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**House of Representatives Standing Committee on Climate Change, Water, Environment and the Arts**

**Inquiry into climate change and environmental impacts on coastal communities**

**Submission by the Australian Bureau of Meteorology**

The Bureau of Meteorology (Bureau) offers the following submission to this inquiry referred to the committee by the Hon Peter Garrett AM MP, the Minister for the Environment, Heritage and the Arts, and Senator the Hon Penny Wong, the Minister for Climate Change and Water, on 20 March 2008. The Bureau limits its contribution to the following Term of Reference:

- the impact of climate change on coastal areas and strategies to deal with climate change adaptation, particularly in response to projected sea-level rise.

**Key Points**

This submission draws on authorative statements made in the recently released Intergovernmental Panel on Climate Change (IPCC) *Fourth Assessment Report* (IPCC, 2007). The important policy-relevant messages in that report include:

- there is very high confidence that coasts are experiencing the adverse consequences of hazards related to climate and sea level;
- there is very high confidence that coasts are likely to be exposed to increasing risks in future decades due to many compounding climate change factors. The accumulated impacts of rising sea level, more intense storms, larger wave and storm surges, altered precipitation/runoff and ocean acidification will have overwhelmingly negative impacts on coastal ecosystems and infrastructure;
- there is very high confidence that the impacts of climate change on coasts are exacerbated by increasing human-induced pressures. The growth in population and intensification of land use along the coast is increasing our vulnerability;
- there is high confidence that the adaptation costs for climate change will be much lower than the damage costs without adaptation for most developed coasts; and
- while further sea-level rise is virtually guaranteed, present-day human development of the coastline continues, which will further increase vulnerability.

These findings underline the need for further efforts in understanding some of the key uncertainties in how climate change will impact on the coastal environment. The Bureau and CSIRO are jointly developing world-class climate models and related technologies through the recently established Centre for Australian Weather and Climate Research. Whilst modelling efforts are on-going across the globe, their emphasis is often not on Australia, or even the Southern Hemisphere. It is essential that Australia maintains a strong climate modelling program.

Continued maintenance of the climate record in perpetuity, which involves the routine sampling of meteorological and related hydrological and oceanographic data across the nation and surrounding oceans, remains a cornerstone in identifying and responding to climate change and variability. The Bureau's infrastructure for establishing the climate record, the foundations of which were laid down 100 years ago, has served Australia well and must be secured for future generations.

**Background**

While many uncertainties remain about climate change, there is a body of evidence already collected, as well as a range of estimates of future impacts including sea-level rise, that can be used to aid decision-making and assist in the formulation of strategies for adaptation. Much of this information can be extracted from IPCC (2007) which provides a very comprehensive summary of the current scientific understanding of climate change. In addition, the Bureau of Meteorology/CSIRO study: *Climate Change in Australia (2007)* provides valuable synthesis of a large body of climate research that has been undertaken for the Australian region in recent years.

It is clear that Australia and the globe are currently experiencing rapid climate change. This change is observed in atmospheric and oceanic temperatures, weather circulation patterns, sea-level rise, and changes to snow and ice. It is very likely that most of the warming observed since the mid-20th century is due to the accumulation of greenhouse gases in the atmosphere. $CO_2$ concentrations have increased from around 311 parts per million volume (ppmv) in 1950 (from ice core data) to in excess of 380ppm in 2007 (as recorded at Australia's Cape Grim baseline station operated by the Bureau of Meteorology); an increase of more than 20% in 50 years. According to ice cores, this is the highest concentration in the earth's atmosphere for at least 700,000 years. Most of this increase can be attributed to human activities.

The impact on the coastal system is multi-faceted. We can consider the coastal system as the low-lying areas and shallow coastal waters, including their human components. In addition to local drivers and interactions, coasts are subject to external events that pose a hazard to human activities and may compromise the natural functioning of coastal systems. Terrestrial sourced hazards include river floods and inputs of sediment or pollutants; marine-sourced hazards include storms surge and waves.

Sea-level rise across the globe is projected by the IPCC to be 18-59 cm by 2100, with a possible additional contribution from ice sheets of 15-20 cm. However, there is considerable conjecture that further ice-sheet contributions that cannot be quantified presently may increase the upper limit of sea-level rise substantially. Global climate models also indicate that mean sea-level rise on the east coast of Australia may be greater than the global mean sea-level rise.

The establishment of a network of high precision sea-level monitoring instruments around Australia and the Southwest Pacific in the early 1990s and the ongoing operation

of these has established that the rate of sea-level rise in the region is at the high end of IPCC projections. The rates in the northwest of Australia are highest but even the lower rates in the southeast are greater than anticipated. These higher rates in sea-level rise match other indicators of climate change in being at the high end of projections.

It is important to understand this climate change trend in the context of large regional variability in sea level. The oceans surrounding Australia are particularly influenced by two dominant climate variations: the El Nino-Southern Oscillation (ENSO) and the Southern Annular Mode (SAM).

During ENSO events sea levels may vary by up to 55 centimetres along the equatorial Pacific and the effects may last longer than two years. Since the early 1990s this large scale perturbation has occurred just once and makes the estimation of the long term trends more difficult.

In addition to interannual variability in sea level associated with such climate variations, sea level also varies on shorter time-scales with tides, wind-driven waves and surge events. When extreme events such as a storm surge (region of elevated sea level at the coast caused by the combined effect of falling atmospheric pressure and intense winds of severe weather events such as tropical cyclones) occur on the back of higher base-state sea level, either due to sea-level rise, high tides, interannual climate variations or the combination of these, the accumulated effects lead to inundation and damaging waves that penetrate further inland. When one considers the projection of more extreme storms, with higher surges, higher wind driven waves and more precipitation over land, this should be expected to lead to further increases flooding, erosion and damage to built infrastructure and natural ecosystems.

The large flat expanses of coastal wetlands and flood plains in Kakadu for instance, will be significantly affected. An analysis of the increase in frequency of extreme events for a rise of ten centimetres in sea levels at 28 locations around Australia shows that Darwin, Brisbane, Sydney and Melbourne will experience four to six times as many as currently observed.

A comparison of Sydney sea levels during the first and second halves of last century shows that the highest sea level experienced every 2 to 3 years in the first half became an annual event in the second half. A similar analysis for Fremantle shows the same result. At both locations the extreme sea levels have risen by about 10 centimetres between the first and second halves of the previous century.

If the sea-level rise experienced since the early 1990s continues, there will be a further 10 centimetres added by about the year 2020 relative to the 1990 levels. This will have happened in just 30 years, not over the 100 years as observed at Fremantle and Sydney in the past.

## References

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