Climate Change Adaptation Research Grants Program
- Settlements and Infrastructure Projects

Project title:
A model framework for assessing risk and adaptation to climate change on Australian coasts

Principal investigators: Prof Colin D. Woodroffe
Lead organisation: University of Wollongong

Objectives:
We intend to develop a modelling framework to integrate geomorphological, engineering and economic approaches to assessing risk for the Australian coast. Coastal land use planning and management need an indication of the degree of risk, and we will develop:

i) a probabilistic engineering-based model linking wave characteristics at a site and risk of coastal recession (PCR), with demonstrated validation on a data-rich coast (Narrabeen, NSW);
ii) a geomorphologically-based modelling framework (the coastal tract, CT) adopting a sediment budget perspective and using simulation to model variation in trend along SE Australian coasts,;
iii) an extension of this geomorphological-engineering CT framework to the less-intensively researched coasts of SW and NE Australia (and NW Australia, where practicable) integrated with the first-pass national 'Smartline' assessment of coastal vulnerability,
iv) a state-of-the-art approach for quantifying economic risks associated with coastal inundation and erosion hazard identified in i) – iii) (expected losses, downside risks), and
v) a decision-support framework for using risk estimates to evaluate adaptation strategy options.

Project design and methods:
Combining an engineering perspective with geomorphological assessment of sediment budgets will provide probabilistic forecasts of risk that can be used by coastal managers and planners to improve adaptation related to coastal settlements and infrastructure. The Gantt chart below links research objectives, deliverables, and milestones, and shows integration of components between the 3 universities. In order to enhance the implementation of the research output, a steering committee structure is proposed. The steering committee members will be coastal managers and planners typical of those that will, in the future, implement the methodologies developed by this research. The steering committee will meet formally twice to allow the research team time to adjust methodologies appropriately. The steering committee will be updated regularly between these formal meetings on the research progress with short (1 or 2 page) communications. It is envisaged that the steering committee will be open to email communications on key project matters between the formal meetings, and in early 2012 we will hold a workshop with potential end-users to develop methods to make the tools more widely available and easy to use.

1) The strength of our combined collaborative application is the integration of engineering and geomorphological perspectives in addressing probability of inundation and coastal erosion risks as a result of variations in SLR and storm characteristics. Producing an overview of existing approaches, and synthesising these, together with outlining the innovative frameworks we develop, will be important to ensure the transparent uptake of these methods by researchers, managers and policy-makers, overseen by CW and RA1.

2) The Joint Probability Method (JPM) and Probabilistic Coastal Recession (PCR) model applications will be undertaken at UQ by DC and RA3, in close collaboration with RR. Preliminary integration of these probabilistic approaches has been successful [1, 2, 10], and the Narrabeen Beach data set (where beach morphology has been surveyed at monthly intervals for over 30 years) provides the necessary data to validate the approach and derive probabilistic estimates of erosion hazard, and hence guidelines for adaptation such as setback lines, for this site, which has expensive coastal real estate threatened by storms and SLR.

3) The Coastal Tract (CT) framework will provide quantitative estimates of exchanges between significant sediment stores to forecast future sediment transport and delivery, including uncertainty. This involves interpreting geological archives of sediment accumulation to reconstruct sediment budgets for key sections of coast, identifying the principal sediment sources (e.g. supply of sediment from rivers, biological production of carbonate sediment [coral, shell]) and sediment sinks (e.g. wind-blown accumulation in dunes). Long-term trends (millennial to century scale) in sediment movement will be inferred from existing coring and stratigraphic data, together with geochronology (dating) of key sites. The CT framework will be developed by PC and RA2 using computer simulations that combine analysis of geomorphic change with detailed representation of sources and sinks and the range of plausible climate-change effects. The CT framework will be extended to consider a range of other coastal settings in SE Australia, in particular the South Coast of NSW, (RA1, CW, PC and RA2, in collaboration with appropriate coastal councils (e.g. Wollongong City Council). Aerial photographic interpretation of shoreline behaviour will be reconstructed at decadal time scales, partly as validation of the longer-term trends, and to estimate perturbations on the shorter time scale, due to storm erosion and human intervention, such as through dune fencing and revegetation. Evaluation of the latter effects will be valuable to assess different adaptation options in future. The CT framework will provide boundary conditions for the JPM/PCR models in the form of long-term coastal evolution trends, which are not taken into account by contemporary hazard modelling approaches.

4) Extension of the CT framework and proof of concept will involve selecting study sites in each of the other sectors of the Australian coast, where we have reliable geological histories derived from past research studies and ongoing collaborations. In NE Australia this will involve developing a framework for considering the susceptibility of low-lying islands (on the Great Barrier Reef and in Torres Strait [14]), and this will occur in collaboration with the global climate centre at UQ (through SuperScience fellowships in collaboration with Ove Hoegh-Guldberg [OH, CW et al]). In SW Australia, this will involve ongoing collaboration between PC and Geoscience Australia to look at vulnerability of the area around Perth. We will also explore developing similar concepts for NW Australia [13], which is likely to be the focus of future development and infrastructure expansion.

5) Economic modelling is an integral and innovative component of this project in order to translate the outcomes of the probabilistic beach-erosion modelling approach into risk information that can help policymakers decide on alternative adaptation strategies. The innovative economic risk model (ERM) that will be developed herein will be integrated with the physical hazard estimation models to result in a unified model framework (CT, JPM, PCR, ERM) for assessment of at-a-site recession risk and setback options by RA3 in close consultation with DC, RR, PC and RJ. This work will include preparing a user-manual and tutorial for the new modelling framework using the Narrabeen site. This will be overseen by the steering committee to enhance the uptake of the integrated coastal risk model by coastal managers and planners.

6) In the Netherlands, a nation that has been successfully combating extreme flooding and erosion hazards for millennia, it has been shown that there have been great difficulties in reforming/updating flood safety standards. For many years, studies focused on the ability to quantify flood probabilities (so that safety standards can be defined as flood probabilities rather than exceedance probabilities of water levels). However quantitative probability estimates do not in themselves provide guidance to policymakers to revise the type of safety standards, including political risks of having to explain a change of tactics, and a firmer economic and land-use basis is needed to demonstrate potential consequences of the different erosion cases.

7) We will engage with a broader range of potential end-users and prepare a joint research proposal for submission to the ARC Linkage scheme to extend this collaborative and integrative research.

8) We place a high priority on making these approaches and methodologies accessible to managers, and foreshadow a workshop, in conjunction with DCC-NCCARF (including linking our framework to the firstpass ‘Smartline’ mapping of the Australian coast), in 2012 to demonstrate the outcomes, and build capacity amongst potential stakeholders.