

Capability Statement

Global Water Institute (UNSW-GWI)

Welcome to the UNSW Global Water Institute

- a world leader in *multidisciplinary* water research, innovation and problem solving.

Global water issues have never been so prominent, and the demand for solutions never so high. With that in mind we are reaching across campus and forming new alliances to have a global impact.

We welcome you to join us on this global venture.

Our Vision

The vision of the Institute is to be *a world leading centre for research, capacity building and sharing of water knowledge, technologies and expertise, informing and connecting research to smart water policy and management, and facilitating sustainable outcomes from water use.*

Collaboration, the key to success

Opportunities abound through partnerships and collaborations with businesses, governments, development banks, NGOs, communities and other research providers. We offer our partners:

- Opportunities for enhanced collaboration
- Broader, more integrated water research
- Strategic international partnerships
- Stronger opportunities for research funding
- Easy access to top water expertise and facilities
- Long-term productive relationships
- Increased capacity through tailored education

The UNSW Global Water Institute (UNSW-GWI) will work with you to meet today's challenges and develop innovations to shape the future of water.



Solving global water issues together

We are working on:

- Water scarcity and access to good quality water
- Water and wastewater treatment and reuse
- Arresting the rapid loss of aquatic biodiversity and ecosystem decline
- Reducing health impacts of poor water quality
- Adapting to effects of climate change
- More efficient irrigation to meet growing demand for food
- Sourcing renewable hydropower sustainably
- Education and capacity building
- Smart policy, robust governance and resilient institutions
- Water and waste water used for epidemiology of a variety of health impacts

Multi-disciplinary powerhouse

Our university-wide institute draws on the knowledge and expertise of over 475 academics, researchers, PhD students and professional staff from a range of disciplines and touching all Faculties. Our key centre collaborations across the University are:

[Applied Marine and Estuarine Ecology Laboratory](#)
[Australian Centre for Sustainable Mining Practices](#)
[Centre for Ecosystem Science](#)
[Centre for Marine Bioinnovation](#)
[City Futures Research Centre](#)
[Climate Change Research Centre](#)
[Connected Waters Initiative](#)
[Cyanobacterial Research Group](#)
[Environmental Humanities Group](#)
[Evolution and Ecology Research Centre](#)
[Sino-Australian Research Centre for Coastal Management](#)
[Sydney Institute of Marine Science and the World Harbour Project](#)
[UNESCO Centre for Membrane Science and Technology](#)
[Water Research Centre](#)
[Water Research Laboratory](#)

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Market leaders in...

Water & wastewater management

Water and Wastewater Treatment:

performance assessment and optimisation of key processes including activated sludge; membrane bioreactors; dissolved air flotation; microfiltration; ultrafiltration; nanofiltration; reverse osmosis; chlorine disinfection and advanced oxidation processes.

Water Recycling for Potable and Non-Potable Reuse: process assessment and validation; monitoring and critical control points; regulation and guidelines; public perception and community consultation.

Membranes: our UNESCO Centre for Membrane Science and Technology is the leading centre for membrane development in Australia, with facilities for characterisation of the structure, properties and transport mechanisms in synthetic membranes; sustainable membrane processes for environmental and industrial applications; membrane module design, operation and process control; novel membranes and membrane processes; methods to control membrane fouling.

Trace Organics: analytical method development and determination; assessment of chemical contaminant fate during engineered water treatment and environment process; organic contaminants including pharmaceuticals, hormones, disinfection byproducts, pesticides and algal toxins.

Physicochemical Processes in Natural and Engineered Systems:

transformation and fate of contaminants; transport and immobilisation of radionuclides; algal growth and toxicity; generation of reactive oxygen species; advanced oxidation processes; electrochemical water treatment technologies; nucleation and aggregation phenomena; hydration and crystallisation processes; mineral recovery and tailings management.

Odorour and Gaseous Emissions: the UNSW Odour Laboratory is a leading edge facility that provides specialist olfactory and chemical analysis for the characterization of odorour and gaseous emissions from point and area sources.

Cyanobacteria and their

Toxins: identification of genes responsible for the production of toxins in several strains of cyanobacteria and investigation of the mechanisms of toxin biosynthesis, regulation of toxin genes, and the evolutionary ecology of these aquatic microbes.

Risk Assessment and Management:

exposure assessment; reliability assessment; hazardous events and failure modes; quantitative microbial risk assessment; quantitative chemical risk assessment; risk management protocols.

Water resource management & climate change

Groundwater Resource and Quality: water quality and biogeochemical processes; interconnectivity of surface water and groundwater; environmental and isotopic tracers; groundwater resource impacts from changing climate and landuse, including agriculture, coal seam gas and mining; hydraulics and chemistry of aquitards; coastal zone groundwater connectivity; fractured rock systems and preferential flow; cave and karst hydrogeology; Managed Aquifer Recharge; heat as a groundwater tracer; fate of hydraulic fracturing fluids; contaminated land remediation; subsurface contaminant and heat transport; fate of engineered nanoparticles; 3D geological models; site characterization; resource assessment - bore design, aquifer testing, core-testing, flow through sorption testing, water level and quality monitoring, geophysical

survey, groundwater flow and transport modelling and conceptual model development; solutions for effluent re-use and disposal.

Climate Change and Climate Variability Impacts on Water: El Niño - Southern Oscillation (ENSO) and related phenomena in the Tropics and their impacts on regional climate and water security; temperature and rainfall variability and extremes - and how these are affected by land processes at regional scales; the present and future impact of global warming and carbon dioxide/ocean acidification on life in the oceans and on land;

key ocean processes that affect the climate system, including processes such as ENSO, the Indian Ocean Dipole (IOD), and Southern Ocean circulation; better models for weather and climate prediction for water management; factors that control rainfall and drought; extremes such as heat waves and heavy precipitation events; regional modeling of the climate system for water and catchment managers; land surface models to reproduce ecosystem carbon and water dynamics; understanding marine impacts and responses to elevated CO₂ concentrations and ocean acidification; paleoclimatological understanding of droughts, floods and ecological tipping points.

Hydroclimatology: Modelling changes in flood and drought characteristics resulting from climate change; using principles of uncertainty (including Bayesian and stochastic techniques) to model natural systems; understanding changes in ecology or hydrology resulting from land-use change and rising global temperatures; formulating better approaches for quantifying surface soil moisture and precipitation using remote sensing techniques such as satellites and weather radars; improving the basis for seasonal to interannual to decadal forecasting of rainfall and streamflow to better manage water availability in a sustainable manner.

Hydrology & Flooding: catchment hydrology and quality of runoff; water budgeting; reservoir operations; desalination; sedimentation; geomorphology; salinization; and floodplain management.

Coastal and estuarine management

Coastal Engineering and Management: our hydraulic research station, Australia's largest, addresses coastal processes; coastal hazard definition and inundation; foreshore revetment design and testing; dredging and beach nourishment; design optimisation of coastal structures, harbours, ports and marinas; surfing reefs; optimal methods for coastal climate change adaptation; remediation of historic seawalls; innovative and traditional coastal structures; 'real time' coastal monitoring and measurement; on-the-go electromagnetic conductivity imaging of beach-face salinity processes; impact assessment of near shore coastal structures on beach planform and forensic coastal engineering.

Coastal Oceanography: experts in coastal ocean processes using modern ocean observation (e.g gliders, real time, moorings, and HF ocean radar) and numerical modelling techniques with applications to real world problems such as biophysical coupling and drivers of ocean productivity, connectivity of coastal waters, transport of pollutants and marine pests, impact of climate change on ocean circulation and productivity. Lead of NSW-IMOS (www.imos.org.au); biological oceanography on board Australia's Marine National Facility R.V. Investigator; global analyses of plankton particle size.

Environmental Engineering: Port and harbour hydrodynamics; fate and transport of contaminants; riverbank and boating assessments; sediment transport; acid sulphate soils; impacts of sewage outfalls on the marine environment; dredge plume management; environmental fluid mechanics including multiphase flow, stratification and re-aeration.

Eco-engineering for Coastal Developments: baseline ecological assessments; biodiversity enhancements; multi-functional enhancements; pre-seeding for new developments; retrofitting; intertidal and subtidal. Land reclamation and hardening of the coastlines, ecohydrology, ecosystem dynamics modelling.

Civil Engineering Hydraulics: Design optimisation and performance assessment of hydraulic structures in urban and rural environments such as stormwater systems, dam outlet works, energy dissipaters, ocean outfalls, spillways, levees, fish passages and flood control structures; hydraulics in industrial applications such as pump stations, hydro and thermal power stations, and water and wastewater treatment plants; physical and numerical modelling of turbulent flows including fluid-structure interactions, air-water flows as well as in stationary and transitional flows.

Estuarine management: estuarine and river processes; estuarine process studies; tidal and wetland restoration; broad-based multidisciplinary research to identify, preserve and enhance the resilience of species and

habitats in urban rivers, estuaries and harbours that have high ecosystem and conservation value, digital soil mapping of acid-sulfate soil and shallow saline groundwater, enhancing the capacity of relevant government departments to make key management decisions.

Aquatic ecosystems & biodiversity

River and Wetland Management: risks to biodiversity (invertebrates, vegetation, frogs, waterbirds) of wetlands, rivers, estuaries and groundwater systems; linking hydrological patterns to floodplains and wetlands to restore environmental flows and rivers; understanding anthropogenic drivers of aquatic ecosystems including river regulation; protection of minimally impacted biodiversity hotspots.

Conservation Practice: practices and processes of rigorous adaptive planning and management; identification of ecological values of rivers; environmental planning and policy, conservation tools and strategies; conservation of water and livelihoods.

Marine Bioinnovation: disease in marine seaweeds; microbial process in aquaculture, ecology and function of biofilms; restoration of underwater forests; ecology of invasive species; microbial symbiosis; biogenic habitats and biodiversity; bio-prospecting marine microbial diversity for new drugs and bioactives; microbial interactions with biochar.

Biomonitoring of Aquatic Ecosystems: identification and application of biomonitors to investigate environmental impacts; bioaccumulation studies; development of codes of practice, regulatory standards and guidelines; environmental, ecotoxicology and ecological analysis; environmental risk assessment and modelling. Development of novel biomonitoring tools: ARISA DNA fingerprinting tools; targeted gene sequencing; metatranscriptomics for functional assessments; targeted qPCR for pathogens of interest; cellular biomarkers.

Pollution Research: laboratory and field-based mesocosms; ecotoxicology testing; multiple stressor assessments; application of remote sensing tools to pollution monitoring; compliance for water and sediment quality guidelines.

Public health

Public Health and Health Services: infectious diseases control and prevention; epidemiology of infectious disease outbreaks with particular focus in health services and patient safety.

Health related behaviour: the use of water and beliefs about water related hygiene practices provides important insight into strategies used to improve the health of middle and low resourced countries

Epidemiology of health impacts: water and waste water can provide insight into numerous health outcomes and impacts of healthcare that includes the prevalence and epidemiology of antibiotics usage and the level of antibiotic resistance.

Social science

Environmental Humanities: Social histories of rivers and water; social aspects of urban and rural water use; social aspects of novel water technologies; resource use and conflict; water and international development; social aspects of climate change.

Political ecology of water resource management: Water access and equity, water justice; gender and water management, water in international development, water and climate change vulnerability; local politics of water planning and management; power and water; local and scientific knowledge in water; stakeholder participation in decision making; representation and accountability in water management.

Policy, planning, governance and sustainability

Water Governance and Policy: regional institution-building for water cooperation; science-policy interface; transboundary water policy and governance; water agreements in Asia; sources of water-related conflicts; sustainable development of water resources in Asia; community engagement; decentralized water management collaborative water governance; water regulation; groundwater law and governance, water metering policy, bore driller regulation, compliance and

enforcement of water extraction; watershed management institutions; cross-scalar interactions in water governance; polycentric and adaptive water governance; watershed and complex adaptive systems.

Hydropower: dam design and impact assessment; hydropower policy and development; standards compliance and regulation of hydropower dams; corporate social responsibility in the hydropower industry; participatory and inclusive approaches to hydro-development.

Water Planning: water allocation planning; co-regulation; agricultural self-management; market based instruments including payent for ecosystem services; water-agriculture-forest nexus.

Sustainability Assessment: triple bottom line reporting; life cycle assessment; environmental foot-printing; multi-criteria analysis.

Programme planning & evaluation: design and implementation of water programme evaluation, knowledge management, capacity building for adaptive water management, aid effectiveness analysis, accountability in water governance, gender inclusive program design and delivery management.

Disaster Risk Reduction and Disaster Management: Disaster justice; disaster recovery planning, flood induced disaster management; disaster risk assessment; foreign aid and disaster recovery; gender in disaster management; disaster and international development; disaster management and poverty; politics of disaster; stakeholder participation in disaster risk reduction; disaster governance; disaster policy; isaster risk reduction.

Industry specialisations

Aquaculture: improving income and food security for rural communities by increasing aquaculture farm yields, reducing environmental degradation, controlling disease outbreaks, managing resource competition, developing sustainable farming practices, building local capacity and increasing benefits to farmers.

Fisheries Enhancements: Design and sustainability of offshore artificial reefs; restocking of estuarine fisheries; urban fisheries ecology; and recreational fishing; DIDSON acoustic camera.

Agriculture and Horticulture: GWI is working with several agricultural, pastoral and horticultural industries to solve their water problems. This ranges across improving irrigation water use efficiency; on-the-go electromagnetic conductivity imaging of soil-water interactions, understanding biochemical interactions in the root zone; methods to adapt to climate change; novel technologies; digital mapping of soil-water properties and soil type at the field, farm and district scale, and sustainability assessments for new enterprises.

Mine Water Productivity and Waste Management: water productivity-footprint in coal and uranium mining; in situ recovery of metals for future mines; groundwater-geomechanical processes for underground roof stability; hydraulics and geochemistry of low permeability barriers; dewatering of excavations; mine water balance and aquifer interference; mine subsidence impacts on shallow aquifers and peat swamps; long term water quality of mine voids and beneficial use options; underground disposal of mine tailings and wastes.

Coal Seam Gas: Water resource impact assessment; mapping aquifer connectivity; geological mapping; geological fault analysis; 3D geological models; groundwater chemical analyses; gas characterization; gas leak detection; and fugitive emission estimations.

Water Utilities: collaboration with water utilities identifying solutions to water shortages, water quality problems and preparing for adaptation to climate change. Improve water quality characterisation, enhance treatment process performance, develop new water quality monitoring techniques and refine stakeholder communication strategies. Undertaking risk assessment activities that have been required of utilities from regulators. Significant contributions to water industry guidelines such as the Australian Drinking Water Guidelines and Australian Guidelines for Water Recycling.