THE UNIVERSITY of ADELAIDE

Research Capability

Environment Institute

make history.

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WELCOME

The University of Adelaide's institutes are globally recognised for their research quality and extensive connections with industry, government and the wider community. The *Environment Institute* supports the University's mission to conduct world-class research and innovation, engage globally and partner with industry, government, and community to create high-value economic and social dividends.

In a changing environmental landscape marked by disasters and debates, the Institute's systemic approach to complex environmental challenges brings together multidisciplinary teams across science, economics, law, psychology, philosophy, health science, social science and engineering. Its researchers excel on the world stage by tackling significant environmental research challenges around water quality, low energy technologies, climate change resilience, adaptation, and mitigation, safeguarding biodiversity, conservation biology, marine and freshwater biology, palaeontology and sustainable landscapes. Common to all these challenges is a need to translate the science into management, policy and technology.

The *Environment Institute* is committed to the pursuit of environmental excellence ensuring the improved health of the environment, enhanced wellbeing and advancing the economy. If you share its vision of providing tangible solutions to support a cleaner, diverse, healthier world, engaging with the Institute is the start of a fulfilling journey.

Professor Peter Høj AC
Vice-Chancellor and President
The University of Adelaide

IN A CHANGING ENVIRONMENTAL LANDSCAPE MARKED BY DISASTERS AND DEBATES, THE INSTITUTE'S SYSTEMIC APPROACH TO COMPLEX ENVIRONMENTAL CHALLENGES BRINGS TOGETHER MULTIDISCIPLINARY TEAMS ACROSS SCIENCE, ECONOMICS, LAW, PSYCHOLOGY, PHILOSOPHY, HEALTH SCIENCE, SOCIAL SCIENCE AND ENGINEERING.

ABOUT THE INSTITUTE

The *Environment Institute* is committed to environmental excellence.

Mission

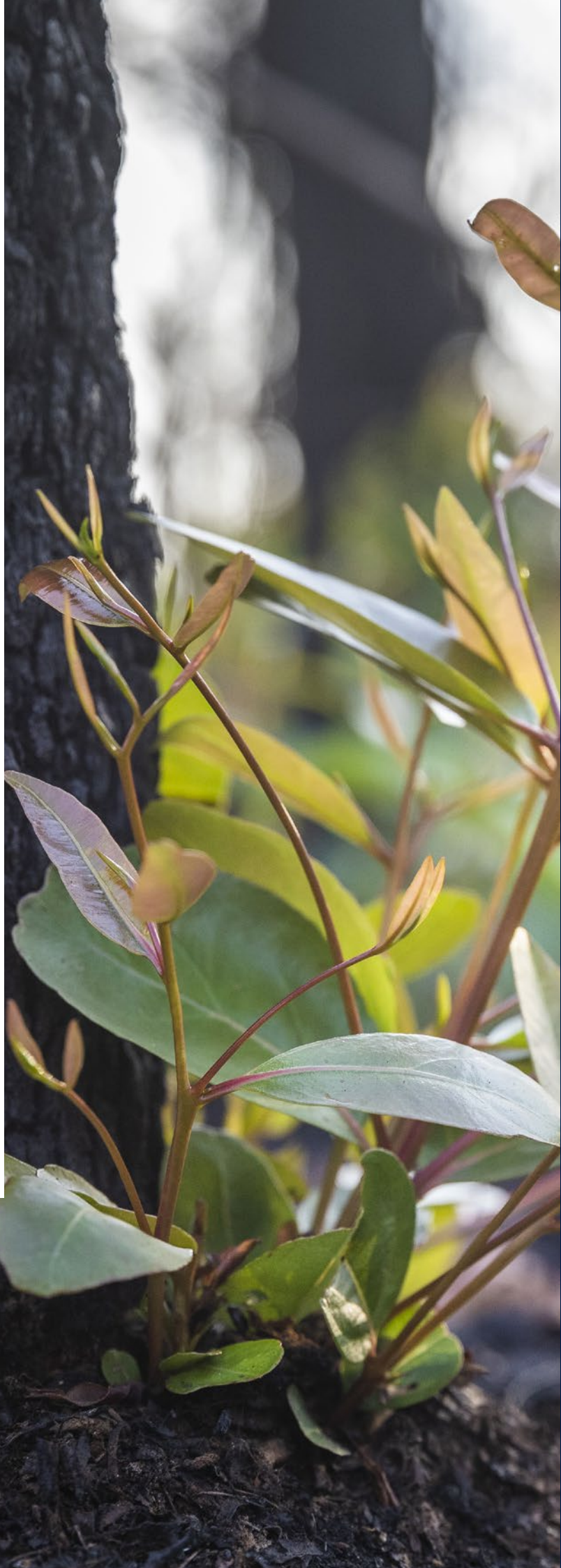
The *Environment Institute*'s mission is to deliver relevant, innovative and actionable outcomes to complex global environmental challenges to ensure sustainable goals benefit the health of our environment, our wellbeing and support the economy.

Vision

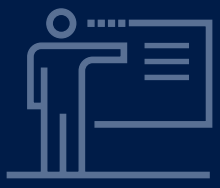
To develop strong local and international collaborations and engagement to address complex future environmental problems while exporting innovation worldwide.

Many complex global environmental challenges threaten the health and wellbeing of our delicate ecosystems, communities and economies. *Environment Institute* researchers engage in a diverse range of cross-disciplinary research to gain an understanding of our environmental past and plan for a sustainable future. We play a vital role in translating research into management, policy and technology. With over 100 research members and significant input from all Faculties within the University, our membership continues to broaden. The diversity of our membership and our access to outstanding research facilities are great strengths to delivering a holistic approach the global issues.

At the *Environment Institute* we are proud to provide ongoing mentoring and leadership development for our early and mid-career researchers. We recognise the importance of offering our less experienced staff every opportunity to succeed in an ever more competitive environment. We have witnessed impressive outcomes from this high-quality program including outstanding success in securing competitive funding.



AT A GLANCE



36 PROFESSORIAL RESEARCHER LEADERS

100+ MEMBERS

630+ PEER REVIEWED JOURNAL ARTICLES ANNUALLY

11
'Nature' journal articles published#

12
'Science' journal articles published#

ARTICLES IN HIGH IMPACT FACTOR JOURNALS IN 2020

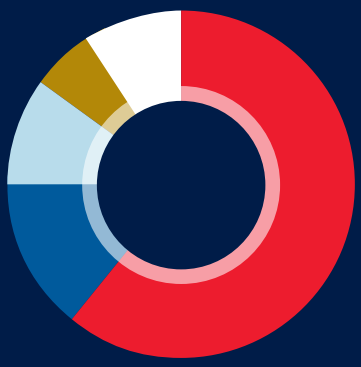
9
15+ JIF*

22
10–14.99 JIF*

55
6–9.99 JIF*

$8.9M
research income (2019)

80+ Research Leadership Development program & coaching since 2011



MEMBERSHIP BREAKDOWN BY FACULTY**

7%	Arts
10%	Engineering, Computer and Mathematical Sciences
12%	Health and Medical Sciences
10%	Professions
61%	Sciences

#2016–2021
*Journal impact factor
**As at December 2020

RESEARCH WITH IMPACT

The institute has significant experience in delivering outcomes of importance to our environmental wellbeing, industry and government agencies.

Research capabilities

We provide new knowledge and develop novel tools to better monitor climate change impacts, biodiversity, invasive species and ecosystem health; past, present and future.

We have experts in:

- Climate change: variation through time, resilience, adaption, mitigation and legal compliance.
- Conservation biology
- Environmental economics
- Evolutionary biology
- Genetics, ancient DNA and DNA barcoding
- Human health, behaviour and mobility
- Landscape transformation and restoration
- Low energy technologies
- Marine and freshwater ecosystems
- Natural hazard risk reduction
- Palaeontology
- Safeguarding biodiversity
- Water quality and supply

The *Environment Institute* is affiliated with the following programs, centre and facilities:

- Adelaide Exposure Science and Health
- Australian Centre for Ancient DNA
- Centre for Applied Conservation Science
- Marine Biology Program
- Spatial Science Research Group
- Sprigg Geobiology Centre
- Unmanned Research Aircraft Facility
- Water Research Centre

Researchers from the University of Adelaide in the field in the Pilbara region, Western Australia. Photo: Nick Stevens

AREA OF EXPERTISE

CLIMATE FUTURES

Mitigating future biodiversity losses and maintaining resilient ecosystems

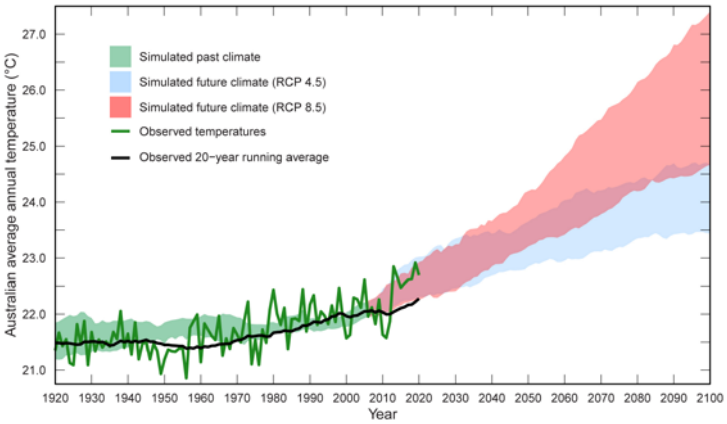
Rangelands in South Australia are threatened by future climatic change

EARTH IS ON A PATH TO DEVASTATING CLIMATE CHANGE THAT WILL TRANSFORM BIODIVERSITY AND DISRUPT SERVICES THAT ECOSYSTEMS PROVIDE TO NATURE AND PEOPLE. WE MUST PLAN TO DO BETTER AND PREPARE TO ADAPT.

Climate warming

Global mean temperatures have risen by 1.1°C since the beginning of the Industrial Period, nearing conditions that have not been experienced on Earth for the past 1.2 million years. This warming, and associated climatic events, has altered biodiversity in every biome, broadly impacting human and natural systems.

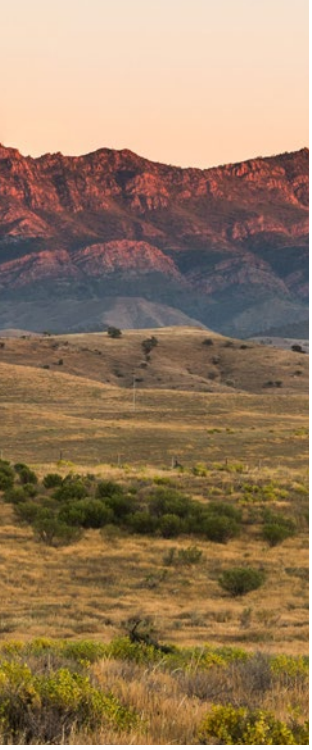
As climate change intensifies in the coming decades, safeguarding biodiversity and ecosystem services must remain high on policy agendas. Understanding, planning and adapting to these climate-driven changes will require multiple lines of evidence, informed by computer models, observed changes in modern times, and historical studies over a range of time scales.



Australian average annual air temperature observed and simulated from global climate models.

Top right: Sediment coring to investigate long term environmental change

Right: Biodiversity surveys identifying vulnerability to climate change



PROJECTIONS FOR AUSTRALIA

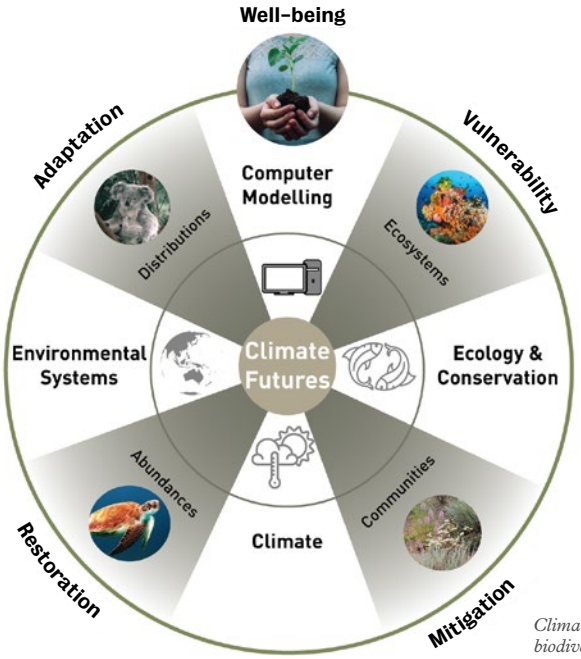
- INCREASING AIR AND OCEAN TEMPERATURES
- MORE HIGH-INTENSITY STORMS WITH HEAVY RAINFALL
- RISING SEA LEVELS
- MORE DANGEROUS FIRE CONDITIONS
- MORE FREQUENT & INTENSE MARINE HEATWAVES
- DECLINE IN WINTER RAINFALL IN SOUTHERN AND EASTERN AUSTRALIA
- HOTTER WEATHER WITH MORE HEATWAVES
- FEWER TROPICAL CYCLONES

Responding to future climatic change

Climate Futures is a transdisciplinary team of researchers at the University of Adelaide who have united to provide the context, tools and policy guidance needed to help mitigate future biodiversity losses and maintain resilient ecosystems in the face of shifting climates.

Our researchers have the expertise needed to identify the trajectory and causes of climate-driven biodiversity responses, and to formulate evidence-based solutions to protect natural and human systems from climatic change. These include, but are not limited to expertise in palaeoecology, historical and contemporary ecology, conservation science, environmental systems and their management, computer modelling, climatic change, and economics and decision making. Our team specialises in identifying problems and delivering integrated, actionable solutions to:

- Identify and mitigate serious effects of climatic change on biodiversity, ecosystems and environmental systems.
- Meet the challenges of extreme events.
- Ensure food security on the land and in the sea.
- Future-proof urban environments and protected areas.
- Develop innovative solutions for transitioning to a low greenhouse gas emissions future.



Climate Futures will safeguard biodiversity under climate change

Partnering with Climate Futures

Climate Futures recognises that atmospheric concentrations of greenhouse gases are increasing primarily due to burning fossil fuels and land use change, and that if emissions are not stopped rapidly, impacts from climate change on living systems will intensify. By harnessing the power of our world-leading research in environmental management under climate change, our research team can assist in delivering solutions for maintaining vulnerable natural systems, using reliable predictions and evidence-based solutions.

Climate Futures has the expertise to provide data and tools that can

- Identify past, and future, climatic change and its effects on environments, fauna and flora.
- Detect, decipher and project extreme events, including heatwaves, droughts, floods and bushfires.
- Assess the effectiveness of greenhouse gas reduction measures, including nature-based solutions, and their associated impacts on the environment.
- Determine the species, communities, ecosystems and production systems that are most vulnerable to future climate change.
- Provide climate-biodiversity solutions that build resilient ecosystems and maintain their services to nature and people.
- Disentangle climate impacts from other stressors of global change that shape biodiversity, including land-use, exploitation and invasive species.
- Ensure cities and towns are well-equipped to address looming climate change
- Protect biodiversity across land tenures in conjunction with improvements in sustainable use and tourism.

We also offer research and support for real-world problem solving of day-to-day issues arising as a result of our changing climate futures. Outputs include socially relevant applications aimed at helping communities adapt to future climatic change. Our research can be applied through diverse models of engagement including partnerships and collaboration among institutions or individuals.

CLIMATE FUTURES AREAS OF EXPERTISE

AREAS OF EXPERTISE	RESEARCHERS
Climatic change • Generation and interpretation of climate change simulations: past present and future • Inferences of past climates using environmental proxies • Detecting and projecting extreme events, including heatwaves, droughts, fire and floods	Associate Professor Lee Arnold Dr Stuart Brown Dr Alexander Francke Associate Professor Damien Fordham Dr Camille Mellin Professor Megan Lewis Professor Bob Hill Associate Professor John Tibby Dr Jonathan Tyler Professor Seth Westra Professor Tom Wigley
Historical impacts and context • Responses of environments, ecosystems flora and fauna to ancient and historic climate change • Detection and attribution of human-driven climate impacts in terrestrial, freshwater, estuarine and marine systems. • Climate-driven changes to ecosystem services for nature and people	Associate Professor Lee Arnold Dr Alexander Francke Associate Professor Diego Garcia-Bellido Dr Camille Mellin Professor Ivan Nagelkerken Associate Professor Patrick O'Connor Dr Jasmin Packer Dr Liz Reed Associate Professor John Tibby Dr Jonathan Tyler
Future impacts and planning • Vulnerability assessments for species, ecological communities and ecosystems • Redistribution of biodiversity • Extreme events and biological systems	Associate Professor Damien Fordham Professor Ivan Nagelkerken Associate Professor Patrick O'Connor Professor Michelle Waycott
Biodiversity solutions • Evaluating management interventions for vulnerable species, communities and ecosystems • Future proofing protected areas, including predator-free safe havens • Restoring ecosystems and their services that benefit people and planet • Conservation decision making and policy	Professor Sean Connell Associate Professor Damien Fordham Dr Alice Jones Professor Ivan Nagelkerken Associate Professor Patrick O'Connor Dr Jasmin Packer Professor Michelle Waycott
Human well-being • Food security and production systems • Urban living in a changing climate	Dr Alice Jones Dr Camille Mellin Dr Heidi Alleway Professor Veronica Soebarto
Climate change mitigation • Solutions for transitioning to a low greenhouse gas emissions future: carbon co-benefits from biodiversity restoration	Dr Alice Jones Associate Professor Patrick O'Connor Professor Michelle Waycott
Socio-cultural management • Environmental monitoring and sustainable tourism • Natural history and biodiversity heritage outreach	Professor Sean Connell Associate Professor Diego Garcia-Bellido Dr Liz Reed Professor Michelle Waycott

CONTACT CLIMATE FUTURES

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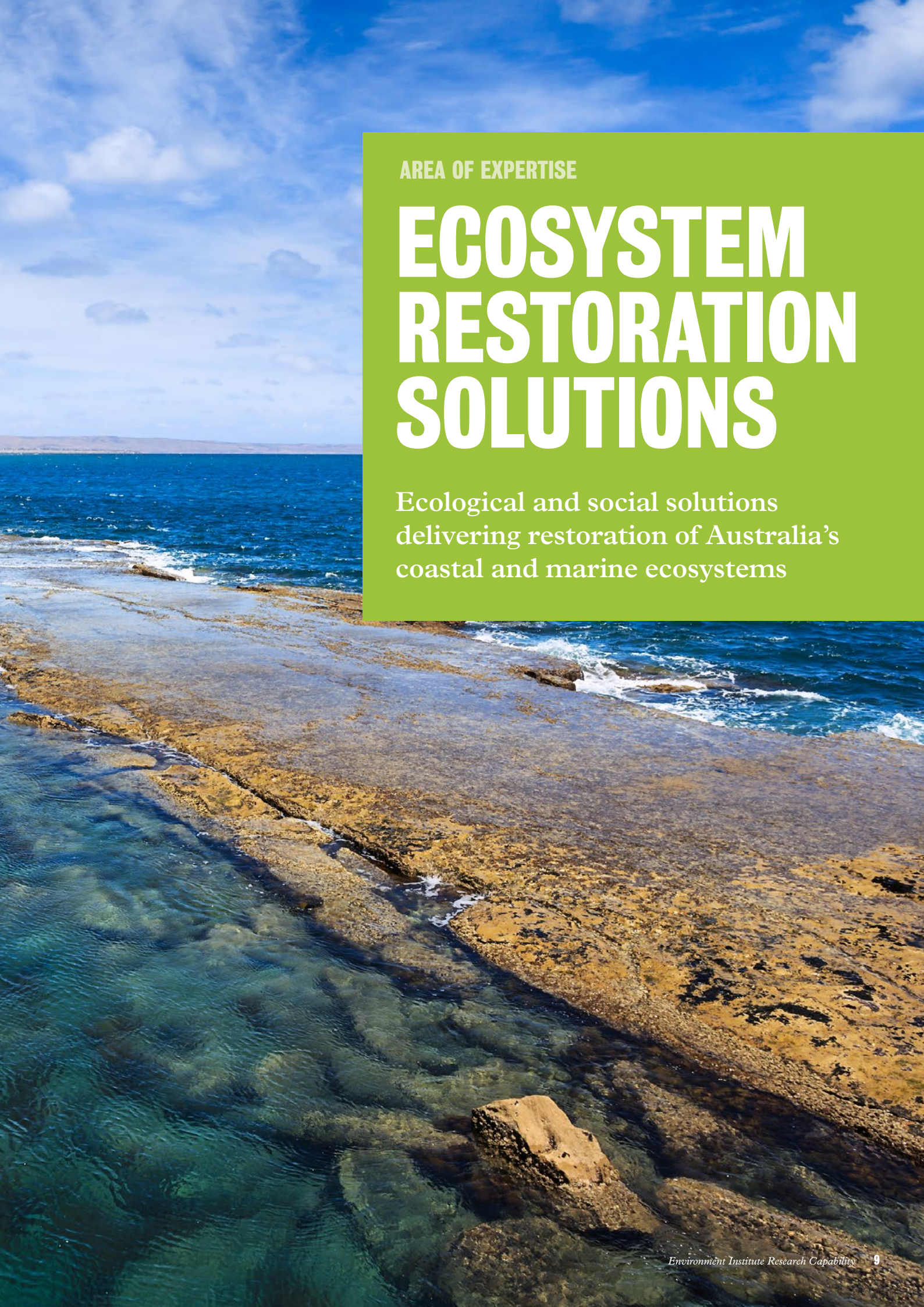


AREA OF EXPERTISE

ECOSYSTEM RESTORATION SOLUTIONS

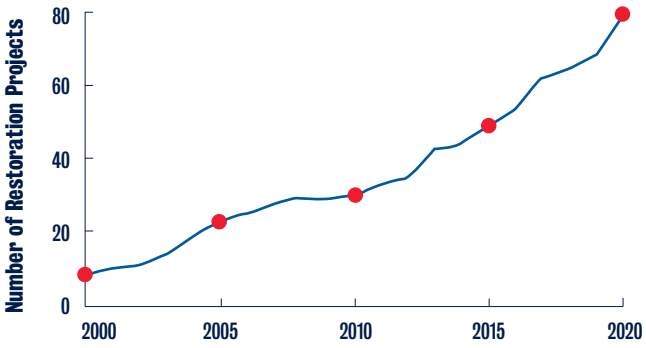
Ecological and social solutions delivering restoration of Australia's coastal and marine ecosystems

SOUTH AUSTRALIA PROVIDES NATIONAL LEADERSHIP IN MARINE RESTORATION. LONG-TERM SUCCESS REQUIRES EVIDENCE-BASED PRACTICES THAT MAXIMISE THE ECOLOGICAL AND SOCIAL BENEFITS OF RESTORATION.

Imagery collected by a drone can be used to build 3D models s to estimate above-ground biomass

Australia's marine & coastal environment

Marine and coastal restoration efforts are rapidly accelerating across Australia. In South Australia, the successful restoration of lost seagrass communities, kelp forests, shellfish reefs, mangroves and saltmarshes will help secure the state's socio-economic well-being and coastal ecosystem resilience. Restoration success in a fast-changing world requires the best scientific knowledge and fit-for-purpose approaches to ecosystem restoration.



Cumulative number of marine and coastal restoration projects across Australia over the past two decades. Data from The Australian Coastal Restoration Network's Coastal Restoration Database.

Successful restoration of marine and coastal ecosystems provides recreational opportunities, public health benefits, increases fish production, improves coastal water quality, increases blue carbon storage and supports more resilient communities of marine species. Realising these benefits is complicated by a lack of knowledge on appropriate restoration practices that achieve the best ecological and social outcomes. Most marine restoration efforts are informed by past examples that utilise outdated practices informed by terrestrial restoration science. A step-change is required, where fit-for-purpose solutions drive marine and coastal restoration success.

South Australian marine ecosystem restoration requires solutions designed for the southern Australian context. This involves restoration practices that are innovative and cost-effective, adaptive to change, and that account for the multiple social, cultural, and economic users of the marine environment. Developing solutions for in situ practice, restoration management, and social and industry engagement, will ensure marine restoration programs provide long-term ecological and social benefits for a sustainable southern Australia.

Ecosystem Restoration Solutions: Expertise in repairing southern Australia's marine & coastal environments

Ecosystem Restoration Solutions is a team of multidisciplinary researchers at The University of Adelaide with broad experience in the ecological, socio-cultural, technological, and economic complexities of marine and coastal management.

Our researchers have wide-ranging expertise in the management and restoration of seagrass meadows, shellfish reefs, saltmarsh, mangrove and kelp forests, and coastal wetlands. We work with diverse government, industry, and community stakeholders on co-designing actionable solutions to:

- Provide a knowledge base to inform best practice for diverse marine and coastal restoration programs, including current pressures and future environmental change.
- Apply emerging technologies that assess and improve restoration outcomes and knowledge.
- Increase opportunities to derive multiple benefits from restoration projects (e.g. blue carbon benefits) by incorporating natural synergies (e.g. multi-habitat connectivity) into restoration planning.
- Generate opportunities for industry participation or co-design of restoration projects to boost ecological and economic outcomes.
- Identify the drivers of public acceptance of restoration projects and promote public participation.
- Visualise and communicate restoration opportunities and benefits through graphic, written, and conceptual models.

BENEFITS OF RESTORATION TO SOUTH AUSTRALIA

Ecological

Provide productive coasts with healthy habitats and wildlife

Social

Engage with stakeholders to plan access to coastal resources

Economic

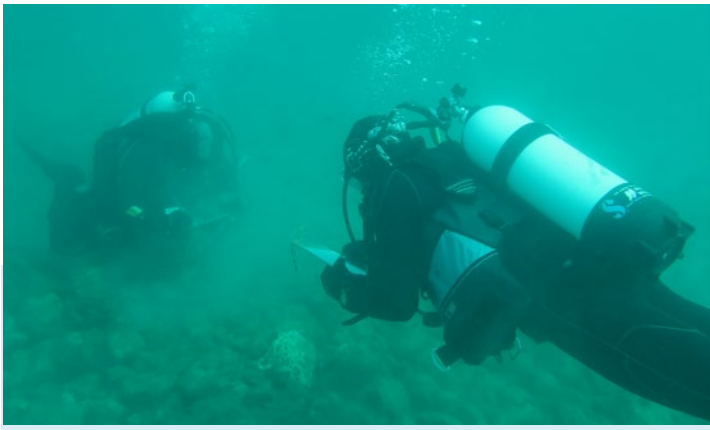
Engage business in the shared use of coastal benefits

Partnering with Ecosystem Restoration Solutions

We recognise that for restoration to be a successful practice for managing marine and coastal systems, it must meet the expectations of diverse social, economic, and political stakeholders. Marine and coastal environments are complex systems, where nature and socio-economics are integrated. They are ecologically dynamic and are increasingly impacted by climate change. By harnessing the power of world-leading research to conserve and enhance the resilience of marine ecosystems, we can deliver new knowledge on the best restoration practices for ecological and social benefits. Such partnerships can help position South Australia as a global leader in ecosystem restoration.

Ecosystem Restoration Solutions has the expertise to generate knowledge and solutions to:

- Monitor marine and coastal habitat condition and water quality, site suitability analyses for restoration, and restoration monitoring.
- Identify and assess the social and economic benefits of restoring biodiverse habitats and their multiple ecosystem services (e.g. f isheries productivity, water quality, coastal protection and carbon sequestration).
- Design and implement multi-species and multi-habitat restoration practices with demonstrated ecological resilience, productivity and climate change mitigation benefits.
- Develop frameworks for the sustainable management of restored ecosystems.
- Forecast the adaptive capacity of natural and restored ecosystems to climate change.
- Provide solutions and identify industry partnerships to overcome ecological, economic, or social constraints to restoration, including accessing carbon and biodiversity crediting mechanisms to help fund coastal restoration projects.
- Engage and educate the public on restoration projects through citizen science programs and communication of engaging restoration content (e.g. video streams).



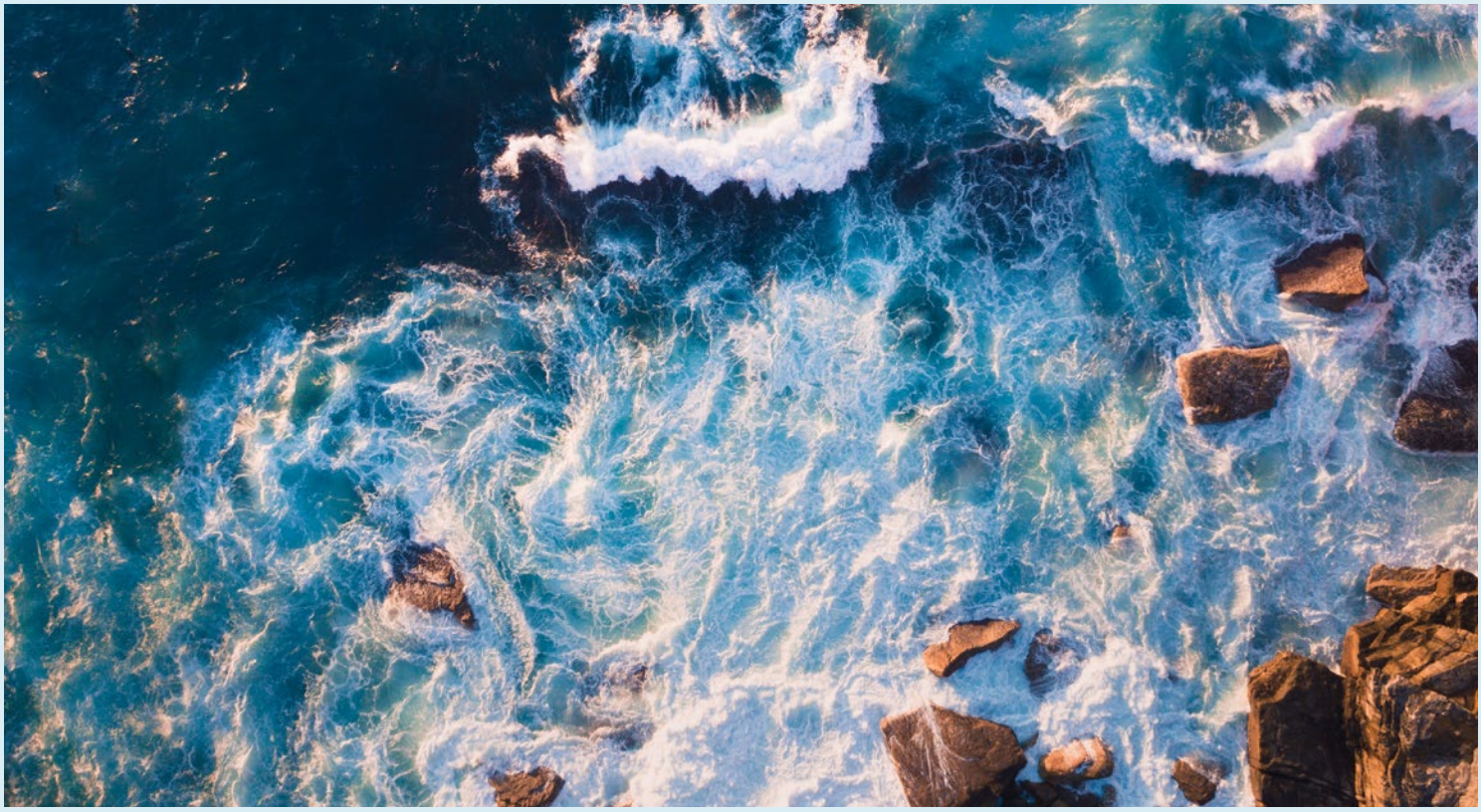
Case Study: Accelerating Restoration

To maximise the social, economic, and political benefits of marine restorations, our researchers have developed strategies to accelerate restoration outcomes. This has involved adapting emerging conservation technologies to our team's understanding of the natural ecological processes that boost recovery. Such strategies have reduced the time required for restoration projects to achieve their goals.

Ecosystem Restoration Solutions has been integral to the early success of South Australia's restored shellfish reefs.

Our researchers have moved past traditional mono-cultures to develop a new multi-species approach to restoration which offers resilience and permanence. Other techniques have involved playing natural marine sounds to attract baby oysters to restoration sites where they would otherwise be lost at sea. These strategies reduce the time, cost, and risk of restoration projects whilst working towards outcomes that contribute to society's well-being.

Image: Counting the fauna that has settled on the newly constructed shellfish reefs, South Australia.



ECOSYSTEM RESTORATION SOLUTIONS AREAS OF EXPERTISE

AREAS OF EXPERTISE	RESEARCHERS
Marine and coastal monitoring • Novel remote sensing techniques for coastal ecosystem condition monitoring & drone-based monitoring of coastal wetlands and seagrasses (for assessing and predicting the success of conservation, restoration and water quality management actions). • Documenting environmental change from "pre-impact" data; including historical records, sediment records, marine fauna and flora surveys, aerial imagery, carbonate proxies and isotopes. • Cumulative impact assessment, ecosystem resilience and benefit of coastal management.	Professor Sean Connell Professor Bronwyn Gillanders Dr Alice Jones Dr Dominic McAfee Dr Camille Mellin Professor Ivan Nagelkerken Dr Patrick Reis Santos Dr Ramesh Raja Segaran Associate Professor John Tibby Dr Jonathan Tyler Professor Michelle Waycott
Restoration and blue carbon • Seascape and multi-species design to optimise outcomes. • Boosting restoration success cost effectively. • Mangroves, seagrasses, oyster reefs. • Coastal carbon and biodiversity crediting mechanisms and markets.	Professor Sean Connell Professor Bronwyn Gillanders Dr Alice Jones Dr Dominic Mcafee Professor Ivan Nagelkerken Professor Michelle Waycott

CONTACT ECOSYSTEM RESTORATION SOLUTIONS

Professor Sean Connell
Theme Lead – Marine and Freshwater Ecosystems

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Telephone +61 8 8313 5513

AREA OF EXPERTISE

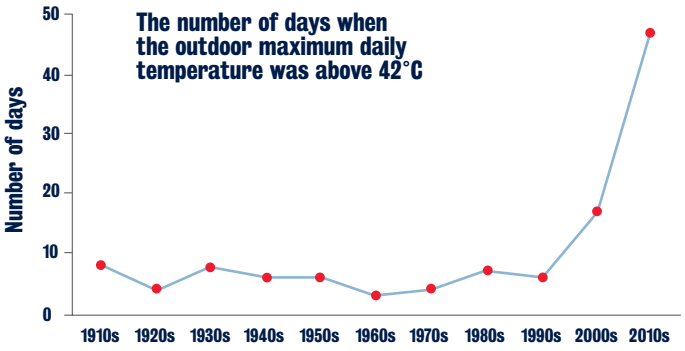
GREEN URBAN FUTURES

Future-proofing our cities against extreme heat events through re-vegetation

THE RECENTLY RELEASED CLIMATE CHANGE SCIENCE AND KNOWLEDGE PLAN FOR SOUTH AUSTRALIA STATES THAT: "RESPONDING TO OUR CHANGING CLIMATE REQUIRES SOUTH AUSTRALIA TO PREPARE AND ADAPT. TO DO THIS WELL, WE NEED TO BE EQUIPPED WITH THE BEST SCIENCE AND KNOWLEDGE."

Adelaide's Climate Challenges

Adelaide's future climate is projected to be increasingly hot and dry, with the temperatures rising and rainfall declining[1]. The increase in extreme temperatures is especially alarming, as observed below.



Australian Climate Observations Reference Network — Surface Air Temperature (ACORN-SAT) data for Kent Town.

The recent, rapid growth in the number of extremely hot days in Adelaide will potentially have catastrophic impacts on human health, including the elderly and people with comorbidities. These temperatures will also adversely impact ecosystems and biodiversity, and it is crucial to future-proof Adelaide against these changes as quickly as possible.

Trees are the best way to cool cities, provide visual relief, increase biodiversity, and enable people to be happier and healthier. Trees should not be seen as a cost or a liability — they are a **benefit**. Currently, we are not planting enough trees because they complicate engineering requirements for underground services. Trees are also being removed because there is the mindset that they have no value, and their removal comes without cost. Our priorities must change. Fitting trees into the existing and future infrastructure will not be trivial, but it is essential to sustain the long-term health of our city and its people.

BY HARNESSING THE POWER OF WORLD-LEADING RESEARCH TO FOSTER THE RESILIENCE OF OUR NATURAL AND BUILT ENVIRONMENT, OUR UNIVERSITY RESEARCHERS CAN ASSIST IN DELIVERING AN EXCEPTIONAL ADAPTATION, AND A GREEN MODEL FOR OTHER ARID CITIES TO FOLLOW.

Green Urban Futures: Responding to Adelaide's climate challenges

Green Urban Futures is a multidisciplinary team of researchers at the University of Adelaide who have united to provide significant solutions to major climate challenges now and for the future.

Our researchers have wide-ranging expertise that can establish South Australia as a global leader in providing 'green urban futures' such as trees, green walls and roofs, cool surfaces, and the infrastructure required to enable these solutions. Our team will identify problems and deliver integrated, actionable solutions to:

- Better understand how to maximise the benefits (e.g., cooling, amenity, biodiversity, health) and minimise the costs of urban greening.
- Identify the best tree mix to make Adelaide a truly green city that is resilient to a changing climate.
- Assess the ecological behaviours and needs of different tree species, and how they translate to responses at different scales (e.g., lot, neighbourhood, suburb, city).
- Increase our capacity to implement greening strategies (e.g., water supply infrastructure, soils) and assess their potential co-benefits (e.g., flood control, water quality improvement).
- Understand the drivers of public acceptance and promote public participation in measures identified as most effective.
- Evaluate scenarios that stress-test the performance of potential solutions under a range of critical, plausible, future conditions, e.g., population, climate, demographics.
- Visualise and communicate green future alternatives through graphic, written, and conceptual methods.

1. www.goyderinstitute.org/_r210/media/system/attrib/file/201/SA%20Climate%20Ready%20Regional%20-Summary%20-%20AMLR.pdf

Our researchers are working with a number of councils to develop smart stormwater solutions that reduce peak flows considerably, thus avoiding or minimising costly stormwater system upgrades, while providing water for urban greening.

Plane tree foliage on an extremely hot day in December 2019 on the Barr Smith Lawns, North Terrace Campus, University of Adelaide. The change in foliage in the morning (left) and the afternoon (right) shows heat damage experienced by one tree on a day whose maximum temperature exceeded 45°C. While the tree survived this event, the damage was extensive. As the number of extreme heat days grows, the capacity of this, and similar, species to absorb heat damage will decline.

Partnering with Green Urban Futures

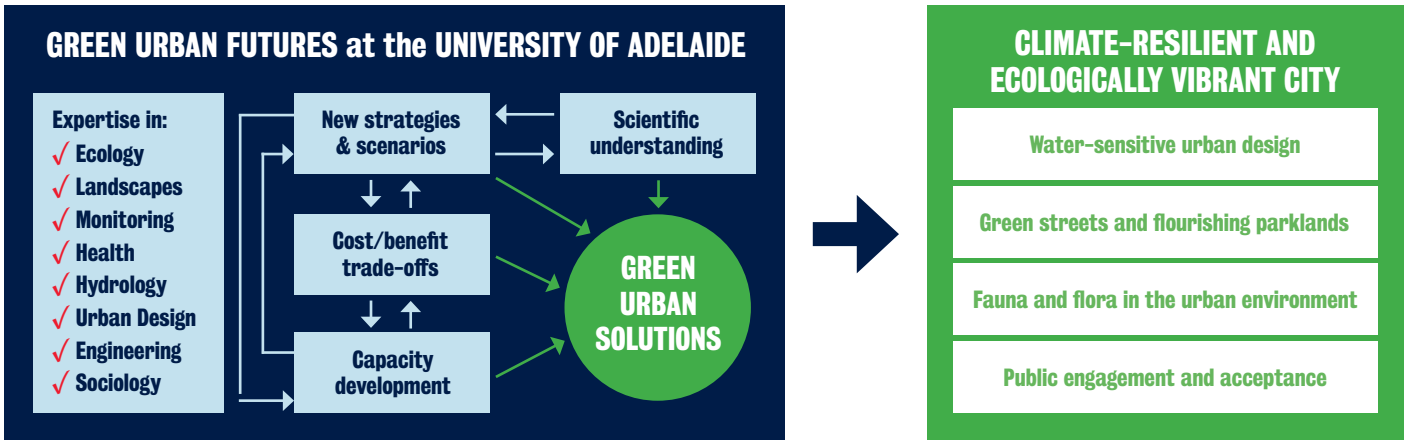
Green Urban Futures recognises that achieving a climate-resilient and ecologically vibrant city is not a case of re-imagining a static environment; instead, this transformation must be achieved in the face of hostile environmental change that is impacting all cities globally. By harnessing the power of world-leading research to foster the resilience of our natural and built environment, our university researchers can assist in delivering exceptional adaptations, and a green model for other arid cities to follow.

Green Urban Futures has the skill sets to provide significant data and solutions to:

- Identify the best species for selection as street trees.
- Monitor tree health, using both remote (e.g., hyperspectral, Normalised Difference Vegetation Index) and proximal (e.g., temperature, soil moisture, tree water status) methodologies.
- Forecast and model water requirements for healthy urban forests and smart watering to reduce heat[2].
- Assist in planning for water sources and delivery for optimal use of this precious resource.
- Design landscapes suitable for cooling residential areas as well as urban centres.
- Assist with building design to minimise heat risk and monitor human health during peak stress periods; and analyse where the problem areas are and determine processes for decreasing future risk.
- Better understand the social drivers of canopy loss and how to engage communities in the preservation of valuable trees.

We also offer research and social science skills to assess and promote public acceptance and participation in the measures identified as most effective in adapting to challenging environmental conditions. There is also potential for pilot-scale projects to be trialled in collaboration with the University of Adelaide, at its North Terrace, Waite, and Roseworthy Campuses.

2. www.sawater.com.au/news/smart-watering-drops-temps-to-cool-costs



The Green Urban Futures team is well-placed to deliver multidisciplinary solutions to combat extreme weather events.

GREEN URBAN FUTURES AREAS OF EXPERTISE

AREAS OF EXPERTISE	RESEARCHERS
Green streets and flourishing parklands • Planning and design of constructed ecologies and urban planting. • Greenfield development assessment. • Monitoring, sensing, and management of streets and parklands through smart technologies. • Visualisation of urban greening outcomes and scenarios. • Modelling of built environment energy saving through green infrastructure. • Understanding ecosystem services of the urban forest.	Dr Ehsan Sharifi Dr Carlos Bartesaghi-Koc Dr Scott Hawken Prof. James Hayter Dr Tanya Court Prof. Veronica Soebarto *Architecture & Built Environment* Dr Ramesh Raja Segaran *Director, Unmanned Aircraft Research Facility*
Selection of tree species for urban spaces • Reviewing and assessing living collections and urban plantings across Adelaide using international data. • Monitoring water status and general health of trees in real time. • Assessing heat damage to individual trees and groups of trees. • Proposing solutions to ensure individual tree survival or replacement options where appropriate.	Prof. Bob Hill *Director, Environment Institute* Dr Kate Delaporte *Curator, Waite Arboretum* Dr Vinay Pagay *Advanced sensing technologies*
Environmental engineering solutions • Decision support (optimisation, multi-criteria analysis, trade-off analysis) and decision-making under uncertainty (sensitivity analysis, uncertainty analysis, scenario analysis). • Climate impact analysis and adaptation (climate stress testing, adaptive pathways). • Water sensitive urban design (alternative sources of water, smart systems, stormwater control), water quality, resources and supply, disaster risk analysis and mitigation (heatwave, bushfire, flooding, coastal inundation), water-energy nexus. • Green networks and patch dynamics (landscapes that promote cool air flows, beneficial microclimates and adaptive ecologies).	Prof. Holger Maier Dr Mark Thyer *Environmental Engineering* Prof. Seth Westra *Hydrology and climate risk* Assoc. Prof. Luke Mosley *Water Research Centre* Dr Scott Hawken *Landscape Architecture and Urban Design* Prof. Tim Cavagnaro *Soil Science*
Socio-cultural perceptions of environmental resource management • Assessing public acceptance and participation in greening measures. • Conducting interviews, focus groups, and collecting oral histories to evaluate social commitment to increasing green cover via tree planting and sustainable water management. • Proposing policy solutions in response to public concerns.	Dr Georgina Drew *Anthropology and Development Studies* Prof. Melissa Nursey-Bray *Social Sciences*
Community health adaptation to extreme heat and climate change • Assessing mental health impacts from extreme heat at local government level to develop tailored adaptation measurements. • Assessing health challenges in sub-standard housing and working with building and landscaping to improve benefits. • Developing tailored extreme heat and community health adaptation strategies for specific councils, based on their characteristics (e.g., landscaping, demographics).	Prof. Peng Bi *Public Health and Environmental Medicine*
Remote sensing of environmental dynamics across platforms • Multi-scale environmental senses with ground vehicles, drones, conventional aircraft and satellites. • Sensing and monitoring urban land use, land surfaces and vegetation. • Assessing condition, spatial distribution and change in greenspace and trees.	Dr Ramesh Raja Segaran *Director, Unmanned Aircraft Research Facility* Prof. Megan Lewis *Environmental Remote Sensing and Geospatial Sciences* Dr Carlos Bartesaghi Koc *Architecture & Built Environment*

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AREA OF EXPERTISE

LOW ENERGY TECHNOLOGIES

New Materials for Enduring Challenges

A CONSISTENT RISE IN ATMOSPHERIC CO_2 CONCENTRATIONS HAS UNDERPINNED SIGNIFICANT SOCIETAL AND SCIENTIFIC CONCERN DUE TO ITS DIRECT ROLE IN CAUSING POTENTIALLY CATASTROPHIC CLIMATE CHANGE.

Energy Evolution

A major source of increases in anthropogenic CO_2 is from the combustion of fossil fuels, thus a transition to renewable energy sources is critical to the future energy landscape. Net-zero emissions and an ultimate clean energy future will rely on technological solutions for energy distribution (storage and transport) and utilisation, and more energy-efficient technologies in health and agriculture. Developing novel Low Energy Technologies is crucial for meeting environmental challenges.

Responding to the Energy Challenge

The Centre of Advanced Nanomaterials is responding to the challenge of developing Low Energy Technologies. We are researching nanomaterials technologies and integration that underpins Chemical Energy Storage; Energy Waste Management; and Heterogeneous Catalysis to produce green chemical feedstocks from chemical waste.

Major projects:

- **Catalysts for CO_2 conversion and utilisation.** Nanomaterial-derived catalysts for methanol (industry sponsored) and methane synthesis from CO_2.
- **Hydrogen (H_2) Distribution Solutions.** Metal-organic Framework-based H_2 Storage and Distribution Technology.
- **New membrane technologies.** New industrially relevant materials for separation and combined conversion and separation.
- **Nanomaterial "Cold Chain" Technologies.** Development of materials handling solutions for energy efficient distribution and handling of biomaterials.

Catalysts for CO_2 conversion and utilisation

The conversion of CO_2 into useful chemical products is a long-standing challenge. Although an attractive source of carbon, CO_2 is considered too thermodynamically and kinetically stable for industrial use. However, new developments in the field of catalysis have made the hydrogenation of CO_2 to methanol economically feasible. Methanol is a versatile chemical that can be used directly as a fuel or as a chemical building block for more complex molecules that are necessary to make everyday products such as adhesives, silicone and foams. The Centre for Advanced Nanomaterials is partnering with chemical companies to develop new nano-structured catalysts to make the conversion of CO_2 to methanol more efficient and commercially viable. Using CO_2 as a feedstock makes a positive impact on the global carbon cycle, and moreover, it is an attractive carbon source as it is a non-toxic, renewable resource that is both inexpensive and abundant.

Hydrogen is poised to replace fossil fuels. The Centre for Advanced Nanoscience are developing solutions to roadblocks to the hydrogen economy.

OUR RESEARCH GROUP HAS DEVELOPED A NOVEL TECHNOLOGY FOR THE ENCAPSULATION AND PROTECTION OF BIOMACROMOLECULES SUCH AS PROTEINS, ENZYMES AND DNA.

Transport and delivery of modern therapeutics requires a cold-chain to maintain efficacy.

H_2 Distribution Solutions

Hydrogen is poised to play a major role in the transition to a low carbon economy by replacing fossil fuels as a primary energy source. To deliver hydrogen at competitive prices to natural gas and coal several technological challenges need to be overcome. One of these is enhancing the storage efficiency of hydrogen gas for transport and distribution. The Centre for Advanced Nanomaterials is developing novel nanoporous materials and their composites that can store hydrogen at lower pressures and higher temperatures than current systems. This will allow for the safe and efficient commercial deployment of hydrogen storage at multiple a range of scales.

New membrane technologies

Membrane separation technologies are highly advantageous and can provide energy savings of up to 50% compared with alternative technologies. The Centre for Advanced Nanomaterials has had a long-term focus on new nanoporous materials for separation of gas mixtures, including CO_2/CH_4 and CO_2/N_2. Combining these nanoporous materials with industry-standard polymer membranes has led to the emergence of new mixed matrix membranes with improved operating parameters. To achieve efficient conversion of CO_2 into green methanol, we are also developing hybrid membrane technology that combines polymer membranes with bespoke catalysts for these conversions. The outcome will be technology which enables future fuels to be produced, enabling industries to convert their CO_2 wastes into a valuable energy product or feedstock. The combination of a catalytic reactor with membrane separation provides for process intensification to reduce the capital cost.

Nanomaterial "Cold Chain" Technologies

Vaccines and biomolecule-based pharmaceuticals are critical to the future health of Australia's population. Although virus-based vaccines are being developed for an increasing number of illnesses and infectious diseases, their stability represents a critical challenge. A similar challenge pertains to proteins and nucleic acid-based medicines. The term 'cold-chain' refers to the requirement that the vaccine or biologic must be transported at low temperatures to remain stable and in their active form. This necessitates refrigeration, which poses significant logistical issues when transporting to remote areas. Our research group has developed a novel technology for the encapsulation and protection of biomacromolecules such as proteins, enzymes and DNA. Our approach encapsulates biomacromolecules in a protective coating within seconds in aqueous conditions at room temperature. Remarkably, these coatings protect biological materials from environments that typically lead to denaturation and inactivation.

Partnering for Low Energy Technology Solutions

The future of the environment is dependent on the nature of our ongoing relationship with energy. The Centre of Advanced Nanomaterials can offer research and support for the design, synthesis, and applications of porous materials.

LOW ENERGY TECHNOLOGIES AREAS OF EXPERTISE

AREAS OF EXPERTISE	RESEARCHERS
Material Synthesis Gas adsorption Catalysis	Professor Christian Doonan *Director, Centre of Advanced Nanomaterials*
Material Synthesis X-ray Diffraction Catalysis	Professor Chris Sumby *Deputy Director, Centre of Advanced Nanomaterials*

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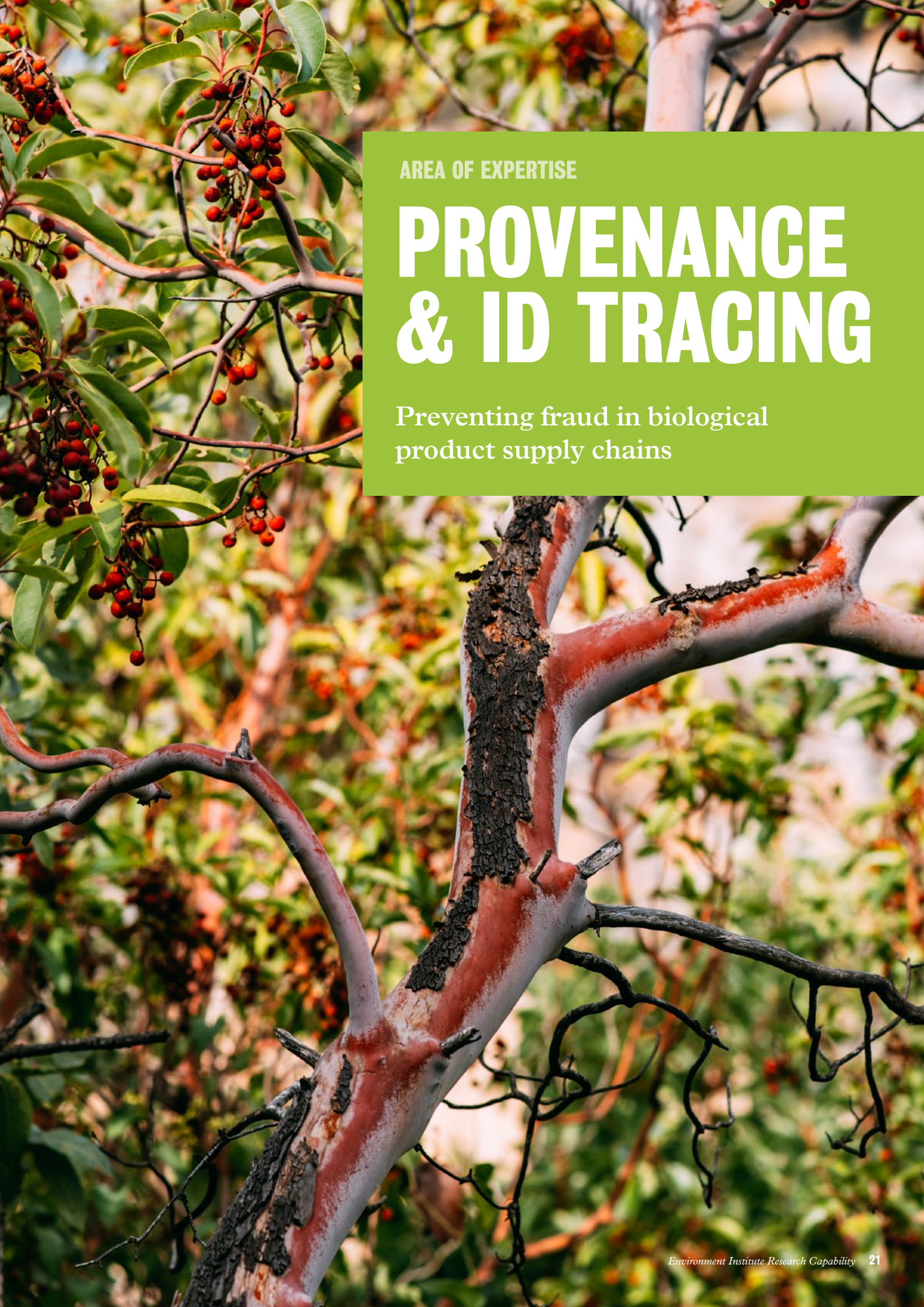


AREA OF EXPERTISE

PROVENANCE & ID TRACING

Preventing fraud in biological product supply chains

A HIGH PROPORTION OF GLOBALLY TRADED PRODUCTS, INCLUDING FOOD AND TIMBER, ARE THE TARGET OF FRAUD. TECHNOLOGY NOW EXISTS TO IDENTIFY AND STOP THIS ILLEGAL TRADE

Ecological fraud

The United Nations and Interpol estimate the cost of trading illegally sourced timber at $206 billion each year. Illegal logging not only leads to real economic impact, including to local communities, but also results in a loss of biodiversity and increased carbon emissions, which makes it the largest environmental crime by value in the world.

In Australia, local timber producers are at a disadvantage, having to compete against cheap, illegal imports. It is estimated that $800 million of Australia's imported timber may be illegal in origin.

Legislation to criminalise the importation of illegally sourced timber has been recently introduced to Australia, Europe and Indonesia. The USA has stepped up its enforcement of the Lacey Act, which prohibits the import of illegally sourced timber. There is a global need and a growing demand for tools and systems that reduce the trade in illegal timber.

Premium Australia food products also attract the unwanted attention of fraudsters wanting to cash in on Australia's food and wine reputation. Globally Price Waterhouse Cooper report that food fraud is valued at $54 billion, and that a single food fraud incident can cost 2-15% of the annual revenue of a company. Recently Food Innovation Australia Ltd reported that lost Australian food and wine export sales due to food fraud was estimated at $1.7B per year and that more must be done to protect products and brands in foreign markets.

University of Adelaide expertise

Researchers at the University of Adelaide are developing cutting edge DNA technologies and sophisticated chemical tracing methods for a broad range of biological samples to answer questions related to illegal trade, biosecurity, environmental crime, conservation management and crime scene investigation.

This expertise includes the purpose-built state-of-the-art laboratory - the Advanced DNA Identification and Forensics Facility (ADIFF) - housed in the Braggs building at the University of Adelaide, which develops and utilises cutting-edge molecular techniques, including a patented method for extracting DNA from timber, to analyse plant, animal, and environmental samples.

ADIFF is a member of the Australasian Environmental Law Enforcement and Regulators neTwork (AELERT). All methods developed in ADIFF are available as a commercial service. The team of scientists at ADIFF can work with clients to develop suitable methods if there are none currently exist.

Focal areas

Timber species and provenance ID

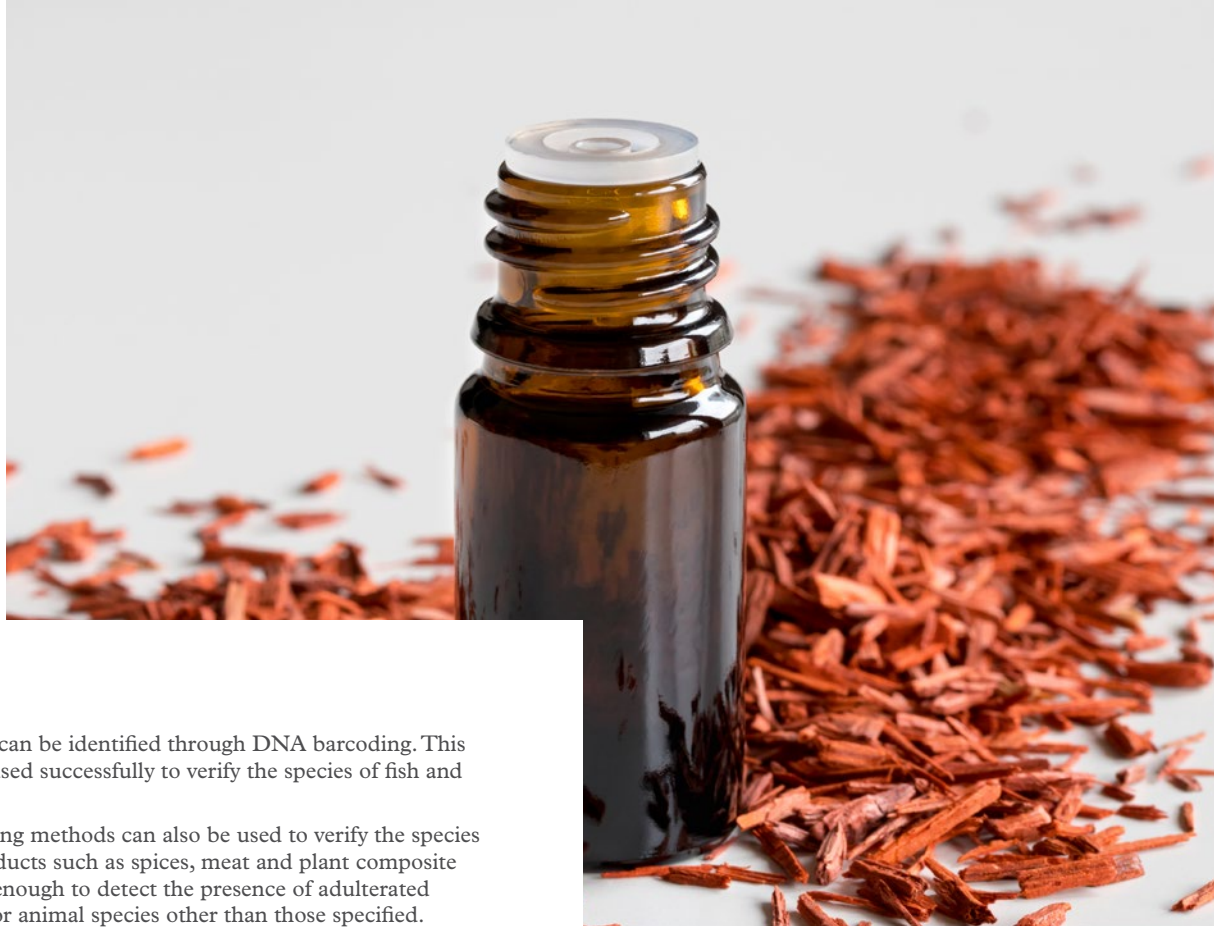
Our team of researchers have been instrumental in the implementation of scientific verification within international timber supply chains. The timber industry estimates that 10-30% of timber exports are illegal. But a recent blind sample of imports into Australia placed the proportion of illegally sourced timber at 40%.

Our teams specialise in the identification of genetic markers through rigorous screening of plant species across their natural ranges. These advanced DNA analysis tools can be applied to timber samples to identify the geographical provenance of a sample and provide individualisation for illegal logging and chain of custody analysis. Currently, genetic markers can be used to determine the provenance of the following timber species: teak, sandalwood, oak, meranti, bigleaf maple African cherry and African teak. The development of markers for more species is an ongoing process.

In addition to generating genetic tools for provenance testing, timber material screens can be developed to differentiate between closely related species such as sandalwood or meranti. These tools are commercially available and have been used to provide evidence in ongoing cases of illegal logging.

Species identification is also possible – we use a novel DNA barcoding method targeting multiple single-copy chloroplast loci to identify the species of plant material. This method can be applied to a wide variety of different plant materials including fresh leaves, processed timber and even pollen off the legs of bees.

We also have the capability to use stable isotopes to identify the geographical origin of samples. When DNA cannot be recovered, the unique isotopic signature of a sample can be used to identify the provenance. Spatial variation created by differences in hydrology, climate, soil/bedrock type and agricultural practices results in an isotopic signal that contains a unique ratio of heavy and light isotopes that can be used to trace the sample back to its origin.



Food

Problems with food fraud can be identified through DNA barcoding. This type of analysis has been used successfully to verify the species of fish and other animal products.

These novel DNA barcoding methods can also be used to verify the species composition of mixed products such as spices, meat and plant composite products, and is sensitive enough to detect the presence of adulterated samples containing plant or animal species other than those specified.

Oils and processed food products

For more highly processed products we can apply a range of chemical and visual tracing and identification methods, for example stable isotopes, metabolomic profiling or computer vision analysis.

Stable isotope profiling has been used successfully to solve cases of illegal logging of sandalwood timber and oil products in Australia. These and other methods hold tremendous promise for verifying the origin of processed food, beverage and oil products in Australia's supply chains.

Mixed sources, eDNA and forensics

Metabarcoding has proven to be a valuable tool that has been widely applied to characterise the mix of species in a range of biological samples:

- Pollen isolated from bees or honey can be DNA metabarcoded to identify the source plants, which in turn can confirm regional origin or pollination source.
- The diversity of prokaryotes, eukaryotes and fungi can be used to characterise environmental samples. For example the metabarcoding profile of soils has potential to be used as a forensics tool to verify the region of origin of soil samples.
- The characterisation of diatoms from eDNA extracted from freshwater samples has also shown promising results as a forensics regional identity tool.

Weed and pest origins

The agriculture and environment costs of invasive species due to lost production and control cost in excess of $5B per year in Australia.

Our teams are developing rapid ID tools and modelling and gene drive technologies to identify and control outbreaks. DNA analysis can also help identify the original source of introduction of a pest or weed and help direct control efforts or technology development.

Supply chain analysis

Not all supply chains represent risk of illegal sourcing or mixing of products. Geo-referenced information and supply chain analytical tools can be used to assess the risk profile of supply chains and then used to direct the application of a range of suitable verification tools, as identified above.

Here at the University of Adelaide we have used these methods to assess risks in timber, wildlife and medicinal product supply chains.

AGRICULTURE AND ENVIRONMENT COSTS OF INVASIVE SPECIES DUE TO LOST PRODUCTION AND CONTROL COST IN EXCESS OF $5B PER YEAR IN AUSTRALIA.

PROVENANCE & ID TRACING AREAS OF EXPERTISE

AREAS OF EXPERTISE	RESEARCHERS
Timber species and provenance ID • DNA barcoding • eDNA, pollen and soil profiling	Professor Andrew Lowe Dr Arif Malik
Plant product DNA barcoding • eDNA analysis • weed profiling	Professor Michelle Waycott Dr Kor-jent Van Dijk
Fresh water profiling	Professor Justin Brookes
Stable isotope and chemical tracer analysis	Dr Cesca McInerey
Animal and human forensics ID	Associate Professor Jeremy Austin
Invasive species monitoring and removal • Biosecurity modelling and monitoring • Supply chain risk analysis	Associate Professor Phill Cassey
Soil profiling	Professor Rob Fitzpatrick

CONTACT PROVENANCE & ID TRACING

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AREA OF EXPERTISE

SUSTAINABLE LANDSCAPES

Designing functional landscapes

FUNCTIONAL LANDSCAPES CAN BE DESIGNED USING REVEGETATION THAT SUPPORTS THE RETURN OF ECOSYSTEM SERVICES. WE CAN DEVELOP A WHOLE NEW ECONOMY ON A LARGE SCALE IN SOME OF AUSTRALIA'S MOST DEGRADED ECOSYSTEMS.

Designing functional landscapes

Decades of unsustainable farming practices have degraded the health and function of large areas of broadacre and pastoral production landscapes in Australia.

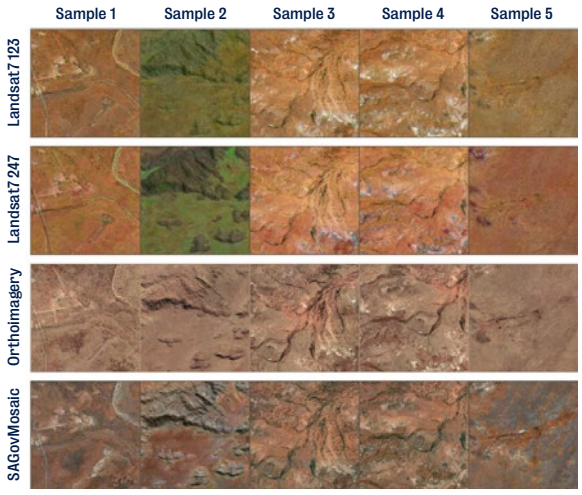
There is an opportunity to regain health and value for these landscapes through the return of ecological function in soils and accompanying vegetation. Such outcomes can be achieved through the design and implementation of vegetation plantings that regenerate ecosystem services in degraded landscapes i.e. carbon sequestration, soil function, pollination, water filtration, livestock shelter, native biodiversity and habitat.

The restoration of these functions and services will not only increase land value, but offers the potential to develop a new production economy and one that, once proven, could be rolled at scale in some of Australia's most degraded landscapes.

Design and planting of appropriate vegetation has the potential to:

- sequester carbon in vegetation and soils,
- rejuvenate soils and improve microbial diversity,
- improve water run off quality,
- maximise pollination services and support other ecosystem services
- return biodiversity - in particular ground cover and mid story plants, creating more cover, and faunal habitat and food sources which will help with insect, animal and bird population recovery.

The overall benefit of combining these areas of research and regenerating ecosystem services at a site is likely to be realised as a value-add to the land use and increase in land value. The concept is extensible and can be adapted for any site, and can be rolled out across different regions, potentially building into a national program and of sustainable landscape clusters.



University of Adelaide expertise

Here at the University of Adelaide we have nationally and internally leading groups with a range of complementary expertise applying technology to ecosystem challenges, including:

Terrestrial Ecosystem Research Network

The University of Adelaide hosts the Surveillance Monitoring capability of the Terrestrial Ecosystem Research Network (TERN), a facility of the federally supported national research infrastructure. TERN monitors the stocks and flows of Australia's ecosystems, natural and production, including:

- Soil physiochemical and carbon stocks
- Vegetation structure and diversity
- Invasive species
- Functional traits
- Isotopic and genotype profiles

TERN has also established excellent relations with several national environmental monitoring agencies who have adopted TERN's methods for ecosystem condition monitoring and provide baseline data against which to track changed composition and trajectory of ecosystem. Members of the team also offer statistical review services to give clients certainty in environmental decision-making.

Climate resilient conservation and restoration

Making sure that conservation and restoration strategies incorporate climate resilient adaptive potential is essential to ensure long term outcomes. Researchers at the University of Adelaide use a range of genomic and adaptation assessments to understand the adaptive capacity of plant and animal populations, including rare and endangered species. In many cases, this information is combined with habitat suitability assessment and modelling to recommend best-practise conservation and restoration outcomes.

Our researchers have developed conservation and restoration strategies for a broad range of nationally and international threatened plants and animals. They have been integral in the development of fundamental conservation and restoration principles and practises which have resulted in changed thinking and adoption of science within the sector. Examples include overturning local provenance procedures in restoration or reintroduction programs to incorporate more adaptive potential to allow future climate resilience.

Farming for carbon and ecosystem services

Whilst unsustainable land exploitation has led to a decline in ecosystem services, there is an opportunity to develop land management practises that harness and improve these services, including carbon sequestration, soil function, pollination, water filtration, livestock shelter and native biodiversity and habitat.

There is a huge demand among the farming community to improve carbon sequestration systems, reduce carbon emissions and become carbon neutral. However more work is required in this area and more science is needed which leverages agronomic expertise that already exists at farming sites. Our research has assessed the benefit of habitat plantings and system management that can easily support pollination services and improved carbon sequestration, including examining how such benefits can be stacked together for multiple beneficial outcomes.

Advanced monitoring technologies

Technology is transforming the way we track the state and trajectory of our natural world and the impact we are having on it, for example using satellites to monitor habitat clearance and field-based sensors to monitor our natural and managed systems in real time. Whilst there is currently a lot of interest in applying technology to agriculture – agtech – similar technologies are currently at a more mature stage of deployment and use in the ecosystem and conservation monitoring domains.

The market for the technologies is worldwide. The global value of the environmental technologies market was reported to be $1.12 Trillion in 2017, including water, pollutant, carbon, waste, instrumentation and consulting services. Technologies that focus on ecosystems are a significant subset of the broader environmental sector, and the global market for these technologies is continuing to grow and increased by approximately 10% pa between 2012 and 2017[1].

Our researchers are developing a range of remote and infield sensor technologies that allowing easy monitoring of natural and production systems to improve our understanding of:

- Carbon stocks and changes
- Impact of current farming and land management practises
- Vegetation change, including weed invasions
- Water and energy use efficiency at vineyard level
- Microbial community composition and function

Partnering with Sustainable Landscapes

Sustainable Landscapes has expertise to work with partners on the following type of projects and outcomes:

- Automated measurement of soil carbon sequestration
- River and wetland impact assessment
- Realtime assessment of livestock and broad acre landscape regeneration
- Mine site recovery monitoring
- Environmental outcome prediction and tracking
- Automatic labelling and processing of e-samples for biodiversity and ecosystem condition and function analysis (e.g. soil/pollen)
- Automatic mapping ecosystem services
- Integration of sensor and monitoring technologies and machine learning into environmental and landscape monitoring for better predictions and outcomes.

Our Partners

We are currently working with the following partners but also wish to extend this collaborative base:

- Aerometrex - automated monitoring and mapping of green space in cities (Australian Institute of Machine Learning)
- Airborne Logic - automated carbon mapping in forests using computer vision citrus water use (Australian Institute of Machine Learning, Environment Institute)
- Australian Antarctic Division - whale sound identification using machine learning (Australian Institute of Machine Learning)
- Blinman Progress Association - wheel cactus identification using drones and machine learning (Australian Institute of Machine Learning, Environment Institute)
- Department of Agriculture, Water and Environment - ecosystem condition monitoring (Terrestrial Ecosystem Research Network)
- Duxton Asset Management - mapping of soil health and ecosite services
- FarmMap - automated pastoral land assessment (Australian Institute of Machine Learning)
- Lux - automated fish counting using underwater cameras (Australian Institute of Machine Learning)
- Primary Industries and Regions South Australia - pastoral land assessment using satellite images, GIS and machine learning (Environment Institute, Australian Institute of Machine Learning, Waite Research Institute)
- Riverland Wine - predictive modelling of vine performance and water requirements (Faculty of Engineering, Computing and Mathematical Science, Australian Institute of Machine Learning, Waite Research Institute, Environment Institute)
- Wine Australia - predictive modelling of vine performance and water requirements (Faculty of Engineering, Computing and Mathematical Science, Australian Institute of Machine Learning, Waite Research Institute, Environment Institute)

1. 2019 Top Markets Report Environmental Technologies 2020, www.trade.gov/sites/default/files/2020-05/2019%20Environmental%20Technologies%20Top%20Markets%20Report.pdf

SUSTAINABLE LANDSCAPES AREAS OF EXPERTISE

AREAS OF EXPERTISE	RESEARCHERS
Ecosystem condition monitoring – natural and managed systems • Terrestrial Ecosystem Research Network: using a range of DNA, stable isotope, sensor and remote sensing technologies to assess the baseline condition and trajectory of change of Australian ecosystems • Unmanned Research Aircraft Facility and Remote Sensing group	Professor. Andrew Lowe Dr Greg Guerin Professor Megan Lewis Dr Irene Martin Dr Ramesh Segaran Associate Professor Ben Sparrow
Monitoring and restoration of water and marine resources • Aquatic ecology, restoration and monitoring	Professor Justin Brookes Professor Michelle Waycott
Monitoring of terrestrial and airborne samples • eDNA analysis	Professor Michelle Waycott Professor Andrew Lowe Dr Kor Jent-van Dijk Dr Arif Malik
Monitoring and optimisation of agricultural systems • Application of machine learning and sensor technology to the improved use of water resources in vineyards	Dr Tien Fu Lu Professor Andrew Lowe Professor Javen Shi Professor Seth Westra
Creation and management of ecosystem services Pollination reserves • Carbon • Stacked ecosystem services and economics	Professor Tim Cavagnaro Dr Katja Hogendoorn Proessor Andrew Lowe Associate Professor Patrick O'Connor
Machine learning and artificial intelligence • Satellite imagery analysis • Tracking change in long term, diffuse and disconnected datasets using machine learning • Airborne/aquatic drone and ground-based cameras and computer vision for automated surveillance of pests and species of interest • Automated advisory and language-based decision support systems for ecosystem managers • Automated carbon measurement from image capture of vegetation • Automated species identification in-field and lab (whole organism, pollen, timber samples etc) • Robotics	Dr Dong Gong Dr Lingqiao Lu Dr Tien Fu Lu

CONTACT SUSTAINABLE LANDSCAPES

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Theme lead – Sustainable Landscapes

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AREA OF EXPERTISE

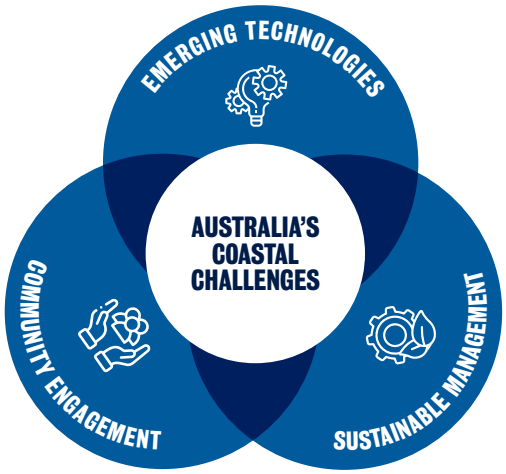
SUSTAINABLE MARINE AND COASTAL FUTURES

The Blue Economy

AUSTRALIA HAS A STRONG COASTAL CULTURE. "OUR COAST IS INTIMATELY LINKED TO OUR NATIONAL ECONOMY, INDUSTRY, ARTS, SOCIAL LIFE STYLE AND CULTURAL IDENTITY, WITH MORE THAN 85 PER CENT OF AUSTRALIANS LIVING WITHIN 50 KILOMETRES OF THE SEA"[1]

The Blue Economy Challenge

Australian consumers are increasingly motivated to buy quality seafood of known provenance, spend time in and around clean seas and know that the coasts they live beside are governed by sustainable policies. We are seeing national demand for sustainable coastal planning, reduced carbon footprints, improved water quality, aquaculture and restoration of ecosystems and wildlife, which can be addressed by drawing from decades of experience of our researchers.



Australia's Coastal Challenges

Responding to the challenge

Sustainable marine and coastal futures is a multidisciplinary team at the University of Adelaide who provide knowledge and solutions to sustain economic and population growth with improved access to quality coasts and their food production.

Our researchers work across fisheries and seafood quality, water quality, ocean warming and acidification, restoration of marine habitats, nature-based solutions to climate change (including blue carbon), conservation technologies, biological forensics, and education and training. Our team can help solve complex problems and create market opportunities with actionable solutions to:

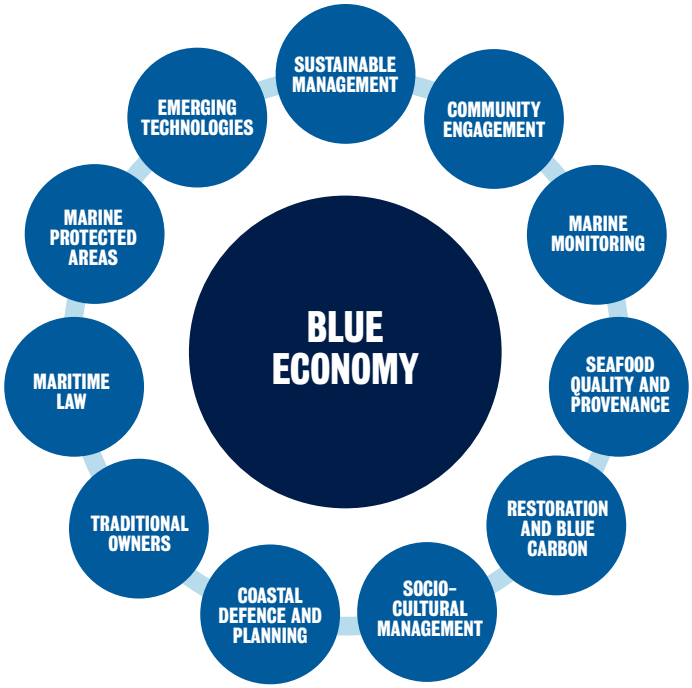
- Identify the quality of seafood and its provenance whilst assessing its future as a sustainable and reliable source of quality food in a changing climate.
- Protect, manage, and restore habitats (e.g. oyster reefs, seagrass, mangroves, rocky reefs, salt marsh) across large areas and show the benefits to people, food production, climate change mitigation and recovery of wildlife populations.
- Deploy cost-effective technologies that monitor coastal and marine ecosystem condition, detect the presence of pest or invasive species and protect native species.
- Understand the drivers of public acceptance and promote public participation in solutions.
- Visualise and communicate sustainable marine and coastal futures through live video, graphic, written and conceptual models.
- Provide school content for marine conservation and map onto the curriculum at state and national scales.

Partnering with Sustainable Marine and Coastal Futures

By harnessing the power of world-leading research to conserve and restore marine and coastal ecosystems and enhance their resilience to environmental change, our university researchers can assist in delivering coastal adaptation strategies, and lead the challenges of blue economies wishing to grow along-side social expectations of quality of life, equity and access for all.

We have the skill sets to provide:

- Marine and coastal monitoring of water quality, coastal habitat condition and change, and biodiversity monitoring.
- Identify how seafood quality might improve or decline as oceans warm and acidify, support the development of a climate-smart aquaculture industry and inform the design of climate-friendly aquaculture operations.
- Design and restore multi-species seascapes to improve their economic and social benefits.
- Nature-based solutions to climate change through coastal restoration for blue carbon and biodiversity benefits.
- Assess the environmental, economic and social benefits of improving water quality and natural and artificial coastal defences to rising sea levels.
- Educate the public on the value of adopting new management and encourage their participation through citizen science, school curriculum and continuous under-sea video footage.
- Co-design projects that innovate solutions to problems or economic and social opportunities for coastal people and industry.



The Sustainable Marine and Coastal Futures team is well-placed to lead the challenges of the blue economy

1. Australia State of the Environment Report (2019). Australia State of the Environment Report. [online] Australia State of the Environment Report. Available at: https://soe.environment.gov.au/.

OUR RESEARCHERS ARE WORKING WITH THE FEDERAL AND STATE GOVERNMENT TO RESTORE PRODUCTIVE MARINE HABITATS THAT PRODUCE SEAFOOD AND UNDERSTAND HOW FUTURE OCEANS WILL ALTER THEIR VALUE (E.G. OMEGA-3 CONTENT). SOME OF THIS WORK INVOLVES SMART MONITORING AND CITIZEN SCIENCE ALONG-SIDE SOCIAL SCIENTISTS THAT EVALUATE THE SOCIAL BENEFITS.

SUSTAINABLE MARINE AND COASTAL FUTURES AREAS OF EXPERTISE

AREAS OF EXPERTISE	RESEARCHERS
Marine monitoring • Smart technologies and remote sensing • eDNA to detect long term ecosystem dynamics and pest or unwanted species • Water quality, pollution, micro-plastics, waste-discharge, pharmaceuticals, water recycling • Marine cumulative impact assessment	Dr Ken Clarke Professor Sean Connell Professor Bronwyn Gillanders Dr Alice Jones Dr Camille Mellin Professor Ivan Nagelkerken Dr Ramesh Raja Segaran Dr Patrick Reis Santos Professor Michelle Waycott
Seafood quality and provenance • Omega-3 and future changes in nutritional profiles • Fisheries and coastal nursery habitats • Species range shifts under global change • Traceability and provenance • Climate resilience and emissions reduction in marine aquaculture	Professor Bronwyn Gillanders Dr Alice Jones Dr Camille Mellin Professor Ivan Nagelkerken Dr Patrick Reis Santos Professor Michelle Waycott
Restoration and blue carbon • Seascape and multi-species design to optimise outcomes • Boosting restoration success cost effectively • Nature-based solutions to climate change: restoration of mangroves, seagrasses & saltmarshes for blue carbon sequestration and fisheries production • Access to carbon and biodiversity offsetting and crediting markets to fund coastal restoration • Conservation technologies	Professor Sean Connell Professor Bronwyn Gillanders Dr Alice Jones Dr Dominic Mcafee Professor Ivan Nagelkerken Dr Ramesh Raja Segaran
Socio-cultural management • Show the social value of the public embracing a change in management or policy • Imbed content in high school curriculum	Dr Georgina Drew Professor Melissa Nursey-Bray Dr Rebecca Vivian
Coastal defence and planning	Professor Holger Maier
Traditional owners • Engage communities to be part of environmental decision making.	Professor Melissa Nursey-Bray
Maritime law • Mining and petroleum law within environmental regulation	Dr Alexandra Wawryk
Marine Protected Areas • Monitoring for effectiveness • Connectivity	Professor Bronwyn Gillanders Dr Alice Jones Dr Camille Mellin Professor Ivan Nagelkerken

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AREA OF EXPERTISE

WATER RESEARCH CENTRE

Bringing disciplines and capabilities together to solve real-world problems

RESEARCH AREAS

- Agriculture
- Climate and natural disasters
- Contested basins
- Culture and society
- Economics
- Energy
- Environment
- Infrastructure
- International development
- Law
- Literacy and communication
- Mining
- Municipal water
- River Murray
- Security
- Space
- Urban design

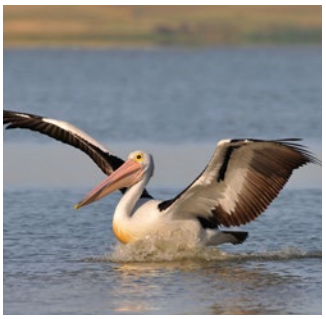
THE WATER RESEARCH CENTRE PROVIDES THE EXPERTS, STIMULUS AND SUPPORT NEEDED TO CREATE IMPACT.

Making waves with research

Water resources are a key strategic asset for all nations worldwide. Our research is targeted to underpin more sustainable management of these natural resources.

Our centre includes hydrologists, ecologists, biogeochemists, engineers, architects, modellers, economists and social scientists, who work in collaboration with the water sector and water users.

Case studies



Healthy Coorong, Healthy Basin

We helped create the Healthy Coorong, Healthy Basin Action Plan, which is restoring the Coorong to healthy vegetation and abundant and diverse waterbirds, fish and plants.

Now, along with the Goyder Institute, we are addressing scientific knowledge gaps about nutrient loads, adaption pathways under climate change, water resource optimisation, and more.

Decision-Support System

Our researchers set up a support system for opera-tional and policy decisions on water management in South Australia's South East. The system can incorporate new data as it becomes available, and takes into account inherent uncertainties.

The region is a biodiversity hotspot and site of a number of Ramsar listed wetlands, and has many primary industries, including wine, wool, meat, dairy, forestry and timber.

Vitivisor – Vineyard Precision Control

Agribusiness everywhere is undergoing a digital revolution. This project is developing an open-source platform to improve vineyard production outcomes like gross margins and productivity.

We road-tested a pilot guidance system that includes irrigation and other water management information. Now, we are optimising the system with sensing and automation technologies, and configuring the dashboard to be predictive and advisory.

Defining Water User Rights

Our law experts are revisiting fundamental water law to analyse and better understand the ways in which law defines user rights to accessing water.

Two perspectives are being considered: top-down, such as the creation of water rights by governments, and bottom-up, such as the aspirations of extractive consumers, environment uses and Indigenous flow rights.

How we bring multidisciplinary capabilities together:

RESEARCH THEMES

- MURRAY-DARLING BASIN
- SECURITY AND SUSTAINABILITY
- TECHNOLOGY, ENGINEERING AND DESIGN
- FAIRNESS

Cross-theme capabilities

- Stakeholder engagement and design-led problem solving
- Geospatial science and remote sensing to understand variability in the landscape, understand what occurs where and why, and monitor change
- Unmanned research aircraft including drones to collect high resolution imagery and datasets
- 'Beyond line of sight' technologies that enable users to collect information that is not in visual range
- Robotics, IoT, data science and machine learning to develop modern systems and technologies
- Legal regulatory frameworks and how they underpin, for example, social licence to operate.

Networking and collaboration

The centre runs a series of events to stimulate project ideas, share knowledge and provide networking opportunities.

- Workshops with members and partners to scope out industry-driven project ideas
- Seminars to showcase major innovations
- Networking events to celebrate milestones and get to know each other.

Benefits of partnering with us

- Commercial benefits; save time and money by cost-sharing
- Innovation through research collaborations, which are a major source of new innovations
- Custom water research solutions; we deliver research tailored to meet your specific needs. We pair your project with researchers that can meet the research needs, in terms of both expertise and ability to deliver to the timeframe
- Trust; having our team in your corner can generate greater trust by communities and government in your particular water solution
- Equipment; access the full analytical capabilities of the University of Adelaide's research infrastructure, and that of our partners
- Problem solving; our team has extensive experience on some of the nation's most complex water issues
- Leverage; we have access to funding schemes to make your investments stretch further.

Relationships with other institutions

The centre is a member of the University of Adelaide's Environment Institute and works closely with the Institute for Mineral and Energy Resources, the Australian Institute for Machine Learning and the Waite Research Institute.

CONTACT WATER RESEARCH CENTRE

Do you work in the water industry and could benefit from our research and development expertise?
The Water Research Centre is looking for partnership opportunities for challenges that may be great or small.

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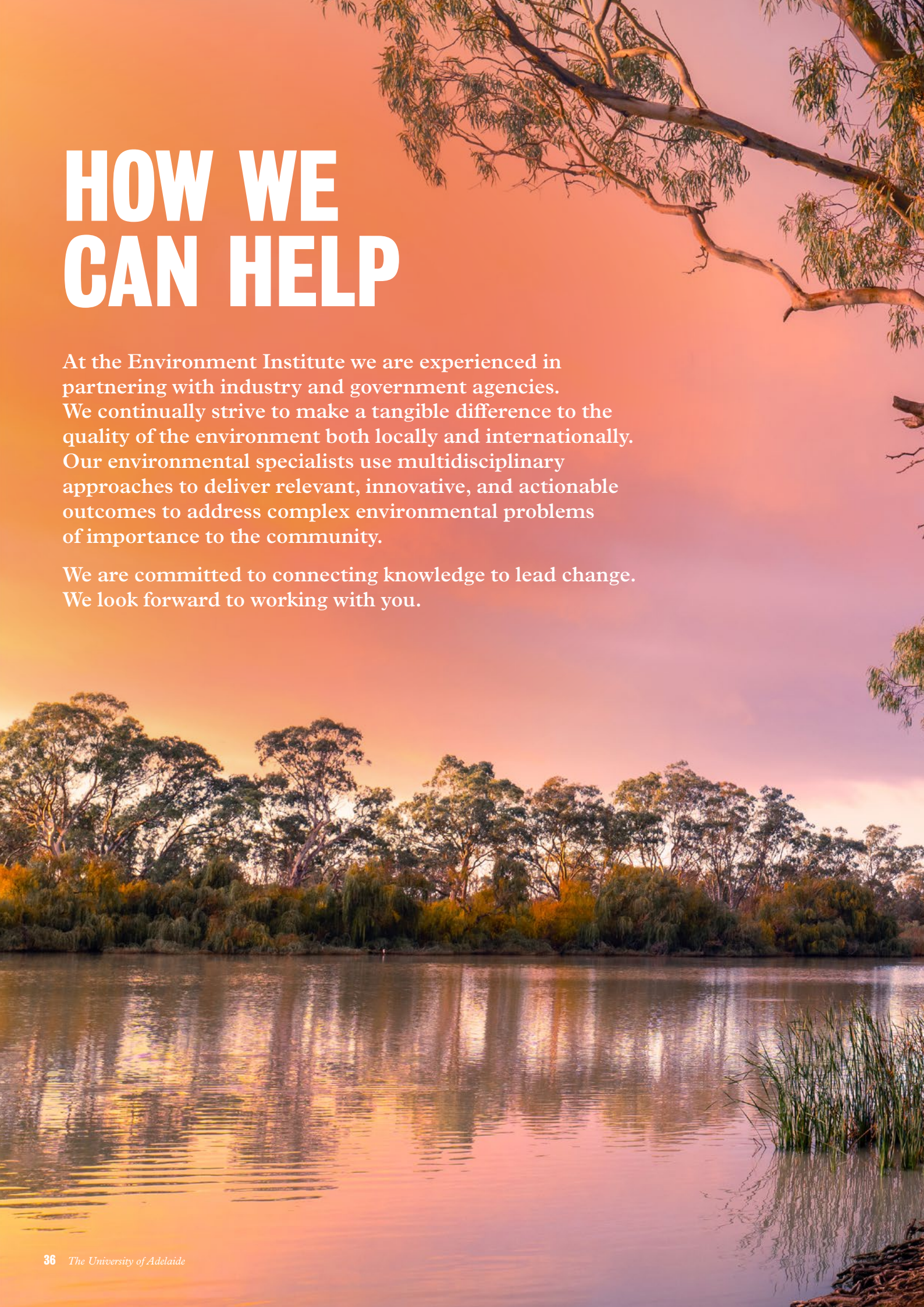
HOW WE CAN HELP

At the Environment Institute we are experienced in partnering with industry and government agencies. We continually strive to make a tangible difference to the quality of the environment both locally and internationally. Our environmental specialists use multidisciplinary approaches to deliver relevant, innovative, and actionable outcomes to address complex environmental problems of importance to the community.

We are committed to connecting knowledge to lead change. We look forward to working with you.



KAURNA ACKNOWLEDGEMENT

We acknowledge and pay our respects to the Kaurna people, the original custodians of the Adelaide Plains and the land on which the University of Adelaide's campuses at North Terrace, Waite, and Roseworthy are built. We acknowledge the deep feelings of attachment and relationship of the Kaurna people to country and we respect and value their past, present and ongoing connection to the land and cultural beliefs. The University continues to develop respectful and reciprocal relationships with all Indigenous peoples in Australia, and with other Indigenous peoples throughout the world.

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