The University of Wollongong (UOW) works with industry, community partners and researchers at other institutions in Australia and overseas to solve environmental challenges that face today’s world.

Employing emerging technologies, particularly in the areas of sustainability in infrastructure and energy security, UOW’s interdisciplinary research is tackling challenges from flood management to climate change, to protecting coastal ecosystems.

Sustaining marine environments
The University’s strategic research initiative, the Global Challenges Program, includes a research theme of Sustaining Coastal and Marine Zones, which brings together researchers from the diverse fields of science, marine conservation, law, geography, and biology to look at issues such as climate change, preserving vulnerable coastlines and food security.

Sharks, threatening or threatened?: This project examines spatial data of shark sightings, tracking, beach use and shark attack data; and reviews what is known about shark ecology and conservation in the Illawarra and Shoalhaven regions. Drawing on multidisciplinary expertise, this project explores how we can best govern species that are both threatened and potentially threatening to humans.

Managing mangrove blue carbon: The Blue Carbon Futures team is investigating the social and environmental processes contributing to change in mangrove distribution in Australia, Vietnam and Brazil. The team is using innovative technology, along with environmental accounting, to quantify the benefits of mangroves to reduce greenhouse gases. Domestic and international frameworks as well as the social/governance context of mangrove areas are being assessed for the potential to provide incentives for managing, preserving and restoring mangrove forests.

Launching a Blue Economy: This project has connected with stakeholders across public and private sectors to investigate the capabilities of the Illawarra and Shoalhaven regions to build and support a new Blue Economy based on sustainable and equitable use of the natural capital of our oceans. It will specifically highlight potential areas for sustainable development and growth as well as addressing key environmental concerns for the regions. It aims to develop a “blue print” to guide the successful implementation of a regional Blue Economy, including identifying possible areas of innovation and growth. UOW’s expertise in growing a Blue Economy is spread across the Australian National Centre for Ocean Resources and Security (ANCORS), the Global Challenges Program, SMART Infrastructure Facility and the iAccelerate Centre business incubator and accelerator to provide innovative solutions to marine issues.

Ocean management and ship safety: Based at UOW, ANCORS plays a key role in international ocean management in vital areas, including maritime security, offshore jurisdiction and enforcement, ocean law, fisheries management, and the protection of the marine environment. ANCORS is Australia’s only multidisciplinary university-based centre dedicated to research, education and training on ocean law, maritime security and natural marine resource management. It provides consultancy services to governments on a range of ocean laws, policy and management issues, management of ocean resources, ship safety and marine pollution.

The Global Challenges project Dragging the Chain examines the effect of deep-water anchors on the seabed of Australia’s east coast. The project is mapping the sea floor along the strip where the deep-water ships anchor at Port Kembla, approximately three nautical miles off shore, to investigate the impact on the environment and marine life. This work will have implications for coastal zones around the world, in both tropical and temperate climates.
Sustainable fisheries

The ANCORS Fisheries Governance research program develops practical solutions to ongoing fisheries management and development challenges.

The Fisheries Governance program works widely throughout the Asia-Pacific region and beyond, working closely with regional organisations, governments and stakeholders. ANCORS is a research partner in the Nippon Foundation Nereus Program; a global partnership of 17 leading institutes working to advance our comprehensive understanding of the global human-ocean system across the natural and social sciences.

Nereus partners pursue sustainability in a way that observes the location, identity, context, and history of the communities we work with as diversities to be embraced rather than differences to be overcome.

ANCORS also recently founded a new partnership with the Japanese Fisheries Research and Education Agency and Global Fishing Watch to investigate illegal, unreported and unregulated fishing, and to strengthen transparency and governance of fisheries within the Pacific region.

Since May 2014, ANCORS, in partnership with the Government of Kiribati’s Ministry of Fisheries and Marine Resource Development (MFMRD), WorldFish, and the Pacific Community (SPC), have been working with Kiribati communities to support the management of the nation's coastal fisheries through the development of Community Based Fisheries Management approaches.

The project team is funded by the Australian Government through the Department of Foreign Affairs and Trade (DFAT) and the Australian Centre for International Agricultural Research (ACIAR).

A second phase for the program was announced in 2018, to build on this work to scale out improvements in the wellbeing of people in Pacific coastal communities through more productive and resilient fisheries and better food and nutrition security. The project involved establishing local pilot programs in Vanuatu, Solomon Island and Kiribati, with schemes overseen by island councils.

The Global Challenges Program also supports various sustainable fisheries projects.

In September 2018, ANCORS and UOW entered into a formal collaboration with the Japanese Fisheries Research and Education Agency and the global non-profit organisation Global Fishing Watch to investigate illegal, unreported and unregulated fishing. The collaboration strengthens fisheries governance, builds transparency and supports a sustainable future for the Pacific region’s fisheries.

Innovative energy storage

The Energy Storage Materials Research Group at UOW’s Australian Institute for Innovative Materials (AIIM) is developing materials and technologies for a new generation of energy storage devices that have high energy density, long life cycles and are low in cost.

UOW’s Institute of Superconducting and Electronic Materials (ISEM) has been undertaking electric vehicle research since 2013, with the team already having retrofitted a standard passenger vehicle to be fully battery-powered. ISEM has also developed advanced materials and novel techniques for use in lithium batteries, supercapacitors, fuel cells, hydrogen storage, and in hybrid electric vehicles and portable technology devices.

AIIM also comprises the Intelligent Polymer Research Institute (IPRI), where researchers are working with nanomaterials in areas such as renewable energy, plastic solar cells, lightweight batteries and electronic textiles.

UOW research groups from the Australian Power Quality and Reliability Centre and the Sustainable Buildings Research Centre (SBRC) are working alongside ISEM to develop a pilot-scale sodium materials production facility to prototype and develop modular and expandable battery packs. The Australian Renewable Energy Agency project will see renewable energy systems installed in the Illawarra Flame House at UOW’s Innovation Campus, and Sydney Water’s Bondi Pumping Station. These sites will showcase the next generation of sodium-ion battery technology and energy management systems.

Electrical power system security

UOW headquarters the Australian Power Quality and Reliability Centre (APQRC), which has been working in conjunction with the electricity industry for more than two decades to improve the quality and reliability of electricity supply.

APQRC undertakes high quality collaborative research, and facilitates education in distribution and transmission system power quality, reliability and renewable energy systems. The expertise and world-class test facilities of the Centre are available to industry and electricity utilities to provide advice and consulting in areas such as power quality monitoring and reporting, power quality investigations and reliability improvement, and renewable energy systems.

The Centre has been and continues to be proactive in making contributions to future directions in power quality to the electricity supply industry, governing, regulatory and standards bodies, customers, and the community in general.

Facilitated by the APQRC, UOW offers one of the most comprehensive and respected undergraduate degree courses in electrical engineering in Australia, as well as a number of postgraduate degrees in power engineering. These include the highly specialised modular Master of Electrical Power Engineering degree program that has been carefully developed to help upskill working professionals.

Electrifying mining vehicles

There are currently more than 600 diesel-powered man transporters in Australia’s coal mining industry alone.

UOW researchers at the Australian Institute for Innovative Materials (AIIM) are working to produce battery-powered underground coal vehicles. This has been recognised as a significant project for the future of coal mining in Australia.

Researchers are expecting to develop the first battery-powered underground coal vehicle in the world by December 2019. This adds to UOW’s earlier achievement of creating a hybrid vehicle by retrofitting a standard passenger car.
Smart cities
Smart Cities can help achieve better energy efficiency and healthier environments. The focus is about using the Internet of Things to improve the liveability of our cities and creating a network that allows us to share our knowledge as a community.

The Digital Living Lab, launched by the University’s SMART Infrastructure Facility in 2017, is leading the digital revolution in the Illawarra, connecting the city of Wollongong through a network of gateways across the region.

Working with innovators and researchers at UOW and in the wider community, SMART is coordinating the effort to become a truly smart city through a number of projects as part of the Digital Living Lab. Initial projects address a range of environmental factors including monitoring landslides, mapping fire hydrants, wheelchair accessibility mapping, floodwater management, shark monitoring, and air quality management.

The Digital Living Lab won the award for Best Community Initiative at the 2018 Committee for Sydney Smart City Awards.

The built environment
The Sustainable Buildings Research Centre (SBRC) is a multidisciplinary facility that hosts a wide range of research and industry collaborations to address the challenges of making buildings sustainable.

The SBRC pioneers new approaches to building design, construction and retrofitting techniques to create more effective places to live and work. It is a demonstration facility for industry and the community for activities relating to sustainable buildings and energy efficiency, while also demonstrating the financial advantages of energy efficiency.

SBRC projects include developing sustainable building technologies for residential and commercial applications, analysing and improving thermal design for buildings to reduce the need for using energy for heating and cooling, renewable energy technology application, and developing control and sensor technology to improve building performance.

The SBRC is working with steel producer BlueScope on the development and testing of next-generation steel building products including photovoltaic thermal roofing, cool roof products and other innovative building envelope systems. It is also working with other key industry partners on innovative control systems for building services, including air-conditioning systems and automated natural ventilation systems.

The SBRC is a research participant in the Cooperative Research Centre for Low Carbon Living (CRCCLCL). Engineers and built environment researchers have joined five other partner universities and 48 industry and government participants in a project to lower carbon emissions in the Australian built environment and deliver a competitive advantage for industry. SBRC is collaborating with ACCESS researchers as part of an Office of Environment and Heritage Research node on Energy Efficiency Decision Making.

The SBRC also offers training for professionals working in the sustainable buildings and energy efficiency industries, with a focus on key demand areas of:
- Energy efficiency in the built environment
- Energy efficiency in electrical systems
- Energy efficiency enhancements in industry
- Changing user perceptions and day-to-day behaviours

Sustainable home for ageing population
In late 2018, a collaborative between UOW, UOW in Dubai and TAFE NSW was awarded second place in an international sustainability competition in Dubai.

Team UOW Australia-Dubai produced a sustainable and comfortable home for the Solar Decathlon Middle East 2018 in Dubai.

The Solar Decathlon Middle East 2018 is dubbed the "energy Olympics", where 15 teams from 11 countries had designed and built sustainable homes that compete across 10 contests, from architecture to sustainability, with the added challenge of coming up with a design that is functional and suited to the desert heat.

Team UOW Australia-Dubai, comprising more than 40 students from UOW and TAFE NSW designed, prototyped and built a design that addresses not only the competition needs, but also caters for the needs of an ageing population, supporting people living with dementia and other age-related disabilities.

The house takes its name – Desert Rose – from the flower that flourishes in challenging environments.

Team UOW, combining UOW and TAFE NSW Institute, became the first Australian team to win entry to a Solar Decathlon after being named the overall winner of the Solar Decathlon China 2013 with their Illawarra Flame House.

Biodiversity and heritage
UOW is leading researchers from around the world on a research quest to investigate Australia’s unique biodiversity and Indigenous heritage. Launched in June 2017, the Australian Research Council Centre of Excellence for Australian Biodiversity and Heritage (CABAH) is the first of its kind in the world and works across six research themes that address key questions concerning the human and environmental history of Australia, Papua New Guinea and eastern Indonesia from 130,000 years ago.

The Centre encourages budding young scientists through a unique outreach program at schools and museums throughout Australia and focuses on nurturing the careers of Indigenous and female researchers.

Climate change and air quality
UOW’s Centre for Atmospheric Chemistry (CAC) is supplying data from ground sites in Wollongong, Darwin and Burgos (the Philippines) to validate Japan’s GOSAT and NASA’s Orbiting Carbon Observatory-2 (OCO-2) satellite measurements. The ground instruments – monitored and operated by UOW scientists – capture infrared light rays, which are absorbed by carbon dioxide, methane and other trace gases, that can be measured to determine the amount of these gases in the air.

These sites are part of a network of about 30 ground sites for remote sensing distributed around the world.

Statistician at UOW’s Centre for Environmental Informatics (CEI) in the National Institute for Applied Statistics Research Australia (NIASRA) are working with NASA to integrate various greenhouse gas data sources. These include the GOSAT and OCO-2 data, the network data that UOW contributes to, other ground-based data, and data from aircraft. The integration results in global maps of greenhouse gases with statistical measures of their uncertainty. These maps give the most precise picture yet of greenhouse gases in the atmosphere, how much is absorbed and where.

CAC is also supplying data in a major study to help understand and manage air pollution in the Western Sydney region. The Western Air-Shed and Particulate Study for Sydney is part of the National Environmental Sciences Program Clean Air and Urban Landscapes Hub. The UOW-led study brings together experts from UOW’s CAC, and SMART Infrastructure Facility, alongside teams from the University of Melbourne and the University of Western Australia to contribute to the understanding of the main drivers of poor air quality events within the Western Sydney region.
Much of the research at CAC is focused on measuring and understanding the drivers of Australia's anthropogenic emissions of greenhouse gases into the atmosphere. Agriculture is responsible for a large amount of these emissions, with the major greenhouse gases being methane, predominantly from ruminant livestock, and nitrous oxide from fertilised soils. This work is essential to inform the Australian National Greenhouse Gas Inventory of the magnitude of agricultural greenhouse gas emissions to the atmosphere.

CAC collaborates widely in Australian and international atmospheric science communities including other universities, CSIRO, ANSTO, BOM, federal and state government departments and international networks. CAC offers the most intensive atmospheric composition and chemistry research and training program in Australian universities. The centre’s dedicated set of equipment is also used to make measurements of gas concentrations in smoke plumes at hazard reduction burns.

Cyclone threat to reef fish
Climate change poses a number of threats to the long-term viability of the Great Barrier Reef and the species that live on it. While the damage caused by more frequent coral bleaching is well documented, the impact of more intense tropical cyclones is less well studied due to their short duration and unpredictability.

In 2018, researchers from UOW’s Centre for Sustainable Ecosystems Solutions studied the effect of two successive category 4 cyclones – Cyclone Ita in April 2014 and Cyclone Nathan in March 2015 – on the social structure of coral reef fish at Lizard Island.

Uncovering history of reef
A study led by UOW’s School of Earth and Environmental Sciences and the University of Sydney saw 17 scientists from six countries drill 16 different sites of the Great Barrier Reef to uncover a history hidden under the decay.

The reef has endured five death events, which were largely induced by fluctuations in sea level. The 10-year study provided the first continuous record of the reef's evolution over a long period of time.

Managing bushfire risk
The Centre for Environmental Risk Management of Bushfires (CERMB) at the University of Wollongong undertakes research into the assessment, measurement and mitigation of bushfire risk, and the consequences of climate change.

The NSW Office of Environment and Heritage worked with UOW and the NSW Rural Fire Service to establish the Enhanced Bushfire Research Hub, which is a three-way collaboration between land managers, fire-fighters and researchers.

The Hub was announced in 2018 and UOW leads the centre, which includes a team of world-class experts from Western Sydney University, the University of NSW, and the University of Tasmania.

The Hub will provide the NSW-centred scientific research needed to ensure the safety of communities, property and the environment, as experts will work with the communities most vulnerable to bushfires.

CERMB also works with other state government agencies, the Bushfire and Natural Hazards CRC, and internationally with agencies such as the United States Geological Survey and the European Union.

The Australian Centre for Culture, Environment, Society and Space (ACCESS) also investigates how social and cultural factors affect people’s responses to natural disasters, including bushfires. ACCESS researchers have collaborated with the NSW Rural Fire Service and the Nature Conservation Council to evaluate training programs for landholders and to investigate contemporary non-Indigenous landholders’ relationships to fire and its use in land management.

Flood management
A world-first collaboration led by UOW’s SMART Infrastructure Facility has had a huge impact on how Jakarta's residents and government agencies prepare for, and respond to, severe monsoonal flooding.

Crowd-sourcing urban data collection project PetaJakarta.org is a web-based platform created to harness the power of social media to gather, sort and display information about flooding for Jakarta residents in real time. Open source software CogniCity, developed by SMART, allows for information on Jakarta's flooding to be collected and disseminated by community members through their mobile devices.
Ecosystem and natural resource management

UOW’s Centre for Sustainable Ecosystem Solutions (CSES) is an interdisciplinary research initiative targeted at ecosystem management, conservation biology and environmental biology. Its work draws upon the core disciplines of ecology, physiology, genetics and animal behaviour.

The Centre’s research focuses on invasive species, disturbance regimes (such as seabed disturbance or fire), climate change (understanding how plants and animals are impacted by climate change in Australia and Antarctica), biodiversity (understanding how biodiversity and ecosystems will respond to global environmental change), human inputs (impacts of urban developments on biodiversity), and innovative solutions (using novel technologies for assessing biodiversity and ecosystem health remotely).

ACCESS researchers are engaged in research across ecosystem and land management decision-making. Their experience encompasses Indigenous land management, pastoral land management, national park management, urban planning, and rural land management. Invasive species management by landholders and agencies is a strong theme, with recent research on weed hygiene practices funded by the NSW Department of Primary Industries and work with the Nursery and Garden Industry, NSW and ACT regarding an accreditation scheme for the industry.

Indigenous environmental relationships

Researchers from ACCESS combine insights from human geography and Indigenous methodologies to examine lessons from Indigenous relationships to place, including national park and World Heritage management, pastoral management, contemporary Indigenous uses of fire, hunting, Aboriginal land tenures, and remote area weed management practices.

Ethnic diversity and the environment

Effective environmental management needs to take account of Australia’s diverse population.

The broad aim of ACCESS’s research is to leverage ethnic diversity to help address complex environmental challenges.

ACCESS’s research focuses on better understanding how diverse sets of knowledge, and unique skills, shape people’s interactions with urban, peri-urban, rural and regional Australian environments. This includes asking the following questions:

- How do diverse cultural groups understand and value nature? Exploring how values, experiences and practices from countries of origin are brought to bear in the context of Australian landscapes.
- How does cultural diversity shape agricultural practices? Food production is central to sustainable futures. ACCESS’s focus is on farms in the ethnically diverse Sunraysia horticultural region (straddling the Murray River in south-western NSW and north-western Victoria); and also on community, market and backyard gardens in peri-urban and urban settings around Wollongong and Sydney.
- How do diverse cultural groups understand and respond to debates over environmental sustainability and climate change?

ACCESS is exploring how environmental concerns and understandings of climate change shape the ways diverse groups live their daily lives – in their households, and in their interactions with local environments.

Coastal reservoir research

The Indian Institute of Science Bangalore and UOW have jointly established an International Association for Coastal Reservoir Research (IACRR), which has already earned a world-class reputation.

IACRR is dedicated to advancing all aspects of coastal reservoirs and promoting the sustainable development and management of surface water otherwise lost to the sea.

IACRR was founded in January 2017 and is an international non-profit organisation set up to promote and develop coastal reservoirs. IACRR welcomes members from various sectors such as engineers, scientists, researchers, industry players, suppliers, contractors, developers, water agencies, operators and decision makers.