THE UNIVERSITY OF SYDNEY

Geography Honours Projects

Honours project topics and supervisors available for 2020

Faculty of Science, School of Geosciences

Contents

Dr Naama Blatman-Thomas

Who I am

I am a lecturer in urban geography with expertise in multi-disciplinary research and multi-site ethnographies. Previously a visiting academic and adjunct lecturer at James Cook University, I undertook various research and teaching positions at the school of social sciences. I hold a PhD in Politics and Government from Ben-Gurion University in Israel and an MA in Sociology and Anthropology from Tel-Aviv University in Israel. Prior to my academic work, I worked for many years in human rights organisations in Israel/Palestine. In my academic work, I endeavour to apply research as a way of advancing justice in cities and beyond and contributing to dismantling colonial structures of dispossession that are prevalent in our societies.

Why you should talk to me about Honours

I am an interdisciplinary and comparative urban ethnographer whose research focuses on questions of dis/possession, land, mobilities, identity and human rights in settler-colonial cities in Israel/Palestine and Australia.

The core of my academic engagement is urban colonialism, specifically the histories, realities and future reconfigurations of settler-colonial cities. I am interested in how settler colonial urbanisms took (and still take) form in Israel/Palestine and Australia, how Indigenous people have coped with and resisted these forms of urban oppression and what kinds of futures can emerge from these pasts and presents that are principally decolonial.

The majority of my work has been carried out with two Indigenous communities -- Palestinian citizens in the north part of Israel (the Galilee) and Aboriginal and Torres Strait Islander people in north Queensland. While I maintain strong connections to both these spaces, I have recently begun collaborating with Aboriginal groups in the greater Sydney area.

Another focus on my academic life is localising and decolonising teaching and learning in human geography and considering the role of geographers in decolonising universities more broadly. To that end, I collaborate with stakeholders in the faculty and across the university to develop and include new tools, approaches and methods that emphasize Indigenous intellectual sovereignty as key to accessing geographical knowledge, concepts and data.

HONOURS FOCUS AREAS: Urban colonialism including but not limited to structures and dynamics of racial capitalism, gentrification and housing inequalities, dis/possession and politics of place-making and reclamation by Indigenous peoples and their allies. I am particularly interested in supervising students whose research interests are embedded in a strong critique of global inequality. While especially keen to work with students who are interested in Israel/Palestine and/or Australia, am happy to supervise work in other geographical areas.

How to contact me

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Associate Professor Eleanor Bruce and Dr Kevin Davies

Who we are

Associate Professor Eleanor Bruce

I am a physical geographer. My research interests focus on the geographical dimensions of coupled human-environment systems and how spatial models can be used to examine drivers of environmental change. This has involved investigating biophysical coastal process response to climate variability, landscape change detection and the role of participatory mapping and Volunteered Geographic Information (VGI) in monitoring environmental change involving collaboration with local conservation management authorities, government agencies and UNESCO.

The nexus of water-energy-food security is integral for ensuring climate compatible development. My recent work as part of an interdisciplinary collaboration has focused on methods for incorporating sustainable livelihoods within these nexus relationships. This has involved using spatial modelling and remote sensing to assess environmental livelihood security (ELS) in coastal environments of the South Pacific.

Dr Kevin Davies

My research focuses on the use of satellite remote sensing, geospatial analysis, and GIS to improve our understanding of geographical issues. My current research includes satellite-based land use mapping and geospatial data collection for improving livelihoods and natural resource management in the Pacific Islands. I also investigate the use of CubeSats for landscape monitoring as part of the University's SpaceNET project.

Why you should talk to us about Honours

HONOURS PROJECTS:

1. **Spatio-temporal patterns of coastal slatmarsh and mangrove biomass**

Mangroves and saltmarshes are major sources of organic carbon that are important for global strategies to mitigate global warning. Global degradation and loss of these critical ecosystems have reduced organic carbon stocks potentially increasing release of CO_2 into the atmosphere. In addition, the ability of tidal communities, such as mangroves, to transgress inland under changing sea levels, will also impact on these environments. In urban environments, such as Sydney, coastal squeeze resulting from development pressures reduces the lateral space (accommodation space) for transgression of mangroves and other intertidal ecosystems. Assessing above ground carbon in mangrove and saltmarsh areas requires fine scale measurement of biomass. In the absence of detailed systematic field surveys, satellite and UAV borne sensors can be used to characterise patterns of aboveground biomass.

Current understanding of how saltmarsh and mangrove biomass varies across fine spatial and temporal scales and the drivers behind these trends is limited. This research project would contribute to methods for characterising spatio-temporal variability in biomass estimates in saltmarsh and mangrove communities in the Sydney Harbour and Parramatta River using ultra high-resolution UAV data, broader scale satellite imagery and field survey. This project presents an opportunity to work closely with industry partners involved in UAV and satellite data capture (Arbour Carbon) and other marine research institutes.

Research partners: ARC Training Centre for Cubesats, UAVs and Their Applications (CUAVA), Arbor Carbon, UWA Oceans Institute & Australian Institute of Marine Science (AIMS)

http://ww.cuava.com.au/

2. Coastal ecosystem services, Tonga

Susceptibility to climate variability and extremes is acutely felt by many natural resource-dependent coastal communities of the South Pacific. Livelihood and food security in these environments are inextricably linked with coastal ecosystem health. Focused on mangrove ecosystems, this project would involve the use of Earth observation data to examine the influence of biophysical interactions operating in inter-tidal environments on local livelihood and food security in Tongan coastal communities. This would potentially involve integrating remotely sensed indicators of ecosystem status and qualitative information on subsistence usage patterns, fishing activities and land use practices, to investigate key socio-ecological system interlinkages and beneficiaries of coastal ecosystem services.

Funding is available to support field travel.

https://livelihoodsandlandscapes.com/fiji-and-tonga/

3. Mapping coastal seagrass ecosystems using high resolution remote sensing

Extensive meadows of seagrass in shallow coastal waters provide important ecosystem services that directly or indirectly benefit human needs, particularly in the stabilisation of nearshore sediments and as nursery grounds for commercial fish species. Previous research has shown that the spatial patterning and species present within seagrass meadows can influence the ecosystem service flows from these environments. For example, do well established meadows vs. areas comprising smaller colonising species provide habitat characteristics that support commercially important fish or stabilise sediments? There has been no systematic review of seagrass ecosystem service provision in the South Pacific. High resolution bathymetric (LiDAR) data and satellite imagery (Digital Globe) are available that cover extensive seagrass meadows in the nearshore area of Tongatapu, Tonga. Spatial modelling and remote sensing-based research on these coastal seagrasses can provide valuable insight on species composition, benthic substrates and other variables that influence the ecosystem service contributions for local communities.

Funding is available to support field travel.

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Dr Emma Calgaro & Professor Dale Dominey-Howes

Who we are

Dr Emma Calagaro

I am a human geographer specialising in disaster risk reduction, vulnerability, and resilience. My research explores the drivers of vulnerability and resilience in the coupled human-environment system with a regional focus on South-East Asia, Australia and the South Pacific.

Taking a systems approach, my current work explores two fundamental questions designed to advance greater inclusion of minorities in the disaster space:

1) what does inclusion means in the context of DRR and;
2) what steps - including knowledge generation and sharing, processes and practices - are needed to make Inclusive DRR a lived reality.

Professor Dale Dominey-Howes

I'm a Geographer by training with expertise in environment & society in relation to hazards,

- disasters and risk
- My work spans the interface between the human and earth environments/sciences - exploring the characteristics of natural hazards and their impacts on people, communities and human systems
- My socially oriented work examines risk knowledge and perception, action and inaction and policy planning and implementation
- The goals of my work are to *develop appropriate disaster risk reduction strategies*; *enhance community resilience*; and *reduce losses from natural disasters*.
- I also have expertise, skills and interest in coastal geoarchaeology with a regional focus on the east Medierannean Sea region, and Greece in particular. My own PhD research involved the reconstruction of ancient disasters impacting coastal archaeological sites and over the years I have continued research in collaboration with colleagues, friends and former research students. I welcome the chance to continue such research in the future!

Why you should talk to us about Honours

Dr Emma Calgaro

My research interests include:

- Human dimensions of environmental change and risk responses
- Theoretical approaches in vulnerability research and sustainability science with an emphasis on contextual influences on change in the coupled human-environment system
- Linkages between culture and risk
- Disability, risk, equity and resilience

- Inclusion in disaster risk reduction in theory and practice
- Natural hazards and disaster risk reduction, with an emphasis on tourism and the coastal zone
- Climate change adaptation, with a focus on coral reefs and climate change impacts on tourism livelihoods in Asia and the South Pacific
- Building resilience and adaptive capacity to change
- The politics of aid and change
- Geographies of scale, place, and temporality and their application to sustainability science and development

Professor Dale Dominey-Howes

My interests are:

- Society & Environment interactions in relation to Natural hazards (tsunami, storm surges, tropical cyclones, volcanic eruptions, earthquakes & climate change) and Disaster & risk management (hazard, risk and vulnerability analysis, (re-) insurance, coastal and urban policy, emergency management planning and principles)
- Marine and coastal geology / coastal processes (coastal evolution and change, contemporary shoreline processes, sea level change, Quaternary environments / palaeo-environmental reconstruction)
- One Health (interactions between natural environmental, human and socio-economic and animal systems)
- Climate change, adaptation and policy (with specific focus on the Pacific Islands and in tourism)
- My expertise and research techniques include:
- Hazard, risk, vulnerability and resilience assessment
- Social dimensions of risk and vulnerability (including questionnaire surveys, focus groups, perception studies); complex coupled human-environment systems
- Policy sciences & governance
- Epidemics, pandemics & One Health, and
- Earth System Sciences (including geology and physical geography).
- At the present time, I am involved in a variety of research projects focusing on hazards and risk in Australasia, the Indo-Pacific region and further afield in conjunction with members of my research group and international colleagues.

HONOURS FOCUS AREAS: Natural hazards; disasters, disaster risk reduction; vulnerable people; coupled human-environment systems interactions; people with disabilities; sexuality & gender – in relation to disasters; Australia, SW Pacific; SE Asia

1. Industry sponsored/embedded Honours opportunities in natural hazards with Molino Stewart

Supervisors: Dr Filippo Dall'Osso (Senior Natural Hazards Analyst – Molino Stewart Ltd) and Professor Dale Dominey-Howes

Molino Stewart (**https://molinostewart.com.au/**) is a flood, natural hazard, ecological and environmental consulting company based in Sydney. Their core expertise includes environmental and ecological assessment and management, plus all aspects of flood, bushfire and other natural hazard risk management.

For over two decades Molino Stewart has been helping private and public sector clients navigate complex environmental, ecological and natural hazard challenges, so they can achieve their desired objectives in the most cost-effective manner.

Project topics:

The following industry-sponsored Honours research projects are available for the right candidate commencing S1, 2020:

1. Vulnerability of utility networks to cascading impacts from natural hazards
2. Better ways of estimating flood damage to take into account velocity as well as depth data
3. Woronora River flood education intervention – effectiveness evaluation 20 years on
4. Relative vs absolute risk indexes: are relative indexes sufficient for effective risk planning and, if not, how can these be approximated to absolute indexes?

Why take an industry-based embedded Honours research topic/project?:

There are a number of advantages to taking an industry sponsored/embedded Honours project. These include:

- Direct experience working on an industry relevant topic
- Value added skills development including in a business-oriented environment
- Networking and job seeking opportunities
- Enhanced cv track record
- Potential for further career development options (subject to the right candidates' performance and available possibilities)

For expression of interest, please contact Professor Dale Dominey-Howes in the first instance.

NOTE – these projects will still be administered in the standard ways through the university system

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Dr Rebecca Cross

Who I am

I am a postdoctoral researcher in the School of Life and Environmental Sciences and a lecturer in Human Geography in the School of Geosciences. My research interests are founded in rural geography and sociology at the nexus of human/nature interactions, with a focus on natural resource management, regenerative and sustainable agriculture, farming sub-cultures, local knowlegde and citizen science, Indigenous land and food knowledge, grass-roots innovation, agroecological extension and social research methodology. My main focus is on documenting local knowledge, local narratives and local innovations to better understand the social and ecological functions that underpin sustainability and regenerative capacity of livelihoods and communities in rural, regional and remote Australia.

Why you should talk to me about Honours

Environmental conservation and agricultural production are often perceived to be competing land use objectives. Integrating production and conservation via innovative land management techniques (such as strategic grazing, pasture cropping and cool burns) with a focus on native grasses and plants is proving to be both profitable and enjoyable for land managers. Local innovation, local knowledge and local socio-cultural dynamics that influence sustainable land management and sustainable use of species are key to socio-ecological adaptation and resilience building across regional, rural and remote landscapes. I have been an transdisciplinary researcher on a number of projects that focus on these themes.

I also have a strong interest in developing cultural competence in science pedagogy and has been involved in a number of research and teaching initiatives within the Science faculty via the Wingara Mura-Bunga Barrabugu program. The development of AGEN 3008 Indigenous Land and Food Knowledge, the Field-site Communities project (which aims to foster collaboration between Traditional owners and Usyd farms) and the Grasses for Grains project (which aims to explore synergies between native grass management, local Indigenous knowledge and native grass food products) are particular examples.

HONOURS FOCUS AREAS: Developing remote sensing products to enhance irrigation efficiencies: stakeholder needs analysis with the Birchip Cropping Group (some funding available); Mapping networks and knowledge sharing among freshwater fishers in NSW for improved river health; Native grasses for grains: aligning Indigenous aspirations and capacities in the Narrabri region; The impact of carbon farming on local socio-cultural dynamics in the NSW rangelands

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Dr Bob Fisher

Who I am

I am an anthropologist. My PhD research was a study of human ecology, focusing on strategies for adapting to drought in the Thar Desert in Rajasthan. I specialise in social and political ecological aspects of natural resource management, particularly involving community forestry. After working in Nepal with the then Nepal-Australia Forestry Project in the late 1980s, I taught at the University of Western Sydney, Hawkesbury, before becoming Deputy Director of the Regional Community Forestry Training Center in Bangkok from 1997 to 2001. I am currently a Senior Lecturer in the School of Geosciences and a Senior Researcher with the Mekong Research Group.

Recent publications include "Linking Conservation and Poverty Reduction: Landscapes, People and Power" (Fisher et al, 2008. Earthscan) and the edited volume "Adaptive Collaborative Management of Community Forests in Asia: Experiences from Nepal, Indonesia and the Philippines" (Fisher et al 2007, CIFOR).

Why you should talk to me about Honours

I specialise in social and political ecological aspects of natural resource management, particularly involving community forestry. I have carried out research or consultancies in a wide variety of countries, including Nepal, India, Mozambique, Iran, Kyrgyzstan, Mongolia, Papua New Guinea, Pakistan, Thailand, Laos, Vietnam, Cambodia, Liberia and Ghana. I aim to combine theoretical and applied interests and have a strong interest in action research.

HONOURS FOCUS AREAS: Natural resource management (especially forests), REDD+, development geography, SE Asia, Africa or PNG

How to contact me


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Dr Jo Gillespie

Who I am

I am an environmental legal geographer interested in the complex intersection of geography and law. My research investigates environmental protection and human environment geographies throughout Australia and the Asia-Pacific.

Why you should talk to me about Honours

My research explores the ways in which law and geography collide to shape our world. It uncovers how regulatory frameworks both enable and disable people environment-place interactions. My work untangles how law, as a place-making device, is contingent upon situated human and physical geographical conditions.

My research explores:

- Environmental law and governance regimes
- The role of ENGOs in environmental litigation
- Protected areas, with a focus on world heritage and wetland management
- Environmental justice, legal geography, political ecology
- Environmental ethics and environmental (human/non-human) rights

HONOURS FOCUS AREAS: Environmental governance, management, law and ethics; Protected areas, national parks, world heritage places, wetlands; Role of environmental NGOs; Environmental human rights, justice, stewardship and land ethics

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Associate Professor Kurt Iveson

Who I am

I am primarily interested in the question of how social justice can be achieved in cities. Within this broad interest, my previous research has focused on two main areas. First, I have examined the significance of the urban public realm for citizenship and democracy. This has included looking at contests over different uses of urban public space, including the politics of protest, graffiti writing, cruising, hanging out, and outdoor advertising. Second, I have explored how urban planning might work better to achieve social justice in cities. In particular, I have considered the ways in which planners should conceptualise, and respond to, different forms of diversity in the city.

Why you should talk to me about Honours

My current research is focused on the governance of the outdoor media landscape (from graffiti to government notices, shop signage and outdoor advertising), and on the spatial politics of urban informatics systems (with a particular focus on their implications for privacy and urban citizenship).

HONOURS FOCUS AREAS: The privatisation of public space in Sydney; Post-amalgamation local government in Sydney – sites of urban citizenship

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Professor Phil McManus

Who I am

I am a Professor of Urban and Environmental Geography. I am a human geographer with interests in sustainable cities, environmental issues and human/animal relations.

Why you should talk to me about Honours

My current research focuses on sustainable cities, transport infrastructureand representations of nature in the construction of a range of environmental issues. Within the area of sustainable cities I am researching the use of metrics such as Ecological Footprints and migration issues such as the tree-change phenomenon in Australia. My research on nature includes human-animal relations, particularly thoroughbred breeding and the uses of nature. My work combines urban environmental history with policy and planning research that is future-oriented.

HONOURS FOCUS AREAS:

Challenges of urban sustainability, in Sydney and elsewhere; Human-nature interactions; Urban environmental histories

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Dr Jeff Neilson

Who I am

I am a geographer focusing on economic geography, environmental governance and rural development in Southeast Asia, with specific area expertise on Indonesia.

Why you should talk to me about Honours

I am currently leading a five-year research project examining the livelihood impacts of farmer engagement in value chain interventions across Indonesia. This research is contributing to cutting-edge international debates on the development effects of sustainability and certification programs, Geographical Indications and direct trade initiatives. My team collaborates with non-government organisations, development agencies, governments and the private sector to address the global challenge of poverty reduction. Research findings are contributing to a global shift within value chain sustainability programs towards an enhanced service delivery function and greater sensitivity to the livelihood priorities of rural households. This research project is also contributing to conceptual developments in global value chain theory, including the opportunities for regional development to be stimulated (or not) through engagement with the global economy.

I am a fluent Indonesian language speaker and have conducted extended periods of ethnographic field research in the Toraja region of Sulawesi, where I pursue research in cultural change, landscape history, the ceremonial economy and oral poetic traditions.

My research interests are diverse and include issues of food security and food sovereignty, the global coffee industry, the global cocoa-chocolate industry, agrarian reform movements, sustainable livelihoods and alternative measures of well-being, agroecology, and environmental governance.

HONOURS FOCUS AREAS:
Environment and development in Southeast Asia; Global value chains, development and smallholder farmers; The future of the global coffee and chocolate industries

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Associate Professor Dan Penny

Who I am

My research is focussed on environmental histories and reconstructions. My work takes place in a variety of contexts both throughout the global tropics, particularly mainland Southeast Asia and central America, and throughout Australia. A key emphasis of my work is to understand the response of human communities to environmental change. For well over a decade I have studied the environmental history of medieval cities in Cambodia, particularly the world-famous city of Angkor. I have recently expanded this work to the Maya cities of central America.

Why you should talk to me about Honours

My work feeds into understanding how the past can tell us more about the future. Through environmental reconstructions we can better understand many current environmental challenges.

I apply expertise in palaeo-botany and sedimentology to document the response of ecosystems to climatic variability and human activities over long periods of time. The aim of this research is to reveal the complex mechanistic interaction between the biosphere (including humans) and the atmosphere in order to better understand the Earth System.

HONOURS FOCUS AREAS: paleo-environmental change; biogeography; palynology

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Professor Bill Pritchard

Who I am

I am Professor of Geography and Head of School, specialising in agriculture, food and rural places. What drives me is an interest in the ways that global and local processes are transforming places, industries and people's lives. I did my PhD at the University of Sydney looking at the ways that rural communities were coping with the restructuring of food processing industries and after a period of time working for a community organisation and in the NSW Premier's Department, I re-joined the University of Sydney as a lecturer. My work transcends several complementary key themes. I'm interested in understanding the globalisation of food systems by using global value chain methods to document processes of social and environmental change across sites of agricultural production and sites of food consumption; the changing patterns of rural land ownership and use in Australia, and the impacts of rapid socio-economic and ecological change on systems of food production and consumption within India.

Why you should talk to me about Honours

Talk to me if you have an interest in the ways that we are changing our uses of the planet for agriculture, and how this impacts on people and communities. I have a major research project currently in partnership with the NSW Department of Primary Industries on the issue of who is buying and selling rural land in the State, and what this means for rural communities. I also have strong ongoing research interests in India, especially relating to food systems, food security and climate change. But I'm also open to topics beyond my funded research activities. If you have interests broadly in the area of human geography with a focus on the interplay of economic and environmental systems, talk to me.

HONOURS FOCUS AREAS: Any geographically-relevant issue relating to India; rural change in Australia; global value chains and economic geography.

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Dr Sophie Webber

Who I am

I am a human geographer, who conducts research about the political economies of climate change and international development assistance, principally in South East Asia and the Pacific region. In conducting this research, I draw insights from economic, environmental and urban geography.

Why you should talk to me about Honours

My previous Honours students have worked on projects related to climate change, adaptation and resilience, and international development. Since graduating, they have gone on to work in activism and advocacy, and government policy-making, and have published their Honours theses research in international journals.

I am interested in supervising Honours students working on topics including climate change adaptation and resilience, the politics of climate science and climate finance, market-based environmental governance and policy, international development including evidence-based policy making, and Southeast Asia and the pacific regions.

HONOURS FOCUS AREAS: Climate change adaptation and resilience; The politics of climate science and climate finance; Market-based environmental governance and policy; International development, including evidence based policy in international development; SE Asia and SW Pacific regions

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Associate Professor Jody Webster

Who I am

My research in sedimentology and stratigraphy focuses on carbonate sedimentology, climate change, and tectonics and it tends to take me to all the beautiful places in the world (e.g. the Great Barrier Reef, Tahiti, Hawaii, Papua New Guinea, Seychelles, Brazil).

I am particularly interested in coral reef and carbonate platform systems, both modern and ancient, and their associated sedimentary systems; as tools to address fundamental questions in paleoclimate variability and tectonics, and in turn the influence of these factors on the geometry, composition and evolution of these sedimentary systems.

Why you should talk to me about Honours

My research is multidisciplinary nature, encompassing traditional elements of sedimentology and stratigraphy, combined with the novel use of marine geology and geophysics, GIS, paleobiology, paleoecology, and geochemistry (stable isotopes, trace elements, radiometric dating). I am also heavily involved in several large international research programs including the Integrated Ocean Drilling Program (IODP) which is focused on recovering sediment cores from the sea bed to understand past sea level and climate changes. I am also investigating reef growth sea level and palaeoclimate histories in the Southern Great Barrier Reef.

HONOURS PROJECTS:

1. **Vertical motions of the Tasman and Coral Sea: possible link to Ontong Java Plateau collision?**

Supervisors: Maria Seton & Jody Webster

The collision of the world's largest Large Igneous Province, the Ontong Java Plateau (OJP), with the Melanesian Arc is proposed to have caused subduction polarity reversal along the South Solomon Trench, leading to a cascade of events such as a change in direction of the Australian plate, ore-deposit formation along the Melanesian Arc, and possibly a reorganisation of the entire plate-mantle system. Although this major tectonic event is well-recognised in the literature, determining the timing of plateau accretion is difficult as three independent approaches (palaeomagnetics, marine geophysics and onshore geology) yield timings that differ by over 30 million years.

In this project, you will use a novel and multi-disciplinary approach to explore the far-field effect of this collision on the vertical motions of the submarine seamounts and ridges in the Tasman and Coral Seas. You will integrate age and paleo-environment data from recently collected sedimentary samples and construct alternative plate kinematic models of the OJP collision in GPlates. The reconstructions will be fed into geodynamic models of mantle structure and the dynamic topography predictions will be compared to your paleo-environmental data. This project involves collaboration with colleagues from the University of Wollongong.

2. Multi-core parallel tempering for extending BayesReef for modelling reef growth on geological timescales

Supervisors: Rohitash Chandra & Jody Webster

Estimating the impact of environmental processes on vertical reef development in geological timescales is a very challenging task. This is due to complex models and data with missing information. py-Reef Core is a vertical reef growth simulation model for geological timescales. BayesReef has been proposed to estimate and provide uncertainty quantification for py-Reef Core which features environmental condition parameters. BayesReef features limitations when the size of the problem increases due to computational requirements in sampling and hence only a few parameters were estimated. Parallel tempering (PT) is an advanced MCMC method suited for irregular and multi-modal distributions. Moreover, PT is more suitable for multi-core implementations that can speed up computationally expensive geophysical models. The Honours research project extends Bayeslands using parallel tempering to estimate dozens of parameters on a synthetic reef core dataset.

3. HALO - Halimeda bioherm Origins, function and fate in the northern Great Barrier Reef

Supervisors: Jody Webster, Luke Nothdurft (QLD University of Technology) & Robin Beanab (UQLD)

Calcareous green alga Halimeda is a major contributor to coral reef shelf sediments and is found along the entire Great Barrier Reef (GBR), Australia. Previous studies of extensive Halimeda deposits, or bioherms, show they represent important inter-reef habitats and potential carbon sinks in the GBR Marine Park, covering ~26% of the northern shelf, equal to the modern coral reef system. Pioneering work in 70-80s indicate the bioherms are in depths of ~20-40 m forming linear ridges and flat-topped mounds ~20 m thick.

However, new bathymetry data reveals a completely different picture of their morphology, characterised by complex reticulate (honeycomb-like) shapes and covering an area >3X original estimates. These new findings confirm the Halimeda bioherms are much larger and more complex than previously thought – challenging existing paradigms as to their origin, development and significance. We will study these enigmatic features, building directly on a recently funded (US$2.5 mill) RV Investigator cruise scheduled for May-June 2020. We will conduct high-resolution multibeam mapping, subbottom profiling, sediment coring and innovative seabed/habitat imaging (AUVs, ASV, ROV). This will increase our understanding of the fundamental processes that control bioherm development, and have direct implications for environmental managers tasked with predicting how these poorly studied inter-reef environments might respond to future climate change.

Note: multiple opportunities exist to join the voyage on the RV Investigator next year and then undertake post cruise research on the data and samples as part of your hons, Mphil or PhD project(s). The HALO project is also funded by an $150,000 grant from the Ian Potter Foundation to support pre- and post cruise activities and science.

4. Death by a thousand cuts: understanding the role of paleowater quality (high sediment & nutrient flux) in the growth and demise of the Great Barrier Reef over the past 30,000 years

Supervisors: Jody Webster, Dirk Erler (Southerb Cross University) & Greg Webb (UQLD)

Exp. 325 revealed that the Great Barrier Reef (GBR) had a complex and dynamic history of reef growth and demise over the past 30 kyr, characterized by five distinct reef sequences. Reef death occurred in

two ways: subaerial exposure caused by sea-level fall or due to rapid sealevel rise and associated environmental changes. Previous work highlighted the importance of high sediment flux and poor water quality, rather than abrupt sea-level rise alone, in ultimately determining reef demise. The objective of this project is to investigate the role of paleowater quality (sediment and nutrient flux) had in controlling the evolution of the GBR over the past 30 ky. We will investigate fossil coral reef material for IODP Expedition 325 (Great Barrier Reef Environmental Changes) to: (1) reconstruct a unique, high-resolution record of sediment and nutrient flux to the reef using a suite of geochemical proxies (major trace and rare earth elements, nitrogen isotopes); and (2) relate the changes in paleowater quality to changes in reef communitie s, accretion and bioerosion, that ultimately led to reef demise. This project will greatly improve our understanding of the critical environmental thresholds that led to reef demise in the past and how reefs recovered after disturbances on different spatio-temporal scales.

Note: this project is funded by new ANZIC IODP Legacy grant to support analyses on the fossil core reefs cores.

5. The origin of the Great Barrier Reef – when, where and why?

Supervisors: Jody Webster & Greg Webb (UQLD)

The origin of the Great Barrier Reef is still shrouded in mystery. The when, where and why of how this iconic reef system turned-on is still very poorly understood. You will integrate new and existing sedimentologic, biologic, geochemical, and chronological data sets from a unique suite of fossil reef cores from the GBR (Ribbon Reef 5, Boulder Reef) to explore the past evolution of the GBR in response to major global climate and environmental changes. Using a suite cutting edge analytical techniques, combined with a quantitative paleoecologic approach, will test a range of hypotheses put forward to explain the turn-on of the GBR (sea level, SST, sediment influx, upwelling etc). This will provide new insights into how the GBR ecosystem evolved over past 700 ka.

6. The lives and deaths of the Great Barrier Reef – combining data & models to understand the evolution of Australia's iconic reef

Supervisors: Jody Webster & Tristan Salles

Predicting how the Great Barrier Reef (GBR) will respond in the face of future global climate changes is both poorly constrained and controversial. This relates to our incomplete understanding of how reef systems respond to environmental changes but also the lack of baseline data — particularly on centennial to millennial time scales. The study of the evolution of the GBR over past 500-600 ka can provide unique insights about how this iconic reef system responded to abrupt and major environmental changes over a range of spatio-temporal scales. In this project, you will integrate existing sedimentologic, biologic, geochemical, and chronological data sets from a unique suite of fossil reef cores from the GBR. Then you will use sophisticated modelling software (pyReef-Core) that predicts core stratigraphy, facies, and reef communities, in combination with innovative data sciences tools (BayesReef - bayesian inference computational algorithm) to optimize model inputs/parameters, to explore the past evolution of the GBR in response to major global climate and environmental changes.

Note: this project is part of the new DARE ARC ITTC and fully funded PhD scholarships are available to suitable candidates.

7. The last coral reef frontier - quantitative geomorphology of the modern Coral Sea reefs

Supervisors: Jody Webster & Tristan Salles

High-resolution LADS bathymetry data from southern Great Barrier Reef showing reef and inter-reef areas (data source **http://www.hyrdro.gov.au/aboutus/lads/lads.htm**)

The project will investigate new and existing high-resolution remote sensing data (LIDAR & multibeam bathymetry data, aerial photographic imagery) to understand the main processes controlling the geomorphic variation of reef and associated environments in the largely unexplored reefs of the Coral Sea. Using advanced GIS and 3D visualization tools, we will develop a new quantitative morphologic characterisation of the reef and inter-reef areas (ie. terraces, banks, sediment wedges, channels, shoals, sand wave/dunes). We will also explore the relationships between the benthic habitats/sedimentary facies, the quantitative geomorphic data and physical processes operating in the Coral Sea. This project could also incorporate sophisticated new numerical reef model tools (pyBadlands, pyReef) under development by the GRG. The project will have implications for improving our understanding modern reef environments and processes as well enhancing our knowledge of ancient carbonate platforms.

8. Controls on the Holocene evolution of the Great Barrier Reef: linking 4D numerical mod eling and observational data

Supervisors: Jody Webster & Tristan Salles

This project will investigate the relationship between biological and geological processes controlling the evolution (stratigraphic ages, residence times and geometries ('architecture') of coral reef systems. We will construct new 4D numerical models using state of the art software (eg.,pyBadlands, pyReef) and compare them against observational reef data sets from the Great Barrier Reef that grew during the Holocene (9,000 years to now). We aim to assess the sensitivity of coral reef systems to various environmental stresses (eg. sea-level rise, subsidence and sediment flux) acting on different timescales, magnitudes and rates. The project may also involve field work to One Tree Reef in the southern GBR to calibrate model parameters and processes against real world sedimentary and biological examples.

Note: this project is part of the new DARE ARC ITTC and fully funded PhD scholarships are available to suitable candidates.

How to contact me

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Associate Professor Ana Vila-Concejo

Who I am

My career started in Spain, where I did my undergraduate and MSc studying urban estuarine beaches at the University of Vigo; and Portugal, where I completed my PhD at the University of Algarve investigating the short and medium term evolution of tidal inlets in a barrier island system. Then I moved to Australia and started looking into the morphodynamics of flood-tide deltas in wave-dominated coasts within the framework of an ARC funded linkage project which was based in Port Stephens. In 2010 I started researching the morphodynamics of sand aprons in reef platforms. In 2011 I was awarded an ARC Future Fellowship to continue the studies in the dynamics of coral sands. I am the Deputy Director of One Tree Island Research Station; between 2012 and 2015 I was the Director.

Why you should talk to me about Honours

I am interested in the contemporary processes and morphodynamics of coastal systems. I am a keen fieldworker and have experience in acquiring and processing hydrodynamic, topographic and bathymetric data. I have also worked with fluorescent tracers for studying sediment transport processes. I also use Geographic Information Systems (GIS) as a tool to analyse recent and present data.

HONOURS PROJECTS:

1. **Morphologic evolution of the rubble cays at One Tree Reef**

Supervisors: Ana Vila-Concejo & Tristan Salles tristan.salles@sydney.edu.au

One Tree Reef in the Southern Great Barrier Reef has two rubble cays: One Tree Island is located on its SE corner, and Two Tree Island is located on its NE flank. They are both composed of unconsolidated sediment that is deposited under high energy conditions. We have a collection of remotely sensed images that can be used to determine the decadal evolution of the islands; we also have some annual measurements taken over the last few years using state-of-art techniques such as real time kinematic positioning systems and structure from movement remote sensing using kites. This project encompasses analysing the decadal and annual evolution of One Tree Island in relation with the wave climate and cylonic events.

2. **What is special about beaches in estuaries and bays?**

Supervisors: Ana Vila-Concejo & Shari Gallop (U Waikato, NZ)

Despite the ubiquitous distribution of beaches in estuaries and bays, little is known of the short to long term morphodynamics of these systems when compared to open coast environments. The fact is that they are often taken as small-scale versions of their oceanic counterparts. However, recent research shows that they behave in different ways and that the key to their behaviour seems to reside on the ratios of the different types of energy (swell waves; wind waves; infragravity energy; tidal currents) that they

receive. In this project, the student will survey the hydrodynamics and topography of estuarine beaches in the Sydney region, including Sydney Harbour, Botany Bay and/or the Pittwater estuaries, and will determine the processes inciting geomorphic change and evolution of these systems.

3. What will happen to Sydney's beaches with climate change? How can we prepare?

Supervisors: Ana Vila-Concejo & Shari Gallop (U Waikato, NZ)

This project involves monitoring of beaches on selected Sydney Eastern suburbs including Bondi Beach. The student will measure the topography of selected beaches monthly and after storms. One question relevant to 2019 is why do the beaches have so much sand? The students will analyse topographic and video data from 2015 until present to quantify the processes that control sediment deposition. Analyses of longer data series of wave climate will allow to compare those years with past erosive states like, for example 2011. Where is the sand coming from? Where will it go? And what are the conditions that will trigger erosion again? Most importantly, this research aims to quantify sand management approaches to adapt to climate change.

4. Estuarine beaches of Sydney Harbour: what's going on in Rose Bay?

Supervisors: Ana Vila-Concejo & Tristan Salles

Natural oyster reefs were extinct from NSW estuaries in the late 20th century. But some of them survived and are still going. While scientists still don't understand why some reefs have survived, we suspect that the physical and sedimentary processes exert some control in whether they survive or not. Oysters are being used all over the world to remediate contaminated estuaries. With our research we want to understand the following:

- What ranges of physical and sedimentary processes, allow oyster reefs to thrive
- What are the effects that oyster reefs have on the sediments
- What are the effects that oyster reefs have on physical processes such as wave and current attenuation

This research is part of collaborative research with Marine Biology. This is a new, interdisciplinary, line of research that started in 2018.

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