

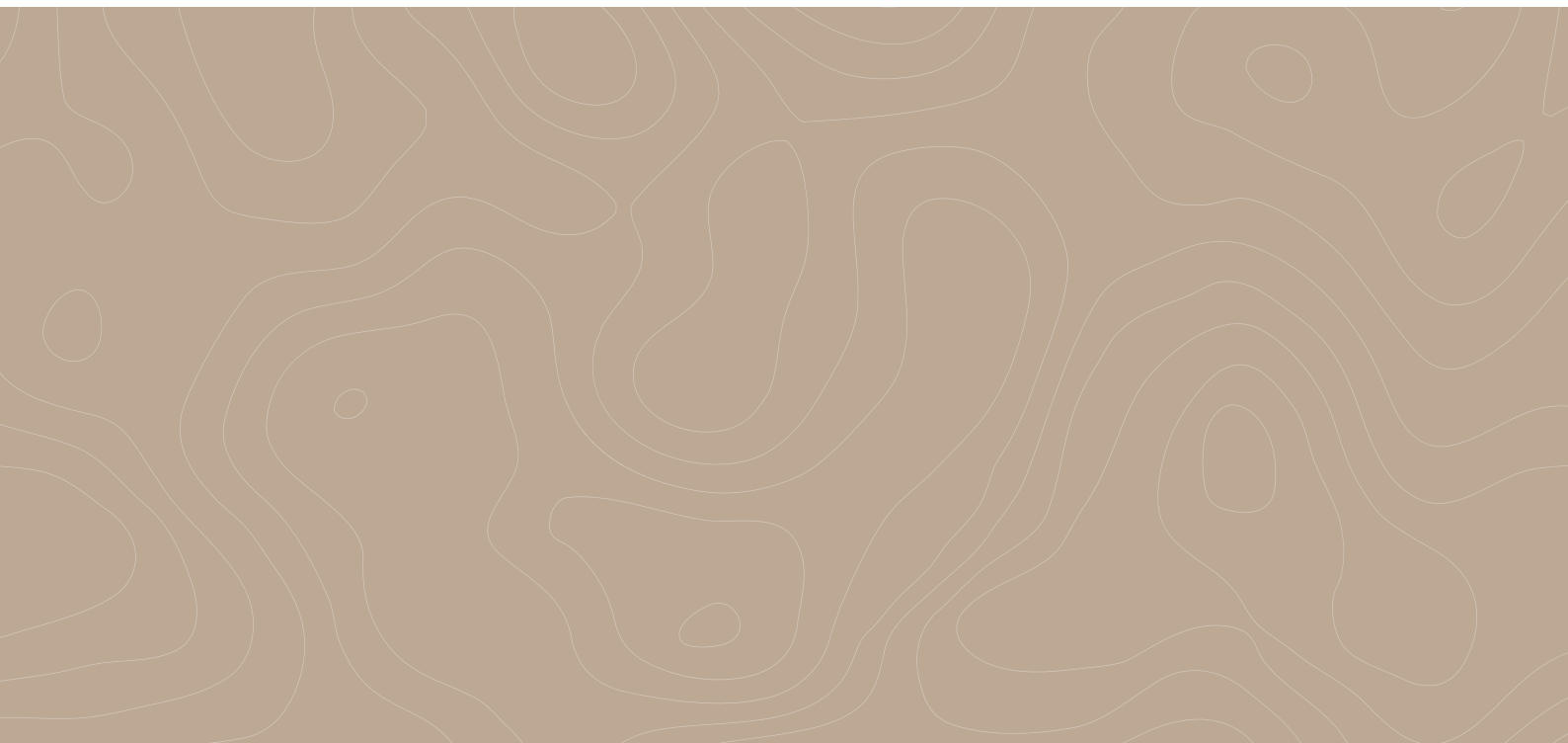
National Centre for Groundwater Research and Training

ANNUAL REPORT 2015



NATIONAL CENTRE FOR
GROUNDWATER
RESEARCH AND TRAINING





The National Centre for Groundwater Research and Training was established in June 2009 as an Australian Research Council Centre of Excellence, co-funded by the National Water Commission.

Its role is to advance understanding of Australia's groundwater resources, and to train the next generation of groundwater researchers.

This report summarises the NCGRT's Flinders performance between 1 January 2015 and 31 December 2015. It outlines progress towards achieving our strategic plan objectives.

Contents

1	Vision and mission
2	Director's report
3	Organisational Structure
4	RESEARCH LEADERS
5	Senior researchers & professorial fellows
6	Postdoctoral & research fellows
8	Adjunct status
11	Researcher awards
13	Featured Research Projects
15	Grant and contract income
16	Outputs summary
17	OUTREACH
17	Events
18	Seminars
19	Media
20	2026 vision
21	FUTURE KPI'S
21	Key performance indicators 1-2
22	Key performance indicators 3-4
23	APPENDICES
23	Appendix 1: Research collaboration
24	Appendix 2: Publication listings

Our vision

To enhance Australia's environmental, economic and social wellbeing, by improving groundwater management outcomes. To do this by building capacity and capability in the groundwater sector, through equipping people with new knowledge and tools gained through Australian groundwater research effort, effectively communicated to where it has highest implemented value.

Our mission

To be an institution of national and international standing, which fosters collaboration between scientists, government and industry to continually advance knowledge and management of Australia's groundwater resources.

To undertake the scientific research needed to improve our understanding of Australia's groundwater systems.

To train the next generation of expert researchers and groundwater professionals.

To support the development of new benchmarks for groundwater assessment and management.

Director's report

2015 has been an extremely busy and productive year for the National Centre for Groundwater Research and Training and for groundwater in Australia. A number of significant milestones have been achieved this year, specifically the finalisation of the Australian Research Council (ARC) co-funded Centre of Excellence (2009-2015) and the submission and approval of the final report. All of this work could not be achieved without the dedication and hard work of the Centre's staff, researchers, students, collaborators and supporting institutions. Everyone must be commended on their efforts over the past 7 years - it has been an enormous effort.

Continuing beyond the ARC Centre, we are progressing with restructuring the Centre's governance, including the formation of our new Advisory Board and implementation of a new administrative structure. We are extremely delighted to announce the Centre's new Advisory Board members who are a group of highly distinguished members within the groundwater sector. Our Advisory Board will be instrumental in shaping and guiding the strategy for the Centre moving forward. We are also progressing the Centre's Collaborative Memorandum of Understanding with 30 University, Industry and Government partners. NCGRT remains the only National Collaborative Groundwater Research Centre of its kind in Australia.

In a challenging climate the Centre has remained committed to securing additional groundwater research funding with the assistance of our partners. We have seen a number of significant successes in groundwater research grants which relate to Australia's contemporary groundwater problems, including a \$2 Million national groundwater partnership between the Murray Darling Basin Authority (MDBA) and NCGRT to examine groundwater research needs for the Murray Darling Basin and the Plan. A selection of researchers from our partnering institutions and Flinders University spear-headed the development of successful ARC Grant Proposals, two are based at here at Flinders; Groundwater flow age distributions; Understanding open pit mine hydrology and Cross-cultural management of freshwater on resource-constrained islands.

In addition to our research success the Centre has aspired to new heights this year facilitating and hosting a very successful Australian Groundwater

Conference in Canberra. Our collaboration with the Australian Chapter of the International Association of Hydrogeologists to deliver this event was highly productive and well received. Over 330 people attended the conference, the quality of talks was outstanding, and the support and encouragement we received was overwhelming. Additionally, it has also been a big year for Industry Training with NCGRT running short courses, workshops, and a number of seminars throughout the year attracting over 1288 attendees nationally.

I would like to highlight some of the Centre's achievements across the nation in 2015 and more broadly throughout the ARC Centre of Excellence (2009-2015). Some of these highlights include:

- Securing cash and in-kind contributions in excess of \$65M to conduct groundwater research;
- Producing over 704 journal and book publications making this one of the most significant bodies of groundwater research in Australian history;
- Forging collaborative links with over 30 research organisations based in Australia and internationally;
- Representing groundwater research on nearly 500 significant national and international bodies including the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining development, the Australian Academy of Technological Sciences and Engineering, and membership of Editorial Boards for leading International journals;
- Recruiting and training 77 Early Career Researchers, 72 PhD researchers and 73 Honours students;
- Delivering a dynamic researcher training program, including an Annual Summer School, dedicated to equipping our PhD and Early Career Researchers with skills necessary to make a successful transition to careers in science, education, industry and policy.

On a personal note I have been humbled to be honoured as the 2015 South Australian Scientist of the Year. Winning this award is a fantastic opportunity to elevate the profile of Groundwater Science, NCGRT and Flinders University.



I have also been fortunate to experience the exhilarating pace of the newsroom this year in my role as the Scientist in Residence, at The Advertiser. Working with journalists and editors on a range of key issues relating to water and the environment has been a tremendous and valuable experience. Raising public awareness of our precious resource has not stopped there. I also recently wrote a piece for the Australian Academy of Technological Sciences and Engineering, which discussed many of the current challenges and opportunities for groundwater and groundwater reform in Australia.

I would like to end this report by thanking Flinders University for their continued and significant support and wise counsel. This has been invaluable to provide us with the capacity to conduct innovative and collaborative research that informs and improves our understanding and management of Australia's vital groundwater resource. Although the Centre has various partners from government, industry and other academic institutions this report primarily focusses on the Flinders University component.

Professor Craig T. Simmons FTSE

A handwritten signature in black ink that reads "Craig T. Simmons".

Director, National Centre for Groundwater Research and Training

Organisational structure

The Centre's Headquarters

Administered by Flinders University, the NCGRT is fortunate to be housed in a research intensive university ranked in the top 2% of Universities world-wide. Flinders has research partnerships with prestigious research institutions around the globe ensuring our reach is beyond our Australian shores. Flinders is committed to being a leader, nationally and globally, in the science and management of groundwater resources. Flinders expertise, networks and infrastructure in groundwater research is second to none.

Administrative Team

The NCGRT is fortunate to have a dynamic and aspirational administrative team located at Flinders University, led by Director Professor Craig Simmons, Fellow of Australian Academy of Technological Sciences and Engineering (FTSE) and 2015 SA Scientist of the Year. This team is focused on converting strategic direction into operational outcomes, including communicating research outcomes, coordinating professional development training and facilitating the biennial NCGRT/IAH Australasian Groundwater Conference.

Groundwater Training Advisory Group (GTAG)

Building capacity in industry, government, science and community sectors is one of NCGRT's key strengths. Through collaborative efforts the NCGRT has established a long-standing highly recognised training and outreach program to communicate complex science and management techniques. Guiding this function is the GTAG, a dynamic and diversified group of experts who provide valuable input into our professional development program by identifying skill gaps and opportunities within the marketplace.

Partners

The NCGRT could not deliver its outputs without its partners to create critical mass. Comprising 12 major research institutions, 11 government departments and 7 industry partners, the calibre and diversity of this partner group provides unprecedented opportunities for Australian researchers to participate in large-scale, inter-disciplinary research, collaborating with an outstanding range of colleagues both nationally and internationally. The partners create significant leverage and co-investment opportunities and an ability to design research projects that can add demonstrable value to end-users and their local communities. This has directly strengthened the potential for the groundwater research base to support Australia's economic, environmental and social policy objectives. Refer to Appendix 1 for a full list of NCGRT partner organisations.

Advisory Board

The Centre is strengthened by its powerful Advisory Board, comprising senior executives, groundwater professionals and policymakers from government and industry. They bring a breadth of expertise and experience across the groundwater industry, and are committed to ensuring that groundwater is kept on the National agenda. The Board's role is to set strategic objectives to advance groundwater research, to identify and promote discussion of emerging strategic issues in the Australian groundwater sector and to suggest collaborative national responses.

The Board was established to support the Centre in cementing our reputation as a global leader in the field of groundwater research, and realising our ambition of becoming a financially self-sustaining research organisation. To be successful, the Centre will need to continue to evolve and new Board members will constantly challenge the Centre to look beyond the status quo and identify innovative new pathways to maximise the value of our research work.

2015 NCGRT Advisory Board Members



Mr Ken Matthews AO -
Chair ATSE Water Forum and
former CEO and Chair of the
National Water Commission



Mr Greg Claydon -
Executive Director, Science
and Planning, WA Department
of the Environment



Dr Rhondra Dickson -
Deputy Secretary, Department
of the Environment and former
Chief Executive, Murray-
Darling Basin Authority



Dr Rob Vertessy -
Former CEO, Bureau of
Meteorology.



Mr Tony Slatyer -
First Assistant Secretary,
Department of Agriculture and
Water Resources



Dr Paul Hardisty -
Director, Land and Water
Flagship, CSIRO



Dr Chris Pigram -
CEO, Geosciences Australia



Mr Phillip Glyde -
Chief Executive, Murray-
Darling Basin Authority

Research leaders



Professor Craig Simmons
Director, National Centre for Groundwater Research and Training

Professor Craig Simmons FTSE is a leading groundwater scientist, recognised for major national and international contributions to groundwater science, education and policy reform. Director of the NCGRT, he is one of Australia's foremost groundwater academics and has been a significant contributor to global advances in the science of hydrogeology for many years. He is Deputy Chair and member of the Australian Government's Statutory Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). He is also a member of the U.S. National Academies of Sciences, Engineering, and Medicine Roundtable on Unconventional Hydrocarbon Development. Professor Simmons is Matthew Flinders Distinguished Professor of Hydrogeology and Schultz Chair in the Environment at Flinders University. He is a Fellow of the Australian Academy of Technological Sciences and Engineering and Deputy Chair of the Academy's Water Forum. Professor Simmons' work has been recognised by numerous national and international research and teaching awards including the Anton Hales Medal for outstanding contributions to research in the Earth Sciences by the Australian Academy of Science. He was also named the 2015 SA Scientist of the Year. Professor Simmons has served as an Editor and Associate Editor for numerous major international journals including Water Resources Research, Journal of Hydrology, Hydrogeology Journal, Groundwater, Environmental Modeling and Assessment and Vadose Zone Journal.



Professor Okke Batelaan
Dean, School of Environment

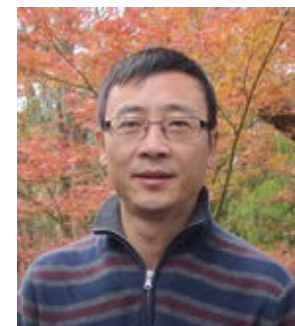
Professor Okke Batelaan is a graduate of the Free University of Amsterdam, Netherlands (MSc - Hydrogeology) and of the Free University Brussels, Belgium (Ph.D. - Engineering). He worked for 23 years at the Free University Brussels and led for 6 years the hydrogeology group at the KU Leuven, Belgium. Since 2012 Okke is the Strategic Professor in Hydro(geo)logy and currently Dean of the School of the Environment, Flinders University. Okke has broad experience in teaching groundwater hydrology and modelling, GIS-remote sensing for hydrological applications. He has supervised more than 140 MSc and 25 Ph.D. students. His extensive research experience and a publication record covers shallow groundwater hydrology and modeling, recharge-discharge estimation and modeling, urban hydrology and distributed modelling, ecohydrology and impacts of landuse and climate change on groundwater systems. He coordinated-participated in a large number of projects in Europe, Africa, South America, Asia and Australia. He is also the editor-in-chief of Journal of Hydrology: Regional Studies and MDPI-Hydrology.



Professor Adrian Werner
ARC Future Fellow

Professor Adrian Werner is a Professor of Hydrogeology at Flinders University. After completing a Civil Engineering Degree at Central Queensland University in 1992, he worked for the Queensland State Government until 2006 on water resources projects, specialising in surface and subsurface hydrology. Adrian completed a Ph.D. at the University of Queensland in 2004 on the topic of coastal aquifer hydrodynamics, and holds Associate Editor Positions with the Journal of Hydrology (since 2007) and Advances in Water Resources (since 2012).

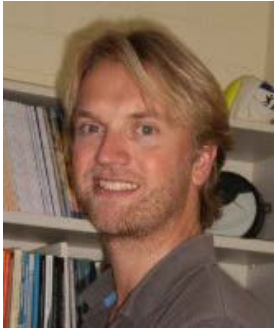
Adrian contributes to various undergraduate and postgraduate topics in hydrology and hydrogeology. He was Chief Investigator in Program 2 of the National Centre for Groundwater Research and Training, through which he leads both theoretical research in hydrology and practical problem-solving of real-world water-resources issues. His current research focuses on coastal hydrogeology, surface water-groundwater interaction and other subsurface transport problems using a variety of field, laboratory and computer modelling techniques.



Associate Professor Huade Guan
Lecturer

Associate Professor Huade Guan obtained his Ph.D. in hydrology from New Mexico Institute of Mining and Technology in 2005. He holds a teaching and research balanced position in the School of the Environment, teaching Hydrology and Ecohydrology. Huade's research lies in the fields of hydrometeorology, terrestrial ecohydrology, and hydrology.

His interests are mostly focused on water resource and environmental issues that are related to the hydrometeorological and ecohydrological processes occurring from the interface of land surface and atmosphere, through soil and vegetation, to groundwater table. Huade is an Associate Editor for Journal of Hydrology.



Dr Vincent Post
Lecturer

Dr Vincent Post is currently a research associate at the Federal Institute for Geosciences and Natural Resources (BGR) in Hannover, Germany. He obtained a Ph.D. degree in hydrogeology from the VU University in Amsterdam in 2004. He worked as an assistant professor at Flinders University from 2004 to 2010, and subsequently as a senior lecturer between 2010 and 2015. His main expertise is on the fate of solutes in groundwater, in particular in coastal areas. He is one of the lead developers of the PHT3D code, a 3D reactive transport simulator with capabilities for variable-density and unsaturated flow. He now works in Hannover at BGR.



Dr Ilka Wallis
Lecturer

Dr Ilka Wallis is a hydrogeologist with areas of expertise in the development of reactive geochemical transport models which integrate fundamental processes that are normally studied in isolation (hydrogeological, mineralogical, geochemical and biochemical). Areas of specialisation include the assessment and prediction of the variability of the redox zonation in aquifers, the corresponding impact on the fate of pollutants (such as nitrate), water quality changes during managed aquifer recharge, incorporation of environmental tracer data into geochemical reaction networks (age indicators, such as Helium/Tritium), the mobilisation and remediation of metals (such as arsenic) and the quantifying of feedback mechanisms between chemical reactions and physical flow in aquifer systems. Ilka obtained her MSc at Christian-Albrechts-University Kiel, Germany and her Ph.D. at Flinders University, specialising on the quantification of arsenic mobilisation and attenuation by coupled flow and multi-component reactive transport modelling.

Senior researchers & professorial fellows



Associate Professor Andrew Love
Senior Research Fellow

Associate Professor Andrew Love is Senior Research Fellow in the School of the Environment and the NCGRT. Throughout his career he has developed a number of advanced skills in hydrogeology, including inter alia environmental tracers and hydrochemistry, geology and hydrogeology of sedimentary aquifers, fractured rock hydrogeology, field based methods and technologies and density driven flow. His skill set is slightly different to the majority of the group but importantly is highly complementary. Andrew adds a strong geological bent as well as field hydrogeology and environmental tracers that considerably help the current group. This has direct application to current and future groundwater related issues including large scale coal development, coal seam gas, shale gas extraction, geothermal, mining, farming and climate change. Andrew is also currently an Associate Editor for the journal Geofluids.



Professor Peter Cook
Professorial Research Fellow

One of Australia's foremost groundwater scientists, Professor Cook has almost 30 years of experience in groundwater research. He has co-written books on environmental tracers and ecohydrology and has published more than 80 research papers in leading international journals. He was the National Ground Water Association's Henry Darcy Distinguished Lecturer in Ground Water Science in 2009, the first time this honour has been awarded to a scientist from outside North America.

Between 2009 and 2014 he was Deputy Director of the NCGRT. His main research interests are using environmental tracers to understand groundwater flow systems, and interaction between groundwater and surface water.

Postdoctoral & research fellows



Dr Margaret Shanafield
DECRA Fellow Chief Investigator

Dr Margaret Shanafield is a hydrologist and hydrogeologist who studies hydrological processes at, or just below, the earth's surface. Primary research interests include the use of multiple tracers to delineate groundwater recharge processes, and investigation of surface infiltration processes and their connection to aquifer replenishment.

She completed her education in the US, and has been at Flinders since the end of 2010, first as a postdoctoral researcher, and now as an Australian Research Council Discovery Early Career Researcher Award (DECRA) fellow. Dr Shanafield's current focus is on understanding how intermittent streams function, how to predict when they will flow and dry up, how that affects a basin's water balance, and what water quality impacts it can have.



Dr Hugo Gutierrez Jurado
DECRA Fellow Chief Investigator

Dr Hugo Gutierrez Jurado is a ecohydrologist specialised in the study of water and energy fluxes along areas of vegetation transitions and environmental gradients in tropical, temperate, arid and semiarid regions. His work focuses on the measurement and modelling of hydrologic and biophysical fluxes relevant to the understanding of terrain-vegetation-climate couplings and the resulting landscape patterns emerging from those interactions. His current research interests lie on the quantification and prediction of climatic-vegetation effects on water fluxes from the unsaturated zone to the groundwater table and vice versa. In addition, he is interested in the study of non-equilibrium thermodynamics applied to land surface processes and its potential applications for the prediction of hydro-climatic effects on ecosystems.



Dr James McCallum
Postdoctoral Research Fellow

Dr Jim McCallum is a postdoctoral fellow (or ARC linkage fellow) at the National Centre for Groundwater Research and Training. Jim specialises in the application of environmental tracers and residence times to solving groundwater problems. He studied environmental science at Flinders University before obtaining experience as a consultant and in government working as a Hydrogeologist. Jim then completed a Ph.D. in numerical groundwater modelling focussing on the simulation of environmental tracers and residence times. His research interests include determination of contaminant protection time frames, identifying recharge times, and assessing short and long term sustainability of human induced groundwater stresses. Jim implements both numerical and field based methods in his work. He aspires to apply new and novel techniques to the solution of important environmental problems.



Dr Daniel Partington
Postdoctoral Research Fellow

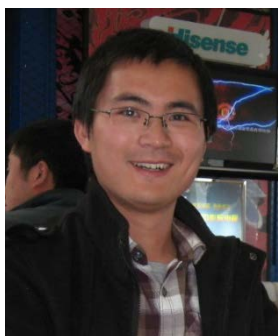
Dr Daniel Partington is a postdoctoral fellow at the National Centre for Groundwater Research and Training specialising in hydrological modelling and in particular fully integrated surface-subsurface flow modelling. Dr Partington studied civil & environmental engineering and maths & computer science at the University of Adelaide, then after 2 years working as an engineer returned to the University of Adelaide for a Ph.D. which focused on physics-based hydrological modelling (surface-water groundwater interaction). His research interests are more broadly around hydrological modelling, both simple and complex and how the two interface. His research aspirations are to improve hydrological modelling to get the best outcome for our water resources and the environments they support.



Dr Eddie Banks
Postdoctoral Research Fellow

Dr Eddie Banks has worked across the private sector, state government and academia over the past decade, investigating interactions between surface water and groundwater, and groundwater flow processes in fractured rock aquifer systems.

Dr Banks is passionate about applying sound scientific methodologies and analytical research methods to support natural resource managers, landholders and the community to advance sustainable water resource management.



Dr Yueqing Xie
Postdoctoral Research Fellow

Dr Yueqing Xie is a hydrogeologist, specialised in hydrological modelling. He has interests in combining field methods and computer models to advance knowledge and inform water resource management. He completed both his Bachelor and Master degrees at the University of Geosciences (Beijing). The topic of his Master research was related to slope stability analysis broadly in the discipline of geological engineering. Afterwards, he came to Flinders University to pursue his Ph.D. degree with NCGRT. His Ph.D. research examined the predictability of variable density flow in groundwater. On completing his PhD, he continued research as a Postdoctoral Research Fellow at NCGRT. Since then, he has worked on a number of projects, largely about regional-scale surface-water groundwater interactions and regional-scale groundwater recharge, which are critical for water resource management.



Dr Juliette Woods
Postdoctoral Research Fellow

Dr Juliette Woods holds a joint position as the Principal Groundwater Modeller at the SA Department of Environment, Water and Natural Resources (DEWNR) and as a Research Fellow at the School of the Environment. At DEWNR, she provides high-level technical advice on groundwater models for the SA government; the joint role with Flinders enables collaborative research that improves SA's groundwater management. She specialises in the salinity in the lower River Murray, but also works on regional-scale water resource models, surface-groundwater interaction, and impact studies. She has worked in groundwater modelling in academia, government and industry since 1996. She was awarded a Ph.D. in Applied Mathematics at the University of Adelaide in 2004 on the simulation of variable-density flow and solute transport. She was a research fellow at the University of Texas, Austin, and later became Principal Groundwater Modeller at an SA consulting company.



Dr Yuting Yang
Lecturer

Dr Yang's research interests include monitoring and modelling the exchanges of energy and mass (water and carbon dioxide) at the soil, vegetation, and atmospheric interface and the interactions between hydrology and ecology; remote sensing in hydrological and ecological modelling; hydrological and ecological response to climate change and land use/cover change; watershed hydrological modelling using distributed hydrological model; vadose zone hydrological modelling (including root water uptake) and remote sensing (i.e., surface and root zone soil moisture); monitoring and analysing extreme climate events (i.e., drought and flood), surface vegetation behaviours and groundwater depletion by using Gravity Recovery Climate Experiment (GRACE) satellites data, in combination with land surface/hydrological modelling and statistical analysis. He currently works with CSIRO.



Dr Guoliang Cao
Postdoctoral Research Fellow

Dr Guoliang Cao received his Ph.D. in hydrogeology from the University of Alabama in 2011. He joined the Center of Water Research at Peking University after coming back to China. He worked as a postdoctoral research assistant and visiting scholar at the NCGRT from Feb. 2014 to Feb. 2016. Currently, he is working as senior engineer at the China Institute of Water Resources and Hydropower Research. His interested research areas cover regional groundwater modeling including flow, solute transport and land subsidence simulation, evolution of regional groundwater flow, groundwater resources renewability assessment and groundwater resources management. He has been working in groundwater sustainability in the North China Plain, which is one of the primary economic regions in China.



Tariq Laattoe
Research Associate

Dr Tariq Laattoe is a Research Associate in the NCGRT. He has a particular interest in numerical modelling of groundwater flow phenomena on floodplains with a focus in both variable-density, and reactive transport. Graduating with a Ph.D. from Flinders University in 2015, he currently works in close collaboration with the SA Government's DEWNR on a project investigating the freshwater lenses of the Lower River Murray. His recent works comprise multiple publications from his thesis examining flow, transport and bio-geochemical reactions in hyporheic zones. Tariq is also author of a book chapter examining seawater intrusion in coastal aquifers accompanying land surface inundation from a transgressing coastline. As both an undergraduate and postgraduate, Tariq was a recipient of numerous scholarships and awards both academic and industry related, most notable the South Australian Hodgson Medal.



Dr Leanne Morgan
Postdoctoral Research Fellow

Dr Leanne Morgan completed her Ph.D. in Hydrogeology through Flinders University on 'Practical approaches to seawater intrusion investigation and management'. Leanne's research and teaching interests are in coastal hydrogeology, groundwater modelling, groundwater-surface water interaction and water resources management. Leanne's research includes practical and theoretical work and she engages in a range of methods including analytic and numerical modelling and laboratory-scale analysis. She has extensive industry experience in the development of regional-scale groundwater models for groundwater resource assessment. This has informed her teaching by providing her with an understanding of methods that underpin theoretical research in hydrology as well as practical problem-solving of real-world, water resource management issues. She currently works jointly at Flinders and DEWNR.



Dr Etienne Bresciani
Postdoctoral Research Fellow

Dr Etienne Bresciani is a hydrogeologist specialised in regional groundwater modelling. His main research focuses on the development of modelling tools and strategies for the investigation of groundwater flow and groundwater-surface water interaction at the regional scale.

After graduating from a Ph.D. in Earth Sciences at the University of Rennes 1 (France) in 2011, he joined the NCGRT at Flinders University as a post-doctorate fellow in 2012. Since then he participated in a number of research projects including the Goyder project for the Assessment of Adelaide Plains Groundwater Resources.

Adjunct **status**



Dr Andrew Herczeg
Director, Geochemical Solutions & Professor, School of the Environment

Dr Andrew Herczeg is a hydrogeochemistry specialist. He has extensive experience in regional scale groundwater systems and river basins. His expertise is application of chemical and isotopic tracers to assess hydrological processes such as recharge, discharge, inter-aquifer exchange and surface water-groundwater interactions. He is currently working with colleagues at Federation University and RMIT on surface water-groundwater interactions in the basalt plains of western Victoria. Together with Peter Cook, he edited the book "Environmental Tracers in Subsurface Hydrology" which remains the standard reference in the field today. Dr Herczeg has 35 years' experience in research, consulting and management in the water industry. His main experience is researcher and project and program leader at CSIRO Land and Water from 1988 to 2011 working in groundwater systems throughout Australia.



Dr Peter Dillon

Dr Peter Dillon retired from CSIRO in September 2014 where he led research for more than 20 years on managed aquifer recharge (MAR). In 2015 he was given the opportunity by NCGRT as its Distinguished Lecturer 2015 to present talks on this topic around Australia and in NZ. This talk pointed forward to the water banking frontier where MAR can have most impact as an adaptive measure to mitigate effects of climate change on water supply security. The content of the talk was also published as a paper in AWA J Water. He presented a paper at AGC 2015 as a digest of what he learned while on tour from a survey of attendees at those talks about their perspectives on strengths and weaknesses of current approaches to developing MAR in each jurisdiction of Australia. He is founding Co-Chair of the International Association of Hydrogeologists Commission on MAR. His former team produced 30% of all journal papers on MAR in 2010-2014 and still contribute to the development of an expanding MAR industry in Australia, which recently reached 8% of the volume of groundwater extraction in Australia.



Professor John Doherty
Director Watermark Numerical Modelling

Professor John Doherty is the author of PEST. John has worked for over 35 years in the water industry, first as a groundwater exploration geophysicist, then as a modeller. He has worked in the public, private and education sectors. Professor Doherty was the NCGRT's 2011 Distinguished Lecturer.

He now directs his own company, Watermark Numerical Computing, which undertakes software development and advanced modelling for mining, environmental, agricultural, water supply, remediation and geothermal applications. He also works as an adjunct professor with the National Centre for Groundwater Research and Training.



Dr Glen Walker

Dr Glen Walker had worked with CSIRO for over 30 years before retiring in 2014. For most of this time, he led projects and conducted research in groundwater and salinity; winning the WE Wood Award for National Excellence in Salinity Research. Topics included recharge and discharge estimation, stream and floodplain salinisation, catchment modelling for salinity management and regional groundwater assessments.

In 2015, Glen Walker became an adjunct researcher with Flinders University and formed his own consultancy, Grounded in Water. In 2016, he became a member of the Independent Expert Scientific Panel for Coal Seam Gas and Large Coal Development within the Department of Environment and Energy.



Dr Glenn Harrington
Director and Principal Hydrogeologist, Innovative Groundwater Solutions

Dr Glenn Harrington is a highly motivated and widely respected hydrogeologist with almost 20 years' experience in groundwater assessment and management. He began his professional career in the South Australian Government where he worked for many years in a variety of roles ranging from research and technical assessment through to policy development and senior management. After a year working abroad as a postdoctoral scientist in Canada, Glenn had another two-year stint in state government before moving into the private sector. It was through this experience that he recognised the importance of building trust and respect with clients and the broader water industry. More recently Glenn has held senior leadership and management roles in CSIRO, where he led the groundwater research portfolio of the organisation and was responsible for managing large, multi-disciplinary projects in all parts of the country, including northern Australia and Tasmania.



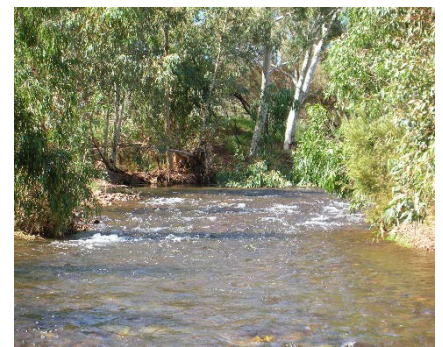
Dr Henning Prommer

Dr Henning Prommer is a Principal Research Scientist in the Urban and Industrial Water research program at CSIRO Land and Water (Floreat, WA) and Winthrop Research Professor in a joint appointment between CSIRO and the University of Western Australia (UWA). In this role he is leading the WA node of the NCGRT. His main expertise is the development of (bio) geochemical transport models and their application to an integrated quantification of physical flow/transport processes and geochemical reactions. A strong focus of his research is the assessment and prediction of the variability of the redox zonation in aquifers, the corresponding impact on the fate of anthropogenic macro- and micro-pollutants, weathering reactions, and the mobilisation and remediation of heavy metals. Henning's group has worked closely with the WA Department of Water to innovate the Perth Regional Aquifer Modelling System (PRAMS) to work towards (i) optimised groundwater management and (ii) the integration simulation of groundwater age tracers and (iii) simulation of large-scale groundwater quality evolution.



Table: NCGRT Researchers and Students

FUSA Academic Staff	Senior Researchers	Postdoctoral/Research Fellows	Ph.D. Candidates	Masters Students
Craig Simmons	Andy Love	Margaret Shanafield	Roger Cranswick	Olanrewaju Abiodun
Okke Batelaan	Peter Cook	James McCallum	Karina Gutierrez Jurado (2016)	Darryl Harvey
Adrian Werner	Adjunct Status	Daniel Partington	Michelle Irvine	
Huade Guan	Andrew Herczeg	Eddie Banks	David Poulsen	
Vincent Post	Peter Dillon	Yueqing Xie	Salini Sasidharan	
Ilka Wallis	John Doherty	Juliette Woods	Cameron Wood	
	Glen Walker	Tariq Laattoe	Andrew Knight	
	Glenn Harrington	Leanne Morgan	Matt Knowling	
	Henning Prommer	Etienne Bresciani	Tariq Laattoe	
		Guoliang Cao	Megan Sebben	
		Hugo A Gutierrez Jurado	Hannah Sharp	
		Yuting Yang	Sugiarto	
			Ty Watson	
			Robert Andrew	
			Joni	
			Shrestha Pradhan	
			Lesja Soloninka	
			Wesley Burrows	
			Stacey Priestley	
			Manh Vu	
			Nyda Chhinh	
			Amirhosein Esfahani	



Research awards

Science Excellence Awards SA 2015 SA Scientist of the Year

Professor Craig Simmons, Director of the NCGRT won the coveted South Australian Scientist of the Year award for 2015.

His outstanding record of personal contributions to Australian science, education and policy reform are helping to build a prosperous and sustainable Australia.

Professor Simmons was lauded for his work on groundwater, a resource of critical importance to the Murray-Darling Basin system, water and food security, mining and the nuclear industry, and coal seam gas and fracking.

Professor Simmons has positioned Australia as a world leader at the forefront of groundwater science and his work is answering critical questions about our environment, food and water security, coal seam gas and fracking, mining and nuclear and radioactive waste disposal.

The Science Excellence Awards of SA is an initiative of the Department of State Development. The award recognises an individual who demonstrates outstanding excellence in any field of scientific endeavour and has made a significant national or international contribution to the field of Research.

Chinese Academy of Sciences Fellowship 2015

Professor Adrian Werner was awarded the President's International Fellowship, Chinese Academy of Sciences (CAS). This international fellowship supports highly-qualified international scientists to work and study at CAS institutions to strengthen scientific collaboration with CAS researchers.

Water Industry Alliance 2015 Chairman's Award

Dr Peter Dillon was awarded the Water Industry Alliance 2015 Chairman's Award for his outstanding contribution to the South Australian water industry.

Ian Potter Foundation Travel Award 2015

Dr Yueqing Xie was awarded \$5000 through the Ian Potter Foundation and the School of the Environment, Flinders University to attend the European Geosciences Union General Assembly on 17-22 April, 2015 in Vienna, Austria.

Australian Research Council (ARC) Awards

ARC Discovery Early Career Researcher Award (DECRA) 2015

Dr Hugo Gutierrez-Jurado is an early career researcher who joined NCGRT and Flinders School of the Environment in early 2012. He has recently received a prestigious ARC Discovery Early Career Researcher Award (DECRA).

Dr Gutierrez-Jurado is focussing his DECRA research on developing and improving low cost field monitoring techniques to estimate and partition the exchanges of water and energy between the land surface and the atmosphere.

Understanding the dynamics of water transfers from the soil and the vegetation to the atmosphere remains one of the most pressing and elusive challenges in hydrologic and terrestrial ecology studies. Hence, the final aim of this research is to generate tools that will allow us to better quantify and understand the impact of changes in climate and vegetation cover on the amounts of water that are transferred from the land to the atmosphere and its cascading effects on the availability of water resources of vast regions.

ARC Discovery Early Career Researcher Award (DECRA) 2015

Dr Margaret Shanafield was awarded an ARC Discovery Early Career Researcher Award (DECRA). Dr Shanafield is focussing her DECRA research on tying together stream infiltration and groundwater recharge in the Willunga Basin near Adelaide. The quantification of recharge to aquifers remains a fundamental challenge for groundwater development worldwide, particularly in arid areas where recharge rates are small.



Photo: Professor Adrian Werner

The Willunga Basin provides an ideal setting for investigating links within the hydrologic cycle. Margaret is looking forward to using this resource to investigate how storm events contribute to groundwater recharge through local streambeds, which are typically thought to be the main source of infiltration in arid regions.

ARC Future Fellowship Award 2015

Professor Adrian Werner was awarded the prestigious ARC Future Fellowship to undertake research aimed at improving knowledge of coastal aquifer processes and management practices in order to increase the security of highly vulnerable freshwater.

In particular, it aims to address critical barriers to the regional-scale investigation of coastal aquifers, including island lenses – the most vulnerable freshwater resources on earth. Threats to coastal aquifers are intensifying globally, and key knowledge gaps prevail in our current understanding and representation of transient, regional-scale seawater intrusion.

The project plans to use coastal aquifer case studies from Australia and overseas to evaluate seawater intrusion reversibility, intermittent pumping effects, offshore aquifer processes, and management approaches. The project may improve coastal aquifer practices globally by unravelling the driving forces of transient seawater intrusion and developing new seawater intrusion models.

The Future Fellowship scheme supports research in areas of critical national importance by giving outstanding researchers incentives to conduct their research in Australia.



2015

SA Power Networks

**South Australian
Scientist of the Year**

WINNER

Professor Craig Simmons

Director, National Centre for Groundwater Research and Training,
Flinders University

Hon GAIL GAGO MLC
Minister for Science and
Information Economy



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2015
SA POWER NETWORKS
SOUTH AUSTRALIAN
SCIENTIST OF
THE YEAR
Professor C. Simmons

AWARDS

Featured research projects

Murray-Darling Basin Authority (MDBA) – NCGRT strategic partnership

Project description

The Centre entered into a \$2 million strategic research partnership at the beginning of 2015 to deliver important technical and scientific support for decision-making in the Murray Darling Basin.

A Steering Committee was established to help guide the successful implementation of the partnership process which is conducting investigations into groundwater and surface water interactions, groundwater replenishment processes, and the impact that social and economic factors may have on groundwater management into the future.

ARC Linkage Project – Groundwater flow age distributions: Understanding open pit mine hydrology

Project description

Taking place within the Pilbara region of north-western Australia, this project represents a major collaboration of expertise between NCGRT and Rio Tinto Iron Ore.

The project aims to understand groundwater flow and groundwater mixing processes in complex heterogeneous environments.

It will also help understand groundwater flow around open pit mines, and the effect of these mines on the regional flow system.

ARC Linkage Project - Cross-cultural management of freshwater on resource-constrained islands

Project description

This project aims to develop a methodology for community-led adaptive water management on resource-constrained islands. It will involve Indigenous communities in the development of predictive groundwater models.

The project plans to apply 3D participatory mapping, a stakeholder engagement process led and owned by local communities on Milngimbi Island in the NT.

The outcomes will contribute to solving water supply problems in remote communities in Australia and overseas.



Featured research projects

[The National Collaborative Research Infrastructure Strategy \(NCRIS\)](#)

Project description

The NCRIS Groundwater infrastructure program provides strategically located groundwater research infrastructure across Australia. The infrastructure, consisting of boreholes, high frequency water level logging, climate stations and real-time telemetry, enables research into the climatic drivers for groundwater recharge. The program provides access for the research community to use the borehole infrastructure for groundwater sampling and supports long-term water resource sustainability research to safeguard future agricultural production, drought proofing local communities and informing sustainable mineral resource development.

This program has seven national field sites with bore fields including weather stations, monitoring infrastructure and equipment; the database and interactive website is hosted at ANU; and auxiliary laboratory and field equipment. Sites are located in the Ovens Valley (VIC), Willunga (SA), Ti Tree (NT), Fowlers Gap (NSW), Namoi (NSW), Wellington (NSW) and Baldry (NSW) regions. The two sites managed by NCGRT/Flinders University are Ti Tree and Willunga.

The **Ti Tree** site is located 100 km north of Alice Springs, and aims to understand groundwater recharge processes in arid climates, the role of infiltration from ephemeral streams, and the interaction between groundwater and vegetation. The research site is a collaboration between FUSA, UTS, and the NT Government.

The **Willunga** catchment represents a peri-urban environment, with conflict for water between agricultural and horticultural industries and suburban development. The research site focusses on the role of faults in controlling groundwater flow, the connectivity between intermittent streams and the groundwater, and coastal processes. The site represents a collaboration between FUSA, ANU, Onkaparinga Council, the Adelaide and Mount Lofty Ranges Natural Resource Management Board and the SA Government.

NCGRT/Flinders University Researchers

Professor Peter Cook, Nicholas White (Field Technician)

Collaborating organisations

University of New South Wales (Lead), Monash University, Australian National University

[Department of State Development \(DSD\) – Water Resource Impacts of Unconventional Gas Developments](#)

Project description

Commissioned by the Minister for Mineral Resources and Energy, NCGRT/Flinders University is to undertake research and provide a report reviewing and synthesising available information on water resource impacts of unconventional gas developments, and to describe methods that can be used to assess risks of current and future developments. The project, in effect, is a global scale metadata analysis of unconventional gas impacts.

NCGRT/Flinders University researchers

NCGRT/Flinders University Researchers Professor Peter Cook, Professor Craig Simmons & Dr Margaret Shanafield

[OWS - Provision of hydrology research to better include faults and aquitards in Australian regional groundwater models to improve assessment of impacts of CSG extraction](#)

Project description

This project focuses on identifying and assessing the risks associated with deep groundwater extraction and depressurisation. Recent research, discussion with the IESC and consultation with industry stakeholders identified the need for a project to specifically address the following three issues. Each issue forms a component of the research project:

1. **Aquitards:** Improving understanding of vertical hydraulic conductivity in aquitards to examine the risk of depressurisation at a range of scales.
2. **Faults:** Improving methods and processes for assessing fault properties (including sub-seismic) in CSG reservoirs and their impact on production performance. Improving understanding of faults at various scales and their influence on propagating depressurisation to linked aquifers and surface environments. In addition, how do fault properties in the CSG reservoir and adjacent strata impact the risk of pressure

propagation to adjacent aquifers or even surface environments?

3. **Modelling:** Better conceptualisation, representation and parameterisation of aquitards and faults in regional groundwater models to reduce uncertainty in regional groundwater flow and pressure simulation.

This project directly contributes to the overarching goal of the IESC research agenda, that is: 'to increase the scientific evidence that underpins decisions about CSG and large coal mining development, enabling decisions to be based on the most rigorous science available.' The research is also expected to:

- Assist better decision-making, regulation, natural resource management and industry practice
- Build knowledge about the highest risks to freshwater resources, land and ecosystems
- Help provide data and knowledge that can support the Bioregional Assessments in priority areas

NCGRT/Flinders University researchers

Professor Craig Simmons, Professor Peter Cook, Dr James McCallum, Dr Eddie Banks, Mr Nicholas White (Field Technician)

Collaborating organisations

CSIRO (Lead), University of Queensland



Grant and contract income 2015

Table: 2015 NCGRT FUSA - Grant and Contract Income

GRANTING BODIES	LEAD CI
National Centre for Groundwater Research and Training	
Australian Research Council; Monash University	Simmons, Craig
Goyder Institute	Werner, Adrian
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Cook, Peter
Goyder Institute	Batelaan, Okke
Goyder Institute	Guan, Huade
Goyder Institute	Batelaan, Okke
Australian Research Council	Werner, Adrian
Goyder Institute	Harrington, Nikki
Goyder Institute	Woods, Juliette
Australian Research Council	Gutierrez-Jurado, Hugo
Australian Research Council	Shanfield, Margaret
Depart. Environment Water and Natural Resources (DEWNR); SA Water	Guan, Huade
The Secretariat of the Pacific Community	Werner, Adrian
Goyder Institute	Shanfield, Margaret
Australian Centre for International Agriculture Research	Batelaan, Okke
Depart. Environment Water and Natural Resources (DEWNR); Rio Tinto Ltd	Werner, Adrian
Australian Institute of Nuclear Science and Engineering (AINSE)	Post, Vincent
Murray-Darling Basin Authority	Simmons, Craig
Department of State Development	Simmons, Craig
Australian Research Council; Rio Tinto Ltd	Simmons, Craig
Australian Research Council; Power & Water Corporation.; The University of Auckland	Batelaan, Okke
Adelaide and Mount Lofty Ranges NRM Board	Simmons, Craig
Commonwealth Department of the Environment and Energy	Simmons, Craig
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Simmons, Craig
Commonwealth Scientific and Industrial Research Organisation (CSIRO)	Simmons, Craig
Goyder Institute	Simmons, Craig
City of Onkaparinga	Guan, Huade
The Government of Western Australia	Werner, Adrian

**Data provided by research Services Office in accordance with 2015 NCGRT FUSA Membership*

Outputs summary

Publications

The NCGRT researchers at Flinders University have had another busy year producing publications. C1 publications remain very high with 46% of the papers published in the top 10% journals by impact factor of the Web of Science Water Resources category, while a number of other papers are part of higher impact journals in other categories.

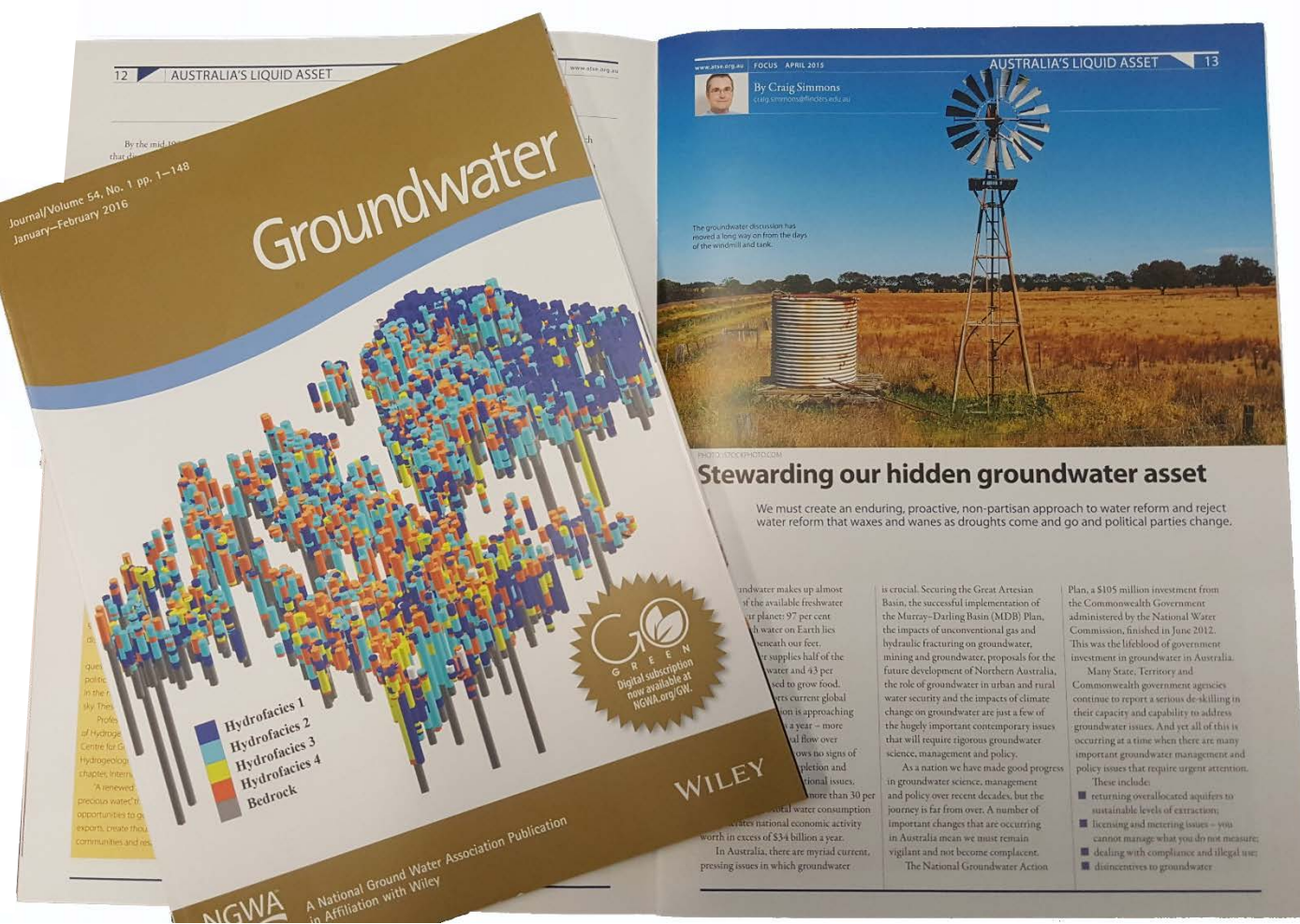
Table 1: 2015 FUSA Output Summary

CENTRE / INSTITUTE	Authorships	All publications	HERDC only
National Centre for Groundwater Research and Training	32.46	75	72

Table 2: 2015 NCGRT - FUSA Output

CENTRE / INSTITUTE	2015	
	Output	%
A1 - Report	3	4.00
A2- Report (ERA only)	5	6.67
A2 - Report (not ERA eligible)	1	1.33
B1 - Chapter	1	1.33
B2 - Chapter	1	1.33
C1 - Journal Article	63	84.00
E2 - Conference	1	1.33
TOTALS	72	100

**Figures as provided by Research Services Office according to 2015 FUSA membership*



Outreach - events

2015 proved to be another exceptionally busy year for the Centre delivering 25 events to 1288 participants from government, industry, community and academic sectors.

A key focus this year was project managing and delivering the first NCGRT/IAH Australian Groundwater Conference to over 330 delegates from across the nation. There were 240 oral presentations presented and a host of plenary and keynote presentations, panel sessions and posters showcasing the latest research and innovation in groundwater in Australia.

Delegates found the conference to be an extremely valuable networking experience to build existing and new collaborations and share research discoveries. The next conference will take place at UNSW Sydney in 2017.

In a challenging marketplace the short courses felt the economic pressures of tightening professional development budgets. Attendance rates dropped by 17% on 2014 short course results, however due to the Centre's primary role managing the Australian Groundwater Conference less short courses were scheduled this year. The conference attendance numbers helped to bolster the overall attendance results, providing a successful outcome for the year.

The Centre was also host to a number of distinguished international and national guest speakers. A number of seminars were provided to around 640 attendees who gained a valuable insight into research being conducted by a selection of world-leading groundwater experts.

Dr Peter Dillon was chosen as the 2015 NCGRT Distinguished Lecturer. He presented a series of lectures on, Progress in Managed Aquifer Recharge and the Water Banking Frontier which was followed by an interactive session: "Listening to local MAR progress, plans and implementation issues".

Future outreach activities are currently being explored to meet the demands of our stakeholder groups. Professional development delivered via online platforms will be increased in future offerings to account for tight training budgets amongst our prospective audiences and a greater diversity in events will also be considered.

Our outreach and engagement activities, including our workshops and short course program require continual monitoring to ensure we are delivering the correct mix of fundamental and specialist training into the market place.

Our stakeholder surveys, evaluations and Groundwater Training Advisory Group are assisting us to manage this into the future.

Table: NCGRT 2015 Courses and Events

COURSES	LOCATION	ATTENDEES	NOTES
Australian Groundwater Modelling School	Adelaide Sydney	13 11	
Australian Groundwater School	Adelaide Sydney Perth	22 25 26	
Environmental Tracers in Groundwater Hydrology: Tools for Improved Process Understanding	Perth Adelaide	19 26	
Modelling Groundwater with Source	Adelaide	9	Collaboration with eWater
Modelling for Managers and Decision Makers	Online	15	
Introduction to Pumping Test Analysis	Adelaide	26	
Managed Aquifer Recharge	Melbourne	18	
WEBINARS			
Modelling Groundwater-Surface Water Interactions using Source	Online	21	
Improving Adelaide's Groundwater Management for Managers and Decision Makers	Online	45	
CONFERENCES/CONFERENCE WORKSHOPS			
Australian Groundwater Conference	Canberra	334	Collaboration with IAH (Aust Chapter)
Drilling into the Future of Unconventional Gas – Oz Water	Adelaide	35	Collaboration with AWA
Total		645	



Australian Groundwater Conference

Opening the conference, Assistant Minister for Agriculture & Water Resources, Senator Anne Ruston, said the government was committed to managing Australia's groundwater resources sustainably and with long-term vision.

There was an array of interdisciplinary and specialist talks which spanned across the conference themes. The panel discussions, and the Q&A time after presentations provided a robust platform to address critical groundwater issues. The conference highlighted that a national conversation must continue and the IAH and NCGRT will to facilitate this.

Delegates experienced great opportunities to network including a BBQ dinner at the National Botanic Gardens, networking drinks and for some, a Trivia Night.

Ozwater'15

Ozwater is the Australian Water Association's international water conference and trade exhibition. In 2015, the NCGRT held a workshop "Drilling into the Future of Unconventional Gas".

The panel featured experts on coal seam gas from around Australia: Mr Barry Goldstein - SA Department of State Development, Mr Rick Wilkinson - APPEA, Professor Peter Cook - NCGRT/Flinders University, Ms Gayle Milnes - EACD, Prof. Damian Barrett - GISERA. The NCGRT also held a trade display at this event.

SA Groundwater Forum 2015

The NCGRT collaborated with the SA Chapter of the IAH to deliver this Forum. The focus of this inaugural one day groundwater forum was to showcase the current status of SA's groundwater resources, profile the latest developments in various aspects of the groundwater industry, as well as discuss future opportunities within South Australia.



SEMINARS

SEMINARS			
South Australian Groundwater Forum 2015	Adelaide	140	Collab. with IAH
South Australian IAH/NCGR T Modellers' Forum #5		28	Collab. with IAH
Dr. Dorthe Wildenschild - Oregon State University 2014 Darcy Lecture: What Happens in the Pore, No Longer Stays in the Pore: Opportunities and Limitations for Porous Media Characterisation and Process Quantification Using X-ray Tomography.	Adelaide	21	Collab. with IAH and NGWA (USA).
Dr. Kent Novakowski - Queens University Lecture: Flow and Transport Properties of Fractured Bedrock Aquifers in the Vertical Direction	Adelaide	14	
Mr William L. Fisher - Department of Geological Sciences, Jackson School of Geosciences and University of Texas Lecture: The American Revolution in unconventional oil and gas continues	Adelaide	25	
Dr. Peter Dillon - Adjunct Professor Flinders University 2015 NCGRT Distinguished Lecture: Progress in Managed Aquifer Recharge and the Water Banking Frontier followed by an interactive session: "Listening to local MAR progress, plans and implementation issues".	Adelaide Perth Darwin Brisbane Sydney Canberra Melbourne Hobart Christchurch	57 64 12 50 33 18 52 10 39	Collab. with IAH State chapters. The University of Canterbury and the Hydrological Society NZ.
Dr. Rainer H. Helmig - Institute for Modelling Hydraulic and Environmental Systems, University of Stuttgart, Germany 2015 Henry Darcy Lecture: Evaluating the Competitive Use of the Subsurface: The Influence of Energy Storage and Production in Groundwater.	Adelaide	41	Collab. with IAH and the US based NGWA.
Mr Ronald B. Peterson 2015 NGWA McElhiney Lecture: Drilling Fluids: A Common Sense Approach	Adelaide	19	Collab. with IAH and the US based NGWA.
Associate Professor Bayani Cardenas - The University of Texas Austin Lecture: Seminar based on the upcoming paper: The global volume and distribution of modern groundwater, by Tom Gleeson, Kevin M. Befus, Elco Luijendijk, Scott Jasechko, and M. Bayani Cardenas, which has been reviewed and revised for publication.	Adelaide	10	
Dr. Jean-Daniel Rinaudo - BRGM (French Geological Survey) Lecture: Shifting from a free access to a regulated exploitation regime: groundwater policy reform in France.	Adelaide	10	
Total		643	

Outreach - media

Professor Craig Simmons': Scientist in residence (The Advertiser)

Professor Craig Simmons is raising public awareness of this precious natural resource as Flinders University's first Scientist in Residence at The Advertiser, working with journalists and editors on a range of key issues relating to water and the environment.

Media mentions

In 2015, the NCGRT had several media mentions in local and national media sites (print, radio and online).

Professor Simmons was also featured in an articles written in The Advertiser: water scientist dives into newsroom after winning coveted title (published August 14, 2015). An article was also written; SA Scientist of the Year Craig Simmons is The Advertiser's Scientist in Residence (published adelaidenow.com.au 14 August 2015).

In 2015, Professor Simmons was made Associate Editor and Member of the Editorial Board of the international journal Water Conservation Science & Engineering.

The Australian Academy of Technological Sciences and Engineering (ATSE) also published two pieces written by Professor Simmons: "Stewarding our hidden groundwater asset," (April 2015 Focus magazine) and "Unconventional Gas is here - massive challenges, but we must meet them" (December 2015 Focus magazine).

NCGRT Corporate Communications

The NCGRT redeveloped its online presence in 2015, complete with a refreshed website, logo, corporate style and e-news.

For 2015, the Centre produced approximately 38 e-news communication emails to a national and international database of approximately 10,000 stakeholders. These emails highlighted the Centres events, research and training offerings.



2026 vision

Having moved out of a period of drought and extreme uncertainty about water availability, Australia still faces the immense challenges of a growing demand for water and climate change. Our need for sustainable groundwater resources continues to increase. With this, there remains an ongoing need for a collaborative and independent organization of groundwater experts to consolidate the research effort, to lead the debate about groundwater issues and management, to advance Australia's position as a world leader in groundwater science, and to build our capability to face current and future challenges.

Groundwater makes up 97 percent of the freshwater on Earth. It supplies half of the world's drinking water and 43 percent of the water used to grow food. In Australia, groundwater represents more than 30 percent of our total water consumption and generates economic activity worth more than \$34 billion per year. Yet, unseen and often perceived as either infinite or unimportant, it is a sleeping giant. During times of water scarcity, will we be able to rely on groundwater to bridge the gap? There is still no simple answer to that question. Groundwater depletion and pollution are huge international issues.

This became glaringly apparent in Australia during the Millennium Drought, when surface water ran critically low. Groundwater received unprecedented attention. The National Groundwater Action Plan, a \$105 million investment from the Commonwealth Government, administered by the National Water Commission was the lifeblood of government investment in groundwater in Australia. The NCGRT positioned itself at the forefront of groundwater research in Australia, building on national and international linkages to dramatically advance the knowledge of our most precious resource and contributing to the high level discussions about Australia's sustainable use of groundwater. We as a country made good progress in groundwater science, management and policy. COAG's National Water Initiative set the standards for water management and the States strove to achieve them. The gaps in our capability to do this became obvious. The drought broke, complacency set in. Groundwater returned to being the sleeping giant.

Major challenges in the management of groundwater remain, including:

- Returning over-allocated aquifers to sustainable levels of extraction;
- Accurately quantifying groundwater use (licensing and metering);
- Double accounting and double allocation of surface water and groundwater;
- Quantifying environmental groundwater needs;
- Impacts of mining and unconventional gas on groundwater systems, including cumulative impacts of multiple developments;
- Effects of climate change on the availability and quality of groundwater resources;
- Seawater intrusion in coastal aquifers;
- Salinisation of groundwater resources;
- Better use of Managed Aquifer Recharge for water storage;
- Managing groundwater in expanding urban and irrigation areas;
- Protecting groundwater quality under changing land uses.

The knowledge base of groundwater remains low relative to the size of the management challenges we imminently face. However, the momentum is great and both within Australia and internationally, we have immense capability to address these issues. Opportunities for a co-ordinated national and international response to the water management challenges facing us must be grasped.

In this time of challenge and opportunity, the NCGRT has a clear mission: to maximise Australia's groundwater research outcomes, to foster collaboration, national and international linkages and debate, to help build Australia's groundwater expertise and build capacity and capability. We must do this now. The next drought may be just around the corner.



Future KPI's

KPI 1: Promoting excellence in Australian groundwater research

Australia is a world-leader in groundwater research and must continue to push the frontiers of science in an area that is critical to our national interest. We will proactively engage with all levels of government, industry and the community to ensure that our research delivers outcomes that drive improvements in practice and policy. We will operate collaboratively at a national scale and continue to attract some of the best researchers from around the world if we are to bring about solutions to national and global challenges in water resources management. We will communicate our achievements to ensure they benefit our community.

Priorities

- Undertake world-leading fundamental and interdisciplinary groundwater research.

- Support proactive engagement between stakeholders and NCGRTs research, government and industry partners and provide a network for all key agencies in groundwater to unite in a single centre.
- Facilitate and build projects, provide leadership, foster collaboration, discussion, dialog for Australian and international groundwater research.
- Build strong competitive national and international partnerships to address the most significant Australian and international groundwater problems.
- Measure and promote the national groundwater footprint.
- Facilitate new projects and partnerships through stakeholder and researcher forums, incl. Centre Participants Forum.
- Engage with major organisations to build strongest national and international linkages (e.g. IAH, National Groundwater Association, Australian Water Association, Water Industry Alliance, Goyder) (Linkages with learned academies including Australian Academy of Technology and Engineering and, US National Academies of Science).
- Import and export groundwater researchers through projects and partnerships (national and international).
- Measure, promote and communicate nationally significant projects undertaken by NCGRT researchers, partners, students and other organisations in Australia.
- Measure and communicate national groundwater footprint through newsletters, media and social media.

NCGRT Objectives

- Establish collaborative research programs, engaging with government stakeholders to identify clear objectives and draw on its research and industry partners to bring together project teams that will achieve these objectives.

KPI 2: Building capacity and capability through research and training

The future of Australia's groundwater resources depends on attracting the best and the brightest to the field, equipping them for the many and varied roles they will take on. It is increasingly important that, as well as achieving excellence in their field of research, the new wave of researchers emerging from our universities are skilled in identifying stakeholder needs, managing projects to time and budget constraints and communicating their outcomes to a wide audience. It is equally important that our groundwater industry as a whole is abreast of cutting edge science and techniques. Through its unique partnership structure, NCGRT has the ability to facilitate collaborative projects and match these with the right students creating a win-win for all. NCGRT is likewise able to liaise with its government and industry partners to identify and deliver specific training needs for students and industry professionals through its acclaimed, longstanding and leading industry training program.

Priorities

- Facilitate recruitment of the best post-doctoral fellows, PhD, Honours and Masters Students.
- Ensure that our emerging researchers are well-equipped with the skills required to thrive in a modern/contemporary world of managing our groundwater resource into the future.
- Ensure that outcomes of cutting edge research are used to build capability in the Australian groundwater sector.
- To work in conjunction with our leading water associations to optimise outcomes for water resource management across the nation.

NCGRT Objectives

- Seek partner projects to pair with scholarships and align students with research projects to build capacity and capability.
- Build strong functional and communication links between key Australian groundwater researchers, managers, industry and government through Centre Participants Forum; Board; regular one on one discussions with NCGRT Director.

- Provide training and mentoring for post-graduate students and post-doctoral fellows to build communication, project management and stakeholder liaison skills.
- Bring the national community together for biennial Australasian Groundwater Conference, jointly with IAH (networking, strategic leadership, promoting knowledge sharing, outreach).
- Share best and brightest with the country through programs such as the successful NCGRT Distinguished Lecture Series collaborating with the Australian Chapter of the International Association of Hydrogeologists.
- Use industry training courses strategically for knowledge transfer for research projects, for both NCGRT and its partners.
- Disseminate cutting edge research outcomes and facilitate discussion on best practice, policy and management from leading groundwater experts across the globe

Future KPI's

KPI 3: Australia's enduring groundwater organisation: providing trusted independent advice on groundwater issues and leading Australia's groundwater strategic discussions

Regardless of the current water availability situation and changing political agendas, our groundwater resources must be managed to meet future growing demands and pressures from changing climate and population growth. Challenges continue to arise and strategies must be revised. Open dialogue between scientists, industry experts and government is crucial. The NCGRTs Advisory Board is a very high level group of influential leaders who are addressing our groundwater issues, strategy, challenges and opportunities at a national level. The NCGRT working with the key water associations is the ideal organisation to act as a conduit between the best practitioners in the groundwater industry and government and community on groundwater science and issues. We must continue to measure and manage the national groundwater footprint as a sector to ensure our groundwater resources and associated groundwater-dependent ecosystems are supported for future generations to come.

Priorities

- Broker, facilitate and contribute to National discussion and debate on groundwater.
- Maintain community and political awareness of the importance of groundwater.
- Provide trusted independent advice on groundwater issues.

Objectives

- Actively contribute to and lead national debate on and raise awareness of groundwater issues through media, contribution to learned Academies, The National Groundwater Sub Group, Science Meets Parliament, industry and research publications, social media, NCGRT newsletters and webinar series, in association with IAH where this is mutually beneficial.
- Support and facilitate the leading scientists, government and industry practitioners from its partner organisations in occupying leadership roles on major national and international committees and boards to influence and shape the groundwater agenda.
- In collaboration with the Australian Chapter of the IAH, convene a biennial Australasian Groundwater Conference to promote discussion about the

pressing issues facing groundwater science, policy and management, highlight the successes, identify knowledge gaps and set the agenda for research, training and adoption of new knowledge.

- Fill a national groundwater advisory role, link with industry and National Groundwater SG on ad hoc basis to ensure linkages with states and industry.
- Maintain links with learned academies such as the Australian Academy of Technologies, Science and Engineering (ATSE) and the US Water Forum.
- Raise awareness in media through strategies including Scientist in Residence with the Advertiser and other national newspapers.
- Promote and feature partners, stories, projects and people.
- Support schools to incorporate groundwater educational activities into their program.
- Facilitate national workshops on pressing and contemporary issues intersecting groundwater such as the nuclear debate, coal seam gas as an alternative energy source, Northern Australia developments and the coexistence in the Murray Darling Basin.

KPI 4: Establishing and maintaining the benchmarks for tools and methodologies used in groundwater assessment and management in Australia

Groundwater assessment and management in Australia can benefit from the period of intensive advancement in tools and practices over the past decade. Groundwater professionals require targeted resources and support to keep abreast of such advancements and assist with determining the best fit-for-purpose techniques in individual situations.

Priorities

- Promote the adoption of best practice techniques through outreach programs.
- Foster relationships with industry partners through collaborative projects that trial and demonstrate best practice techniques.
- Facilitate continued improvement of best practice through national debate and discussion.

Objectives

- Consult with industry, government and research leaders to identify best practices and benchmarks and develop resources and training strategies to encourage use of these in industry.
- Work with industry and researchers to define key research issues, discovery-driven innovation and explore opportunities for collaborative research.

- Have discussions with key bodies to enable the rollout of key strategies.
- Build industry training further to deliver highly focussed training courses to encourage best practice.
- Deliver professional outreach to communicate knowledge transfer for research projects, both the NCGRT and more broadly to encourage adoption of new knowledge and techniques.
- Facilitate the publication and dissemination of knowledge from NCGRT research projects to end-users.
- Encourage the incorporation of outreach and communication components into NCGRT research projects.
- Develop think tanks and discussion forums to improve best practice into the future

Appendix 1

research collaboration

Table: List of Partner/Collaborating Organisations as at cessation of ARC SRI funding (2015 onwards)

NAME OF ORGANISATION	TYPE OF ORGANISATION	COUNTRY	DATES OF INVOLVEMENT
Australian National University	Collaborating University	Australia	2009-2015 Current
Charles Sturt University	Collaborating University	Australia	2009-2015 Current
Commonwealth Scientific and Industrial Research Organisation	Partner - Scientific Research	Australia	2009-2015 Current
DHI Group	Partner – Industry	Multinational	2012-2105 Current
Geoscience Australia	Partner – Scientific Research	Australia	2009-2015 Current
Innovative Groundwater Solutions Pty Ltd	Partner - Industry	Australia	2013-2015 Current
James Cook University	Collaborating University	Australia	2009-2015
La Trobe University	Collaborating University	Australia	2009-2015 Current
Monash University	Collaborating University	Australia	2009-2015 Current
Queensland University of Technology	Collaborating University	Australia	2009-2015
University of New South Wales	Collaborating University	Australia	2009-2015 Current
University of Queensland	Collaborating University	Australia	2009-2015 Current
University of South Australia	Collaborating University	Australia	2009-2015 Current
University of Western Australia	Collaborating University	Australia	2009-2015 Current
University of Technology Sydney	Collaborating University	Australia	2009-2015 Current
SA Department of Water, Land and Biodiversity Conservation (now known as the Department of Environment, Water and Natural Resources)	Partner - State Government	Australia	2009-2015 Current
NSW Department of Primary Industries	Partner - State Government	Australia	2009-2015
NSW Office of Water	Partner- State Government		2011-2015 Current
United Water	Partner – Industry	Australia	2009-2012
US Geological Survey	Partner - Scientific Research	United States	
SA Water	Partner – Industry	Australia	2009-2015 Current
Sinclair Knight Merz (now Jacobs Group (Australia))	Partner - Industry	Multinational	2009-2015 Current
Aquaterra Consulting Pty Ltd	Partner- Industry	Australia	2009-2015

Additional partners joining NCGRT from 2015 onward:

- Edith Cowan University
- Melbourne University
- Bureau of Meteorology
- Murray Darling Basin Authority
- Australia Nuclear Science and Technology Organisation
- Office of Groundwater Impact Assessment - QLD
- Department of Environment, Land, Water & Planning - VIC
- Department of Land Resource Management - NT
- Department of Science, Information Technology and Innovation - QLD
- Aquanty
- CDM Smith
- Golder Associates

Appendix 2

publication listings

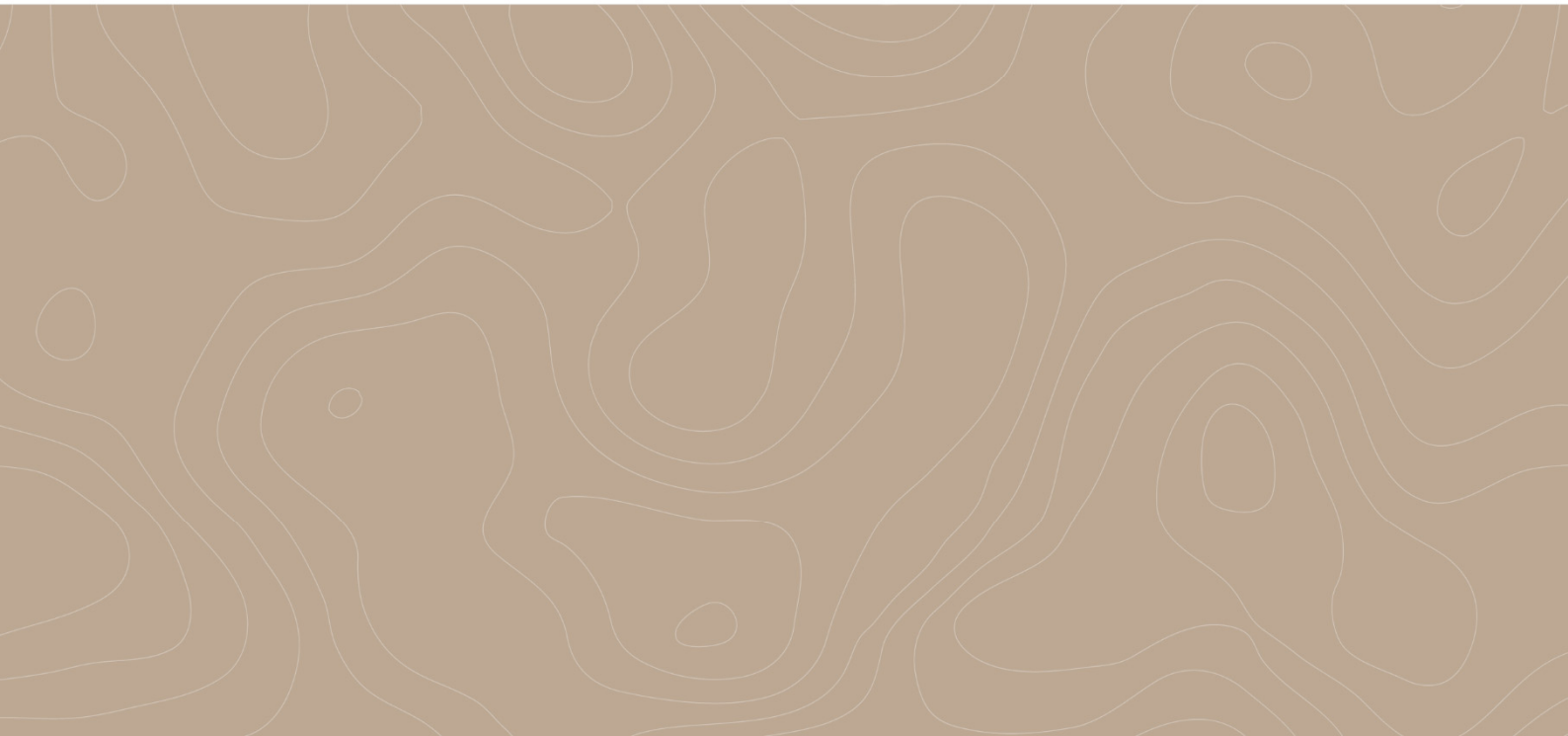
CATEGORY	CITATION
A1 - Report	Woods, J.A., Laattoe, T., Werner, A.D., Gonzalez, D., Riches, V.A., Vears, L., et al. (2015). Modelling salt dynamics on the River Murray floodplain in South Australia: Conceptual model, data review and salinity risk approaches. Adelaide, South Australia: Goyder Institute for Water Research.
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	Barnett, S., Lawson, J., Li, C., Morgan, L.K., Wright, S., Skewes, M., et al. (2015). A Hydrostratigraphic Model for the Shallow Aquifer Systems of the Gambier Basin and South Western Murray Basin. Adelaide, South Australia: Goyder Institute for Water Research.
A2 - Report (ERA only)	Morgan, L.K., Harrington, N.M., Werner, A.D., Hutson, J.L., Woods, J.A. and Knowling, M.J. (2015). South East Regional Water Balance Project – Phase 2 Development of a Regional Groundwater Flow Model. Adelaide: Goyder Institute for Water Research.
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The top half of the image features a dark blue background with a white topographic map pattern, showing various contour lines and shapes.

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The bottom half of the image shows a landscape with a body of water in the foreground, reflecting the sky and trees. The trees are bare and silhouetted against a light, hazy background. The water is a deep blue color.