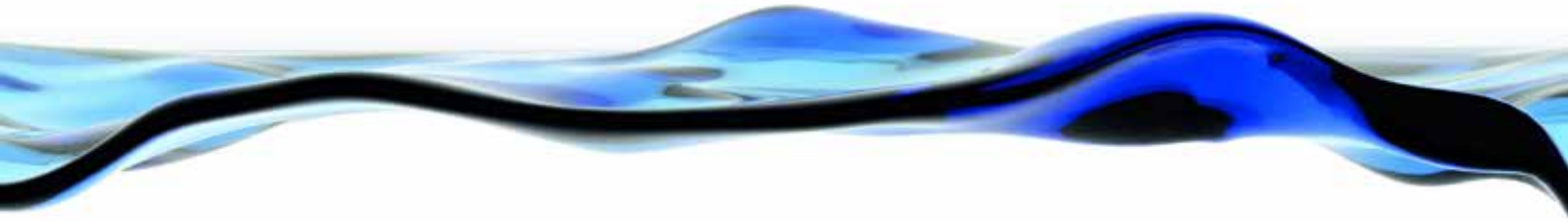
Goyder Institute for Water Research
Annual Report 2012-13



GOYDER INSTITUTE FOR WATER RESEARCH

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Photo opposite page: Claire Punter

Message from the Chair

The third year of the Goyder Institute has been one of great activity and very significant achievement, providing strong evidence of the effectiveness of the role of the Institute as the independent expert science advisor to Government on issues related to water. The work on the science supporting the new Murray Darling Basin Plan was particularly noteworthy in showing the Goyder Institute's ability to deliver focused expert analysis and advice under short deadlines. This delivery can only be achieved because it is based on established trusted relationships between scientists and between scientists and Government.

A number of major research programs are now well underway covering many regions of the State: research developing new techniques for finding water for outback communities and industry (G-FLOWS1) and investigations of the ecosystem response to the 2010 floods in the South Australian part of the River Murray (Murray Flood Ecology) are good examples. Two other studies have commenced to inform water management in the Adelaide Plains and Mount Lofty Ranges and build on work that has been undertaken on water sustainability in these areas. These projects are the Adelaide Plains Groundwater Study – mapping the aquifers below Adelaide to understand how these systems work and assess the potential to use them to store water to help drought-proof Adelaide. The Mount Lofty Ranges Water Allocation Planning Project will refine the understanding of environmental water needs, patterns of flow and water quality within the Mount Lofty Ranges to support sustainable water management into the future.

This year saw the departure of Minister Paul Caica and I would like to gratefully acknowledge his strong support of the Goyder Institute in its foundation years. We welcome the new Minister for Water and the River Murray, the Hon. Ian Hunter and have already begun working with him to establish priorities for Goyder Institute research in the coming years. The year has also seen two changes on the Institute Board: Bill Young (CSIRO) has left to take up a position leading the World Bank's South Asia Water Initiative, based in New Delhi, and Professor Sakkie Pretorius (UniSA) has moved to the University of Newcastle. I would like to particularly acknowledge the major contributions Bill Young has made to establishing and building the Goyder Institute's research plans from the earliest days and to wish him well in his challenging new role. I welcome to the Board Dr Carol Couch, the new Director of CSIRO's Water for a Healthy Country Flagship, Professor Richard Head, UniSA and Mr Tim Goodes, a long time contributor to the Goyder Institute as the representative of the Department of Environment, Water and Natural Resources.

Finally I would like to thank all involved in making this year such a successful one for the Goyder Institute. I look forward to our focus on scientific research translating into informed water policy, improved customer understanding, and its ongoing application bearing fruit in the coming years.

Ian Chessell
Chair, Goyder Institute for Water Research

Message from the Director

Getting into the swing of team activities at the Goyder Institute Science Retreat at Victor Harbor in June 2013. Photo: Churchhill Photography

We have now reached the end of the third year of the Goyder Institute for Water Research. The first two years of the Institute were dedicated to the development and execution of our Strategic Research Plan and the establishment of a reliable Goyder Institute office that would help to build upon the foundations of cooperation and collaboration between our partners. We have achieved much to-date and there are still quite a few exciting challenges to be addressed in the coming years. We have already committed some $33M to dedicated research activities, which in turn has attracted more than $8M in additional support from agencies and external stakeholders. Our 2013/14 Annual R&D Plan details all of our investments and achievements and provides the directions about how we plan to commit another $10M to new research activities in the coming years.

After three years of dedicated research, we are starting to produce some significant results from our various projects. We are engaging more with our researchers, end-users and the public to build a positive research culture. This Annual Report describes some of the research highlights from our projects, and reports on the various activities undertaken to facilitate our engagement with all of our stakeholders. I am especially proud of the contributions made by the Goyder Institute to underpinning the scientific content of the South Australian Government's analyses of the Murray Darling Basin Plan and the subsequent negotiations for better outcomes for the South Australian section of the Murray River, the Lower Lakes and the Coorong. You can read all about our involvement in this process further on in this Annual Report.

This will be the last Annual Report from me as Director of the Goyder Institute. I am sure that the Goyder Institute will continue to provide outstanding results and outcomes in the coming period under new leadership. I am very proud of what we have all managed to achieve during the first three years, and I am sure that we will continue to read about the significant impacts of the Goyder Institute research in years to come. The initial term of the Goyder Institute ends in June 2015, but discussions with our key stakeholders have already started to examine the possibilities for extending beyond this date. I believe that our track record will speak for itself when it comes to demonstrating the immense value that the Goyder Institute has delivered to water research in Australia and to the people of South Australia in particular.

Tony Minns
Director, Goyder Institute for Water Research
director@goyderinstitute.org

Photo opposite page: Claire Punter

Goyder Institute Partners

The Goyder Institute for Water Research is a partnership between the South Australian Government through the Department of Environment, Water and Natural Resources, CSIRO, Flinders University, the University of Adelaide and the University of South Australia. The Institute will enhance the South Australian Government's capacity to develop and deliver science-based policy solutions in water management. It brings together the best scientists and researchers across Australia to provide expert and independent scientific advice to inform good government water policy and identify future threats and opportunities to water security.

Goyder Institute Associates

Goyder Institute Associates typically contribute expertise and capabilities in areas outside of those contributed by the Goyder Institute Partners. Associates may participate in capacity building, knowledge exchange and/or specific research projects, and invest in the Goyder Institute Research program with in-kind commitments in the same manner as Goyder Institute Partners. The following Associate organisations have contributed the outcomes of the Goyder Institute in 2012-13.

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Strategic Progress

In June 2009, the South Australian Government released *Water for Good*, its policy directions and actions for water security in South Australia to underpin a growing population and the State's economy, and to preserve the State's environment and quality of life against the challenge of an outlook for reduced rainfall. *Water for Good* outlines actions to be taken to ensure the State's water supplies are secure, safe and reliable to sustain growth for at least the next 40 years. It provides actions to diversify the State's water sources, improve water conservation and efficiency, and improve and modernise its water industry.

The State Strategic Plan Goal for water resources is that South Australia has reliable and sustainable water resources and is a leader in wastewater, irrigation, stormwater, and groundwater management. However, managing water supplies in a variable climate will require adaptive and innovative solutions.

The Goyder Institute for Water Research themes of Urban Water, Environmental Water, Water for Industry and Climate Change were selected as areas for priority research that would most clearly and effectively support these policy directions. The research themes contribute to a number of the state government's seven strategies priorities, namely; "*Premium food and wine from our clean environment*"; "*Realising the benefits of the mining boom for all South Australians*"; and "*Creating a vibrant city*".

The Goyder Institute Strategic Research Plan 2011-2015 details the long-term strategic outcomes for the Institute's research programme which in turn will help ensure the water resources of the State of South Australia are sustainably managed for the economic, social and environmental benefits mentioned above. The Strategic Research Plan links the ongoing and proposed research activities to these outcomes through "Roadmaps". Each strategic Roadmap is implemented through an integrated set of Research Projects with associated Research Project Plans.

This 2012/13 Annual Report provides a synopsis of this annual rolling portfolio of projects that are the mechanism for achieving the outputs required to contribute to the Roadmaps and ultimately the States long term water security and sustainability.

Photo: Claire Punter

Urban Water

Water for Good provides an outlook that water availability and reliability may vary substantially across South Australia. The key drivers for future water availability will be climate condition and population growth. South Australia now faces climate variability and changing climate conditions that put new pressures on water use and threaten supply. Planning for future supply with a high level of uncertainty is complex and requires a flexible approach. Water planning must consider the quantity and quality of all current and potential water resources in each region. *Water for Good* calls for strategies to reduce the reliance on traditional water sources, such as the River Murray and the Mount Lofty Ranges reservoirs, by increasing stormwater harvesting and wastewater reuse.

The *State Stormwater Strategy* released in 2011 provides a 'road map' for achieving the stormwater-related targets in *Water for Good*. The Strategy initially focuses on Greater Adelaide and recommends that the initiatives and policies be applied first in the city. In the medium to longer-term, their reach will be widened to include regional South Australia, particularly larger urban centres.

Water for Good identifies a need to develop master plans for effectively managing stormwater and wastewater in Greater Adelaide. This strategy is a precursor to a more detailed '*Blueprint for Urban Water*' which will bring

together stormwater and wastewater and examine matters such as the costs and benefits of various strategic water projects and products, a demand study to identify possible users of various water products, including the demands of agriculture to the north and south of metropolitan Adelaide, and land-use planning considerations for strategic infrastructure investment (including investment related to mitigating flood risks).

The Goyder Institute has commissioned research into WSUD, the Optimal Water Resources Mix for Adelaide and a national project on Managed Aquifer Recharge and Stormwater Use Options. Allied projects under the Water for Industry theme are researching the storage capacity, sustainable yield and salinity constraints of the Adelaide Plains groundwater resources, Adelaide Mount Lofty Ranges water allocation planning to improve catchment surface water storage and runoff models, and the hydro-ecological response of catchment environmental assets. These complement and will contribute to this urban water research program.

Photo: Claire Punter

U.1 Water Sensitive Urban Design

Water for Good supports the development of South Australia as a water sensitive state. Water Sensitive Urban Design (WSUD) is a key tool to delivering a water sensitive city. A proposed Policy and Strategy for Water Sensitive Urban Design in South Australia was developed by DEWNR in 2012/2013, which includes targets for WSUD that are based on a Goyder Institute review of interim targets and stakeholder consultation.

The Goyder Institute investment is focused on understanding the impediments and opportunities in implementing Water Sensitive Urban Design in SA. The outcomes of this research will provide government agencies and other stakeholders with the scientific, technical, social and economic basis to elevate implementation of WSUD and enable the government to achieve the relevant actions in the proposed WSUD policy.

U.2 Water Resources Mix for Adelaide

Adelaide water source options include the Mount Lofty Ranges water supply catchments, River Murray, seawater desalination plant, stormwater recycling, effluent recycling, groundwater use and conservation measures. The *State Stormwater Strategy* recommended research to underpin urban water policy, in particular, the integrated management of water resources. *Water for Good* states that demand for South Australia's limited, high quality natural fresh water for drinking can be reduced by recycling and using stormwater for non-drinking purposes. Recycling can be more costly than other traditional supply options however the value lies in the opportunity to simultaneously diversify water supplies and provide other benefits, such as improved water quality in the Gulf and resilience of our urban landscapes and green spaces during drought.

The Goyder Institute Water Resources Mix Program is supporting the achievement of these statewide aims through focussed investment in assessing potential uses of stormwater, analysis of water governance options in delivering a diversified water supply, understanding household water use and developing methods for determining trade-offs between the multiple objectives of water security, economic efficiency and environmental benefits of different water supply options.

To facilitate ongoing interaction with key government stakeholders responsible for delivery of urban water management in South Australia, a Stakeholder Reference Panel has been established. The Stakeholder Reference Panel provides a mechanism for ongoing dialogue between the Goyder Institute experts and government policy makers in providing the best available science regarding integrated water resource management issues for consideration in the development of the '*Blueprint for Urban Water for Greater Adelaide*'.

Photo: Claire Punter

Water for Industry

In this research theme, techniques are being developed to promote equitable water sharing in multi-use catchments and in remote regions of the State. The objective is to develop sustainable water management practices for communities and industries (e.g. food, wine, forestry and mining) that are heavily reliant on safe and secure water supplies. Research projects may concentrate on a number of issues including the characterisation of the regional water resources; the identification of the community and industry water needs; environmental water needs and cultural values associated with the water.

I.1 Water Allocation Planning and Water Quality Improvement

Water allocation plans for prescribed water resources in South Australia specify environmental water provisions for water dependent ecosystems, the consumptive pool for licensed water allocations for consumptive purposes such as irrigation, town water supplies, industrial, recreational and commercial uses within sustainable diversion limits (SDL's). The specification of environmental water provisions and water quality issues, such as salinity, are critical elements in determining SDL's that will help inform the volume of water available in the consumptive pool. To achieve this, a sound understanding of eco-hydrological responses balanced against the provisions for consumptive use is necessary in providing for healthy ecosystems in the water allocation planning process.

The Mount Lofty Ranges and metropolitan Adelaide region encompasses one of the major water resources areas in South Australia. The surface water and stormwater systems are now strongly connected to the Adelaide Plains groundwater systems through managed aquifer storage and recovery of treated stormwater. Draft water allocation plans have been prepared for the eastern MLR catchments draining to the River Murray system and the western MLR.

The research program is focusing on a number of critical elements of the interrelated Adelaide-MLR hydrologic system to address specific issues relating water allocation planning by improving surface water modelling, managing the risks of algal bloom outbreaks in the Torrens Lake associated with stormwater quality, and better specification of the capacity of the Adelaide Plains groundwater system for water supply and water banking. Reducing the impacts of wastewater discharges to the Adelaide coastal waters by creating new opportunities to reuse treated wastewater for irrigation is being addressed as part of a national project to expand the water source options for agricultural industry.

I.2 Mining and Outback Water

There has been significant growth in mining and energy exploration in South Australia, which has identified new major potential opportunities. The scale of the planned developments and potential activity from current mineral exploration is set to generate significant economic value for the State. However, the delivery of this value to the State is dependent on the mining and energy sector being able to access reliable water supplies.

The Department of Environment, Water and Natural Resources (DEWNR) has developed an initiative called 'Finding Long-term Outback Water Solutions' or the FLOWS Initiative, which is supported by Department of Manufacturing, Innovation, Trade, Resources and Energy. The Goyder Institute is addressing the research and development component of the FLOWS Initiative under a staged G-FLOWS program. The research has developed methodologies to interpret airborne geophysics to locate and better define new groundwater sources.

The G FLOWS program is contributing to State's strategic priority '*Realising the Benefits of the Mining Boom for All South Australians*' by providing new knowledge on groundwater resources. This work will also assist in the development of water supplies for remote Far North communities under Action 66 in *Water for Good* by identifying alternate groundwater sources to improve water supply security.

Photo: Claire Punter

Environmental Water

The Environmental Water theme is concentrating on developing a detailed understanding of the ecosystems of our major water resources like the River Murray and the wetland systems in the South East of South Australia. These systems contain several RAMSAR wetlands of international importance which require a robust integrated management approach to maintain the environmental values of these regions while also achieving social and economic outcomes.

E.1 River Murray

The priority policy issue for the River Murray with the establishment of the Goyder Institute was the negotiation of the Murray Darling Basin Plan to ensure water security for critical human needs, provision for consumptive purposes such as irrigation, and that sufficient flows would be achieved to meet the environmental water requirements of key environmental assets in the lower River Murray for a healthy river system.

Photo: Claire Punter

The breaking of the extended period of drought in 2010 with flood flows enabled analysis of the ecological responses to flooding in the lower River Murray, which will provide new knowledge for the development of annual and long term watering plans under the Basin Plan.

The Goyder Institute provided scientific expert analysis and review of the Guide to the Murray Darling Basin Plan, an independent expert analysis on the ecological consequences for South Australia of the proposed Basin Plan, and a peer review of the State Governments' scientists' analysis of the ecological implications, risks and consequences of the draft Basin Plan. A key element of the South Australian Government's response to the Basin Plan was its strong scientific analysis of the MDBA's work to determine the volume of water necessary to achieve environmental water requirements for key environmental assets in South Australia based on the Goyder Institute advice. The work underpinned the South Australian Government's

Photo: Claire Punter

successful negotiation of the Basin Plan and $1.77 billion in additional funding to return 3200 gigalitres of water to the environment, and to remove constraints that impede delivery of that water.

E.2 Surface Water, Groundwater, Wetland Relationships

The South East is one of the major water resource domains in South Australia. The water resources have historically been managed as separate groundwater and surface water systems. Both systems emanate in western Victoria and flow regionally towards the coast or north westerly with surface water towards the Coorong and groundwater towards the Mallee and the River Murray. The surface water and groundwater systems are highly interconnected. Regional policy and resource management issues are the delivery of environmental water to wetland systems along the coast and to the upper South East through the South East drainage system and a revised management approach for the high value (low salinity) groundwater resources of the Lower South East.

Surface water flows are now able to be routed through the waterways and floodways from the lower south east to the upper south east wetlands and the Coorong to mimic the historic flow paths prior to the establishment of the drains in the lower south east. The Goyder Institute surface water - groundwater -, wetlands program is to support management of the water resources of the South East as a holistic system recognising the interconnection between surface water, groundwater and wetlands to maximise the economic and social benefits of the regional water resources and to provide adequate environmental water provisions to the regions wetland system, natural discharge processes and contributions to the Coorong.

Climate Change

This is a cross-cutting research theme to support the incorporation of climate adaption policy into the research outcomes from the urban water, environmental water and water for industry research themes.

C.1 Regional Climate Change Downscaling

Investment in this roadmap has been focused on downscaling climate projections for South Australia to provide an agreed set of climate projections for South Australia. The climate projections for each of the eight natural management regions will support proactive responses to climate change in water resource planning and management. They will be adopted as the agreed climate projections for the development of climate adaption policy by all State government agencies in areas such as health, agriculture and infrastructure planning. The climate projections will support the State Strategic Plan Goal; "*We adapt to the long term physical changes that climate change presents*" and implementation Target 62: Climate change adaptation, "*Develop regional climate change adaptation plans in all State Government regions by 2016*".

Water for Good indicates that climate change impacts (temperature increases and water inflow reductions) are expected to increase demand and reduce water supply in the Greater Adelaide region. Climate change can give rise to; greater variability and more extreme weather events; changing rainfall patterns; increased evaporation and less surface water runoff and recharge, and water quality impacts such as increased salinity and blue green algae blooms. Agriculture, natural ecosystems and water resources are likely to be significantly affected if rainfall declines. General increases in rainfall are only indicated for the northern regions of the state, which can be subject to monsoonal influences from northern Australia. In the southern agriculture areas annual rainfall is projected to decrease by up to 8 or 9 percent by 2030 and up to 25 or 30 percent by 2070.

Regional water demand and supply statements are being prepared to ensure that long-term solutions for each region are based on a thorough understanding of the state of local water resources, the demand for them and likely future pressures. Potential climate change impacts are a critical scenario affecting future water availability and will be incorporated in each of the regional demand and supply statements.

Photo: Claire Punter

Ongoing Direction - priority policy areas for future research

The 2013/14 Annual Research & Development Plan and Budget will detail the potential future investment in research activities over the remaining term of the Goyder Institute. Priority areas of investment will build further on the activities identified in each of the strategic themes / roadmaps.

In addition, some investment may be needed to support activities that integrate across themes and for targeted research and development advice projects that bring together existing pieces of information to support policy development and decision-making.

Science impact and the Murray Darling Basin Plan (science underpinning policy)

In December 2012, the Murray-Darling Basin Plan was signed into law. The Goyder Institute was involved with the analyses of the consequences of the Basin Plan from the early stages of its development. In the first instance, the Institute undertook a Science Review of The Guide to the Proposed Basin Plan that was released in October 2010. Upon release of the Proposed Basin Plan in November 2011, the South Australian Government sought advice from the Institute on the likely ecological consequences for South Australia of the proposed Plan. The Goyder Institute assembled an Expert Panel to provide (largely qualitative) advice based on interim reports of the South Australian Government evaluation of the proposed water recovery scenario. In finalising the Basin Plan, the Murray-Darling Basin Authority (MDBA) undertook modelling of additional water recovery scenarios. The Government comparative analysis of these additional scenarios was peer reviewed by experts from the Goyder Institute. The independent role of the Goyder Institute in analysing and reviewing the Basin Plan documents released for consultation has evolved steadily over time, from undertaking the scientific assessments itself, to providing expertise to support the State Government assessments and then, finally, in a role as peer reviewer.

Science Review of the Guide to the Basin Plan

When the Guide to the Basin Plan was released in October 2010, the South Australian Government did not have the resources available to undertake a scientifically defensible review of the Guide within the time available. They commissioned a science review of the Guide to the Basin Plan through the Goyder Institute to determine whether the proposed sustainable diversion limits would meet the South Australian Government's environmental water requirements and improve or maintain water quality consistent with the Murray-Darling Basin Authority targets, as well as to assess the socioeconomic implications of reductions in diversion limits to the major water users within South Australia.

The analyses and associated tools applied in this review provided new insights into the development of uniform and transparent techniques and methodologies that could be used to help analyse environmental and socioeconomic aspects of the Plan by the South Australian Government. During this analysis a number of benefits and risks were identified and documented and provided scientific input into the South Australian Government's consideration of the relative merits of each water recovery scenario.

Photo: Michele Akeroyd

The Draft Basin Plan

When the Draft Basin Plan was released for public consultation on the 25th November 2011, the South Australian Government was itself in a position to evaluate the consequences of the proposed water recovery scenario, but in the interests of sound governance and quality assurance, the Goyder Institute was sought to provide expert judgement about the adequacy of the methods used by the South Australian Government in their evaluation of the Draft Basin Plan water recovery scenario of 2750 GL. The Institute was also to provide advice about any perceived limitations in the Plan development and to identify the ecological benefits, risks and opportunities of the proposed water recovery scenario.

In response to the breadth of knowledge and the short timeframes required to undertake this evaluation, the Goyder Institute established an Expert Panel comprising experts in the areas of riverine, floodplain and estuarine ecology from its partner institutions. Overall, the Expert Panel found that there were important benefits identified under the Draft Basin Plan water recovery scenario of 2750 GL, in particular increases in within-channel variations to stream flows that increased the flooding frequency and duration of low-elevation wetlands, and some improvement in the connectivity between the Lower Lakes and Coorong. However, for much of the medium to high elevations of the floodplains that require medium to high flows, the environmental water requirements were not met. In addition, the Coorong, Lower Lakes and Murray Mouth Ramsar site remained at risk from low water levels and high salinities during dry periods.

The Expert Panel concluded that the ecological character of the South Australian environmental assets, as defined in current water management plans, were unlikely to be maintained under the Draft Basin Plan water recovery scenario of 2750 GL and recommended that the following issues should be taken into consideration in the finalisation of the Basin Plan:

- Modelling of a wider range of possible water scenarios, including additional volumes of water for the environment and scenarios with relaxed operational and physical channel-capacity constraints;
- Interventions to rehabilitate currently degraded assets to reduce the risk that the desired ecological character will continue to deteriorate prior to full compliance with Sustainable Diversion Limits;
- Management of drought recovery of degraded assets following prolonged periods of low flows;
- Articulation of Environmental Water Requirements specific for the main channel; and
- Climate change impacts on the water recovery scenarios.

During 2012, as part of the finalisation process of the Basin Plan, the Murray-Darling Basin Authority undertook additional analyses of some supplementary water recovery scenarios, including additional volumes of water and relaxing of some key constraints, as recommended by the Goyder Institute Expert Panel. Following the modelling of additional water recovery scenarios by the Murray Darling Basin Authority, a detailed evaluation of the model outputs was undertaken by SA Government scientists, and peer-reviewed by the Goyder Institute.

Both the South Australian Government and Murray-Darling Basin Authority analyses demonstrated that there were marked ecological improvements evident with 3200 GL compared to the 2750 GL scenario. Following the outcomes of these analyses, the Basin Plan was revised to include a water recovery scenario of 3200 GL and a program to relax key constraints in water delivery was established. The final Basin Plan was underpinned by the outcomes of the South Australian science reviews and analyses.

The Murray-Darling Basin plan process is an example of how a knowledge institute like the Goyder Institute can be effective and efficient in providing defensible science into policy considerations and decision making by governments. The return on investment from the State Government investment in the Goyder Institute has been significant. For example, the science outcomes from the Goyder Institute Basin Plan analysis alone has been fundamental in securing Federal funding of $1.77 billion to support recovery and management of the additional 450 GL agreed to in the Basin Plan to meet South Australian Environmental Water requirements, and $265 million for the River Murray Improvement Program in partnership with the Water Industry Alliance.

Photo: Claire Punter

External Engagement

To further improve the collaborative approach to science and policy integration in Goyder Institute projects and to assist in capacity building within stakeholder agencies, regular workshops, conferences and other forums between scientists, policy-makers and other stakeholders have been organised by the Goyder Institute Office during 2012/13, in consultation with the project teams. Part of the annual budget is targeted towards activities that facilitate knowledge management and stakeholder engagement. During 2012/13 these activities have included capacity building workshops; the Annual Goyder Institute Water Forum; networking and team-building activities; support to visiting fellows; sponsorship of conferences and symposia; and scoping of the knowledge encapsulation requirements for project outcomes - a few specific examples follow.

Science Retreat

The Goyder Institute held its Science Retreat on the 3rd and 4th of June 2013 at Victor Harbor. The retreat was attended by representatives from each of the Goyder Institute partners and associates, which included members from all research projects and the Research Advisory Committee and Management Board. The purpose of the retreat was to share the science findings to date and to further develop team collaborations and working styles.

The project presentations from each Goyder Institute project were informative and for the first time built a picture of the package of research being delivered to meet the outcomes of each Goyder Institute Theme and Roadmap. The other focus of the Science Retreat was related to advancing our teamwork skills to improve collaborative effectiveness.

Feedback indicated that participants found the science retreat very rewarding and believed it encouraged networking and better relationships with collaborators, helped to develop a better understanding of the breadth/diversity of the Goyder Institute projects, fostered deeper self awareness (*through the Belbin surveys and analysis*), encouraged a greater acceptance that people are individuals and operate differently in their work and communication styles whilst acknowledging that these differences can create a better team (and outcomes) depending on the specific roles of the individuals. All those who attended the Science Retreat felt that these outcomes would translate into a more enjoyable and fulfilling working environment for the Goyder Institute research teams and encouraged each of us to 'Own the Goals'.

PhD Forum

The Goyder Institute held a forum specific to its PhD program recipients on the 17th May 2013 at the Centre for Professional and Continuing Education at The University of Adelaide. The purpose of the Forum was to provide an opportunity for the Goyder Institute PhD researchers to meet with stakeholders to showcase their research and to promote networks and linkages. The Forum showcased the high quality of the Goyder Institute PhD students and the breadth of the research issues covering the full range of Goyder Institute interests. Opportunities to strengthen the linkages between the Goyder Institute PhD Students and stakeholders will continue to be explored in 2013/14.

Photos this page: Churchhill Photography

Water Industry Alliance

At an "Industry Night" in April 2013, Goyder Institute Director, Dr Tony Minns, gave a presentation describing how the Goyder Institute research program has been planned and established to produce the scientific outcomes to underpin policy, and he went on to describe the results and outcomes of some of the current Roadmaps projects (i.e. investments to date/progress report).

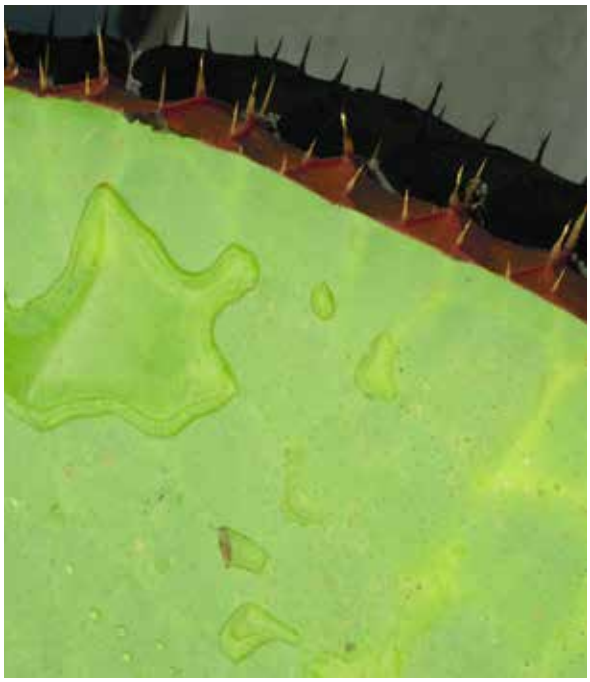


Photo: Claire Punter

AWA SA Branch Conference: Way Out Water

On the 17th August 2012, the AWA SA Branch Conference brought together members of the water industry from around the state to discuss emerging trends and current challenges being addressed in South Australia. The 2012 conference had the theme *Way Out Water - Beyond the City and Into the Future*. It included topics such as remote, regional and mining water management, energy neutrality, resource recovery, innovative water technologies, and emerging developments in water management for cities of the future.

The Goyder Institute was a Bronze sponsor of this event with Dr Tony Minns as a Keynote Speaker on the role of the Goyder Institute in supporting evidence based decision making in South Australia and Neil Power presented a plenary paper on the G-FLOWS initiative.

Australian Water Research and Development Coalition

The Australian Water Research & Development Coalition (AWRDC) was launched at OzWater2012 to support a more cooperative and coordinated approach to national urban water R&D investment. The AWRDC comprises industry, State and Commonwealth funded organisations that broker and invest in urban water R&D in a broad range of research areas including drinking water; recycled water; stormwater; desalination; groundwater; wastewater; water quality; public health; smart cities; infrastructure; climate and energy; policy and regulation; technology; and consumer insights. More information on the AWRDC can be found at www.awrdc.org.au

Over the past year, the AWRDC has been working to ensure that Australia's investment in urban water R&D is coordinated and optimised. A key focus has been on data and knowledge management, and the Goyder Institute has been instrumental in leading the way for national data for urban water. The AWRDC is partnering with the Australian National Data Service (ANDS) to implement appropriate solutions that will ensure the ongoing access to water research data, information and knowledge generated from R&D investments. An urban water portal has been created and processes have been developed to ensure that data is added to the Australian Government's Research Data Australia metadata store with consistent metadata identifiers. The Goyder Institute for Water Research is the focus of one of the pilot projects that is currently being undertaken. Further information can be found at:

researchdata.ands.org.au/urban-water-national-collection

and

researchdata.ands.org.au/goyder-institute-for-water-research

AWRDC

Governance

Management Board

The Management Board meets quarterly to set the strategic vision and direction for the Goyder Institute and to monitor its implementation and outcomes. The Board reviewed and approved annual research programs and budgets, and monitored the effective delivery of the research projects.

The Board comprises an Independent Chair, the Director of the Goyder Institute, two representatives from CSIRO, two representatives from the State Government, and one representative from Flinders University, the University of Adelaide and the University of South Australia.

The members of the Goyder Institute Management Board from July 2012 until June 2013 were:

Ian Chessell
Independent Chair

Tim Goodes
Group Executive Director, Strategy & Advice, DEWNR

Jim Hallion
Chief Executive, DP&C

Bill Young
Director, WfHC Flagship, CSIRO

Scott Keyworth
Manager Research Adoption, WfHC Flagship, CSIRO

Tony Minns
Director, Goyder Institute for Water Research

David Day
DVC (Research), Flinders University

Bob Hill
Executive Dean, Faculty of Sciences, University of Adelaide

Sakkie Pretorius
DVC (Research & Innovation), UniSA
Ceased Feb 2013

Richard Head
DVC (Research and Innovation), UniSA
Commenced Mar 2013

Research Advisory Committee

The RAC met six times in 2012-13 to advise the Management Board on progress, milestones and implementation of Goyder Institute research activities, and to consider the strategic direction for the research projects into the next years of the Institute. It reviewed and approved several reports for inclusion in the Technical Report Series and formulated recommendations to the Board regarding the direction, content and quality of project plans, and expressions of interest for various research activities proposed by the Goyder Institute research partners.

The RAC is chaired by the Goyder Institute Director and comprises a research coordinator from each research partner, up to two representatives from agencies as determined by the State, a representative of SARDI, a representative of the SA Water, and up to three specialists as agreed by the Management Board.

The members of the RAC from July 2012 until June 2013 were:

Chair: Tony Minns
Director,
Goyder Institute for Water Research

Mike Burch
Manager,
Research &
Innovation,
SA Water

Jim Cox
Principal Scientist,
Water Resources
and Irrigated Crops,
SARDI

Ian Prosser
Science Director,
WfHC Flagship,
CSIRO

Sandy Carruthers
Director,
Science, Monitoring
and Knowledge,
DEWNR

Chris Saint
Director,
SA Water Centre for
Water Management
and Reuse,
UniSA

Justin Brookes
Director,
Water Research
Centre,
University of
Adelaide

Neil Power
Director,
State Research
Coordination,
DEWNR

Peter Cook
Deputy Director,
NCGRT,
Flinders University

Financial Report

Research Program

The 2012/13 financial year completes the third year of the Goyder Institute for Water Research. To date, the South Australian Government has committed $15.97M cash to research projects with in-kind commitments totalling $16.54M to be provided by the research partners. This brings the collective life-to-date committed investment across all approved research projects to $32.51M.

Research Projects

The commencement and consolidation phase of the Institute in years one and two have now seen it mature in its third year. Whole of life actual expenses of $17.77M compare with a budget of $19.31M leaving a variance of $1.54M. The underspend is generally caused by slow starts to a number of projects following delayed contract completion, which impacts the ability to effort log. Research cash payments in 2012-13 totalled $4.90M which included initial payments for new projects, scheduled milestone payments and delayed milestone payments from the previous financial year.

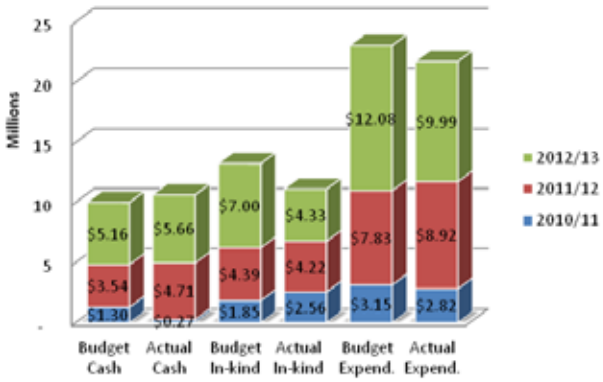
Administration Program

Total actual expenditure in 2012-13 was $0.87M compared to a budget of $1.0M. The bulk of the underspend being in the salary area where more leave was taken than planned (compensating for last year where less leave was taken) as well as some minor decreases in FTE numbers. Similarly to last year, the administration program is tracking very close to budget on a whole of life basis.

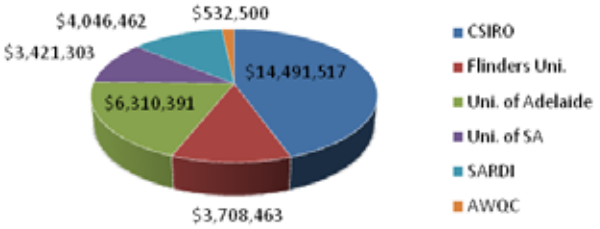
Alliance Trust Account

The closing balance of the Trust account at 30 June 2013 was $5,000,122. During the course of the year, the Trust received $5,000,000 in cash from the State and $216,569 in interest. The Trust paid CSIRO $628,715 for Administration and Knowledge Management expenses (excludes Directors salary) and paid $5,153,584 to the research participants which includes PhD supplements of $255K.

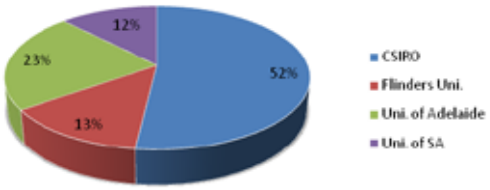
Overall Budget by Year

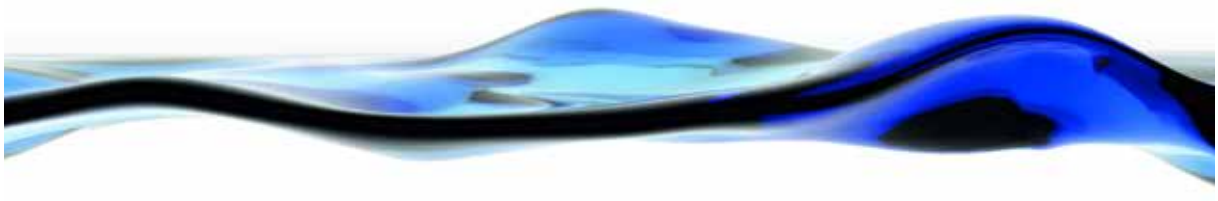


Whole-of-Life Research Allocation - all Participants



Whole-of-Life Research Allocation - Partners





Key Project Achievements

Again 2012/13 has been a productive year for the Goyder Institute with more important projects completed and the ongoing delivery of significant pieces of work (some still in their infancy). Key project achievements include:

Climate Change Theme: Program C.1 Regional Climate Change Downscaling	
C.1.1. Downscaled Climate Projections for SA Development of an agreed set of downscaled climate projections for South Australia.	**Key Achievements:** The varying influence of climate drivers on rainfall across the eight SA NRM regions has been published in a leading scientific journal and a preliminary set of downscaled climate projections has been produced for the Onkaparinga test case catchment. A suite of diagnostic tools have been developed that not only measure model performance but also provide an indication of possible actions which can be taken to remedy model weaknesses. The project has also produced a number of peer reviewed journal publications, including an article in Nature and an invited paper in a book commissioned by the International Water Association on climate change impacts.
Urban Water Theme: Program U.1 Water Sensitive Urban Design	
U.1.2 WSUD Impediments and Opportunities Identify and address impediments and constraints as well as identify opportunities and enabling mechanisms to facilitate the strategic uptake of WSUD in the State, with a focus on local capacity building and cost of living.	**Key Achievements:** Interim reports have been produced on an inventory of WSUD activities in SA, the social acceptance of WSUD, and a methodology for investigating WSUD potential in SA.
Urban Water Theme: Program U.2 Water Resources Mix for Adelaide	
U.2.1 MARSUO Investigating managed aquifer recharge and stormwater use options for Adelaide.	**Key Achievements:** The catchment risk assessment approach developed in MARSUO has been adopted by Water Proofing the South and Water Proofing the West projects, and National Guidelines are being developed for Managed Aquifer Recharge with the National Water Commission.
U.2.2 Optimal Water Resource Mix Supporting integrated water management for Metropolitan Adelaide.	**Key Achievements:** A draft technical report has been produced summarising capital and operating costs of, and greenhouse gas emissions from, all major sources of water. Installation of 150 smart meters in households has been completed with follow-up attitudinal/behavioural surveys underway. A draft technical report has been prepared that has reviewed the institutional arrangements for implementing a portfolio of supply sources in Australian cities as well as international practices Collaboration across research partners and Government agencies has been critical in achieving the goals of this project, in particular the contributions from DEWNR, SA Water and the EPA.
U.2.3 Water Governance Assessment Identify options for improved water governance in managing the complexity of diversified supply.	**Key Achievements:** The legal and governance options and risks of the scenarios identified in the development of the proposed Urban Water Blueprint are being assessed to inform decision making around the selection of models and implementation approaches.

Photo: Claire Punter

Water for Industry Theme: Program I.1 Water Allocation Planning and Water Quality Improvement	
I.1.1 AMLR WAP Scoping Identify high priority R&D needs to support water allocation planning.	**Key Achievements:** The project has provided a review and evaluation of components of the WAP framework including the establishment of relationships between hydrology and ecological expression, a process to determine the effectiveness of returning low flows for environmental watering, and the notion of a library of metrics to support future WAPs across the state. It also assessed surface water-groundwater interaction models that may help in the WAP process in SA, and it explored opportunities for new areas of research such as hydro-economic modelling (i.e. transparently balancing social, economic and environmental needs for water).
I.1.2 Torrens River Water Quality Improvement Trial Determining the feasibility of an 'amenity flow' for the Torrens Lake to reduce or eliminate algal blooms.	**Key Achievements:** The use of flows to control cyanobacterial growth shows promise as an event management technique to control the growth of cyanobacterial biomass. This is supported by both the modelling of growth and dilution and the results of this first field trial.
I.1.3 Recycled Water and Salinity Demonstrating the economic and environmental value of water recycling to Australia's agri-food industry.	**Key Achievements:** Rainfall redirection treatments have been established at the grape site at McLaren Vale and year one plant samples have been collected. Analysis of these samples is ongoing.
I.1.4 AMLR WAP Program Refine the understanding of environmental water needs, patterns of flow and water quality within the Mount Lofty Ranges.	**Key Achievements:** Baseline environmental monitoring has been completed and installation of instrumentation to undertake full monitoring (flow, veg and macroinvertebrates) has been completed and full monitoring is now underway. The modelling framework has been developed and the background databases on water quality in the Mount Lofty Ranges has been collated.
I.1.5 Torrens Lake Dilution Flow Trial for Summer 2012/13 A second trial to further examine the feasibility of an 'amenity flow' for the Torrens Lake to manage algal blooms.	**Key Achievements:** The final report of the second trial is being prepared to inform any future decision making regarding the provision of amenity flows to manage algal blooms in the Torrens Lake.
I.1.6 Adelaide Plains Groundwater Assessment Assessment of the Adelaide Plains groundwater resources.	**Key Achievements:** Starting to provide an understanding on issues such as flow across faults and leakage between aquifer and seawater intrusion that can inform our assessment of the Adelaide Plains region groundwater resources.
Water for Industry Theme: Program I.2 Mining and Outback Water	
I.2.1 G-FLOWS - Phase 1 Facilitating long-term outback water supplies.	**Key Achievements:** Development of a new hydrogeological framework for the Musgrave province which combines and interprets multiple datasets from industry and government to help target finer-scale assessment of groundwater resources. It has provided a summary of existing and ongoing social/cultural/ecological research relating to water in the arid-zone of Australia.
Environmental Water Theme: Program E.1 River Murray	
E.1.3 Murray Flood Ecology Ecological responses to flooding in the Lower River Murray following drought.	**Key Achievements:** Technical reports have been completed and approved for publication. Some key findings of the research investigations include: • The river requires flooding to transfer nutrients into and along the River channel. Floods improve longitudinal and lateral connectivity, facilitate natural processes, and lead to a more diverse and interesting River. Artificially inundating the floodplain during a period of low flow, although required at times, will not serve the complete ecological function of a natural flood. Low flows are also important for some species that thrive under these conditions. • Recognising that some species may have a lag in response time is essential for accurately and effectively quantifying and understanding the processes involved in riverine ecology. • It is very important to recognise the origin of the water. Water from different sources will have different biological and chemical characteristics that will have different effects on the ecosystem response to watering events. • Floodplains provide a valuable service to the health of the river: as a food source, and a source of propagules to repopulate populations from areas where they have disappeared.

E 1.5 River Murray Scoping Study Identify research priorities in the broad area of River Murray flows and environmental flow management in South Australia.	**Key Achievements:** Research gaps within the River Murray Road Map have been identified with the provision of expert advice regarding the options available to address these gaps.
E.1.6 Peer Review of the SA Government Analysis of the Murray Darling Basin Plan An independent peer review of the additional model scenarios for the proposed Basin Plan.	**Key Achievements:** The South Australian Science Team (in DEWNR) was able to rapidly extend the modelling done by the MDBA to show and communicate the ecological benefits to the South Australian River Murray floodplains and CLLMM region within very short timelines. The outcomes of the Peer Review were directly relevant to policy makers within the State Government in supporting the states position on environmental water to support ecological objectives.
E.1.7 River Murray Program Conceptualise the current understanding of the ecological and cultural response to flow for the entire SA MDB and use this information to build a decision framework for decision making.	**Key Achievements:** In development.
E.1.8 Riverbank Collapse Understanding riverbank collapse to inform management.	**Key Achievements:** Supporting DEWNR in developing a long-term management strategy for riverbank collapse and identify changes that are required to development planning guidelines and legislation to reduce the likelihood of future risks associated with riverbank collapse events.
E.1.9 In-Channel EWRs Development of ecological objectives and ecological targets for the River Murray in-channel functions and assets.	**Key Achievements:** Information being generated is feeding directly into the first draft of the SA River Murray LTWP which in turn will facilitate the development of the state's annual environmental water plan.
E.1.10 SDL Adjustment Mechanism Science review of the benefits and risks of the adjustment methodology for South Australian ecosystems.	**Key Achievements:** Experts from the Goyder Institute for Water Research have been engaged to provide eco-hydrology advice on the development of the ecological elements of the SDL adjustment method.
Environmental Water Theme: Program E.2 Surface Water, Groundwater, Wetland Relationships	
E.2.3 Regional Groundwater Balance Development of a framework for a regional groundwater flow model for the Lower Limestone Coast region.	**Key Achievements:** Important datasets have been collated including historical land use time series and hydrogeological data related to geological faults, and methods to quantify submarine discharge have been tested.
E.2.4. Improved Modelling of Catchments and Drains Improving the ability to estimate flow volumes of drains in the SE drainage network.	**Key Achievements:** Initial results of the statistical modelling component of this project indicate that novel inputs including remotely sensed soil moisture and modelled rainfall forecasts provide valuable information for forecasting flows in the upcoming month.
E.2.5 Wetlands in SE Understanding the response of wetland ecosystems in the South East to changes in water quality and salinity.	**Key Achievements:** A number of activities have now commenced, including stakeholder engagement, identification of sources of data and literature with some preliminary analysis already undertaken.

Photo: Claire Punter

PhD Support

The Goyder Institute awards PhD Supplements to outstanding PhD candidates from each of the University partners. Eight supplements commenced in 2011, nine in 2012 and eight were awarded in 2013.

PhD Students	Title	Road Map	Candidature
ADELAIDE UNIVERSITY			
Chris Stokes	Methods for the Reduction of Greenhouse Gas Emissions Associated with Water Distribution Systems	U2 Water Mix	2011 to 2014
Eva Beh	Optimal Sequencing of Water Supply Options at the Regional Scale Incorporating Sustainability and Uncertainty	U2 Water Mix	2010 to 2013
Michael Di Matteo	Multi-objective decision analysis for blending of urban water resources for potable and non-potable water supply	U2 Water Mix	2012 to 2015
Deborah Furst	The Chowilla Floodplain: The influence of water regime on the development and transport of zooplankton and the implications for native fish	E1 Murray	2010 to 2013
Chaturangi Wickramaratne	Synergistic effects of nutrients and climate change on cyanobacteria	I.1 WAP & WQ	2012 to 2015
Kayla Gilmore	Hypoxia in the Murray River region: identifying impacts to fish and tracking long-term trends	E1 Murray	2013 to 2016
Sanjina Upadhyay	Flow and nutritional resources: does DOC or phytoplankton productivity drive food webs in the Lower River Murray?	E1 Murray	2013 to 2016
FLINDERS UNIVERSITY			
Jessica Liggett	An analysis of surface-subsurface exchange and solute transport processes in a fully integrated code	E2 Wetlands	2010 to 2013
Saskia Noorduijn	Quantifying surface water-groundwater fluxes in a heterogeneous environment	E2 Wetlands	2010 to 2013
Megan Sebben	Numerical modelling of ephemeral, transient wetland systems using a fully integrated code	E2 Wetlands	2012 to 2015
Kelly Wiltshire	Connection and Continuity - Investigating Ngarrindjeri history and life ways of Waltowa Wetland	E1 Murray	2010 to 2014
Harriet Whiley	Detection of opportunistic intracellular pathogens in potable and reuse water	U2 Water Mix	2011 to 2014
Matthew Knowling	Effect of climate change and groundwater management approaches on the Uley South Basin, Eyre Peninsula	I2 Outback	2012 to 2015
Robert Andrew	Natural and managed hydrological changes and the implications for urban planning and water management	U1 WSUD	2013 to 2016
Saeedeh Gharib Choobary	Land surface and atmosphere interactions in selected environments with emphasis on the temperature effects	C1 Climate	2012 to 2015
UNIVERSITY OF SOUTH AUSTRALIA			
Mostafa Razzaghmanesh	Climate change and stormwater quality effects from green roof design in Adelaide	U1 WSUD	2011 to 2014
Hamideh Nouri	Precision Irrigation of the Adelaide Parklands with Recycled Wastewater	U1 WSUD	2010 to 2013
Kelly Hill	Development of low-clogging permeable pavements suitable for harvesting and reusing stormwater runoff from roads, car parks and industrial areas	U1 WSUD	2012 to 2015
Sina Alaghmand	A conceptual model to capture salinity risks from the River Murray floodplains	E1 Murray	2011 to 2013
Sithara Gamage	Probabilistic nature of hydrologic losses in South Australian forest catchments	E2 Wetlands	2010 to 2013
Mamunur Rashid	Assessment of climate change impacts on the spatial variability of rainfall and its influence on runoff generation	C1 Climate	2012 to 2015
Alaa Ahmed	Hydrogeology of fractured rock aquifers in the Central Flinders Ranges, SA	I2 Outback	2012 to 2015
Niranjani Premila Semananda	Experimental investigation into performance of capillary subsurface irrigation of container gardens using recycled water	U1 WSUD	2012 to 2016
Shiv Umapathi	Integrated water consumption characteristics through real-time monitoring and ongoing community engagement at a new development that is representative of future residential living	U1 WSUD	2012 to 2015
Jonathan Cohen	Impacts of catchment conditions, climate and seasonality on water quality	I.1 WAP & WQ	2013 to 2016

Publications

Publications are one important component of documenting the project outcomes and activities of the Goyder Institute. In 2012/13 a number of Goyder Institute Technical Reports, journal papers and other articles were published providing details of the quality research being undertaken by the Institute. These publications are listed below and further details can be found on the Goyder Institute website at www.goyderinstitute.org

Technical Report Series

E.2.2 South East – Phase 1

- Gibbs MS, Maier HR and Dandy GC (2012) Development of Decision Support Frameworks for Water Resource Management in the South East. Goyder Institute for Water Research Technical Report Series **No. 12/3**. Adelaide, South Australia. ISSN: 1839-2725.

I.1.2 River Torrens Water Quality Improvement Trial

- Brookes JD (ed) (2012) River Torrens Water Quality Improvement Trial - Summer 2011/12. Goyder Institute for Water Research Technical Report Series **No. 12/4**. Adelaide, South Australia. ISSN: 1839-2725.

E.1.3 Murray Flood Ecology

- Aldridge K, Lorenz Z, Oliver R, Brookes J (2012) Changes in water quality and phytoplankton communities in the Lower River Murray in response to a low flow-high flow sequence. Goyder Institute for Water Research Technical Report Series **No. 12/5**. Adelaide, South Australia. ISSN: 1839-2725.

- Cheshire K, Ye Q, Wilson P, Bucater L (2012) From Drought to Flood: Annual variation in larval fish assemblages in a heavily regulated lowland river. Goyder Institute for Water Research Technical Report Series **No. 12/6**. Adelaide, South Australia. ISSN: 1839-2725.

- Oliver R and Lorenz Z (2013) Floodplain influences on metabolic activity in the South Australian section of the Murray River during the 2010/11 flood. Goyder Institute for Water Research Technical Report Series **No. 13/1**. Adelaide, South Australia. ISSN: 1839-2725.

- Holland KL, Turnadge CJ, Nicol JM, Gehrig SL and Strawbridge AD. (2013) Floodplain response and recovery: comparison between natural and artificial floods, Goyder Institute for Water Research Technical Report Series **No. 13/4**. Adelaide, South Australia. ISSN: 1839-2725.

- Nicol JM, Gehrig SL, Frahn KA and Strawbridge AD (2013) Resilience and resistance of aquatic plant communities downstream of Lock 1 in the Murray River. Goyder Institute for Water Research, Technical Report Series **No. 13/5**. Adelaide, South Australia. ISSN: 1839-2725.

E.1.4 Expert Panel MDB Plan Review

- Lester RE, Fairweather PG and Hamilton BM (2013) Assessing the impact of volumes proposed under the Draft Basin Plan on the Coorong and Murray Mouth region, Goyder Institute for Water Research Technical Report Series **No. 13/2**. Adelaide, South Australia. ISSN: 1839-2725.

U.2.1 Managed Aquifer Recharge and Stormwater Reuse Options (MARSUO)

- Myers, B., Pezzaniti, D. & Gonzalez, D. (2013) Hydrological modelling of the Parafield and Cobbler Creek catchment for hazard analysis planning, Goyder Institute for Water Research Technical Report Series **No. 13/3**. Adelaide, South Australia. ISSN: 1839-2725.

I.2.1 G-FLOWS – Stage 1

- Macdonald JI and McNeil DG (2012) Environmental and cultural values of South Australia's outback water resources. Goyder Institute for Water Research Technical Report Series **No. 12/7**. Adelaide, South Australia. ISSN: 1839-2725.

- Varma S (2012) Hydrogeological review of the Musgrave Province, South Australia. Goyder Institute for Water Research Technical Report Series **No. 12/8**. Adelaide, South Australia. ISSN: 1839-2725.

- Leaney, FW, Taylor, AR, Jolly, ID, and Davies PJ (2013) Facilitating Long Term Outback Water Solutions (G-FLOWS) Task 6: Groundwater recharge characteristics across key priority areas, Goyder Institute for Water Research Technical Report Series **No. 13/6**. Adelaide, South Australia. ISSN: 1839-2725.

- Ley-Cooper, AY and Munday, TJ (2013) Groundwater assessment and aquifer characterizarion in Musgrave Province, South Australia: Interpretation of SPECTREM Airborne Electromagnetic Data, Goyder Institute for Water Research Technical Report Series **No. 13/7**. Adelaide, South Australia. ISSN: 1839-2725

I.1.1 AMLR WAP Scoping Study

- Cox J, Bald M, Burch M, Chittleborough D, Cuddy S, Deane D, Fleming N, Frizenschaf J, Green G, Halfyard R, Holland K, Kookana R, Lomman G, Oliver D, Rassam D, Saint C, Savadamuthu K, Skewes M, van der Wielen M, VanLaarhoven J, van Leeuwen J. (2013) Water allocation planning and water quality improvement scoping study – Discussion paper, Goyder Institute for Water Research Technical Report Series **No. 13/8**. Adelaide, South Australia. ISSN: 1839-2725.

Journal Papers

Alaghmand, S., Beecham, S. and Hassanli, A. (2013), A Review of the Numerical Modelling of Salt Mobilization from Groundwater-Surface Water Interactions, Water Resources, Springer, 40(3), pp325-339.

Beecham, S. and Chowdhury, R. (2012), Effects of Changing Rainfall Patterns on WSUD in Australia, Journal of Water Management, Institution of Civil Engineers UK, 165(5), pp285-298.

Cai, W., T. Cowan, and M. Thatcher (2012) Rainfall reductions over Southern Hemisphere semi-arid regions: the role of subtropical dry zone expansion, Scientific Reports, 2, 702; DOI:10.1038/srep00702.

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Chowdhury, R. and Beecham, S. (2013), Influence of SOI, DMI and Niño3.4 on South Australian Rainfall, Stochastic Environmental Research and Risk Assessment, Springer, doi:10.1007/s00477-013-0726-x

Chowdhury, R. and Beecham, S. (2013), Characterisation of Rainfall Spells for Urban Water Management, International Journal of Climatology, Royal Meteorological Society, Wiley, 33(4), pp959-967.

Gamage, S. H. P. W., Hewa, G. A. and Beecham, S. (2013), Probability Distributions for Explaining Hydrological Losses in South Australian Catchments, Hydrology and Earth System Sciences Discussions, European Geosciences Union, 10(4), pp4597-4626.

Gibbs, MS, Maier, HR, Dandy, GR and Thyer, MA (2012) Is there potential to inform time varying conceptual rainfall runoff model parameters using groundwater data? Hydrology and Water Resources Symposium, Engineers Australia, Sydney.

Kamruzzaman, M., Beecham, S. and Metcalfe, A. V. (2013), Climatic Influences on Rainfall and Runoff Variability in the South-East Region of the Murray Darling Basin, International Journal of Climatology, Royal Meteorological Society, 33(2), pp291-311.

Leigh, S. J. and Zampatti, B. P. (2013) Movement and mortality of Murray cod (Maccullochella peelii) during overbank flows in the lower River Murray, Australia. Australian Journal of Zoology. http://dx.doi.org/10.1071/ZO12124

Liang, C., Jaksa, M. B., Ostendorf, B. (2012). GIS-based Back Analysis of Riverbank Instability in the Lower River Murray. Australian Geomechanics, **47**(4): 59–65.

Miotlinski, K., Dillon, PJ, Barry, KE, Kremer, S. and Pavelic, P. (2013). Recovery of injected freshwater from a brackish aquifer with a multi-well system. Ground Water 06/2013; DOI:10.1111/gwat.12089.

Nouri, H., Beecham, S. Kazemi, F. and Hassanli, A. (2013), A Review of ET Measurement Techniques for Estimating the Water Requirements of Urban Landscape Vegetation, Urban Water, Taylor and Francis, 10(4), pp247-259.

Page, D., Gonzalez, D. and Dillon, P. (2012). Microbiological risks of recycling urban stormwater via aquifers. Water Sci. Tech. 65(9) 1692-5.

Shareef, A., Page, D., Vanderzalm, J., Williams, M., Vadakattu, G., Dillon, P. and Kookana, R. (in press). Biodegradation of two herbicides simazine and diuron during managed aquifer recharge of stormwater. CLEAN-Soil, Air, Water (accepted 2013).

Vanderzalm, J.L., Dillon, P.J., Hancock, G.J., Leslie, C., Dighton, J., Smith, C., Pearce, G. (2013). Using elemental profiles in the sediment of a drinking water supply lake to understand the impacts of urban stormwater recharge. Marine and Freshwater Research, 64(6) 493 – 506.

Vanderzalm, J.L., Page, D.W., Barry, K.E. and Dillon, P.J. (2013), Application of a probabilistic modelling approach for evaluation of nitrogen, phosphorus and organic carbon removal efficiency during four successive cycles of aquifer storage and recovery (ASR) in an anoxic carbonate aquifer. Water Research, 47(7), 2177-2189, http://dx.doi.org/10.1016/j.watres.2013.01.038.

Weller, E. and Cai, W. (2013) Asymmetry in the IOD and ENSO teleconnection in a CMIP5 model ensemble and it relevance to regional rainfall, J. Climate, 26, 5139-5149.

Westra, S. M. Thyer, M. Leonard, D. Kavetski and M. (2012), "Diagnosing non-stationary behaviour in a hydrological model" Hydrology and Water Resources Symposium, Engineers Australia, Sydney.

Zampatti, B. and Leigh, S. (2013) Effects of flooding on recruitment and abundance of Golden Perch (Macquaria ambigua ambigua) in the lower River Murray. Ecological Management and Restoration 14: 135–143. doi: 10.1111/emr.12050.

Other Publications

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Akeroyd, M and Minns, T, 2013, The Murray-Darling Basin Plan: a case study, Water Journal of Australian Water Association, Vol. 40, No. 3, May 2013, 35-39.

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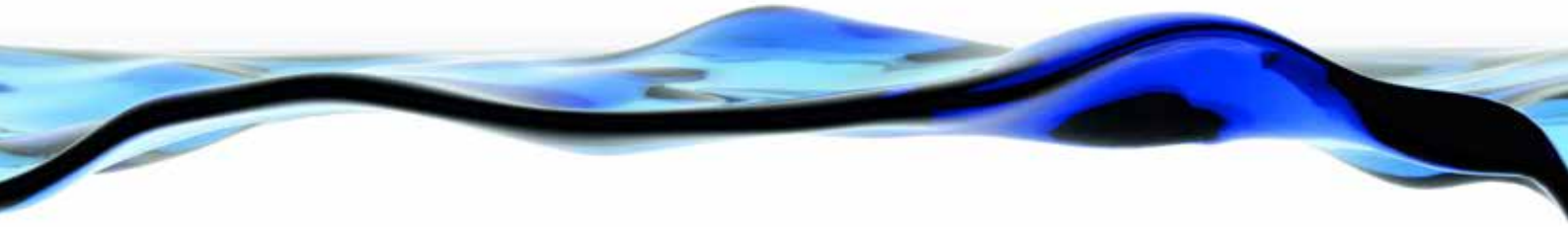

Government of South Australia
Department of Environment, Water and Natural Resources

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The Goyder Institute for Water Research is a partnership between the South Australian Government through the Department of Environment, Water and Natural Resources, CSIRO, Flinders University, the University of Adelaide and the University of South Australia.