2 Climate change and the coast

At the time of producing this manual a number of key Tasmanian government initiatives were still underway and are expected to be achieved over the course of 2011:

- Development of a new Tasmanian Framework for Action on Climate Change
- Finalisation of the state's Regional Planning Initiative
- Development of a state Framework for Mitigating the Impact of Natural Hazards through Land Use Planning
- Consideration of a new State Coastal Policy for Tasmania.

As with all topics addressed by the Manual, chapters will be regularly updated online as these initiatives are finalised and new information is released.

2.1 *Adapting to climate change*

2.2 *Predicted climate and sea level rise changes and consequences*

2.3 *Managing the coast for climate change*

2.4 *Tools and resources*

Tab photo: Existing infrastructure already underwater at high tide in south-east Tasmania. © Leah Page.

This chapter provides an overview of the implications for climate change to coastal management. It describes the coastal landforms, natural values and types of infrastructure most likely to be affected by climate change and sea level rise, and provides information for assessing inundation, erosion and recession risks for a chosen location. Predicted climate and sea level rise changes over this century and the science of climate change and sea level rise are touched on only briefly because many other publications summarise the science well. There is a table summarising climate change information found in other chapters of the Manual and tools and resources for assessing and planning for climate change impacts are at the end of this chapter.

The Manual adopts a precautionary approach to climate change and sea level rise and suggests that coastal managers should plan for the upper levels of predicted changes. This approach will be in tune with growing agreement among researchers that climate change impacts are emerging more rapidly than earlier thought.

Projections based on the best scientific evidence suggest that the global climate will continue to change and sea levels to rise well beyond this century. Many stretches of Tasmania's coastline already experience occasional inundation, and shoreline erosion events are becoming more frequent and widespread.

Over the next century these changes may be very significant in some areas, and could cause major alterations to our coastline and the way we use it. Management of natural and built assets needs to adapt to this.

2.1 Adapting to climate change

This section discusses the importance of adapting to climate change and sea level rise in addition to the already complex and challenging task of managing the existing natural and human pressures on the coast.

Climate change and the rise and fall of sea levels are not new phenomena on this planet and, left alone, the coast's natural systems have great capacity to adapt and establish a new equilibrium. In undisturbed environments plant and animal communities can adjust and move with the changing shoreline, and in unpopulated and undeveloped areas these mechanisms can largely be left to proceed unaided. However, in more developed areas, existing private and public assets may not only hinder natural adaptation by causing 'coastal squeeze' (pressure on natural and cultural heritage values), but also require protection in their own right.

In this manual it is recognised that, in Australia and other countries, artificial shoreline protection is a very costly business, it will impact on the aesthetic and ecological values of coasts, and all protective structures have a limited life span. Tasmania's relatively small population is unlikely to have the economic resources to protect any but the most important built assets and shorelines from erosion and inundation. To help reduce the future cost of shoreline protection, some underlying principles are suggested for managing climate change and sea level rise.

- Work in partnership with local communities and other stakeholders.
- Base decisions on good scientific knowledge – investing in appropriate studies can help avoid very costly and damaging mistakes.
- As far as possible, do not interfere with natural processes.
- Manage the coast's vegetation and habitats to enhance their natural resilience to change.
- Avoid locating new buildings and other infrastructure where there is any chance they might interfere with natural processes, and/or require protection within their expected life span.
- Where intervention is absolutely necessary, thoroughly assess any potential consequences for adjacent shorelines.
- Choose 'soft' reversible coastal protection options in preference to more permanent 'hard' structures.
- Recognise that any intervention to protect assets will almost certainly be costly, ongoing, and continue to increase in scale as sea level continues to rise.

These principles are largely self explanatory. In essence the advice is to plan well with good information and, where engineering or other works are proposed, take every measure to keep disturbance of the area to an absolute minimum (this may involve a review of the existing works culture).

Consider whether the area or asset to be managed is defensible in the long term – in a growing number of places around the world it is being recognised that parts of the coast will have to be left to respond in their own way.

It is also important to recognise the value of no-regrets, low-regrets and win–win adaptation options when managing climate change risks:

no-regrets:

policies and decisions that will have immediate benefits under present-day climate conditions

low-regrets:

low-cost policies, decisions and measures that have potentially large benefits over time

win-wins:

policies, decisions and measures that help manage several coastal hazard or climate related risks at once, or bring other environmental and social benefits, e.g. preservation of natural character.

(Derived from: *Coastal hazards and climate change: A guidance manual for local government in New Zealand*, Ministry for the Environment 2008b)

2.2 Predicted climate and sea level rise changes and consequences

This section summarises climate change predictions and impacts on coastal areas. Information on managing some of these impacts is provided in Chapter 3 Coastal hazards.

Over the coming century scientists expect the sea level to continue to rise, at times at an accelerated rate as has been observed over the last few decades. The Intergovernmental Panel on Climate Change Fourth Assessment Report (IPCC 2007) conservatively estimated a sea level rise of up to 79cm by 2100, however this figure did not allow for polar ice-sheet melting. Measurements since 2007, and improved understanding of ice-sheet responses, show that sea level rise of over 1.0m and as high as 1.5m is possible, and sea levels will continue to rise long after 2100. It is anticipated that these higher projections will be reflected in the next IPCC report, expected in 2014.

Most state governments in Australia roughly agree on the sea level rise benchmarks to use for future planning and management decisions. For example, for planning purposes New South Wales now assumes a sea level increase of 40cm above 1990 levels by 2050 and 90cm by 2100. Victoria has recommended working to a figure of 80cm by 2100, and Queensland is recommending the same 2100 value. It is likely that these benchmarks will be revised upwards following the release of the next IPCC report. There may be small discrepancies between exact figures but there is agreement that sea levels will rise considerably, the mean high and low water mark will increase and storm surges will reach further inland.

Many of Tasmania's coastal areas will be at risk from sea level rise and more severe storm surges associated with climate change, with impacts including increased coastal erosion and recession of erodible shorelines, inundation and flooding of low-lying areas, and coastal infrastructure. Coastal infrastructure in high-risk locations is likely to incur damage or require redesign or relocation.

2.2.1 Storms and inundation

Sea conditions are rarely flat like a pond, and storms in particular can dramatically add to the water level as well as creating very high energy conditions on the shore. Storms are usually caused by low-pressure systems in the atmosphere, with high wind speeds that can generate large waves.

Low pressure, tide and effects of wind can all contribute to a storm surge, or the height of the

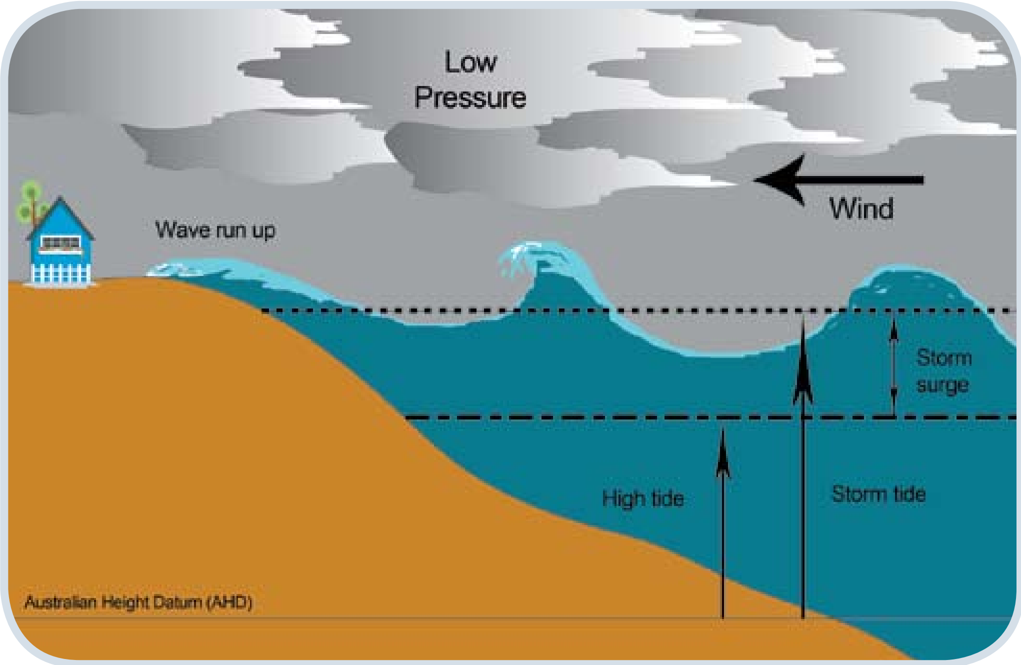

Figure 2.1 Storms greatly increase the height of tides and the level of wave run-up. Storm surge (due to wind and low pressure) increases the height of the tide and wind pushes the waves further onshore. Final inundation height = storm tide + wave run-up.

water above the predicted tide level. Wind blowing across water creates waves, currents and 'wave set-up' where sea water is pushed up into bays and estuaries and piles up against shores. The stronger the wind, the greater these effects will be. All of these can increase the water height during a storm. Together the final water level is called the 'storm tide'. When a wave breaks it can also 'run up' the shoreline to an even greater height, depending on the size of the wave and the slope of the shore.

Effect of low-pressure systems in Tasmania

Low atmospheric pressure itself causes a rise in sea level. Less downward pressure on the sea surface allows the sea level to rise about 1cm per 1hPa fall in pressure.

For example, in the extreme storm off north-east Tasmania that hit the Sydney–Hobart yacht race in 1998, pressure dropped to just below 980hPa. This means that if all other factors were equal, the sea level was approximately 40cm higher than a typical high pressure system of around 1020hPa at that time of year.

In addition, the same low-pressure system that is producing a storm may result in tens of centimetres of rain in nearby catchments. When this rain enters the lower reaches of rivers, estuaries and narrow mouthed bays, it may be unable to escape if a storm tide is also pushing up coastal water levels. This can rapidly cause increased flooding in estuaries.

Severe storms coinciding with a high tide and interacting with the shape of the coastline can not only flood low-lying coastal areas but also quickly cause severe erosion. All of these processes are natural and affect shores episodically under stable sea levels. However, with sea level rise, storm surges that have the ability to cause erosion and flooding will become more frequent, and wave or sea water intrusion will reach higher levels than in the past. Any significant rise in sea level will mean that storm events appear to occur more often because what used to be a minor storm event will become a larger magnitude event due to the increased sea level.

Potential consequences of storms during high tides in light of sea level projections

In simple terms, sea level rise will raise the average water level of oceans and estuaries. As the average water level rises, so too will high and low tide levels affecting the natural processes responsible for shaping the coastline. Exactly how the coast and estuaries will respond is complex and often driven by local conditions but, in general, higher sea levels will lead to:

- increased or permanent tidal inundation of land by seawater
- recession of beach and dune systems and to a lesser extent cliffs and bluffs
- changes in the way that tides behave within estuaries
- saltwater extending further upstream in estuaries
- higher saline water tables in coastal areas and
- increased coastal flood levels due to a reduced ability to effectively drain low-lying coastal areas

These physical changes will have an impact on coastal ecosystems, access to and use of public and private lands, historical and cultural heritage values, arable land used for agriculture, freshwater access, public and private infrastructure, and low-lying areas of coastal land that are affected by flooding.

From *NSW Sea Level Rise Policy Statement* (Department of Environment, Climate Change and Water 2009a)

2.2.2 Coastal erosion and recession

Climate change has implications for the natural coastal processes of coastal erosion and accretion.

Erosion (wearing away of sand, rock and sediment) and accretion (build-up of sand or sediment) are normal cyclical events on soft sediment coastlines (such as beaches and dunes). Where sea levels are rising a threshold is reached where erosion outstrips accretion and the beach will erode more than it is replenished. Once this tipping point is reached, the shoreline will tend to retreat (this process is known as coastal recession).

Many open-coast sandy beaches in south-east Australia have yet to reach this critical threshold, although some appear to have already passed it. Probable examples in Tasmania include the high energy south-west beaches and those subject to unusual conditions such as Roches Beach in south-east Tasmania. Once a beach is in a receding state, the rate of recession and how far it will continue will depend very much on the local characteristics of the area, such as the geomorphology, underlying bedrock, modifications to the shoreline and development of coastal land behind the beach.

2.3 Managing the coast for climate change

This section provides information on the implications of climate change and sea level rise for managing the natural and built environment in coastal areas. Management of the coast and planning new infrastructure or development must take climate change and sea level rise into account. To do this requires an understanding of localised coastal and marine processes and assessing risks to coastal values and infrastructure.

Risk management and responding to hazardous events, such as storms, are critical to coastal planning and management in the light of climate change. In some areas, planning for retreat will also be required. ***Refer to Chapter 3 Coastal hazards.***

Adapting to climate change will cost money. However, planning early to reduce the vulnerability of natural ecosystems and infrastructure to climate change impacts, and initiating appropriate adaptation strategies to reduce these impacts, will save money in the long term.

A growing number of detailed studies of specific coastal areas have identified the extent of the risk from climate change and sea level rise. In Tasmania, Clarence City Council has produced a thorough report *Climate change impacts on Clarence coastal areas – Final report.* (SGS Economics et al. 2009) identifying buildings and infrastructure in low-lying coastal areas in the municipality at risk over this century. This study was in response to community concerns about erosion of beaches and flooding events in coastal areas.

A further example, from Victoria, is a report to the Gippsland Coastal Board on the implications of climate change and sea level rise on vulnerable coastal areas (Gippsland Coastal Board 2008).

The concerning findings of both the Gippsland and Clarence studies highlight the importance of understanding inundation and erosion risks to property and infrastructure in vulnerable low-lying coastal areas. Both these reports have used the best available science, including high-resolution mapping of the height of the land above sea level (digital elevation model). This is obviously essential when working out how far sea level rise or storm tides will penetrate inland. They have also used good geological mapping of the coast to identify, for example, how far soft erodible sediments extend inland and what type of underlying bedrock is present.

In Tasmania the Sharples Report (Sharples 2006) provides information about the state's coastal landform types and their vulnerability to coastal processes such as erosion, recession and storm surge flooding, as a result of sea level rise. Sharples' data on the shoreline type for any part of Tasmania can be found on the Land Information System for Tasmania (LIST) website, and has more recently been incorporated into the national Smartline map, which can be used on the OzCoasts website.

2.3.1 Climate change and coastal values

This section includes a very brief discussion of the natural and cultural coastal values most likely to be affected by climate change and sea level rise. More detailed information is available in Vulnerability of Tasmania's natural values to climate change (DPIPWE 2010). ***Refer also to Chapter 6 Coastal landscape management, Chapter 7 Vegetation management and Chapter 10 Wildlife and pest management.***

In general, the coastlines that are vulnerable to inundation or erosion and recession are low-lying and/or composed of soft erodible materials. However other important factors include the degree of exposure to ocean storms and swells, or to locally

generated wind waves (which may be quite erosive over longer fetches within estuaries and lagoons) and whether the location is in an estuary or embayment fed by an inland catchment where a river flood peak may be held up by a storm tide.

Beach and dune systems may be more resilient to sea level rise because of their dynamic nature and ability to accrete new sediments. There is a summary of the range of coastal landscapes and landforms in ***Chapter 6***, which describes both soft sediment (sandy) and rocky coastlines and coastal values.

Coastal wetlands, and the vegetation communities and biodiversity associated with these systems, will be affected by changes to rainfall patterns and water regimes, along with inundation associated with sea level rise and increased intrusion of salty groundwater.

Vegetation communities and wildlife habitat in other coastal environments will also be affected by changes to rainfall patterns, increased temperatures and changes to fire regimes. Weeds and pests may be favoured by the changed conditions and put increased pressure on species and systems. Loss of threatened species and diminished biodiversity are likely to occur.

The marine environment is also vulnerable to increases in water temperature and changes to ocean currents, which will see species expand their range and compete with Tasmania's unique temperate marine life. Increased acidification of oceans due to rising absorption of CO_2 has the potential to impact on many marine species.

It is more important than ever to conserve natural values and communities and restore degraded ecosystems to help them adapt to the impacts of climate change.

Tasmania's coastline is rich in Aboriginal heritage values and there are also significant maritime and cultural heritage sites. These sites are at risk of damage or loss from erosion and sea level rise.

Recreational areas on the coast will also be affected by erosion and sea level rise. Some sites may become hazardous due to erosion and storm events. Coastal recreation and residential areas may require special management to enable current use to continue. In other areas, retreat may be the only viable option and land managers may need to identify new, more appropriate areas for coastal living and recreation where possible.

2.3.2 Climate change and built assets

Particular built asset types might be more vulnerable to climate change and sea level rise than others. Any low-lying infrastructure near the coast should be assessed for erosion and inundation risk from rising sea levels and other consequences.

It is often forgotten that water tables will rise and salt water will penetrate further inland in ground water as the average sea level rises. Buried linear infrastructure may be particularly vulnerable, including sewer, stormwater and water mains, buried electrical and telecommunications cabling, and gas mains.

Greater hydrostatic pressure on some types of foundations, cellars, tunnels, underground car parks, pools, tanks and sumps will occur. The possibility of mechanical damage and/or corrosion of susceptible structures and materials is real and should be included in maintenance checks. When planning new infrastructure of these types, the design should take into account rising groundwater and possible salt water intrusion.

Roads, rail and other transport infrastructure may also be affected by higher ground water levels causing softening and greater plasticity in the underlying substrate.

Information for planning, designing and constructing coastal infrastructure (such as seawalls and revetments, stormwater outfalls, roads and tracks, boat ramps and crossings) to minimise impacts on the environment is considered in more detail in later chapters. ***Refer to Chapter 12 Stormwater and crossings, Chapter 13 Access management, Chapter 14 Structures and facilities and Chapter 15 Shoreline modification.*** The Manual does not provide particular guidance on how to manage the infrastructure itself to mitigate climate change effects. Expert advice from engineers will be required.

2.3.3 Climate change and coastal industry

Climate change has the potential to affect industries in coastal areas, like tourism, agriculture, fisheries and aquaculture. Major industries should be making their own detailed assessment of the long-term consequences of climate change.

Coastal industries that are based on the productive capacity of the environment, such as fisheries and aquaculture, will be susceptible to rising water

Figure 2.2 The impacts of sea level rise have been noticeable during king tide events. Tidal waters of the Hunter River submerging residential areas in Newcastle, NSW. The king tide in December 2008 combined with a low pressure system to inundate low-lying areas of New South Wales and Queensland. Source: A snapshot of future sea levels: Photographing the king tide (Watson and Frazer 2009). © Bruce Coates. Department of Environment, Climate Change and Water, NSW.

temperatures, changes to ocean currents and ocean acidification. Agriculture will need to take into account changing weather patterns, especially rainfall and altered fire regimes. Any industries with shore-based infrastructure will need to plan for sea level rise.

The tourism industry has an affinity for coastal locations, and planning and maintenance of both major and minor infrastructure will need to take climate change and sea level rise into account. The ecological values on which many recreational tourism initiatives are based may also be affected. The industry does, however, have the opportunity to play a valuable part in raising public awareness of these changes.

2.3.4 Tools for assessing climate change impacts

Antarctic Climate Ecosystems Cooperative Research Centre (ACE CRC) web tool

This web based tool is based on the history of sea levels mapped at 29 ports around Australia provided by the Australian National Tidal Centre. A number of projected sea level rise scenarios from the Intergovernmental Panel on Climate Change, Assessment Report Four (IPCC 2007) are used in the calculations. The user of the tool may expect to gain an understanding of the increase in probability of extreme events caused by a rise in average sea level. The tool is only available to those who have undertaken a workshop and understand the limitations of the data.

Coastal values of southern, northern and north western Tasmania: NRM projects (Coastal Values data)

Through three projects, easily accessible mapped data sets on vegetation, species habitat and geomorphology have been produced to support better strategic planning, land use planning and management of the coast. The projects looked at a 100m-wide coastal strip (from the high water mark) of the northern, southern and Cradle Coast Natural Resource Management (NRM) regions, and collected

Table 2.1 Mapped data sets for the Coastal Values data projects.

Vegetation and fauna layers (8)	Geomorphology layers (9)
• Vegetation	• Geomorphic lines – Condition
• Native vegetation condition	• Geomorphic lines – Geoconservation values
• Native vegetation viability	• Geomorphic lines – Sensitivity
• Vegetation significance	• Geomorphic lines – Lower intertidal landforms
• Weeds	• Geomorphic lines – Upper intertidal landforms
• Observed fauna habitat	• Geomorphic lines – Backshore landforms
• Potential fauna habitat	• Polygons – Historic dune mobility
• Fauna significance	• Polygons – Present dune mobility
	• Polygons – Soft sediment landforms

and assessed a range of coastal vegetation, species habitat and geomorphic values data. National parks and some larger coastal reserves are not included. Available mapped data sets are summarised in Table 2.1.

All these mapped data sets are available on the Tasmanian Land Information System LIST website.

Follow the links to the 'Coastal Values' layer in the layer management function of LISTmaps. Experienced GIS Software users can also download the data sets from the DPIPWE website, or obtain them on CD from the Coastal and Marine Branch, EPA Division, DPIPWE, to upload onto their own computers. Supplementary resources such as Interpretation Manuals and photographs are also available for download.

Foreshore values mapping

The foreshore values database holds information on the values and condition of the foreshore for the three NRM regions in Tasmania. It provides baseline information on the condition of foreshores and identifies pressures for measuring impacts on key marine and coastal ecosystems. It is designed to enable an integrated approach to foreshore management, and is aimed at managers, interested stakeholders and the wider community.

For the purposes of this project, the foreshore is defined as 'the area between the high and low water marks where tidal influence exists, together with saltmarshes, rock platforms and un-vegetated beaches (excluding dunes)'. Adjoining areas are also included where relevant.

The mapped data available includes a single line map for each of four indices and the 13 supporting attributes of foreshores:

- Natural value – biology and geomorphology
- Human use value – amenities, recreation and European heritage
- Condition – ecological disturbance, geomorphology and introduced marine species and beach weeds
- Pressure – anthropogenic modification, recreation and tourism, pollution sources, vulnerability to climate change, and introduced marine species and beach weeds

These electronic mapping layers can be viewed on the Land Information System Tasmania (LIST) website, or requested from DPIPWE. The mapping layers can operate as a stand-alone interpretive tool or be used with other maps.

Maps of vulnerability of the coast to sea level rise (Smartline)

The vulnerability of coastal areas has been mapped by Sharples 2006 using available data, termed a '1st pass' assessment. A more detailed assessment or 2nd pass assessment is currently underway. Maps of coastal landform types and their vulnerability to sea level rise can be found under 'Climate Change' layers on the LIST. The data is presented as a 'smart line' following the coastline, with information on the geology of the coast readily interpreted for particular coastal areas.

Tasmanian Coastal Vulnerability Assessment Project (Tasmanian Planning Commission)

The objective of the Project is to assess the physical vulnerability of Tasmania's coast to climate change.

The first stage of the Project is being undertaken

by the University of Tasmania in partnership with the Antarctic Climate and Ecosystems Cooperative Research Centre (ACE CRC) and the Commonwealth Scientific and Industrial Research Organisation (CSIRO). It involves modelling the extent of potential future coastal inundation under various sea level rise projections and storm surge events.

The modelling results have been mapped using the *Climate Futures for Tasmania* project, Light Detection and Ranging (LiDAR) and Digital Elevation Model (DEM), which provides a new generation of mapping accuracy for the most populated areas of the Tasmanian coast. It is anticipated that the Project outputs will inform strategic land use planning and decision making in the coastal zone.

TASMARC project: monitoring shoreline erosion in Tasmania

The Tasmanian shoreline monitoring and archiving (TASMARC) project is a joint project between the Antarctic Climate Ecosystems Cooperative Research Centre (ACE CRC) and the University of Tasmania (UTAS). It aims to increase knowledge of the effects of rising sea levels and storm surges by carrying out long term monitoring of shoreline movement on beaches on vulnerable parts of Tasmania's coastline.

TASMARC relies on volunteers to survey beach profiles. Over time the TASMARC project aims to build a record of long- and short-term changes to beaches and an understanding of how beaches recover after storms. Results are to be published on the web in late 2010. The network of coastal locations being monitored with TASMARC is growing, and volunteers wanting to monitor new sites are welcomed.

2.3.5 Adapting coastal land management activities for climate change impacts

This section directs the reader to parts of the Manual where impacts of climate change and sea level rise on natural values are discussed and management adaptations or guidelines are provided to respond to the risk of climate change and sea level rise. Determination of risk and appropriate measures will be specific to each location and situation. Collect all relevant information on the site as suggested in ***Chapter 1*** and make an assessment of the level of risk using the suggested tools in ***section 2.4*** or seek specialist advice.

Figure 2.3 A TASMARC monitoring site is identified by a simple fixed marker. © Leah Page

2.3

*Table 2.2 Where to find climate change information throughout the Manual. **

Topic	Section
Chapter 1 Working on the coast	
Coastal processes	1.2
Chapter 3 Coastal hazards	
Storm surges, erosion and other coastal hazards	3.2
Remediation after storm events	3.3
Chapter 4 Community Values	
Throughout chapter where appropriate	
Chapter 5 Cultural heritage management	
Climate change and cultural heritage	5.3
Chapter 6 Coastal landscape management	
Assessing dune erosion	6.2.5
Methods for stabilising dunes	6.2.6
Climate change and dune systems	6.2.8
Climate change and beaches, barways, spits and river mouths	6.3.4
Climate change and estuaries, coastal wetlands and saltmarsh	6.4.9
Climate change and soft rock coastlines	6.6.1
Chapter 7 Vegetation management	
Vegetation management and climate change	7.8
Chapter 8 Weed and disease management	
Climate change and weeds and disease in Tasmania	8.6
Chapter 9 Fire management	
Climate change and fire	9.4
Chapter 10 Wildlife and pest management	
Climate change, wildlife management and pests	10.6
Chapter 11 Soil management and earthworks	
Climate change and acid sulfate soils	11.4.6
Chapter 12 Stormwater and crossings	
Climate change and stormwater management	12.1.7
Chapter 13 Access management	
Throughout chapter, in particular in sections 'Guidelines for...'	
Chapter 14 Structures and facilities	
Throughout chapter, in particular in sections 'Guidelines for...'	
Chapter 15 Shoreline modification	
Shoreline protection works	15.1

*Throughout the Manual, climate change considerations and issues are mentioned where information is available.

2.4 Tools and resources

Complete details of all printed publications listed here are provided in a reference list at the end of the Manual. Other tools and resources including websites are collated in *Appendix 5*.

Antarctic Climate Ecosystems Cooperative Research Centre (ACE CRC) web tool

This web based tool is based on the history of sea levels mapped at 29 ports around Australia provided by the Australian National Tidal Centre.

www.sealevelrise.info

Australian coastal Smartline geomorphic and stability map version 1: Project report (Sharples et al. 2009b)

Climate change 2009: Faster change and more serious risks (Steffen 2009)

Climate change impacts on Clarence coastal areas – Final Report (SGS Economics et al. 2009)

www.ccc.tas.gov.au/

Climate change risks to Australia's coast – A first pass national assessment. (Department of Climate Change 2009)

www.climatechange.gov.au

Climate change, sea level rise and coastal subsidence along the Gippsland coast. (Gippsland Coastal Board 2008)

www.gcb.vic.gov.au/sealevelrise

Coastal climate change – The science basis. (Department of Climate Change and Energy Efficiency 2010)

Australian Government Fact Sheet

www.climatechange.gov.au

Coastal engineering guidelines for working with the Australian coast in an ecologically sustainable way (Gourley et al. 2004)

Provides an overview of coastal engineering principle and practice in Australia and includes many checklists useful for those contemplating a coastal project at any scale.

http://www.engineersaustralia.org.au/search/resources/?query=coastal

Coastal hazards and climate change: A guidance manual for local government in New Zealand. (Ministry for the Environment NZ 2008b)

www.mfe.govt.nz/

Coastal values data

Vegetation, species habitat and geomorphic values data for a 100m wide coastal strip of the northern, southern and north western Tasmania NRM Regions. Available on the LIST.

www.thelist.tas.gov.au

CSIRO GIS layer: Wave height direction and period in the Australian region.

A compilation of essential wave statistics. Although the map appears very coarse each pixel is attributed with locally relevant data obtained from satellite instruments.

http://www.marine.csiro.au/marq/edd_search.Browse_Citation?txtSession=8083

Climate change and coastal risk assessment project.

A suite of tools and documents including:

- Coastal risk management plan: Template and guidelines (DPIW 2009)
- Coastal hazards in Tasmania: General information paper (DPIW 2008c)
- Climate change and coastal asset vulnerability: An audit of Tasmania's coastal assets potentially vulnerable to flooding and sea-level rise (DPIW 2008b)
- Sea-level extremes in Tasmania: Summary and practical guide for planners and managers (DPIW 2008e)
- Historical and projected sea-level extremes for Hobart and Burnie, Tasmania (Hunter 2008)
- Background report: Coastal flooding - Review of the use of exceedence statistics in Tasmania (DPIW 2008a)

www.dpiw.tas.gov.au/climatechange

Draft Queensland coastal plan: Draft state planning policy coastal protection. (Department of Environment and Resource Management, QLD 2009)

Foreshore values mapping

Provides baseline information on the condition of foreshores and identifies pressures for measuring impacts on key marine and coastal ecosystems. Available on the LIST or by request from DPIPWE.

www.thelist.tas.gov.au

General practice note 18: Managing coastal hazards and the coastal impacts of climate change (Department of Planning and Community Development, VIC 2008)

www.dpcd.vic.gov.au/planning

Historical and projected sea-level extremes for Hobart and Burnie, Tasmania. (Hunter 2008)

Technical Report by Antarctic Climate & Ecosystems Cooperative Research Centre (ACE CRC).

Indicative mapping of Tasmanian coastal vulnerability to climate change and sea level rise (Sharples 2006)

NSW sea level rise policy statement (Department of Environment, Climate Change and Water, NSW 2009)

Position analysis - climate change, sea-level rise and extreme events: impacts and adaptation issues. (Antarctic Climate & Ecosystems Cooperative Research Centre 2008)

www.sealevelrise.info

Smartline or coastal vulnerability maps

Maps of coastal landform types and their vulnerability to sea level rise can be found under 'Climate Change' layers on the LIST and the OzCoasts website. The data is presented as a 'smart line' following the coastline, with information on the geology of the coast readily interpreted for particular coastal areas.

www.thelist.tas.gov.au

www.ozcoasts.org.au

TASMARC project: monitoring shoreline erosion in Tasmania

TASMARC relies on volunteers to survey beach profiles. For more information contact: nicholas.boden@acecrc.org.au

Understanding sea-level rise and variability (Church et al. 2010)