

## COASTS: how best can we adapt to the challenges of climate change?

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There is a long tradition in science, including the work of Charles Darwin on coral reefs, in seeking to understand changes to coastal landforms and ecosystems. But we still have much to learn about the dynamics of past and present changes to coastal environments, its people and infrastructure. Global warming adds a new dimension to research on coasts as societies are confronting the need to adapt to new conditions.

Approximately 60% of the global population live in coastal regions (85% in Australia). Their livelihoods and lifestyles are influenced by the forces of the sea and land, but the expectation is that those forces will operate within particular limits. Yet those limits are starting to move beyond the "comfort-zone" of existing settlements and economic activities as ocean temperatures get warmer, sea levels rise, storms become more intense and beaches erode. Scientists have a major responsibility in communicating the projected changes in climatic and oceanographic conditions to ensure that existing and future generations can best adapt to challenges that are most likely to occur.

Even after fifty years of looking at coastal scenery and pondering over questions of why, how and when coasts change, I am still excited by new discoveries. I have been privileged to work with those who have inspired, and to have explored places that make me feel humbled at what coastal scientists must do in order to unlock nature's secrets. These studies have embraced a range of temporal and spatial scales. But they all have one thing in common: a need to understand how coastal systems behave in response to various interacting factors.

Over the last two decades there have been a number of studies which have defined natural climate variability over the last million years. Cores from glaciers, ocean floor and from land sites have revealed the magnitude and frequency of change in sea level, composition of gases in the oceans and atmosphere, temperatures of sea and land areas, distributions of biota, and shoreline positions and shape. This knowledge can be compared with present-day observations and model projections. The result is a strengthening of the conclusion that we are entering a new climate "era" defined by the impacts of human-induced global warming. But the emerging condition of this new era requires an understanding of the legacy of past decisions which have transformed the natural landscapes and marine worlds.

Nature has provided Australia with a diversity of coastal environments. Abuse of natural assets has occurred in many coastal areas and only in recent years have attempts been made to address the disturbances. The Great Barrier Reef offers an excellent example of inter-government cooperation to develop and implement a plan to secure the long-term ecological health of the region. Sand mining along the east coast involved considerable community and political confrontation before agreements were reached to protect vast coastal areas as parks (e.g. Fraser Island, Myall Lakes) but we did inherit, bitou bush, a lasting weed infestation problem.

Sand depletion of treasured beaches remains a significant local issue that is sure to become more contentious with our beach-loving people and tourists. Already large-scale nourishment projects are underway to address the problem such as the Tweed River bypass. While canal estates are banned in one state (NSW), they flourish in others causing damage to ecosystems and placing properties at risk of future inundation. And then there is the mess we have made of the Coorong and Lower Lakes: excessive upstream water extraction in four states deprives the estuary of its natural inheritance combined with a desire in South Australia to use the lower lakes as an irrigation tank.

The wealth of the nation has grown economically as a result of using coastal resources. Here we have built infrastructure to service our growing economy; millions of Australians depend for their livelihoods and lifestyles on those built assets. We are girt by sea and cling to the sea: the coast is our lifeblood.

The past challenge has been to manage the adverse impacts of our use of coastal resources within an environmental context defined by natural climate variability and a specific sea-level range. Governments and communities are committing resources to meet many of the problems even as population continues to expand in the many sea change regions. Now we face the twin pressures in the 21st<sup>st</sup> century of further population expansion along with demographic shifts as we move into the new climate "era". And we have to confront these pressures with a system of government which at times seems dysfunctional when trying to manage and plan for environmental protection and population growth.

One of the key issues is how to assess risks in living and working in vulnerable coastal areas. As our population grows, and we continue to seek to live near our beaches and waterways, what must we do to adapt to the changing conditions?

Our ecosystems, settlements and infrastructure are all adjusted to cope with a relatively constant sea level. Engineers have designed structures and public facilities to withstand extreme natural events that history has shown are likely to occur in different places. These assumptions are now seen as invalid. Unavoidable climate change is occurring and may worsen unless global greenhouse gas emissions are controlled.

Sea levels around the Australian coast are rising. They are projected to continue to rise as oceans warm and glaciers melt for the rest of this century and beyond. The projections are for accelerating rates of sea level rise probably beyond 1.0 metres by 2100, although a range of estimates indicates uncertainty as to the exact levels for a given time and place. Such higher levels take our society outside the "comfort zone" of present and historical conditions. Where natural and built resources are tied to these conditions we must understand how we can best adapt to the consequences of living in this "new climate era" on the coast.

The new era involves more than just sea level rise. Higher temperatures will stress animals and plants including humans. Tropical diseases may be more prevalent in areas now relatively free of such impacts; and those nasty marine stingers of northern could migrate south. It is likely that freshwater resources will decline in southern Australia. Periodic intense coastal storms, perhaps less frequent but more extreme, will ravage coastal settlements. Existing patterns of climate variability will be exacerbated as the "new climate era" starts to bite.

Australia's population is expected to rise in the next 3 decades to beyond 30 million. At present 85% of the population live in coastal regions. Historical trends indicate that growth will continue to focus on or very near the coast. "Seachange" developments outside major urban centres are expected to expand with related changes in demography. Many communities and local councils are experiencing growth pressures including inadequate social and physical infrastructure, destruction of natural habitats, and local conflicts over how to plan for the future. Growth rates of 5% or more per year over the last decade are common as documented by the National Seachange Taskforce.

Coastal problems are national, not just state or local. They do have, of course, state, regional and local manifestations. However, the implications of climate change, population growth and demographic change, and the need to redesign, retrofit and relocate public facilities and infrastructure requires major engagement from the Commonwealth Government. The call for national leadership, strong but unheeded in the past, has grown significantly since the election of the Rudd Government as shown in the report of the Standing Committee to the House of Representatives on Climate Change and the Coast in October, 2009, subtitled "The Time to Act is Now".

Climate change will drive an "adaptation imperative" in coastal Australia. It will necessitate regional planning as insurance against the risk of impacts far beyond what has been foreseen in existing land use and infrastructure plans. Already states have begun to take some steps with new policies and new infrastructure such as water desalination plants. But unless the Commonwealth offers leadership in the form of nationally consistent and continuing guidance and support, sustainable outcomes of benefit to local economies, social conditions and the environment will not occur. In a recent report, it is conservatively estimated that 250,000 residential properties are at risk of inundation or erosion if sea level rises by 1.1m by 2100 (Department of Climate Change, "Climate Change Risks to the Australian Coast", November, 2009).

States, regional NRM entities, and local councils, do not have the technical, professional and in many areas the necessary financial resources to address the coastal adaptation imperative. Increasingly these public authorities require access to new and emerging technologies including digital elevation models (DEMs) that seamlessly link water to land; to information on risk to properties and local infrastructure based on regional climate and sea level models and observations; and to up to date knowledge on changing social conditions.

The Australian Government through its support for national R&D facilities such as Geoscience Australia, CSIRO, the CRCs and AIMS, can provide vital information and decision support tools for application at local and regional levels. Here cooperation with state agencies involved in policy development and technical/financial support within the state is necessary intersecting with many sectors of public administration.

Coastal management and planning into the future should not be seen as just a problem for natural resource managers. It is much more. It is connected with a range of government interests and as such must be “mainstreamed” into finance, audit, infrastructure, economic management, social welfare, health, amenity provision and education as well as Natural Resource Management (NRM). The coast under global warming represents a total societal challenge affecting where we as Australians work, live and play.

Given that the coast is undergoing the twin pressures of climate change and population growth, and that coastal planning and management crosses many institutional lines in all three levels of government, it is urgent that the nation develop new ways to mainstream and coordinate the management of these vital built and natural assets.

Our constitution inhibits direct intervention at the federal level as seen in other countries like USA and South Africa. However, climate change will mean that we must reform some of our processes of government by embracing the emerging knowledge on climate change, including impacts on social and economic conditions, to ensure that the great challenges facing life on our coast appreciate the long time frame in which decisions must be made.

Reforms could take place progressively to address the adaptation imperative. We cannot hope to address population growth, land use planning and infrastructure investments without linking these actions to environmental impacts from past abuse of natural assets and changes in conditions due to global warming. We need to:

1. Formulate a **National Coastal Policy**, in consultation with the states and local government through COAG, and formally supported by an Intergovernmental Agreement, that defines the national need for information, planning and investment in public infrastructure that underpins the provision of facilities vital to securing the services required for the economic and social well-being of Australia in the context of environmental changes and impacts.
2. Establish a **National Coastal Information System**, similar to NOAA in the USA, that will ensure sustained research and innovation in coastal biophysical, engineering and social sciences; in the development of user-oriented decision support systems; in the coordination of diverse state and local information on risk to the adverse impacts of climate change; and in communicating the national adaptation options to communities, the professions and businesses.

3. In order to secure these steps it will be necessary to form a **National Coastal Commission**. This Commission should be empowered under a nationally agreed Coastal Commission Act to (1) review the effectiveness of those actions and investments in coastal planning and management that relate to the long term sustainability of natural and built assets across all levels of government; and (2) provide advice and support to all levels of government on initiatives needed to secure adaptation and improved management of coastal ecosystems, infrastructure, social welfare needs and regional economies.
4. Provide for a secure, long term funding base in the form of a **Commonwealth Adaptation Fund** similar to the Futures Fund for Commonwealth employees which would be available to assist local and regional communities meet the structural adjustment needs that they will encounter as the new climate "era" adversely impacts on property, infrastructure, jobs and lifestyles (for instance the need to build barrages like those on the Thames and to nourish beaches).
5. Adopt a system of **National Environmental Accounts** to measure changes in condition of natural assets as recommended by the Wentworth Group and for coastal catchments by the House of Representatives Standing Committee, which would provide governments with a sound basis for decision making on investing in maintaining and improving those assets as the new climate "era" bites.