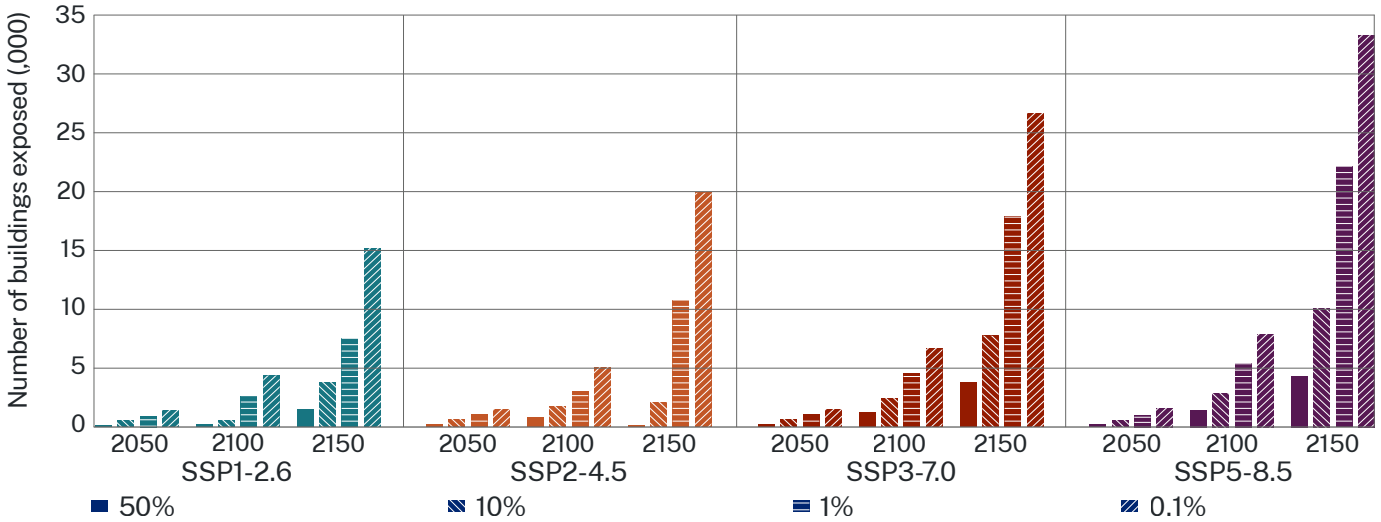


Figure 6: *State-wide building counts exposed to coastal erosion at different probability levels and under different SSP scenarios. NOTE: Several building categories (e.g., residential, commercial) were considered; therefore, the building exposure results presented herein do not represent a single building class only (e.g., major residential).*

Regional breakdown of building exposure

Regional statistics for coastal erosion are grouped under the Australian Sediment Compartments framework[viii], which delineates nine distinct compartments characterised by regionally linked coastal processes and geomorphology. These compartments are the North Coast, Northern Rivers, Mid-North Coast, Port Stephens, Central Coast, Sydney, Illawarra, Shoalhaven, and South Coast.

Currently, the exposure of buildings to coastal erosion hazard is highest in the Sydney and Central Coast regions. These regions represent long established coastal settlements with extensive development adjacent to sandy shorelines. By 2050, under a high-emissions scenario and at a 1% probability level, Sydney and the Central Coast are projected to remain the most exposed regions, with northern compartments such as the North Coast and Northern Rivers showing steadily increasing exposure as erosion extents expand (Figure 7).

By 2100, under a high-emissions scenario and at a 1% probability level, the northern compartments are projected to experience the greatest number of exposed buildings, with the Northern Rivers exceeding 1,000 exposed buildings. Projected regional differences reflect variations in coastal geomorphology and sediment dynamics as well as the level of urban development. For instance, the northern regions, characterised by extensive low-lying floodplains and gently sloping coastal profiles, are projected to be more susceptible to widespread erosion under rising sea levels and cumulative storm activity.

Significant lengths of roads, railways, and other infrastructure are also projected to be at risk of coastal erosion. Further information on the exposure of these asset types is available through the Future Climate and Adaptation Hub on the SEED Data Portal and detailed in the technical report[i].

While coastal erosion is projected to increase over time, proactive adaptation is needed to reduce future impacts and enhance coastal resilience. Coastal communities can implement a range of adaptation measures, including dune recovery, habitat restoration, and the design of resilient infrastructure to accommodate changing conditions. The NSW Coastal Management Framework provides the primary mechanism for managing these hazards, with local councils playing a key role in preparing coastal management programs that identify local issues and outline targeted actions for mitigation and adaptation.

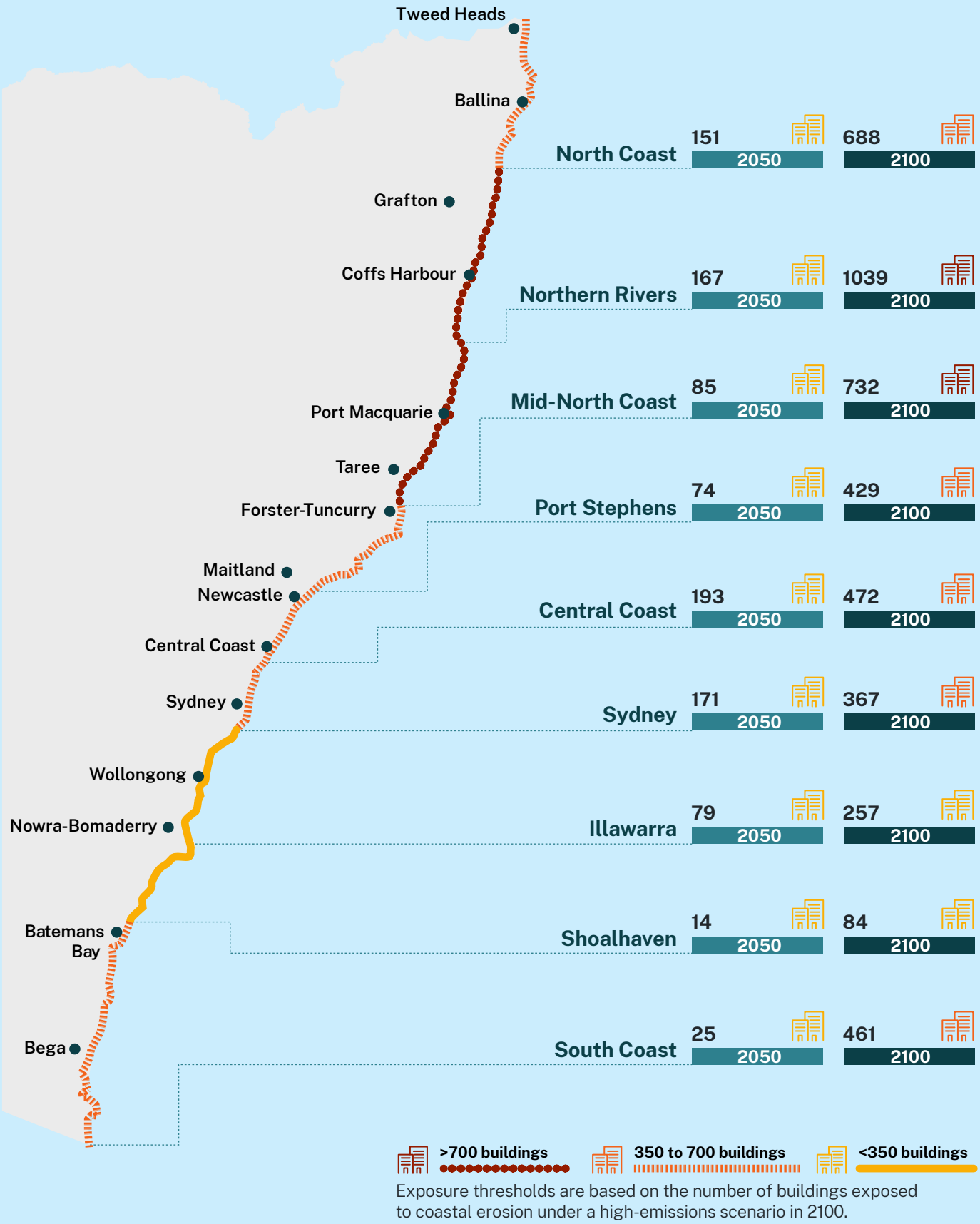


Figure 7: *Map showing the nine primary sediment compartment regions along the NSW coast and the number of buildings exposed to coastal erosion at 1% probability level, under a high-emissions scenario (SSP3-7.0) at 2050 and 2100. NOTE: Multiple building categories were included in the analysis; therefore, the building exposure results presented here do not represent a single building class.*

Climate action and information

Climate action

This coastal erosion snapshot highlights both current hazard-exposure levels and the projected changes under various sea-level rise scenarios. The stark differences between emissions scenarios highlight the need for global action to reduce greenhouse gas emissions, and specifically for NSW to meet its legislated Net Zero emissions reduction target by 2050. Avoiding the more severe outcomes associated with high emissions scenarios depends on timely and sustained mitigation action.

Equally important is the prioritisation of adaptation strategies to manage both existing and future coastal erosion risks. Highly developed and vulnerable areas identified as at risk should be prioritised for early adaptation planning and investment. As hazard exposure is projected to accelerate over time, proactive adaptation now provides an opportunity to strengthen resilience and ensure that communities can adapt effectively and equitably.

Detailed guidance (including options) on managing coastal hazards is included in the NSW Coastal Management Manual, which recognizes that coastal risk management decisions need to consider local circumstances, including the vulnerability of development and local social, economic and environmental factors.

Information

Coastal hazard-exposure projections are delivered with support from the NSW Reconstruction Authority and the Commonwealth Government through the Disaster Risk Reduction Fund. Detailed information on the methods and applications of the hazard projections can be found in the technical report[i]. The projection dataset for coastal erosion is available on the SEED Data Portal. This comprehensive range of future scenarios ensures that decision-makers can plan for likely outcomes while also preparing for less probable, high consequence events.

This snapshot summarises key headline findings for projected coastal erosion, as part of the NSW Coastal Erosion and Inundation Assessment 2025. The assessment forms part of the NSW Government's commitment to 'publish regularly updated and improved local level climate change projections' under Action 3 of the NSW Climate Change Adaptation Strategy.

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