ARI

Australian Rivers Institute

MAGAZINE
Issue 3

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Griffith UNIVERSITY
Queensland, Australia

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DIRECTOR'S WELCOME

Professor Stuart Bunn

We welcome you back to another edition of the Australian Rivers Institute (ARI) Magazine. Over the past few months our staff have been active in strengthening research partnerships and establishing new connections across the globe. The importance of connections, not only with fellow researchers, industry and government but also across ecosystems, forms a central theme of this edition of the Magazine.

Associate Professor Anik Bhaduri has recently returned from India, where the Sustainable Water Future Programme hosted its first international conference, opening up new opportunities for partnership with Future Earth South Asia and the Indian Institute of Science. The Global Wetlands Project (GLOW) team has recently partnered with the Global Mangrove Alliance, strengthening our global reach and impact in coastal wetland management. My recent appointment as a member of the Earth Commission, hosted by Future Earth, also provides an exciting opportunity to further our engagement in international water management and policy.

Several of the articles showcase our 'Source-to-sea' philosophy and why it is important to consider the ecological and physical linkages between catchments, rivers and coasts. The 'Building Catchment Resilience' project, supported by The Ian Potter Foundation, brings together researchers, industry and government to develop innovative tools to guide investment in catchment rehabilitation and in doing so provide considerable environmental and economic benefits downstream. We also showcase some of the work we are doing to reduce land-based pollution and improve water quality in the Great Barrier Reef catchments.

We explore the 'grand challenge' of balancing water needs for humans and nature. Our work in the Northern Australia Environmental Research Hub is featured, highlighting the important linkages between river flows, estuaries and the fisheries and birdlife they sustain, and the implications of water resource development for agriculture. Professors Fran Sheldon and David Hamilton discuss the recent review of the water sharing plan for the Barwon-Darling River system and Fran further explores the broader issues of large-scale water diversion schemes in an opinion piece on the 'Bradfield Scheme'.

We trust you enjoy the third edition of the Magazine and hope it connects with you in some small way.

'Our 'source-to-sea' philosophy is showcased in this edition of the Magazine, with several articles highlighting the importance of the ecological and physical connections between catchments, rivers and coasts'

NEWS

Review of the Barwon-Darling River Water Sharing Plan

Professor Fran Sheldon has recently conducted an independent technical review of the Water Sharing Plan of the Barwon-Darling unregulated and alluvial water sources.

The report was prepared at the request of the New South Wales Natural Resources Commission, after the mass fish kill events experienced in the Barwon-Darling River early in 2019, and the continued drying of remnant pools along the entire river system.

The report outlines the importance of protecting low flows for ecosystem health in the Barwon-Darling as well as the necessity of improved hydrological modelling and ecological monitoring to help water managers make more informed decisions.

Fran hopes that the recommendations from the report will be incorporated into a revised Water Sharing Plan, and that with greater protection of low flows, the ecosystem health of the Barwon-Darling will start to improve.

For more information go to page 7 in this edition.

ARI Director Stuart Bunn Appointed Earth Commissioner role

Australian Rivers Institute Director Stuart Bunn has been appointed by Future Earth as an 'Earth Commissioner'. He joins 19 other world leading scientists to address risks and targets to regulate the earth's stability.

The Earth Commission is taking steps towards establishing global and regional scientific targets for a stable planet, including land, water, oceans and biodiversity, alongside climate.

The commission identifies that human activity has placed unprecedented pressure on the earths natural resources and habitats. Tangible scientifically backed targets are required to guide further human development to limit stresses on land, biodiversity, freshwater and oceans. Developing these targets is the goal of the Earth Commission.

The Earth Commission will immediately begin synthesising scientific knowledge on the major biophysical processes that regulate earth's stability and develop targets to ensure this stability. Finalisation of this is expected by 2021.

New Grant helps save Nemo from the lab

An Australian Research Council Linkage grant was awarded to ARI Professor Fred Leusch and Dr Jason Van de Merwe, to fund a major new project, *Saving Nemo: Reducing animal use in toxicity assessments of wastewater*.

The project seeks to develop alternatives to the current method for testing wastewater toxicity on living organisms with newer methods that are more cost efficient and, importantly, not tested on animals and thus more ethical.

'It is very important that we assess the toxicity of wastewater discharges, to ensure they do not pose a risk to living organisms, including humans, in the receiving environment,' Leusch said.

However, current methods for testing typically involve exposing live animals, including fish, to varying levels of toxicants in a laboratory.

'In Australia, the toxicity of wastewater discharges is done by Direct Toxicity Assessment (DTA), which consists of taking a sample of the wastewater and exposing a variety of living organisms, including animals such as fish, to the wastewater,' Leusch said.

'We want to replace the animals with more ethical cell-based bioassays, which can determine how toxic a water sample may be to living organisms but without having to kill any animals.'

Cell-based bioassays are increasingly being used for water quality monitoring by researchers. This project takes the next step by bringing together researchers from ARI-TOX (ARI's Toxicology Research Group) with industry (Melbourne Water, Sydney Water, Logan City Council and Water Research Australia) and government departments (Victoria's Environmental Protection Authority, South Australia's Environmental Protection Agency, and the Queensland Department of Environment and Science) to demonstrate how these tools can be applied in a regulatory framework.

'We are hoping to produce data and protocols that will empower environmental regulators to accept these emerging tools, which will enable the water industry to better understand and manage the risks associated with wastewater discharges,' Leusch said.

The benefits of the research in producing a successful and accurate result for testing water are apparent. They ultimately mean researchers can soon begin collaborating with regulators and water professionals on a new Australian regulatory framework to replace whole-animal testing with cell-based bioassays.

In addition, the new approach is much more cost efficient than testing on live animals, which will allow more frequent monitoring and thus a greatly improved assessment of potential environmental impacts.

Building Catchment Resilience

The Australian Rivers Institute, in partnership with The Ian Potter Foundation, has launched the 'Building Catchment Resilience' project.

Innovative digital planning and visualisation tools have been designed to explore realistic scenarios of the catchment, to facilitate discussions with investors and the community, and guide investment that maximises the benefits of catchment works in terms of flood mitigation, biodiversity, water quality and waste assimilation.

The project builds on many years of collaborative research in the region, which has determined the causes of the problem and the most effective on-ground actions to address them. The tool is being developed and demonstrated in the Laidley Catchment in Southeast Queensland, including an on-ground research and monitoring component. Once proven, the tools will be developed to use in other catchment settings, nationally and overseas.

The Building Catchment Resilience project is supported by a $1M grant from The Ian Potter Foundation, with additional funding and in-kind support from government, industry and research partners. The consortium members are:

- The Ian Potter Foundation
- Australian Rivers Institute, Griffith University
- Queensland University of Technology (QUT)
- Queensland Government
- Water Technology
- Queensland Urban Utilities
- Seqwater
- Port of Brisbane
- Healthy Land and Water
- SEQ Council of Mayors
- Lockyer Valley Regional Council

For more information about this project go to page 19 in this edition.

GRAND CHALLENGES

CHALLENGE 1

BALANCING WATER NEEDS FOR HUMANS AND NATURE

Tale of floods and droughts

By Professor Fran Sheldon

Australia is known for its contrasting weather. This year alone we have seen flooding in the North and continued drought in the South.

The Situation

Flooding in Australia's north has contributed to the deaths of around five hundred thousand cattle, while the situation in Australia's south has led to vast areas of the Murray Darling Basin drying up, contributing to mass fish kills.

Ironically, the same devastating rain that flooded the north also triggered an agricultural and ecological boom across the inland areas of northern and southern central Australia.

The boom in the north, however, contrasts with increasing 'bust', or drought, in the south-east. The drought, which is continuing to tighten its grip, is causing widespread environmental and socio-economic damage. Many farmers have already de-stocked and there is little hope of growing crops as storage reservoirs in the northern Murray-Darling Basin are the lowest on record.

Ecologically we have seen mass fish kill events across many systems and the cost of the continuing drought is probably not yet fully realised.

The Solution?

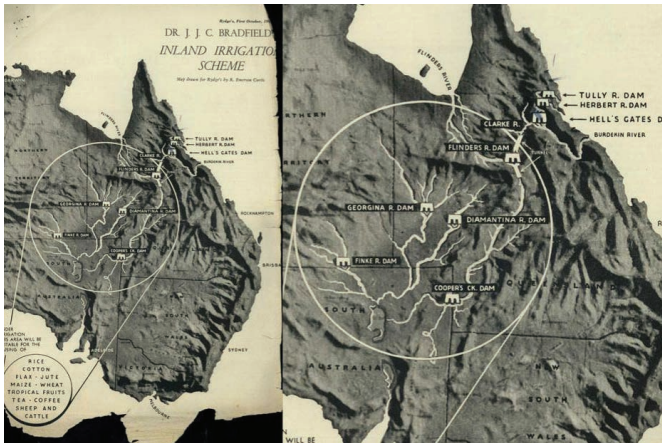
At times like this the apparent inequity of water distribution across the Australian continent gives rise to discussions on large-scale water redistribution projects. One famous example, that gets media attention every time the south is in drought as the north floods, is the Bradfield Scheme and its various derivations. It is an ambitious combination of dams, pumps and channels that would see water captured and diverted from the north and redistributed to fuel agriculture in the south.

When Bradfield type schemes are discussed, the economics of such schemes are usually touted as the main prohibitive factor in their development, with environmental impacts coming second and often thought to be offset by the predicted benefits of increased agricultural production.

Unfortunately, the environmental impacts of such projects would be catastrophic for both the northern rivers, which would be donating water for agricultural production in the south, and for the inland rivers, which would be receiving the water.

There are three myths that emerge every time the Bradfield Scheme is raised:

1. Water flowing north to the sea is wasted: NO—this water carries vital nutrients into the Gulf of Carpentaria and the Coral Sea. These nutrients are vital for near-shore marine productivity. The water from the headwaters (where flow would be diverted) is also vital for the lower floodplains of the rivers, and any diversions in the headwaters would be catastrophic for the lower reaches of these northern rivers.
2. Diverting water inland would change the climate in inland Australia producing more rain: NO—climate models have been used to estimate the impact of a full Lake Eyre (and its rivers) on local climate. The impact is marginal or non-existent (Hope et al. 2004).
3. The cost would be repaid through agricultural production: NO—all estimates have the costs of constructing a Bradfield type scheme in the tens of billions of dollars; way more than any resulting agricultural production could repay.



CREDIT: Map Drawn for Rydge's by R. Emerson Curtin.

'Unfortunately, the environmental impacts of such projects would be catastrophic for both the northern rivers'

Hope, P.K., Nichols, N. and McGregor, J.L. (2004) The rainfall response to permanent inland water in Australia. Australian Meteorological Magazine 53:251–262
Nilsson, C., Reidy, C.A., Dynesius, M. and Revenga, C. (2005). Fragmentation and Flow Regulation of the World's Large River Systems. Science 308: 405–408

What about the often-neglected environmental impacts?

Globally, most rivers have had their flow regimes changed through flow regulation (Nilsson et al. 2005) and these alterations can cause large-scale impacts. For dams, upstream and downstream impacts include inundation of the land and river ecosystem upstream of the project to fragmentation and de-watering of the river downstream. These impacts change the migration pathways of fish and other vertebrates and affect dispersal of a range of flora and fauna, impacting populations and in some instances causing extinction.

The Bradfield Scheme proposes capturing water in the northern rivers and diverting it inland. These northern rivers include the tropical rivers that drain eastwards into the Coral Sea, their flow fuelled by predictable and relatively frequent rainfall, and the rivers of the wet-dry tropics that drain west and north into the Gulf of Carpentaria. These are more hydrologically variable, they have a distinct wet season when their flows are fuelled by monsoonal rains, and a dry season with no rain when they dry back to isolated waterholes.

These rivers are currently some of the last remaining unregulated rivers in Australia, and indeed the world. Diverting water from them would cause ecological destruction, flooding of terrestrial land in their upper reaches and fragmenting and dewatering of their lower reaches.

The ecological destruction would be just as great for the inland rivers that would receive the water. The fauna and flora of these inland flowing rivers are adapted to boom and bust cycles, reflecting their highly variable hydrology. Creating permanent flow in these systems would be just as ecologically catastrophic as removing water from their northern neighbours.

It is time in Australia that we accepted the vagaries of our climate and stopped trying to even its variability. The rivers of southern Australia are in extremely poor condition due to over exploitation of a variable water resource.

The solution to remedying the water crisis in the south, however, is not to create one in the north, but rather manage our southern rivers to better cope with the droughts when they come, as they always will.

Key Messages:

- Water flowing north to the sea is wasted: NO—this water carries vital nutrients into the Gulf of Carpentaria and the Coral Sea.
- The cost would be repaid through agricultural production: NO—all estimates have the costs of constructing a Bradfield type scheme in the tens of billions of dollars, way more than any resulting agricultural production could repay.
- The solution to remedying the water crisis in the south, is not to create one in the north, but rather manage our southern rivers to better cope with the droughts when they come, as they always will.

Understanding the links between river flows, estuaries, shorebirds and fisheries

Professor Michele Burford has been leading a cross-institutional research team studying the links between the rivers in the Gulf of Carpentaria and coastal productivity that supports fisheries and migratory shorebirds.

The rivers of the Gulf are likely to be threatened by intensive water resource development (dams, irrigated agriculture etc.) and climate change. Professor Burford's project aims to quantify the importance of a range of river flows to flood-driven estuary production, with environmental and economic implications.

The natural flows and flooding of the rivers help support diverse aquatic life, and any changes to flows created by water development may affect fish and prawn stocks in estuaries and coastal areas, as well as endangered species such as migratory shorebirds. A reduction in stocks impacts the economy (commercial fisheries, tourist fishers) as well.

The team's research on the Flinders, Gilbert and Mitchell Rivers in the Gulf of Carpentaria is supporting water planning, fisheries management and shorebird conservation through increasing the understanding of the links between river flows, estuaries and ecosystem assets such as migratory shorebirds, prawns and fishes.

The team have so far sampled prawns and water quality in the three rivers. Their analysis has shown that the drop in salinity in estuaries during the wet season removes a lot of the food supply, and drives prawns out into the offshore fishery—highlighting the importance of river flows.

Also examined were the algae and animals living in the estuarine mudflats. These systems are very productive and provide an important food source for prawns, shorebirds and other aquatic animals. Our partners in the project, the Carpentaria Land Council Aboriginal Corporation (CLCAC) and Queensland Wader Study Group (QWSG), are also counting migratory shorebirds at the three estuaries to provide key information on this important habitat. The final year of work will involve filling in knowledge gaps, analysing data and providing information critical for water planners. At the completion of the projects there will be a greater understanding of these systems and how they respond to flow and how water development may impact on environmental and economic assets (fisheries).

This research is funded by the Australian Government's National Environmental Science Program (NESP). The NESP's Northern Australia Environmental Resources Hub brings together scientific expertise from various institutions to develop research projects that support the sustainable development of northern Australia.

Project partners

- Australian Rivers Institute
- CSIRO
- Queensland Government
- Charles Darwin University
- Northern Territory Government
- Carpentaria Land Council Aboriginal Corporation
- Queensland Wader Study Group

Photo Credit: Professor Michael Douglas

AN ECOSYSTEM IN DISTRESS: THE NEED TO PROTECT FLOWS AND ENHANCE ECOSYSTEM RESILIENCE IN THE BARWON-DARLING RIVER

By Professors Fran Sheldon and David Hamilton

The NSW Natural Resources Commission has now released its final report on the review of the Water Sharing Plan for the Barwon-Darling Unregulated and Alluvial Water Sources 2012.

The Barwon-Darling Water Sharing Plan sets rules on the flows required in the river before extraction can commence. It uses three types of licenses: A Class (access to the more frequent low flows), B Class (access to higher flows contained within the channel) and C Class (access to larger flows and floods). Setting the access rules in the Water Sharing Plan effectively means setting the minimum environmental flow requirements for maintaining a functional Barwon-Darling ecosystem. The minimum flows are critically important to avoid unnatural drying of riverine pools and reaches, and to prevent catastrophic loss of species. A new Water Sharing Plan is due in 2023. However, rapidly deteriorating environmental conditions in the Barwon-Darling River, including mass fish kills, drying pools and social stress, have triggered an early review of the 2012 rules.

For the Barwon-Darling Water Sharing Plan, flow data have been modelled to extend over all gauges and management zones for 1895–2009. The model requires key input data, including surveys of river cross sections and comprehensive flow records, to validate the accuracy of flow predictions. In a river like the Barwon-Darling, where the channel is composed mostly of silt and clay, large floods can move this material around, resulting in changes in channel cross-sectional area and inability to validate flow predictions. Hydrologists refer to this process as 'non stationarity' and it requires regular channel measurements before data can be deemed reliable.

Lack of comprehensive modelled data for 2010–2019 for the Barwon-Darling river greatly increases the uncertainty of assessing environmental impacts from the 2012 Water Sharing Plan rule changes and modelling for this period is urgently needed.

In the absence of modelled data we can still use other 'lines of evidence' to understand flow changes and potential environmental impacts. We know that the current cease-to-flow period in the Barwon-Darling is the longest on record and longer than any cease-to-flow period in two of the three previous significant droughts (World War II Drought: 1939–1945 and Millennium Drought: 2001–2009), but similar to that recorded for the Federation Drought (1895–1903). We also know that the fauna and flora of the Barwon-Darling are not typical of a river that frequently dries.

The long-term record and modelled 'pre-development' flows suggest that there was river flow in the Barwon-Darling at Wilcannia 94% of the time. As climate becomes more unpredictable, balancing the needs of the environment with those of extractive industries is essential. For the Barwon-Darling, and other inland rivers, protecting the low flows is not only critical for environmental assets, but it can also protect infrastructure and livelihoods. If the Barwon-Darling River below Bourke continues to dry, we will lose not only iconic river mussels and fish but also the thin margin of old river red gums along the river banks, which are in deteriorating condition and vulnerable to collapse. These trees form the riparian zone of the Barwon-Darling and many are hundreds of years old. They perform a key ecosystem service of holding the riverbanks together and reducing erosion through their extensive root networks. Without them, when the large floods return, as they will, the erosion of the banks will likely send millions of tons of sediment down the Darling River towards the River Murray, with widespread impacts.

'If the Barwon-Darling River below Bourke continues to dry, we will lose not only iconic river mussels and fish but also the thin margin of old river red gums along the river banks'

GRAND CHALLENGES

CHALLENGE 2

TACKLING LAND-BASED WATERWAYS POLLUTION

Great Barrier Reef recovery interventions— are we on target?

Climate change and poor water quality are placing unprecedented pressures on the Reef. It is imperative that these stressors are eased to provide the reef with the opportunity to recover.

The Situation

Protecting the Great Barrier Reef (GBR) from poor water quality is a major goal for both state and federal governments—both have committed to major land management reforms in the GBR region. Current targets are to reduce sediment and nutrient loads on the reef by implementing 90% of 'best management practice' in agricultural areas near the GBR by 2025.

Sediment and associated nutrients eroded from the land could have adverse impacts on the GBR. Researchers know adopting 'best land management practices' can significantly reduce the amount of sediment delivered to the reef. One way of reducing sediment delivered to the reef is managing the activity of gullies.

Photo Credit (page 8 and 9): Matt Curnock. Support for the aerial footage was provided by TropWATER JCU, the Marine Monitoring Program - Inshore Water Quality through the Great Barrier Reef Marine Park Authority, the Queensland Government, the Landholders Driving Change project led by NQ Dry Tropics, CSIRO and the National Environmental Science Program Tropical Water Quality Hub.

The Solution

Implementing best management practice systems in grazing lands is expected to reduce gully erosion by 25% compared to conventional practices. Reducing erosion from gullies provides an opportunity to make significant inroads on the water quality improvement targets.

Gullies often form in areas dominated by grazing activities, where land disturbance and limited groundcover from vegetation can leave soil exposed, increasing the potential of erosion during rainfall periods. While it is known that land-use practices such as managing stocking rates will reduce erosion, what is not well understood is how long it takes for changes in land management practices to translate into observed reductions in the sediment load.

The Research

There is little doubt that over time implementing 'best management practices' will lead to the reduction in sediment nutrients being delivered to the coastal zone. Given that the reef is already showing the negative effects of climate change and poor water quality, it is important to understand whether the current pace of action is sufficient to protect the reef in the short-term. The Queensland Government and the Australian Government aim to achieve a reduction in end-of-catchment sediment and particulate nutrient loads arising from human activities by 25% and dissolved inorganic nitrogen loads by 60% by 2025[1]. These targets are designed to improve water quality immediately around the reef.

ARI member and Queensland Water Modelling Network Fellow Dr Melanie Roberts, working in collaboration with Rob Ellis from the Department of Environment and Science, are investigating the potential impact of improved land use management practices on the end-of-system sediment loads due to gully erosion. Results from this study will inform decision-makers on the scale and pace of action that needs to be taken to improve water quality of the GBR, and help to communicate the time scale for water quality improvements.

A period of 1 July 1986 to 30 June 2014 has been used to simulate the benefits of improved land use management practices. As an example, if 90% of the Bowen River catchment were managed according to 'best management practices', gully erosion would be reduced by 12.4% across the full 28-year simulation. If, however, benefits are delayed for 5 years, only a 7.5% reduction in erosion is achieved.

A delay of just five years in seeing the benefits of improved land management practices could be equivalent to missing the target for land managed under best practices. A more detailed assessment is going to be made inclusive of range of climatic and landscape scenarios, thereby providing a robust decision support tool.

Project Partner

Melanie Roberts thanks the Queensland Government for their support through the Queensland Water Modelling Network (QWMN) Fellowship. The QWMN aims to improve the state's capacity to model its surface water and groundwater resources and their quality.

Key Messages

- Climate change and poor water quality are placing unprecedented pressures on the reef, and it is imperative that these stressors are eased to provide the reef with the opportunity to recover.
- Delaying the introduction of 'best land management' practices could mean state and federal governments miss their sediment reduction goals in the GBR region.
- Implementing 'best management practice' in grazing lands is expected to reduce gully erosion by 25% compared with standard practices.

'Implementing best management practice systems in grazing lands is expected to reduce gully erosion by 25% in comparison with standard practices'

[1]Australian and Queensland Governments. (2018). Reef 2050 Water Quality Improvement Plan 2017–2022, 1–56.

The importance of improving water quality—the connection between Wetlands and the Great Barrier Reef

The 2019 Great Barrier reef Outlook Report identified the risk of nutrient runoff from catchments for the reef as 'Very High'. This report corroborates with other reports on water quality of coastal ecosystems, identifying that many are under pressure from high nutrient loads from agriculture and urban runoff.

Improving land use management to reduce nutrient run-off, alongside limiting fertiliser application and better timing its application to prevent nutrient runoff, will be essential for governments to meet targets for coastal water quality. However, often the natural environment is overlooked for its ability to remove nutrients before they reach coastal environments.

Coastal wetlands act as a natural filter, removing nutrients from waterways, and preventing their discharge into coastal regions. Currently the Great Barrier Reef Report Cards do not account for the ability of wetlands to remove nutrients. This is a current knowledge gap, and studies of tropical coastal wetlands extending to catchment scale are scarce.

Dr Fernanda Adame led an ARI team alongside collaborators in Queensland Government's Department of Environment and Science, who recently tested whether natural coastal wetlands in a tropical catchment (the Tully-Murray) in North Queensland could remove substantial nitrogen exported to the Great Barrier Reef during a flood event. Denifrication rates were measured in different coastal wetlands (mangroves, saltmarshes, waterbodies with macrophytes, and floodplain wetlands dominated by *Melaleuca* spp.) to assess the potential contribution to nitrogen loss during a 6-day flood in March 2018.

Denitrification is the main process associated with permanent removal of nitrogen from an ecosystem as it transforms nitrate into nitrogen gas. The measured denitrification rates where used in a model that includes the main biogeochemical processes affecting nitrogen transformations within wetlands (nitrification, denitrification, plant uptake, sedimentation, and mineralisation), and accounts for transport via the duration, depth, and flow of water.

Results show that wetlands can remove nitrogen from floodwaters, and therefore prevent them reaching the reef. This is important as it highlights the protective value that wetlands offer to the Great Barrier Reef. These results should be taken into consideration when developing management plans for Great Barrier Reef recovery and protection.

The model simulation indicated that flood inundation of large areas of natural wetlands (>40% of the catchment area) could potentially remove 70% of the incoming nitrate loads in the first 24 hours of the flood.

Nitrogen removal was variable across the landscape and 'denitrification hotspots' were identified in sub-catchments with high nitrate concentrations and large areas of wetlands; over half of the sub-catchment inundated during the flood. Protected national park wetlands in river mouths are the most effective areas at removing nitrate during flooding.

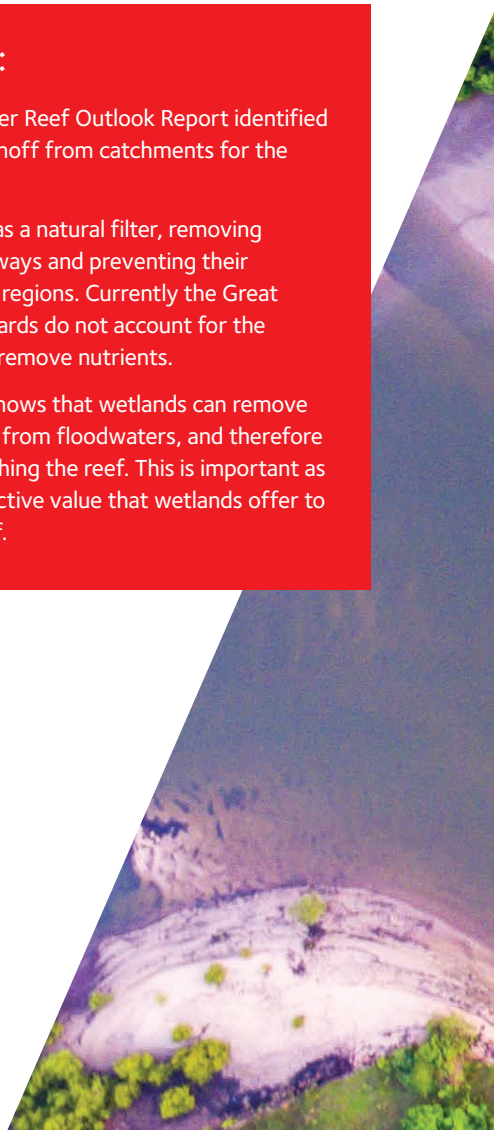
Tropical coastal wetlands appear to have a key role in reducing the export of nitrate to coastal zones during floods, and their restoration and management could improve the health of coastal and marine ecosystems. By better mapping the potential for wetlands to remove nitrogen during flooding events, we are paving the way for wetlands to have a role in protecting the Great Barrier Reef.

Project partners

- ARI: Fernanda Adame, Melanie Roberts, David Hamilton, Jing Lu
- Department of Environment and Science Wetland Team.

Key Messages:

- The 2019 Great Barrier Reef Outlook Report identified the risk of nutrient runoff from catchments for the reef as 'Very High'.
- Coastal wetlands act as a natural filter, removing nutrients from waterways and preventing their discharge into coastal regions. Currently the Great Barrier Reef Report Cards do not account for the ability of wetlands to remove nutrients.
- The team's research shows that wetlands can remove considerable nitrogen from floodwaters, and therefore prevent nitrogen reaching the reef. This is important as it highlights the protective value that wetlands offer to the Great Barrier Reef.



Impacts of chemical contaminants in waterways

By Professor Frederic Leusch

The Situation

Our chemical industry is thriving. From a growing register of pharmaceuticals, an ever-expanding arsenal of pesticides, and an increasing array of personal care and industrial applications, modern day society is firmly grounded in the synthetic chemistry age.

The Chemical Abstract Service, which assigns a unique identification number to each chemical, receives an average of 15,000 new chemical registrations a day, a new chemical every six seconds.

There are clear benefits to the availability of some of these chemicals, however, what impact is our chemical heavy lifestyles having on the environment? We are using extraordinary quantities of chemicals every day, and the vast majority end up in our waterways. Herbicides wash off our driveway, fertilisers wash off our field in rainwater runoff, and industrial compounds, personal care products and pharmaceutically active ingredients end up in wastewater discharges. We can now detect caffeine and the artificial sweetener acesulfame in almost every river water sample, even at 'pristine' sites.

Studies have also detected perfluorinated acids, a class of industrial compounds, in rainwater. The active ingredient in the birth control pill, a compound called ethinylestradiol, has been found in rivers worldwide at concentrations that can cause feminisation of male fish. A wide range of human contaminants have been found in fish tissues, including metformin (a diabetes medication), fluoxetine (the active ingredient in Prozac), diazepam (the active ingredient in Valium), antibiotics, caffeine, the insecticide DEET, amphetamines, and on and on.

The Impact

The ecological impacts of these chemical contaminants is often poorly understood and the effects of pharmaceutical active ingredients in particular have proven difficult to assess. We now know that chemicals can have different effects on different species. The active ingredient in the medication Prozac for example, which in humans helps treat depression, can cause fish to become more bold and risk-taking. Conversely, metformin, a drug prescribed for diabetes in humans, decreases aggression in male fish.

The majority of our chemical contaminants end up in our waterways ... so that Ibuprofen you took last night (and excreted this morning), the triclosan in your antibacterial soap, the simazine from your weed-free driveway, and the caffeine from your 5 am coffee all end up together in the same river.

Wildlife is exposed not to one, but to a complex cloud of organic, inorganic, thermal and microbial contaminants. Understanding the way these complex mixtures interact and affect living organisms is very difficult, and site specific.

The Response

So, how do we move forward?

First, we need to better understand the risks and prioritise actions.

We must develop high-throughput methods to test real water samples containing real mixtures of contaminants—not individual compounds, tested one by one. These high-throughput methods need to be ethical—we can't continue to conduct toxicity testing on animals such as fish and other creatures.

Recently ARI-TOX has received funding from the Australian Research Council to apply these techniques to test the toxicity of wastewater, in a paradigm called Effect-Based Monitoring (EBM). These tools will help us understand which contaminants pose the biggest risks, and allow us to focus our attention where we should. But, we also need to understand our role in this.

We can no longer look at wastewater treatment plants as a "source" of these contaminants to our waterways—they are simply a "pathway" and remove as much of these contaminants as their design allows. We are the source.

We ingest, use, and release these chemicals into the environment. It is time that we took a closer look at how we can reduce our environmental footprint, and start encouraging companies to assess the full impact of the chemicals they produce, at all stages of their life cycle.

Protecting our waterways against excessive levels of chemicals, reduces water filtration costs helps protect biodiversity and protects the fisheries and tourism industry. Let's be honest, nobody wants to eat chemically loaded fish or water.

Key Messages:

- The use of chemicals in our daily life is unprecedented and we need to be mindful of what we expose ourselves and waterways too.
- Limiting chemicals in our waterways reduces water filtration costs, helps protect biodiversity, the fisheries industry and tourism industry.
- Fish and other creatures that utilise waterways are exposed to multiple chemicals throughout their lifecycle and the reactions in species to chemical compounds varies greatly and can have severe impacts on varying species.
- The active ingredient in the birth control pill, a compound called ethinylestradiol, has been found in rivers worldwide at concentrations that can cause feminisation of male fish.

New research method assessing chemical impacts on marine life

The new ARI-TOX group is utilizing a novel method to further understand the impact agricultural pesticides and other pollutants in runoff is having on marine life.

Dr Jason van de Merwe and the team at ARI-TOX have begun utilizing a unique way to test the chemical impacts and toxicity on iconic marine life including such animals as dolphins, whales and turtles. The method is performed without ever harming the animals being tested, an important ethical metric that the team wanted to meet.

'We are establishing cell cultures for various marine wildlife species as part of a Sea World Research and Rescue Foundation grant. The team is building a 'Marine Wildlife Cell Culture Bank' that will initially have 25 different cell cultures from 10 different species,' said Dr van de Merwe.

Small tissue samples are collected from animals in the wild, many of which are being examined as part of other research within the ARI-TOX group or with Griffith Universities partners from Sea World and Australia Zoo.

From these tissue samples, cells are cultivated back at the laboratory. Once cultivated they are exposed to various chemicals to assess the effects on the cells.

'We know very little about the effects of chemicals in larger animals like turtles because we can't easily bring them into the lab to conduct traditional toxicity testing,' Dr van de Merwe said.

'But we can establish their cell cultures in the lab by adding very small tissue samples to the right media under the right conditions, and waiting for the cells to start growing. This gives us a large, growing cell culture which we can keep frozen until we are ready to use them in cell-based toxicity tests.'

'We expose the cells to chemicals of interest, and measure the response of the cells. This provides important information that enables us to understand the effects of those chemicals in these large, often threatened animals.'

Cell-based testing is commonly used when determining human health risks, but typically when determining toxicity of chemicals in animals, tests are performed on whole animals. However, this method has become ethically problematic and scientists have begun shifting towards testing predominately on cell cultures. These new cell based culture experiments happen to also lower costs of testing —so the new method is cheaper and more ethical.

The ARI-TOX team and Dr van de Merwe also recently published research which looked at pesticides in the Mon Repos beaches in south-east Queensland, this area is a major nesting site for turtles and tourist destination. The team hopes to expand on this research through their newly developed cell culture method, and determine what harm these pesticides are having on baby turtles hutching from Mon Repos' beaches.

'Our novel and ethical approach to toxicity testing in marine wildlife will generate a greater understanding of how the chemicals we use affect them, which will contribute to their conservation and management' said Dr van de Merwe.

Key Messages:

- Cell-based testing is commonly used when determining human health risks, but typically when determining toxicity of chemicals in animals tests are performed on whole animals.
- This method has become ethically problematic and scientist have begun shifting towards testing predominately on cell cultures. These new cell based culture experiments happen to also lower costs of testing—so the new method is cheaper and more ethical.

GRAND CHALLENGES

CHALLENGE 3

ARRESTING AQUATIC BIODIVERSITY DECLINE

Connections matter for ecosystems, but how do we know which ones?

By Dr Chris Brown

The cliché goes that all species, including humans, are part of intricately connected ecosystems. So disrupting just one species can impact all the others.

The moral of the story is that humans need to make sure they don't upset the natural balance.

It may well be that ultimately all species are connected. But it is also true that some connections matter more than others in different times and places.

It's not hard to find examples of where connections matter. The current pace of environmental change and human development sees old ecological connections disrupted and new ones created all the time. For instance, centuries of forest clearing in the catchments around south east Queensland have seen increasing levels of soil erosion, which eventually ends up in Moreton Bay. This soil provides nutrients that can feed productive fisheries, but also clouds the water affecting light dependent seagrass meadows.

Restored fish habitat means enhanced fisheries Industry

New research from Dr Chris Brown, Dr Fernanda Adame, Professor Rod Connolly, Dr Mischa Turschwell and PhD Candidate Andrew Broadley outlines the need to better protect fish habitats to improve fisheries stocks.

This study reviewed habitat requirements for fish stocks globally. Of the habitats reviewed it was revealed that almost half are known to be in decline.

'Our work is significant because overfishing is often pinned as the only cause of declines in the productivity of fisheries, which implies stricter fisheries regulations are the sole solution to overfishing. We found that nearly half of the world's best researched fish stocks are using habitats that are in decline, like seagrass and mangroves,' said the study's lead author Dr Chris Brown.

Fish habitats have come under major stress due to pollution, coastal development and problematic fishing activities. With the increase in development along coastal regions, seagrass meadows and mangrove forests have been replaced with water-front apartments and numerous other infrastructure projects.

'Managing fish catch is an important part of ensuring we have sustainable fisheries that support food production and jobs. But we can't just count on good fisheries management. Protecting the fish habitats we have left and restoring lost habitats like mangroves is crucial,' Dr Brown said.

'We need to look beyond fisheries to other activities that are degrading habitats, like pollution that comes from land, and coastal development.'

'We analysed habitat use for 418 of the best researched fish stocks. These are stocks for which detailed monitoring data are available. They are commonly used to estimate how sustainable fish are at the global scale,' Dr Brown said.

'We need to look beyond fisheries to other activities that are degrading habitats, like pollution that comes from on land, and coastal development.'

'Restoration of critical fish habitats such as mangroves, seagrass, and floodplains will increase the resilience of fish populations against overfishing. For example, in the Wet Tropics, northern Australia, reconnecting coastal lagoons with mangroves and the Great Barrier Reef has been the primary objective of many restoration projects for fish species such as barramundi to have a better chance of growing and reproducing', said study co-author Dr Fernanda Adame.

'Managing fish habitats can be hard—we need to coordinate our management across the land and sea and across different industries, like infrastructure development and fisheries. But doing so is crucial to supporting the jobs created by fisheries and the opportunity to fish recreationally that is enjoyed by millions of Australians.'

Collaborators:

The study was led by researchers from the Australian Rivers Institute with a partner from the University of Washington. The study was supported by funding from the Australian Research Council and the Richard C. and Lois M. Worthington Endowed Professorship in Fisheries Management.

Key Messages:

- The study reviewed habitat requirements for fish stocks globally. Of the habitats reviewed it was revealed that almost half are in decline.
- Managing fish catch is an important part of ensuring we have sustainable fisheries that support food production and jobs.
- Protecting the fish habitats we have left and restoring lost habitats like mangroves is crucial.

GLOW UPDATE, ARI partnering to restore global wetlands

By Dr Tom Rayner

Griffith University has joined the Global Mangrove Alliance (GMA). The key target of the group is to increase the global area of mangrove habitat by 20% by 2030. This deliberately-ambitious target is designed as a call-to-arms for the coastal conservation community.

ARI's Global Wetlands Project (GLOW) is coordinating involvement in the alliance, by helping improve access to scientific understanding and delivering tools to inform action. The goal is to help make the GMA's efforts as effective and efficient as possible.

GLOW has recently published some key pieces of research. These include a new review examining the role of coastal wetlands, like mangroves, for marine megafauna conservation. Links between these species and habitats were shown to be far richer and more common than previously realised.

GLOW Research Fellow Dr Michael Sievers presented this work as part of the 5th Mangrove, Macrobenthos and Management conference, held in Singapore during July 2019. Dr Fernanda Adame also presented her award-winning blue carbon work on the mangrove forests of Mexico (see ARI magazine August 2018 edition).

GLOW researchers are now heading to the 2019 International Congress for Conservation Biology in Malaysia to give presentations, host a symposium on coastal wetlands and facilitate a new proposal for a working group on coastal wetland conservation. These international events provide an important platform for uptake of ARI research into global environmental policy.

Papers:

- Dr Fernanda Adame wins Keeling Curve Prize for climate change solutions. **kcurveprize.org/**
- Sievers et al. (2019). The role of vegetated coastal wetlands for marine megafauna conservation. Trends in Ecology & Evolution **doi.org/10.1016/j.tree.2019.04.004**

'The goal is to help make the GMA's efforts as effective and efficient as possible.'

Photo Credit: Tom Rayner

GRAND CHALLENGES

CHALLENGE 4

MAKING CATCHMENTS MORE RESILIENT TO CLIMATE CHANGE

A changing climate and growing population will add more pressure to our already stressed catchments.

By Professor Adrian Volders

Most major metropolises rely heavily on their surrounding catchments to supply food and water, assimilate waste and help protect human populations from extreme weather events.

Major weather events such as droughts and floods drive and change the system and functionality of catchments. The millennium drought followed by the 2011 and 2013 flood events in south east Queensland showed the vulnerability of the region's catchments. Massive amounts of sediment were washed from the catchments, impacting on Brisbane's water supply, food production and transport.

The resilience of catchments to these weather events—which are predicted to become more extreme under a changing climate—has been reduced by the previous clearing of vegetation and the modification of streams and channels.

New initiatives and programs like ARI's Catchment Resilience project are now being developed to address the declining condition of catchments. Coupled with the emergence of markets in water quality, nutrient offsets and carbon sequestration, a new era of catchment restoration activities now appears possible. Where to invest in catchments to maximise outcomes across a range of multiple benefits such as flood mitigation, sediment reduction and water quality improvement is a challenge that ARI is seeking to address.

'The resilience of catchments to these extreme weather events—which are predicted to become more extreme under a changing climate—has been reduced by the previous clearing of vegetation and the modification of streams and channels.'

Our aim is to create and pilot world-leading prioritisation models, tools and animations to guide investment that maximises the benefits of catchment works in terms of flood mitigation, biodiversity, water quality and waste assimilation. Our previous research has identified where key problems are occurring in catchments.

The next phase of the project will develop methodologies that ensure maximum benefit across a range of environmental values are achieved through the siting of on-ground works.

The flagship Building Catchment Resilience project will develop an analytical tool that can be used to explore cost effective options for the optimal on-ground investment to reduce sediment and nutrient loss, minimise flood risk and maximise biodiversity outcomes.

An innovative digital technology interface will enable realistic visual representations to facilitate discussions with investors and the community to run scenarios and explore trade-offs and synergies. Initially the tool will be developed and demonstrated in the Laidley Catchment including an on-ground works component. The tool will be designed to be easily adaptable to other catchments.

A consortium of Queensland organisations led by ARI has been granted $1M over four years from the Ian Potter Foundation to undertake the Building Catchment Resilience project. Consortium members include Griffith University, the Queensland Government, Queensland Urban Utilities, Seqwater, the Port of Brisbane, Queensland University of Technology, Water Technology and Healthy Land and Water.

Partners

- The Ian Potter Foundation
- Australian Rivers Institute, Griffith University
- Queensland University of Technology (QUT)
- Queensland Government
- Water Technology
- Queensland Urban Utilities
- Seqwater
- Port of Brisbane
- Healthy Land and Water
- SEQ Council of Mayors
- Lockyer Valley Regional Council

Key Messages:

- The millennium drought followed by the 2011 and 2013 flood events in south east Queensland showed the vulnerability of the region's catchments. Massive amounts of sediment were washed from the catchments, impacting on Brisbane's water supply, food production and transport.
- Coupled with the emergence of markets in water quality, nutrient offsets and carbon sequestration, a new era of catchment restoration activities now appears possible.
- Where to invest in catchments to maximise outcomes across a range of multiple benefits such as flood mitigation, sediment reduction and water quality improvement is a challenge that ARI is seeking to address.

OPINION, PEOPLE AND PERSPECTIVE

How does modelling inform science?

By Dr Ben Stewart-Koster and Dr Mischa Turschwell

When someone asks us what we do and we say 'I do modelling', sometimes, for a brief second, that's what people think.

Then they realise that since we don't have chiselled abs and stunning features, there must be some other kind of modelling. We don't wear lab coats and we don't strut the catwalks of New York or Paris but we are scientists who do modelling!

In the mainstream media and on social media, it's common to read statements that models are not 'science'. In this view there seems to be only a single type of science, where nutty professors sit in labs doing experiments and making chemicals explode. But, modelling has become an essential part of science, particularly natural sciences where we attempt to understand many facets of complex systems.

Our modelling involves systematically collating our best understanding of a particular system or phenomena on a point in time, and making predictions of what might happen if everything we understand is correct. Natural systems are exceptionally complex and we are capturing and describing processes that might otherwise be missed without models.

Statistician George Box was right when he said: 'All models are wrong but some are useful', as we are unlikely to describe perfectly all the patterns and processes in the natural world. But sometimes the patterns we find in models can provide us with incremental increases in knowledge that help us conserve a species, understand what affects the distribution of a population, or predict how things like increased temperatures are going to affect species.

Equally, there is a necessity to do observational science in the natural world as experimental approaches are not always feasible or ethical (i.e. clearing vegetation in a national park to quantify the impacts of habitat degradation on a population of organisms). So instead we need to use models. The data required for modelling comes from a range of sources, such as traditional scientific data collection and experimentation. But what about the wealth of knowledge that doesn't exist as traditional data? Farmers whose families have been working the land for generations and traditional owners who live on the land of their ancestors often have unprecedented knowledge of the natural systems on their land. Fortunately, there are ways to incorporate this kind of knowledge in models when collaborating beyond our discipline.

Recently Dr Turschwell used models to combine three years of research, a range of different data types and all sorts of ecological processes to test how climate warming and replanting trees along riverbanks (riparian restoration) might affect population survival for a threatened fish species. His models found that compared to current climatic conditions, climate warming scenarios reduced the probability of survival. However, these reductions were almost completely offset, and even improved, when riparian zones were restored across the catchment.

In a recent project focused on rice and shrimp farming in Vietnam, a team of Australian researchers led by Professor Michele Burford collaborated with local scientists and farmers. As we were new to the system and had limited knowledge of the region, we began by conducting a systematic process of knowledge gathering with the farmers. After several days of exhausting workshops, we developed a probabilistic model of how the system worked based on the knowledge the farmers had developed over decades of experience. With their input, we established baseline understanding of the system and designed several years of research to complement this existing knowledge. Dr Stewart-Koster is currently combining the farmers expertise with our research findings into a new updated model of the system.

Modelling is so much more than sitting behind a computer all day writing code—although that can be a lot of it! Models allow scientists to test hypotheses and make predictions about how complex systems may respond to changes in the future. Modelling is about being creative in finding solutions to problems that may not otherwise be solved using traditional scientific methods.

So hopefully we've persuaded you that there's a lot more to life than being really, really, ridiculously good looking, and scientific modelling can help us find out what that is.

Natural systems are exceptionally complex and we are capturing and describing processes that might otherwise be missed without models.

LIFE AS A SCIENTIST

By Advance Queensland Research Fellow, Dr Carmel McDougall

Life as a scientist can look quite different, depending on which scientist you ask! For me, it's a combination of lab work, field work, bioinformatics, writing, teaching, managing, and communicating with stakeholders. It's busy and keeps me on my toes, but I wouldn't have it any other way.

It's a really exciting time to be a molecular biologist. The last decade has seen significant advances in the field—we can now, quite cheaply, perform deep sequencing on very small amounts of material, for example, single larvae or even single cells. We can detect an organism's presence by simply sequencing the water or soil that it lived in. These technologies open a wealth of opportunities for studying developmental biology, evolution, and ecology—to name a few.

As exciting as these techniques are, working with industry I've come to realise that it's not always the most cutting edge projects that can make the biggest difference. Often, simply applying scientific thinking to a problem provides hugely beneficial outcomes. I'm lucky to be able to work across pure and applied research, getting the best of both worlds.

Helping Queensland's oyster farmers

I'm just about to start the final year of an Advance Queensland Fellowship, a project with the ambitious aim of 'reinvigorating the Queensland oyster industry'. The industry has been experiencing low levels of production since the 1920s for a number of reasons. A key reason is repeated mass mortality events due to QX disease, a malady specific to Sydney rock oysters.

Recently, farmers have been looking at the possibility of growing other, lesser-known native oyster species. A prime target is the tropical black lip oyster but there is a significant challenge. We don't really know how to best grow these in the hatchery, we're not so sure of its natural distribution, and we don't really know which species it is.

Over the past two years I've worked with oyster farmers to conduct trial hatchery runs of the black lip, and am currently working on ways to address the major identified challenge—getting the larvae to settle and metamorphose into juveniles. Along with a number of enthusiastic helpers I've also initiated 'the great Queensland oyster hunt', a series of field trips to collect oysters for morphological analysis and genetic sequencing.

This has provided lots of surprises, including the presence of a number of oyster species we didn't know we had. The current count is eight intertidal species and a few more subtidal—and we have a lot more sequencing to do, so watch this space!

Another unexpected outcome of this research has been the ability to feed these results into two shellfish reef restoration projects currently underway in South-East Queensland. It's fantastic that this research will not only help our oyster farmers, but will also contribute towards improving the health of our local estuaries.

'I'm just about to start the final year of an Advance Queensland Fellowship, a project with the ambitious aim of 'reinvigorating the Queensland oyster industry.'

LIFE AS A SCIENTIST

By Senior Researcher, Graeme Curwen

Senior Research Assistant Graeme Curwen is known for his sharp humour and adventurous nature when he's not behind a desk.

Curiosity can sometimes become a career

I have a deep emotional attachment to rivers and maps, and my work at the Australian Rivers Institute as an environmental spatial analyst is a perfect match for my love of the two. Both have given me unbridled joy and deep satisfaction, but some have put my life in danger. Well, maybe it was my fault, but that's another story.

My interest in environmental science was sparked early while on a primary school field trip to a popular recreation spot called Coe's Ford, on the Selwyn River in Canterbury, New Zealand. My teachers made us roll stones over to check the other side for the number of aquatic bugs, such as mayflies, caddis and stoneflies. This was a basic way to measure water quality.

Growing up in New Zealand in the 1960s and 70s, I'd always taken for granted that rivers were clear, abundant and full of trout to be caught. I dreamed of joining organised drift dives to count trout populations. I eventually did a few drifts solo to find where the trout lurked. Doing your own exploring can be a joy and you get to relive that childhood sense of wonderment.

Sadly, in recent years Coe's Ford has been reported as devoid of surface flow. The sad pools that remain are highly polluted, toxic, unswimmable and totally degraded. My childhood memories are not able to be lived by the current generation.

Some of my fondest childhood memories are of an environment that was clean, safe, fun and rewarding. Unfortunately, with increased population sizes, industrialisation and heavy agricultural development we have seen many ecosystems damaged. This is one of the reasons I became an environmental research scientist, to try to help protect many of these fragile ecosystems and restore them to their natural levels of beauty. I put my efforts towards good stewardship of the environment, rather than exploiting it.

I've helped save government money, reefs, rivers and fisheries

My work as a GIS and Remote Sensing analyst has contributed to environmental protection projects in many parts of the world, mostly done without leaving the office, using imagery collected from satellites planes and ships. A sample of these projects includes:

- Mapping forests and reefs in lagoons in the Solomon Islands to help locals repel clear felling of their forests by multinational corporations. The logging was damaging their forests, reefs and fisheries industry.
- Calculating the volume of erosion in the Upper Brisbane River after the 2011 floods, with a follow up project mapping the risk of erosion in all significant watercourses in South East Queensland. This helps inform catchment restoration investors of the best use of money and time, which in turns helps save farmland soil and fragile ecosystems near river mouths.
- Mapping locations of sea bed mining leases to help estimate the harm that might be done to nearby fisheries.

The work never ends...currently I'm working on two major projects

- Project 1: I'm quantifying the area of mangroves and intertidal mud that is used as a habitat for juvenile prawns in three catchments in the Gulf of Carpentaria. This project is investigating the current environmental status and predicting future status of prawns in the face of proposed damming or abstraction of water to intensify agriculture in the so-called 'Food Bowl of the North'. Major changes to rivers could potentially damage prawn numbers in the region—not good for the environment or for prawn fisheries.
- Project 2: I'm mapping the hot spots for gully erosion in the Bowen Catchment. This area is a heavy producer of fine sediment for the Great Barrier Reef Lagoon, acting as a stress for coral, by smothering them, blocking sunlight and transporting damaging levels of nutrients. Once we finish mapping, gullies will be ranked in order of priority for remediation. Results of trial remediation sites are extremely promising, with major gullies essentially shut off. This means improving conditions for the Great Barrier Reef and the entire ecosystem that depends on it.

I really love working with a range of researchers on diverse and novel topics. The changing subjects and new problems to solve keep things interesting. Providing information to better inform conservation is a rewarding feeling—it's nice to know that my work can have a positive and significant impact on so many different areas of the environment, and as a by-product, the economy.

ECR SPOTLIGHT

By Dr Sarah Laborde

‘Life as a scientist’

The best part of scientific research for me is the possibility to pursue questions I am passionate about. I often reflect with gratitude that this is my job!

My work has taken me all over the place, geographically and metaphorically. Ten years ago I was an environmental engineer studying the water currents of Lake Como (Italy), then a growing curiosity about the way knowledge about water develops in different contexts led me to broaden my disciplinary interests to environmental anthropology and social studies of science.

I spent many nights on those tiny Lake Como fishing boats, exchanging, listening, watching and documenting the fishermen’s very sophisticated experiential knowledge of the lake’s waters. The question of how aquatic sciences and other ways of knowing water (‘experiential’, ‘traditional’ etc.) are defined, develop and interact has been one of my key reasons for being a researcher ever since.

Prior to starting as a Research Fellow with ARI, my research took me to the banks of the Missouri River in North Dakota and the Logone River in Cameroon.

Current Research

I am currently thinking about how different understandings of rivers can coexist and intersect, and what that means for environmental policy. This is important because, in Australia and elsewhere, understandings of what a particular river is and what its water is for are far from universal.

For example, senior Traditional Owners of the Mardoowarra/Fitzroy River catchment, where I currently spend much of my time, have described the river as a living ancestral being at the heart of the country’s health, intergenerational learning, and social and cultural life. At the same time, the Fitzroy River is seen as an underutilised water resource by proponents of agro-industrial development, and as a relatively pristine ecosystem by conservationists.

These views may not be fully incompatible, but supporting genuine, productive conversations across them is crucial for the future of the river catchment.

I work on a National Environmental Science Program (NESP) project with Professor Sue Jackson, which is based on collaboration with traditional owners. It aims to articulate the social and cultural dimensions of water in the Fitzroy catchment.

Can these important relationships be considered in water planning processes that currently emphasise (firstly) economic and (secondly) environmental considerations? If so, how? And, if not, what does that mean for water planning and management?

My most valued teachers in this research are the people and places of the West Kimberley. One of their key lessons is one I need to be regularly reminded of: to start by being quiet and listening.

The question of how aquatic sciences and other ways of knowing water (‘experiential’, ‘traditional’, etc.) are defined, develop and interact has been one of my key reasons for being a researcher ever since.

NEW STAFF

Research

- Dr Yantao Li
- Dr Man Xiao
- Dr Johnvie Goloran
- Dr Soyoung Jeong
- Dr Ali Shokoohmand
- Dr Edoardo Bertone
- Dr Kaitlyn O'Mara
- Dr Matthew Hayes
- Dr Christina Buelow
- Dr Eva McClure

Technical

- Dr Bruce Lan
- Ms Renee Piccolo
- Ms Emma Henderson
- Ms Leigh Gould
- Mr Dale Bryan-Brown
- Ms Ellen Ditria

Professional

- Ms Carolyn Parkinson

Visitors

- Associate Professor Yajuan Li, Gansu Agricultural University, PR China
- Dr Khatereh Nobaharan, Islamic Azad University, Iran
- Ms Mia Turner, The Pennsylvania State University, USA
- Professor Bastiaan Ibelings, Universite de Geneve, Switzerland
- Ms Camila Campos Couto, Institution Internationalization Program (CAPES Print), Brazil
- Professor Xinmei Fu, Southwest University of Science and Technology, PR China
- Dr Yanyan Li, NanChang Institute of Technology, PR China
- Ms Cristina Veriato de Freitas, Sao Paulo Research Foundation (FAPESP), Brazil

New PhD Candidates

- Katherine Glanville, Role of groundwater in the ecophysiology, functional ecology and services of *Eucalyptus* ecosystems.
- Mohammad Ramezani, Evaluating the impacts of urban development and climate change on water quantity and quality.
- Pankaj Ram Kaushik, Quantifying changes in the ecohydrology of the Great Artesian Basin from space and on-ground observations.
- Rahat Shabir, Influence of soil type and amendments of recycled organics on chemodynamics of phosphate interaction with heavy metals.
- Gamage Wijewickrama, Next-generation models to predict cyanobacteria harmful algal blooms.
- Yahui Che, Predicting the frequency and areal extent of dust-storm events in eastern Australia.

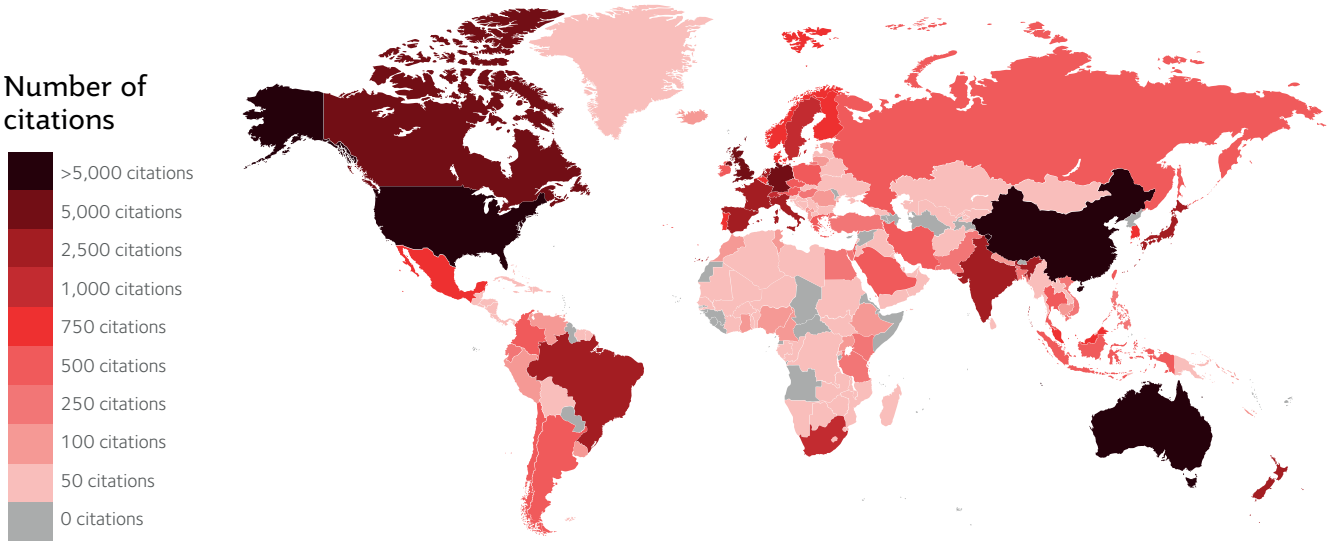
PhD Conferrals

- Dr Man Xiao, Variation within and between species and strains on cyanobacterial competition: a study of problematic *Cylindrospermopsis raciborskii* and *Microcystis aeruginosa*.
- Dr Sunny Yu, Freshwater ecoregion framework delineations for water resources management within a city.

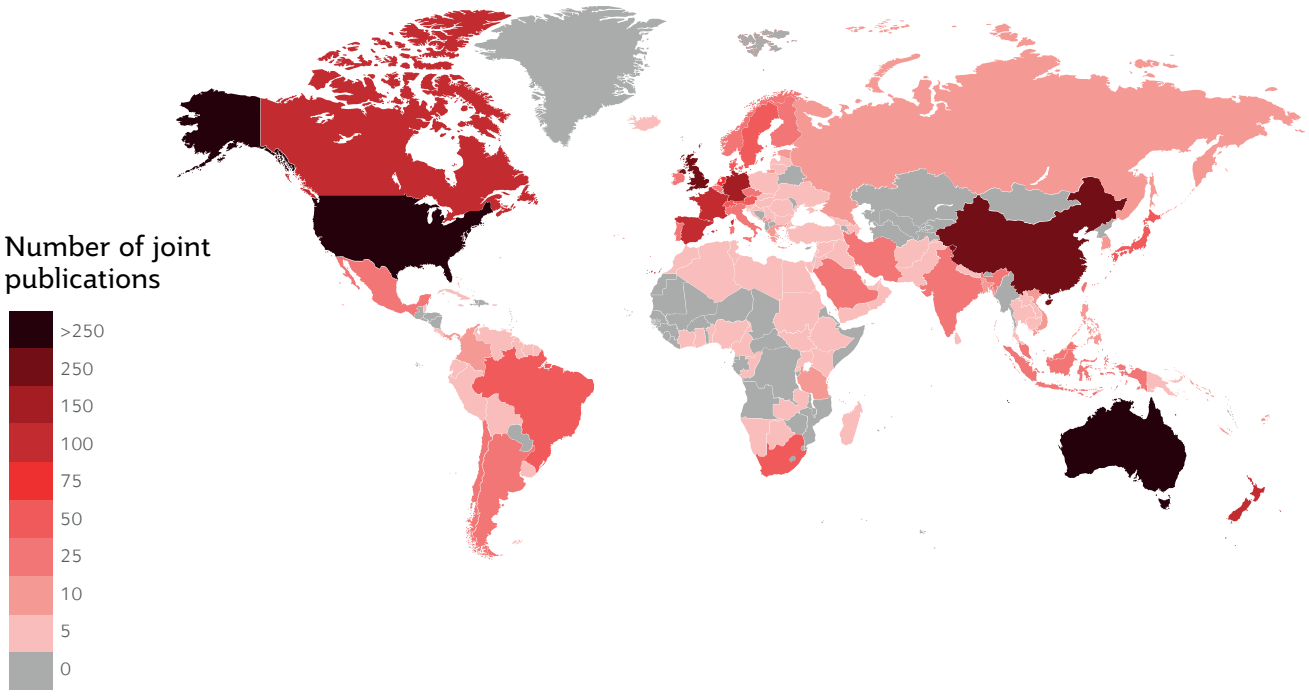
Photo Credit: Tom Rayner

ARI researchers have a strong network of international collaborators and our science is having a significant impact around the world

Journal citations



Journal papers co-authored



(All map data figures captured from year of Institute establishment 2006 until 2019).

Photo Credit: Tom Rayner

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