

Executive Summary

The Byron Shire's coastline extends from the local government area's southern boundary on Seven Mile Beach to its northern boundary at South Golden Beach. The Shire's coastline is a highly dynamic coastal environment and has experienced numerous coastal erosion events and a variety of coastal management responses.

Coastal management strategies are often expensive and robust scientific knowledge is essential for effective coastal planning. To fully appreciate the dynamics along the Byron Shire coast a sand movement and coastal hazard assessment within two sediment compartments has been completed in accordance with the NSW Coastal Management Manual. The sand movement component was used to inform a Shire-wide coastal hazard assessment. The study supports the preparation of Coastal Management Programs (CMPs) by Byron Shire Council in accordance with the NSW Coastal Management Framework. Stage 2 of CMP preparation involves undertaking detailed studies that help Council to identify, analyse and evaluate risks, vulnerabilities and opportunities.

This report provides a summary of the outcomes of a comprehensive study of the regional and local coastal processes operating on the Byron Shire coastline. The report covers a 35km long stretch of coastline including 25km of sandy beaches, two major headlands including mainland Australia's most easterly point, three coastal lagoons and the Brunswick River estuary. It is a coastline that grades from highly developed within Byron Bay township to natural along other sections. It is a coastline that is impacted by waves, tides, river flows, wind and human modification, all of which vary alongshore. Combined, these present an extremely complex and dynamic natural system that within and through which, there is considerable sand movement.

The study adopts a data-driven approach. At its centre is an analysis of the Byron coastal sand budget, which maps historical sand volume changes in 64 sediment cells. These are used to infer the rates and directions of sand movements. The most likely drivers for the observed sand volume changes are described based on observational data, previous literature, state-of-the-art numerical modelling and/or coastal processes knowledge. Key outcomes from the contemporary assessment are:

- The beaches along the Byron Shire coast experience change over various time scales, driven by persistent changes to sand budgets (long term) and climatic cycles (medium term) as well as storms and seasonal variations (short term).
- Average net longshore sand transport in the Byron Shire is from south to north and ranges from 450,000m³/year along its southern coastline to 510,000m³/year along its northern coastline ($\pm 20\%$). However, longshore sand transport rates are highly variable responding to variation in the direction and energy in the offshore wave climate, which is sensitive to climate cycles of years, decades and longer timescales.
- A net gain in sand volume was observed at Tallow Beach which led to shoreline accretion along this stretch of coast. This is likely due to an extensive lower shoreface sand body that is reasoned to promote onshore supply of sand to the Broken Head to Cape Byron beach compartment.
- Headland bypassing around Cape Byron results in a highly variable sand supply to the southern embayment with the annual range estimated to be from around 150,000 to over 900,000m³/year. When coupled with the wave propagation characteristics of the embayment, the variable sand supply leads to a highly variable shoreline in the southern embayment.
- Sand movement pathways within the embayment follow two pathways: a littoral pathway (4m water depth) and a cross-embayment pathway (up to 15m water depth). Based on sand volume changes determined from repeat surveys the relative split between the two pathways, when averaged across the embayment, has been calculated to be 70 : 30 (littoral : cross embayment). This is revised from previous assessments that assumed a 50 : 50 split between the pathways.

- The Shire's geomorphic structure, including bedrock and coffee rock reefs and outcrops influence wave propagation, sand movements, shoreline dynamics and surfzone morphology. Further, the embayment's extensive reefs reduce the volume of sand that can be stored in the southern embayment.
- Existing coastal structures, including the Jonson Street Protection Works and Belongil seawalls interact with the embayment's natural sand movements, with the level of interaction (over the medium to long-term) largely controlled by the amount of sand in the embayment, which in turn is a function of headland bypassing and wave climate.
- Along the Shire's northern coastline, contemporary changes in sand volumes and shoreline position have been minimal with some sections of beach trending towards an accretionary behaviour.

In line with the Coastal Management Act 2016 and NSW Coastal Management Manual, a coastal hazard assessment was undertaken considering a range of specific coastal hazards, including:

- A probabilistic beach erosion and shoreline recession hazard assessment. This was informed by a statistical model comprising a volumetric coastline response model that uses detailed terrain data and a parametrised sand budget to predict the potential range of present and future coastal erosion hazards.
- A high-level geotechnical assessment of the coastal cliffs at Broken Head, Cape Byron, Wategos and The Pass.
- A coastal inundation hazard assessment for the Byron Shire open coast, including detailed assessments at Belongil Beach, New Brighton Beach and South Golden Beach.
- Estuary specific hazard assessment at Ti Tree Lake, Tallow Creek, Belongil Creek and Brunswick River. The type of hazards assessed vary for each estuary and include:
 - Coastal lake or watercourse entrance instability which may affect flood hazards and beach and foreshore erosion hazards as well as the estuary flushing and associated water quality.
 - Inundation of land surrounding estuaries by tidal action under average meteorological conditions.
 - Erosion and inundation of foreshores caused by tidal waters and the action of waves.

Key outcomes from the coastal hazard assessments are:

- The probabilistic coastal erosion and recession hazard assessment suggests that built public and private assets are located within the immediate hazard extent at Clarkes, Main, Belongil and at New Brighton (lower likelihood) beaches. By 2120, the hazard extents would affect a considerably larger number of additional public and private assets and foreshore area at the northern end of Seven Mile Beach, Broken Head to Suffolk Park, Clarkes to Main Beach, Belongil Beach, Brunswick Beach, New Brighton and South Golden Beach. Where regional geology data (or other evidence) suggests that erosion and recession may be limited by hard substrate, the actual hazard extents are subject to confirmation through site-specific geotechnical assessment. A detailed asset exposure and risk assessment, including possible consequences, was not completed as part of this study.
- The review of coastal cliff and geotechnical hazards did not identify any significant areas that require further detailed assessment at this time (where observed). Although some areas of localised wedge failure or slumping were observed, they were generally minor and not representative of the overall rock mass.
- The coastal inundation assessment reveals that for the immediate timeframe, beachfront properties and areas with beach access along Belongil Beach, in southern New Brighton Beach and South Golden Beach are affected. For the 2120 planning timeframe, considering sea level rise, impacts on most beachfront properties along both the southern and northern sections of New Brighton Beach and extensive overwash along the entire beach at South Golden Beach are projected, resulting in significant coastal inundation. At Belongil, the 2120 coastal inundation hazard extends across the full width of Belongil Spit to the creek. Estimated wave overtopping volumes exceed safe thresholds for most of the

abovementioned locations at varying planning timeframes, posing a potential safety hazard for individuals and property in immediate overwash areas. Other sites potentially exposed to coastal inundation but not assessed in detail as part of this study include Wategos Beach and Main Beach (Jonson Street Protection Works - assessed in Bluecoast, 2022b).

- The estuary entrances to Ti Tree Lake and Tallow Creek are relatively stable. The entrance to Belongil Creek has been observed to vary over an approximately 600m alongshore area. The migrating entrance channel and risk of breakthrough of Belongil Spit exposes surrounding land and properties to a variety of coastal and estuarine hazards. In the absence of effective and long-term coastal management of the beach and dune, a coastal storm event with a 1% annual exceedance probability could result in a breakthrough of Belongil Spit that isolated private property along the narrow sand spit. The key factors affecting the entrance stability of Belongil Creek have been identified as long-term shoreline recession, variable sand supply linked to headland bypassing and downdrift effects by existing seawalls during low beach levels. Sea level rise, including estuary sequestration of sand from the littoral zone, is likely to exacerbate the identified hazards.
- By 2040, high tides can expose public infrastructure and properties surrounding Belongil Creek to inundation. With sea level rise, land and development surrounding Tallow Creek and Brunswick River may also be exposed to tidal inundation by 2120.
- Localised bank erosion and inundation of foreshores is observed along Belongil Creek and to a greater extent within the Brunswick River estuary. Sea level rise will likely affect the frequency and duration of inundation of foreshores, further impacting bank stability and vegetation health where this is already occurring as well as affect additional areas.

The approaches adopted herein are reasonable and valid for assessing the Byron Shire's coastal hazards and underlying coastal processes. However, it is important that decision-makers recognise the assumptions underlining the assessments as well as the inherent uncertainties. The key assumptions and uncertainties for each of the hazard assessments are outlined in the relevant sections in this report.

The outcomes of this report will be used to undertake a detailed risk assessment of coastal hazards affecting the Byron Shire's coastline to identify and evaluate management options and support decision-making in Stages 3 and 4 of CMP preparation.