the likelihood of occurrence, a vulnerability to that hazard, and therefore a consequential impact. Structured risk assessment involves the analysis of all these elements, as a way of identifying realistic and appropriate options for mitigating or managing the risk.

With a changing environment in the coastal zone, especially due to sea-level rise, the risk management approach allows for the hazards to be quantified, costs and benefits of various options to be evaluated, and appropriate responses to be implemented and evaluated.

With important hazards affecting the coastal zone, including storm surge induced flooding and coastal erosion, activities to improve the understanding of the nature of the hazards, their impacts and appropriate management options will continue to be required.

Further Information

Improved understanding of the probabilities of extreme sea-levels of various magnitudes has been developed by Hunter (2008). Although severely restricted in the tide gauge sites available for analysis, this work is applicable throughout Tasmania, as described in the DPIW paper *Sea-level extremes in Tasmania: Summary and Practical Guide for Planners and Managers*. The value of the analysis by Hunter is that it allows the level of risk throughout the lifespan of an asset, short or long, to be assessed more clearly. The *Summary and Practical Guide for Planners and Managers* extracts some of the statistics more commonly used by planners and managers in Tasmania, to provide a quick guide to the levels of risk likely to be experienced around Tasmania, and how they are likely to change during this century.

The Clarence foreshore project being conducted by the Clarence City Council will provide valuable guides to the assessment and treatment of risk through local government planning processes. The Climate Change and Coastal Risk Management Project being conducted by the Department of Primary Industries and Water will also provide tools and resources to assist with improving risk management approaches to local values and assets around the Tasmanian coast.

Further Resources

DPIW 2008 *Sea-level extremes in Tasmania: Summary and Practical Guide for Planners and Managers*, Department of Primary Industries and Water, Tasmania.

DPIWE 2004 *Information Paper: Sea level change around Tasmania*, May 2004, Department of Primary Industries, Water and Environment

Hunter, J. 2008 *Historical and Projected Sea-Levels Extremes for Hobart and Burnie, Tasmania*, Technical Report prepared by the Antarctic and Climate and Ecosystems Cooperative Research Centre - December 2007. Published by the Department of Primary Industries and Water, Tasmania.

IPCC 2007 Fourth Assessment Report (AR4), available from www.ipcc.ch

Sharples, C. 2006 *Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea-Level Rise: Explanatory Report (Second Edition)* Consultant Report to Department of Primary Industries & Water, Tasmania.

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Disclaimer

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Tasmania
Explore the possibilities

Coastal Hazards In Tasmania

General Information Paper

2008

Department of Primary Industries and Water

Tasmania
Explore the possibilities

The coastal zone is highly valued, with a range of natural values, and significant residential, commercial and infrastructure development. As with many areas, there are a range of natural hazards that occur for which long term management, assessment and strategic mitigation is required. Some of the natural hazards that could occur in Tasmania's coastal zone include inundation from storm surges, erosion, tsunamis and landslides.

Sea-level rise increases the threat from these existing hazards. A rise in the mean sea-level also means that storm surges will rise to higher levels, and the normal cut-and-fill erosion cycle of shorelines will tend towards progressive erosion.

This paper focuses on inundation and erosion from storm surge and the increasing impact of sea-level rise. It outlines a risk management approach for responding to these issues.

The risks from inundation and erosion to the coastal zone have been highlighted by studies such as *Indicative Mapping of Tasmanian Coastal Vulnerability to Climate Change and Sea-Level Rise: Explanatory Report 2nd Edition* by Consultant Geoscientist Chris Sharples (Sharples 2006). It was also recognised during the community survey for the Tasmanian Emergency Risk Management Project coordinated by the State Emergency Service in 2003.

With the impacts of climate change including rising sea levels and potentially an increase in the frequency of extreme weather events, there is a range of information that is required to better assess and manage the risks to natural values and built assets around the coastline.

Of particular importance is an improved understanding of the projected sea-level extremes for Tasmania. Together with an understanding of local geomorphology and the values and assets in a local area, this information will improve the ability to provide practical risk management advice on hazard zones around the coast.

Hazards in the Coastal Zone

Storm Surge inundation

A storm surge is a region of elevated sea level at the coast caused by the combined effect of lower atmospheric pressure and intense winds from offshore storms.

There is a rise in sea level of about 10mm per hectopascal fall in atmospheric pressure (the so-called 'inverse barometer effect'). However, the larger contribution is often due to wind that, in effect, pushes the water against the coast. Factors influencing storm surge include: wind strength, wind direction relative to the coast, and how the storm itself moves in relation to the coast. The shape of the sea floor and the proximity to bays, headlands and islands also affects the height of a storm surge. Wide and gently sloping continental shelves amplify the storm surge, and bays and channels can funnel and increase the storm surge height.

Storm surges can interact with other ocean processes, such as tides and waves, to further increase coastal sea levels and flooding. A storm surge will have maximum impact if it coincides with high tide. Breaking waves at the coast can also produce an increase in coastal sea levels known as wave run up.

Erosion

Erosion is the process of the gradual wearing away of land by water, wind and general weather conditions.

Coastal landforms, particularly "soft" shores such as sandy, muddy, clayey and gravelly coasts, are some of the most mobile and changing environments. Coasts naturally change their physical form over relatively short periods. Over longer periods they can be relatively constant, or experience progressive erosion or accretion, especially in response to very long term changes in the vertical movement of land after the last glacial period.

Changes in sea level result in physical changes to shorelines, particularly to softer sandy shores, as the coast adjusts to changing water levels. The coastal vulnerability assessment by Sharples (2006) highlighted that sandy shores backed by low-lying sandy plains are most vulnerable to shoreline erosion and inundation from the impacts of sea-level rise and climate change. Sharples also assessed other soft shorelines vulnerable to erosion and recession, as well as hard-rock sea-cliffs, which have some vulnerability due to undercutting, causing rockfalls, slumping and collapse.

Tsunami

Sudden displacement of a large volume of water in the ocean can lead to a series of waves being generated, called a tsunami. They are often caused by displacement of seafloor along underwater faultlines and associated earthquakes, volcanic activity, and submarine landslides. While the waves generated by these events can be quite low while in the deep ocean, as they approach the shore through shallower water, they can rise to significant heights. For example, the 2004 Boxing Day tsunami that effected many countries around the Indian Ocean generated waves at the shore of up to 20 metres.

Tsunamis can have a major impact on coastal areas, and cause widespread damage. However, the accurate identification of vulnerable areas is often difficult as it involves detailed modelling and mapping of the coastal zone.

Sea-level rise

The largest source of sea-level rise is due to the expansion of the oceans as they warm. Contributions also come from the melting of glaciers and land-based ice sheets.

In addition, coastal subsidence or uplift of the land can influence the relative local sea level. Sea level also responds to changes in atmospheric and ocean dynamics at seasonal, inter-annual, and decadal time-scales. The most striking example occurs during El Niño events, when the sea level rises in the eastern Pacific and falls in the western Pacific. Regional variations from the global average can be expected due to regional differences in weather patterns and ocean currents. As sea level rises, material on erodable shorelines is eroded from the upper sections and deposited on the near-shore ocean bottom. Consequently the ocean moves landwards or, in other words, the shoreline recedes.

The Intergovernmental Panel on Climate Change (IPCC) Fourth Assessment Report (2007) provided projections for sea-level rise for the twenty first century. The projected range was 18–59cm, with a potential addition of 10–20cm depending on the contribution from increased ice flow from Greenland and Antarctica. Recent analysis from CSIRO and the Antarctic Climate and Ecosystems Cooperative Research Centre based at the University of Tasmania shows current observed sea-level rise of around 3mm per year, which is consistent with the upper level of projected sea-level rise.

The Fourth Assessment Report highlights that coasts are likely to be exposed to increasing risks, with the effect exacerbated by increasing human-induced pressures on coastal areas.

Coastal Hazard Mapping

Mapping hazard zones as a foundation for planning and management requires an understanding of the magnitude and likelihood of those hazards.

The Sharples Report (2006) integrated geomorphology and topography to outline the indicative vulnerability of the Tasmanian coastline to the impacts of climate change and sea-level rise.

Sharples mapped the potential storm surge inundation zones using historically recorded storm surge events, and examined the increase in the hazard zone with projected sea-level rise. The inundation zones corresponded to coastal areas potentially susceptible to flooding in a 0.01% exceedance (approximately 2 year return period) storm surge events. While this level of hazard is slightly different to the 1% annual exceedance probability level used in most regulatory standards for risk management, it provided a useful Statewide assessment of the potential hazard areas.

Further work to identify extreme sea-level exceedance levels for the State has been undertaken by Hunter (2008). This provides detailed information designed to assist a broad range of planners, managers and developers.

Understanding the nature of the hazards present in the coastal zone is a foundation to being able to appropriately manage them. Where the hazard is likely to have an impact on coastal values or assets, this constitutes a risk that needs to be recognised and managed appropriately. For this, a risk management approach is taken.

Using a Risk Management Approach

The Australian Risk Management Standard AAS/NZS 4360:2004 "... provides a generic framework for establishing the context, identifying, analysing, evaluating, treating, monitoring and communicating risk." The Standard has been utilised throughout Australia and adopted by Emergency Management Australia and the Tasmanian State Disaster Committee.

Risk assessment follows a standard approach as outlined in the figure.

Risk is a combination of the presence of a hazard (or threat),

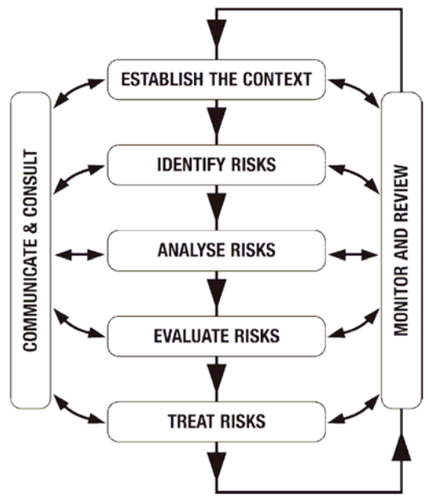

Figure. The risk management process (Source: Emergency Management Australia 2004 *Emergency Management in Australia: Concepts And Principles*).