DELIVERING KNOWLEDGE ON COASTAL ADAPTATION –THE NSW ADAPTATION RESEARCH HUB COASTAL PROCESSES NODE

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Abstract

The NSW Adaptation Research Hub (the Hub) is a collaboration between leading NSW universities and the Office of Environment and Heritage. There are three research nodes within the hub – Biodiversity, Adaptive Communities and Coastal Processes. The Hub was officially launched in late 2013 and will see a range of projects completed over a three year period. A key focus for the Hub is the development of policy and operationally relevant research.

The Coastal Processes Node is led by Sydney Institute for Marine Science with support from the Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI).

The Node is focused on improving the knowledge base and information on coastal and estuary impact assessment, risk management and adaptation responses. It will inform management decisions and actions taken by local communities and councils in the coastal zone.

Key research projects include:
- **Quantification of Regional Rates of Sand Supply to the NSW Coast** Led Macquarie University and Office of Environment and Heritage
- **East Coast Lows – Assessment of our Capacity to Predict Storm Erosion Hazard in NSW** Led by University of New South Wales
- **Risk Assessment and Strategic Response – NSW Estuaries** Led by University of New South Wales and Macquarie University
- **Responses - Adaptation Protection Options - Nourishment and Seawalls** Led by ACCARNSI, Macquarie University and University of New South Wales
- **Risk and Uncertainty, and Visualisation of Coastal Risks** Led by Risk Frontiers, Macquarie University

The outcomes of these research projects will help address knowledge gaps in climate change adaptation, foster innovation and facilitate collaboration between the NSW Government and leading experts. This paper will explore the collaborative nature of the Hub and how research outcomes are being driven by operational needs.

Background

The NSW Government is committed to assisting local government, business and the community build resilience to future extreme events and hazards by helping them to understand and minimise the impacts of climate change (NSW 2021 A Plan to Make NSW Number 1 *Goal 23 page 46*).

Climate change is a global phenomenon, with impacts felt at local and regional scales – including in NSW, which already has a very variable climate. All communities and industries will be exposed to the impacts of climate change however the effects will vary based on regional and local topographical differences. Information about future impacts on the natural environment will be important for sectors to assess and prioritise their climate change risks, identify vulnerabilities and develop adaptation response strategies.

The NSW Office of Environment and Heritage (OEH) has established a Hub for Adaptation Research in NSW, to harness the capabilities of NSW research institutions to deliver climate impact and adaptation science research of state significance. The Hub comprises three priority research nodes in the areas of
1. Coastal Processes and Responses – hosted by the Sydney Institute of Marine Science (SIMS) and the Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI)
2. Biodiversity – hosted by Climate Futures at Macquarie University with support from CSIRO; and
3. Adaptive Communities – hosted by the Institute for Sustainable Futures at UTS with support from CSIRO.

The state has contributed $2.75 million to be shared equally between the nodes over three years.

The objectives of the NSW Research Adaptation Hub are to:
• Foster integrated climate impacts and adaptation research in the NSW university sector to enable effective climate change adaptation in NSW
• Cost effectively deliver priority knowledge for OEH and its customers
• Ensure transfer of skills and knowledge between the University sector, Government staff and the communities that OEH serves, specifically regional communities.

The Hub is administered by OEH. To ensure strong linkages to policy and operational outcomes each Node is governed by a steering committee comprising equal representation from OEH and the research partners. OEH membership has been chosen to represent Science, Policy and Operational (both Parks and Regional Operations) staff to develop the collaborative linkages necessary to ensure research is policy and operationally relevant.

Coastal processes and responses node

In the development of the Coastal Processes and Responses Node, OEH sought Expressions of Interest from universities and research institutions to host the node. The Node is designed to support the NSW Government by:
• Building on OEH policy, projects and programs to provide communities in coastal zones with information to reduce their risk and vulnerability to current climate variability, as well as to the future impacts of climate change
• Developing a NSW-wide coastal hazard assessment methodology and process to identify and assess the impacts of sea level rise, storm surges and coastal erosion.
Applicants were encouraged to provide matching funding, through financial or in-kind contributions to the research and to develop multi-disciplinary, multi-institutional approaches, requiring cooperation and integration.

Why research coastal processes and responses?

International and regional research indicates that sea levels are rising. The ecosystems and communities of the NSW coastal zone face the dual pressures of altered climate regime and rising sea level in the medium to long term. The NSW population is heavily concentrated along the coast and as Australia's most populous state has significant settlements, infrastructure and economic interests that will be affected by sea level rise. Over 60% of the population (4.4 million) lives in Sydney, with a further ~20 per cent (1.38 million people) living in coastal local government areas beyond the Sydney region.

Building on current sources of coastal information

The Coastal Processes and Responses Node will seek to provide information that is useful for local communities and councils to implement adaptation strategies in coastal zones to reduce their risk and vulnerability to local climate impacts. The Node will be required to interact with and build on existing OEH policy, projects and programs as described below.

NARCliM - NSW and ACT Regional Climate Modelling

The Office of Environment and Heritage (OEH) has designed the *NSW and ACT Regional Climate Modelling (NARCliM)* project to deliver a robust picture of the likely regional impacts of the changing climate in NSW. The modelling is being conducted by both OEH and the Climate Change Research Centre staff at the University of New South Wales.

When completed, NARCliM will place NSW at the forefront of climate projections research both nationally and internationally. This is the first time that projections at this fine-scale (10 km grid squares) relevant to local decision making, will be available for NSW and the ACT communities. Three 20-year simulations will be performed with each Global Climate Model/Regional Climate Model combination: one recent period (1990-2010) and two future periods (2020-2040 and 2060-2080).These projections will be publicly available in 2014 and provide valuable information for managing climate impacts on health and settlements, agriculture, fire weather extremes, flooding and services such as water and energy supplies.

ESCCI - Eastern Seaboard Climate Change Initiative

Established in 2010, the Eastern Seaboard Climate Change Initiative (ESCCI) is a cooperative research consortium led by OEH and includes NSW Government Agencies, Australian Bureau of Meteorology, Sydney Institute of Marine Science and a number of major universities in NSW. ESCCI aims to address information gaps in the nature and impacts of climate change and climate variability on the Australian east coast, ranges and inshore marine environments.

A major research component of ESCCI is to understand the formation and impacts of East Coast Lows and how their frequency and intensity may alter with climate change. This research will help the community understand existing coastal weather systems,

how they may impact coastal populations, how they have varied over the last 1000 years and how they may be affected by predicted changes to our climate.

OEH Knowledge Strategy

OEH has a strategic approach, called the Knowledge Strategy, to determine our 'knowledge' priorities. The Knowledge Strategy aims to strengthen the alignment of science undertaken by OEH with its legislative, policy and management needs. Short, medium and long term priorities for knowledge have been developed for several 'themes'. Climate change is an issue that cuts across all themes.

The two themes relevant to the Coastal Processes and Responses Node are:
- *Coastal, Estuarine and Marine Environments* - This theme identifies the knowledge OEH needs to fulfil its responsibilities to protect NSW's coastal, estuarine and marine environments. Coastal environments are defined as the terrestrial fringe where landforms and biota are strongly influenced by marine processes. The theme calls for an increased investment in knowledge to support assessments of coastal hazards to guide development planning and secure critical human and ecological assets while adapting to climate change (eg. sea level rise). This would include using available seafloor/terrestrial topography maps (ie. coastal digital elevation model), coastal erosion and estuarine inundation assessments, and increased accessibility to information (eg. Coastal Information System)
- *Climate Change Impact and Adaptation* - This theme identifies the knowledge OEH needs to understand the impacts of climate change on NSW and enable communities to adapt to these impacts. In regards to coastal zone management, the theme's priorities include ensuring NSW has the best plans, legislation and other arrangements to deal with coastal risk. This is addressed further in the Coastal, Estuarine and Marine Environments Knowledge Theme, and complements work on coastal erosion modelling to improve coastal erosion hazard assessment methodologies.

Delivery of new coastal information

A distinguishing feature of the NARCliM project is the level of end-user engagement, from project development to information product design and technical support. Ensuring model output accessibility and useability underpins each step of the NARCliM project. OEH is currently undertaking detailed consultation with end-users from a broad spectrum of business, government and research sectors, on the type of information they would like delivered. Of utmost importance to the success and value of the project is the means for the wider community to access both raw data and processed information. Development of data inquiry, summary and visualisation tools is being driven by input from the consultation processes. Importantly, the NARCliM project has resulted in multiple sub-projects that use the baseline data to deliver a suite of impact and hazard assessment research.

The work carried out by the Coastal Processes and Responses Node will follow the NARCLiM model through concentrating on key enabling research and providing information that will allow end users and other researchers to tailor their own programs using the climate and coastal systems knowledge and adaptation platform built by the hub.

Research questions

The Coastal Processes and Responses Node will contribute to developing adaptation strategies for local communities in coastal environments. The node will assist OEH to provide robust guidance for coastal and estuary management reflecting the response of our coastal systems to climate variability and climate change.

The following research questions were provided as an example of the envisaged work. This list was not exhaustive and applicants were encouraged to consider and expand upon them as they see appropriate.

- Develop tools to help councils and other organisations identify and assess the impacts of projected sea level rise and altered climate regimes on NSW coastal communities and infrastructure, ecosystems and cultural heritage.
- Understand the linkages between climate change, oceanic conditions and coastal hazards
- Understand the influence of current climate variability on coastal processes and assess how this will change with projected climate change scenarios
- Identify the extent of threats posed by coastal erosion events, shoreline recession and coastal flooding, especially under climate change and sea level rise scenarios
    - estuary foreshores and associated ecosystems
    - soft and hard open coastlines
    - communicating probabilistic risk
- How does beach erosion risk change with climate change; both sea level rise and changing wave climate
- Understand potential impacts of extreme events (e.g. floods, droughts, heat waves, storms) on estuarine habitats and develop climate change ecological risk profiles for a range of estuary types along the NSW coast.

The Hosted Node and Current Program

In a highly competitive process the node was awarded to a consortium researchers of the Sydney Institute of Marine Science (SIMS) and Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI). The mutli-disciplinary team draws from the partner universities of SIMS, the members of ACCARNSI and both science and practitioner staff in OEH.

The research team includes: Peter Steinberg (SIMS); Ron Cox (ACCARNSI UNSW); Kristen Splinter, Ian Turner, Bill Peirson, Will Glamore (Water Research Lab UNSW); Ian Goodwin, Melanie Bishop, Belinda Cooke (Macquarie University); John McAneney, Kevin Roche (Risk Frontiers Macquarie University); Chris Lee, Dave Hanslow, Bruce Coates, Phil Watson, Michael Kinsella, Marc Daley, Peter Scanes (OEH) and international collaborators Kate White, Jeff Melby, Heidi Moritz (US Army Corps of Engineers). The team is also supported by more than 10 PhD and Honours students.

Through an iterative process between the research team and OEH staff, a research program has been developed that leverages the considerable expertise of both the research team and OEH, existing projects funded through ARC linkage grants and the current work programs of OEH.

The key projects of the Node include:
- *Regional Rates Of Sand Supply To The Coast*; Aims to identify which regional coasts have an active sand supply and are less impacted by sea-level rise in

the medium term and identify marine sand deposits suitable and available for future beach nourishment - Ian Goodwin (Macquarie)

- *East Coast Lows – Assessment Of Our Capacity To Predict Storm Erosion Hazard In NSW*; Seeks to obtain a unique and comprehensive dataset comprising immediately pre-and post-ECL storm response at nominally 3-5 adjacent coastal embayment in NSW and associated wave climate (number and location of study sites to be finalised jointly by UNSW and OEH), to quantify the inter-and–intra-embayment variability and trends in the observed erosion response to a single storm event, and to evaluate the performance of existing numerical modelling tools used to determine coastal erosion setback in NSW - Ian Turner (WRL UNSW)

- *Responses - Adaptation Protection Options - Nourishment and Seawalls;* Will provide guidance for effective design, staged implementation and ecological impacts of coastal adaptation options for the protection of settlements and infrastructure with focus on sand nourishment and seawalls. It will build understanding of redistribution of placed nourishment sand and test common used models against existing available post nourishment data and recovery data to be collected after a major ECL storm event (linkage to Turner Project) Provide guidance for upgrading primary armour of existing seawalls as design wave height increases with sea level rise and provide practical guidance as to likely ecological impacts of nourishment and seawalls including protocols for timely assessment - Ron Cox (ACCARNSI UNSW)

- *Risk Assessment and Strategic Response – NSW Estuaries;* Seeks to address the following questions: 1) How are estuaries anticipated to change with climate? 2) What built environment options can be exercised to address these changes in estuaries and mitigate impacts in adjacent settlements and infrastructure? 3) What are the likely impacts on estuarine ecosystems of climate change? 4) What appropriate strategies can be exercised to minimise ecological, social and financial risk in NSW estuarine systems? 5) How can current practice be improved? And 6) What are the key datasets and theoretical constraints to improving our understanding of estuary responses to climate change? - Bill Peirson (WRL UNSW)

- Risk, uncertainty and visualisation of coastal risk; Project 1 quantified high-resolution address exposure in relation to elevation thresholds and various distance ranges from the shoreline. This project used the LiDAR-derived DEM data obtained from LPI and OEH. Further projects will leverage evidence-based inundation and scenario data produced by OEH to provide a series of detailed digital maps that identify potential impact areas for all NSW LGAs and the development of risk registers of exposed Features of Interest - John McAneney and Kevin Roche (Risk Frontiers Macquarie)

Next Steps

The node has just passed one year in operation and research projects are well underway and making good progress. As research progresses we look forward to sharing results, which deliver/share research quality datasets; develop case studies to test models and methods; provide practical guides/manuals for decision makers; deliver journal, conference papers and research reports; and engage the community through workshops and seminars. We look forward to sharing research outcomes at future NSW Coastal Conferences.