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Living Water

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Exhibition guide

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Introduction

Water is an ancient, living thing. It has cycled through the atmosphere, soil, oceans, and bodies for billions of years – shaping the land, creating habitats, and sustaining life. As a crucial resource covering over 70% of the planet's surface, water is at the centre of every community, holding social, economic, and cultural importance. Extreme shifts in water patterns, from floods to droughts, disrupt an ecosystem's delicate balance and impact the interconnected relationships among all forms of life. Yet, water remains adaptable and resilient. Despite growing threats posed by pollution, misuse, and climate change, researchers remain committed to discovering solutions to safeguard our marine, freshwater, and urban water systems.

Living Water: 75 years of water research at UNSW connects water research across various environments and disciplines. From seagrass reforestation to aquafarming, hydrology to art, this research speaks to the multitude of ways water shapes existence and impacts survival. By drawing together breakthrough studies, technological innovations, and community engagement efforts, we gain insight into how scientists, engineers, artists, and researchers address

complex challenges related to the stewardship of the planet's water systems. *Living Water* highlights significant contributions made by UNSW toward water governance and security, the support of healthy oceans and resilient coastlines, ensuring safe and equitable access to water, and sharing the knowledge we need to protect this vital resource into the future.

Many of the water systems featured in *Living Water* flow through Aboriginal Land, inscribed with more than 65,000 years of rich history and heritage. We recognise the ongoing relationship the Traditional Owners have with these lands and waters and thank them for their care and protection of these ecosystems for generations. This exhibition takes place on unceded lands of the Bedegal and Gadigal peoples. Always was, always will be, Aboriginal Land.

In celebration of UNSW's 75th anniversary, this exhibition is a collaboration between UNSW Library and UNSW Global Water Institute with funding support from the Faculty of Arts, Design & Architecture, Faculty of Business, Faculty of Engineering, Faculty of Law & Justice, Faculty of Science, and UNSW Library. *Living Water* is presented across all three UNSW Libraries: Main Library, Level 5; Law Library; Art & Design Paddington Library.

The River Ends as the Ocean

Creative Practice Lab, Theatre and Performance
School of the Arts & Media
Faculty of Arts, Design & Architecture, UNSW Sydney

Video: Aunty Rhonda Dixon-Grovenor, *Aunty Rhonda's Walk*, 2021. Single-channel video with sound, 14:40 minutes. Credit: Paul Costello ASC. Director of photography, sound, and editing.

Video: Dr Clare Britton, *20 Kilometers of Water*, 2014-2019. Silent single-channel video, 15:11 minutes.

Graphic: Sketch of Cooks River and tributaries. Credit: Cooks River Environment Survey and Landscape Design: Report of the Cooks River Project (1976) and Dr Clare Britton.

The River Ends as the Ocean is an ongoing collaboration between activist, artist, researcher, and Elder Aunty Rhonda Dixon-Grovenor; feminist, cultural theorist, and writer Astrida Neimanis; and artist Clare Britton. This project encompasses film, publications, storytelling, public walks, and workshops that focus on bodies of water and how

they can help us reimagine justice, care, responsibility and relation in the time of climate catastrophe.

The film *Aunty Rhonda's Walk* (2021) follows Aunty Rhonda Dixon-Grovenor as she leads a durational public walk along the river Gooliyari (known as Cooks River). The walk moves through Wangal, Gadigal, and Bidjigal Country. This film was shown as part of the 13th Shanghai Biennale's "Bodies of Water" Phase 2: An eco-system of alliances, presented at the Powerstation of Art in Shanghai in 2021.

20 Kilometres of Water (2014-2019) follows the same river underwater from Strathfield Golf Club to Botany Bay/Kamay. It was filmed while walking where the river is shallow and then by rowing from the Canterbury Ice Rink to where the river enters the bay. *20 Kilometres of Water* is a meditation on water, gravity, light, and time, exploring both the trouble and beauty of this particular river.

These works took place on Bidjigal, Wangal, Gadigal, and Gameygal lands.

Acknowledgements:
Project Liaison: Dr Clare Britton
The durational public walk, *The River Ends as the Ocean: Walk the Tide Out* (filmed in *Aunty Rhonda's Walk*), was supported by the New South Wales Government through Create NSW.

The artist would like to thank The Composting Feminisms Reading Group, Magnetic Topographies and Press, Sydney Environment Institute, Frontyard Projects, The Mullets, The Tempe River Canoe Club, the Wurridjal Festival, Jason L'ecuyer, The Intermedial Composition Network and the Esme Timbrey Creative Practice Lab and Technical Resource Centre at UNSW, Alisa Croft at Pinch Press, Steven Graham at the UNSW print centre, Lucy Parakhina, Julie Rrap, Sydney College of the Arts, Krusa Neimligers, Kim Ligers, James Brown, Liz Warning, Paul Costello, Jazlyn Morgan, Julie Vulcan, Andres Jaque, Filipa Ramos, Yang Yang, Les and Matt Prest, Amber Slade, Therese Keogh, Kenzee Patterson, Tessa Zettel, Jennifer Mae Hamilton and everyone who walked the tide out.

Living Seawalls

Centre for Marine Research and Innovation
School of Biological, Earth and Environmental Sciences
Faculty of Science, UNSW Sydney

Object: Marine-grade 3D-printed concrete tiles.

Image (top left): Living Seawalls installed along the shoreline of Sydney Harbour. Credit: Photograph by Alex Goad.

Image (top centre): Living Seawalls along Sydney Harbour. Credit: Photograph by Aria Lee.

Image (top right): Underwater detail of Living Seawalls with marine life, Balmain. Credit: Photograph by Aria Lee.

Image (bottom left): Living Seawalls installed at Sawmiller's Reserve along Sydney Harbour.
Credit: Photograph by Alex Goad.

Image (bottom centre): Detail of marine life habitat on Living Seawalls. Credit: Photograph by Leah Wood.

Image (bottom right): Underwater detail of Living Seawalls with well established marine habitats.
Credit: Photograph by Sian Liddy.

Living Seawalls are revolutionising the way we build in the oceans. Through innovative design that combines ecological and engineering know-how, we developed an adaptable and affordable mechanism for encouraging marine life back to waterside infrastructure.

Living Seawalls address the growing but often overlooked consequence of marine built infrastructure, such as seawalls, breakwaters, and pier pilings, to biodiversity loss in our oceans. These structures have a significant environmental footprint and collectively modify an area of seafloor that exceeds the size of the world's mangrove forests and seagrass beds. The ecological impact of marine infrastructure arises from the destruction and degradation of natural habitats, in addition to their flat and often smooth surfaces, which provide little protection to seaweeds and marine animals from predation and environmental stressors. The net effect is the loss of native biodiversity and the proliferation of pest species.

Living Seawalls can be found in several sites in Sydney Harbour, throughout NSW, around Australia (including Perth, Adelaide, and Townsville), and internationally (including Wales, England, and Singapore).

Acknowledgements:
Project Liaison: Associate Professor Mariana Mayer Pinto
Living Seawalls is a collaboration between UNSW, the Sydney Institute of Marine Science (SIMS), and Macquarie University.

The research project is led by Associate Professor Mariana Mayer Pinto (UNSW), Associate Professor Katherine Dafforn, and Professor Melanie Bishop (both from Macquarie University), with Dr Aria Lee as Project Manager. Alex Goad from Reef Design Lab designs the panels and other products. Funding support from Sydney Institute of Marine Science, Lim-Sutton Initiative, Harding & Miller Foundation, and many other funding bodies over the years.

Accounting for outside options in discrete choice models: An application to commercial fishing effort

School of Economics
Faculty of Business, UNSW Sydney

Image: Facsimile of a drawing by Jacques Burkhardt (1808-1867), *Panulirus argus* (1855). Credit: Ernst Mayr Library, Museum of Comparative Zoology, Harvard University.

In her study of discrete choice models, Dr Tess Stafford (UNSW Department of Economics) analyses the behaviour of commercial fishermen in the coastal waters off Southern Florida. Her paper focuses on how a researcher characterises a person's choice set and how poor groupings of choices can produce models that result in poor policy predictions. Through a case study, she demonstrates how a fisherman can choose between fishing for the Florida Spiny Lobster (*Panulirus argus*), fishing for stone crab, and staying home. A researcher solely interested in the lobster fishery may simplify a fisherman's choice set to fishing for lobster and everything else, thereby grouping fishing for stone crab and staying home. The consequence of this poor grouping is that the model may suggest that a policy like creating a

marine reserve is beneficial when, in fact, it displaces effort in the lobster fishery to the stone crab fishery, which could inadvertently cause that fishery to collapse. The application of this work guides future policy and decision-making on fisheries management, which in turn is related to the health of the ocean. Effective fishery management directly impacts ecosystem well-being by maintaining sustainable fish populations, preserving biodiversity, and safeguarding marine habitats.

Acknowledgements:
Project Liaison: Dr Tess Stafford
Scott French, Chris Anderson, Frank Asche, Denzil Fiebig, Alan Haynie, James Morley, Marty Smith, and Jim Wilen. Seminar participants at the UNSW and conference participants at the AERE Summer Conference, WCERE, NAAFE Forum, and IIFET Conference. Data was provided by the Florida Fish and Wildlife Conservation Commission, and funding support was from the National Marine Fisheries Service and a National Sea Grant.

Tess M. Stafford, "Accounting for outside options in discrete choice models: An application to commercial fishing effort," *Journal of Environmental Economics and Management 88* (2018): 159–179.

Ngapa Yaan (Murrawarri)
Niibi Aanmitaagzi (Northern Cree)

Theatre and Performance
School of the Arts & Media
Faculty of Arts, Design & Architecture, UNSW Sydney

Video: *Ngapa Yaan / Niibi Aanmitaagzi (Water Speaks)*, 2022.
Three-channel video with sound, 4:23 minutes.
Credit: Moogahlin Performing Arts with Aanmitaagzi.

Through a durational discursive practice of storytelling and story-weaving connected by a common theme – WATER – the project engages with historical references to water from across different nations and countries. These stories emerge from juxtaposed landscapes, one a frozen inland lake, the other in an often-dry red dusty land. We ask, what knowledge about water is contained and transferred through each story? How do these stories define a relationship to water?

An ongoing artistic and knowledge exchange between First Peoples women performance makers from Australia and Turtle Island / Canada.

Featuring creation stories – Serpent People from Nipissing First Nation (Turtle Island) and Mundagudda from Far West NSW Australia told in Murrawarri and Northern Cree languages alongside footage of their respective lands and waterways. The work foregrounds the crucial connection between language, story, and Country.

Acknowledgements:
Project Liaison: Associate Professor Liza-Mare Syron

Australian project team: r e a (Gamilaraay/Wailwan/Biripi), Guest Artist/Creative Co-Director; Darrin Baker (Samoan/Australian), Camera / Drone Operator / Editor; Christopher McHughes (Murrawarri/Ngemba), Production Support / Drone; Stephen Wilson Barker (Murrawarri), Moogahlin Content Producer.
Moogahlin: Aunty Josephine Byno (Murrawarri), Storyteller / Knowledge Keeper; Lily Shearer (Murrawarri/Ngemba), Lead Artist; Dr Liza-Mare Syron (Biripay), Lead Artist; Kelsey Barker (Murrawarri/Yuwaalaraay/Yorta Yorta), Translator / Script / Narrator; Alison Murphy-Oates (Ngiyampaa/Wailwan), Managing Director; Lacey Boney (Murrawarri/Ngemba), Regional Project Coordinator; Akala Newman (Wiradjuri/Gadigal), Assistant Producer.

Turtle Island / Canada project team: RFPMEDIA – Collaborative Partner; Richard Fortin, Camera Assistant; Bernardo D'Avila, Camera and Drone Operator. Aanmitaagzi: Perry Mcleod-Shabogeesic (Ojibway Anishinabe), Story-teller / Knowledge Keeper; Penny Couchie (Anishinaabe), Creative Lead / Script / Narrator; Meg Paulin-Loziki (Micmac, French, and Polish), Creative Lead; Sid Bobb (Sto:lo/Salish), Creative Lead / Script; Cecile Hookimaw (Mushkegowuk Cree), Translator / Narrator; Bradley Trudeau (Anishinaabe), Camera; Sherry Guppy (Anishinaabe), Production Support; Michaela Washburn (Metis), Production Support; Merilee Helmer (Piikani/Blackfoot), Production Support.

Commissioned by the Biennale of Sydney. Supported by the Creative Australia, Create NSW, and the Consulate General of Canada, Sydney.

CoastSnap

Water Research Laboratory
School of Civil and Environmental Engineering
Faculty of Engineering, UNSW Sydney

Image (background): Historical aerial photograph of Manly Beach, NSW, Guringai Country. Credit: MAP3418 from the Historical Aerial Photography collection. 20 January 1930.

Image (left): Two-dimensional rectified photograph of Manly Beach, processed using photogrammetry to extract three-dimensional information. Credit: Dr Mitchell Harley, UNSW Water Research Lab.

Image (right): Photograph of Manly Beach taken from CoastSnap station. Credit: CoastSnap anonymous contributor.

Video: Timelapse photographs of beaches taken from CoastSnap stations. Blacksmiths Beach (NSW), Burleigh Beach (QLD), Gadhu Beach (NSW), Mollymook (NSW), Nelsons Beach (NSW), Santa Barbara (California, USA), and Tugun Beach (QLD).

Object: CoastSnap station.

CoastSnap is a global citizen science project that harnesses smartphone photos taken by the public to measure changing coastlines. Fixed camera cradles installed at various beach locations enable the collection of images to a centralised database. These images are analysed using a process known as photogrammetry, which turns each image into a satellite view, facilitating the investigation of the changing shoreline position. Founded at Manly Beach in Sydney in 2017, the project has grown exponentially, now consisting of over 500 stations in 32 countries across the globe.

The UNSW Water Research Laboratory (WRL) has been monitoring and collecting data on Australian beaches for decades, employing a diverse range of methods. In April 1976, a monthly beach profile survey program commenced at Narrabeen, located on Sydney's Northern Beaches. Still monitored by WRL today, this is one of a limited number of sites globally with uninterrupted beach monitoring that spans nearly half a century.

Coastal monitoring methods like CoastSnap are about more than just understanding how coastlines change over time,

whether due to rising sea levels, extreme storms, or other factors. Ultimately, the knowledge gained from these studies improves the future management of coastlines.

Acknowledgements:
Project Liaison: Dr Mitchell Harley
CoastSnap was initially supported by an innovation grant from the NSW Department of Climate Change, Energy, the Environment and Water.

The microscopic world of marine sponges

Centre for Marine Science and Innovation
School of Biological, Earth and Environmental Sciences
Faculty of Science, UNSW Sydney

Image on fabric (left): *Cymbastela concentrica*.
Credit: Photograph by Yunke Jia.

Image on fabric (centre): *Cymbastela concentrica*.
Credit: Photograph by Yunke Jia.

Image on fabric (right): *Tethya stolonifera*.
Credit: Photograph by Jessica Taylor.

Specimens were sourced from Bare Island, Botany Bay/ Kamay, NSW, Gweagal and Gameygal Country.

Sponges are abundant organisms in the marine ecosystem and pump large volumes of seawater through their porous bodies (see macro-image in the display case). These sponges also serve as a habitat for a multitude of microbes (see micro-images printed on fabric) that are responsible for nutrient and carbon uptake, as well as the removal of pollutants and toxins from the seawater. The symbiotic relationship between sponges and microbes contributes

to maintaining water quality and influences global geochemical cycles in the marine ecosystem. The research, led by Professor Torsten Thomas and his team at UNSW, is dedicated to understanding the responses and resilience of this sponge-microbe symbiosis to global environmental change. Furthermore, it aims to quantify the impact sponges have on greenhouse gas removal.

Acknowledgements:
Project Liaison: Professor Torsten Thomas

Operation Crayweed

Centre for Marine Science and Innovation
School of Biological, Earth and Environmental Sciences
Faculty of Science, UNSW Sydney

Image (background): Scientist transplanting crayweed specimen. Credit: Photograph by Tom Burd.

Image (left): Scientists securing crayweed to the seafloor along the Sydney coastline. Credit: Photograph by Tom Burd.

Image (right and title image for *Living Water*): Crayweed specimen. Credit: Photograph by John Turnbull.

Operation Crayweed is a conservation initiative aimed at restoring Sydney's crayweed, a type of seaweed vital for marine biodiversity. This project, led by a team of scientists based at UNSW, University of Sydney, and Sydney Institute of Marine Science (SIMS), focuses on the transplantation of crayweed from areas outside of Sydney where healthy populations still survive to areas within the Sydney Metropolitan Coastline where it has disappeared. The local extinction of crayweed in Sydney was likely caused by water pollution in the 1980s – a problem that has now been

resolved. By restoring crayweed populations, Operation Crayweed aims to improve habitat quality for marine life and enhance coastal resilience.

Through community engagement and education programs, Operation Crayweed encourages public participation in coastal restoration efforts and raises awareness about the importance of seaweed ecosystems in maintaining healthy oceans. The project also collaborates with government agencies, research institutions, Traditional Owners and Indigenous knowledge holders, and local communities to implement effective conservation strategies and monitor the long-term success of crayweed restoration.

Overall, Operation Crayweed represents a collaborative effort to conserve marine biodiversity, restore degraded habitats, and foster a deeper understanding of the interconnectedness between humans and the marine environment.

Acknowledgements:
Project Liaison: Dr Claudia Santori and Professor Adriana Vergés
This research has been funded by the NSW Department of Primary Industries under the Environmental Trust and Recreational Fishing Trust grants, the Australian Research Council, the Lim-Sutton and Breen Initiatives and the John T Reid Foundation, as well as the Evolution & Ecology Research Centre, UNSW Sydney, Investa, and many other companies, community groups, and individuals.

Surveying waterbird colonies with a drone

Centre for Ecosystem Science
School of Biological, Earth and Environmental Sciences
Faculty of Science, UNSW Sydney

Image (left): Thermal and drone image of Straw-necked ibis colony (which often breeds in mixed colonies with Australian white ibis and Glossy ibis) nesting in the wetlands of the Murray-Darling Basin. Credit: Photograph by Dr Roxane Francis.

Image (right): Thermal and drone image of Australian pelican colony nesting in the wetlands of the Murray-Darling Basin. Credit: Photograph by Dr Roxane Francis.

All images were collected by experienced and licenced drone pilots with required animal ethics, regulatory, and landholder approvals.

Waterbirds, which are declining across eastern Australia, play an important role in the ecosystem, acting as top-order predators and natural pest controllers, and are, of course, a beautiful part of the Australian landscape. Understanding their breeding requirements is essential to

their conservation. Breeding typically occurs over water, and the availability of suitable habitats, influenced by factors such as river flows and inundation, greatly affect breeding success. Many of these waterbirds breed in large aggregations in remote Australia and may include more than 100,000 nesting birds. It is difficult to estimate the size and progression of breeding colonies, but with drones, we have a birds-eye view of the colonies and individual nests. With drones, we can map colony extents, estimate the age of chicks, and gauge breeding conditions. This information allows us to advise water managers as to what river flow requirements might be necessary to ensure a successful breeding event, enhancing the chance of young fluffy chicks reaching the fledgling stage and contributing new individuals to Australian waterbird populations.

Acknowledgements:
Project Liaison: Dr Roxane Francis and Sharon Ryall
Project team: Dr Roxane Francis, Dr Kate Brandis, plus many valuable field assistants.
Partners and funders: Commonwealth Environmental Water Holder DCCEEW, NSW Department of Climate Change, Energy, the Environment and Water.

Freshwater turtle habitat, dietary and flow requirements

Centre for Ecosystem Science
School of Biological, Earth and Environmental Sciences
Faculty of Science, UNSW Sydney

Object: Turtle trap. Courtesy of Dr Roxane Francis.

Freshwater turtles are in decline globally, including here in Australia, where almost half of Australian freshwater turtle species are formally listed as threatened. To explore conservation and management options, we trapped three species of freshwater turtles across three rivers in the Macquarie Marshes. We collected blood and nail samples and morphometric data before returning the turtles to the river. We explored this data in relation to current and historic flow regimes and habitat variables. Stable isotope analysis of the blood and nail samples found diets varied throughout the year and high levels of dietary overlap amongst the species. Macrophyte cover was an important predictor of turtle abundance for two species but not the third, and salinity was also an important predictor of abundance. The three turtle species each have different habitats and

dietary requirements, and as such, sufficient water flows must remain in our rivers to create a habitat, support the invertebrate and fish populations these turtles feed on, and protect turtle populations in the future.

Information about the turtle trap: We bait the bottom chamber with something tasty like beef liver or dog food and tie it to a tree or root on the riverbank using the rope at the top. Once we launch the trap into the river, the top hoop floats on the water's surface. Turtles attracted to the bait swim into the bottom chamber and nibble away until they need to surface to breathe. They can then swim through the middle chamber up to the surface. We check the traps every 1-2 hours, pulling them from the water and opening the top chamber to access the turtles.

This fieldwork was carried out in the Macquarie Marshes – Bogan River, Macquarie River and Castlereagh River, NSW, Wailwan Country.

Acknowledgements:
Project Liaison: Dr Roxane Francis
Dr Bruce Chessman, Dr Kate Brandis, Dr Richard Kingsford, Dr Eve Slavich, and field assistants and volunteers.

Display case contents (left to right)

Object: Feather from an Australian Pelican (*Pelecanus conspicillatus*). Courtesy of Dr Roxane Francis

Image: Facsimile of a chromolithograph by G. J. Broinowski, *Plate XVIII: Australian Pelican*, 1890.
Credit: *The Birds of Australia*, vol. 1, 1890
by Gracius J. Broinowski
Printed in Melbourne by Stuart
VF 598.2994/2

Image: Facsimile of a chromolithograph by G. J. Broinowski, *Plate XXVI: Straw-Necked Ibis, White Ibis, Glossy Ibis*, 1890.
Credit: *The Birds of Australia*, vol. 2, 1890
by Gracius J. Broinowski
Printed in Melbourne by Stuart
VF 598.2994/3

Object: Feather from a Straw-Necked Ibis (*Threskiornis spinicollis*). Courtesy of Dr Roxane Francis

Image: Facsimile of a colour plate by Vincent Brooks, *Plate CLIII: Phyllospora Comosa*, 1860.
Credit: *Phycologia australica; or, A history of Australian seaweeds*, vol. 3, 1860
by William H. Harvey
Printed in London by Lovell Reeve
MBV 589.3/3

Object: Dried crayweed (*Phyllospora comosa*)
Courtesy of Dr Emily Morandini

Image: *Scopalina australiensis*.
Credit: Photograph by Jessica Taylor.

Object: Dried marine sponges.
Courtesy of Professor Torsten Thomas.

Book: *Descriptive catalogue of the sponges in the Australian Museum, Sydney*, 1888
by Robert von Lendenfeld
Printed in London by Taylor and Francis
KLN 593.4075/1

Book: *Some useful Australian birds*, 1921
by Walter W. Froggatt
Printed in Sydney by William Applegate Gullick Government Printer
KLN 598.2994/73

Book: *Nests and eggs of Australian birds : including the geographical distribution of the species and popular observations theron*, 1900
by Archibald James Campbell
Printed for the author by Pawson & Brailsford Sheffield
KLN 598.256/4

Book: *Prodromus of the zoology of Victoria : or, figures and descriptions of the living species of all classes of the Victorian indigenous animals*, 1885
by Frederick McCoy
Printed in Melbourne by John Ferres, Govt Printer
MBVA 591.9945/1 /(1)

Ocean Accounting: Why Numbers Tell a Deeper Story

Centre for Sustainable Development Reform
School of Global and Public Law
Faculty of Law & Justice, UNSW Sydney

Graphic: Data from pilot ocean accounting projects supported by the Global Ocean Accounts Partnership (GOAP)

Ocean-based solutions can deliver up to 35% of emission cuts needed to keep global temperature rise below 1.5°C by 2050 (Ocean Panel 2023), and its conservation and restoration could help countries achieve their global environmental targets. But how can we harness this potential whilst ensuring sustainable ocean development?

Many governments use ocean accounting to monitor the health of marine and coastal ecosystems over time and the benefits they provide to people. The ocean accounting framework collates social, economic, and environmental information for use in evidence-based decision-making and management, enabling the data to tell a deeper story.

Established in 2019, the Global Ocean Accounts Partnership (GOAP) assists countries in compiling ocean accounts. While the GOAP Secretariat is hosted at UNSW, the GOAP is a global, multi-institutional partnership that supports countries and stakeholders in going beyond GDP to measure and manage progress toward sustainable ocean development. Since 2019, the GOAP has supported collaboration with over 20 delivery partners, 15 pilot ocean accounting projects and nine research Fellows to generate and share knowledge and guidance. Across these pilot projects, GOAP partners have mapped over 825 million hectares of marine and coastal area, including 11 different types of ecosystems, from bustling coral reefs to dense mangrove forests.

The Global Ocean Accounts Partnership (GOAP) is active globally, with 38 Members and 15 pilot projects around the world.

Acknowledgements:
Project Liaison: Bella Charlesworth and Juliet Grimm
Global Ocean Accounts Partnership (GOAP) Members, partners, and Secretariat team. The GOAP Secretariat is hosted by the UNSW Centre for Sustainable Development
Reform and partnership activities are funded by the United

Kingdom’s Blue Planet Fund, World Bank Blue Economy Program, Australia’s Oceans Leadership Package, and the Australia-India Indo-Pacific Oceans Initiative Partnership.

www.oceanaccounts.org

www.sustainabledevelopmentreform.org

75 years of hydrology

Water Research Centre and Water Research Laboratory
School of Civil and Environmental Engineering
Faculty of Engineering, UNSW Sydney

Display case contents (left to right):

Article: "UNSW's role in Australian Rainfall and Runoff"
UNIKEN, issue 20, 4 December 1987, page 2
UNSW Archives. S328.

Book: *Australian Rainfall and Runoff: a guide to flood estimation*, 3rd edition, c.1987
by D.H. Pilgrim, editor-in-chief
Printed in Barton, ACT by Institution of Engineers, Australia
F 551.5781/14 C/(2)

Since it was first published in 1958, *Australian Rainfall and Runoff* (ARR) has been regarded as Australia's leading guideline for flood estimation. The ARR guidelines are pivotal to the safety and sustainability of Australian infrastructure, communities, and the environment. They provide reliable and robust flood risk estimations, ensuring that development does not occur in high-risk areas and that

infrastructure is appropriately designed. Researchers from UNSW have since then played key roles in ARR. Professor Crawford Munro, chair of Civil Engineering at UNSW, edited the 1958 version. In 1982, the then Institution of Engineers, Australia, approached David Pilgrim, an academic at UNSW, to revise and rewrite ARR. This was a five-year project published in 1987, with David Pilgram as editor-in-chief and author of eight chapters of the updated guidelines along with UNSW Professor Ian Cordery. UTS Professor James Ball, who worked for 16 years as an academic at UNSW, was the editor-in-chief of the most recent version of ARR, published in 2019. UNSW Professor Ashish Sharma served on the ARR technical committee, whilst Associate Professor Fiona Johnson, Dr Bruce Cathers, Associate Professor Ron Cox, Mr Grantley Smith, Dr Raj Mehrotra and a number of UNSW alumni were chapter authors. Currently, new advice for incorporating climate change impacts into flood design is being developed with input from UNSW researchers, including Professor Jason Evans.

Acknowledgements:
Project Liaison: Associate Professor Fiona Johnson
Engineers Australia, Geoscience Australia

Wallpaper credits for historic rainfall and flood maps (left to right, top to bottom):

Boundary of 1949 flood in Cooper: [Windorah Region, Queensland]. c.1950s. Credit: National Library of Australia. MAP G9001.C32 1949.

Flood map of Brisbane and suburbs, showing areas that would probably be inundated by floods rising to various heights on the Port Office gauge. Survey Office Department of Public Lands, Queensland. 1933. Credit: State Library of Queensland. RBM 841.15 1933 00016 E.

Mean annual rainfall of Australia / John Bartholomew & Co. 1890. Credit: National Library of Australia. MAP RaA 32 Plate 4.

Duration of wet seasons in Australia / [H.A. Hunt]. Australia. Bureau of Meteorology. c.1910s. Credit: National Library of Australia. MAP G8961.C813.

[Flood levels 1915, with current works]: [on base map] The Federal Territory contour map of city site and adjacent lands / compiled & drawn by Department of Home Affairs, Lands & Survey Branch, Canberra, June 1914; Charles Robert

Scrivener. 1915. Credit: National Library of Australia. MAP RM 3861 (Roll).

Rainfall map of New South Wales. New South Wales. Surveyor-General. 1889. Credit: National Library of Australia. MAP RM 3290.

Map of New South Wales showing average annual rainfall / by D. MacDonald, C.E., M.G.S.A.; engraved by A. Dulon & L. Poates; A.J. Scally, del. The Picturesque Atlas Publishing Company, Limited. 1886. Credit: National Library of Australia. MAP RM 3980.

Map shewing the rainfall over south eastern Australia & Tasmania for the year 1883 / prepared at the Melbourne Observatory, under the direction of R.L.J. Ellery, Govt. Astronomer; constructed & engraved at the Department of Lands & Survey Melbourne under the direction of A.J. Skene, M.A. Surveyor-General; engraved by W. & J. Slight. 1884. Credit: National Library of Australia. MAP RM 856.

Fitzroy River (2-10-1) 30 m. - 60 m. Jan. 1951 flood. No. IN 192 166 : AMTM 12 m. stream strip / I.& W.S.Q. Queensland. Irrigation and Water Supply Commission. 1951.
Credit: National Library of Australia. MAP G9001.C32 1951.

Map of New South Wales : indicating eastern, central and western divisions. New South Wales. Department of Lands. 1907. Credit: National Library of Australia. MAP RM 2307.

Sketch map showing rainfall of agricultural seasons in east extra-tropical Australia / by J.T Wills, F.R.G.S.; J. Bartholomew Edinr. 1887. Credit: National Library of Australia. MAP RM 5084.

Plan shewing [sic] flood gauges and proposed regulating dams, Molonglo and Queanbeyan Rivers. 1929. Credit: National Library of Australia. MAP G8981.C3 1929.

Plan of part of the Hunter River showing flooded districts from Oakhampton to Tomago. Photo-lithographed at the Govt. Printing Office. c. 1870-1875. Credit: National Library of Australia. MAP F 13.

Map showing rainfall and temperature statistics of the proposed site for the Federal Capital and the surrounding districts / compiled at the Commonwealth Bureau of Meteorology, under the direction of H.A. Hunt. Commonwealth Bureau of Meteorology (Australia). 1910. Credit: National Library of Australia. MAP G8981.C8 1910.

Rippon Lea Water Story

School of Humanities & Languages
Faculty of Arts, Design & Architecture, UNSW Sydney

Image: *Acoustic Encounters*. Credit: Photograph by Sonia Leber. N'Arwee't Professor Carolyn Briggs AM, Justin Buckley, Dr Laura Harper, Dr Ana Lara Heyns, Dr Maria de Lourdes Melo Zurita, Dr Xavier Ho, Oscar Raby.

Sound: Melbourne's subterranean waterways.
Credit: Composition by David Chesworth, Sonia Leber and Taylor Coyne.

Rippon Lea Water Story explores waters, memory, plant and animal life, and infrastructure at Rippon Lea, a colonial estate in Melbourne. The project works to challenge the historical meanings of the site – to recognise that it is part of Boon Wurrung Country, connected to a wider ecological and hydrological landscape.

The southeast coast of Nairm/Port Phillip Bay is characterised by wetlands, seasonally occurring watercourses, seeping groundwater, and freshwater springs. Beginning in the 19th century, water was removed from

the surface of this land and gradually piped underground through a process of colonial urbanisation. Rippon Lea sits over this highly modified, watery landscape. The Estate, built in the 1860s, includes an extensive underground watering system that harvests runoff from a naturally occurring spring that was piped underground in the 19th century.

A range of specialist microphones were used to bring awareness to the intricacies of voices and sounds typically not acknowledged at colonial sites: hydrophones listen to the dynamic ecology within the lake; microphones placed down access shafts reveal water flowing under the suburbs; geophones hear the rumblings of trains below the surface.

Exploring Rippon Lea's intricate pipe system opens a door into the subterranean world of Melbourne's hidden water – the ancient waterways that continue to find ways to flow and the ecologies that these continue to support.

This work took place on Nairm/Melbourne - Boon Wurrung Country - Rippon Lea Estate.

Acknowledgements:
Project Liaison: Associate Professor Marilu Melo Zurita
In collaboration with Faculty of Art, Design and Architecture, Monash University.
Research Team: N'Arwee't Professor Carolyn Briggs AM, Justin Buckley, Dr Laura Harper, Dr Ana Lara Heyns, Dr Maria de Lourdes Melo Zurita, Dr Xavier Ho, Oscar Raby.
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Estimating the Effectiveness of Forest Protection using Regression Discontinuity

Institute for Climate Risk & Response
School of Economics
Faculty of Business, UNSW Sydney

Map: Map of Australia charting forest cover changes generated by Global Land Analysis & Discovery (GLAD), 2000-2023 deforestation data. Credit: Hansen/UMD/ Google/USGS/NASA.

This project used high-resolution satellite data to estimate the effectiveness of government protection on forested land across the globe from 2000 to 2022. It looked at the discontinuous change in deforestation outside and inside protection boundaries to determine effectiveness. It finds that protected areas are 30% effective on average, with many countries having extremely ineffective protection, such as Indonesia, the Congo, Bolivia, Venezuela, and Madagascar. Improvements to the quality of protection are just as important as the quantity of protected areas to conserve biodiversity.

Australia had relatively effective protection until the horrendous bushfires of 2019-20, when fire ravaged large swathes of protected and unprotected forest indiscriminately. The impacts of those fires on wildlife and ecosystems inside protected areas will be felt for generations. To the extent that climate change increases the frequency and/or severity of bushfires in Australia, it poses a threat to our ability to protect forest ecosystems.

Acknowledgements:
Project Liaison: Dr Timothy Neal

Display case contents:

Object: *Fragments of dys/utopia*
Scribbly bark and bitumen;
Grey gum bark (thick/rough) and bitumen and orange pigment
Grey gum heartwood (termite-eaten) painted with charcoal
Grey gum root painted with charcoal
Road-train tyre fragments – Barrier Highway 2017

Courtesy of Dr Shaun Watson – Neurologist, Chair NSW Doctors for the Environment

Artist statement:

We stand before the beauty of this world. For so long as it remains, we are delirious in praise.

We blink and in its place is fire, drought, deluge, pestilence, crude oil, bitumen. It seems that we can adapt to most circumstances and dystopia has its own beauty, the luscious surface of bitumen.

Here is a collection of fragments, mostly found on our Blue Mountains block, on Gundungurra Country. They were collected in periods of drought and flood and also intervals of respite, always with the living reality of climate change in mind. Some are unaltered and some are dipped or painted in bitumen or Black Summer charcoal.

I have unwisely worked with large tins of domestic bitumen, often without a mask. Perhaps those polycyclic aromatic hydrocarbons have mutated my DNA? Perhaps I will pay with my life? Isn't that the price we must all be prepared to pay?

Application of Membrane Capacitive Deionisation (MCDI) to Desalination of Brackish Groundwaters in a Remote Community in Central Australia

UNSW Centre for Transformational Environmental Technologies
School of Civil and Environmental Engineering
School of Electrical Engineering and Telecommunications
Faculty of Engineering, UNSW Sydney

Image (left): MCDI unit deployed in Ali Curung, Northern Territory.
Credit: Photograph by Scientia Professor David Waite.

Image (centre): Ali Curung, Northern Territory.
Credit: Photograph by Scientia Professor David Waite.

Images 1-3 (right): Examples of virtual reality (VR) assisted operation of MCDI units. Credit: Yunyi (Jason) Zhu.

A long-term field trial of membrane capacitive deionization (MCDI) was conducted in the remote community of Ali Curung in the Northern Territory to produce safe, palatable drinking water from groundwater that contains high

concentrations of salt, hardness ions (calcium, magnesium, and ferrous ions), and other contaminants. This trial lasted for 1.5 years, which, to our knowledge, is one of the longest-reported studies of pilot-scale MCDI field trials. The 8-electrode MCDI pilot unit reduced salt concentration to below the Australian Drinking Water Guideline value of 600 mg/L total dissolved solids (TDS) concentration with a relatively high water recovery of 71.6 ± 8.8%. The energy consumption of an MCDI system with a capacity of 1000 m3/day is projected to be 0.40~0.53 kWh/m3, which is comparable to the energy consumption of electrodialysis reversal (EDR) and brackish water reverse osmosis (BWRO) systems of the same capacity. The relatively low maintenance requirements of the MCDI system rendered it the most cost-efficient water treatment technology for deployment in remote locations.

Acknowledgements:
Project Liaison: Scientia Professor David Waite
CTET Project Team and Northern Territory Power and Water Corporation.

National Groundwater Recharge Observing System

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School of Civil and Environmental Engineering
Faculty of Engineering, UNSW Sydney

School of Humanities & Languages
Faculty of Arts, Design & Architecture, UNSW Sydney

Image (left): Drip logger deployed in mine at Durham Lead, Clarendon Forest, VIC, Wadawurrung Country. Credit: Dr Wendy Timms.

Image (right): Drip logger deployed in Wollondilly Cave, Wombeyan Karst Conservation Reserve, NSW, Gundungurra Country. Credit: Professor Andy Baker.
Object: Stalagmate drip logger.

Groundwater makes up around 17% of accessible water in Australia and accounts for more than 30% of total water consumption. Despite its importance, it is poorly understood when, where, and by what process our groundwater resource is being replenished. This is technically called groundwater recharge.

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The National Groundwater Recharge Observing System detects water as it drips into underground spaces in its journey from the terrestrial environment through the ground, especially where the bedrock contains fractures that expedite flow through the dry, upper layers of soil to the water table below.

The project aims to improve understanding of groundwater recharge through a sensor network deployed in underground spaces located between soils and aquifers across the southeast of Australia. This recharge-observing system will generate knowledge that is fundamental for water resource management.

Displayed is a drip logger, one of the many placed underground in tunnels, caves, and mines in dozens of locations around Australia to measure the timing of groundwater recharge. A drip logger operates like a miniature drum, detecting the vibrations caused by water drops falling on it and recording this data in its internal memory. You are welcome to tap the logger to record your visit to the *Living Water* exhibition.

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