SYDNEY COASTAL COUNCILS GROUP INC.

Councils **caring for the coastal and estuarine environment**

INFORMATION RESOURCE

COASTAL AND ESTUARINE HAZARDS AND WATER QUALITY

Information sources on coastal and estuarine hazards

The Coastal Management Act 2016 defines a coastal hazard as meaning the following:

a) beach erosion,
b) shoreline recession,
c) coastal lake or watercourse entrance instability,
d) coastal inundation,
e) coastal cliff or slope instability,
f) tidal inundation,
g) erosion and inundation of foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

Information sources, resources and tools for the seven coastal hazards defined in the Coastal Management Act are provided below.

Coastal Hazard 1. Beach Erosion

- A coastal zone emergency action subplan[1] is a plan that outlines the roles and responsibilities of all public authorities (including the local council) in response to emergencies immediately preceding or during periods of beach erosion, coastal inundation or cliff instability, where the beach erosion, coastal inundation or cliff instability occurs through storm activity or an extreme or irregular event. For the purposes of this subsection, those roles and responsibilities include the carrying out of works for the protection of property affected or likely to be affected by beach erosion, coastal inundation or cliff instability.

- The CoSMoS[2] example outlines a comprehensive approach to estimate coastal inundation and erosion risk. CoSMoS uses a nested modelling system whereby different process-based numerical models are run sequentially with each providing the boundary conditions to subsequent models. Although complex, this approach captures the physical links between the larger scale processes (e.g., in Australia, an East Coast Low in the Tasman Sea) and local-scale inundation and erosion, and therefore will give the most realistic assessment of inundation and erosion risk.

- UNSW Water Research Laboratory NSW Beach Profile Database of 150 locations along the NSW coast.

Coastal Hazard 2. Shoreline Recession

- CoastAdapt Shoreline Explorer[3] interactive map provides three datasets[4]:
  1. Sediment compartments and their characteristics
  2. Smartline
  3. Water Observation from Space
  4. *More information available* here[5].

- The simple two-dimensional model, known as the 'Bruun Rule' (Bruun 1962, 1988), can be used as a coarse first-order approximation for determining sea level rise induced recession for planning purposes along the open coast. Using the Bruun Rule, recession due to sea

[1] https://www.environment.nsw.gov.au/resources/coasts/110631gdntemacsubs.pdf
[2] https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos?qt-science_center_objects=0#qt-science_center_objects
[3] http://coastadapt.com.au/coastadapt-interactive-map
[4] https://coastadapt.com.au/tools/coastadapt-datasets
[5] https://coastadapt.com.au/sites/default/files/factsheets/Datasets_guidance_1_present.pdf

level rise can be estimated simply as the product of the sea level rise (over the planning timeframe of interest) multiplied by the inverse of the active profile slope.

- One of the great strengths of the Bruun Rule is that it provides a clear explanation for why the risks from sea-level rise are not simply the direct effects of inundation, but also takes account of the accompanying erosion and shoreward recession of the coast. However, the Bruun rule assumes an entirely sandy coast backed by dunes and thus would be inappropriate to apply along rocky or reef coasts. Three-dimensional models are available that take into account more processes, such as longshore sediment movement, but these are more complex to use. The NSW Government (2010) recommends that, where the Bruun Rule is to be applied, surveys are carried out to accurately determine the input parameters.

- For further information on the Bruun Rule and its application, see Section 4.1 of For further information on the Bruun Rule and its application, see Section 4.1 of Information Manual 2: Understanding sea-level rise[6] and Section 6.4.3 of Information Manual 3: Available Datasets and Section 6.4.3 of Information Manual 3: Available Datasets[7]

Coastal Hazard 3. Coastal Lake or Watercourse Entrance Instability

- The Estuaries of NSW website[8] lists all NSW Estuaries and gives them a classification based on 5 groups: Oceanic Embayments, Tide Dominated Estuaries, Wave Dominated Estuaries, Intermittently Closed Estuaries, and Freshwater Bodies.

- This report[9] provides tidal information for most NSW estuaries (The Floodplain Risk Management Guide[10]).

- To establish initial water levels in the waterway this report[11] provides tidal plane information on water levels for most NSW estuaries (The Floodplain Risk Management Guide[12]).

Coastal Hazard 4. Coastal Inundation

- A coastal zone emergency action subplan[13] is a plan that outlines the roles and responsibilities of all public authorities (including the local council) in response to emergencies immediately preceding or during periods of beach erosion, coastal inundation or cliff instability, where the beach erosion, coastal inundation or cliff instability occurs through storm activity or an extreme or irregular event. For the purposes of this subsection, those roles and responsibilities include the carrying out of works for the protection of property affected or likely to be affected by beach erosion, coastal inundation or cliff instability.

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[6] https://coastadapt.com.au/sites/default/files/information-manual/IM02_Understanding_sea_level_rise.pdf
[7] https://coastadapt.com.au/sites/default/files/information-manual/IM03_Available_datasets_0.pdf
[8] https://www.environment.nsw.gov.au/topics/water/estuaries/estuaries-of-nsw
[9] https://new.mhl.nsw.gov.au/docs/oeh/tidalplanes/mhl2053%20OEH%20tidal%20planes%20analysis%20final%20report.pdf
[10] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/modelling-catchment-flooding-oceanic-inundation-150769.pdf?la=en&hash=41092E03528FEF91161826E5FE5D9E5CD2D13598
[11] https://new.mhl.nsw.gov.au/docs/oeh/tidalplanes/mhl2053%20OEH%20tidal%20planes%20analysis%20final%20report.pdf
[12] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/modelling-catchment-flooding-oceanic-inundation-150769.pdf?la=en&hash=41092E03528FEF91161826E5FE5D9E5CD2D13598
[13] https://www.environment.nsw.gov.au/resources/coasts/110631gdntemacsubs.pdf

- The Australian Flood Risk Information Portal (the portal)[14] hosts data and tools that allow public discovery, visualisation and retrieval of flood studies, flood maps, satellite derived water observations and other related information from a central location. You can search for studies and maps by; selecting an Area on the Map, an address search, specifying your search parameters.

- CoastAdapt has inundation mapping for each coastal local council in Australia, for 2050 and 2100, and two scenarios of greenhouse gas concentrations, see CoastAdapt datasets 2: future sea-level rise and its effect on coastal inundation[15];

- Coastal Risk Australia has developed an interactive map tool[16] for a wider range of sea-level rise scenarios designed to communicate coastal inundation associated with sea level rise to the year 2100. Using Google Earth Engine technology, CRA allows you to investigate the extent of coastal inundation using the latest 3D models of the Australian coastline. Tit has been developed by the Cooperative Research Centre for Spatial Information (CRCSI) to communicate the risks of coastal flooding from sea-level rise using Google Earth Engine technology. The tool allows users to simply investigate the extent of inundation from four climate change scenarios using a new 5 m resolution digital elevation model derived from high-resolution airborne LiDAR, and bucket-fill inundation modelling. Areas at risk of inundation under each scenario are shown in light blue. The tool covers the highly developed areas of Australia's coast, and wherever high-resolution elevation (Lidar) data are available.
    - In both datasets, inundation mapping is only available where LiDAR surveys have been carried out.

- The CoSMoS example outlines a comprehensive approach to estimate coastal inundation and erosion risk. CoSMoS[17] uses a nested modelling system whereby different process-based numerical models are run sequentially with each providing the boundary conditions to subsequent models. Although complex, this approach captures the physical links between the larger scale processes (e.g., in Australia, an East Coast Low in the Tasman Sea) and local-scale inundation and erosion, and therefore will give the most realistic assessment of inundation and erosion risk.

- The performance of process-based numerical models at predicting inundation and erosion has improved in recent decades. Examples of commonly used process-based numerical models include:
    - Delft3D (https://www.deltares.nl/en/software/delft3d-4-suite/) coupled with the wave model SWAN (http://www.swan.tudelft.nl/),
    - XBeach http://oss.deltares.nl/web/xbeach/ and
    - Mike21 (https://www.mikepoweredbydhi.com/products/mike-21.
        - Each of these models operates differently but all are capable of predicting inundation and erosion. As process-based numerical models explicitly account for a range of processes, they can be applied in a wider range of environments (e.g. rocky and sandy coasts). Similar to empirical models however, it is important to select a numerical model that considers processes that are likely to be important. For example, XBeach does not account for salinity variations and so it would be an inappropriate model to use in an estuarine environment.

[14] http://www.ga.gov.au/flood-study-web/#/search?utm_source=promotion&utm_medium=homepage&utm_content=Flood_Studies&utm_campaign=Online-Tools
[15] https://coastadapt.com.au/tools/coastadapt-datasets#future-datasets
[16] http://coastalrisk.com.au/
[17] https://www.usgs.gov/centers/pcmsc/science/coastal-storm-modeling-system-cosmos?qt-science_center_objects=0#qt-science_center_objects

- Sydney Coastal Councils Group Project 'Mapping and Responding to Coastal Inundation'. Information and reports are available here.

- Sydney Coastal Councils Group – Coastal Vulnerability to Multiple Inundation Sources Project 2014. For project information click here.

Coastal Hazard 5. Coastal Cliff or Slope Instability

- A coastal zone emergency action subplan[18] is a plan that outlines the roles and responsibilities of all public authorities (including the local council) in response to emergencies immediately preceding or during periods of beach erosion, coastal inundation or cliff instability, where the beach erosion, coastal inundation or cliff instability occurs through storm activity or an extreme or irregular event. For the purposes of this subsection, those roles and responsibilities include the carrying out of works for the protection of property affected or likely to be affected by beach erosion, coastal inundation or cliff instability.

- The Landslide Risk Management guidelines[19] (by the Australian Geomechanics Society) provides guidance to practitioners on the steps of a hazard analysis; consequence analysis; risk estimation; risk assessment; risk management; and reporting standards.

- The Australian Geomechanics Society has also published A National Landslide Risk Management Framework for Australia[20] with the aim of managing the risk to occupants and property from landslide hazards. It outlines a landslide risk assessment and management process within the current legislative framework. Landslide Risk Management Concepts and Guidelines [21] presents a risk classification for slope instability for use in the Sydney Basin (Newcastle-Sydney-Wollongong-Lithgow).

- Sydney Coastal Councils Group worked collaboratively with the Australian Geomechanics Society on the Landslide Risk Management Investigations project. Information and reports are available here.

Coastal Hazard 6. Tidal Inundation

- Inundation mapping[22] is provided for mid- and end century for all Australian local councils where LiDAR surveys have been carried out to provide accurate elevation data.

Coastal Hazard 7. Erosion and Inundation of Foreshores caused by tidal waters and the action of waves, including the interaction of those waters with catchment floodwaters.

- The NSW Nearshore Wave Transformation Toolbox[23] is an advanced set of tools that provides coastal professionals with access to over 35 years of nearshore wave conditions along the NSW coast. The toolbox allows users to visualise nearshore wave conditions for locations and time periods of interest, and functionality to generate and export datasets. The tools transform ocean wave data collected through the NSW Coastal Data Network Program to the coastline.

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[18] https://www.environment.nsw.gov.au/resources/coasts/110631gdntemacsubs.pdf
[19] https://australiangeomechanics.org/wp-content/uploads/2010/11/LRM2007-c.pdf
[20] https://australiangeomechanics.org/wp-content/uploads/2010/11/LRM2007-Framework.pdf
[21] https://australiangeomechanics.org/wp-content/uploads/2010/11/LRM2000-Concepts.pdf
[22] https://coastadapt.com.au/sea-level-rise-information-all-australian-coastal-councils
[23] http://forecast.waves.nsw.gov.au/index.php?date=2017-12-18&id=3000726&time=15&cont=10&zoom=7&latitude=-33.5&longitude=151.75&init=1&bounds=%28%28-36%2C+138%29%2C+%28-31%2C+173%29%29

- The Floodplain Risk Management Guide[24] provides the opportunity to understand the interaction of catchment flooding with oceanic inundation. It provides advice on approaches that can be used to derive ocean boundary conditions and design flood levels for flood investigations in coastal waterways considering the interaction of catchment flooding and oceanic inundation for the various classes of estuary waterways found in NSW and likely corresponding ocean boundary conditions.
    - The guide outlines three modelling approaches: a simplistic approach, a general approach and a detailed approach. The first two approaches comprise components related to elevated ocean water levels, tidal anomalies and wave setup and can be considered conservative in some situations, particularly where these factors are reduced or negated by entrance conditions. To be consistent with the guide, studies undertaken for a local council or with state government funding under the State Floodplain Management Program should follow either the general or detailed approaches.

    - These case studies[25] demonstrate the use of the *Floodplain Risk Management Guide: Modelling the Interaction of Catchment Flooding and Oceanic Inundation in Coastal Waterways*.

General Information:

Sea Level Rise

- Utilise Design ocean still water levels at Fort Denison for 2010 and predicted levels for 2050 and 2100 incorporating projected sea level rise when designing structures, determining oceanic inundation/wave runup levels and for oceanic and hydrodynamic modelling processes where full oceanic tidal conditions are expected (Coastal Risk Management Guide[26], p4).

- Sea Level Rise and You[27] has graphs and tables showing sea-level rise amounts and allowances for all Australian coastal councils, from the present day through to 2100.
    - Guidance on how to use Shoreline Explorer and Sea Level Rise and You- Dataset Guidance 1[28] and Dataset Guidance 2[29]

Climate Change

- Guidance on risk assessment[30] gives an overview of three different types of risk assessment approaches and their appropriate context of use.

- Risk assessment templates[31]: CoastAdapt provides three risk assessment templates that allow users to systematically follow the guidelines for assessing climate change risks, and record relevant information gathered at each step of a risk assessment.

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[24] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/modelling-catchment-flooding-oceanic-inundation-150769.pdf?la=en&hash=41092E03528FEF91161826E5FE5D9E5CD2D13598

[25] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Floodplains/examples-using-the-floodplain-risk-management-guide-150770.pdf?la=en&hash=5C6FF55A8559853B4B990FD579CA50A9F95A2043

[26] https://www.environment.nsw.gov.au/resources/water/coasts/10760CoastRiskManGde.pdf

[27] https://coastadapt.com.au/sea-level-rise-information-all-australian-coastal-councils

[28] https://coastadapt.com.au/sites/default/files/factsheets/Datasets_guidance_1_present.pdf

[29] https://coastadapt.com.au/sites/default/files/factsheets/Dataset_guidance_2_future.pdf

[30] https://coastadapt.com.au/how-to-pages/how-to-conduct-a-climate-change-risk-assessment

[31] https://coastadapt.com.au/tools/decision-support-templates-create-risk-register

- Guide to Climate Change Risk Assessment for NSW Local Government[32]: This guide is designed to assist councils meet the requirement of the 2011–2012 NSW Waste and Sustainability Improvement Payment Program to prepare a climate change risk assessment for their operations.

- The AdaptNSW website provides information sources and data on climate change.

- Sydney Coastal Councils Group engaged CSIRO to develop a Climate Ready Tool for biodiversity management through the Salty Communities Project.

- Climate Change in NSW Estuaries including 8 modules developed by UNSW Water Research Laboratory through the Coastal Processes Node. www.estuaries.wrl.unsw.edu.au

Other

- The Knowledge Strategy[33] sets priorities for the knowledge needed by OEH to support NSW Government and corporate objectives. Coastal, Estuarine & Marine Environments is one of six 'knowledge themes' in the Knowledge Strategy.

- OEH's Coastal Information System will support local and regional planners, communities and organisations by providing easy access to coastal information. An online interface will host interactive content and multimedia to provide information on coastal topography and bathymetry, hazard assessments, coastal zone management plans, and information on habitats and shoreline characteristics.

- CZMPs are transitioning to a **Coastal Management Program (CMP)**, which identifies coastal management issues in the area, actions required to address issues, and implementation timeframes. The Manual Part A[34] and Manual Part B[35] provides mandatory requirements and guidance for the preparation, development, adoption, implementation, amendment and review of coastal management programs. It provides step by step guidance on how to prepare a coastal management program and integrate coastal management actions with councils' strategic and land-use planning processes.

- OEH can help councils preparing a CMP with the following data and technical advice: wave data and data on historical coastline changes; information on coastal/estuarine processes, sediment cells/coastal geomorphology/coastal engineering; information on coastal hazard and risk assessment; advice on ecosystem health and habitat mapping.

- Sydney Harbour Coastal Zone Management Plan Scoping Study developed by GHD in partnership with Sydney Coastal Councils Group.

- Greater Sydney Harbour Estuary Coastal Management Program Scoping Study, BMT 2018.

- Coastal Management Glossary[36]

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[32] file:///C:/Users/admin/Downloads/20110593riskassesslg%20(1).pdf

[33] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Research/Knowledge-strategy/coastal-estuarine-marine-environment-knowledge-strategy-130594.pdf

[34] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Coasts/coastal-management-manual-part-a-170671.pdf

[35] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Coasts/coastal-management-manual-part-b-stage-1-170672.pdf

[36] https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Coasts/coastal-management-glossary-180195.pdf

- Legal and Policy framework for Coastal Management in Australia[37]

- Guide to Hazard Mapping: How to choose an appropriate spatial scale for coastal hazard mapping[38]

- Kinsela and Hanslow (2018) Coastal Erosion Risk Assessment in New South Wales: Limitations and Potential Future Directions[39], Coastal and Marine Unit, Science Division, Office of Environment and Heritage, NSW, Australia. This paper reviews coastal erosion risk assessment practices in NSW in the context of present theory and available tools.

- Paper by Silvia G. Tonyes et al (2015) - Sand dynamics as a tool for coastal erosion management: A case study in Darwin Harbour, Northern Territory, Australia[44]

Water Quality Data

- Beachwatch Water Quality Data
  - Enterococci data download[40]: The enterococci data collected under the Beachwatch Programs can be viewed or downloaded to Excel. Enterococci results are usually updated within one week of sample collection.

- Microbial assessments of beach water quality
  - Microbial monitoring of water quality collects information on levels of faecal contamination over time. The Enterotester tool is available for download from the WA Health website. [41]

- Algalert is a decision support tool that has been developed by the Climate Change Cluster (C3) at the University of Technology (Sydney) and Hornsby Shire Council which provides coastal managers with the necessary information to monitor and respond to Harmful Algal Blooms (HABs). Here [42]is the link to the tool. The Algalert website [43]provides more information on Algal Blooms, including hot spots.

- Information on WaterNSW Monitoring Sites, and the Water Monitoring Network – access to real time data.

- Sydney Water – Water Analysis report for drinking water – click here to check water quality in your area.

- Botany Bay and Catchment Water Quality Improvement Plan

- Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions, Office of Environment and Heritage.

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[37] https://www.environment.gov.au/system/files/resources/68cbcb67-bd6c-41ee-b214-02a5143d90d9/files/coastal-cc-annex.pdf
[38] https://coastadapt.com.au/sites/default/files/factsheets/Coastal_Hazard_Mapping_Guide.pdf
[39] http://www.coastalconference.com/2013/papers2013/NSWCC_Kinsela_Hanslow_2013.pdf
[40] https://www.environment.nsw.gov.au/beachapp/report_enterococci.aspx
[41] https://ww2.health.wa.gov.au/Articles/A_E/Bacterial-water-quality
[42] http://www.hornsby.nsw.gov.au/__data/assets/pdf_file/0017/107432/ALGALERT-HAB-Review_FINAL_UTS_HSC.pdf
[43] https://sites.google.com/site/algalert/alerts-hawkesbury-river-nsw-australia
[44] https://researchonline.jcu.edu.au/42277/1/Tonyes%20et%20al%202015.pdf