

Future Coasts
part of the Victorian
climate change
adaptation program

Planning for coastal climate change

An insight into international and national approaches

June 2009

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For further information on the Future Coasts program or obtain an electronic copy of this report please visit our website:

www.climatechange.vic.gov.au/futurecoasts

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Introduction

Coastal vulnerability stemming from sea-level rise, changing weather patterns, storm surges and coastal erosion is challenging traditional systems for use and development of coastal lands. The cumulative impact of these factors into the future represents a significant challenge for coastal planners and managers requiring different approaches and tools to respond.

The Intergovernmental Panel on Climate Change (IPCC) has highlighted the potential global risks from climate change for coastal communities (IPCC 2007). More specific research in Australia by CSIRO indicates, from a coastal perspective, potential impacts in Australia arising from rising sea levels and changing weather patterns leading to an increase in storm surge (McInnes 2005, 2006). This has been supplemented by additional research by states and territories and selected local councils.

Opportunity exists for all stakeholders to learn from a variety of approaches around the world and at a national level, to tackle what is essentially a common challenge. Learning from other jurisdictions will ensure efficiency and consistency in developing responses to the long-term management of coastal impacts from climate change.

In Victoria, work is underway to better understand and plan for future impacts. The recently released *Victorian Coastal Strategy 2008* has identified the strategic policy imperative of planning for the long-term impacts of climate change on the coast. In addition, the Victorian Government has developed the next stage of its climate change strategy with the release of the *Victorian Climate Change Green Paper* (June 2009) which identifies climate change adaptation as an important response element.

From a coastal perspective, the Victorian *Future Coasts* program (part of the Victorian Climate Change Adaptation Program) is currently underway. The *Future Coasts* program represents a multi-million

Future Coasts Program

The *Future Coasts* program incorporates three main objectives which are:

- Providing data and information that will inform management of climate change impacts on the Victorian coast.
- Generating assessments of the Victorian coastline's physical vulnerability to sea level rise and storm events.
- Providing guidance on interpretation and application of climate change science, research and information to coastal managers and planners.

Further information about the Future Coasts Program can be obtained from the following website:

www.climatechange.vic.gov.au/futurecoasts

dollar investment by the Victorian Government to address climate change adaptation on the coast.

Purpose

The purpose of this report is to provide an insight into existing international and national approaches which have been, or are being developed to respond to coastal climate change impacts.

This report provides an overview of a variety of case studies across a range of jurisdictions focused on long-term management of the coastal impacts from climate change. This report does not seek to appraise or critically assess each case study outlined in this report.

The information contained within this report aims to assist a range of current projects and provide an opportunity to learn about alternative approaches from other jurisdictions.

This report will be used to inform the development of coastal adaptation measures as part of the Victorian Government's *Future Coasts* program and for the Minister for Planning's *Coastal Climate Change Advisory Committee*.

Approach

This report examines a small selection of international and national approaches to coastal climate change adaptation. The following three-stage approach was adopted:

1. A desktop literature review of approaches developed/adopted within Australia and internationally to respond to coastal climate change vulnerability.
2. The identification, in consultation with the Department of Planning and Community Development, of the key jurisdictions to be considered within the scope of this project.

The case studies have been selected to illustrate the range of measures being undertaken at the national, regional and local level in nations that have similar land-use planning systems. The exception is the Asia-Pacific region; included given its immediate relevance to Australia. Case studies included are:

- New Zealand (Christchurch)
- United Kingdom (London)
- European Union (the Netherlands and Venice)

- Canada (New Brunswick and Halifax)
 - United States (New York, San Francisco, Chesapeake Bay and Florida)
 - South Africa (Cape Town and Western Cape)
 - Asia-Pacific through the activities of PEMSEA
 - Australia (Sydney coastal councils, Shire of Byron Bay, Western Port Greenhouse Alliance, Clarence City Council).
3. A professorial advisory committee from the Global Cities Research Institute to review the draft report.

Finally, conclusions are drawn from the above concerning the options for managing coastal impacts of climate change along the Victorian coastline.

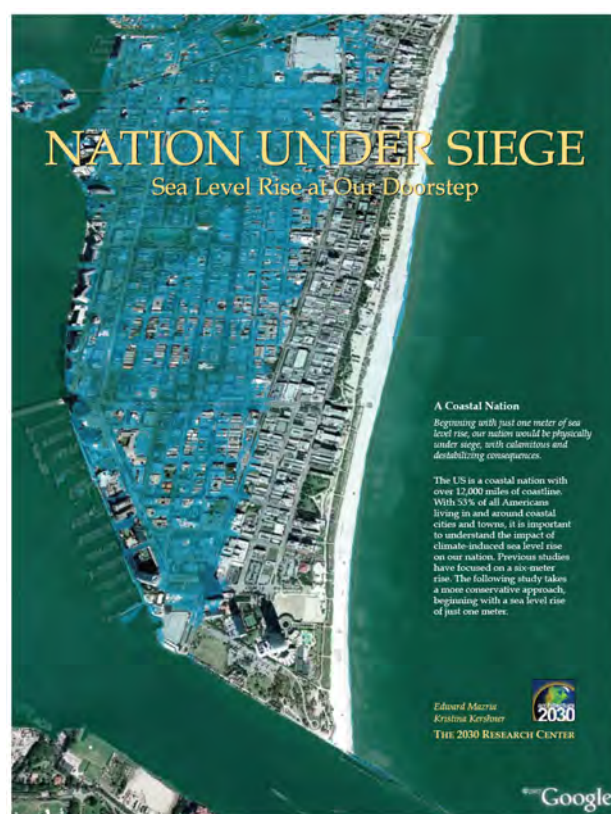
Projections for coastal inundation

The Intergovernmental Panel on Climate Change Fourth Assessment Report 2007 (IPCC) projects sea-level rise by up to 0.8 metres by the end of the century factoring in the melting of polar ice sheets. This has been recognised by the Commonwealth Department of Climate Change and has been adopted as a strategic policy basis by a number of states including Victoria, in its *Victorian Coastal Strategy 2008*.

Subsequent research by Professor Will Steffen for the Federal Department of Climate Change indicates that sea level rise could rise at the upper end of the IPCC projections (Steffen 2009:1).

A report released by the 2030 Research Center (2007) draws on the paleohistorical literature to draw a similar conclusion stating: *'during the last interglacial period which occurred some 125,000 years ago, when the earth was 2° to 3° Celsius warmer, sea level was four to six meters higher than today'* (2030 2007:1).

Other leading scientists (Church et al 2008) have suggested an estimate of between 1 to 2 metres by 2100. Significant uncertainty exists regarding future extent of sea



Source: The 2030 Research Centre (2007) - United States
www.architecture2030.org/current_situation/cutting_edge.html

level rise beyond IPCC projections which depend on a range of factors such as greenhouse gas emissions scenarios and rates/extent of land ice melt.

The above suggests that the IPCC forecasts are conservative and should be treated as a minimum and a more pessimistic estimate of sea-level rise and storm surge may be required for planning purposes. The recently released *Victorian Coastal Strategy 2008* has recognised this by stating: '*As scientific data becomes available the policy of planning for sea-level rise of not less than 0.8 metres by 2100 will be reviewed*' (VCC 2008:38).

Victoria has the advantage of two detailed regional studies, undertaken during 2008, that apply the IPCC and CSIRO projections to local circumstances. This approach to regional planning for climate change is considered leading practice in Australia and as shown later in this report, the preferred model internationally. The conclusions of the two regional studies in Gippsland and Western Port on coastal inundation include:

Western Port: '*a current 1 in 100 year storm surge could become a 1 in 4 year storm surge by 2070; the land area subject to inundation during a 1 in 100 year storm surge event may increase by 4 to 15% by 2030 and 16 to 63% by 2070; inundation would impinge upon over 2000 individuals, over 1,000 dwellings and approximately \$780 million in improved property value; public infrastructure is also at risk*' (WPGA: ii and iii).

Gippsland: '*Sea level rise by the year 2100 will result in as much as 40 to 79 m erosion/retreat along Gippsland's sandy coast; modelling of the Ninety Mile Beach indicates that a 0.8 m sea level rise coinciding with a 1 in 100 year storm surge and flooding in Lake Reeve could result in several breaches of the barrier dunes protecting Lake Reeve*' (GCB 2008:8).

While there is considerably more work to be undertaken, these regional studies provide an early indication of the planning challenges ahead and a basis from which to trial adaptation responses. As the science unfolds at a more local level, community concerns will need to be met with appropriate planning responses to ensure the future well-being of coastal communities and environments.

The cost of 'action' and 'inaction' on coastal adaptation

The cost of action and inaction on climate change was originally highlighted by the *Stern Report 2006* which stated that the cost of action in reducing greenhouse emissions would be much less than inaction 'and can be limited to around 1% of global GDP each year' (Stern 2006: iv).

More specifically in relation to coastal inundation, the subsequent report by the European Environment Agency: *Climate Change: the Cost of Inaction and the Cost*

of Adaptation' estimates a twelve-fold difference between action and inaction. It estimates that inaction on coastal adaptation for the European Union could cost US\$1.5 billion per annum compared to US\$18 billion per annum for inaction.

The principal cost involved in this estimate is the value of the loss of land. A similar economic analysis would be valuable for the Victorian coastline to underpin future strategic responses to projected coastal inundation.

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International insights

Planning for coastal inundation in relation to climate change may be a relatively new phenomenon for some countries, however there are parts of the world that have been managing such issues for centuries.

The following case studies are drawn from countries with similar planning regimes to Victoria including the United Kingdom, the USA, Canada, South Africa and New Zealand.

A range of factors including geography, urban planning and natural resource management, coastal governance arrangements, have influenced responses to coastal climate change impacts.

Countries such as the Netherlands and cities such as Venice have, for many years, developed and implemented a range of measures to address coastal inundation. Other nations, such as Australia, are only beginning to consider these issues.

The recently released *Victorian Coastal Strategy 2008* outlines the need to prioritise the planning and management of responses and adaptation strategies to vulnerable areas across general themes such as; 'protect', 'rebuild', 'elevate', 'relocate' and 'retreat'.

It is in this context that the following discussion on international practice is provided. Each country is developing a range of measures along this continuum, often influenced as much by history and culture as geography.

**Natural Resources Canada (2007) –
Adaptation definition**

'Adaptation to climate change is any activity that reduces the negative impacts of climate change and /or takes advantage of new opportunities that may be presented.

Adaptation includes activities that are taken before impacts are observed (anticipatory) and after impacts have been felt (reactive).

Both anticipatory and reactive adaptation can be planned (i.e. the result of deliberate policy decisions), and reactive adaptation can also occur spontaneously.

In most circumstances, anticipatory planned adaptations will incur lower long -term costs and be more effective than reactive adaptations'.

Asia-Pacific

New Zealand and Christchurch

New Zealand has adopted a national approach to coastal management. It has developed a framework which includes a national policy statement implemented through regional and local councils. The *New Zealand National Coastal Policy Statement* 1994 is currently being reviewed by the Minister for the Environment with a revised statement expected in 2009. The draft *National Coastal Policy* 2008 encompasses the precautionary principle and provides detailed options for planning responses in an accompanying manual for local government (Ministry for Environment NZ 2008 b).

Key elements:

- National coastal policy statement supported by national legislation.
- Specific recognition of climate change and coastal hazards in legislation.
- Regional coastal strategies and plans.
- Guides for local government on coastal inundation and risk management.
- A focus on being precautionary to avoid projected impacts and risks.

The primary legislation is the *Resources Management Act* 1991 that outlines the statutory responsibilities for regional and local councils. Under the *Resources Management Act* 1991, all regional councils are required to prepare regional coastal plans that must give effect to the New Zealand National Coastal Policy. Within the Act, 'sea-level rise' is managed as a 'natural hazard'. The *Resources Management Act* 1991 specifically states that 'particular regard shall be had to climate change effects' (S7). Furthermore, the *Civil Defence and Emergency Management Act* 2002 provides for local councils: 'to identify, assess and manage hazards and to communicate information about hazards including sea-level rise'.

The current New Zealand Coastal Policy Statement (1994) states: 'that policy statements should recognise the possibility of a rise in sea level and should identify areas which would as a consequence be subject to erosion or inundation' (3.4.2). The *Resources Management Act* 1991 provides a mandate for regional councils to manage natural hazards (Section 30, 31 and 35). Predicted 'sea-level rise' and the impacts of climate change are managed through regional, district and coastal plans and consequent provisions in the regional planning schemes.

At the local level, New Zealand has adopted a risk management approach to climate change and the coast. During 2008, the New Zealand national government produced two important guides for local government in planning for climate change:

- Ministry for Environment NZ (2008) *Preparing for Climate Change – A Guide for Local Government in New Zealand* July 2008.
- Ministry for Environment NZ (2008) *Coastal Hazards and Climate Change – a Guidance Manual for Local Government in New Zealand* 2nd Edition July 2008.

The *Preparing for Climate Change* report is in three parts: the first explaining the impacts of climate change including sea-level rise and storm surge, the second outlining the ‘social and legal obligations’ to consider in planning and decision making including checklists to assist councils’ assessment, and thirdly, how councils can integrate the impact of climate change into council decision making (Ministry for Environment NZ: 2). The New Zealand checklist for local councils is provided in Appendix 1 as an example what could be considered in Victoria.

The more detailed *Coastal Hazards and Climate Change – a Guidance Manual for Local Government in New Zealand* (Ministry for Environment NZ 2008 a) provides more specific guidance on the impact of climate change on coastal environments. This comprehensive and practical guide for managing sea level rise and coastal inundation provides a risk management framework for local government to make decisions regarding planning applications, where coastal hazards are involved. It identifies six categories of planning responses – ‘information and education, land use planning regulation, building consent controls, financial mechanisms e.g. land purchase, long-term financial infrastructure planning, and protection structures’.

A relevant local example of integrating the impacts of climate change particularly sea-level rise into a local planning scheme is provided by the *Christchurch City Plan* and associated *Urban Development Strategy* (Christchurch City Council 2008). In determining responses to coastal inundation, consideration is given to floor levels, subdivision restrictions, bank improvements and tidal barrages.

Overall, New Zealand is taking a comprehensive risk management approach to coastal inundation at the national, regional and local level. Policy direction is provided at the national level and specific practical advice to local government. In terms of the continuum of ‘abandon’ to ‘defend’, all options are considered and a framework for assessment and decision is provided to enable local adaptation solutions to be developed.

PEMSEA

Website: www.pemsea.org

It is estimated that in East Asia, 1.5 billion people live within a hundred kilometres of the region's coasts (PEMSEA 2007:3). In this region there is considerable dependency on the coastal environment for livelihood and subsistence. The impact of coastal inundation on low-lying land in the Asia-Pacific will be substantial, and given the density of population, will ultimately involve the whole region in providing a solution.

The key regional mechanism for facilitating sustainable outcomes for oceans and coasts in the Asia-Pacific is through the PEMSEA (Partnerships in Environmental Management for the Seas in South East Asia) Agreement. This involves national ministerial level engagement by Cambodia, People's Republic of China, Democratic People's Republic of Korea, Indonesia, Japan, Lao People's Democratic Republic, Philippines, Republic of Korea, Singapore, Timor-Leste, and Vietnam. The Victorian Government is a signatory to the PEMSEA agreement.

The *Putrajaya Declaration* 2003 is a Pemsea ministerial declaration for 'regional cooperation for the sustainable development of the seas of East Asia'. The *Hakiou Partnership Agreement* 2006 further details operating arrangements for implementing the partnership.

Within the PEMSEA framework, coastal strategies have been developed in many regions including (PEMSEA:16):

- Bali and Sukabumi (Indonesia)
- Bataan, Cavite, Manila Bay and Batangas (Philippines)
- Nampho (DPR Korea)
- Sihanoukville (Cambodia)
- Klang (Malaysia)
- Chonburi (Thailand)
- Danang (Vietnam)
- Xiamen and Bohai Sea (People's Republic of China).

Key elements:

- The regional partnerships and long term relationships developed through PEMSEA.
- The ongoing shared coastal research program involving many nations.
- The high level of risk of coastal inundation of low-lying islands and highly urbanised coastal areas with considerable regional and local planning to be undertaken in the future.
- The commitment to integrated coastal management by PEMSEA and the funding of a range of land use and coastal responses.

The PEMSEA Network of Local Governments for Sustainable Coastal Development (PNLG) and the PEMSEA Small Grants Program support the local coastal strategies.

Planning for sea-level rise and coastal inundation is seen as a key element for PEMSEA. Many of the islands in the Asia-Pacific region are low-lying and at high risk of inundation. The issue of environmental refugees is recognised, but not yet planned for. Disaster management for the coastal environment is a priority:

'... proactive disaster risk management in Asia has to become part of the development agenda to deal with the growing variety and intensity of hazards in general, and that coastal areas should receive special attention due to economic activities as well as emerging long term risk scenarios associated with climate change, global warming and sea-level rise in particular'

Source: N.M.S.I Arambepola Director and Team Leader Urban Disaster Risk Management Asian Disaster Preparedness Center (ADCP), Bangkok, Thailand.

The overall approach through PEMSEA is to use the mechanism of *Integrated Coastal Management (ICM)* as the tool for planning for coastal inundation. The PEMSEA ICM framework identifies five key components to achieving sustainable development of the coastal and marine areas:

1. Natural and human-made disaster prevention and response management (including sea-level rise, tsunamis, tidal storms and flooding)
2. Natural coastal habitat protection, restoration and management
3. Water use and supply management
4. Pollution and waste reduction management
5. Food security and livelihood management.

PEMSEA has identified the key tool for coastal planning, factoring in predicted sea-level rise, is through a system of coastal land use zoning.

Three case studies are provided by PEMSEA as examples of best practice implementation (PEMSEA 2007:40):

- **Xiamen** (China): *Functional Zonation Scheme* is a model of a 'sea use' zoning integrated into the city's land use scheme. During 2007, the municipality of Xiamen commenced a program of shoreline defence by restoring the mangrove system in Tong'an Bay.
- **Sihanoukville** (Cambodia): *Coastal Use Zoning Scheme* is a zoning scheme for both land and sea in one unit to enable an integrated approach to coastal management. This scheme has been approved by the National Coastal Steering Committee of Cambodia.

- **Danang** (Vietnam): *Coastal Use Zoning* manages and allocates spatial uses for sea resources (PEMSEA: 40). The city of Danang has identified high-risk areas and is moving people to higher ground. It is also incorporating adaptation measures into the planning schemes including developing detailed maps, identifying relocation sites, designing safer buildings, tree planting and a communication network.

Details on each of the case studies is available through the PEMSEA website.

Europe

Great Britain and London

Source: www.defra.gov.uk/envIRON/fcd
www.london.gov.uk/mayor
www.thamesweb.com
www.ukcip.org.uk

London is predicted to be subject to flooding from five sources: the sea (tidal flooding), the Thames and its tributaries, heavy rainfall, the sewers and rising groundwater (Greater London Authority 2008:11).

The United Kingdom is adopting a flexible approach to coastal protection for sea-level rise and storm surge. In areas that have traditionally been protected, consideration is being given to re-flooding parts of the coast as the British Government realises that it cannot economically sustain the fight against nature.

The overall strategy is now one of 'managed retreat' or 'managed realignment'. This is expressed in the *Making Space for Water* (DEFRA 2005). The Government has committed £2.15 billion over the next three years on flood protection. The national environment agency has surveyed 6000 miles to determine which areas should be afforded protection and which left to nature.

At the city level, the Mayor of London released *The (draft) London Climate Change Adaptation Strategy* (Greater London Authority 2008). The Strategy uses the UKCIP *Climate Adaptation: Risk, Uncertainty and Decision Making (2003) guidance*, the report has identified the risks including flooding.

In a regional flood risk appraisal, the Greater London Authority has identified three key steps in its methodology:

Key elements:

- A national climate change risk strategy and regional 'London' climate change adaptation strategy.
- Triple bottom line approach to managing risk of inundation.
- Managed retreat and realignment of the coastline in line with nature.
- Regional flood risk appraisal combined with development contributions towards emergency management.



Source: Thames River Estuary Project: *London Climate Chang Change Adaptation Strategy*

1. The probability of a flood occurring
2. The consequence of a flood
3. The vulnerability of the people and assets that may be affected by the flood.

The Greater London Authority has identified 1.25 million people, 481,180 properties as well as extensive 'social and civil infrastructure' at risk. The infrastructure of concern has been identified as that which needs to be operational to 'manage a flood or to ensure that parts of London not flooded can continue to function as normal' (GLA 2008:15).

The responses recommended in the London strategy for the next 20-30 years for the tidal section of the Thames, downstream of the Thames Barrier, include:

- Raising the height of the defences downstream of the Thames Barrier and adjustments to the barrier itself.
- Identifying where the line of flood defences may have to be moved in the future to provide more sustainable flood risk management.
- Identifying the number of riverside sites (open space and industrial land) downstream of the Thames Barrier that could provide space for future flood storage and so reduce flood risk.
- Encouraging spatial planning in the long term (second half of this century) to review opportunities to 'risk trade' (swap vulnerable land uses in flood risk areas with less vulnerable land uses elsewhere). (GLA 2008:21).

More specifically, the *Thames Estuary 2100* project has adopted a 'trigger' response to sea-level rise outlining a range of adaptive responses to specified levels of sea-level rise. The responses outlined by the London Mayor are categorised under the following headings:

- **Prevent:** improve the standards for risk management including setbacks, construction materials, urban permeability for sustainable urban drainage.
- **Prepare:** the London Resilience Partnership to review the *London Flood Response Strategic Plan*.
- **Response:** developers on flood risk areas to contribute to flood emergency plans.
- **Recover:** local councils to prepare recovery plans that identify immediate and long-term recovery commitments. Housing Associations to encourage social housing tenants living with flood risk to take out 'insurance with rent' contents insurance cover (GLA 2008:xii).

The approach prepared by London is methodical and detailed and takes a wider view of coastal inundation by addressing economic, social and environmental

issues. It places responsibilities on all sectors in terms of the costs of adaptation. There is a strong emphasis on building resilience. In requiring developers within flood risk areas to contribute to emergency flood plans, it sends a clear message that those who choose to build in high-risk areas will pay a premium to minimise the costs to the community (Greater London Authority 2008:27).

Overall, the planning for coastal inundation in the United Kingdom is similar to New Zealand in that it provides a national risk policy framework and guidance through the UKCIP *Climate Adaptation: Risk, Uncertainty and Decision Making (2003) report*. The London adaptation plan inclusion of a 'trigger' approach, developer responsibility and social impacts provides an example of planning for climate change in a global city.

European Union

The European Union (EU) has been investing considerable funds in climate change adaptation including possible coastal inundation. The EU report: *Action against climate change – adapting to climate change 2008* states:

'The threat from sea-level rise illustrates the advantages of taking early action. The cost of building additional flood defences is estimated at up to four times less than the damage that sea-level rise will cause by 2080s.

Without early policy action on adaptation, the EU and its Member States may be forced into sudden and reactive measures in response to increasingly frequent crises and disasters. This will not only prove much more expensive than planning ahead, but will also hurt Europe's economy, social stability and security.' (EC 2008:17)

The need to adapt to climate change is also emphasised in *Europe's Environment – The Fourth Assessment Report by the European Environment Agency*. In particular this report emphasises the need to include the marine environment in policy responses:

'Adaptation policies should include measures to reduce other, non-climatic pressures in order to increase the resilience of marine ecosystems and the coastal zone to climate change' (EEA 2008: 17)

The following two case studies illustrate a national (the Netherlands) and a local (Venice) response to coastal inundation. Flood management is not new to Europe but the consequences of significant coastal inundation are given the location and density of coastal populations and infrastructure.

The Netherlands

The Netherlands provides a useful case study as it has been responding to coastal inundation for a long period of time. Over 60% of the nation is below sea level and much of that area is economically productive. The Netherlands has a long history of planning for coastal inundation.

Following the major floods of 1953, the Netherlands invested over E\$13 billion (Kabat & Vellinga 2005:284) in protective dykes and surge barriers in the Delta area. However, more recently there has been a realisation that building higher and higher defences is not the long-term answer and a 'living with water' strategy is now the preferred approach. This means allowing for flooding in certain circumstances is acceptable within the range of possible responses from 'do nothing', 'adapt', 'retreat' to 'defence'.

The national government of the Netherlands is committed to being a leader on climate change adaptation and has embarked on a program of 'climate proofing' the nation. The principal mechanism for this is the preparation of a *National Climate Change Spatial Plan*. The Dutch Delta Committee was established to provide advice to the Netherlands Minister for Housing, Spatial Planning and the Environment.

The Dutch Delta Committee report was presented to the Minister on 3 September 2008. It provides 12 recommendations (see Appendix 2) for climate proofing the Netherlands for the next century. Implementation of the recommendations is to be supported by a *Delta Act* and a *Delta Fund*.

The key issue for the Netherlands is security, but the recommendations cover a wide range of interrelated matters including recreation, infrastructure and energy. The climate proofing strategy provides a national approach at the same time as providing tailored solutions for different regions, with an emphasis on action now rather than later.

Key elements:

- Preparation of a national spatial plan for climate change adaptation.
- A specific national commission of inquiry (Delta Commission) supported by a Delta Act and a Delta Fund.
- Recognition that a strategy of defence only is not sustainable and a range of 'softer' measures is required including flooding in some areas.

More details can be found at:

www.deltacommissie.com/en/advies

Venice

Website: www.corila.it

Venice has a long history of planning for coastal inundation. It already faces the problems of storm surge and subsidence and now has the added challenge of sea-level rise from climate change.

Rebuilding at higher levels and modifying structures has been the adaptive response. Venice is seen as a place to be conserved for its world heritage significance and existing buildings need to be maintained accordingly. The dedicated research centre *Corila*, a consortium for coordination of research activities concerning the Venice Lagoon System, has undertaken extensive research into the inundation of Venice.

Key elements:

- A substantial financial commitment by the national ,regional and local government in a comprehensive defence plan for protecting Venice.
- A plan designed to prevent flooding but also protect the heritage value of Venice.
- A dedicated research centre to provide continuing monitoring and investigation.

Since 2000 there has there have been two main strategies adopted to address coastal inundation. The first is the Moses project (Modulo Sperimentale Elettromeccanico), approved by Italian Prime Minister, Silvio Berlusconi. The project is planned to take up to eight years to complete at an estimated cost of \$4 billion. There has been significant scientific and environmental controversy over the proposal due its high level of structural intervention into the coastal and estuary environments (Owen 2007).

The key elements of the Moses project include the construction of a system of mobile barriers together with complementary public works designed to protect Venice from inundation. The '78 buoyancy flap gates' in four rows is substantial and is expected to manage a 60 cm increase in sea level, slightly higher than the IPCC projections for this region.

The other more specific response under consideration is called the 'Rialto'. This is designed to 'lift' nominated buildings by one metre in response to projected sea-level rise. This is to be achieved by using piston-supported poles at the base of each building. The logistics and cost implications will be very significant but the research into such a mechanism will be useful to others cities of world or national heritage significance. It is difficult to know what to do when a particular building cannot be altered.

Not surprisingly, the adaptive response to coastal inundation by the Venetians is one of defence and immediacy. Venice is suffering the combined impacts of sea-level rise and subsidence, now being flooded more than 100 times a year. The heritage value of its built form raises particular concern, along with the cost of inaction. The value of Venice as a case study is to provide ideas for those areas where 'defence' mechanisms will be required, such as in highly urbanised areas on high-risk land.

On the first of December 2008, Venice experienced the worst floods or '*aqua alta*' in 20 years. The 'sea level rose to 1.56 metres above normal, submerging nearly all of the city' including St Marks Square (BBC 2008).

Canada

New Brunswick and Halifax

Website: www.gnb.ca
www.halifax.ca/regionalplanning

Canada has developed a national response to climate change adaptation outlined in its report: *From Impacts to Adaptation: Canada in a Changing Climate*. It concludes in part that: 'integrating climate change into existing planning processes, often using risk management methods, is an effective approach to adaptation' (Government of Canada 2007:3).

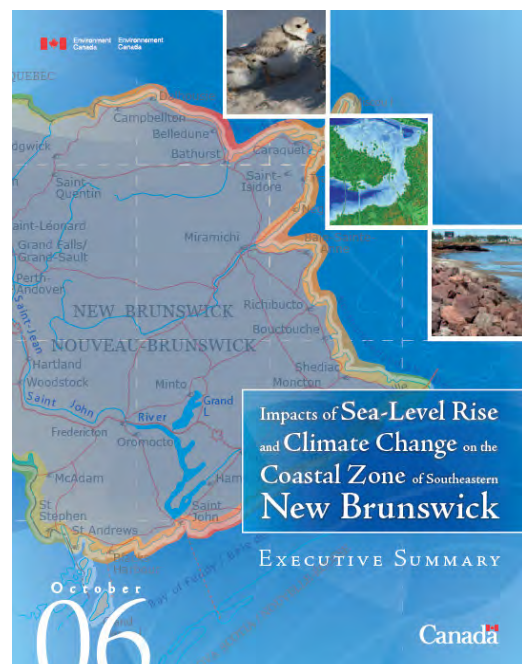
A key report developed as part of the national program is: *Impacts of Sea-Level Rise and Climate Change on the Coastal Zone of South-eastern New Brunswick 2006* (Environment Canada 2006).

Specifically in relation to adaptation on the coast, the following two conclusions were made:

1. Appropriate adaptation strategies may take many forms and may include components at different scales. The provincial *Coastal Areas Protection Policy* provides an umbrella for coastal management and adaptation measures at a local level. Communication and coordination of efforts between various levels of government, community leadership, local organizations and citizens are essential ingredients for success.
2. Among the possible tools that can help communities, the environmental impact assessment process should ensure that climate change considerations are included prior to any new development projects being started.

Key elements:

- A national response to climate change adaptation.
- In New Brunswick the application of a land use buffer zoning response to coastal inundation.
- In Halifax, an example of using the Environment Impact Assessment process as a trigger for action.
- Emphasis is given to the importance of community engagement in developing coastal adaptation plans.
- Need to work with nature rather than against.



Source: New Brunswick – Coastal Areas Protection Policy 2006 (www.gnb.ca)

New Brunswick provides a good case study at the provincial or state level in a federated system similar to Australia. The shoreline is 5,501 km in length comprising 87% of the New Brunswick boundary.

The approach to coastal protection is through a zoning approach:

- Zone A: discernable landward limit of the feature (dune, beach, wetland, dykeland, platform)
- Zone B: 30 metres landward of the limit of Protected Area A
- Zone C: Transitional Zone, generally area at least risk, with development able to occur.

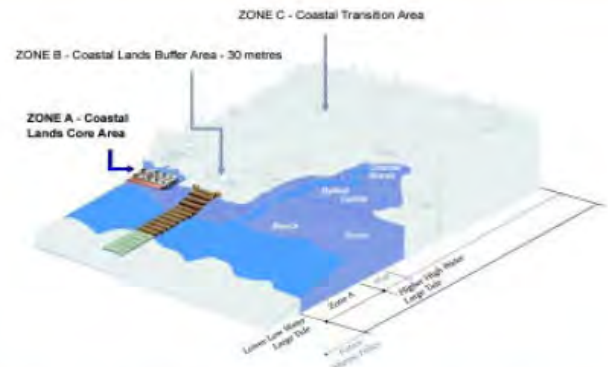
The key objectives of the New Brunswick policy are to:

- Maintain flora and fauna
- Minimise contamination
- Reduce threats to personal safety by storm surges
- Protect coastal and inland areas from storm surges
- Minimise expenditures (storm surge repair and control of coastal erosion).

The *Halifax Regional Municipal Planning Strategy* provides a good example of incorporating coastal issues in relation to sea level rise into a regional plan. A two-stage approach is taken with interim controls being implemented pending the completion of a *Potential Hazards to Development Functional Plan*. The interim regional control for Halifax is (Halifax 2006):

'E-16 HRM shall, through the applicable land-use bylaw, prohibit all residential development on the coast within a 2.5 metre elevation above the ordinary high water mark, except for lands designated Halifax Harbour on the Generalised Future Land Use Map (Map 2) and industrial lands within the port of Sheet

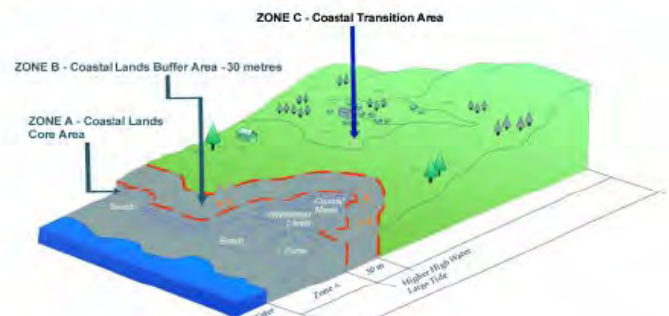
ZONE A - COASTAL LANDS CORE AREA



ZONE B - COASTAL LANDS BUFFER AREA



ZONE C - COASTAL TRANSITION AREA



Example: Coastal buffer zone system and acceptable activities

Source: New Brunswick – Coastal Areas Protection Policy 2006 (www.qnb.ca)

Harbour. Provisions shall be made within the by-law to permit residential accessory structures, marine dependent uses, open space uses, parking lots and temporary uses within the 2.5 metre elevation.'

Canada provides an excellent example of action on climate change adaptation from the national down to the local level, including a specific focus on sea-level rise and coastal inundation. The national framework is established, regional planning is the key tool for delivery and specific tools include coastal setbacks and environmental impact assessment processes. The importance of community engagement in developing any area-specific coastal adaptation plans is emphasised.

United States

The *US Coastal Zone Management Act* 1972 provides the national framework for coastal planning at the state and local level. The National Oceanic and Atmospheric Administration (NOAA) and the United States Environmental Protection Agency are the principal national bodies involved in examining the impacts of sea-level rise on US coastlines.

The *Coastal Zone Management Program Strategic Plan 2007-2012* identifies four main drivers for the Coastal Zone Management Plan (NOAA 2007):

- Coastal Management Act 1972
- NOAA vision
- US Oceans Plan and the report by the US Commission on Ocean Policy and Pew Oceans Commission
- the Presidents Management Agenda and the Government Performance and Results Act (GPRA).

Key elements:

- New York City Panel on Climate Change – Authoritative Local Advice.
- Adaptation Strategies to respond to sea level rise risk for New York City.
- A National Coastal Zone Management Act and Coastal Zone Strategic Plan 2007-2012.
- Chesapeake Bay – multi state integrated approach supported by scientific research program.
- San Francisco – coastal planning institutional arrangements supported by a Governor committed to planning for Climate change.
- Florida - a relevant evidence based climate change adaptation research program providing practical advice to local government.

The *Coastal Zone Strategic Plan* identifies sea-level rise as a 'chronic threat'. It further states that:

'There are growing concerns about how and whether to rebuild coastal communities after major hazard events, and how to mitigate future coastal hazards' (NOAA: 4).

NOAA published *Envisioning Our Coastal Future* 2008 as a discussion paper to commence a review of the US Coastal Zone Management Act 1972. It identifies responding to climate change impacts, including sea-level rise, as a priority. There is a great deal of activity at the local level, more than can be covered in this overview. The following examples provide an indication of the range of land use responses to sea-level rise.

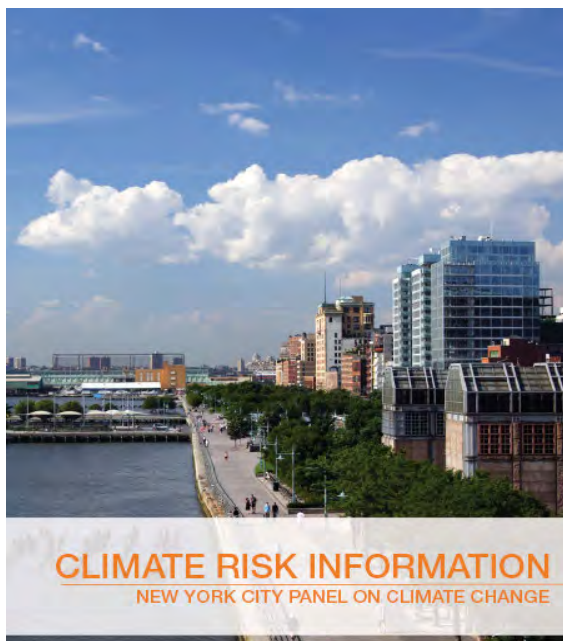
New York

Website: www.nyc.gov/html/planyc2030

The City of New York launched a comprehensive climate change program for New York in 2007.

The *New York City Panel on Climate Change* (NYCPCC) advises the Mayor on issues related to climate change and adaptation. Made up of climate change and impacts scientists, legal, and insurance and risk management experts, the NYCPCC is modelled on the Intergovernmental Panel on Climate Change (IPCC).

Among its activities, the NYCPCC is working to develop climate change projections for New York City; create a set of workbooks to assist the City's Climate Change Adaptation Task Force; and draft a technical report on the localised effects of climate change on New York City – similar to the IPCC reports on global climate change.



New York City Panel on Climate Change

Source: City of New York - www.nyc.gov/html/planyc2030

The key strategic plan guiding efforts is *PlaNYC 2030* (NYC 2006) which is a 30-year strategic document that provides a comprehensive approach towards 'A Greener, Greater New York'. The PlaNYC 2009 progress report indicates that a city-wide process to respond to climate change impacts will commence during 2009. The progress report indicated the following key actions that are being pursued:

- 1. Create an inter-agency taskforce to protect New York City's vital infrastructure.**
 - *Expand adaptation strategies beyond the protection of our water supply, sewer, and wastewater treatment systems to include all essential city infrastructure.*
- 2. Work with vulnerable neighbourhoods to develop site-specific protection strategies.**
 - *Create a community planning process and "toolkit" to engage all stakeholders in community-specific climate change adaptation strategies.*

3. Launch a city-wide strategic planning process for climate change adaptation:

- *Create a strategic planning process to adapt to climate change impacts*
- *Ensure that New York's Federal Emergency Management Administration (FEMA) 100-year floodplain maps are updated*
- *Document the city's floodplain management strategies to secure discounted flood insurance for New Yorkers*
- *Amend the building code to address the impacts of climate change.*

Maryland

Website: www.chesapeakebay.net
www.dnr.state.md.us/Bay/czm/sea_level_rise.html

An early approach to rising sea levels was initiated by the State of Maryland - *A Sea Level Rise Response Strategy for the State of Maryland 2000* funded by NOAA and the State of Maryland. It was comparatively far-sighted in the emphasis it placed on the impacts of climate change, including sea-level rise, nearly a decade ago. This is underpinned by the Chesapeake Bay Agreement 2000 - a partnership between the States of Virginia, Maryland, and Pennsylvania, the District of Columbia, the Chesapeake Bay Commission and the US Environmental Protection Agency. The Chesapeake Agreement specifically addresses the challenge of sea-level rise (CBP 2008).

During September 2008, a report *Climate Change and the Chesapeake Bay: State of the Science Review and Recommendations* was published concluding that the bay will be affected by increasing acidification, rising sea levels and increasing water temperatures leading to increased coastal flooding and submergence, growth of harmful algae, loss of underwater bay grasses and conditions that favour warm water fish and shellfish (STAC 2008).

The scientific advisory group has called for a climate change action plan to be prepared. The Maryland/Chesapeake scenario provides a model of a long-term multi-jurisdictional partnership since 1983, taking an integrated and evidence-based approach to overall bay health and the impacts of climate change.

California

Website: www.climatechange.ca.gov/adaptation

California is undertaking a significant public consultation program in developing a *California Climate Change Adaptation Strategy*. This is following the *Global Warming Solutions Act* (AB32) primarily focussed on mitigation and the Governor's Executive Order s-3-05 for a report on adaptation efforts. This project commenced in July 2008 and is to be completed by April 2009. It is comprehensive in approach examining biodiversity and habitat, infrastructure, oceans and coastal resources, public health, water, and working landscapes (forestry and agriculture).

The *Oceans and Coastal Resources Adaptation Strategy* specifically addresses sea level rise and coastal inundation. The

Oceans and Coastal Resources Adaptation Strategy is at an early stage of public consultation and will include 'adaptation strategies for coastal habitats and infrastructure along the 1100 miles of California's coastline'

The Bay of San Francisco provides an excellent case study involving a myriad of land use issues similar to those facing some Australian cities, including Melbourne. The Bay Conservation and Development Commission and the California Coastal Commission undertake coastal management in San Francisco.

The Bay Conservation and Development Commission (BCDC) is taking an active role in planning for sea-level rise and the consequences for San Francisco. The BCDC has prepared *A Sea Level Rise Strategy for the San Francisco Bay Region* 2008 that identifies the measures required to adapt to projected sea-level rise:

- The most significant structural, environmental, aesthetic, social, cultural and historic resources that must be protected from inundation.
- Those areas inappropriate for protection from inundation.

San Francisco Bay Scenarios for Sea Level Rise SFO



San Francisco airport at one metre sea-level rise

Source: California Climate Change Portal -
www.climatechange.ca.gov/adaptation/index.html

- Those areas most suitable for wetland restoration, habitat enhancement and other opportunities that would enhance the biological productivity of the bay.
- Undeveloped uplands suitable for marsh migration.
- Strategies and techniques that will make future conservation and development projects more resilient to climate change.

The BCDC's preferred strategy is an adaptation plan for sea-level rise for the next 50 years that enhances the 'biological productivity of the San Francisco Bay estuary, advances continued economic prosperity in the bay area, and addresses environmental justice issues' (BCDC2008:6-7).

In the past, the BCDC has focussed on addressing the problem of a shrinking bay due to reclamation. Now it is faced with the issue of a widening bay due to sea-level rise, requiring quite different responses ranging from seawalls to softer options referred to as 'living shorelines' (Bedsworth, L and Hanak, E 2008: 17).

Florida

Website: www.cuesfau.org
www.tcrpc.org

The State of Florida contains '8,400 miles of tidal coastline' that contribute significantly to the state's economy including tourism, fisheries, recreation and boating. The Department of Environmental Protection is responsible for coastal management, implementing 23 statutes concerning coastal management. Both federal and state agencies have funded key reports on sea-level rise and climate change for Florida. These include:

- Florida Atlantic University (2008) *Florida's Resilient Coasts: A State Policy Framework for Adaptation to Climate Change*, commissioned by the National Commission on Energy Policy, Centre for Urban and Environmental Solutions.
- Florida Atlantic University (2007) *Living on the Edge: Coastal Storm Vulnerability of the Treasure Coast Barrier Islands*, Center for Urban and Environmental Solutions.
- Treasure Coast Regional Planning Council (2005) *Sea Level Rise in the Treasure Coast Region* Treasure Coast Regional Planning Council .

Other key coastal research examining the economic risk of not taking adaptation action include:

- Caribbean Conservation Corporation and Sea Turtle Survival League et al (2006): *Florida's Coastal and Ocean Future: A Blueprint for Economic and Environmental Leadership*

- National Ocean Economic Program (2006) *Phase 1: Facts and Figures, Florida's Ocean and Coastal Resources*.

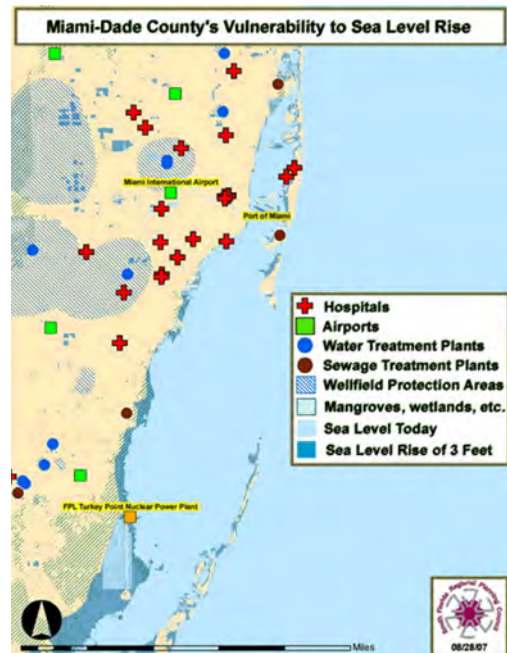
Arising from the above research, the State Department of Community Affairs commissioned the preparation of *The Florida Planning Toolbox* (CUES 2007).

The Planning Toolbox includes a section on coastal planning and adaptation that provides a range of tools that can be used in response to sea level rise.

The results of risk and vulnerability assessments provide a basis and framework for Florida in identifying, prioritising, and deciding how to pay for and implement the strategies needed to adapt to and prepare for the impacts of climate change. A selection of identified strategies, specific to the needs of a community, can be found at Appendix A.



Source: Florida Atlantic University
www.cuesfau.org/toolbox/index.asp



Source: South Florida Regional Planning Council
www.sfrpc.com

South Africa

Western Cape and Cape Town

Website: www.capegateway.gov.za

South Africa has adopted a national approach to coastal management and has legislated to incorporate climate change issues, including sea-level rise, within this approach.

The national legislation provides for implementation at the provincial and municipal level and requires matters including sea-level rise to be included in any future land use planning. It does not prescribe how, but does include the designation of a national coastal zone within which it establishes a set of principles to be adhered to for coastal environmental protection.

Specifically, the Parliament of the Republic of South Africa has incorporated climate change considerations into a new national bill for 'Integrated Coastal Management'. In particular the bill proposes a coastal zone.

Key elements:

- National coastal legislation requiring matters including sea level rise to be included in any future land use planning.
- The designation of a national coastal zone within which a set of principles must be adhered to for coastal environmental protection.
- Cape Town: the inclusion of a coastal buffer zone at the local level.
- Western Cape: the potential consequences of medium and long-term climate change and associated sea-level rise must be taken into account in all coastal planning and management.

In determining the boundary of the national coastal zone, the draft legislation specifies that the following 'must' be taken into account:

'The potential for the number and severity of natural disasters to increase due to effects of global climate change and other impacts on the environment, and the importance of taking preventative measures to address these threats' S28 (d).

The implementation of the Integrated Coastal Management Act relies on Chapter 3 of the South African Constitution on the principles of cooperative governance.

The *National Environmental Management: Integrated Coastal Management Act* 2008 also provides for the establishment of a 'National Coastal Committee' that 'must promote integrated coastal management in the Republic and effective cooperative governance by coordinating effective implementation of this Act' s35 (3).

The national coastal legislation requires municipal coastal programmes to be implemented. An example is the *Western Cape: Integrated Coastal Management Programme* that provides for land use responses to climate change on the South African coastline. It specifies that 'the potential consequences of medium and long term climate change and associated sea-level rise shall be taken into account in all coastal planning and management' (Objective C5.2).

The City of Cape Town is also tackling climate change impacts at the local level. Cape Town includes 307km of coastline that is protected by a *Coastal Zone Management Strategy 2003* supported by specific sustainable coastal management plans. The City of Cape Town is undertaking a '*Sea Level Rise Risk Assessment*' to predict the ramifications of sea-level changes as a result of climate change on existing coastal systems. As the Mayor of Cape Town explained:

'The sea-level risk assessment will also feed into the City's draft coastal development guidelines, which is currently being discussed by the various Sub-councils, and which have already highlighted the need for preserving a coastal buffer in all coastal areas that have not yet been developed.' (Cape Town City Council media release 9 May 2008)



Arniston West Cape South Africa

Source: Google images

National Insights

The following provides a brief overview of state, regional and local examples aimed at better understanding the impacts of climate change along the coast from projected coastal inundation.

Commonwealth, States and Territories

At a national level, a House of Representatives Standing Committee, *Inquiry into Climate Change and Environmental Impacts on Coastal Communities* is currently underway.

In addition the Commonwealth Department of Climate Change is currently undertaking a five-year assessment of coastal vulnerability along the Australian coastline. This includes specific coastal case studies examining coastal vulnerability and a digital elevation coastal vulnerability mapping program.

This investigation and analysis will support various state and local government initiatives underway and will provide a basis for future planning activity.

At the state level there are a range of activities underway, commenced at various times since the 1990s. Appendix B provides a brief overview of activities in each state and territory relating to management of the coastal impacts of climate change.

While there are differences in approach, there is general recognition that planning for sea-level rise and storm surge is now necessary, consistent with emerging international practice.

There is an emerging need for increased national engagement on this issue to facilitate coordinated state and local action.

Opportunity would appear to exist within existing arrangements such as the *Planning and Local Government Ministers' Council*, the *Natural Resources Ministerial Council* and the Council of Australian Government (COAG) arrangements for further development of coordinated approaches and action.

Shire of Byron Bay – New South Wales

Website: www.byron.nsw.gov.au

Byron Bay Shire has been a pioneer in tackling the issue of climate change and in particular, developing a response to sea level rise. The council has adopted a strategy of 'planned retreat' to coastal erosion and coastal inundation:

'Planned retreat in this context means that certain limited and temporary residential development has been permissible on lands subjected to coastal hazards strictly on the basis that once those hazards are realised, that residential development must be relocated to a safer distance for the erosion risk zone'. (Byron Bay 2008:1)

Over the last 20 years there has been a mixed response to this approach, from the perspectives of emergency management and from residents. Following significant storms during 1999, the council developed an *Emergency Action Plan for Coastal Erosion* (2003) as an addendum to the *Byron Bay Flood Plan*.

In its submission to the House of Representatives *Inquiry into Climate Change and Environmental Impacts on Coastal Communities*, Byron Bay Shire concluded that:

'If sea levels continue to rise, the coastal hazard management approach of planned retreat may indeed become a more commonly adopted approach. Councils need support from state and federal government to aid the implementation of this strategy and require more robust legislation to support its implementation' (Byron Bay 2008: 8).

The council is undertaking a comprehensive review of its coastal policy, due for release during 2009.

Sydney Coastal Councils – New South Wales

Website: www.sydneycoastalcouncils.com.au

A regional approach to a major metropolitan area is provided by the Sydney Coastal Councils Group Inc. (SCCG) comprising fifteen coastal councils. SCCG was established in 1989 to 'promote co-ordination between member councils on environmental and natural resource management issues relating to the sustainable management of the urban coastal environment' (SCCG 2009).

A major initiative is the SCCG *Climate Change Adaptation Project* which is funded by the Commonwealth Department of Climate Change: *A Systems Approach to Regional Climate Change Adaptation Strategies in Metropolises*. It has been undertaken by the SCCG in partnership with CSIRO Climate Change Adaptation Flagship and the University of Sunshine Coast.

The project has two major phases – the first to identify ‘the barriers and opportunities to adapting to the impacts of climate change’ and the second to ‘design and implement adaptation strategies through demonstration projects’. The strength of this project is the ‘systems’ approach that seeks to take a holistic view of developing adaptation responses to climate change impacts including sea-level rise and storm surge. The other is the regional perspective, involving a significant number of local councils committed to taking a coordinated approach to adaptation.

Gippsland Coastal Board – Victoria

Website: www.gcb.vic.gov.au/climate.htm

The Gippsland Coastal Board (GCB) is the regional coastal board under the Victorian Coastal Council, established under the Coastal Management Act 1995. The GCB is undertaking significant research into the impact of climate change on the Gippsland coastal environment. In a recent report: *Climate Change, Sea-level Rise and Coastal Subsidence along the Gippsland Coast*, the Gippsland Coastal Board states:

‘The threats to Gippsland are real, and are significant. The best scientific predictions are indicating that within 50 years parts of the Gippsland coast will be inundated to an extent requiring protection or relocation of assets, including dwellings and commercial buildings. Decisions need to be made now about how to deal with this situation’ (GCB 2008: 4).

The GCB, in partnership with the CSIRO Climate Change Adaptation Flagship, has undertaken a series of three major research projects (McInnes et al 2005a, 2005b, 2006):

- **Stage 1 Report:** The effect of climate change on coastal wind and weather patterns
- **Stage 2 Report:** The effect of climate change on storm surges
- **Stage 3 Report:** The effect of climate change on extreme sea levels in Corner Inlet and the Gippsland Lakes

The research has focused on the likely future environmental impacts along the Gippsland coast. A regional forum was held in September 2008 involving

a wide range of coastal decision makers on the options for adapting to climate change on the Gippsland coast. The outcomes of that forum are on the Gippsland Coastal Board's website.

The research by the GCB is informing all levels of government including the Department of Climate Change, the Victorian Coastal Council and the local councils in the Gippsland region. In particular, the Shire of Wellington in Gippsland is working with the local community to find a solution to long-term 'old and inappropriate subdivisions' in areas at high risk of coastal inundation in the future. This is a valuable case study for coastal councils facing similar circumstances.

The Gippsland Coastal Board has also supported the pioneering efforts of visualisation models for Lakes Entrance, Loch Sport and Inverloch. The most advanced model is that of Lakes Entrance (Cunningham Arm). The visualisation approach has been used to provide an understanding and communicate potential impacts. This approach has recently been applied to the coastal settlements of Loch Sport and Inverloch/Venus Bay.



Lake Entrance Visualisation Model

Source: Monash University / GraceGIS

Western Port Greenhouse Alliance –Victoria

Website: www.wpga.org.au

The Western Port Greenhouse Alliance (WPGA) comprises the five local councils fronting Western Port Bay – Bass Coast, Frankston, Cardinia,

Mornington Peninsula and Casey. The WPGA 'carries out projects to help councils and the community respond to climate change'.

During 2008 the WPGA, with funding support from the Commonwealth Department of Climate Change and the Victorian Department of Sustainability and Environment, produced two major reports:

- *People, Property and Places: Impacts of climate change on settlements in the Western Port Region* June 2008 (WPGA2008a) and the
- *Impacts of Climate Change on Settlements in the Western Port Region - Climate Change Risks and Adaptation Report* October 2008 (WPGA 2008b).

In assessing climate change risks for the Western Port region, the WPGA identified that risk number one is 'uncertainty over, or lack of planning controls in areas affected by coastal inundation and/or flooding' (WPGA 2008b:8).

The WPGA approach is an example of a continuing collaborative research program at the local level with active engagement of the local community in planning for climate change, including sea-level rise and coastal inundation.

Clarence City Council – Tasmania

Website: www.ccc.tas.gov.au

Clarence City Council in Tasmania is undertaking a project – *Integrated Assessment and Responses to Sea-Level Rise Impacts on Clarence Foreshore, Tasmania*, funded by the Commonwealth Department of Climate Change with state funding provided by the State Emergency Service, through the Tasmanian Risk Mitigation Programme.

This is a pilot project to examine approaches that could be adopted by small coastal communities. The report *Climate Change Impacts on Clarence Coastal Areas Clarence City Council, December 2008* outlines a range of 'adaptive' measures that can take place (Clarence City Council 2008:vii):

- Practical management options including planning controls for new development, which deal with building setbacks, minimum floor levels, appropriate engineering assessments, and appropriate construction techniques (e.g. piled buildings, flood resistant materials).
- A development freeze in some locations where erosion threatens future development and protection is either impractical or undesirable.
- Physical works such as seawalls, groynes, dune management or sand nourishment, offshore breakwaters and/or surfing reefs, temporary or

permanent flood barriers, reconstruction of public infrastructure (e.g. roads, other services) above flood levels.

- Detailed emergency management and evacuation planning, with hazard reduction requirements for affected properties.
- Providing community education and information to improve awareness and ability to cope ongoing monitoring, analysis and review of findings and additional data collection or studies.
- A timeframe for review – currently five years for council planning schemes.

Summary

This report provides a snapshot of land use responses to the coastal inundation from other countries and from around Australia.

Clearly some countries have a more developed response, more often a result of their long term natural vulnerability to coastal flooding as opposed to the new challenge of predicted sea-level rise from climate change (Venice, the Netherlands, London).

However, where there is a significant national commitment to climate change adaptation, this has largely been followed by local examples of implementation (Canada, UK, EU and NZ). Where a national emphasis on climate change has been absent, a national framework for integrated coastal zone management has provided an umbrella for regional/local coastal adaptation responses such as California (US Coastal Management Act) and South East Asia (PEMSEA).

The range of policy responses by each country span the options from 'protect' to 'do nothing'. All involve a degree of national policy commitment with some nations choosing statutory planning measures and guidelines (New Zealand, Canada, Australia) and others undertaking more comprehensive approaches to adaptation (Venice, London, The Netherlands). The United States, at the state level, is undertaking considerable research with an emphasis on guidelines and regional institutional coordination.

Within Australia, planning for adaptation to sea-level rise and coastal inundation is at an early stage. As indicated earlier in this report, in the absence of any national planning guidelines, each state/territory is developing its own response. The insurance industry is also factoring risk into its future planning and discussing how it can engage with the community in improving community resilience (ICA 2008).

A national response to coastal inundation is likely to be considered following the report from the Commonwealth House of Representatives *Inquiry into Climate Change and Environmental Impacts on Coastal Communities* is expected late in 2009. Coordination of an emerging national response with state initiatives will be important and as evident from this report, consistent with international practice.

The current actions at the state/territory level indicate the commencement of government action to plan for sea level rise and coastal inundation. However there is little consistency in the specifics. The range of activities is largely

confined to establishing a predicted sea-level rise and in part, applying planning guidelines for coastal hazards. The emphasis at the state level is one of 'prevention and retreat' by minimising the extent of new development in vulnerable coastal areas.

A key issue deserving attention is the link between emergency management, coastal inundation and land use planning. The *London Climate Change Adaptation Strategy 2008* discussed in this report provides a useful example of integrating land use responses. Australia has had extensive experience in emergency management in relation to disasters such as fire and inland flooding and is beginning to develop innovative approaches to building community resilience. An example is the Bushfire CRC publication: *Community Bushfire Safety* (Handmer, J & Haynes, K 2008). Some of this experience may provide useful lessons for long term planning for coastal inundation.

Clearly there are initiatives emerging at levels of government in response to planning for coastal inundation. At the national level there is investment in research and development, at the state level there is policy development and at the local level there are specific examples of possible land use responses. All these actions are contributing to a developing matrix of possible responses to coastal climate change impacts.

The submissions by the states/territories to the House of Representatives Inquiry have suggested a national role in coordinating state and local activity. This would include providing some agreed planning parameters for sea-level rise, a tool box of possible actions and a collaborative research agenda (HofR 2008).

Drawing on this review of international responses to coastal inundation, it is suggested that the following approaches could be considered in developing a Victorian response to coastal inundation to guide regional and local implementation in areas at risk:

- The presence of a national policy commitment and frameworks towards climate change adaptation.
- A national coastal management framework for federal funding, coordination and support for state/regional and local initiatives.
- An understanding of the long-term benefits of 'working with nature' in developing adaptive responses, particularly in relation to costs.
- An understanding that coastal responses will require a nexus between knowledge and extent of vulnerability, land use planning, emergency

management and community resilience strategies to cope with the immediate, short and long term responses.

- An appreciation that planning for coastal inundation means planning for a wide range of infrastructure and coastal land uses which involve all levels of government (e.g. transport, energy, water, ports and airports, commercial, retail and housing development).
- Specific tools will be required to respond to different and localised circumstances including environmental assessment processes for large scale infrastructure/major development.
- Overall a precautionary approach may need to be taken to placing any future development in areas designated to be at high risk from coastal inundation in order to minimise future impacts on coastal communities.

To conclude, the purpose of this report is to provide an overview of current practice in planning for coastal inundation. It provides a foundation of evidence for further research and policy development in this critical area.

It is clear that considerable activity is occurring internationally and there is an opportunity for Australia and in particular Victoria, to draw upon this experience and with our own geographical and institutional arrangements, develop a suite of responses for coastal adaptation.

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Appendices

Appendix A: The Florida Planning Tool Box

Source: <http://www.cuesfau.org/toolbox/subchapter.asp?SubchapterID=128&ChapterID=3>

Buildings and Infrastructure

- Strengthening building codes in coastal areas to provide additional protection for properties from wind and storm surges.
- Changing the placement and design of infrastructure (for example, for water supply, wastewater treatment, power plants and other utilities, and transportation).
- Implementing stormwater management processes that more closely mimic nature by retaining rainfall close to its source so that it can be filtered, stored, and allowed to evaporate (by, for example, adopting Low Impact Development practices, described in the Water Resource chapter).
- Creating more shade and reflective surfaces through building and landscape design to make buildings more comfortable when the weather is warmer.
- Retrofitting roads and bridges, which may involve rebuilding roads and bridges at higher elevations and developing engineering techniques that allow them to float or withstand flooding.

Coastal Defences and Economies

- Conserving land in coastal areas by removing or limiting development potential through acquisition, conservation easements, and the purchase and transfer of development rights (all described in the Agricultural Land Conservation chapter).
- Protecting and restoring natural defences such as salt marshes, sand dunes, and natural vegetation. (See the Coastal Planning chapter for a discussion of soft and hard coastal strategies and Florida's Coastal Construction Control Line Program.)
- Constructing hard structures such as seawalls and floodwater control gates where appropriate (for example, urban areas).
- Revising port master plans to reflect the impact of sea-level rise.
- Adopting soft defence strategies, such as establishing aquatic vegetation beds, using natural or artificial breakwaters, and beach nourishment, where appropriate (for example, shorelines that are more undeveloped and where a seawall would inhibit wetland migration and damage natural defence systems).
- Addressing climate change impacts in plans for working waterfronts (described in the Coastal Planning chapter).

Emergency and Hazard Planning

- Working with at-risk neighbourhoods to develop site-specific approaches.
- Considering the impact of sea-level rise or flooding and storm surges and more frequent and intense tropical storms in local emergency evacuation plans,
- Elevating structures above the minimum threshold for the 100-year storm.

Health and Human Services

- Increasing preparedness and response to outbreaks of diseases that may become more prevalent with warmer temperatures.
- Preparing to reduce and respond to heat stress, which increases the incidence of heart attacks and other emergency room visits.

Land Use and Growth Management

- Considering climate change impacts in all nine of Florida's required comprehensive plan elements, particularly those addressing Coastal Management and Capital Improvement.
- Identifying adaptation projects in a community's hazard mitigation plan.
- Enacting land use policies (for example, overlay zones, described in the Land Use Planning and Development chapter) to minimize development in coastal hazard areas (locating it away from coastal hazards and retreating or relocating public facilities and infrastructure) and low lying interior areas.
- Incorporating sea-level rise scenarios in modelling of the 30-year erosion line used for the Coastal Construction Control Line (described in the Coastal Planning chapter) and revising land suitability criteria to prevent development of vulnerable land.
- Allocating land for long-term potential population migrations.

Natural Systems and Resources

- Using more climate-resilient landscaping and crops that do not require irrigation.
- Examining local and regional water supply plans in light of likely climate change impacts, including an emphasis on greater reuse and recycling of water.
- Implementing fishery and coastal resource management policies that incorporate the likely impacts of global warming on marine food chains, marine life, and marine ecosystems, including coral reefs.
- Developing programs that facilitate species migration (for example, planting foods and providing shelter for birds whose habitat is covered with water).

Appendix B: Australian State and Territory Responses

Managing climate change impacts on the coast: A stock take of policies and technical documents from around Australia, April 2009

Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
VICTORIA	<p>The Victorian Coastal Strategy 2008 (VCS) sets the overall strategic direction for planning and management of the coast.</p> <p>Plan for sea level rise of not less than 0.8 metres by 2100, and allow for the combined effects of tides, storm surges, coastal processes and local conditions, such as topography and geology when assessing risks and impacts associated with climate change. As scientific data becomes available the policy of planning for sea level rise of not less than 0.8 metres by 2100 will be reviewed.</p> <p>State Planning Policy Framework, clause 15.08 is updated to reflect latest VCS.</p> <p>http://www.vcc.vic.gov.au/2008vcs/part2.1climatechange.htm</p>	<ul style="list-style-type: none"> • Currently developing interim guidelines about how to applying 0.8 metres sea level rise on coast • Ministerial Direction– non urban to urban new developments • General Practise Note – managing coastal hazards and the coastal impacts of climate change • Advisory Note – detail on planning for 0.8 metre sea-level rise <p>http://www.dse.vic.gov.au/DSE/nrenpl.nsf/LinkView/9237AC17626E8D9ACA2572C6001E86EBEF546347BB845D44CA2572DA007FE2BE</p>	<ul style="list-style-type: none"> • DEM for whole of coast at 20 cm contour detail • Bathymetry for whole of coast • Modelling work to be undertaken to look at erosion, inundation along the coast – scale and detail of this modelling is yet to be determined <p>http://www.climatechange.vic.gov.au/futurecoasts</p>	<ul style="list-style-type: none"> • The Future Coasts Program undertaken by DSE will investigate adaptation options and an assessment framework • Planning Advisory Group set up by Department of Planning and Community Development (DPCD). Terms of Reference to be release shortly.
NEW SOUTH WALES	<ul style="list-style-type: none"> • NSW Coastal Policy <p>http://www.planning.nsw.gov.au/plansforaction/coastalprotection.asp</p> <ul style="list-style-type: none"> • State Environmental Planning Policy (SEPP) No. 71 - Coastal Protection commenced on 1 November 2002. The Policy has been made under the <i>Environmental Planning and Assessment Act 1979</i>. 	<p>The definition of the coastal hazards takes into account the impact of sea level rise and future shoreline recession.</p> <p>Regional strategies require councils to consider increased coastal hazards when developing new LEPs.</p> <p>NSW Coastline Management Manual</p> <p>To guide for local councils, CMA and communities develop coastal zone</p>	<ul style="list-style-type: none"> • Local govt doing LIDAR capture • State bathymetry - LAD's (needs to be ground truthed well) • Coastal vulnerability assessment – risk based approach – value asset (\$ values erosion etc) • 95 % complete not yet released <p>http://www.planning.nsw.gov.au/plans</p>	<ul style="list-style-type: none"> • Govt doesn't have funding to buy back land • Department of Planning will develop guidelines for consistent assessment of future developments in vulnerable areas. • The Coastline Management Manual is being reviewed by

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Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
	<ul style="list-style-type: none"> Regional Strategies for coastal areas Draft policy plan for 0.9 m sea level rise to 2100 <p>http://www.planning.nsw.gov.au/plansforaction/climatechange_sealevel.asp</p> <p>http://www.environment.nsw.gov.au/resources/climatechange/09125DraftSLRpolicy.pdf</p>	<p>management plans. Adopts a risk management approach</p> <p>http://www.environment.gov.au/coasts/publications/nswmanual/index.html</p> <p>Local Environmental Plan template</p> <p>The LEP template includes provisions for consideration and accommodation of the impacts of climate change and sea level rise.</p> <p>Floodplain guidelines</p> <p>DECC's Floodplain Risk Management Guideline Practical Consideration of Climate Change</p> <p>http://rdaguidelines.planning.nsw.gov.au/pubDetails.cfm?PublicationID=85</p> <p>SLR Technical Note</p> <p>The government has issued a technical note which explains how the sea level rise benchmarks were derived.</p>	<p>foraction/climatechange_mapping.asp</p>	<p>DECC.</p>
TASMANIA	<p>State Coastal Policy 2008 has been endorsed Government and is about to be referred to the RPDC for formal public consultation under the <i>State Policies and Projects Act 1993</i>. Implementation guidelines will also be referred.</p> <p>Standard planning scheme provisions will be developed as a recommendation of 'Better Planning Outcomes' project. New Coastal</p>	<p>DPIW managed Coastal Risk Assessment project The Project is developing tools and resources to assist with risk-based management and planning for various assets and values in the coastal zone.</p> <p>http://www.dpiw.tas.gov.au/inter.nsf/WebPages/HBAW-7HNVLZ?open.</p>	<p>Clarence City Council 'CC Impacts on Clarence Coastal Areas' project is a detailed integrated assessment of climate change risks</p> <p>http://www.ccc.tas.gov.au/webdata/resources/files/CCICCA-Final-Report-A415375.pdf</p> <p>Current State initiative to draw together available data into 'toolbox'</p>	<p>Work across government during 09/10 will focus on:</p> <p>Policy settings</p> <p>Planning provisions</p> <p>Implementation of Risk Assessment template with local Councils</p>

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Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
	<p>Policy and other policies will be implemented through these provisions.</p> <p>http://www.justice.tas.gov.au/landuseplanning/better_planning_outcomes</p> <p>Existing State Coastal Policy 1996 – Outcome 1.4.3 is a driver for current policy and program responses to the potential effects of climate change (including sea level rise) on use and development in the coastal zone.</p> <p>Regional Planning</p> <p>Four regional planning strategies will include coastal planning issues and CC/SLR. They will contribute to implementation of new coastal policy. Current planning schemes will be replaced by a 'model' scheme that will implement the regional strategies.</p> <p>Sea level rise</p> <p>No statewide approach at this stage – individual planning schemes vary, but a number use 3 m AHD inserted in the late 1980s. Tasmania may not adopt a uniform SLR value at this stage, but is adopting a risk based approach taking location and planned life of development into account.</p>	<p>Technical documents include:</p> <ul style="list-style-type: none"> • Template Coastal Risk Management Plan • General Information Paper on Coastal Hazards on Tasmania • Climate Change and Coastal Asset Vulnerability: An audit of Tasmania's coastal assets potentially vulnerable to flooding and sea-level rise • Sea-Level Extremes in Tasmania: Summary and Practical Guide for Planners and Managers • Reference Manual: Historical and Projected Sea-Level Extremes for Hobart and Burnie, Tasmania • Background Report Coastal flooding: Review of the use of Exceedence Statistics in Tasmania 	<p>to support 'Clarence' type projects across Tasmania. Resources to be sought to address gaps. Data includes:</p> <ul style="list-style-type: none"> • LIDAR 25 cm contours to 10m for more populated coastlines - free to all to use • Bathymetry a significant gap • Foreshores and immediate hinterland values mapping underway • Inshore marine habitat mapping to 40m (SeaMap Tasmania) 	<p>Identification of risk to natural systems</p> <p>Publishing coastal works and CC response manual</p> <p>Collaboration with local govt. under Statewide Partnership Agreement</p> <p>http://www.climatechange.tas.gov.au/features/Partnership_Agreement_on_Climate_Change.pdf</p>
SOUTH AUSTRALIA	<p>Policy</p> <p>Coast Protection Board Policy Document,</p>	<p>Coast Protection Board Policy Document, endorsed 30 August 2002 – includes:</p>	<p>Port Adelaide Seawater Stormwater Flooding Study Project led and partly</p>	<p>April 10 2008 - State Government reaffirmed its</p>

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Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
	<p>endorsed 30 August 2002.</p> <p>Coast Protection Board Policy translated into coastal Development Plans (the statutory development control documents – one Development Plan for each area) by way of a Ministerial amendment in 1994.</p> <p>The Board recommends sea level rise of 0.3 m by 2050 to be adopted for most coastal development (provided that development can be practicably protected against the further rise of 0.7 m to 2100).</p> <p>In regards to coastal erosion, development setbacks should generally take into account 100 years of erosion at a site (taking into account local coastal processes and assuming a sea level rise of 0.3m by the year 2050). For major developments, especially those establishing entire new communities, 200 years of recession should be considered, and also the effect of sea level rise on this over the longer period.</p> <p>Currently the Board policy is under review – on 27 March 2009 the Board endorsed the Final Report of its Sea Level Rise Advisory Committee and approved targeted stakeholder consultation</p>	<p>Appendix 1- <i>Standards applying to new development with regard to coastal flooding and erosion and associated protection works</i>, includes 11 Standards including the following:</p> <p>S1 – Site and Building Levels</p> <p>S2 - Flood Protected site and building levels</p> <p>S3 - Sea Level Rise for Major Developments</p> <p>S4 – Setback for Erosion</p> <p>S5 – Impact of Protection Works</p> <p>Appendix 2 - <i>Draft Development Guidelines and Risk Assessment Criteria for Coastal Acid Sulfate Soils in South Australia</i></p> <p>The 1994 Ministerial amendment to Development Plans provided a set of regional and council-wide objectives and principles. The provisions included matters of environment protection, the preservation of scenic, heritage and other values, maintenance of public access and hazard risk minimisation (coastal flooding and erosion):</p> <p>Those provisions included the following Principles:</p> <p><u>Maintenance of Public access</u></p> <p>15 <i>Development adjacent to the coast should not be undertaken unless it has or incorporates the provision of a public</i></p>	<p>funded by City of Port Adelaide Enfield with further funding from Commonwealth and State sources. The project is in two parts –</p> <p>Stage (1): A full assessment of the potential risks associated with the projected coastal impacts of climate change, combined with the existing flooding profile (completed);</p> <p>Stage (2): A strategic plan to address the issues identified in the above study, with associated investment programme (underway)</p> <p>Funding from the Natural Disaster Mitigation Program has been provided for sea flood risk mapping on low-lying coastal areas of Yorke Peninsula. The project incorporates the following key steps:</p> <ol style="list-style-type: none"> 1. Identification of Priority areas 2. Aerial Photography 3. Establishment of new survey benchmarks in coastal areas 4. Building of a Digital Elevation Model for Flood Mapping 5. Analysis of Flood Hazard under current and future sea level rise scenarios. 	<p>support to review the Coast Protection Act.</p> <p>Continuing effort to improve Development Plans to ensure that sensitive coastal features (including areas subject to coastal hazards) are included in appropriate coastal zones</p> <p>Coast Protection Board advice provided to Planning Authorities on development applications is not always accepted. Therefore the Government is examining extending powers of direction to the Coast Protection Board under Schedule 8 of the Development Regulations particularly in relation to coastal hazards. This is consistent with Strategy 4.3 of the Government's Living Coast Strategy</p>

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Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
		<p><i>reserve, not including a road or erosion buffer provided in accordance with Principle 26, of at least 50 m width between such development and the toe of the primary dune or the top edge of the escarpment, unless the development relates to small scale infill development in a predominantly urban zone.</i></p> <p>21 <i>For the purposes of assessing coastal developments the standard sea-flood risk level for a development site is defined as the 100 year average return interval extreme sea level (tide, stormwater and associated wave effects combined), plus an allowance for land subsidence for 50 years at that site.</i></p> <p>22 <i>Land should not be divided for commercial, industrial or residential purposes unless a layout can be achieved whereby roads, parking areas and adequate development sites on each allotment are at least 0.3 m above the standard sea-flood risk level, unless the land is or can be protected in accordance with Principle 25.</i></p> <p>23 <i>Commercial, industrial or residential development should only be undertaken where:</i></p>	<p>(four townships completed, two remaining).</p> <p>Funding has also been provided from the Natural Disaster Mitigation Program for a scoping study into South Australia's vulnerability to tsunamis, storm surge and sea level rise. The objective of the study is to identify knowledge gaps and prioritise future studies/works. The project is nearing completion with the final report to be delivered in June 2009.</p>	

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Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
		<p>(a) <i>building floor-levels are at least 0.25 m above the minimum site level of Principle-21 (i.e. 0.55 m above the standard sea-flood risk level), unless the development is or can be protected in accordance with Principle 25; and</i></p> <p>(b) <i>there are practical measures in accordance with Principle 25 available to the developer. or subsequent owners, to protect the development against a further sea-level rise of 0.7 m above the minimum site level determined by Principle 22.</i></p> <p>24 Buildings to be located over tidal water or which are not capable of being raised or protected by flood protection measures in future, should have a floor level of at least 1.25 m above the standard sea-flood risk level.</p> <p>25 Development which requires protection measures against coastal erosion, sea or stormwater flooding, sand drift or the management of other coastal processes at the time of development, or which may require protection or</p>		

Managing climate change impacts on the coast: A stock take of policies and technical documents from around Australia, April 2009

Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
		<p>management measures in the future, should only be undertaken if:</p> <ul style="list-style-type: none"> (a) the measures themselves will not have an adverse effect on coastal ecology, processes, conservation, public access and amenity; (b) the measures do not now, or in the future require community resources, including land, (c) the risk of failure of measures such as sand management, levee banks, flood gates, valves or stormwater pumping, is appropriate to the degree of the potential impact of a failure; and (d) adequate financial guarantees are in place to cover future construction, operation, maintenance and management of the protection measures. <p>26 <i>Development should be set-back a sufficient distance from the coast to provide an erosion buffer which will allow for at least 100 years of coastal retreat for single buildings or small scale developments. or 200 years of</i></p>		

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Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
		<p><i>retreat for large scale developments such as new towns, unless:</i></p> <p>(a) <i>the development incorporates private coastal works to protect the development and public reserve from the anticipated erosion, and the private coastal works comply with Principle 25; or</i></p> <p>(b) <i>the council is committed to protecting the public reserve and development from the anticipated coastal erosion.</i></p> <p>27 <i>Where a coastal reserve exists, or is to be provided in accordance with Principle 15, it should be increased in width by the amount of buffer required.</i></p> <p>Note : SA Supreme Court Determination: Northcape Properties Pty Ltd V District Council Of Yorke Peninsula [2008] SASC 57 (4 March 2008)</p> <p>http://www.austlii.edu.au/au/cases/sa/SASC/2008/57.html</p>		
QUEENS- LAND	The State Coastal Plan commenced in February 2002 and describes how the coastal zone is to be managed as required by the <i>Coastal Protection and Management</i>	<ul style="list-style-type: none"> Technical guidelines about assessment of storm tide inundation risk – applies a non-statutory SLR factor of 0.3 m/50yrs. This factor applied since 1993 (now under 	<ul style="list-style-type: none"> Erosion prone area mapped (0 to 400 m on open coast depending on coast type; default 40m from MHWS tide in tidal waterways) 	<p>Revising Coastal Plan</p> <p>Section 42 of the Coastal Protection and Management Act 1995 requires that coastal plans</p>

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Source: Inter-governmental Coastal Advisory Group (ICAG)

State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
	<p><i>Act 1995.</i></p> <p><i>Supported by regional coastal plans (four completed)</i></p> <p><i>Coastal plans have status of State planning policy</i></p> <p>The State Plan states that coastal management plans must address the impacts of climate change.</p> <p>Policy 2.2 – Physical Coastal Processes</p> <p>2A Principle – Trends in climate change including sea level rise, more extensive storm tide flooding and associated potential impacts are taken into consideration in planning processes.</p> <p>Policy 2.2.1 – Adaptation to Climate Change - Has a range of principles but not SRL number.</p> <p>Regional plans and planning schemes under Planning legislation provide means to give effect to coastal policies in development decisions</p> <p>Coastal Act provides that State can take land in erosion prone area (without compensation) where approval is given to subdivide – provisions sit outside planning & development system</p>	<p>revision)</p> <ul style="list-style-type: none"> Guidelines published to show how coastal policies can be integrated into local planning schemes and applied in development assessment <p>Erosion</p> <p>Information Fact Sheet - Assessment of erosion prone area width – Section 2.6 – Brunn Rule used.</p> <p>Estimated SRL in based on the best current information available and the current value adopted for use in erosion prone area determination over a 50 year planning period is 0.3m.</p> <p>Shoreline erosion management plans – state funds 50% with councils – aimed at erosion response in advance of it becoming an emergency problem shows 'hot spots' for councils eg: Cairns, sunshine</p>	<ul style="list-style-type: none"> Aerial photograph program regularly flown (every 4 years along east coast – NSW to Cooktown). Moved from film to digital images in 2008 DEM - State has recently adopted data standard and has funded program (with Commonwealth) to acquire DEM between NSW & Cooktown, plus hotspots (e.g. Torres Strait & remote communities). Expect data capture to be complete by end 2010 Plot erosion, accretion at local scale (using aerial photo collection) 	<p>be reviewed within seven years of commencement. The Minister for Sustainability, Climate Change and Innovation announced the commencement of the review on 26 January 2008.</p> <p>New State coastal plan at an advanced stage – expected to release draft for public review in 3rd quarter 09. SLR factor being revised.</p>
WESTERN	State Planning Policy 2.6 – State Coastal Planning Policy. This must be taken into	SPP – Schedule 1 – Coastal Development	<ul style="list-style-type: none"> DEM and bathymetry capture 	<ul style="list-style-type: none"> Discussion paper about

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State	Policy/Strategies/Plan	Technical documents	Modelling/mapping	Future Work
AUSTRALIA	<p>account by decision makers in coastal planning.</p> <p>Currently have 100 m setback (from vegetation line) (with increase in 0.8 m sea level rise this would increase to 140m – this setback area is for both public access and physical erosion management)</p>	<p>Setback Guidelines for Physical Processes.</p> <p>There are three parts to the calculation:</p> <ol style="list-style-type: none"> 1. trend of erosion (S1) 2. incidence of extreme storm events (S2) 3. magnitude of sea level rise (S3) <p>Guidelines based on 100 year planning time frame.</p> <p>Distance to allow for sea level rise has been derived from IPCC 2001 of 0.38 m and applied to the Brunn rule with the multiplier of 100.</p>	<p>occurring at various locations</p> <ul style="list-style-type: none"> • Tsunami modelling, flood modelling and storm surge modelling 	<p>canal estates</p> <ul style="list-style-type: none"> • Preparing a revision of the S3 component. • Reviewing policy guideline document to implement provisions in policy – may include sea level rise to 0.8 m