coastline

Coastal Vulnerability Assessment

SOUTH AUSTRALIAN COAST PROTECTION BOARD **No.31**

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PORT PIRIE, WEDNESDAY, AUGUST 15, 1934

PIRIE'S MOST DISASTROUS FLOOD

Two Infants Drown

Hundreds of Families Driven from Inundated Houses

Babe Swept From Parents' Arms And Drowned

WHOLE TOWN ALMOST SUBMERGED

Hundreds Spend Fearful Night On Roof Tops In Gale

TOWNSPEOPLE UNITE TO HELP THOUSAND HOMELESS

Government Hurries Relief To Stricken Area

FAVORS STRONGER EMBANKMENT

Can Be Pumped Later, Says Engineer

INTRODUCTION

It has been estimated that around 60% of the world's population live near the coast and not surprisingly it is here that many problems are being experienced due to unrestricted development and unsustainable use of coastal resources. In addition to these problems, concern has recently been expressed about possible effects of climate change in coastal areas. Potential impacts such as sea level rise, changes in the frequency, intensity and patterns of storm events and associated storm surges and flooding, could make already degraded coastal areas even more vulnerable to erosion.

This *Coastline* describes a study undertaken by the Mawson Graduate Centre for Environmental Studies at the University of Adelaide as one of a number of studies conducted around Australia by the Commonwealth Department of the Environment, Sport and Territories (DEST). Detailed reports and a CD-ROM on these studies have been produced by DEST. Further information on the South Australian study can be obtained from the South Australian Coasts and Marine Section of the Environment Protection Agency of the Department for Environment, Heritage and Aboriginal Affairs Section and the references listed at the end of this publication.

THE INTERNATIONAL CONTEXT

Increasing global concern about climate change and the possible impacts led to the establishment of the Intergovernmental Panel on Climate Change (IPCC) in 1988 to assess scientific information on different components of the climate change issue and also to formulate some reasonable response strategies. In order to do this the IPCC set up a number of groups and sub-groups to deal with different tasks. A Coastal Zone Management Subgroup had the task of making recommendations on coastal management strategies for the next 10-20 years and on the development of policies related to climate change and sea level rise. A major driving force for this work was the concern about the potential impact of a rising sea on low-lying countries and small island states many of which do not have the financial capacity to respond adequately to such changes.

In 1991, following Coastal Zone Management Subgroup workshops held in Miami (USA) and Perth (Australia), the IPCC published a document describing a common methodology for the assessment of the vulnerability of coastal areas to sea level rise,(IPCC, 1991). The IPCC defines vulnerability of a coastal system as *the degree to which: (a) the performance, ie., production of goods and services, and (b) the state of the coastal system will be adversely affected by the various agents of change* (World Coast Conference, 1993, p7). *The role of vulnerability assessment using the IPCC Common Methodology is to examine a coastal nation's ability to cope with the consequences of global climate change, including accelerated sea level rise* (World Coast Conference, 1994, appendix 1, p5).

It is important for a country to understand the bio-physical and socio-economic effects of climate change and assess the costs and benefits of alternative responses in order to improve coastal zone planning and management. Two scenarios were used for the vulnerability case studies relative to current sea-level. These were for a 30cm and a 1.0m (the IPCC low and high estimates from the 1990 scientific reports) sea-level rise by the year 2100. In January 1994, 46 vulnerability case studies in various countries around the world had been completed or were in progress.

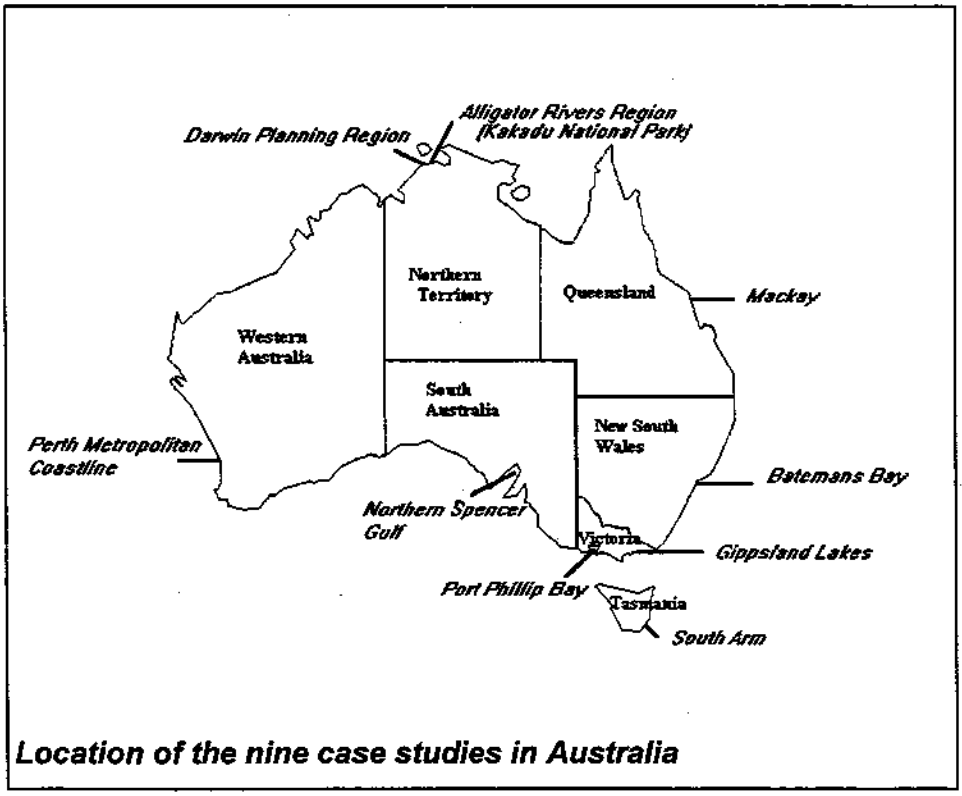
AUSTRALIAN COASTAL VULNERABILITY ASSESSMENT STUDIES

In Australia, nine case studies were undertaken to assess the vulnerability of selected areas of the coastal zone during 1994 and 1995. The National Coastal Vulnerability Assessment Case Studies Project was funded by DEST and each state carried out one study except for Victoria and the Northern Territory (two studies each).

The aim of carrying out Vulnerability Assessment studies was *to help achieve the sustainable use* of *coastal resources by identifying coastal vulnerability and incorporating coastal values and hazards into planning and decision making for integrated coastal zone* management (DEST, 1996, p 24). In order to achieve that aim, the studies had the purposes of:

- *collecting, collating and analysing existing information on climatic and other changes and describing the different physical, biological, social, economic and cultural conditions at the localities and sites being assessed,*
- *delineating the coastal areas that could be vulnerable to changed climatic conditions, sea level rise and human induced factors,*
- *documenting the governmental arrangements and responses to environmental change, in terms of coastal planning and management, that were particular to the jurisdiction where the case studies were undertaken; and*
- *determining how VA could be integrated into management processes of the particular jurisdiction* (DEST, 1996, p 1).

In August 1995, a national workshop was organised by DEST and held at the Mawson Graduate Centre for Environmental Studies in Adelaide, to discuss the major findings of the VA case studies. Results of these studies were then taken by Australia to the IPCC meeting in Montreal in October 1995.

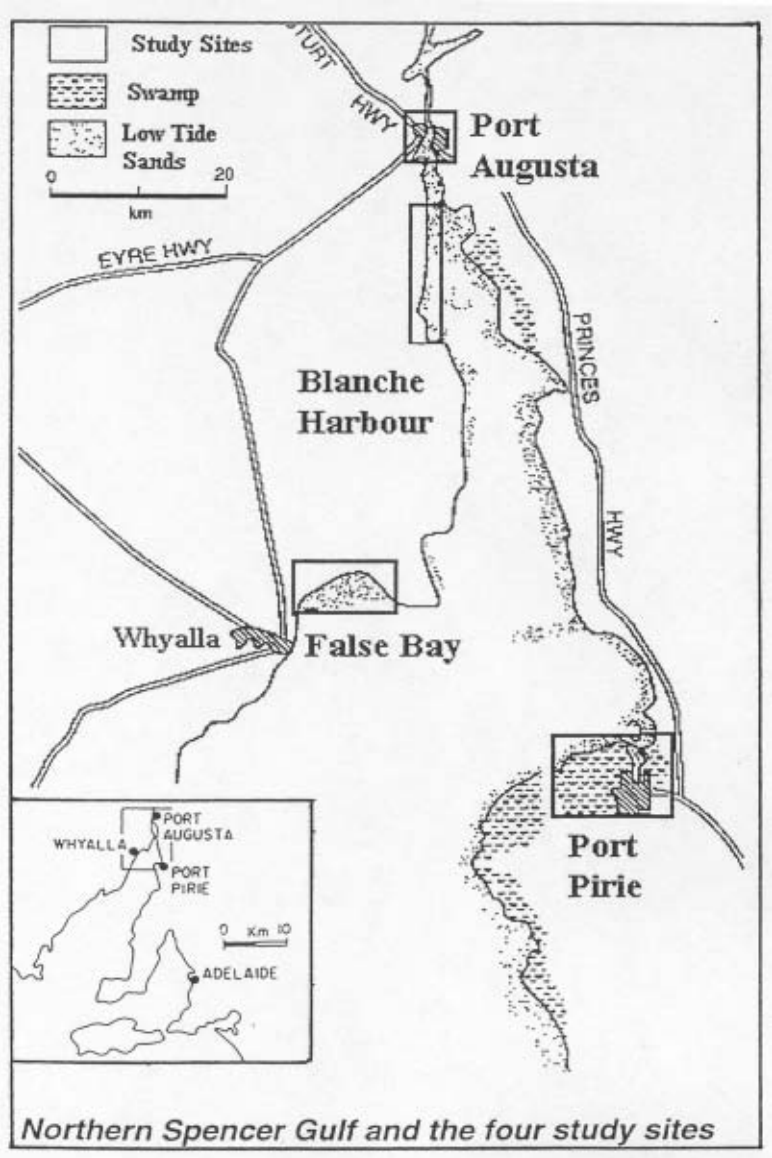


Location of the nine case studies in Australia

SOUTH AUSTRALIAN CASE STUDY - WHY NORTHERN SPENCER GULF?

The South Australian Coastal Vulnerability Assessment Study was conducted in one of Australia's few inverse estuaries, the Northern Spencer Gulf. This area was selected by the Coastal. Management Section due to its unique bio-physical characteristics and changing socio-economic structure. Furthermore, it was expected that the vulnerability assessment could be carried out within the wider context of the Spencer Gulf and Flinders Ranges Regional Development Strategy which was being prepared for South Australia. The strategy would provide an opportunity to include the potential coastal impacts of climate change into both regional and local planning. However, during the course of the study the strategy took on a much larger focus including most of the north and west of South Australia and the Department of Premier and Cabinet, the co-ordinating government department felt that the Vulnerability Assessment was not relevant to the economic focus of the strategy.

The study area is bordered by the industrial towns of Whyalla, Port Augusta and Port Pirie. Four selected study sites within the study area were chosen for a more detailed analysis; False Bay, Port Pirie, Port Augusta and Blanche Harbour.



Northern Spencer Gulf and the four study sites

THE NORTHERN SPENCER GULF

The Northern Spencer Gulf is in an and environment with a relatively sheltered coast, unaffected by swell waves. This inverse estuary has wide mudflats, sand and sea-grass banks, mangroves and extensive supratidal areas subject to tidal flooding. Potential sea-level changes are important for the area given existing flooding problems in two of the three cities in the region (Port Pirie and Port Augusta).

The northern area of the gulf is shallow, experiences high summer temperatures and is considered to be an inverse estuary because of high evaporation rates in the north with little fresh water inflow. The tolerance of marine organisms to such extremes is unique in world marine systems. The area also covers part of the transitional zone between the agricultural zone of the state and the and interior so there are marked changes in the vegetation, landscapes and landuses across the region.

FACTORS CONSIDERED AND SOURCES OF INFORMATION

The study produced an overview of the biophysical and socio-economic characteristics of the region drawing on aspects of regional strategic studies funded by the Commonwealth and State governments. The strategic studies focused on the dominance of industrial and economic activity in the three cities, Whyalla, Port Pirie and Port Augusta. The coastal vulnerability study used existing contour data, academic literature, government reports, environmental impacts statements, consultants reports, flooding data, tidal studies, and biophysical information stored on GIS databases.

CONSULTATION AND COMMUNITY INVOLVEMENT

Further vulnerability data were collected from four coastal sites; two industrial cities with sheltered coastal environments and extensive intertidal and supratidal deposits in the north and eastern part of the Gulf (Port Pirie and Port Augusta); one less developed holiday shack area on the north western side of the Gulf (Blanche Harbour); and a south facing bay of conservation value and low scale industrial usage (False Bay). During the course of the report there was consultation with state and local governments, industries and community groups, particularly the Spencer Gulf Environmental Alliance.

METHODS, TECHNIQUES AND RESULTS

Different methods and techniques were applied to each of the four sites. Much of the information used in this study was available from government departments, libraries, universities and other sources although some primary data (such as surveying and aerial photography) were collected.

At Port Pirie, flooding studies (Lang, Dames and Campbell 1991a) led to the construction of protective works across the supratidal flats. Further detailed levelling and vegetation surveys were conducted for the coastal vulnerability study to provide an insight into the potential effects of sea-level change on vegetation communities in the area. The effect of geological uplift on sea level in the Port Pirie area was also noted (Harvey and Belperio, 1994). At Port Augusta, a flood hazard study (Lang, Dames and Campbell 1991 b), conducted in response to local coastal, flooding problems, recommended various protection works. At both Port Pirie and Port Augusta, the flood studies provided essential detailed contour data which were not previously available.

At Blanche Harbour extensive holiday shack development has resulted in building levels which are inconsistent with state government coastal hazard policies. Options for relocation are too expensive and private protection works may cause future problems. To overcome this situation, the government has introduced the Blanche Harbour Management Plan which recognises, but does not accept responsibility for, the greater. vulnerability of properties in this area.
At False Bay, near Whyalla, there is nearby industrial development but the bay is an important conservation area for prawn larvae. At this site special aerial photogrammetry together with ground based survey was used to produce detailed contours with 0.5m intervals, which were then entered onto the State's GIS biophysical data base. This technique was relatively expensive. Results provided an accurate indication of the restricted areas, caused by levee construction for salt production, available for mangrove and samphire migration in the event of sea-level rise.

Another technique investigated for the whole of Northern Spencer Gulf was the use of detailed GIS based Holocene geological maps, to identify levels of susceptibility to coastal flooding. This technique could be relatively inexpensive, accessible and useful for coastal managers around Australia.

In total, nine different techniques were used for the study. Some could be used in other studies according to the issue and their priority. For example, the levelling and vegetation survey technique will be applicable for areas of conservation significance. The detailed aerial photogrammetry and GIS manipulation was relatively expensive and is more suited to areas of high economic value. The GIS Holocene geological mapping would be less useful for high energy coasts.

The approach of the study was to utilise existing sources of information where possible. Although a good level of collaboration was expected, it was often difficult to get responses to enquires. However, an increased use and accessibility of data bases was identified as being desirable for greater co-ordination of information for the application of vulnerability assessment to coastal management. The report also noted that human induced hazards may pose a greater threat to the region than that of climate change, and therefore there needs to be greater monitoring of these activities.

RESPONSES: IDENTIFICATION AND IMPLEMENTATION

The four sites indicated different issues of protection, relocation and adaptation in response to sea-level rise, similar to the response strategies identified by the IPCC global studies. Both Port Pirie and Port Augusta have adopted a protective strategy to defend the cities against flooding. At False Bay, which is economically less vulnerable, the artificial levee banks can be raised further but already impact on the landward migration of mangroves and samphire. At Blanche Harbour a policy of relocation was considered but the costs were greater than the benefits for local shack owners so the response is one of "do nothing".

The study indicated the need for further interaction between State and Commonwealth coastal programs with community groups and local government. This would benefit from considerable local coastal knowledge and expertise in addition to keeping communities better informed.

POLICY IMPLICATIONS

The current South Australian policy on coast protection and new coastal development was prepared by the Coast Protection Board and endorsed by the South Australian Government in May 1991. The policy, which is described in *Coastline Number* 26 (Coast Protection Board 1992), relies in part on local records of coastal erosion, flooding and sea level rise but more importantly has incorporated the earlier IPCC estimates of greenhouse induced eustatic sea level rise. These estimates (which have now been reduced slightly) predicted a sea level rise to the year 2100 of approximately 0.66m (range 0.33m to 1.10m) for the IPCC 'business as usual' scenario. Given these estimates the Coast Protection Board used the 'precautionary principle' in preparing its policy. The precautionary principle which was adopted by all Australian governments in 1992 states that *where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for postponing measures to prevent environmental degradation.*

In accordance with this principle the Coast Protection Board has adopted the policy that any new coastal development should be capable of being reasonably protected from a I m sea level rise by the year 2100. The policy establishes the 100 year average return interval (ARI) water level as a standard for coastal development in South Australia. It recommends that site and building levels should be determined by adding 0.3m to the 100 year ARI water level and (where appropriate) making an adjustment for localised subsidence or uplift. Floor levels of buildings should be an additional 0.25m above this level, and buildings should not be approved unless they are capable of being protected or raised to withstand a further 0.7m of sea level rise (eg by means of a bund wall). In the case of flood protected sites, the calculation of the 100 year ARI design flood level must incorporate the extreme tide (plus surge) and stormwater events, together with wave effects within the development.

The policy also makes a general recommendation for an erosion setback distance. This is to be based upon 100 years of erosion at a site, allowing for local coastal processes and a sea level rise of 0.3m to the year 2050, taking account of storm erosion from a series of severe storms. For major coastal development it is suggested that calculations are based upon 200 years of erosion.

The policy is less specific about the protection of existing property although it reaffirms an earlier Government policy not to protect private property. Although part of the Coast Protection Board's duties are to protect the coast, most coast protection works are carried out by local councils.

It should be noted that sea-level rise scenarios are constantly being re-assessed as new data come to light. There has been a downward revision for the predicted rise in sea level. It now ranges from 25 to 80 cms for the year 2100, with a best estimate of 50 cms. This is 25% lower than the best estimate of 1990 which was 66 cms by 2100. However, it should be noted that this represents a rate that is two to four times that experienced during the last 100 years (I PCC, 1995, chapter. 9, p.2). This merely reflects the extent of scientific uncertainty and should not be seen as a reason to abandon the precautionary principle in policy formation.

Existing State coastal policies appear appropriate for responding to sea-level rise scenarios except in the special case of shack freeholding where lower standards have been agreed upon. In addition, the success of the policies rely to a large extent on implementation and monitoring by local councils. There also needs to be increased integration mechanisms to improve coastal management in the region. Thus for vulnerability to be incorporated into integrated coastal zone management there needs to be greater priority for coastal management at higher levels of government with increased funding and resources.

DISCUSSION: HOW USEFUL IS COASTAL VULNERABILITY?

The short answer is that the use of the IPCC Common Methodology for assessing coastal vulnerability (which was designed for world wide application) has a number of limitations and there have been problems with applying it directly in Australia (see Kay et al 1996). However, it has been useful in getting. Australian governments to undertake their own studies and develop methodologies and techniques for assessing coastal vulnerability which are suitable for the different legislation and coastal planning systems around Australia.

The South Australian study has been useful because it has identified what type of information is available in our State to investigate the potential impacts of sea-level rise. In many areas the accuracy of contours is less than the actual predicted sea-level rise and there is even less information on how the coast would respond. The study has identified a number of techniques

which are useful for assessi ng coastal vulnerability. Some of these are expensive and would only be warranted where there is a high risk to people or coastal property. Generally, it is considered that South Australia already has an appropriate policy response to any potential increase in coastal vulnerability. An important finding with the Northern Spencer Gulf study is that perhaps the threat of coastal vulnerability from sea-level rise is less important in some areas than the threat of human induced coastal hazards.

FURTHER READING

Clouston B and Carvalho P (1996). Review of Methodology for Assessing Coastal Vulnerability, in Harvey, N (Ed) *Proceedings of* the Australian National Coastal Conference, G*lenelg, 1996, 145-150.*

Coastal Protection Board (1992). Coastal Erosion, Flooding and Sea Level Rise Standards and Protection Policy, Coastline, No 26.

Department of Environment, Sport and Territories (1995). *Living on* the Coast, *The Commonwealth Coastal* Policy, Commonwealth of Australia, Canberra.

Department of Environment, Sport and Territories (1996). *National Coastal* Vulnerability Assessment (VA), Case Studies Project, Commonwealth of Australia, Canberra.

Harvey, N and Belperio T (1994). Implications of Climate Change for the South Australian Coastline, in Transactions *of* the Royal Society *of* South Australia, 118 (1) 45-52.

Harvey, N, Clouston, E and Carvalho, P (1995). Coastal Vulnerability *of* the *Northern Spencer* Gulf, Commonwealth Department of Environment, Sport and Territories, Canberra.

Intergovernmental Panel on Climate Change (1991). Common Methodo1gy for Assessing *Vulnerability to* Sea-level Rise, prepared by the IPCC Coastal Zone Management Subgroup, The Hague, Netherlands.

Intergovernmental Panel on Climate Change (1992). Global Climate *Change and* the Rising Challenge *of* the Sea, prepared by the IPCC Coastal Zone Management Subgroup, The Hague, Netherlands.

Intergovernmental Panel on Climate Change (1995-in press). Second Assessment Report, prepared by the IPCC IPCC Coastal Zone Management Subgroup, The Hague, Netherlands.

Kay R, Eliot, 1, Caton, B, Morvell, G and Waterman P (1996). A Review of the Intergovernmental Panel on Climate Change's Common Methodology for Assessment of Vulnerability to Sea-Level Rise, Coastal *Management, 24*: 165-188.

Lange Dames and Campbell (1991 b). Tidal *Flooding Study,* for the City *of* Port Augusta, South Australia. Report, prepared for the city of Port Augusta.

Lange Dames and Campbell Ply. Ltd. (1991 a). Tidal *Flooding Study,* for the City *of* Port Pirie, South Australia. Report prepared for the city of Port Pine.

McLean R and Mimuna N, (Eds.), (1993). Report *of* IPCC Eastern *Hemisphere Workshop* on the Vulnerability of Sea level Rise and Coastal Zone *Management, T*sukuba, Japan, 3-6 August, 1993. Intergovernmental Panel on Climate Change.

World Coast Conference (1994). Preparing to Meet the Coastal *Challenges of* the 21st Century, Conference Report, Report of the World Coast Conference, Noordwijk, The Hague, Ministry of Transport, Public Works and Water Management.