HAZARD NOTE

bushfire&natural HAZARDSCRC

ISSUE 16 MAY 2016
TOPICS IN THIS EDITION | COASTAL | CYCLONE | STORM SURGE | TSUNAMI

OCEANS ON THE RISE

ABOUT THESE PROJECTS

This is an overview of the *Coastal management* cluster of Bushfire and Natural Hazards CRC research projects. This cluster has two linked studies:

1. **Developing better predictions for extreme water levels** – Prof Charitha Pattiaratchi, Dr Sarath Wijeratne, Dr Ivan Haigh, Matt Eliot, Dr Ivica Janekovic, Dr Yasha Hetzel, The University of Western Australia. Contact chari.pattiaratchi@uwa.edu.au
2. **Storm surge: resilience to clustered disaster events on the coast** – Dr Scott Nichol, Dr Andrew McPherson, Floyd Howard, Dr Wenping Jiang, Dr Gareth Davies, Duncan Moore, Dr Jane Sexton, Geoscience Australia; Professor Tom Baldock, Dr David Callaghan, Dr Uriah Gravois, University of Queensland. Contact scott.nichol@ga.gov.au

CONTEXT

Around 85% of Australia's population live within 50km of the coast, alongside a significant proportion of key assets and infrastructure. Yet these coastlines are exposed to a range of natural hazards that can cause severe damage. This research will strengthen Australia's capability to make informed decisions for an improved resilience of coastal communities and infrastructure.

DEVELOPING BETTER PREDICTIONS FOR EXTREME WATER LEVELS

▲ **Above:** RESEARCH IS INVESTIGATING WHERE EXTREME WATER LEVELS CAN IMPACT THE COAST AND CAUSE DAMAGE, SUCH AS AT JIMMY'S BEACH IN NSW. PHOTO: NSW SES

BACKGROUND

The potential impacts of extreme water levels along Australia's coasts are increasing. To better prepare, coastal engineers, managers and planners need accurate estimates for extreme water levels. This project is developing better predictions and forecasts for storm surges, surface waves, continental shelf waves, meteotsunamis, mean sea level rise and the transition from tropical to extra-tropical cyclones.

RESEARCH ACTIVITY

Extra-tropical cyclones are cyclones that continue much further south than normal, and differ from tropical cyclones in that their energy source is not a warm ocean, but temperature differences in the atmosphere. Cyclones that undergo extra-tropical transition can interact with approaching cold fronts and extend cyclone-like conditions over a larger area and to latitudes that do not typically experience such storms. A preliminary review of the literature and extra-tropical cyclone tracks has been undertaken, with few studies previously investigating this in Australia.

Continental shelf waves are a lesser known effect of cyclones that make landfall, and can spread along the coast, influencing water levels thousands of kilometres away. In Australia, continental shelf waves travel in an anticlockwise direction. A model is being used to investigate the effects in Western Australia, which has the highest number of continental shelf waves in Australia.

A further model has been developed and tested that combines (couples) waves and storm surge along Australia's entire coast. It was not anticipated that this would be able to be completed when the project began, and it is the first time a coupled model of this nature has been used in Australia.

Meteotsunamis are caused by the passage of thunderstorms. Atmospheric pressure changes and if the propagation of the pressure disturbance matches the speed generated by a wave, then a meteotsunami could occur. Water levels may only change by up to a metre, but when high tide is factored in, this can become significant. WA can be considered a global hotspot for meteotsunamis, with 25 occurring in 2014. In one instance the increased current from a meteotsunami resulted in a container ship in Fremantle Harbour breaking free from its moorings. The ship collided with the Swan River bridge that carries the Perth to Fremantle train line, closing the bridge and train line for two weeks. Initial work in WA has been expanded to cover all states and the Northern Territory, with 13 locations reviewed for meteotsunami activity between 2009 and 2014.

RESEARCH OUTCOMES

Preliminary findings show that in Australia the south west of WA is the area most at risk from extra-tropical transitions of cyclones, late in the cyclone season, when intense cyclones are most likely to interact with approaching cold fronts. These storms are more likely in La Niña years. The general eastward component of movement of tropical cyclones in the South Pacific means that extra-tropical transition is not as likely on the east coast, as many of the storms curve away from the coast as they move south.

Results from the continental shelf wave model show that a cyclone's path, speed and category affect continental shelf wave generation and propagation. Cyclones that travelled parallel to the coast generated continental shelf waves that were faster than the cyclone forward speed and produced higher amplitude waves than those generated by different trajectories. It is recommended that design criteria, modelling studies and inundation risk assessments for coastal regions in WA consider the effects of continental shelf waves.

Several test cases have been completed using the coupled wave and storm surge model; results indicate that including the effects of waves in the model will account for up to 10-50% of simulated surge heights during an extreme event. Further simulations are being completed for historically significant storm surge events.

Meteotsunami analysis has showed that 214 events occurred over the five-year period. The largest number of events, as well as water heights, occurred in WA at Hillarys Harbour, Cape Cuvier Wharf and Esperance, although significant water heights also occurred in Tasmania at Burnie, Victoria at Portland and in New South Wales at Port Kembla.

STORM SURGE: RESILIENCE TO CLUSTERED DISASTER EVENTS ON THE COAST

▲ **Above:** A RESEARCHER USES A GROUND PENETRATING RADAR DEVICE AT OLD BAR BEACH IN NSW TO UNDERSTAND HOW THE BEACH WILL REACT TO A STORM. PHOTO: GEOSCIENCE AUSTRALIA

BACKGROUND

The aim of this project is to develop a new methodology to quantify the impact and risk of clustered storms on the coast, with an initial focus on storm surge, erosion, reshaping of the coastline, and inundation and damage to buildings and infrastructure.

RESEARCH ACTIVITY

Research is being undertaken at two study sites: Old Bar Beach on the NSW Central Coast, and the Adelaide metropolitan beaches. Data collection has been undertaken at both sites, identifying and defining a minimum thickness for beach and dune sediments, along with determining if the sites have any bedrock that may limit the volume of sand that is needed for beach recovery after a storm.

The data collection, along with a geomorphic mapping assessment, are informing the modelling of shoreline response to clustered storms.

A literature review has also been completed to review suitable models and model frameworks, selecting the best one for each study site. Four models were considered, along with three model frameworks.

RESEARCH OUTCOMES

At Old Bar Beach, bedrock outcrop near the shore and higher on the beach has significant implications for modelling of beach response to storm surge, as reefs close to shore may refract wave energy, concentrating it in one area. Considerations for modelling Old Bar Beach need to take into account reefs and the presence of bedrock because these formations also limit the local supply and transport of sand for beach recovery following a storm.

Data showed that the Adelaide metropolitan beaches are susceptible to erosion, due in part to a limited sand supply and shallow bedrock that is exposed in offshore reefs, particularly at Kingston Park. Considerations for modelling the Adelaide beaches should consider the variations in the sea floor and coastal infrastructure such as artificial reef, groins, seawalls and piers.

END USER STATEMENT

This cluster is delivering high quality science to improve our ability to model extreme water levels around the coastline. A range of organisations will benefit from the findings, from federal agencies, to state departments and emergency service agencies. Federal agencies such as Geoscience Australia and the Bureau of Meteorology will benefit from the science and the data that is being produced, while state planning or transport departments need to know where these events might happen along the coast, and how bad they might be. These departments need to know where to zone land for development, and importantly, land to not be developed, along with optimising their planning schemes. Emergency services will be able to use the scenarios presented in the research to plan their response to natural hazards.

– Dr Martine Woolf, Section Lead, Hazard and Risk Infrastructure and Applications, Geoscience Australia

The Bushfire and Natural Hazards CRC is a national research centre funded by the Australian Government Cooperative Research Centre Program. It was formed in 2013 for an eight-year program to undertake end-user focused research for Australia and New Zealand.

Bushfire and Natural Hazards CRC
Level 1/340
Albert Street
East Melbourne
VIC 3002
www.bnhcrc.com.au