COASTAL COMPARTMENTS PROJECT

SUMMARY FOR POLICY MAKERS

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The Coastal Sediment Compartment project aims to improve coastal risk assessments undertaken at national and regional levels, and better integrate approaches to the management of the coastal zone.

Climate change including sea level rise exposes Australia's highly-populated coasts to current and increasing risks of tidal inundation, estuary flooding and shoreline erosion. In addition to the loss of coastal land, there will be increasing risks associated with storm surge and changes in wave climate. Storm surge is responsible for damage experienced during large coastal storms, and can destroy buildings, wash away roads and run boats aground. Changes in the direction of wave approach coupled with changes in wave energy could increase erosion in areas that at present are less frequently affected. We need to plan for these risks if we are to protect coastal homes, infrastructure, and businesses from negative economic, social and environmental impacts.

Australia's shorelines historically have been stable compared to other parts of the world. Under a worst-case scenario , global sea levels may rise by up to 1m by the end of this century (compared to 1986-2005); as a consequence steps need to be taken by all spheres of government, the private sector and communities to embrace the likelihood that climate change will impose different circumstances for land-use planning and coast and estuary management.

In order to prepare effectively, coastal decision-makers need information on the risks to different regions of the Australian coast, as well as a coordinated approach between tiers of government with coastal management and planning responsibilities. The compartment approach provides a framework for improved coastal management and planning. It identifies boundaries within which to consider the implications of coastal engineering works and other management and planning decisions to reduce the long-term risks to the Australian coast while protecting those coastal values that are so vital to Australian communities. The Coastal Sediment Compartment project had two components:

(i) Identification of coastal sediment compartments at a national scale that reflect variation in coastal environments relevant to coastal management; and

(ii) Demonstrating the improved accuracy in shoreline erosion risk assessments achievable by using coastal compartments in two case study projects on the east and west coasts.

COASTAL BASICS

Geomorphology: the science of evolution and change of landforms

Coastal compartment: defined area of the coast based on sediment flows and landforms

Wave climate: the average condition of wave height, direction & period over time

IDENTIFYING COASTAL COMPARTMENTS

The first component identified compartment boundaries along the entire Australian coast at a number of scales. A compartment defines an area of coast based on sediment flows, at a primary level based on the influence of large landforms and offshore processes; at a secondary level on medium

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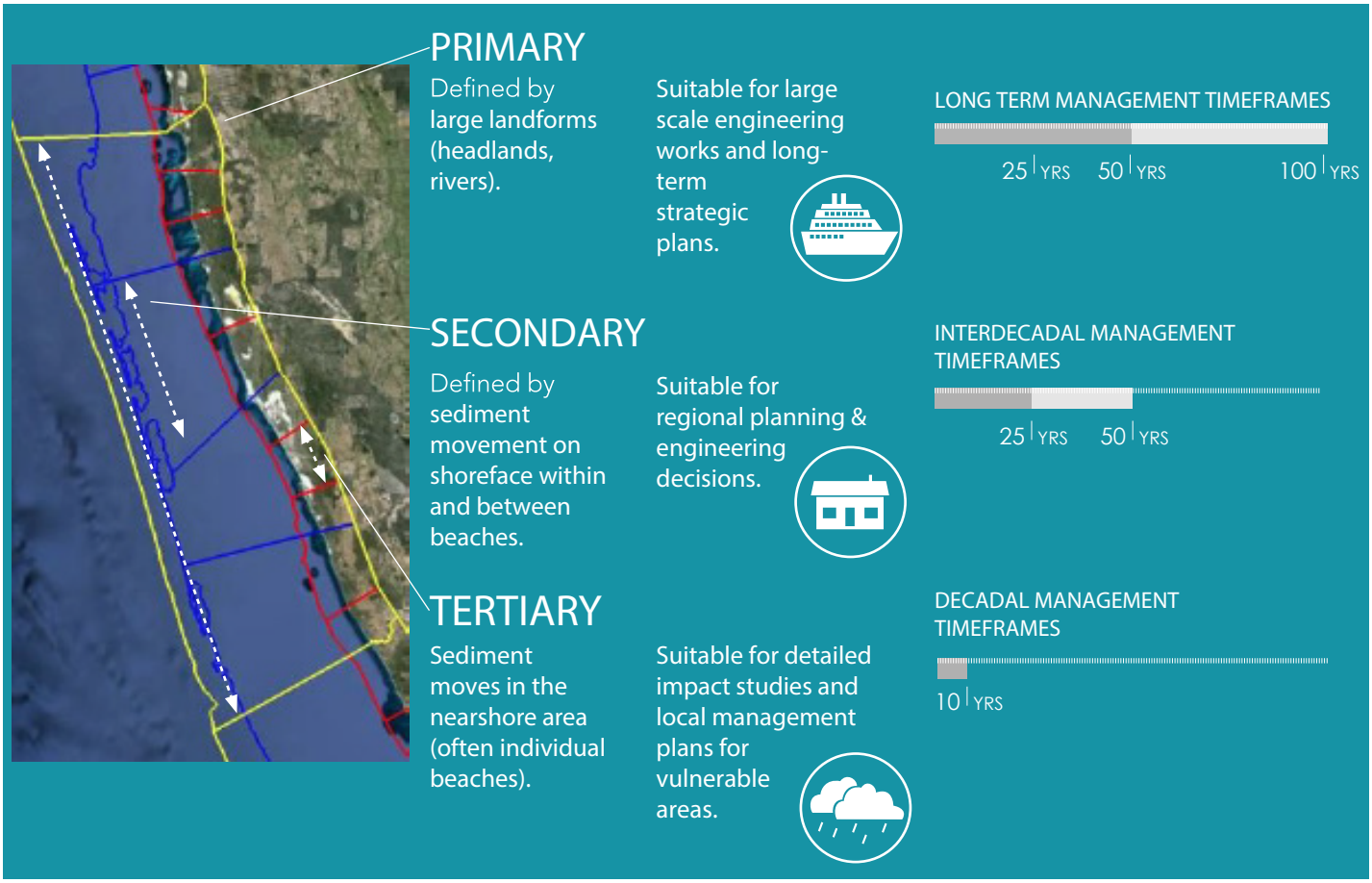
landforms and regional sediment processes and at a tertiary level based on individual beaches. Boundary points were identified for primary and secondary compartments, recognising sediment processes and influential geologic structures (Figure 1).

Changes within coastal compartments, especially at secondary or tertiary scales, involving for instance the alongshore loss or gain of sand, operate regardless of administrative (like local government) boundaries. Coastal compartments offer a consistent framework for regional planning and coastal management by defining 'natural' management units. Larger primary compartments can define the external conditions for smaller tertiary compartment analysis, providing consistency in the translation of coastal process studies completed at each scale. Compartments provide a consistent geomorphological approach that supports interpretation of historic trends, understanding of contemporary processes, and most importantly the projection of future coastal change.

ACCURACY IN FORECASTING SHORELINE CHANGE

The second component of the project was to undertake two case studies down to the tertiary scale: one on the west coast (Swan and Pilbara regions), and the other on the east coast (Avoca and Cabarita Beaches in NSW). The two case studies were designed to test the applicability of the sediment compartment approach as a framework for assessing future shoreline movements. They also illustrated the comparative value of different shoreline movement methodologies, such as sediment budget models and probability-based assessment, and best practice assessment considerations for application at different

FIGURE 1: COASTAL COMPARTMENT SCALES, USE AND TIMEFRAMES



compartment scales. The findings of these projects can be used to improve the way coastal risk assessments are undertaken, in particular when commissioned from consultants. They also offer federal and state governments a common approach by which they can evaluate and monitor future investments in coastal management at both regional and local scales.

West coast: Swan and Pilbara

The project in WA (conducted by Damara) examined how a coastal compartment framework can guide impact assessments at primary, secondary and tertiary scales and provide a more detailed assessment of coastal sensitivity to dynamic coastal processes, such as sea level rise. The two areas studied both contained significant coastal rock formations but otherwise presented very different morphologies: the temperate carbonate-rich Swan coastal plain; and the more tidal Pilbara region influenced by sediment supply from large arid-region river systems. The project demonstrated:

- A key advantage of the compartment approach is that shoreline changes can be shown to be strongly related to sediment transfers over different temporal and spatial scales.
- Use of some available simplified models in forecasting shoreline change can have significant shortcomings; choice of assessment methodology should be guided by compartment scale and improved assessment types, such as uncertainty analysis.
- Understanding offshore sediment sources is critical to accurate assessment of future shoreline change; remote sensing techniques are now available to assist in mapping these offshore sediment flows, both within and between compartments.

FIGURE 2: CASE STUDY LOCATIONS

East coast: Cabarita and Avoca beaches

The Water Research Laboratory (WRL) of the University of NSW studied two tertiary-level compartments, Avoca Beach and Cabarita Beach, to test the applicability of deterministic and probabilistic approaches to coastal impact assessments. The two areas are both open sandy coasts, but represent 'closed' and 'leaky' sediment compartments which respond differently to coastal hazards. The project found:

- Probabilistic modelling combined with a sediment budget approach is a powerful method for evaluation of long-term shoreline response. The probabilistic approach uses past historical data to estimate the probability of an event occurring in the future. This improves levels of certainty through indication of sediment budget sensitivity to future changes, such as sea level and wave energy. As part of the project, coastal recession amounts were projected for the two beaches for a range of future climate scenarios to 2100.
- Storms that severely erode beaches and dunes often occur in multiples. The impact of a single storm in a given period may be of less importance than a multiple event. Assessments should include analysis of the

impact of joint occurrence of extreme wave heights and water levels of multiple storm events.

- There is a fundamental need for more information on offshore conditions: bathymetric data, surface sediment types and sediment quantities extending onto the inner continental shelf. Understanding offshore sediment sources is critical to accurate assessment of future shoreline change; where practical all possible sediment interactions should be investigated to improve the accuracy of modelled results.

A FRAMEWORK FOR COASTAL DECISION MAKERS

International best-practice

The coastal compartment approach has been used internationally to determine how coastal processes move sediments along pathways to or from offshore sources, and from rivers, to beaches, dunes, and into and out of estuaries. For example, in the UK coastal compartments are used as a basis for regional coastal management plans. Regional coastal groups develop Shoreline Management Plans in conjunction with the UK Environment Agency.

These plans incorporate both present and future risk and enable local governments, in conjunction with agencies of the UK government, to reach decisions on what and where to protect or permit the sea to invade the land. For example, flood defences around the Blyth estuary in Suffolk were abandoned in 2009, allowing the grazing area to become marshland. The wetland area creates a buffer protecting buildings further inland from storm surge.

The need in Australia

The need for a similar regional approach to assessing coastal hazard impacts and consequent risk in Australia emerged from the First Pass National Coastal Assessment (DCC, 2009). This Assessment found there was a need to develop better methods to understand the direction and rate of present and future coastal change for decision making.

Many settled areas of the coast in Australia have built assets at risk to future changes of shoreline position and inundation from sea-level rise. Continuous pressure exists to build and rebuild private and public assets in areas at risk to coastal and flood hazards, both now and under projected climate change conditions.

Local governments often do not have access to up-to-date information and with few exceptions, lack resources as individual administrative units to apply any sophisticated, science-based approach to assessing vulnerability of built assets. Often little consideration has been given to the operation of processes over broader administrative areas coincident with natural compartment boundaries. The impact of coastal management decisions made in one local government area, such as building sea walls or protective structures, can have down-stream effects on others, such as loss or gain of beach width – potentially leading to property destruction and loss of natural heritage.

Use of the sediment compartment approach at a national level in Australia could facilitate a more coordinated and efficient response to the impacts of climate change. Such an approach could: (i) help avoid inefficient duplication of expenditure on hazard and risk assessment; (ii) overcome to some degree the inequitable distribution of financial and technical resources with some councils better equipped than others to take action; (iii) lessen future hardship of owners and managers of threatened private and public property; and (iv) create saving of taxpayers' funds on disaster relief and legal disputes over compensation.

Application for national consistency & local effectiveness

The project reached two conclusions: (1) that there is considerable scope for the application of the coastal sediment compartment approach, combining field observations (above and below present sea level) and modelling at scales relevant to decision-makers (noting there will be a need to improve data sources in many "hot spot" areas); and (2) that coastal planning and management linked to scales

of sediment compartments is a more productive approach than relying on arbitrary administrative boundaries or simple geomorphic models.

There are a number of applications for the coastal compartment approach in coastal decision-making, such as in planning or engineering works. The number and level of compartments considered should be chosen based on a combination of regional and local characteristics, proximity to other compartments and the design life or management timeframe of the project. For example, large-scale engineering works, such as ports and harbours, should be assessed at all levels within the hierarchy to ensure assessment of down-drift effects.

The sediment compartment approach benefits federal, state and local governments through improved consistency, accuracy and understanding of cross-jurisdictional issues. Preliminary work in Western Australia by the Department of Transport shows an interest in this approach by an operational state agency.

There should be no question that Australia faces serious challenges in preventing adverse impacts of climate change in coastal regions. The compartment approach offers a framework for state and local governments to enter into an agreement with the Australian Government to share information on future risk, and in collaboration develop a long-term mechanism to ensure coastal regions are better prepared to meet future challenges of coastal hazards and impacts.

References

DCC (Department of Climate Change) 2009, Climate Change Risks to Australia's Coasts, http://www.climatechange.gov.au/climate-change/adapting-climate-change/australias-coasts-and-climate-change/coastal-risks-0/climate

This project was initiated on the advice of the former Coasts and Climate Change Council; it was managed by Geoscience Australia with financial support of the former Department of Climate Change and Energy Efficiency.

This summary was prepared by Professor Bruce Thom at the request of the Department of Environment.

For more information on the project please see:

- GA coastal compartments maps: http://www.ga.gov.au/metadata-gateway/metadata/record/gcat_76502
- WRL case study
- Damara case study