ARI

Australian Rivers Institute

MAGAZINE
Issue 6

SPECIAL FEATURES IN THIS ISSUE:

GRIFFITH UNIVERSITY

DIRECTOR'S WELCOME

Welcome to this edition of the ARI Magazine, featuring two events which were held in the last half of 2023. 'Green and Blue by '32' profiled catchment restoration opportunities leading up to the Brisbane Olympics in 2032, and the annual Peter Cullen Lecture was held in Brisbane in partnership with Canberra University and the Peter Cullen Trust. Also featured in this edition are several high-profile papers published in the journals Nature and Science are also featured in this issue.

Universities are increasingly being challenged to show how they generate 'impact' from their research and publications. As universities grapple with showcasing and quantifying their impact, I believe the Australian Rivers Institute can be an exemplar for showcasing the broader societal benefits and impact of our research. Based on publications alone, about 30 per cent of ARI publications are cited in policy documents, representing 17 percent of the annual policy citations by Griffith University. The impact of a publication can also be assessed by the number of online mentions of a paper, the so-called 'Altmetric" score. For example, two recent papers published in the high profile *Nature* journal and co-authored by ARI staff, are featured in this issue and have Altmetric scores in the thousands and are in the top 1% of *Nature* articles of similar age, with key scientific messages being quickly and widely circulated.

The Australian Rivers Institute has long-standing partnerships with many local, state and national governments departments, NGOs and stakeholders, as well as internationally. These partnerships have supported the development of environmental report cards, long-term monitoring programs and guidelines and regulations for environmental flows and water management generally. The impact of this research is more difficult to quantify and is often the result of many years of developing trusted relationships with partners and co-designing research that meets the needs of regulators, policy-makers and communities. Among current research programs in ARI, the Pacific Water Research Program of the *International Water Centre* is bringing together partners in the Pacific and Australia to address the multiple water challenges facing Pacific Island communities. Many of these problems directly impact the lives of people in the Pacific and fall under the categories of water supply, sanitation and hygiene (WASH) and water security.

Impact is also generated through ability to bring people together to disseminate scientific information and bring focus to specific topical areas, including water management. Our organisational and hosting efforts in *Green and Blue by '32*, the *Peter Cullen Lecture*, the *Freshwater Sciences Joint Meeting 2023* and the *Australian Marine Sciences Association Annual Meeting 2023* constitute important service roles to engage broadly in education and communication about water science.

Achieving research impact will be an essential part of our strategy to continue as a high-profile water research institute at Griffith University. We believe that our continued excellence in publication, development and mentoring of Higher Degree Research students and Early Career Researchers and the impact of our research will ensure our continued success into the future.

Professor David Hamilton
Director, Australian Rivers Institute

NEWS IN BRIEF

- Dr Melanie Roberts received a prestigious ARC Mid-Career Industry Research Fellowship of $1,035,000. Dr Roberts will work with the Queensland Department of Environment and Science and the Queensland Water Modelling Network from 2024 to 2027 to develop a new catchment gully erosion model to inform investment to protect the Great Barrier Reef.
- Dr Michael Klunzinger was recently appointed as one of 12 Australian scientists in the Commonwealth Threatened Species Scientific Committee. Dr Klunzinger was appointed for a term of four years by Hon. Minister Tanya Plibersek.
- Congratulations to Michelle Hobbs, recognised by Cosmos Magazine during NAIDOC week (2-9 July 2023) as one of 52 Aboriginal and Torres Strait Islander people who are "changing the world". Proud Bidjara woman Michelle Hobbs, a PhD student (supervised by Professors Fran Sheldon, Mark Kennard and Sue Jackson), was also joint winner of the 2023 Australian Academy of Science Aboriginal and Torres Strait Islander Scientist Award.
- ARI's 3-Minute Thesis (3MT) Event was held on Wednesday, 9 August 2023. PhD student Katie Turlington from the Australian Rivers Institute won the event with her presentation on 'The heartbeat of freshwater streams' and Jessica Strickland from the Australian Rivers Institute and Coastal & Marine Research Centre took out the People's Choice Award for her presentation on 'Detection of Irukandji Jellyfish at Ningaloo Using Environmental DNA'.
- An Implementation Agreement between Griffith University, Australian Centre for International Agricultural Research and Department of Science and Technology (DOST) Philippines is set to advance research in soils, ecology and land and water management in agriculture. The scientific and technological cooperation will include a joint PhD program, academic exchanges, postgraduate supervision and training programs.
- Congratulations to Dr Michael Sievers who was the recipient of the Cronin Early Achievement Award of the 2023 Coastal & Estuarine Research Federation (CERF).
- Higher Degree Research student Mariah Millington won the Australian Freshwater Sciences Society's 2023 Symposium for Freshwater Sciences (SFS) conference Travel Grant, Best Poster Presentation and was Runner Up for Best Oral Presentation for her research on wildlife trade of freshwater fish.
- Higher Degree Research students, Jasmine Rasmussen and Ellen Ditria, won prizes at the 2023Australian Marine Sciences Association (AMSA) Conference. Jasmine Rasmussen won the FRDC best oral presentation in natural resources sustainability and industry development for her work titled 'Mangrove restoration in contaminated environments: A toxic trap for fauna?'
- ARI Adjunct Professor Bill Young was appointed Chair of the independent Murray–Darling Basin Authority science advisory committee in August 2023.

NEWS

GRIFFITH-LED CRC ATTRACTS $140 MILLION TO TACKLE PLASTIC WASTE

The Solving Plastic Waste Cooperative Research Centre has been announced as one of the successful Cooperative Research Centres (CRC) to be supported by the Federal Government.

Minister for Industry and Science The Honourable Ed Husic confirmed the Solving Plastic Waste CRC, one of two national CRCs to be funded in the current CRC Program selection round, would be established with $40 million in federal funding. The total resources available to the Solving Plastic Waste CRC is valued at $140.6 million, including the CRC Program grant and contributions from partners.

The bid led by Griffith University and the Australian Rivers Institute brings together industry, government and the research sector to establish a CRC that will assist in solving Australia's plastic waste problem by enhancing end-user driven collaboration which addresses the current challenges across the entire plastics value chain.

"Plastics play a major role in the global economy, benefiting a wide range of industries like agriculture, healthcare, packaging, construction, and transportation," Interim CEO Dr Ian Dagley said.

"But the existing linear plastic value chain is unsustainable. It sees most of the end-of-life value of plastics lost and the result is plastic waste pollution, which poses a major environmental challenge."

Solving Plastic Waste CRC Research Director Professor Chengrong Chen from the Australian Rivers Institute said: "The Solving Plastic Waste CRC will work with the plastic sector to accelerate Australia's progress towards eliminating plastic pollution, establishing a circular and Climate Neutral plastic economy, while growing its advanced manufacturing sector.

"It will deliver major economic and environmental benefits and support training for careers in Australia's transformed plastics industry."

The Solving Plastic Waste CRC is a collaboration involving eleven Australian universities, CSIRO and more than 33 industry and other end user partners. CRC research programs, identified through engaging with industry and government, will focus on:

- Materials and design – to reduce products' environmental impact;
- Maximising the recovery and value of end-of-life plastics;
- Implementing a circular economy for plastics in Australia;
- Mitigating the risk of microplastics in agricultural soils.

Griffith University Vice Chancellor and President Professor Carolyn Evans said the Solving Plastic Waste CRC would serve as an essential bridge between industry, researchers, and governments, demonstrating the University's commitment to providing solutions to humankind's great challenges.

"It is with tremendous pride and excitement that Griffith University has led the development of the Solving Plastic Waste bid through to successful endorsement by the Federal Government, and we acknowledge the tireless efforts and commitments made by our partner universities and industries," Professor Evans said.

"The plastics value chain is fundamental to advanced manufacturing, packaging, food and groceries, as well as the waste and resource recovery sector.

"Through its activities, the CRC will contribute to the global competitiveness, productivity, and sustainability of Australian industry.

"It will deliver new technology, skills and regional solutions to grow sustainable businesses and new markets, creating a valuable circular economy and a cleaner and safer environment."

For more information, visit https://www.plasticwastecrc.com.

GREEN & BLUE BY '32 - RESTORING CATCHMENTS & RIVERS IN SEQ AHEAD OF THE 2032 OLYMPICS

Can we turn our catchments and cities green and make our waterways blue by 2032, and if so, how?

This is the question that was asked by the Griffith-led event *'Green and Blue by '32 - Scaling efforts in SEQ to restore our catchments and rivers, in time for the 2032 Olympics and Paralympics'* on 19 October at the Brisbane Convention & Exhibition Centre, the second in a series of events from the Green & Blue by '32 initiative.

With the Olympic and Paralympic Games being hosted in Brisbane in 2032, there is a once-in-a-lifetime opportunity to leverage this global sporting event to deliver benefits to the South East Queensland (SEQ) region.

Green and Blue by '32" brought together Griffith University, Australian Rivers Institute, International WaterCentre, Queensland Water Modelling Network, River Basin Management Society, the Moreton Bay Foundation, Stormwater Queensland, Australian Institute of Landscape Architects, Stormwater Australia, the Green Infrastructure Research Labs/Cities Research Institute, Flood Community of Practice and Engineers Australia, to use the Olympics as an impetus to restore the diverse habitats of SEQ and improve the environment, waterways and overall liveability of the region.

"Our first event in October concentrated the energy of the Green and Blue by '32 partners to build a set of visions and pathways for accelerating and scaling up work to restore catchments and waterways across SEQ," said Professor Stuart Bunn, a key speaker at the event from the Australian Rivers Institute.

"Informed by science, economics and practice, and guided by Indigenous understanding and values, the goal is to accelerate and scale up momentum to restore the diverse landscapes of SEQ and protect the environmental, social, cultural and economic values that attract people to the region."

The key questions addressed during the event included: what a Green and Blue by '32 future will look like for SEQ; why it matters; what needs to be done to get there from science, Indigenous, economic, finance and delivery perspectives; and how do we do it at the scale and speed necessary?

"The true value of this event is the diversity of researchers, practitioners, Indigenous peoples and operators contributing to the dialogue and learning about how effective restoration might be brought about more rapidly and at scale across SEQ," said Associate Professor Brian McIntosh, event organiser with the International WaterCentre.

"The event helped shape thinking, catalyse learning, and foster new connections and collaborations that build momentum towards a green and blue legacy for SEQ after the 2032 Olympic and Paralympic Games."

The interactive whole-day event included talks from leading researchers, Indigenous and practice presentations drawn from Universities, Indigenous groups, consulting firms, and implementation agencies. It evaluated what restoration and Green & Blue by '32 means from various perspectives:

- Landscapes past and future - Indigenous perspectives on restoration (Madonna Thomson, Jagera Daran and Beverley Hand, Mimburi Upper Mary Aboriginal Association Inc.)
- Reflections on the history of SEQ catchment restoration science and action and our pathway ahead (Professor Stuart Bunn, Australian Rivers Institute, Griffith University, Dr Paul Maxwell, EcoFutures Consulting and Alluvium Group)
- From a geomorphology and hydrology perspective (Dr Michael Cheetham, Water Technology, Associate Professor Andrew Brooks, School of Environment and Science, Griffith University)
- From a terrestrial ecology perspective (Professor Sam Capon, Australian Rivers Institute, Griffith University and Moreton Bay Foundation)
- From a wetlands and aquatic ecology perspective (Dr Alice Twomey, School of the Environment, University of Queensland)
- From a shellfish and coastal ecology perspective (Robbie Porter, Shellfish Revolution, OzFish)
- From a community engagement perspective (Dr Angela Dean, School of Agriculture and Food Science, University of Queensland)
- From an environmental planning perspective (Georgina Pratten and Stephen Orr Landscape Architects/Planner, LatStudios)
- From an economic perspective (Associate Professor Jim Smart, Australian Rivers Institute, Griffith University)
- How we can create a lasting GBx32 legacy for SEQ from the Olympics and Paralympics (panel discussion - Cameron Jackson, Urban Utilities; Kim Markwell, E2Designlab; Madonna Thomson, Jagera Daran; Cath Thrupp, CarbonPlanet)

Workshop sessions further weaved together perspectives for restoration of SEQ in three geographic parts – north (Sunshine Coast and inland), central (Brisbane and Ipswich corridor) and south (Gold Coast and inland) and included discussion on action and implementation; the who, how, when and where of restoring the region.

"The Green and Blue by '32 event series aims to bring sectors together, to identify, align and plan a common vision for South East Queensland," Associate Professor McIntosh said.

"Imagine people swimming in our rivers, cool, tree-lined cities and diverse, flourishing ecosystems and communities. I can't think of a better legacy to leave for South East Queensland, but it will take all of us working together to achieve it in time for the Olympic Games."

ASSESSING IMPACTS OF DROUGHT & WATER EXTRACTION ON GROUNDWATER FROM SPACE

A new project led by Griffith University is using big data from satellites to assess the impacts of droughts and water extraction on groundwater resources in Australia.

Chief investigator Dr Christopher Ndehedehe from the Australian Rivers Institute won an Australian Research Council (ARC) Discovery Early Career Researcher Award of over $428,000 for this project, which will generate new insights into the mechanisms driving changes in groundwater availability and help identify the risks associated with sustained groundwater extraction.

"More than half of the world's largest aquifers have rapidly declining groundwater storage, jeopardising global food and water security and ecosystems' sustainability," said Dr Ndehedehe.

"The impacts of droughts and water extraction on groundwater resources are currently poorly understood in Australia and difficult to monitor, threatening national water security and drought resilience."

Dr Ndehedehe's project will employ unprecedented ways of harnessing big data from satellites to assess groundwater status, improving the capability of water resource management agencies to monitor water availability and sustainably manage these critical resources. The results of this research will help farmers and communities to reduce adverse outcomes from drought by enabling earlier access to the critical data needed to inform production decisions.

The project will make further use of this data for environmental monitoring, which could be incorporated into existing online water monitoring platforms, generating publicly accessible groundwater information and expanding global markets for Australian satellite-based monitoring.

"For example, excessive groundwater pumping draws down the water table and, under prolonged drought conditions and higher evaporation, groundwater depletion causes wells to run dry because recharge is unable to replace the groundwater as quickly as pumping removes it," Dr Ndehedehe said.

"This loss in groundwater can affect water-dependent ecosystems, including declines in unique aquatic biodiversity and tree mortality, resulting in the collapse of forests.

"However, our knowledge of groundwater drought and the extent to which it occurs is lacking due to insufficient in-situ data and capacity to quantify and predict changes in water storage through space and time."

Satellites like the Gravity Recovery and Climate Experiment (GRACE) has enabled the monitoring of freshwater changes, including groundwater. But how well do they compare with monitoring of groundwater levels from bores, and can this technology be established as a foundation for water resources planning and accounting in Australia?

This project is an important opportunity to evaluate the use of GRACE satellite data as an independent line of evidence to understand the influence of climate variability and water extraction on groundwater availability. A key goal is to develop a machine learning technique that combines both big satellite data and in-field measurements/observations of rainfall, temperature, etc. to identify areas where groundwater resources are affected by human water extraction or drought.

"With access to big data and computational infrastructure, it is possible to quantify groundwater withdrawals by incorporating climate data and satellite observations of evapotranspiration, surface water, and landcover change in a machine learning model," Dr Ndehedehe said.

"This should overcome the challenges and large degree of uncertainty associated with numerical models and difficulty in applying them over sizeable areas.

"This research will overcome the key impediment associated with quantifying groundwater use in Australia and provide a reliable groundwater withdrawal monitoring technique, which can be incorporated into national groundwater information systems to support drought policy and the strategic management of freshwater in water-stressed agricultural areas."

The project will provide a new national capability to assess and monitor groundwater resources from space, providing data for government, farmers, communities and traditional owners to better prepare for future droughts, increase disaster preparedness and sustainably manage groundwater resources in a changing climate.

"Key findings and outcomes from the project include the development of a novel machine learning framework to downscale the coarse spatial resolution of GRACE data, making it more detailed so it can be used for the management of water resources on local scale."

BUILDING DIVERSITY IN STEM & FRESHWATER SCIENCE

In the lead-up to the Freshwater Sciences Downunder conference in Brisbane, Griffith University's Australian Rivers Institute hosted a group of minority students from the United States as part of the Society for Freshwater Science (SFS) Emerge Program.

"The Emerge Program is a fantastic initiative aimed at broadening diversity, inclusion and participation in the aquatic sciences by supporting people from underrepresented minority groups to pursue careers in this field," said Professor Stuart Bunn from the Australian Rivers Institute.

To increase the diversity in perspectives in freshwater conservation and the freshwater science community, the SFS Emerge Program provides people from a broad range of backgrounds a chance to reach their potential through fellowship and mentorship.

Professor Mark Kennard, an ecologist from the Australian Rivers Institute, developed a freshwater science field program for the group in the Mary (Moonaboola) River in Southeast Queensland.

"We are giving this group of emerging aquatic scientists a feel for what it's like to undertake freshwater science and catchment restoration on one of Australia's most interesting river systems," Professor Kennard said.

After a Welcome to Country from the local Jinibara people, the students toured rehabilitation sites with the Burnett Mary Regional Group and Mary River Catchment Coordinating Committee and saw the Mary River's unique fauna, including the Australian lungfish and Mary River turtle.

These types of sustained peer-to-peer and peer-mentor relationships and the strong sense of group identity that the students build out of these experiences may play a significant role in efforts to recruit and retain underrepresented minorities in STEM.

After a visit to Noosa National Park and the Australia Zoo, the students attended the SFS conference in Brisbane.

"We are delighted to have hosted the 2023 joint meeting of the Society for Freshwater Science and the Australian and New Zealand Freshwater Science societies here in Brisbane," Professor Bunn said.

"This is the first time the Society for Freshwater Science held its annual conference outside of North America and it provided an opportunity to broaden 'north-south' collaborations and explore solutions to the many challenges facing our freshwater ecosystems."

"With over 750 delegates attending from 30 countries spread across the globe, this was an exciting and timely event for our river city."

RECOVERING AND RESTORING THREATENED SPECIES IN QUEENSLAND'S MOONABOOLA (MARY RIVER)

Funding for restoration in the Mary/Moonaboola River will help the river's unique threatened species like the Australian lungfish and Mary River turtle.

With $550,000 in funding over three years from the Resilient Landscapes Hub of the Australian Government's National Environmental Science Program (NESP), a new collaborative research project will help ensure that river restoration in the Mary is targeted to benefit threatened species.

"Queensland's Mary River catchment is a hotspot for threatened species that rely on freshwater and riparian habitats," said research leader Professor Mark Kennard from the Australian Rivers Institute.

"These include species like the evolutionarily significant Australian lungfish and the Mary River turtle, which can only be found in this river system."

Floods, fire, habitat loss and invasive species have put these animals in further jeopardy, but this Griffith University-led project aims to deliver the science to support on-ground management and recovery of these threatened freshwater species in the Mary.

"Our project will fill critical knowledge gaps on where these animals are, the status of their populations, their ecological and cultural values, and the threats they face," said Professor Kennard.

The NESP project team will conduct field sampling of fish, turtles, frogs and other species, map their critical habitats and identify areas needing restoration.

"Our recent canoe survey along 200 km of the Mary River revealed that some areas are still in very good condition and likely support healthy populations of these species, but other parts of the river are severely degraded and in urgent need of repair.

"The information we gather will be used to prioritise on-ground restoration actions to benefit multiple threatened species and their habitats."

The research approach used in the study of the Mary River and the knowledge gained will be transferable to other ecosystems across Australia.

"Crucially, the Mary River catchment is also home to passionate people involved in strong local organisations who want to save threatened species and achieve a resilient, sustainable and productive catchment," stated Professor Kennard.

"We're looking forward to working closely with the Burnett Mary Regional Group, other catchment management groups, Traditional Owners, government and landholders.

"Our shared goal is to improve knowledge, capacity and the tools needed for the management and recovery of threatened freshwater species and their critical habitats in Moonaboola."

For more information about the project, please visit: nesplandscapes.edu.au/projects/nesp-rlh/mary-river/

PETER CULLEN TRUST MEMORIAL LECTURE

The annual Peter Cullen Lecture is a partnership between Griffith University, the University of Canberra and the Peter Cullen Trust to deliver an open lecture on critical issues facing water and environmental management in Australia.

The 2023 lecture was held at Griffith University's Southbank Campus on 15 November and delivered by David Papps, the Commonwealth Environmental Water Holder, from 2012 to 2018. The title of Papps' presentation was 'On science, politics, pragmatism and harsh reality: reflections on the Murray-Darling Basin Plan and its implementation'. The event was held the same week as the Peter Cullen Trust Women in Water Leadership Program Graduation.

The Peter Cullen Trust was set up with Commonwealth and donor contributions as a legacy to Professor Peter Cullen, a renowned Australian scientist who made significant contributions to water and natural resource management.

The Trust has played an essential role in the education and life skills of Australia's future water leaders. Peter was well known for his engagement with politicians and decision-makers on topical water issues. Some of his commentary is as relevant today as ever; "While scientists can measure what we should do with rivers, the fate of our rivers will depend on politicians having the courage to follow scientific advice."

In line with Peter's vision, David Papps' lecture did not disappoint as he delivered both constructive mechanisms to address current water challenges and stinging criticism of politically motivated decisions that have negatively impacted the environment and the communities that the decisions were intended to benefit.

The lecture focused on the Murray-Darling Basin, and one of the issues examined was the sustainable water diversion limit, designed to return water to the environment through engineered efficiencies in water management (e.g., from reduced water losses from irrigation).

Papps had a healthy degree of scepticism about whether the process would work and whether there was the political motivation to make some hard decisions about some of the 'winners and losers' in the water allocation process. Next year's Peter Cullen Lecture will be in Canberra and hosted by the University of Canberra.

IN FOCUS

TRADITIONAL OWNERS TAKE THE LEAD SAFEGUARDING FRESH & MARINE WATERWAYS

The fact that the Gulf of Carpentaria region is seen as one of Australia's iconic, pristine and remote natural environments, full of wildlife and natural wonders, can lead to complacency when it comes to monitoring the health of these ecosystems to ensure they're not being degraded over time.

A collaboration between Griffith University and the Carpentaria Land Council Aboriginal Corporation (CLCAC) is helping to overcome this complacency by training groups of Traditional owners to take the lead monitoring and safeguarding fresh & marine waterways in the Gulf of Carpentaria region.

Aquatic systems, such as wetlands, lakes, rivers and streams, groundwater seeps and estuaries can suffer from water quality problems, both natural and manmade, which impact drinking water supplies, and the animals and plants that live in these systems. There is also increasing pressure from water resource development, which can impact on waterway productivity and health.

Traditional Owners have lived in northern Australia for tens of thousands of years and have a deep knowledge and connection to these aquatic systems, and a desire to protect them.

In the southern Gulf of Carpentaria lands, the CLCAC undertake ranger programs support the health of the lands and waters, which stretch from the lower Gilbert River to the Queensland/Northern Territory border, including the Wellesley Islands. Their program now includes water quality monitoring in both marine and freshwater lakes, wetlands, rivers and estuaries, thanks to a collaboration CLCAC initiated with Griffith University researchers.

This program involved identification of sites either of particular significance and/or where there is concern about water quality.

Professor Michele Burford from the Australian Rivers Institute, and Mr Stephen Faggotter from Griffith University's School of Environment and Science conducted training of water quality monitoring methods with CLCAC rangers.

"We developed a monitoring program tailored for each ranger group," Professor Burford said.

"Currently, three ranger groups are now conducting their own regular monitoring of the region, with the training of one more group soon to begin."

The water quality data collected is entered directly into a database while on site, making it quicker and easier to scan the data for quality control, and examine sites of particular concern.

This type of monitoring by Traditional Owners provides a means of looking at long term trends of related to factors that may affect water quality, such as agricultural development or climate change.

"Already monitoring by Griffith-trained Traditional Owners has revealed sites with high nutrient levels after large rain events in the wet season," Professor Burford said. "High nutrient loads in waterways have the potential to cause algal blooms."

"Through monitoring by Traditional Owners we have also discovered sites with low dissolved oxygen levels late in the dry season as water levels drop, which can affect the ability of fish to breathe and may even lead to fish kills."

The accumulating data the monitoring the health of fresh and marine waterways can be linked directly with attributes of particular significance and important habitats to traditional owners in this region.

For example, water quality can be linked with the sustainability of stocks of fish, crabs and prawns which are culturally important and/or provide a supplementary food supply for traditional owners in the region.

"It is hoped that this project will provide a starting point for a wider and ongoing collaboration to support environmental management in the unique Gulf country," Dr Burford concluded.

IS FLOOD POLLUTION CAUSING TURTLE STRANDINGS? ARI RESEARCHERS LOOK FOR ANSWERS IN THEIR CELL RESPONSE

Last year was a grim season for sea turtles in Queensland's Wide Bay-Burnett region, with more than ten times the usual number of sick and dying animals, including over 100 turtles, pulled from the water.

The Australian Rivers Institute Toxicology Research Group (ARI-TOX) is investigating the potential role that chemical pollution had on the elevated green turtle strandings on the Fraser Coast following the major flooding events in early 2022.

"At this stage, we don't know if these strandings were related to disease, parasites, changes to quantity and quality of food sources, chemical pollutants, or a combination of multiple factors," said ARI-TOX marine ecologist and eco-toxicologist Dr Jason van de Merwe.

"During large flooding events, chemical pollutants, such as pesticides and industrial chemicals, are often washed into coastal areas, where they can then accumulate in the resident sea turtles.

"Many of these chemicals have known effects on humans and other animals, so we are looking into if and how they're contributing to the observed elevated strandings of green turtles."

Researchers at ARI-TOX collaborated with the Queensland Department of Environment and Science to capture green turtles foraging in the waters of Hervey Bay adjacent to pollution sources in river mouths and urban outflows while also assessing turtles in the eastern bay areas, further away from potential pollution sources.

With assistance provided through the jointly funded Commonwealth-State Disaster Recovery Funding Arrangements, the general health and demographics of the green turtle population were recorded during these sampling events, including size and age, indicators of health and body condition, and breeding status.

Blood samples were also collected from each turtle for investigations into health and toxicology, the latter to be performed by ARI-TOX researchers.

"Full credit must be given to the Australian Government and the Queensland Department of Environment and Science for initiating such a swift and comprehensive investigation into the potential impacts of the 2022 floods on the health of marine wildlife," Dr van de Merwe said.

"They did a great job assembling a multi-disciplinary team of sea turtle experts, wildlife veterinarians, pathologists and toxicologists. As toxicologists, our role in this project is to determine the amount and types of metals and organic contaminants found in these sea turtles and investigate whether there are any links to the health and demographic data collected.

"We measure metals using well-established analytical techniques, however, due to the vast array of organic pollutants that are found in the marine environment, we measure the toxicity of the specific mixture of organic contaminants extracted from each individual turtle sampled, using a cell-based test.

"To test the combination of contaminants that the turtles accumulate, we concentrate the mixture of organic contaminants found in a sea turtle blood sample, perform a series of dilutions of this concentrate, and, using a novel sea turtle-specific cell-based toxicity assay, expose sea turtle cell cultures from ARITOX's Marine Wildlife Cell Bank to this concentration gradient.

"These assays will allow us to understand if the level of pollutants currently found inside the turtles is toxic to their cells and if not, how much it has to increase to cause a toxic response."

In a separate component of the project investigating the impacts of flooding on marine wildlife, the ARI-TOX team are also collaborating with SeaWorld and other wildlife hospitals to measure the chemical contamination of sea turtles, dolphins and dugongs that are currently being stranded in Southeast Queensland.

"The goal of this aspect of research is to determine again what the potential role of chemical pollution is in causing the elevated levels of marine wildlife strandings we have been seeing in the region in recent years," Dr van de Merwe said.

WHY WAS BRISBANE'S 2022 FLOOD DIFFERENT?

Only 11 years after the devastating 2011 flood, Brisbane was again inundated, but this time it was different. In a new edition of '*A River with a City Problem*', Dr Margaret Cook, from Griffith University's Australian Rivers Institute, shows that while the quick-moving water followed familiar riverine flood paths on the city's southside, northside residents were left unprepared as waters inundated areas untouched since 1974.

Although forecasts predicted that the weather system would move south, the rain remained over Brisbane for days, dumping phenomenal volumes of water. Then Premier Annastacia Palaszczuk expressed the thoughts of many:

"We never expected this rain; this rain bomb is just unrelenting. It's not a waterfall; it's like waves of water. The 'intense weather' was like an unpredictable cyclone."

Between 23 and 28 February, the Brisbane City Council area received between 400 and 1,100 millimetres (on average 795 millimetres), much of which fell between Friday, 25 and Sunday, 27 February.

"Not since the 1893 floods had Brisbane experienced these volumes in one month," Dr Cook said. "The three-day record exceeded that of the 1974 flood, with the northside suburb of Alderley receiving more than a metre of rain over those three days."

"In 72 hours, Brisbane received around 80 per cent of the city's average annual rainfall; that's almost all the rainfall that London gets in an entire year. Upstream, Wivenhoe Dam, the city's main flood mitigation strategy, received about three Sydney Harbours worth of water in under three days."

Fortunately, at the start of the 2022 flood event, Wivenhoe Dam was only 56 per cent full and was able to hold back 2.2 million megalitres before water releases were necessary. The problem was that the rainfall downstream of Moggill was more than three times the rainfall in 2011.

Although a moderate flood alert was issued on 26 February, constantly changing weather scenarios caused predicted river flood heights to be revised five times in the next 11 hours, with alerts being out of date soon after (or before) their release.

"People might be surprised to hear the peak flood height in 2022 at the Brisbane City Gauge in Edward Street was 3.85m, substantially lower than the 4.46m recorded in 2011," Dr Cook said.

"The 2011 event was primarily a riverine flood, with the heaviest flooding in the main river itself, which is vastly different to what we saw in 2022. In last year's event, flooding occurred in the Brisbane River and creeks and through overland flow, all at once."

"Flooding in creeks, especially on Brisbane's north side, surpassing all previously height records heights, including those in 1974, which were much more like the 2022 flood."

In Brisbane's north, Kedron Brook broke records with 893 millimetres, compared with 661 millimetres in 1974 and 315 millimetres in 2011. The swollen creeks soon reclaimed their floodplains, flooding streets and homes. After two La Niña years of frequent rain, the soaked ground increased run-off and overland flow, which, when combined with creek flooding, meant areas left dry in 2011 flooded in 2022.

Jamica Santos had lived near Enoggera Creek in Acacia Drive, Ashgrove for 25 years. In 2011, floodwaters reached her driveway. In 2022, the creek rose less than two metres outside her home.

"It was crazy," She told *The Courier-Mail*, "it just kept rising, it wouldn't stop. I was scared because of how quickly it was rising."

She wasn't alone. Images of flooded streets, submerged homes and dramatic rescues on social media showed residents were caught off-guard by the rapidly rising floodwaters. People and pets were rescued by watercraft as 2,770 Brisbane streets flooded, and the Bruce, Warrego and Ipswich highways were all closed for days. Thirteen people lost their lives in the 2022 floods, with 23,400 properties flood-affected in all but 11 of Brisbane's 188 suburbs.

Pontoon debris was found as far away as K'gari (Fraser Island) and Noosa, and Moreton Bay was shrouded in a plume of mud for weeks. Once again, Brisbane faced a massive recovery effort and a substantial financial liability, while city residents again confronted property loss, homelessness and heartache.

With two major floods in quick succession (2011 and 2022) that were so vastly different in mechanism and outcome, we have been given a sharp reminder of the region's sub-tropical climate and propensity to flood.

"Despite the region's complex network of four rivers and 22 creeks, we tend to focus only on the Brisbane River when it comes to flooding," said Dr Cook.

"But as 2022 showed, floods can occur via the river, Brisbane's creeks or from overland flow, or any in combination of these. While history offers insights into flood patterns, every flood will be different, and we need to be prepared for all scenarios."

With climate change and growing levels of urban density, the risk of extreme flooding is predicted to increase, making proactive changes essential to reduce risk rather to avoid being caught by surprise by the inevitable next flood. But as Dr Cook points out, Brisbane's current reliance on a dam, the Wivenhoe, to save it from floods heavily depends on where that rain falls.

"Dams have a finite storage capacity, and while they can hold back upstream floodwaters, heavy rainfall downstream will fill Brisbane's creeks and stormwater systems and inundate the city as it did in 2022. To avoid this, any flood mitigation strategy must consider that Brisbane creeks, overland flow and stormwater systems, can all flood independently of the river. This complex hydrology needs to be front of mind when planning and redeveloping the city."

After the 2011 floods, measures were introduced to raise and retrofit homes to make them more flood resilient, and since 2022, a buy-back scheme was implemented to move 500 homes from the floodplain. "These are all proactive steps in the right direction as we develop adaptive strategies to living with the region's complex flood hazard," Dr Cook concludes. "But more needs to be done regarding re-zoning, preventing increased development in flood-prone areas and removing more properties from these areas."

"We need to go beyond dams for flood mitigation and embrace strategies like revegetation and creating flood soaks on the floodplain, better stormwater management, new building designs and materials and lastly, public education to adapt to living in a sub-tropical city like Brisbane, situated on a river that floods."

The second edition of 'A River with a City Problem' by Margaret Cook is now available in book shops or the University of Queensland Press.

PROTECTING HIGH-VALUE WATER SOURCES IN CENTRAL QUEENSLAND

Griffith University researchers are taking a novel multi-disciplinary approach to understanding and protecting high-value water sources in central Queensland's Great Artesian Basin.

This research program will reveal new knowledge about Great Artesian Springs ranging from cultural values and uses to a better understanding of biogeochemical processes, water flows and recharge for the benefit of a wide range of stakeholders, including local First Nations peoples, conservation groups, landholders and government agencies.

"We're looking at the processes and value of Queensland's Great Artesian Springs, specifically the Wardingarri Springs, in some extremely diverse ways, as can be seen in the projects of two current PhD students, Mr Clint Hansen and Ms Monica Esmond," said lead researcher Professor Matt Currell of the Australian Rivers Institute and the School of Engineering and Built Environment at Griffith University.

"Mr Hansen, an Iman Traditional Owner, is conducting both qualitative and quantitative research focusing on First Nations water rights, uses and values of the region."

This research is helping to document the cultural values supported by the springs and other waters of the Wardingarri (Upper Dawson) catchment, in the context of ongoing extraction of coal seam gas and water from the underlying Surat and Bowen basins.

"As a local Traditional Owner, Clint brings unique and invaluable skills and knowledge to his research, into the ground and surface water systems flowing through Iman Country," Professor Currell said.

"His positionality and mutual respect within his community ensure that his research is highly impactful and will benefit the Iman People and their Country for years to come."

Ms Esmond's research is is using isotope chemistry to 'fingerprint' different waters and to better understand the source aquifers for different springs in the region, the timescales of groundwater recharge and flow to springs, and the biogeochemical processes and dependencies of spring ecosystems.

"Monica is using a suite of environmental isotopes sampled in the springs, surface water and groundwater of the region, and combining this with analysis of environmental DNA as a way of pioneering a new approach to identifying the contributions of water from different springs into surface water," Professor Currell said.

"She is primarily focusing on the catchments of the Wardingarri and Carnarvon Creek – a region of outstanding cultural and ecological significance, which to date, has had limited hydrogeological research conducted.

"The combination of environmental isotopes and eDNA promises to give unique and important insights on the waters of this vitally important region, and their vulnerability to climate change and resource extraction."

Early findings from the research and a letter to the Commonwealth Minister for Water and the Environment from the research team, traditional owners and conservationists, has helped inform decision-making regarding oil and gas industry plans to discharge wastewater to the Wardingarri system.

Overall, this multi-disciplinary research program is providing enhanced knowledge for the long-term protection of nationally and globally important springs and the communities they support.

A JUST WORLD ON A SAFE PLANET: QUANTIFYING EARTH SYSTEM BOUNDARIES

Griffith researchers collaborated on a new study that shows humans are taking colossal risks with the future of civilisation and everything that lives on Earth.

Published in *Nature,* researchers from across the globe delivered the first quantification of safe and just Earth system boundaries on a global and local level for biophysical processes and systems that regulate the state of the Earth system.

"For the first time, we have assessed safety and justice for humanity on Earth, quantifying some of the key variables regulating life support and Earth system stability," said author and member of the Earth Commission, Professor Stuart Bunn from the Australian Rivers Institute.

"By incorporating justice, the idea of avoiding significant harm to people across the world, into our assessment of Earth system boundaries, it further tightens safe operating range for humans on Earth with regard to climate, water, biosphere, nutrient use/cycle and pollutants."

As this research convened by the Earth Commission concludes, this issue is extremely challenging because several of these safe boundaries have already been crossed.

"We are in the Anthropocene, putting the stability and resilience of the entire planet at risk. This is why, for the first time, we present quantifiable numbers and a solid scientific foundation to assess the state of our planetary health not only in terms of Earth System stability and resilience but also in terms of human well-being and equity / justice," said Professor Johan Rockström, Earth Commission Co-Chair, lead author and Director of the Potsdam Institute for Climate Impact Research.

Justice tightens the available space for humans on Earth

The Earth system is an interconnected set of biophysical processes that operate across regions and scales, where interference in one part of the world can enormously impact other regions.

This study builds on the scientific evidence defining the biophysical conditions to maintain a stable planet to underpin life on Earth by providing safe and just Earth system boundaries for five critical domains that play a crucial role in life support and Earth stability. It also explores what is needed to minimise significant harm to humans due to changes in the Earth system.

"**Safe** boundaries ensure stable and resilient conditions on Earth and use an interglacial Holocene-like Earth system functioning as a reference point for a healthy planet," said co-author and Earth Commission staff member Dr Ben Stewart-Koster from the Australian Rivers Institute.

"Some boundaries, such as surface and groundwater flows, are designed to protect ecosystems and ecosystem services on which communities rely."

A stable and resilient Earth is dominated by balancing feedbacks that cope with buffer and dampen disturbances. Cutting-edge science on climate tipping points features as one major line of evidence to set safe boundaries.

Just boundaries minimise human exposure to significant harm or irreversible adverse impacts on countries, communities and individuals from Earth system change and ensure minimum access to resources for people.

The Safe and Just boundaries take the stricter of the two quantified levels.

For a safe future, the world needs global targets beyond climate

Global target setting has focused on climate change and limiting global warming well below 2 °C and aiming at 1.5 °C according to the Paris Agreement. The world has already passed the safe and just climate boundary, which is set at 1 °C above pre-industrial temperature levels, as tens of millions of people are already harmed by the current level of climate change.

Science also clearly shows there is a need to manage all the other biophysical systems and processes on Earth that determine the liveability of the planet.

Health indicators for people and the planet

The quantified safe and just boundaries for other biophysical systems such as biodiversity, freshwater and different kinds of pollution to air, soil and water have also mostly been breached.

For example, human activities are altering water flows, excessive amounts of nutrients are released into waterways from fertiliser use, and limited natural areas are left.

"Human activities are altering surface water flows, and unsustainable groundwater pumping will lead to rapid declines in groundwater storage, jeopardising global food security, and decreasing ecosystem resilience to drought as well as causing the loss of groundwater-dependent ecosystems", said co-author Dr Christopher Ndehedehe from Griffith University.

"These pose existential threats for a stable planet, ecosystems, and their vital contributions to people."

"The results of our health check are quite concerning: Within the five analysed domains, several boundaries, on a global and local scale, are already transgressed. This means that unless a timely transformation occurs, it is most likely that irreversible tipping points and widespread impacts on human well-being will be unavoidable. Avoiding that scenario is crucial if we want to secure a safe and just future for current and future generations," continued Rockström.

Science for real-world application

"The Earth Systems Boundaries need to be translated so that businesses, cities, governments and civil society can understand their share of resources and responsibilities", said co-author and Earth Commission staff member Syezlin Hasan from the Australian Rivers Institute.

"This will underpin the setting of actor-specific science-based targets to address increasing human exposure to the climate emergency, biodiversity decline, water shortages, ecosystem damage from fertiliser overuse in some parts of the world coupled with lack of access elsewhere, and health damage from air pollution.

In a time of increasing scrutiny and expectations, the resilience and success of businesses, cities and governments will depend on their ability to accurately measure their resource use and environmental impacts and take swift actions towards reducing their negative impacts on people and the planet. This can enhance their ability to take advantage of opportunities that arise within the finite limits of the earth.

"A safe and just transformation of the planet requires urgent, collective action by actors within governments, cities and businesses to move us back within Earth system boundaries and keep our planet's life support system intact," Professor Bunn said.

"With this global scientific assessment, we provide all stakeholders with scientific boundaries that can enable a prosperous and equitable world development on a stable planet, a better future for people and the planet. This new science functions as input to the development of science-based targets. These can be adopted by cities, businesses and countries to address the systemic global crises of climate change, biodiversity loss, nutrient overloading, overuse of water, and air pollution." concludes Rockström.

This study was part of the work carried out by the Earth Commission, hosted by Future Earth.

https://doi.org/10.1038/s41586-023-06168-4

PLASTICS ARE BREAKING UP, NOT DOWN, IN LAKES WORLDWIDE

For the first time, plastics have been assessed in lakes across the world in a new study published in the *Nature* journal, with some lakes worse impacted than oceans.

The study shows that plastic fragments and fibres from washing clothes and packaging residues in freshwater lakes and reservoirs are higher than those in plastic islands in the ocean – the so-called plastic 'Garbage patches'.

"Plastics and microplastics affect lakes and reservoirs on a global scale, including the most remote lakes", said co-author Professor David Hamilton, Director of Griffith University's Australian Rivers Institute.

"In addition to negatively impacting drinking water, plastics pollution has harmful effects on aquatic organisms and ecosystem function. Plastics don't break down, they mostly break up into smaller and smaller particles, with increasing potential to be absorbed by living organisms, including humans."

The research was coordinated through the *Global Lake Ecological Observatory Network* (GLEON), an international consortium of researchers known for investigating global-scale processes and phenomena occurring in freshwater environments. Professor Hamilton was one of the founding members.

The research used plankton nets to sample the plastic debris in 38 lakes in 23 different countries. The samples were analysed at the University of Milan-Bicocca, using Raman micro-spectroscopy to accurately determine the polymeric composition of microplastics.

Lakes with the highest contamination of plastic debris are some of the primary sources of drinking water for local populations, including Lakes Maggiore (Italy), Lugano (Switzerland/Italy), Tahoe (US) and Neagh (UK). Lakes in Australia showed moderate levels of plastics contamination.

"Lakes act as '**pollution sentinels**' because they integrate and accumulate microplastics arising from the atmosphere and land," said Professor Hamilton

"Plastics that accumulate on the surface of aquatic systems can promote the release of methane and other greenhouse gases," explains Veronica Nava, a research fellow at the University of Milan-Bicocca's Department of Earth and Environmental Sciences under the supervision of Professor Barbara Leoni, coordinator of the Inland Water Ecology and Management research group.

"Plastics can reach beyond the hydrosphere and interact with the atmosphere, biosphere and lithosphere, potentially affecting biogeochemical cycles."

"Additionally, these environments can retain, modify, and transport plastic debris across watersheds to the oceans," Ms Nava concludes.

"These results demonstrate the global scale of plastic pollution. No lake, not even those furthest from anthropogenic activity, can be considered truly pristine. This should prompt us to review pollution reduction strategies and waste management processes."

https://doi.org/10.1038/s41586-023-06168-4

STUDENTS FLOW TO AN INTEGRATED APPROACH TO WATER MANAGEMENT

For Ammar Orakzai, there's always something to learn in the water, sanitation and hygiene (WASH) field; it's what drew him to the whole water cycle approach of the Master of Integrated Water Management program of the Griffith University based International WaterCentre.

As UNICEF's Chief of the Water, Sanitation and Hygiene Program in Tajikistan, Ammar leads the overall Climate resilient water and sanitation program with a budget of 16 million USD.

"We focus on policy and strategic engagement to strengthen the enabling environment for WASH actions, providing technical support to the government on Sustainable Development Goal six (SDG 6.1 and 6.2), to '*Ensure access to water and sanitation for all*', by targeting both rural and urban environments, with a child rights perspective in mind,' said Ammar.

"We also support infrastructure projects including in social institutions (such as schools and health care facilities), disaster risk reduction, climate resilience, emergency preparedness and response and inclusion.

A key aspect of Ammar's role is developing and implementing an expanded WASH strategy for UNICEF Tajikistan that incorporates a broader engagement with enabling environment, which includes policy, regulation, legislation, sector planning, partnerships, sector coordination and financing in addition to grassroots level work.

"By providing technical support to the Ministry of Health and Social Protection in close coordination with the Ministry of Energy and Water Resources, World Bank and United Nations Development Program in Tajikistan, we are helping to direct the development of the sanitation and hygiene component of the Tajikistan's National Water Strategy."

Ammar credits the Master of Integrated Water Management delivered by the International WaterCentre, as being a crucial springboard that helped to prepare for understanding the bigger picture and cross-sector linkages of the water landscape.

"It equipped me to deal with the wicked problems in the water sector across the globe," Ammar said.

"I discovered the program in 2017 while searching for an inter-disciplinary course to complement my work with UNICEF, coordinating the Cluster for humanitarian WASH response to a conflict situation in Pakistan."

Having extensive experience in the international WASH sector since 2006 in a development and humanitarian context and several different countries across South and Central Asia, Middle East and East Africa, Ammar came to the realisation that integrated water management requires a holistic, whole of water cycle approach which is interdisciplinary and inclusive.

"We often work in boxed approaches in the sector, but an Integrated Water Management approach is needed if we want to solve the long-standing challenges in the water sector."

"Although I had experience in countries like Pakistan, Afghanistan, Turkey, Syria, Iraq, Philippines, Greece, Somalia and Tajikistan, some of which had fragile environments, I needed to increase my knowledge of technical, social, economic, environmental and political aspects of water management. The master's program allowed me to develop my capacity to use whole of water cycle, multidisciplinary approaches to water management."

Water management the world over is facing a host of serious challenges that will require future water managers to have the ability to cross social, environmental and technological boundaries, combining multi-disciplinary knowledge with theory to inform effective practice.

The Master of Integrated Water Management is one of the few programs that take a truly integrated approach to water management, bringing together social, economic, ecological, and engineering dimensions to effectively address complex sustainable development challenges that have water at their core.

"The program expanded my ability to understand the holistic picture and see the interconnected elements of WASH and sustainable development and the potential interactive effects they have on one another, which I previously wasn't so clear on," Ammar said.

At the heart, the program incorporates practical projects providing those enrolled with the opportunity to apply the knowledge they have gained.

"The projects were crucial for applying the WASH knowledge we had learnt. They also cultivate critical thinking in real-life situations through field experience and interaction with experts enrolled in and associated with the program."

Ammar's final project determined the feasibility of adopting a "Water Sensitive Cities" approach and principles in Karachi, a metropolitan city in Pakistan, assessing the enabling environment, infrastructural capacity and other relevant factors within the city.

"The skills I learnt in the master's program and assessing the enabling environment of Karachi were directly applicable to my current role as UNICEF's Chief of Water, Sanitation and Hygiene Program in Tajikistan."

Despite Ammar's substantial experience in the WASH field, he found the program still provided the ability to grow his understanding of water management in specific areas he was interested in.

"I had already worked extensively in the area of WASH in rural environments, so I tailored my major to urban water management, which provided me with key insights into new and different approaches to present and future water challenges and potential solutions that I wasn't familiar with."

"I also loved that this program was for everyone," Ammar recalls. "The students enrolled came from diverse backgrounds, and for me, that added value to the depth of discussions and enriched the overall experience."

"The program definitely strengthened my understanding of the WASH and IWM field and gave me experience applying the knowledge I gain which I use daily in my work with UNICEF as the Chief of Water, Sanitation and Hygiene Program in Tajikistan, helping to achieve positive outcomes for those vulnerable populations, especially children, facing water stress.

RESEARCH HIGHLIGHTS

BUSHFIRE-FIGHTING CHEMICALS EXTINGUISH FROG DEVELOPMENT

A new Griffith study has found that bushfire fighting chemicals commonly marketed as environmentally friendly can severely affect frog development.

Published in *Aquatic Toxicology*, the study assessed two chemicals, Phos-Chek LC95W and BlazeTamer380, used globally as alternatives for firefighting foams containing per- and poly-fluoroalkyl substances (PFASs), the latter of which has a history of detrimental environmental effects, impacting wildlife decades after their use.

"While many current firefighting chemicals are an improvement on past formulations containing PFASs, there has been very little testing done, so we don't have a good understanding of their ecological impacts, especially on sensitive frog species," said ecotoxicologist and senior author Dr Chantal Lanctôt from the Australian Rivers Institute's Toxicology Research Group (ARITOX) and Frog Research Team.

"This study shows that run-off or accidental application of these chemicals into small waterways can have significant implications for the growth of frogs, impairing the development of striped marsh frog (*Limnodynastes peronii*) tadpoles and even leading to death."

"With global wildfire events becoming more frequent and severe due to the warmer and drier conditions, there is an increasing demand for aggressive and effective bushfire management techniques, using firefighting chemicals, to suppress and stop the fires spreading."

The recent unprecedented Australian 'Black Summer' bushfires saw major world heritage sites burnt and firefighting chemicals applied to otherwise pristine environments that are habitats and breeding sites for many frog species.

With many Australian frog populations experiencing declines and little known about how firefighting chemicals impact at-risk species, this research evaluates the risks of these chemicals to protect key biodiversity assets during fire suppression and management activities.

"The landscape-scale application of firefighting chemicals could have important ramifications for sensitive frog species, especially those already threatened by chytridiomycosis, the deadly disease impacting frog populations globally", said co-author and wildlife disease expert Dr Laura Grogan from the Griffith Centre for Planetary Health and Food Security.

Therefore, understanding these products' potential direct and indirect ecological impacts is critical for protecting sensitive and developing frog species, particularly the chemicals' long-term and sub-lethal effects.

The group noted that over 16 days, both the firefighting chemical formulations tested affected the growth and development of frogs, with the Phos-Chek formulation causing the death of all but 8% of animals at upper concentrations (1 g/L).

"Delayed growth and development can be a real problem for frogs, leading to competitive disadvantages. It reduces breeding success and increases an animal's susceptibility to predation," said co-author and threatened species management and conservation expert Dr Clare Morrison from the Centre for Planetary Health and Food Security.

The authors stress that understanding the ecological risks of firefighting chemicals is central to aligning bushfire management with conservation actions to better protect Australia's at-risk frog species.

The study was funded through the South East Queensland Fire and Biodiversity Consortium and Healthy Land and Water. It was part of an Australian Research Council Discovery Early Career Award to Dr Lanctôt.

https://doi.org/10.1016/j.aquatox.2022.106326

SCIENTIFIC CHALLENGES & KNOWLEDGE GAPS WITH NUTRIENT OFFSETTING

New Griffith-led research outlines the steps needed for nutrient offsetting to achieve its potential as a more cost-effective way of improving water quality.

Published in the *Journal of Environmental Management*, this research identifies the scientific challenges and biophysical-chemical knowledge gaps that prevent nutrient offsetting from being incorporated in catchment health programs and suggests strategies to bridge these gaps and increase confidence in environmental outcomes for waterway health.

"Nutrient offsetting allows polluters to pay for reductions in nutrient load flowing into a river from alternative sources, preferably upstream with a lower cost," said senior author Professor Michele Burford at the Australian Rivers Institute.

"To date, nutrient offset/trading has not been widely adopted, partially due to the inability of regulatory mechanisms to address the concept and the complexity of the necessary governance structure.

"However, there are also uncertainties in the biophysical-chemical understanding of nutrient sources and their impacts on waterways for offset programs."

"It is critical to assess the feasibility of employing nutrient offsetting to manage nutrient load in waterways and achieve catchment health."

To this end, offset programs need to evaluate appropriate time- and spatial-scales (local, catchment, or regional) for assessing and managing nutrient load and quantify the differences in characteristics between point and non-point nutrient sources to ensure that offsets can realistically achieve environmental management goals.

"Accurately quantifying the diffuse source nutrient loads is challenging," said lead author Dr Jing Lu, a research fellow at the Australian Rivers Institute. "For nutrient offset to be successful, we need better monitoring design to quantify nutrients entering waterways, as well as robust modelling approaches to reduce uncertainties."

"Catchment interventions also need effective ongoing monitoring programs and modelling to ensure that nutrient reductions are sustained over the period of the offset program and to reduce the uncertainty of an intervention's effectiveness.

"A better biophysical-chemical understanding of a catchment also allows us to prioritise areas within catchments with key nutrient sources appropriate for targeted interventions to achieve aquatic ecosystem health."

Monitoring nutrient discharge patterns and developing methodologies to determine environmental equivalency ratios that quantify the impacts of different nutrient sources on ecosystem response across seasons and at various river sites, can further ensure that nutrient offsetting leads to genuine ecosystem health improvements and positive environmental outcomes for our waterways.

The research is funded through an Australian Research Council Linkage Project and includes industry collaborators Urban Utilities and the Queensland Government Department of Environment and Science.

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SEDIMENTATION SIFTED OUT OF POLLUTION PRIORITIES

Research has revealed that sediment runoff from land use change and unsustainable development is missing from global priorities despite being one of the greatest threats facing freshwater and marine ecosystems.

Published in *Science,* Dr Caitie Kuempel from Australian Rivers Institute outlines how the Kunming-Montreal Global Biodiversity Framework (GBF), targeted to halt biodiversity loss and restore natural ecosystems by 2030, overlooks sediment runoff, a key driver of poor water quality that threatens freshwater and marine ecosystems.

While the GBF includes four goals and 23 targets to halt biodiversity loss and restore natural ecosystems and reduce pollution from sources such as plastics and nutrients, none relates to the enormous loads of sediment being washed into waterways.

"To conserve aquatic environments, the global community must prioritise explicit indicators and commitments to reduce excess sediment," Dr Kuempel said.

Excess sediment is caused by land-use change and unsustainable development, including logging, agriculture, and construction.

"When that sediment enters rivers, lakes, and coastal waters, it can smother nonmobile organisms, such as plants and corals," Dr Kuempel said.

"The cloud of sediment settling out of the water column shades out the available light essential for many species to grow, feed, and reproduce."

For this reason, excess sediment in waterways can have real consequences for ecosystem health and function and reduce the resilience of freshwater and marine ecosystems to climate change.

Globally, more than 40% of coral reefs are at risk from sediment export, and in the southern hemisphere, sediment run-off from land use change has increased by more than 40% since 1984.

"Governments and industry need to work together with scientists to monitor and mitigate anthropogenic sediment impacts on freshwater and marine systems," Dr Kuempel said.

"Water quality and erosion metrics are relatively easy to measure using traditional and remote sensing methods and can be used to identify high sediment levels."

In addition to systematic land restoration and protection to combat land conversion, mitigating the adverse effects of sediment requires erosion and sediment control, including maximising covered ground, managing overland water flow, and sediment trapping, particularly in areas with high erosion risk like steep slopes.

On the other side of the coin, we also need to consider that infrastructure like dams can prohibit the sediment flow required downstream.

"The Australian government has committed to sediment reduction regulations in catchments near the Great Barrier Reef, but policies to reduce sediment loads must be incorporated into global conservation commitments," Dr Kuempel said.

"Managing sediment pollution would help to achieve global goals by facilitating habitat and species conservation, promoting sustainable food production and responsible urbanisation, and improving natural resource management, while at the same time increasing the resilience of freshwater and marine ecosystem to climate change."

https://doi.org/10.1126/science.adh2147

NUTRIENT STRATEGIES, A WAY BLUE-GREEN ALGAE HEDGE THEIR BETS IN BLOOMS

Griffith researchers are helping shed new light on how blue-green algae blooms can continue long after their food source in the water has disappeared.

Published in *Proceedings B*, the Royal Society's flagship biological research journal, and conducted in collaboration with the Nanjing Institute of Geography and Limnology, Chinese Academy of Sciences, this study investigated the role of cellular nutrient storage in blue-green algae and their ability to switch nutrient strategies, which leads to 'winners and losers' when species of blue-green algae are competing for limited nutrients.

"Cyanobacteria, commonly known as blue-green algae, are a group of photosynthetic bacteria often associated with water quality problems in freshwater and marine systems," said co-author Professor David Hamilton, Director of the Australian Rivers Institute.

"Several species of cyanobacteria produce toxins that are harmful to aquatic organisms and humans, which can become concentrated in waterways and lakes in the event of cyanobacteria blooms."

Blooms of cyanobacteria are often a response to warm, calm conditions that allow for both the build-up and rapid growth of algal cells.

"These toxic cyanobacteria blooms and their ecosystem impacts have been associated with excess levels of nutrients in lakes and waterways over the past few decades," said co-author Professor Michelle Burford of the Australian Rivers Institute.

"Despite ongoing research on the cyanobacteria's nutrient food source and how it affects the formation of algal blooms, our understanding of the nutrient–cyanobacteria relationship remains relatively simplistic."

Most research to date has focused on the amount of nutrients the cyanobacteria have available in the external environment. This has led to confusing results and questionable advice about how to limit and manage nutrient loads going into waterbodies to reduce the potential for cyanobacterial blooms.

However, as Professor Hamilton points outs, cyanobacteria possess a number of nutrient utilisation strategies that allow blooms to persist and grow even when levels of their nutrient source, dissolved inorganic phosphorus, which they need to survive, is undetectable in the environment.

"Information on the variety of strategies used by cyanobacteria to maintain dominance and form blooms under low-nutrient conditions is critical for predicting biomass as well as species composition," Professor Hamilton said.

"In our study, we subjected two species of cyanobacteria to different levels of nitrogen and phosphorus in the water in order to look at their strategies nutrient-limited conditions, their ability to store these nutrients within their cells and interplay between nitrogen and phosphorus."

The responses for various strains of the two cyanobacteria species were quite variable. Some took up the nutrients as quickly as possible and expended them to support rapid growth, while others took up the nutrients but stored them to grow slowly but over a more extended period of time.

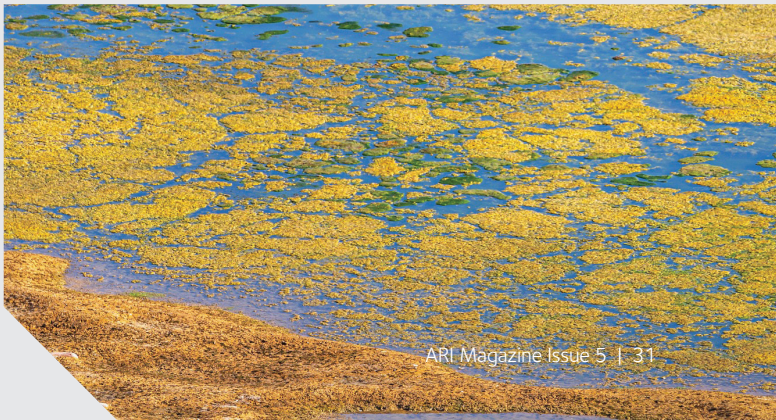
"These growth responses are a bet-hedging strategy for the cyanobacteria; either grow quickly and outcompete your competitors or store the nutrients, grow slowly, and gradually replace other species who got out of the blocks quicker," Professor Hamilton said.

This research explains why cyanobacteria, at times, continue to grow for many generations before they collapse and why blooms can follow storm events after the cyanobacteria have taken up nutrients that wash off catchments into waterways, with important implications for managing nutrients.

Professor Hamilton concluded, "going forward, we strongly advocate for the analysis of nutrients in physiological and modelling studies to help understand cyanobacteria responses to nutrient-limited environments."

The research was supported by an Australian Research Council Discovery Project grant to Professors Hamilton and Burford, and the first author was Dr Mandy Xiao, a Research Fellow in the Australian Rivers Institute who is now an Associate Professor in NIGLAS. The Australian Rivers Institute has a Memorandum of Understanding with NIGLAS, serving as an umbrella for several active research partnerships with NIGLAS.

https://doi.org/10.1098/RSPB.2023.1204



FINGERPRINTING METABOLISM ACROSS THE ANIMAL KINGDOM

Griffith-led research is revealing metabolic strategies that are surprisingly consistent across the rich diversity of life in the animal kingdom.

Published in *Science Advances*, this research shows that despite their outward differences, animals share strategies of mitochondrial metabolism, the energy-producing chemical reactions inside cells.

"Using a carbon isotope approach called "Isotomics", the team investigated how metabolism changes in animals, using chemical signals (13C/12C ratios) from the carbon of the most active amino acids during metabolism," said Emeritus Professor Brian Fry from the Australian Rivers Institute.

"We used the Isotomics method to fingerprint metabolism and metabolic strategies across a diverse group of eukaryotic organisms, including humans, hoofed animals, whales, and a host of fish and invertebrate species.

"We discovered common biochemical fingerprints for metabolism in major life phases, such as growth and reproduction, that were based on isotope values of amino acids, fats and carbohydrates."

This research is the first step in cracking the isotope code for metabolism. Like the genetic code that revealed the fundamental blueprints of life several decades ago, Isotomics reveals the fundamental biochemical pathways of life.

"There is an as yet untapped ocean of metabolic Isotomics knowledge that this study has broken the code to and that we can now begin to access," Professor Fry said.

"Our new Isotomics technique was very reliable, tracing well-known differences between male vs. females, young vs. old, and one species vs another."

Some of the species were similar in surprising ways. For example, the metabolic fingerprints of oysters and humans were very similar because both had very balanced metabolisms.

"Using carbon isotopes, we traced an animal's diet, its metabolic response to the diet, and how diets influence health at a fundamental level," Professor Fry said.

"This ground-breaking technique can teach us a lot about how various animals produce the energy they need.

"Our results show that mammals like humans, for example, use fats as a pantry for thermal regulation in a very extensive endothermic metabolism, while fish and prawns in Moreton Bay did something dramatically and unexpectedly different. They grew fast but then cannibalised their proteins to make reproductive lipids in a boom-and-bust metabolism."

By setting the groundwork for what we could consider normal present-day metabolism, the future applications of this technology could include investigating abnormal metabolism for hidden problems or early warning indicators for human metabolism involved in diseases like cancer.

"This technology could open up a vast array of exciting areas of research," Professor Fry said.

"We can look into how metabolism fingerprints diet-related conditions like obesity or starvation, with police already having shown a definite interest in forensic cases of people held in conditions of forced starvation.

"We can also investigate how metabolism changed in the past by looking at bone protein collagen samples from ancient humans and other animals."

This research also has implications for future wildlife studies.

"We can look for similar metabolic problems or general differences in metabolic strategies that help track other organisms' responses to human-induced stressors like climate change or excess nutrients in waterways, which leads to algal blooms," said Dr Kaitlyn O'Mara, a co-author and research fellow at the Australian Rivers Institute.

https://doi.org/10.1126/sciadv.adg1549

EARLY CAREER RESEARCH SPOTLIGHT

EARLY-CAREER RESEARCHER, DR SHIMA ZIAJAHROMI

Bit by bit microplastics from tyres are polluting our waterways

In urban stormwater, particles from tyre wear were the most prevalent microplastic, a new Griffith-led study has found.

Published in *Environmental Science & Technology*, the study showed that in stormwater runoff during rain, approximately 19 out of every 20 microplastics collected were tyre wear particles, with anywhere from 2 to 59 particles per litre of water.

"Pollution of our waterways by microplastics is an emerging environmental concern due to their persistence and accumulation in aquatic organisms and ecosystems," said lead author Dr Shima Ziajahromi, a research fellow at the Australian Rivers Institute.

"Stormwater runoff, which contains a mixture of sediment, chemical, organic and physical pollutants, is a critical pathway for microplastics to washed off from urban environments during rain and into local aquatic habitats.

"But to date, our knowledge of the amount of microplastics in urban stormwater, particularly tyre wear particles, is limited, as is the potential strategies we can use to minimise this source."

Tyre rubber contains up to 2500 chemicals, with the contaminants that leach from tyres considered more toxic to bacteria and microalgae than other plastic polymers.

"Due to the analytical challenges in measuring this source of microplastics in stormwater, research to date often lacks information about the actual number of tyre wear particles in water samples," said Dr Ziajahromi.

Quantitative information of this type is crucial to improve our understanding of the amount of tyre wear particles in stormwater, assess the environmental risk, and develop management strategies.

"Our study quantified and characterise microplastics and tyre wear particles in both stormwater runoff and sediment of stormwater drainage systems in Queensland," said co-author Professor Fred Leusch, who leads the Australian Rivers Institute's Toxicology Research Program.

"We also assessed the effectiveness of a stormwater treatment device to capture and remove these contaminants from stormwater and evaluated the role of a constructed stormwater wetland for capturing microplastics in the sediment, removing it from stormwater runoff.

"The device is a bag made up of 0.2-millimetre mesh which can be retrofitted to stormwater drains. Although originally designed to capture gross pollutants, sediment, litter, oil, and grease, it significantly reduced microplastics from raw runoff, with up to 88% less microplastics in treated water that had passed through the device."

Sediment samples collected from the inlet and outlet of a constructed stormwater wetland contained between 1450 to 4740 particles in every kilogram of sediment, with more microplastics in the sediment at the inlet than the outlet, indicating the wetland's ability to remove them from stormwater.

"Microplastics that enter constructed wetlands for stormwater drainage systems settle in the sediment and form a biofilm, leading to their accumulation over time and removing them from stormwater runoff," said Dr Ziajahromi.

"Urban stormwater runoff typically requires treatment for the removal of suspended solids and nutrients such as nitrogen and phosphorus in many jurisdictions in Australia, with some also requiring the removal of gross pollutants. However, regulations are lagging behind when it comes to microplastics and tyre wear particles."

"Our findings show that both constructed wetlands and the stormwater capture device are strategies that could be potentially used to prevent or at least decrease the amount of microplastic tyre wear particles being transported from stormwater into our waterways."

This research was funded by SPEL Stormwater.

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EARLY-CAREER RESEARCHER, DR REBEKAH GRIEGER

How will abandoned farmlands respond to sea level rise?

A Griffith University study found that wetland vegetation will naturally re-establish on abandoned agricultural land threatened by rising sea levels.

Published in *Restoration Ecology*, the study assessed the potential for abandoned agricultural land in South East Queensland to naturally regenerate into supratidal wetlands (those above the tidal line) under conditions that simulate sea level rise by reinstating the tidal flow to the area.

"We discovered that the wetland vegetation can recover after agricultural abandonment in favourable conditions where there was no tidal water," said lead author Dr Rebekah Grieger, a research fellow at the Australian Rivers Institute, "but when tides were re-introduced, the vegetation suffered."

With the sea level predicted to rise, the structure and type of trees/plants that makeup wetlands above the tidal range are likely to change as they become inundated with saltwater.

"These changes could provide some unique opportunities for the restoration of adjacent agricultural land," Dr Grieger said.

"Regeneration of coastal wetland vegetation on abandoned sugarcane cropland, specifically through tidal reinstatement, provides important opportunities to evaluate the ecological outcomes of this management approach and explore impacts of projected climate change."

Coastal wetlands are among the most economically and environmentally important ecosystems globally, providing ecological services such as improving water quality, providing habitat, carbon sequestration, and storm buffering.

However, coastal ecosystems are facing global decline from a host of ongoing threats, including wetlands modified for conversion to economically productive agriculture and horticultural systems, as well as other threats impacting their structure and function.

"In tropical and subtropical coastal regions, sugarcane cropping has led to the widespread clearing of coastal vegetation, the levelling of the landscape, and construction of drainage channels with flood gates to control water levels," Dr Grieger said.

"So, the restoration of abandoned agricultural lands provides us with a great opportunity to reestablish lost wetland ecosystems and the services they provide like carbon sequestration, water quality improvement, and weed management."

"Our goal was to better understand the ability for wetlands to naturally regenerate after the cessation of sugarcane farming and how coastal wetlands in subtropical southeast Queensland respond to the sudden and permanent changes to tidal inundation likely to occur as a long-term outcome of sea level rise."

To investigate the ability of wetlands to naturally regenerate, the researchers assessed an area of agricultural land previously used for sugar cane cultivation that had been abandoned for a decade and a half. Supratidal wetlands, which are generally exposed to low salt levels, are highly vulnerable to climate change and the associated rise in sea levels.

"In the 15 years since crop abandonment, distinct communities of typical supratidal wetland vegetation have naturally re-established, predominantly in freshwater, with minimal management intervention," Dr Grieger said.

"Reinstating natural tidal flows to degraded wetlands and agricultural lowlands, which in the past were naturally exposed to tidal fluctuations, increased the flooding of these areas by brackish water and triggered some strong responses of vegetation."

As salinity is a key driver of vegetation composition, the current state of supratidal wetlands with relatively low salinity can be threatened by saline water inundation. As such, despite the benefits of restoring tidal wetland environments, this approach could impact freshwater biota sensitive to salty flood waters.

"We found that restoration through reinstatement of tidal flows affected these vegetation communities through reduced understory diversity and coverage," Dr Grieger said.

Passive wetland restoration relies on germination from in-situ soil seed banks and local water-mediated dispersal, however, past agricultural land use can reduce the abundance and viability of seeds stored in the soil.

The researchers found that while tidal reinstatement reduced the germination capacity of non-salt tolerant species, soil seed banks not only reflect the current standing vegetation communities but provide a store of species that represent a range of potential vegetation types that can establish under changed conditions, indicating potential future vegetation transitions.

"Tree communities appeared resilient to tidal reinstatement in the short term and may persist for some time yet, however, salt-tolerant understorey species spread under tidal reinstatement conditions," Dr Grieger said.

"Following the removal of flood gates, species richness and understory vegetation cover generally decrease, except in marsh plots, where salt-tolerant species increased throughout.

"While supratidal wetland vegetation can re-establish on abandoned farmland with minimal management intervention and little need to actively replant these landscapes, the increased saltwater flooding, likely to occur long-term sea level rise, puts these communities at risk of transitioning to salt-tolerant vegetation, with reduced species richness, plant abundance, productivity, and regeneration."

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EARLY-CAREER RESEARCHER, DR ARTHUR BARRAZA

Pollutants may mimic female sex hormones, feminising endangered green sea turtles

A Griffith-led study on the influence of pollution on the sex ratio of clutches of green sea turtles has found that it may compound the female-biasing influence of rising global temperatures.

Published in *Frontiers in Marine Science*, the researchers concluded that exposure to heavy metals cadmium and antimony and certain organic contaminants, accumulated by the mother and transferred to her eggs, may cause embryos to be feminised in green sea turtles (Chelonia mydas), a species already at risk of extinction from a current lack of male hatchlings.

"Green sea turtles are listed as endangered on the IUCN Red List of Threatened Species, threatened with risk of extinction due to poaching, collisions with boats, habitat destruction, and accidental capture in fishing gear," said author Dr Arthur Barraza, a researcher at the Australian Rivers Institute at Griffith University.

"But they also face another more insidious threat linked to climate change. Sea turtles' embryos developing in their eggs have temperature-dependent sex determination, which means more and more develop into females as temperatures keep rising."

Hundreds of females are born for every male in the northern part of the Great Barrier Reef off Australia.

"Our research shows that the risk of extinction due to a lack of male green sea turtles may be compounded by contaminants that may also influence the sex ratio of developing green sea turtles, increasing the bias towards females," Dr Barraza said.

"We studied the effects of pollution on the development of green sea turtles at a long-term monitoring site on Heron Island, a small coral sand cay in the southern Great Barrier Reef, where between 200 and 1,800 females come to nest every year."

At the Heron Island study site, the sex ratio is currently more balanced than near the equator, with two to three females hatching for every male.

Conducted as part of WWF-Australia's Turtle Cooling Project, researching ways to counter the occurrence of female-bias nests at warm beaches due to climate change, the authors collected 17 clutches of eggs within two hours of being laid. They reburied them next to probes recording the temperature every hour inside the nest and at the beach surface.

When the hatchlings emerged, their sex was determined and levels of the 18 metals, as well as organic contaminants like polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and polybrominated diphenyl ethers (PBDEs).

"These contaminants are all known or suspected to function as 'xenoestrogens' or molecules that bind to the receptors for female sex hormones," said senior author Dr Jason van de Merwe, a marine ecologist and ecotoxicologist at the Australian Rivers Institute.

"Accumulation of these contaminants by female turtles happens at foraging sites. As eggs develop within her, the females absorb the accumulated contaminants and sequester them in the liver of the embryos, where they can stay for years after hatching."

Although the final sex ratio varied between clutches, most nests produced predominantly female hatchlings, with the greater the amount of estrogenic trace elements, particularly antimony and cadmium, in the hatchlings' liver, the greater the female bias within the nest.

"From these results, we concluded that these contaminants mimic the function of the hormone estrogen and tend to redirect developmental pathways towards females," Dr Barraza said.

"As the sex ratio gets closer to 100% females, it gets harder and harder for adult female turtles to find a mate, which is particularly important in the face of climate change already making nesting beaches warmer and more female-biased."

"Determining which specific compounds can change the hatchling sex ratios is important for developing strategies to prevent pollutants from further feminising sea turtle populations," Dr van de Merwe added.

"Since most heavy metals come from human activity such as mining, runoff, and pollution from general urban waste, the best way forward is to use science-based long-term strategies to reduce the amount of pollutants going into our oceans."

This study was supported by funding from the World Wildlife Fund for Nature – Australia (WWF-AU).

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RESEARCH HIGHER DEGREE SPOTLIGHT

HOW MUCH MICROPLASTICS ARE AUSTRALIANS BREATHING INDOORS?

Kushani Perera

Griffith University researchers have taken a forensic look at the amount of airborne microplastics in indoor environments in Australia, and the results are confronting.

Published in *Science of The Total Environment*, the researchers collected and filtered samples of air from seven indoor environments on the Gold Coast where people spend most of their time, including a childcare centre, an office, a school, two homes, a restaurant and a car.

"While all these indoor environments contained airborne microplastic pollution, our results showed that the childcare centre was the worst," said lead author Ms Kushani Perera, a PhD candidate from the Australian Rivers Institute.

"Most people spend more time indoors compared to outdoors, so it's important to quantify the amount of airborne microplastics in indoor air, to understand human exposure."

In this study, microplastic fibres and fragments ranging from 0.020 mm to 5 mm in size were sampled across different indoor and outdoor sites in Southeast Queensland.

"Microplastics were detected in all samples, including outdoor air," Ms Perera said. Plastic pollution in indoor samples was much higher than outdoors, and our sample from the childcare centre had microplastic concentrations 11 times greater than the sample taken outdoors (2.2 particles per cubic metre compared to 0.2 particles per cubic metre)."

"The office and school both had approximately 5-times outdoor concentrations, while the two homes and restaurant were 2.5-4.5 times outdoor levels."

"With these amounts of airborne plastics in indoor environments, our calculations suggest the average Australian male between the ages of 18-64 can breathe in more than 3000 plastic particles every year," Ms Perera said.

Professor Frederic Leusch, a co-author of the study from the Australian Rivers Institute's Toxicology Research Group, said the results can largely be explained by the presence of high plastic-content items indoors, combined with activity levels.

"The largest sources of microplastic pollution are soft textiles, like rugs, carpets, curtains and clothes, which can shed tiny plastic particles that can easily become airborne."

"With the childcare centre, there's more carpet, there's plastic toys, there's more movement in the room as well with kids running, so it's not surprising that airborne microplastics would be high in such an environment."

Fortunately, Prof Leusch highlighted some simple things we can do to reduce our exposure to microplastics.

"The single biggest thing is to regularly open up your windows and get a good breeze coming in from outside.

"Vacuuming regularly will also help. This is because the microplastics in the air will eventually settle into dust on the floor, so if you only vacuum once a month, you may have a large reservoir on the floor that you're re-suspending every time you walk through your house.

"Finally, people need to limit their use of clothes dryers and air conditioners; it's probably the primary source for microplastic particles around the house."

Considering acute, chronic, industrial, and individual susceptibility, more detailed human inhalation exposure levels to airborne microplastics need to be determined for a realistic appraisal of the human health risk, including how much inhaled particles are then exhaled.

Ms Perera said more work was needed to determine if there are any health consequences from inhaling thousands of microplastic particles each year.

"Now we understand the different exposure levels, the next step is to culture human lung cells and expose them to the concentrations and types of microplastics we observed in this study and see what adverse biological effect that can have."

Kushani Perera was supported by a Griffith University International Postgraduate Scholarship.

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FLOATING ALGAE A RAFT FOR JUVENILE PELAGIC FISH

Samuel Mazoudier

Floating macroalgae acts as a raft that provides habitat for a diverse array of juvenile oceanic fish a new Griffith University-led study has found.

Published in *Estuarine, Coastal and Shelf Science*, the study conducted in the Ningaloo Coast World Heritage Area, Western Australia, revealed that fish were more abundant around macroalgal rafts than in open water, with eleven species of juvenile fishes associated with the macroalgae rafts, and one species of both juveniles and adults.

"Floating macroalgal rafts form extensive habitat in coastal waters, supporting abundant and diverse communities of juvenile fishes in the open ocean where structure and food can be sparse," said lead author Samuel Mazoudier, an Honours candidate at the Coastal & Marine Research Centre and the Australian Rivers Institute.

Macroalgal rafts generally form when algae that is attached to the sea floor is dislodged during storms and floats to the surface with the aid of pneumatocysts (air bladders).

"In the Ningaloo Coast World Heritage Area rafts are commonly comprised of Sargassum spp., a species of macroalgae that grows abundantly on coral reefs but that sometimes detaches from the seafloor during storms," said lead researcher Professor Kylie Pitt, Coastal & Marine Research Centre and the Australian Rivers Institute.

"Once detached, the buoyant algae float at the ocean's surface where currents can cause the algae to converge into extensive rafts.

"These rafts attract large numbers of juvenile fish and other animals and are a potentially important transitional habitat for pre-settlement coastal fishes.

"Macroalgal rafts can exceed a square kilometre when currents or wind cause individual algae to converge, thus providing extensive habitat in some regions, and are thus important for supporting biodiversity in marine ecosystems."

This study, in addition to quantifying the diversity and abundance of fishes associated with Sargassum rafts at six sites in the Ningaloo Marine Park, used stable isotopes to determine what fish fed on the algal rafts or preyed on fish associated with the raft.

`"Ultimately, we wanted to find out whether the food web that supported fish around the algal rafts was dependent on the primary production of Sargassum itself or on phytoplankton," said Professor Pitt.

Four of the five types of fish most sampled around the algal rafts had generalist diets whose food webs were predominantly supported by primary production from Sargassum spp. (55–72%) as opposed to plankton.

While only small algal rafts of less than one square metre were sampled in this study, they supported large numbers of juvenile fishes.

"More than 80 fish were observed around a single floating alga," said Mr Mazoudier. "Much larger rafts exceeding 100 metres squared also form in this region and can attract larger animals, including adult squid."

"The prevalence of juvenile fishes around Sargassum rafts highlights a two-directional benthic-pelagic interaction where macroalgae that detach from the sediment of coastal regions provide habitat and acts as the initial food source for pelagic juvenile fishes, which will eventually move back into benthic coastal habitats, where the algal mats originated.

"This study reveals the importance of algal rafts as transitional habitats that provide shelter and food for juvenile fish before settling in coastal areas and for some adult fish.

"But a much more extensive investigation of the temporal and spatial dynamics of these rafts, the organisms that inhabit them, and the potential of rafts to transport and recruit coastal fishes by drifting over considerable distances, is needed."

This research was funded through the Minderoo Foundation.

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NEW STAFF

Research Staff

Professor Matthew Currell
Dr Benny Rousso
Dr Heather Keith
Dr Joseph di Battista
Dr Rahat Shabir
Dr Ryan Heneghan
Dr Orpheus Butler

Professional Staff

Dr Arthur Barraza
Ms Catherine Hanley
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Visiting Academics

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Visiting Scholars

Ms Georgina Rivera Ingraham
Ms Mengyao Li
Ms Ingrid Estrada Galindo
Ms Yiting Li
Ms Zhenguang Lyu
Ms Anouk Glaszmann

PHD CONFERRALS

Lorelle Desley Stanisic, *Unravelling Figuladra: Systematics, phylogeny and biogeography of the land snail genus Figuladra (Eupulmonata: Camaenidae).* Supervisor: Dr Carmel McDougall

Shilpi Kundu, An Analysis of Policy, *Institutions and Practice for Encouraging Climate-Resilient Adaptations in Coastal Agriculture in Bangladesh.* Supervisor: Associate Professor Jim Smart

Rahat Shabir, *Developing effective biochar and biopolymer material as an alternative microbial carrier.* Supervisors: Professor Chengrong Chen & Dr Yantao Li

Jonathan Wanderley Lawley, *What makes blue jellyfish, blue? Integrating chemistry and genetics to unravel colour variation in jellyfish.* Supervisor: Professor Kylie Pitt & Dr Carmel McDougall

Mohammad Ramezani, *Effects of urbanization and climate change on catchment hydrology in South East Queensland (SEQ), Australia.* Supervisor: Professor Bofu Yu

Hsuan-Cheng Lu, *Microplastic pollution in urban wetlands and associated effects on wetland biota.* Supervisors: Professor Fred Leusch, Dr Peta Neal, Dr Shima Ziajahromi, Dr Steve Melvin

Andria Ostrowski, *Stressors in the real world: evaluating impacts of multiple stressors in coastal wetlands.* Supervisors: Professor Rod Connolly & Dr Michael Sievers

Mariah Millington, *The underbelly of the ornamental industry - Unregulated trade and invasive species raise concern for unique native freshwater ichthyofauna.* Supervisors: Professor Mark Kennard & Professor Fran Sheldon

Gebiaw Ayele, *Hydrological and lake modelling of a temperate catchment in North Island, New Zealand.* Supervisors: Professor David Hamilton & Professor Bofu Yu

Pankaj Ram Kaushik, *Quantifying changes in the ecohydrology of the Great Artesian Basin from space and on-ground observations.* Supervisors: Professor Mark Kennard & Dr Christopher Ndehedehe

Yahui Che, *Dust activities in Australia: their severity and spatiotemporal distribution using data from multiple sources.* Supervisor: Professor Bofu Yu

Glauber Cardoso de Oliveira, *Adaptive nested dual data-driven robust multi-objective integrated precinct-scale energy water system planning.* Supervisors: Dr Edoardo Bertone

Tony Kim, *Phytocap soil and vegetation design: laboratory and field trials in Southeast Queensland.* Supervisor: Professor Bofu Yu

Alyssa Giffin, *Marine and coastal ecosystem-based adaptation.* Supervisor: Professor Rod Connolly

NEW PHD/MASTERS CANDIDATES

Jeffrey Ellis, *Tackling nutrient loss and environmental risks in Australian sgricultural soils.* Supervisor: Dr Chris Pratt

Andrew Buckwell, *Sustainable inclusive management of the environment through application of Coasian bargaining.* Supervisor: Dr Syezlin Hasan

Nikol Slynkova, *Microplastics in Great Barrier Reef: abundance, distribution and toxicity on coral health.* Supervisors: Professor Frederic Leusch & Dr Shima Ziajahromi

Suhyun An, *Analysing coastal city resilience: A comparative study of coastal hazard adaptation strategies.* Supervisor: Dr Margaret Cook

Sumbul Saeed, *Bioengineered composite materials as immobilized enzyme scaffolds for industrial applications.* Supervisors: Professor Chengrong Chen & Dr Mehran Rezaei Rashti

Detian Li, *How does fire alter the long-term soil carbon storage and response to global warming?* Supervisor: Professor Chengrong Chen & Dr Mohammad Bahadori

Thanuja Gelanigama Mesthrige, *GIS-based approach for biogas plants' location for biomethane injection in natural gas grid Australia.* Supervisor: Professor Bofu Yu

Most Nilufa Khatun, *Climate change risk and women's vulnerability in the drought-prone area of Bangladesh.* Supervisor: Associate Professor Md Sayed Iftekhar

Philomina Peter, *The combined effects of microplastics and PFAS on microbes, aquatic fauna, and human health.* Supervisor: Dr Edoardo Bertone

Lucas Gimenez, *Chemical cues mediating ecological processes of scyphozoan jellyfish species in Australia.* Supervisor: Professor Kylie Pitt

Richie Palomo Lador, *Vulnerability of the rubber land production areas to the agroclimatic Scenrious and Adampation Strategies towards the long-term sustainability of the rubber-based cropping system in the Northeastern Mindanao.* Supervisors: Professor Chengrong Chen & Dr Johnvie Goloran

Thilakshi Paranavithana, *Impacts of organic amendments on soil carbon sequestration: soil type, type of amendment and climate.* Supervisors: Professor Chengrong Chen & Dr Yunying Fang

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Siobhan Houlihan, *The Impact of Fisheries on Endangered Populations of Marine Turtles and Grey Nurse Shark*. Supervisor: Professor Jason van de Merwe & Dr Kimberly Finlayson

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Nayab Naeem, *Effect of Biochar in Accumulation of Heavy Metals in Plants.* Supervisors: Professor Chengrong Chen & Dr Xiangyu Liu

Ryan Lester, *Toxicological assessment of tire wear particles and leachate to native Australian Fauna.* Supervisors: Dr Steve Melvin

Shritika Prakash, *Understanding the threats to sea turtles and its habitat in the South Pacific.* Supervisors: Dr Jason van de Merwe & Dr Kimberly Finlayson

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