**PROBABILISTIC APPROACHES FOR ASSESSING EROSION HAZARD ALONG NEW SOUTH WALES MID NORTH COAST**

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A probabilistic shoreline hazard assessment has been undertaken for the Clarence Valley coastline on the Mid North Coast of New South Wales. The assessment was unique in its size and scope, implementing a detailed probabilistic methodology that spanned 70km of varying coastline, including a range of open coasts, embayed beaches, multiple headlands, river training walls, sand sources and sinks. It was designed to meet the requirements of the NSW Management Manual, for inclusion within an updated Coastal Management Program.

The coastline was initially subject to a Proximity Analysis (First pass assessment) and a Regional-scale Assessment (Second pass). The First Pass assessment used a simple proximity analysis to consider potentially erodible sandy coastline that featured properties that may be affected by coastal erosion at present or in the future. The Second Pass assessment used a sediment-compartment templating approach to characterize the morphology and sediment budgets of NSW beaches. This was applied through a probabilistic framework to consider uncertainty in model inputs, using a Volumetric Beach Response model described in Kinsela et al (2016).

The new probabilistic assessment has now incorporated additional local-scale data, regional to local-scale wave modelling, long-term recession assessments and new erosion modelling. Coastal recession and erosion has been calculated based on a subset of processes identified within the Kinsela volumetric model, each subjected to new detailed analysis under the framework:

|  |  |
| --- | --- |
| $$E\_{T}=q\_{x}N(1+k)+S+V$$ | (1) |

and

|  |  |
| --- | --- |
| $$k=\frac{q\_{y}\left(future\right)-q\_{y}(present)}{q\_{y}(present)}$$ | (2) |

Where:

* ET = the estimated erosion at a given planning horizon (m)
* qx = historical shore-normal recession rate (m/yr)
* N = number of years to planning horizon
* k = factor applied to qx to account for changes in cross-shore recession deficit due to changes in alongshore sediment transport rates (qy) caused by future changes in wave climate
* qy = current alongshore sediment flux (m3/yr)
* S = shoreline changes due to erosion from changes in sea level (m)
* V = event-based erosion due to storms (m)

The four key terms (qx = historical recession, k = changes in longshore sediment transport deficit, S = shoreline changes due to sea level rise, and V = event-based storm erosion) are described in the following sections.

Historical recession (qx) represents historic shore-normal recession rates calculated using coastal profile data, remote sensing and image analysis. The mean shoreline changes are calculated and assigned variability based on the standard deviation of annual shoreline positions, processed to identify the 5th/95th percentiles. These data attributes will be used to construct a distribution of potential recession rates.

Changes in longshore sediment transport deficit (k) has been calculated using a Sediment Budget approach, supported through shoreline analysis and a regional Longshore Sediment Transport model. Variability in sediment flux has been introduced based on historic decadal fluctuations in the LST rate linked to variations within the mean long-term recession.

Shoreline changes due to sea level rise (S) has been calculated using a volumetric model fit to an idealised shoreface profile (following h(y)=Aym) for each beach. The model raises the beach profile in accordance with sea level rise estimates and translates the shoreface geometry landward to balance the required volumetric change out to the depth of closure. Variability has been introduced based on the potential changes to the depth of closure and sea level rise estimates within 5th, 50th and 95th percentile estimates from IPCC AR6 projections.

Event-based storm erosion (V) has been calculated using the volumetric model solving the Vellinga formula (1982). This model uses a 10,000-year simulated dataset of nearshore wave conditions for each beach, estimated using a combined numerical modelling and machine learning approach. Variability has been introduced based on future wave projections within Collaboration for Australian Weather and Climate Research (CAWCR) datasets. This includes ensemble mean variability for wave height, period, and direction.

Kinsela, et al. (2016): A flexible approach to forecasting coastline change on wave-dominated beaches. Journal of Coastal Research, Special Issue, No. 75, pp. 952-956.

Vellinga (1982): Beach and dune erosion during storm surges. Coastal Engineering, ELSEVIER, vol 6, issue 4, pp. 361-387