THE FUTURE OF COASTS

AUGUST 19 – 20, GRIFFITH UNIVERSITY, GOLD COAST

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AUSTRALIA

CLIMATE KIC
AUSTRALIA
KNOWLEDGE
INNOVATION
COMMUNITY

Australian Academy of Science

NCCARF
National
Climate Change Adaptation
Research Facility
Adaptation Research Network
SETTLEMENTS AND INFRASTRUCTURE

Message from the Director of Future Earth Australia

It is a great pleasure to open the 4th Future Earth Australia ECRP workshop. We are honoured to be in a position to provide both space and opportunity for the next generation of researcher and practitioner leaders to come together and share ideas and passions on cross-cutting sustainability challenges and opportunities of our time. In bringing you together to discuss 'the Future of Coasts', our aim is to enable not only long-lasting relationships, but future collaborative efforts that enable societal transformation. We hope you enjoy the program.

Message from Future Earth Australia's Early Career Researcher and Practitioner (ECRP) Program

Welcome to the first of three Future Earth Australia Early Career Researcher and Practitioner Events for 2019, The Future of Coasts. We are delighted to escape the Canberra cold here at Griffith University on the Gold Coast for what will be a fantastic event.

The Future Earth ECRP executive team would like to take this opportunity to introduce ourselves.

Dr Ray Maher, Co-chair – Ray works at the University of Queensland as a researcher in sustainability strategy, a lecturer in sustainable architecture, and co-director of the award-winning Project Habitation. His work spans built environment, knowledge systems and visual approaches for collaborating to solving complex problems. Ray is passionate about developing interdisciplinary collaborative networks to support more integrated sustainability initiatives.

Chris Lewis, Co-chair – Chris has worked with Geoscience Australia since 2010. His background is in geochronology and isotopic geochemistry, but he considers himself a 'generalist' geologist/geoscientist with a broad range of skill sets and interests in all aspects of geoscience, leadership and management. Chris has a passion for creating an environment where all ECRPs are empowered to remain in their fields of research and reduce the attrition of high-future science-leaders through increased engagement with other ECRPs.

Sarah Crowe, Secretariat support – You have all undoubtably had interactions with Sarah over the course of this event. She is at the coal face (or should we say the renewable energy face) of the ECRP program. She, with guidance from Tayanah, runs the Future Earth Australia ECRP program which includes organising all events, corresponding to the wider Future Earth Australia network, and keeping Chris and Ray in check! Sarah is passionate about supporting ECRPs to better connect and share their work with peers in other disciplines.

As the Future Earth Australia ECRP program grows we would love to keep you all up to date with what is happening. If you would like to find out more information about the Future Earth Australia ECRP program and how you can be involved, please don't hesitate to email us: futureearthaustralia@science.org.au

Future Earth Australia

Future Earth Australia is a unique platform that brings academics, professionals, decision-makers and civil society together to tackle our big sustainability issues. This involves, for example, programs that encourage a linked-up network of researchers, professionals and civil society as a committed community that engage our community of practice to look at how we take on our significant challenges on a systemic level.

A focus of Future Earth Australia is our Early Career Researcher and Practitioner program. The aim of this program is to provide a platform for early career researchers and practitioners to network, share their research and forge collaborations across disciplines. We achieve this by hosting broadly themed 2-3 day workshops across the country. To ensure maximum participation from our early career researchers and practitioners, we provide travel grants to Future Earth Australia members to assist them with the costs of travel.

Climate-KIC

Climate-KIC Australia inspires and enables across-the-board collaboration to deliver transformational climate action. We do this by acting as a catalyst for systemic change, leveraging deep global networks, knowledge sharing and breakthrough innovations to build a thriving and resilient future for Australia. We are an independent, not-for-profit organisation that is structured around a collaborative partnership that links government, research, business and civil society. Climate-KIC Australia works in collaboration with EIT Climate-KIC, its European sister organisation, and Europe's largest public-private climate innovation partnership.

The Australian Climate Change Adaptation Research Network for Settlements and Infrastructure

The National Climate Change Adaptation Research Facility (NCCARF) works to support decision makers throughout Australia as they prepare for and manage the risks of climate change and sea-level rise.

The Australian Climate Change Adaptation Research Network for Settlements and Infrastructure (ACCARNSI) is hosted by the School of Civil and Environmental Engineering at the University of New South Wales (UNSW).

Having built a brand base and reputation that is now well known and acknowledged Australia wide, ACCARNSI will bring together researchers and stakeholders with an interest in climate change adaptation for coastal settlements, public and private infrastructure, the built environment and urban and regional planning. Research direction will assist government, the private sector and vulnerable regions and communities to make informed decisions on how best to educate, plan and manage adaptation for the risks of climate change on coastal settlements, urban and regional built environments and infrastructure.

Day 1 - Monday, 19 August 2019

8.30am	**Tea and coffee on arrival**
9.00am	**Acknowledgement of country and overview of the workshop** *Dr Tayanah O'Donnell, Director Future Earth Australia*
9.05am	**The legal, political and cultural aspects of coastal climate change adaptation** *Dr Tayanah O'Donnell, Director Future Earth Australia*
9.30am	**Finding your career in the climate adaptation space** *Dr Johanna Nalau, Griffith University*
10.00am	**Presentation** *Dr David Souter, Australian Institute of Marine Science*
10.30am	**Session wrap up** *Dr Taryn Laubenstein, Future Earth Australia*
10.40am	**Morning tea**
11.00am	**A decision framework for coastal infrastructure to optimize biotic resistance and resilience in a changing climate** *Dr Mariana Mayer Pinto, University of New South Wales*
11.15am	**Feasibility of coastal wetland restoration of sugarcane land in the Great Barrier Reef catchment for blue carbon, and restoration prioritization to deliver multiple benefits** *Valerie Hagger, University of Queensland*
11.30am	**Stakeholders rate living seawalls benefits as almost double the risks** *Kate Dodds, Macquarie University*
11.45am	**Conservation priorities for intertidal rocky shores assessed with remote sensing** *Dr Nina Schaefer, University of New South Wales*
12.00pm	**Managing changing estuaries under an increasing urban footprint** *Jemma Purandare, Griffith University*
12.15pm	**Session wrap up** *Dr Ray Maher, ECRP Representative, Future Earth Australia*
12.30pm	**Lunch**
1.30pm	**The Gold Coast transformed** *Emeritus Professor Tor Hundloe*
2.00pm	**Potentials of hyperspectral imaging in coastal research** *Jonathan Kok, Australian Institute of Marine Science*
2.15pm	**Accounting for the environmental co-benefits of seaweed farming: a quantitative systematic review** *Scott Spillias, University of Queensland*
2.30pm	**Determining the legacy of groundwater pollution in coastal ecosystems** *Dr Douglas Tait, Southern Cross University*
2.45pm	**Assessing the impacts of sediment-related stressors on coral recruitment** *Gerard Ricardo, Australian Institute of Marine Science*
3.00pm	**Session wrap up** *Dr Taryn Laubenstein, Future Earth Australia*
3.15pm	**Afternoon tea**
3.35pm	**Panel Discussion** **Pathways to practice** *Chair: Dr Tayanah O'Donnell, Future Earth Australia* *Dr David Souter, Australian Institute of Marine Science* *Matt Baldock, Livingstone Shire Council* *Chris Lee, ClimateKIC*
4.35pm	**Wrap up and day 1 close** *Dr Tayanah O'Donnell, Director, Future Earth Australia*
6.30pm	**Group dinner**

Day 2 - Tuesday, 20 August 2019

8.45am	**Tea and coffee on arrival**
9.00am	**Welcome to day 2** *Dr Taryn Laubenstein, Future Earth Australia*
9.10am	**Workshop** *Chris Lee, Director, ClimateKIC*
10.40am	**Morning tea**
11.00am	**Sea level rise around Australian coasts using satellite altimetry data** *Armin Agha Karimi, University of Newcastle*
11.15am	**Next – and end – user tools for the hazards of coastal extreme water levels** *Dr Julian O'Grady, CSIRO*
11.30am	**Modelling future shoreline retreat under climate change for reef-aligned coasts** *Oxana Repina, University of Queensland*
11.45am	**Modelling intertidal elevation and coastal change at continental scale using 30 years of satellite data** *Dr Robbi Bishop-Taylor, Geoscience Australia*
12.00pm	**Session wrap up** *Dr Taryn Laubenstein, Future Earth Australia*
12.15pm	**Lunch**
1.15pm	**Plastic pollution challenges in coastal environment: new methods for assessment and management** *Dr Isabel Jalon-Rojas, University of New South Wales*
1.30pm	**A summary of the Coasts chapter of the 2016 Australian State of the Environment Report** *Dr Graeme Clark, University of New South Wales*
1.45pm	**Achieving social license for sustainable coastal management** *Rachel Kelly, University of Tasmania*
2.00pm	**Enlarging the coastal imagination** *Dr Kim Satchell, Southern Cross University*
2.15pm	**Session wrap up** *Dr Ray Maher, ECRP Representative, Future Earth Australia*
2.30pm	**Afternoon tea**
3.00pm	**Tsunami hazards in Australia: a probabilistic treatment for distant earthquake sources** *Dr Gareth Davies, Geoscience Australia*
3.15pm	**Urban planning, sustainable development and flooding: a case study of Port Harcourt city, Nigeria** *Adaku Echendu, Western Sydney University*
3.30pm	**A conceptual framework for stakeholder engagement in floating housing co-production in Vietnamese coastal context towards disaster-resilience and sustainability** *Bao Ngoc Nguyen, Western Sydney University*
3.45pm	**Staying cool: the importance of shade availability for tropical, estuarine ectotherms** *Chun-Chia Chou, Australian National University*
4.00pm	**Session wrap up** *Dr Taryn Laubenstein, Future Earth Australia*
4.10pm	**Wrap up and forum close** *Dr Taryn Laubenstein, Future Earth Australia*

The legal, political and cultural aspects of coastal climate change adaptation

Dr Tayanah O'Donnell

There is significant debate and contestation over how climate change adaptation measures are to be implemented in developed coastlines. This paper will discuss empirical research spanning six years (PhD and postdoc) in several coastal localities in New South Wales, Australia, which has posited a 'coastal lawscape' lens as one way to better understand climate change adaptation policy and practices. Taking a legal geography approach, a coastal lawscape comprises law, politics and cultural as an interplay of interests and factors of the relationships between private interests and coastal actors. This lens also usefully maps how these groups utilise law and discourses of property to try and shape both the material environment and climate adaptation outcomes.

A decision framework for coastal infrastructure to optimize biotic resistance and resilience in a changing climate

Dr Mariana Mayer Pinto, Katherine Dafforn, Emma Johnston

Coastal ecosystems are under pressure from human activities such as pollution and climate change. Although the rapidly growing numbers of humans living in coastal areas is a large part of the problem, there is great opportunity to improve the resistance and resilience of biotic communities via creative changes to the engineering design of built infrastructure. In this talk, I will discuss past and current efforts to restore urbanised coastal systems. I will also discuss how ecological theories can be applied to create a framework for adaptive building in marine systems that can be used by managers worldwide. Adaptive building has generated innovative designs for terrestrial urban developments, including the provision of ecological services such as microclimate regulation and air quality. Nevertheless, rarely have ecological considerations been incorporated into the design of marine infrastructure and these are yet to account for changes in ecosystem dynamics due to a changing climate. Although we should prioritise the conservation and restoration of natural habitats and the application of soft-engineering approaches, in highly urbanised areas such approaches are often not an option. I will therefore focus here on interventions associated with coastal infrastructure and will explain how climate effects could be mitigated across different spatial scales with both physical and biological interventions. This requires an approach based on ecological theory and takes into account future local and global environmental conditions. By translating ecological theory into practical application, we propose a framework for the choice and design of infrastructure that can underpin effective, forward-looking conservation strategies.

Feasibility of coastal wetland restoration of sugarcane land in the Great Barrier Reef catchment for blue carbon, and restoration prioritisation to deliver multiple benefits

Valerie Hagger, Nathan Waltham and Catherine Lovelock

In Australia, interest in investment in coastal wetland restoration is increasing due to concerns around habitat loss, coastal inundation and erosion, loss of fisheries and climate change. Recently, vegetated coastal wetlands have been highlighted for their significant value in sequestering carbon dioxide, termed “blue carbon”. Coastal wetlands also provide valuable ecosystem services that help to sustain the health and resilience of coral reefs, such as improving water quality from land run-off and providing fisheries habitat.

The purpose of our study is to assess the costs, benefits and feasibility of restoring coastal wetlands for climate change mitigation (carbon sequestration and avoided greenhouse gas emissions) on historic tidally-influenced sugarcane land in the Wet Tropics catchments in northern Queensland. It assesses whether potential carbon credits earned by blue carbon restoration would be sufficient to incentivise conversion of sugarcane cropping by farmers, or whether further ecosystem service payments would be required. It also explores the co-benefits for biodiversity, nitrogen removal and coastal fisheries, and develops a prioritisation approach to identify cost-effective restoration solutions that deliver these multiple benefits.

Preliminary results identified 179 restoration sites that could provide 74,988 tonnes of CO2-e abatement. Cost-benefit analysis over 25 years demonstrate that 30 of the sites (17%) would be profitable if conventional farm management practice was to continue. We prioritise sites incorporating feasibility of restoration, and delivery of co-benefits to identify sites that are cost-effective and could attract additional incentive payments.

The outcomes of this study will support the development of a blue carbon restoration method to reduce national greenhouse gas emissions, and provide guidance for establishing carbon projects that achieve multiple outcomes.

Stakeholders Rate Living Seawalls Benefits as Almost Double the Risks

Kate Dodds, Dr. Maria Vozzo, Dr. Katherine Dafforn, Dr. Mariana Mayer-Pinto and A/Prof. Melani Bishop

Our coastlines are becoming increasingly urbanised, and the proliferation of traditionally designed infrastructure is lowering the ecological value of the coastal zone. Eco-engineering, or greening, projects aim to increase the ecological value of infrastructure, but require stakeholder support to succeed. Determining stakeholder perceptions towards these projects is an important step in increasing their uptake and ultimate effectiveness. A harbour based eco-engineering project, "Living Seawalls", is applying ecological learnings from small scale experiments and a global meta-analysis, to retrofit whole-seawalls with habitat-enhancing tiles that increase complexity and surface area of these otherwise relatively flat and featureless surfaces. Two workshops (including representatives from the public, local government, construction sector among others) held in Sydney used discussion, non-anchored voting and paper surveys to determine perceptions of and willingness to pay for these large scale interventions. Stakeholders considered project benefits to outweigh concerns (65% compared to 35% of votes). These user-defined benefits have informed the monitoring campaign currently measuring the ecological effectiveness of the Living Seawalls project. At least 63% of participants were willing to pay 501AUD or more to 'green' a 10m length of existing seawall. However, participants favoured shared responsibility of these costs and preferred at least matched funding from government. This study explores useful stakeholder engagement techniques for greening projects in general, but also highlights the need for continued investigation into suitable funding and implementation strategies that are based on shared costs and realisation of benefits.

Conservation priorities for intertidal rocky shores assessed with remote sensing

Dr Nina Schaefer, Mariana Mayer-Pinto, KingsleyJ. Griffin, Emma L Johnston, William Glamore, Katherine A. Dafforn

Sea-level rise is an inevitable consequence of climate change and threatens coastal ecosystems, particularly intertidal habitats. Intertidal habitats support significant biodiversity, but are often constrained by landward development. Predicting the effects of climate scenarios on coastal ecosystems is important for understanding the degree of habitat loss for associated ecological communities. We quantified the extent of horizontal intertidal rocky shores along ~ 200 kms of coastline in SE Australia using 61S and remote sensing and used this information to predict changes in extent under four different sea-level rise scenarios (IPCC RCP2.6, RCP4.5, RCP6.0, RCP8.5). We then applied the IUCN Red List of Ecosystems Criterion C2 (habitat degradation over the next 50 years) to estimate the status of this ecosystem in the Hawkesbury Shelf Marine Bioregion. We also used four individual rocky shores to investigate the role of local topography in determining the severity of sea-level rise impacts. We found that, if the habitat loss within the study area is representative of the entire bioregion, the IUCN status of this ecosystem is 'near threatened', assuming that an assessment of the other criteria would return lower categories of risk. There was, however, high spatial variability in this effect. Among the sites surveyed in detail, the ecosystem status ranged from 'least concern' to 'vulnerable', but reached 'endangered' under upper estimates of the most severe scenario. Our results have important implications for conservation management, e.g. planning resolutions that aim to protect and enhance the resilience of coastal environments.

Managing changing estuaries under an increasing urban footprint

Jemma Purandare, Rodger Tomlinson, Nick Cartwright, Mark Gibbs

South east Queensland is experiencing unprecedented population growth, resulting in the rapid development of flood plains and catchments. Much of this development is in the form of large residential subdivisions that are responding to a demand for housing from interstate migrants to Queensland. The development of some of the Gold Coast's northern catchments is resulting in extensive vegetation clearing and loss of cover and habitat, which in turn results in increasing loss of sediment from land. A study to examine the historical contribution of sediments from the northern Gold Coast catchments into a tidal estuary has indicated that changes in sediment yield is likely linked to this loss of vegetation cover. This study further investigates the potential for future sediment load increases as the climate continues to change, and the impact that these changes are likely to have on the management of the estuary and the ecosystems that inhabit them. This may include increasing dredging regimes to maintain navigability, targeted riparian restoration that can address pollutant loads into river systems, and changes to the planning scheme that accommodate vegetative buffer zones designed to protect waterways. The presentation will provide an overview of the finding of the study, relating to both the historical sediment yield trends and the projected changes under various climatic scenarios, and provide commentary on the adaptive estuary management that may be required in the future.

Potentials of hyperspectral imaging in coastal research

Dr Jonathan Kok

Advancements in hyperspectral sensors and aerial drone technologies have opened the potential for more comprehensive ocean colour and shallow benthos measurements to aid in the understanding of ocean and coastal ecosystems. Instead of being constrained to orbiting schedules of remote sensing satellites, coupling compact hyperspectral imaging sensors onto small commercial aerial drones allows for hyperspectral data to be collected on demand. The spatial resolution of the collected data from the low altitude platform is significantly higher than that of satellite systems – between 5 cm and 50 cm per pixel as compared to between 250 m and 1 km per pixel. Though the very high-resolution output from aerial drone systems is advantageous, its area coverage, however, is limited to the flight endurance capacity of the aerial drone and other uncontrollable variables (e.g., cloud, sunlight, winds, tides). Therefore, undertaking successful field campaigns that produce usable and high-quality data requires informed planning and cross-disciplinary experience. This paper proposes a framework for undertaking successful campaigns to collect high-quality, ground-truthed and map-ready hyperspectral data using aerial drone systems in open waters and reef systems. The methods have been developed and trialled at Davies Reef, central Great Barrier Reef, Australia. After the data collection campaign, orthorectification and radiometric calibrations were implemented, producing a standardised georeferenced hyperspectral data cube. Deterministic annealing was used to cluster materials according to their spectral reflectance properties. The resulting analysis, validated against existing in situ data, provided valuable insights into the reef composition that can be used to understand benthic habitats and to document events such as coral bleaching and flood plumes. The high spectral and spatial resolutions produced by the airborne system offers a new compelling tool for mapping and monitoring shallow water reef habitats. Besides coral reefs, close-range hyperspectral imaging can also contribute to other fields of ocean colour, such as satellite calibration, modelling water quality, seagrass meadows, phytoplankton blooms, oil slicks and coral spawn slicks.

Accounting for the environmental co-benefits of seaweed farming: a quantitative systematic review

Scott Spillias, Brian Von Herzen, Eve McDonald-Madden

Offshore seaweed cultivation is quickly gaining attention as a possible strategy for climate mitigation and adaptation, for restoring ocean ecosystems, and for promoting the resilience of coastal communities through the production of food, animal feed, biofuels, and high-value chemicals. However, the ecological and socioeconomic benefits of seaweed farming are likely to be species specific, spatially dependent and sensitive to local contexts. We will present the preliminary results of a systematic review and meta-analysis of the English and non-english literature in which we quantify six of the most often cited environmental co-benefits of seaweed farming: (i) harmful algal bloom inhibition, (ii) nutrient removal, (iii) coastal erosion protection, (iv) wildlife habitat provisioning, (v) ocean acidification buffering, and (vi) carbon sequestration potential. These results will show how the co-benefits of seaweed are distributed geographically, which species are best suited for provisioning each service, and where our current knowledge is still lacking. This will form the basis for developing a research agenda focused on identifying where, how, and if we should promote seaweed farming as a viable tool for coastal restoration and coastal adaptation to climate change. Developing and pursuing this research agenda will be critical for investors, decision-makers, communities, and farmers to make informed choices that will ensure the rapidly growing seaweed farming industry delivers positive environmental outcomes while satisfying growing human needs for material inputs.

Determining the legacy of groundwater pollution in coastal ecosystems

Dr Douglas Tait

Submarine groundwater discharge may be one of the most important yet understudied components of coastal hydrological and nutrient cycles. With SGD now estimated to be 3-4 times that of river inputs into global oceans, understanding how SGD is entering coastal zones and the magnitude of solutes it transports is essential. Importantly, as pollutants can be stored for decades or longer in aquifer systems, determining when and in what form they may be delivered to sensitive coastal waters is necessary to properly manage these valuable ecosystems. My research uses novel natural tracer technology to quantify not only the volume of groundwater discharged to coastal waters, but also its contribution to coastal greenhouse gas, nutrient, carbon and pesticide budgets. For example, resent findings have shown that SGD in the Great Barrier Reef is responsible for 12 times the nitrogen and 3 times the phosphorous than riverine inputs. In other important coastal systems such as Sydney Harbour, the flux of SGD was found to be 120 times more than surface water inputs and is an important driver of powerful greenhouse gases such as methane and nitrous oxide. My work has also highlighted that the consequences of past farming related pollutants and pesticides in agriculturally developed parts of northern Queensland. With potentially decades of discharge to come before any current, more sustainable land use practices may take effect, the work shows that shifting management mitigation measures may be necessary.

Assessing the impacts of sediment-related stressors on coral recruitment

Gerard Ricardo, Ross Jones, Andrew Negri

The ability of coral reefs to recover following disturbances relies on the supply and recruitment of new coral individuals back to the denuded reef. However, a myriad of factors impact whether young corals are able to recruit, particularly for inshore reefs that are subject to higher levels of sediment and nutrient exposure. In this presentation, I will discuss new approaches used to manipulate sediment-related stressors such as suspended sediment, deposited sediment, light intensity, light spectra and algal interactions to derive thresholds and understand cause-effect pathways that may limit coral recruitment. This work will help assist reef managers which local stressors to monitor and manage, and provide insight into which inshore reef sites are optimal for future restoration work.

Sea level rise around Australian coasts using satellite altimetry data

Armin Agha Karimi

For a variety of reasons both scientific and socio-economic, sea level variation is a matter that is of great significance to humanity. Sea levels have been rising at a rate that has been accelerating over the last century. For obvious reasons, coastal areas are the most vulnerable when it comes to changes in sea level and in Australia, about 85% of the population live within 50km of the coast. My study used measurements from different satellite altimetry missions in combination with other data sources (tide gauge and climate indices) to investigate the variability of the sea level around Australia. The sea level trend is estimated as 3.82 ± 0.1 mm/year in the altimetry era, which is slightly higher than the global rate. However, regionally, the sea level trend in the northern coasts of Australia is considerably higher than the southern coasts, which shows the importance of regional sea level variation studies. The sea level trend in the tropical region of the study area accounts for double of the average sea level trend. Considering the low-lying and inhabited coral atolls in the western Pacific Ocean, this result is alarming in terms of soil erosion and even submergence of these islands in the near future.

Next - and end - user tools for the hazards of coastal extreme water levels.

Dr Julian O'Grady

Rising sea levels are placing more coastal assets at risk from inundation. To date, a static inundation approach referred to as the 'bathtub' model has been used to identify the coastal regions and infrastructure at risk from overland flooding due to storm tides (the combination of atmospheric-driven storm surge and astronomical tide) and rising sea levels. The bathtub approach suffers the disadvantage of; (1) not accounting for the time dependence of coastal flooding and hence the duration of flood events and (2) considering only the overland inundation and not the potential inundation that can occur due to backwater effects within underground drainage networks. CSIRO's DATA61 group have developed the CFAST modelling tool to address these shortcomings and in collaboration with CSIRO Oceans and Atmosphere are developing the capability to enable coastal practitioners to more realistically model the impact of sea level rise and storm tides on inundation. Extreme value analysis of storm tide water levels provide a design height for inundation studies. These extreme water levels can be added to the projection of changes in global mean sea level to investigate future extreme water levels. For dynamic modelling of inundation, a time series (not a single height) of water level is required to force the hydrodynamic model boundary. In this talk we will demonstrate the application of the CFAST hydrodynamic model to simulate the dynamic inundation.

Modelling future shoreline retreat under climate change for reef-aligned coasts

Oxana Repina, Dr Daniel Harris

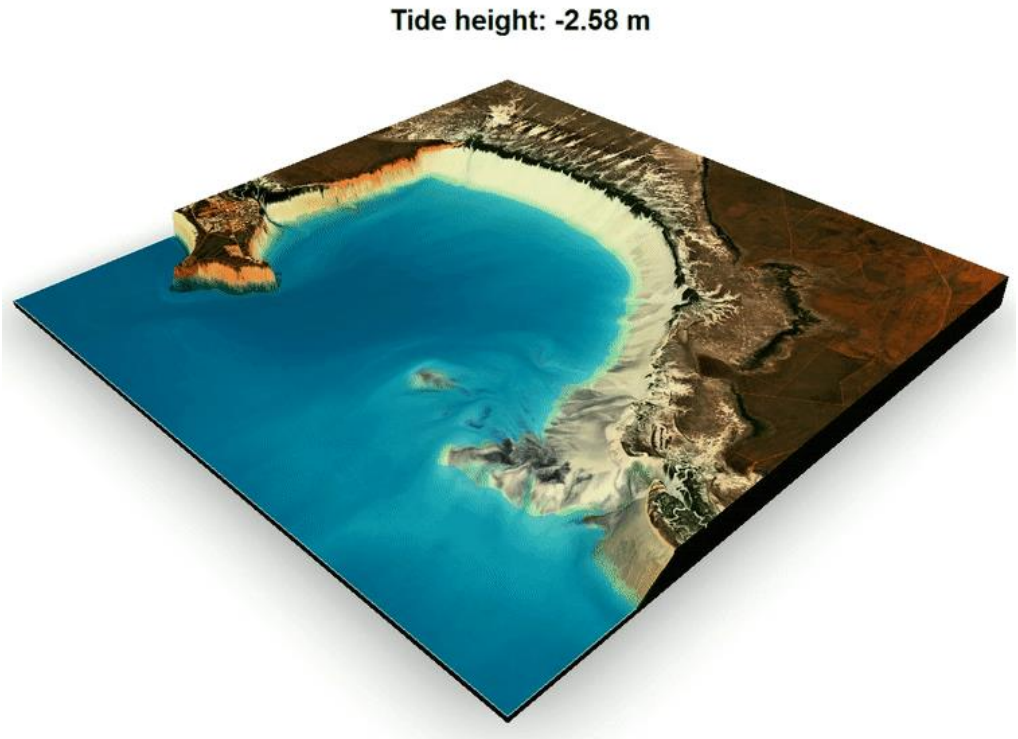
Under climate change, sea level rise is increasingly driving beach erosion world-wide (Vitousek et al., 2017). This puts coastal development at risk. This risk needs to be quantified to make appropriate decisions in coastal management. However, while beaches in New South Wales (nationally) and the USA (internationally) have been studied extensively, few concrete predictions of future shoreline retreat exist for beaches on tropical coastlines. In tropical Queensland, modelling has been undertaken by the Queensland State Government but relies on the Bruun Rule and assumptions that are not strictly valid for the characteristics of the area, and are thus likely to have *under*predicted the area prone to erosion.

This project instead proposes to transfer the approach of Wainwright et al. (2015), recently applied to the NSW coast, to tropical Queensland. The project will use the Shoreface Translation Model (Cowell et al., 1995) to model geomorphic change from sea level and sediment budget changes (i.e. the 'long term' component of erosion/shoreline change), and the JPM-PCR model (Callaghan et al. 2008) to model erosion from storms ('short-term' component) to assess the total 'erosion prone' extent to 2100 for Clifton Beach (Cairns), where development is within 50-100 m of the current shoreline. The models will be run probabilistically (Monte Carlo simulation) to allow for uncertainty in input variables (such as beach profile, final sea level, coastal sediment budget…) and produce the full range of possible erosion distances and their probability, rather than a single point estimate.

Modelling intertidal elevation and coastal change at continental scale using 30 years of satellite data

Bishop-Taylor, R., Sagar, S., Lymburner, L.

Coastal intertidal environments support important ecological habitats and provide many economically significant ecosystem services, but face increasing threats from coastal erosion, land reclamation, and sea level rise. Accurate intertidal elevation data is critical for studying and conserving these coastal ecosystems, however this data has to date been expensive and challenging to obtain across the intertidal zone of a continent the size of Australia. Here we present the first three-dimensional elevation model for Australia's entire coastline generated using satellite data from the 30-year Landsat archive managed within the Digital Earth Australia datacube. Our approach combines automated image compositing, tidal modelling and waterline delineation, allowing us to model over 15,387km^2 of intertidal terrain with accuracy approaching LiDAR across sandy beach and intertidal flat environments (< 40 cm RMSE). The resulting open-access National Intertidal Digital Elevation Model (NIDEM) addresses a key gap between existing elevation and bathymetry datasets, and supports new use cases that require a detailed understanding of the three-dimensional topography of the intertidal zone, such as hydrodynamic modelling, coastal risk management, and predicting the impacts of future sea level rise. We demonstrate how the analytical techniques underpinning NIDEM can also be combined to track coastlines consistently across time, potentially providing a powerful tool for identifying and monitoring hotspots of coastal erosion and change.



Plastic pollution challenges in coastal environments: new methods for assessment and management

Dr Isabel Jalon-Rojas

Coastal and marine environments are the ultimate destinations of man-made plastic debris. Plastic pollution is a threat to ecosystems, biodiversity, socio-economic activities, and human well-being. While ocean pollution has received considerable scientific and public attention, recent concerns focus on the coastal zone due to the proliferation of industries, aquaculture, agriculture, and domestic sewage. The aim of this presentation is to discuss the challenges and innovations necessary to understand, evaluate, and predict the transport, sources, and fate of plastic debris in coastal systems. Here, we review existing observational and modelling tools to deal with this problem, and develop new methodologies to track debris paths, such as observations from smartphones and an innovative numerical model. Our model is the first to consider the vertical movement of micro-plastic debris as a function of its physical characteristics, coastal physical processes such as resuspension and washing off, and biological processes affecting the transport of debris. Results from different model applications show there is a capacity to improve coastal management and restoration: from assessing environmental and economic risks to identifying the most relevant sources and the optimal removal locations. One of these examples is the real-case container spill off Newcastle (YM Efficiency ship). The modelled trajectories of floating debris reproduce the beaching patterns of the spotted debris accurately, showing the potential of this tool to forecast debris trajectories, understand the physical processes governing their transport, and plan the coast restoration.

A summary of the Coasts chapter of the 2016 Australian State of the Environment Report

Graeme F Clark, Emma L Johnston

Australia's coast is vast and diverse. It is the sixth largest of any nation, and contains a variety of habitat types, including sandy beaches and dunes, rocky shores, tidal flats, and estuaries and bays. Our coast is intimately linked to our national economy, industry, arts, social lifestyle and cultural identity, with more than 85% of Australians living within 50 km of the sea. We do, however, risk 'loving our coast to death', as its amenities and resource attract intense human use. Most of Australia's population growth is near the coast, and we rely on the coast for almost all our international trade. The coast is subject to pressures operating on a range of spatial and temporal scales, many of which interact. Now, more than ever, it is important that we understand the environmental consequences of how we use the coast, but significant gaps remain in our understanding of the state of coastal health. Urbanisation, agriculture and resource extraction have already modified much of the coast, and impacts associated with climate change are beginning to emerge. There is still much to protect, however, even in heavily modified ecosystems. Australia is also fortunate to retain large stretches of relatively untouched coast, containing ecosystems with exceptional natural values. This talk presents an overview of the Coasts chapter of the 2016 Australian State of the Environment Report, an expert-driven assessment of the state and trends of pressures and ecosystems of Australian coast, and the outlook for their future.

Achieving social licence for sustainable coastal management

Rachel Kelly, Dr. Aysha Fleming, Prof. Gretta T. Pecl

Coastal environments are complex and dynamic socioecological systems, where social perceptions of ocean stewardship are diverse, resource use is potentially unsustainable, and conservation efforts generally rely strongly on public support or acceptance. As a result, there is increasing consensus on the need to meaningfully include stakeholders and communities in marine planning and management. However, marine stakeholders and communities have diverse and disparate perceptions and relationships with the ocean, further complicating the marine socioecological system and attempts to manage our interactions within it. My research explores how the concept of 'social licence to operate' can be applied to improve community engagement and support for marine planning and management. In conducting qualitative research investigations, I reveal new insights on how marine citizen science can provide means to engage and incorporate community perceptions towards creating more equitable and socially-accepted coastal management. This knowledge is further expanded, to create a framework for developing social licence that aims to guide managers, decision-makers and stakeholders dealing with coastal conflict and opposition in Australia and elsewhere. Future efforts to achieve ocean sustainability will greatly benefit from incorporating community perceptions and other social dimensions of the ocean. Social licence presents a tool and frame through which to examine and understand these perspectives.

Enlarging the Coastal Imagination

Dr. Kim Satchell

Human impacts on the environment are the critical issues of the 21st Century. The increase of population worldwide and the accompanying scale of the industrial-military complex of developed economies are decimating biological diversity through extraction, exploitation, degradation and pollution. The consequences of anthropogenic climate change (changes to the atmosphere and rising temperatures caused by human activity) are already being experienced through extreme weather events from drought to unseasonal inundation, heat, cold, glacial melt and sea-level rise to such an extent that patterns of livelihood and habitation are facing unprecedented threats. What are the fundamental practices of place-making crucial for ecological integrity? What role might the environmental humanities play in communities of environmental practice and education? What are the imaginative approaches that promote ecological literacy and new environmentally aware publics? The future of coastal cultures and environments relies upon an enlarged coastal imagination encompassing a localised sense of place with an integrated view of bioregions and a wholistic sense of planet. The image of a blue ocean planet from space is a poignant reminder of the importance of oxygen, water and the ocean in the hydrological cycle that constitutes the conditions for life. Oceania has become a symbol for indigenous solidarity in the Pacific and more broadly for planetary belonging in the wider context of globalisation (interconnectedness of human fate). In this broader context there is a need for thinkers, designers and practitioners of a range of professions to integrate their plans to adapt to the changing circumstances and mitigate the legacies of the past.

Tsunami hazards in Australia: A probabilistic treatment for distant earthquake sources

Dr Gareth Davies

Although dozens of tsunamis have been observed historically in Australia, only a few were large enough to produce land inundation. Is it likely that larger land-inundation events will occur in future? Although Australia is located in the middle of a tectonic plate, more than 1000 km from nearby subduction zones, large subduction earthquakes have the potential to generate tsunamis with trans-oceanic destructive potential. For example, the 1960 magnitude 9.5 Chile earthquake-tsunami led to 61 deaths in Hawaii (11,000 km from the source) and 142 deaths in Japan (17,000 km from the source). Similarly, the 2004 Indian Ocean tsunami led to approximately 300 deaths in Somalia (5,000 km from the source). To facilitate a nationally consistent approach for understanding Australia's tsunami hazard from distant earthquake-generated tsunamis, Geoscience Australia recently revised the Australian probabilistic tsunami hazard assessment. This involved simulating over a million hypothetical earthquake-tsunami scenarios at the global scale, and estimating their occurrence rates using a combination of earthquake and tectonic observations. The tsunami scenarios were tested by comparison with 18 tsunamis observed in the deep ocean from 2006-2016. Uncertainties in tsunami return periods were quantified with a Bayesian approach. The study provides a nationally consistent source of deep-water earthquake-tsunami scenarios and return periods for tsunami inundation hazard assessment throughout Australia

Urban planning, Sustainable Development and Flooding: a case study of Port Harcourt city, Nigeria

Adaku Jane Echendu

Flooding is a serious problem that impacts on sustainable development globally and is a recurrent disaster in Nigeria. The cost of flooding is enormous with the psychological impact on its victims remaining long after the waters have receded. Climate change and poor planning have worsened flooding in recent years while some flooding like the one being experienced in Port Harcourt, Nigeria could be directly linked to urban planning. My research looks at the flooding problem in Port Harcourt, the capital of Rivers state which lies along Nigeria's coastline. The study adopted a qualitative approach and engaged primarily with urban planners to gain an insight into their understanding of sustainability and urban planning and the connection with the flooding being experienced in Port Harcourt. No prior research has engaged with urban planners in a similar study and this work contributes to filling this gap. Semi-structured interviews was the main method of data collection. Urban planners in the study understood sustainable development to be the main reason for planning and found it hard to separate the two concepts. The flooding was squarely blamed on poor planning practices prevalent in Nigeria which has seen floodplains being developed. Urban planners called for government support to carry out proper planning in line with the tenets of sustainable development and the provision of key infrastructure as a measure to curb the flooding and its attendant impact. The findings of this research will be of value to relevant stakeholders as they seek solutions to the flooding menace.

A conceptual framework for stakeholder engagement in floating housing co-production in Vietnamese coastal context towards disaster resilience and sustainability

Bao Ngoc Nguyen

With its 3260km long coast and 70% of its population living in coastal areas and low-lying deltas, Vietnam is one among five countries most exposed to climate change and sea level rise. Vietnamese coastal residents are most vulnerable to natural hazards especially in terms of housing. In that situation, floating house with its long-standing history could be a neat solution not only for dealing with natural disasters but also for remaining human livelihood and for preserving cultural tradition. There has been a certain number of studies on architectural and engineering facets of floating housing in Vietnam. Nevertheless, there is a lack of a systematic and/or multifaceted research on how to activate that unique type of dwelling practically, efficiently and legally in the local setting. This research proposes a conceptual framework of stakeholder engagement in housing co-production towards the best feasibility and sustainability that helps broaden the knowledge of the realm of these inter-discipline, multi-project and multi-stakeholder collaboration. The authors determine the six key stakeholders, i.e. the central government, the provincial government, the resident, the provider, the financing institution and the consultant, who are supposed to work collaboratively, constructively and proactively. This study not only emphasises how stakeholders interact each other to deliver good multidimensional practices and policies but also devises the way for continuous improvement over the course of implementation. The authors conclude with a reflection on possible obstacles and drivers in Vietnamese context with disaster resilience and sustainability emerged therein.

Staying cool: the importance of shade availability for tropical, estuarine ectotherms

Chun-Chia Chou

Understanding how changes in climate influence interactions between species and their habitats and how organisms mitigate the impacts of climate warming is one of the biggest challenges facing modern-day biologists. In estuary ecosystem, mangroves may possess an ecological function particularly associated with the thermoregulation of ectotherms: shades created by mangrove canopy provide a cooler microhabitat that potentially becomes a thermal refugia for tropical, estuarine ectotherms and is critical for the survival, activity level, and fitness of the organisms. Do shaded areas act as a refugia in terms of thermoregulation? Are there behavioural differences between individuals in the sun-exposed and shaded habitats? Do such differences have fitness consequences? This study evaluated the importance of shade availability in fiddler crabs, *Austruca mjoebergi*, by investigating temperature variation and behavioural responses (distribution, activity level, and time budget) in sun-exposed and shaded microhabitats. We showed that relatively low and stable temperatures in the shade allowed male fiddler crabs to stay longer on the surface compared to sun-exposed males, thus affording them benefits associated with longer feeding periods and more mating opportunities. We highlight the importance of shade availability for tropical, estuarine ectotherms, as a thermal refugia in the context of climate warming and advocate that the information incorporating the interaction between organisms and their habitats is necessary for developing effective conservation management policies. The finding also suggests that the impacts of global warming on the loss of ectotherms may be less dire if land managers protect and increase shade areas.