AUSTRALIA INDIA INSTITUTE

WATER AND FOOD SECURITY IN AUSTRALIA AND INDIA: KEY ISSUES, CHALLENGES AND OPPORTUNITIES FOR COLLABORATION

Summary report of the research collaboration workshops held in partnership with the Australia India Institute, Australia India Water Centre and ARCH-India

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Australia India Institute
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ACKOWLEDGEMENT OF COUNTRY

Australia India Institute acknowledges the Traditional Owners of Country throughout Australia and recognises the continuing connection to lands, waters and communities. We pay our respect to Aboriginal and Torres Strait Islander cultures, and to Elders past, present and emerging.

NOTE

The Australia India Policy and Technical Exchange Program in Water workshop series (the workshops) was the first in a series of four virtual Australia India Research Collaboration Workshops that the Australia India Institute (AII) is delivering under a contract with the Department of Education. The workshops focus on topics of mutual benefit highlighted during the fifth Australia-India Education Council (AIEC) meeting in 2019, when the education ministers of both countries agreed to deepen research collaboration. The four workshop topics are: water, soil and food security, the future of healthcare, environmental change and energy frontiers and digital humanities and intelligent futures.

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FOREWORD

Australia and India, each with diverse landscapes and climates, share a common understanding of the crucial need for sustainable water management. As we confront challenges like water scarcity, pollution, and climate change, our commitment to collaborative research deepens. The joint efforts of both nations in addressing these complex challenges reflects a partnership grounded not only in scientific exploration but also in a shared ethos.

This report is the culmination of a series of workshops focused on water security in Australia and India. Delivered by the Australia India Institute in partnership with the Australia India Water Centre (AIWC), the virtual workshops support both countries' commitments to deepen research collaboration under the Comprehensive Strategic Partnership (CSP) and the Australia-India Education Council (AIEC) for mutual benefit.

These workshops brought together participants from various background, including researchers, postgraduate students, professionals, policy advisors, and practitioners in Australia and India. With keynote presentations and breakout discussions, the online sessions provided an interactive platform for in-depth exploration of the topic. The shared energy and ideas from these workshops have laid the groundwork for lasting collaborations that will shape the future of water security research, training, and capacity building.

Thank you to the Australia India Water Centre, partners, and sponsors, including the Australian Government Department of Education. Particular thanks to Professor Basant Maheshwari, AIWC's Director, whose dedication to water, environment, and sustainability research led the way in organising these insightful workshops. I trust that this document will serve as a valuable reference for understanding contemporary water security issues, guiding future research, policy, and collaboration between Australia and India.

The Hon. Lisa Singh, CEO
January 2024

EXECUTIVE SUMMARY

In May-June 2022, the Australia India Institute (AII), with the support of the Australian Department of Education, and the Australia India Water Centre partnered to convene and deliver a series of four online workshops. These series brought together experts and policy makers from both countries to share their knowledge, experiences and technical capabilities in water resource management, soil, and food security. The workshops also provided opportunities for networking and building collaboration between water researchers and professionals in the longer-term.

The four themes covered by the online workshops focused on groundwater sustainability; soil and water management for food security; wastewater reuse management and sustainability; and water informatics for sustainable water futures. The first workshop on groundwater sustainability highlighted the importance of providing communities with the tools to make the best decisions for their health and sustainability. This requires further capacity building work and research at the local level on groundwater assessment, measurement, and extraction. The second workshop focused on the close links between soil and water health. The participants discussed various aspects of nutrient recycling in the soil to address food security challenges.

The third workshop discussed the need for communities to be more informed about wastewater reuse and recycling. Both Australia and India rely on recycling water and the critical issues for both countries are related to preventing contamination, monitoring pathogen risk and human health. The final workshop explored transdisciplinary approaches in water resource management. Participants discussed the collection, storage analysis, communication and dissemination of water data for better decision-making, policy development and implementation of water initiatives and infrastructure.

PRIORITY AREAS FOR BILATERAL RESEARCH COLLABORATION

Deliver further webinars/workshops/information sharing that is managed by students and early career researchers and professionals, and student-centred engagement in both countries. This kind of engagement builds capacity in young professionals.

- Provide training on processes for communication, collaboration, and networking.
- Identify gaps in groundwater management knowledge in order to develop new research. Indian and Australian organisations could explore collaborative funding opportunities by involving government as well as private parties through a public-private-partnership (PPP) model.
- Explore mutual expertise for training of all stakeholders in groundwater management, commencing with farmers, non-government organisations, researchers, technical advisors and politicians.
- Develop ways to incentivise efficient water practices for farmers so they can implement the practices that are good for soil health.
- Create more opportunities for those experienced in training, research and capacity building to apply their knowledge and expertise on projects.
- Share information about the constant monitoring of wastewater reuse schemes to help people understand the safety aspects and benefits of recycled water.
- Develop and deliver awareness campaigns that include regular information updates using videos, social media and meeting local people. Information should be easy to access.
- Undertake long-term assessments of using recycling water, with a focus on human health and other components such as ground water or surface water contamination. As more is learned about recycled water use, consider how to improve guidelines recycled water use, and how to develop future guidelines.

EXECUTIVE SUMMARY

- Undertake cost-benefit analyses of wastewater reuse systems. Systems may be technically feasible but must also be economically viable and beneficial. Cost benefit analyses should be undertaken as long-term projects.
- Expand the parameters of the data to be included in data collection. Both Australia and India are large countries with diverse climates and accessibility issues. Develop systems to produce quality information and insights.
- Develop an exchange program where people can learn about data collection and analysis by working in an organisational and community environment.
- Provide funding for capacity building activities that can be delivered live and made available through recorded formats. Offer capacity building programs where people can learn how to train others in data collection.
- Continue sharing information and communicating. Encourage individuals to take initiative and responsibility to ensure relationships and communication continues.

INTRODUCTION

During the fifth Australia-India Education Council (AEIC) meeting in 2019, both Indian and Australian education ministers agreed to deepen research collaboration on areas of mutual benefit. Water security is recognised as a critical challenge for both countries under the Comprehensive Strategic Partnership agreement. The Memorandum of Understanding on Cooperation in the Field of Water Resources Management (Water Resources MOU) between the two countries is a joint endeavour that aims to deepen policy and technical cooperation in this field. The Water Resources MOU is led by the Australian Government Department of Agriculture, Water and Environment (DAWE) and the Central Water Commission (CWC) and National Hydrology Project (NHP), Ministry of Jal Shakti, Government of India.

Two of the workshops, on groundwater sustainability and water informatics for sustainable water futures, formed part of the activities of the Joint Working Group convened under the Water Resources MoU. The Australia India Water Centre (AIWC) was contracted by DAWE to deliver these two workshops.

WORKSHOP PARTNERS

The workshops were funded by the Australian Government Department of Education and jointly hosted by the Australia-India Institute and the Australia India Water Centre. They also provided a productive example for supporting collaboration and strategic alignment between the two Australian Government Departments of Education and Agriculture, Water and Environment.

FORMAT AND NETWORKING

The workshops attracted over 500 registrations across the series, with over 300 participants logging-on from Australia and India, including researchers and postgraduate students from AIWC member institutions, Young Water Professionals, professionals working in government and government agencies at the state and federal levels, representatives from non-government organisations (NGOs), policy advisors, consultants, and practitioners.

Participants included professionals from the Jal Shakti Ministry (Government of India), Australian Government Department of Agriculture, Water and Environment and the Australian Government Department of Education.

AT A GLANCE

- **4** workshops
- **518** registrations
- over **300** participants
- **33%** from Australia
- **15** expert speakers
- **14** guided networking sessions with **60** participants from both countries
- delivered in partnership with the **Australia India Water Centre (AIWC)**
- supports the bilateral **Water Resources MOU**
- supported by Government of India's Water Ministry, **Ministry of Jal Shakti** including **Central Water Commission** and **National Hydrology Project**
- supported by the Australian Government through **DAWE** and **DE**
- Workshop Video and presentations available at: **https://aii.unimelb.edu.au/water-and-food-security-workshops/**

INTRODUCTION

WORKSHOP DESIGN

Each 2.5-hour online workshop included keynote speakers who provided current information on speciality topics, followed by breakout discussions. The breakout discussions provided an opportunity for participants to work in smaller groups of 6-8 participants to discuss the content provided by the speakers and identify issues, challenges and opportunities. Each group was moderated by the speaker or another specialist. These discussions led to the development of ideas to initiate and sustain collaboration between Australia and India for research, training and capacity building.

The breakout discussions addressed two questions:

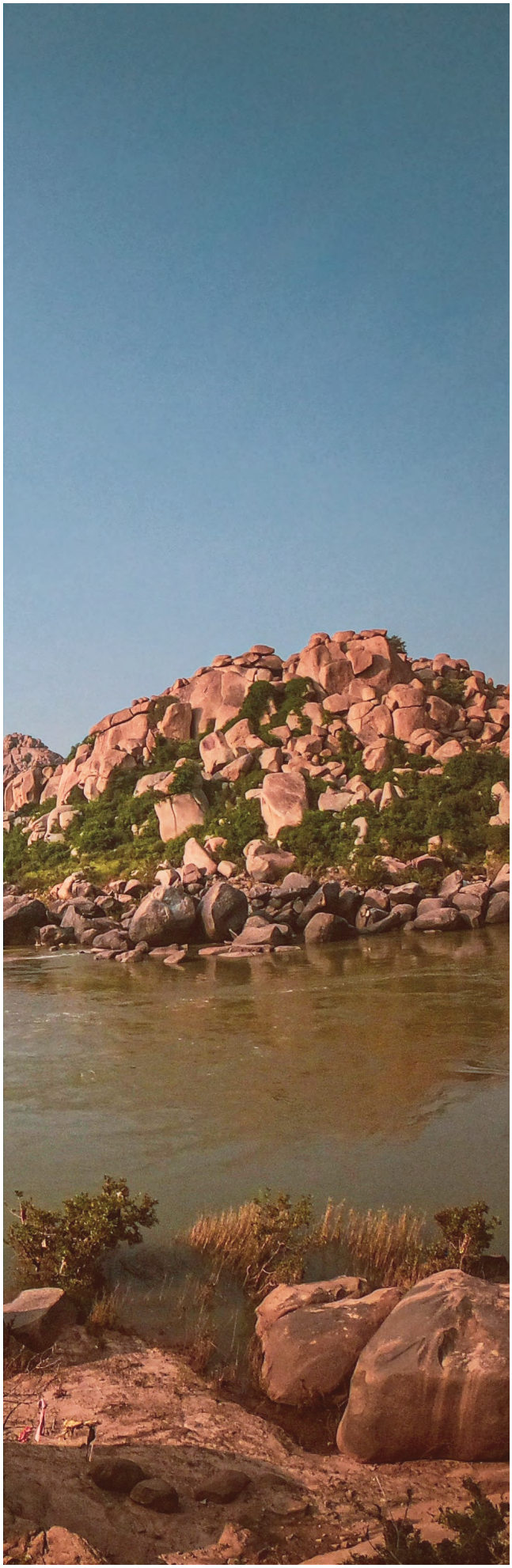
- **Question 1**: What are the key issues, challenges and opportunities related to the workshop topic Informatics in research, training and capacity building for Australia and India for the next 5-10 years?
- **Question 2**: How do we grow and sustain significant collaboration between Australia and India for research, training and capacity building in the workshop topic? Discuss this with regard to engagement with researchers, NGOs, public and private sector.

The responses from the breakout rooms were shared in the larger group and led to further discussion. Following the group discussions, specialists offered ideas in a group discussion.

NETWORKING SESSIONS

At the end of the workshops, a 30-minute networking session was provided where participants could meet others according to interests and speciality topics. Three to five specialty topics were provided for each session, with an Australian researcher present in each room to guide the conversations.

Across all workshops, about 60 participants joined these networking discussions, which covered work projects and activities, exchange of contact details to support researcher connections, sharing of information on resources, activities, events, articles, and professional development.



WORKSHOP OUTCOMES AND IMPACT

- The networking session at the end of each workshop was important for initiating dialogue about possible future collaboration between Australian and Indian researchers. In addition, some presenters expressed an intention to collaborate with each other on specific shared research interests and to share research case studies.
- A series of videos and a consolidated report based on the four workshops have been developed. These outputs will be valuable resources for future dialogue and developing an effective technical exchange program in water between Australia and India.
- On 29 June 2022, the AIWC received letter from the Indian Department of Land Resources, Government expressing willingness to be a partner of Australia India Water Centre to collaborate on research, capacity building and knowledge sharing.
- In July 2022, DAWE invited AIWC to submit a project concept note to the next Australia-India Joint Working Group meeting under the Water Resources MOU, "considering the success of the Water and Food Security Workshop Series".
- On 22 August 2022, the workshop series was mentioned at the meeting of the Australia India Education Council at the University of Western Sydney, co-chaired by the Australian Minister for Education the Hon Jason Clare and the Indian Minister of Education, Skill Development & Entrepreneurship Shri Dharmendra Pradhan.
- On 7 October 2022, the workshop series was discussed with India's Water Minister, Shri Gajendra Singh Shekhawat, during his visit to Western Sydney University, the Australian lead for the AIWC. The discussions with the Minister canvassed future collaboration in water research, education and training/capacity building, community engagement and other aspects to strengthen the relationship between the two countries.

SPEAKERS

The workshop series featured senior administrators from key research centres, universities and government departments, and 15 expert speakers from Australia and India:

- The Hon Lisa Singh, CEO, Australia India Institute
- Professor TG Sitharam, Director, Indian Institute of Technology Guwahati
- Ms Lyn O'Connell, Deputy Secretary, Australian Government Department of Agriculture, Water & Environment
- Dr David Atkins, Assistant Secretary, International, Australian Government Department of Education
- Professor Kevin Dunn, Pro Vice-Chancellor Research, Western Sydney University
- Professor Scott Sheppard, Deputy Vice-Chancellor (International and External Relations), Queensland University of Technology
- Professor Alistair Rendell, Vice President & Executive Dean, College of Science and Engineering, Flinders University
- The current and former Chairman, Central Ground Water Board, Indian Ministry of Jal Shakti
- Deputy Chair, International Centre for Excellence in Water Resources Management and former South Australian Minister for Water Security and the River Murray
- Founding co-chair of the International Association of Hydro-geologists Commission on Managing Aquifer Recharge
- Director, Global Centre for Land-Based Innovation, Western Sydney University
- Chief Advisor and Chairman of Strategy and Policy Unit, National Institute of Urban Affairs and former Director General for the National Mission for Clean Ganga
- Former Chief Engineer, Bangalore Water Supply & Sewerage Board
- Technical Lead, Hydrology, Australian Bureau of Meteorology
- Scientist G and Head Surface Water Hydrology Division, National Institute of Hydrology, Roorkee the Water and Food Security Workshop Series".

SUMMARIES OF WORKSHOPS

WORKSHOP 1 - GROUNDWATER SUSTAINABILITY

SUMMARY STATEMENT

Groundwater extraction, assessment and measurement needs further research and capacity building work to provide communities with the tools to make the best decisions for their health and sustainability.

OPENING REMARKS

The workshop series was launched by the Hon Lisa Singh, CEO, Australia India Institute. Ms Singh spoke about global water scarcity, and the leading role that Australian and India can play in addressing this challenge through greater collaboration.

Professor TG Sitharam, Director, Indian Institute of Technology Guwahati and the Indian lead for the Australia India Water Centre described the work of the AIWC and outlined how these workshops supported the AIWC's objectives. He pointed out that India was not short of water, given its annual monsoons, but needs to do more for water storage. While India is the third largest dam building nation in the world today, with 5,800 large dams and growing, he supports nature-based solutions to water scarcity. This refers to sustainable management and use of nature for tackling socio-environmental challenges, and groundwater is an important part of this.

Ms Lyn O'Connell, Deputy Secretary, DAWE, described the joint endeavours of the Department and the Indian Ministry of Jal Shakti in very positive terms and spoke warmly of her relationship with her counterpart at the Indian Ministry of Jal Shakti. She noted the flooding across eastern Australia and the hardship that caused communities.

She referred to the bilateral MOU in Water Resources Management signed in 2020 and pointed out that the workshops will strengthen the people-to-people ties in the sector and that these ties that can deliver unanticipated results. The aims is to leverage the full benefits of the relationships between Australia and Indian officials, experts and professionals in this crucial area for both sides and build a shared agenda for addressing the water challenges of the future.

Dr David Atkins, Assistant Secretary International, Australian Government Department of Education, acknowledged India's milestone year marking the 75th anniversary since independence. He noted that Australia is India's fifth largest partner for international research collaboration and conveyed the value that the Department places on conversations that these workshops enable between Indian and Australian researchers, universities and industries.

PRESENTATIONS

Dr P Nandakumaran
Chairman (Retired), Central Ground Water Board

Road to groundwater sustainability - some thoughts on how to reach there faster

There is a need to revisit groundwater assessment methodology in order to obtain more realistic field data on groundwater extraction and to increase monitoring of groundwater extraction. Groundwater usage in India has evolved over the years. In the 1960s, groundwater utilisation was minimal and it was not considered a significant resource for users other than for domestic domestic purposes.

Between 1980 and 2000, concerns about groundwater depletion and contamination became prominent. Initiatives to regulate groundwater commenced at the end of 1990s. Activities to raise awareness and build capacity were also initiated at a small scale. In the decades from 2000 to 2020 there were more severe impacts from over-exploitation and contamination of ground water resources. An aquifer mapping and management program was launched by the Central Groundwater Board, which envisaged mapping of aquifers in detail and preparation of management plans for sustainable use of groundwater available in those aquifers.

WORKSHOP 1 - GROUNDWATER SUSTAINABILITY

Discussions canvassed the impact of climate change. Subsequently, a number of national schemes were launched.

The focus has now shifted to long term sustainability and holistic water management, but across India there is a widespread disparity in the approach to the extraction of ground water resources.

The main groundwater sustainability challenges are:

- Resource related – this relates to the hydrological complexity of the country as a whole, and the diversity of environments in which groundwater occurs
- Governance related – there are political dimensions, economic dimensions and social dimensions all intertwined in these constraints.

There is a need for more realistic data on groundwater extraction and state governments need to be sensitised to the importance of this exercise. What is required is aquifer-based volumetric assessment, a greater emphasis on demand side management, and more efficient irrigation practices because India's irrigation efficiency is abysmally low.

Water should not remain the responsibility of the water sector alone: it should become everybody's business. All the ministries which use groundwater must play their part in conserving it, including the Ministry of Agriculture, Ministry of Human Resource Development and Ministry of Urban Development. Everyone must play a part in the sustainable management of groundwater.

Dr Peter Dillon
Honorary Research Fellow, CSIRO Land and Water and co-chair of the International Association of Hydro-geologists Commission on Managing Aquifer Recharge

Managing the risks of aquifer recharge with urban wastewaters in Australia and India

Solutions to the issues of recharge need local empowerment to help people understand the issues and take advantage of the opportunities to improve health and livelihood.

Some agricultural land in India is being lost because of the contamination by wastewater, but there are opportunities to generate substantial new cropping and improved practices as a result of better use of that water.

India is an international leader in Managed Aquifer Recharge (MAR) from a volumetric perspective. MAR is a purposeful recharge of water to aquifers for subsequent recovery or environmental benefit. It is not a method for waste disposal. It involves management and monitoring of quantity and quality to ensure that the risks are acceptable. India has experience with managed aquifer recharge, but most of it is not with recycled water.

MAR needs to be well-documented. This documentation should include, not just the technical elements, but the economics and the social recognition and support to demonstrate its effectiveness. The Australia-India Water Centre brings together the capabilities from both India and Australia and by working together it is possible to achieve outcomes that would be more difficult without the involvement of both countries.

BREAKOUT ROOM DISCUSSIONS

Question 1: What are the key issues, challenges and opportunities related to groundwater in research, training and capacity building for Australia and India for the next 5-10 years?

Key issues included the lack of regulation around ownership of groundwater and the limited acceptance of the safety of using wastewater. Challenges included the need to measure and monitor groundwater more effectively and more carefully. Opportunities exist to provide the tools and capacity building of people to do the measurement and monitoring.

- **Regulation**: There is no regulation around ownership of the groundwater in India but there needs to be community support at a ground level before any sort of regulatory system can be introduced. Without regulation, groundwater management relies on voluntary participation. Regulatory management should go hand in hand with voluntary participation.

WORKSHOP 1 - GROUNDWATER SUSTAINABILITY

- **Social acceptance of using wastewater**: There is a need to change mindsets so people understand the water is safe to use. Further research in this area is required and investigation into what is successful elsewhere.
- **Ecological flow**: There is a need for studies on the ecological maintenance of rivers and how springs rejuvenation helps ecological flow.
- **Data and measurements**: There is a need for measurement of the extractions and the regulatory rating that enables management of water extraction. There is a lack of essential data required for successful modelling, such as digital elevation modelling in the Indian context.

  India and Australia have challenges in monitoring and metering technologies and in bringing new innovations to the table and finding pathways to market that innovative technology.

  In India, there is work needed to build capacity of villagers to measure and report on water levels and usage.

  There are also challenges with skills and expertise in areas of groundwater modelling. In India these technical skills largely sit in academic institutions such as the Indian Institutes of Technology, universities or national organisations such as the Central Water Board or National Institute of Hydrology.

Question 2: How do we grow and sustain significant collaboration between Australia and India for research, training and capacity building in groundwater? Discuss this with regard to engagement with researchers, the private sector, NGOs and government departments & agencies.

Collaboration can be grown by considering innovative models for creating joint studies and joint research programs that provide benefit to participants from both countries. There should be a fair and equitable distribution of resources and a model that enables both counties to get value from the investment.

- Identify the gaps in groundwater management knowledge in order to develop new research. Indian and Australian organisations could explore collaborative funding opportunities by involving the government, as well as involvement of those private parties through PPP model.
- Agencies such as India's Central Groundwater Board could invest in national scale digital elevation models that could be used by a variety of agencies to make other data accessible and useful for research.
- There would be benefits from the exchange of skills and knowledge between people who work in the field, in the laboratories and in academia, and for Australians and Indians to be exposed to activities occurring in the other country.
- Explore the mutual expertise for training of all the stakeholders in the groundwater management, starting from the farmers, NGOs, researchers, technical advisors and politicians.

WORKSHOP 1 - GROUNDWATER SUSTAINABILITY

OPEN FORUM - REMARKS

Mr Sunil Kumar
Chairman, Central Ground Water Board, Ministry of Jal Shakti

The sustainability of the groundwater resources requires a focus on social, economic, and environmental factors. It requires decentralised participation and access to data, and enforcing controls through regulation. A balance must be found between environmental sustainability and industry and infrastructure development. To that end, there needs to be an assessment of the whole of the national resource. It is important to know what groundwater is there, how much and at what times of the year, so it can be protected and resource allocations can be prioritised.

India is in the process of finalising legislation that proposes a three tier system for groundwater management at the district, block and street levels, and through various type of councils and committees, so that groundwater becomes an everyday issue that is the responsibility of every person to help manage.

This model also aims to protect various elements, such as containment points, recharge points, coastal areas and wetlands.

India requires environmentally friendly regulations that provide uniformity across both the national and state levels. The approach must include assessment, protection and regulation of this important resource.

Hon Karlene Maywald
Deputy Chair of the International Centre for Excellence in Water Resources Management and former South Australian Minister for Water Security and the River Murray

At the heart of the challenge of groundwater sustainability is people. We have technology. We know where we need to improve regulation. We understand the problem, but we are not engaging well enough with our communities to bring them along on the journey with us.

Our communities have to live with the decisions that are made at various levels from the central government, right down to the local governments and to the local village level.

We need to be engaging with communities and the people who are living with water scarcity. We need to involve them defining the local problem and how that fits into the larger context.

We need to invite local communities to partner with the scientific community, to work out what questions to address in the research that will be applicable to those communities. And we need to co-design the solutions with local communities.

There are no two communities at the same starting point in relation to water and groundwater management, and no two communities from one end of India to the other, or one end of Australia to the other, have the same issues in their local context. We need to engage deeply with those communities in a way that is meaningful. It is not a matter of ticking a box and saying, we went out and spoke to them. It must involve developing relationships with those communities, building trust and actively engaging them as participants in defining solutions.

OPEN FORUM - DISCUSSION

Moderated by Professor Basant Maheshwari. Dr P Nandakumaran and Dr Peter Dillon joined Mr Sunil Kumar and the Hon Karlene Maywald for this discussion. Participants raised a variety of issues for the panel to address, including:

- COVID waste discharge into water streams, and other drug residues
- policy interventions to facilitate the translation of technologies from laboratory to the field and the cost of upscaling technologies
- increasing water and gray water recharging systems while maintaining water quality, including domestic rain water harvesting
- water ownership regulation
- pumping water to high land and the economic viability of constructing and maintaining infrastructure compared to seeking local solutions such as clean water harvesting or increased water conservation measures

WORKSHOP 1 - GROUNDWATER SUSTAINABILITY

RESEARCHER NETWORKING

Technical specialists hosted about 20 researchers in five networking sessions covering key areas relating to groundwater sustainability:

- Managed aquifer recharge using treated wastewater
- Participatory groundwater monitoring and management
- Groundwater quality
- Groundwater sustainability in urban area
- Water literacy

CASE STUDY

A major flood in South Australia washed away the localised irrigation situated on the river flood plain. Subsequently the government built a new irrigation system 30-40km away from the river and flood plain area, requiring water to be pumped to highland areas. A large area of irrigation was opened up, but without educating the irrigators on how to better use water.

As a consequence, there was more water in the aquifers, but it also resulted in perched aquifers. Those perched aquifers then created problems for the production in the irrigation districts, because all of the root systems became inundated and salinity increased dramatically. So this approach had a range of other negative impacts on that area that then had to be dealt with.

SUMMARIES OF WORKSHOPS

WORKSHOP 2 – SOIL AND WATER MANAGEMENT FOR FOOD SECURITY

SUMMARY STATEMENT

Soil health is closely linked to water health. If soil is polluted, then water is polluted. Ultimately soil health is about recycling nutrients back into the soil and this will be crucial to addressing food security challenges.

OPENING REMARKS

Professor Kevin Dunn
Pro Vice-Chancellor Research, Western Sydney University (WSU)

Professor Dunn noted that WSU researchers are driving work towards the Sustainable Development Goals. He highlighted the importance of water, and the links between water and food security for the livelihood of both countries. He pointed out the need to better understand the health of soil and water and to develop the indicators for effective monitoring and management to ensure long term sustainability is not jeopardised. He spoke about WSU's role as co-lead for the Australia India Water Centre with the Indian Institute of Technology Guwahati and their strong support for this collaboration between Australia and India in the area of sustainable water.

PRESENTATIONS

Professor Brajesh Singh
Director, Global Centre for Land-based Innovation, Western Sydney University

Integrating soil health for sustainable agriculture and food security

There are multiple challenges with water and water management which is why there is a need to focus on soil health. The world population is estimated to reach 9 billion by 2050. The need to produce food is affected by shrinking arable lands due to degradation. Climate variability puts additional pressure on soil degradation, demand for water and irrigation. Temperatures will rise so plants will require more water for the optimal productivity. It is not clear how climate change will impact pests and pathogens. All these factors result in uncertainty about food production and food insecurity.

Another key aspect is the nutrient supply. Phosphorus is a key fertiliser for food production and is expected to peak by 2034. It will then become more expensive which has consequences for food security and food production.

How are we going to increase the sustainable production of agriculture and farm productivity? Increasing soil health can increase the productivity by 15-20%. Soil health combined with new and more resource-efficient crop varieties can achieve a 50% increase in productivity by 2050.

Soil health is critical to productivity. Healthy soils are those that minimise the annual variations in the farm productivity by providing resilience to biotic and abiotic stresses. For example, healthy soil is able to hold more water for longer periods and provides a buffer against the impact of drought or pests and pathogens.

There are five pillars for the soil health that are interconnected and influence each other:

- soil biology
- organic matter
- water
- structures
- nutrients

WORKSHOP 2 – SOIL AND WATER MANAGEMENT FOR FOOD SECURITY

Sustainable farming practice is a critical building block of healthy soils. Precision agriculture leads to overall higher productivity and contributes to environmental health. Satellite imagery is being used to map where soils need more fertiliser and water and the release of these according to requirements results in more uniform, higher productivity of systems.

New tools include nanotechnology and polymer technology. These technologies hold elements, in some cases, water, inside a structure and release only when the plant comes into contact. That increases the water use efficiency and plant yield.

Microbe technology is also transforming agriculture and will have a transformative impact in coming years. It involves looking at how local soils, crop varieties and microbes interact. This will determine the availability of nutrients and water, and ultimately the plant health and the plant productivity.
There should be more focus on education for smallholder farmers on practical ways to improve soil health and incentivising those approaches.

Mr Rajiv Ranjan Mishra
Chief Advisor and Chairman of Strategy and Policy Unit, National Institute of Urban Affairs and former Director General for the National Mission for Clean Ganga

Ganga: Reimagining, Rejuvenating, Reconnecting

The Ganga is the national river of India but cleaning the river is a massive challenge. The river flows for 2,500 kilometres through more than a hundred towns and 4,500 villages. There is a large population in this basin. The Gangetic Plain is a very fertile plain with different kinds of agriculture. There are upland areas in the basin where it is drier and a deltaic region in Bengal.

The initial focus of the National Mission for Clean Ganga (NMCG) was more on the pollution abatement of all types, rather than improving ecology and flow. Subsequently the focus shifted to strengthening the connection of people to the river, and on research and knowledge creation.

In 2016, the NMCG was mandated to regulate the river. This included regulation of industries, regulation of water quality and notification of environmental flows. The task is supported at the highest level, reflected in the membership of the National Ganga Council which is chaired by the Prime Minister and includes chief ministers and several union ministers. This has helped speed up projects and activities.

In 2014, a sewerage treatment project commenced and now there are 160 projects with almost 5,000 MLD capacity. In seven years, capacity increased 10-fold. Since that time, the investment has been significant, and this has had an impact on the field. Institutional mechanisms have been implemented to ensure ongoing academic involvement. For the first time, India introduced a hybrid energy model in sewerage treatment plants, and water reuse projects with industry.

There has been a focus on environmental flow, with international experts brought in to discuss issues as this is still an evolving field in India. Conservation of wetlands is given top priority in this mission all along the Ganga and the Environment Ministry has taken a similar approach for 13 more rivers in the country as part of the development of a scientific forestry program.

Urban River Management plans and River Sensitive Master plans are being developed. Guidelines have been established and the focus now is on capacity building, especially for Water Sensitive Urban Design. India has studied successful international river rejuvenation projects, seeking to learn from best practices. The problem is difficult, and we need to be flexible and find agile solutions. A long term vision is needed and there has be visible results. Reimagining is also important because everyone has a different theory of how to rejuvenate a river.

Financial support has increased significantly. For 30 years, from 1985 to 2014, 40 billion Indian rupees were allocated to this issue. That allocation has trebled over the past 7 years and is now 120 billion Indian rupees.

WORKSHOP 2 – SOIL AND WATER MANAGEMENT FOR FOOD SECURITY

Who ultimately owns the Ganga or any river? Is it solely the government's responsibility? We all use this river, we all go to its banks and use the water for different purpose. How can you make people take the ownership to keep the river clean? A program has been launched for reconnecting with the Ganga which introduces amenities and connections with people.

All kinds of activities have been undertaken to connect with people and communities. The community connection occurs through various programs. One of these programs is Ganga Prahari or friends of Ganga, comprising volunteers. Adventure sports are also used very effectively, these involve rafting expeditions along Ganga. Universities are involved through a University Connect Program which raises students' awareness of water management. To keep any river clean, is a continuous process. New challenges will arise and there will be new sources of pollution. You have to keep improvising and learning. This enormous task is supported through collaborative partnerships with national and international institutions.

What the river teaches you is that, if you do not pollute, defile and obstruct it, it will remain pure. It will bring all the goodness of nature and help you live a happy, healthy, and prosperous life.

BREAKOUT ROOM DISCUSSIONS

Question 1: What are the key issues, challenges and opportunities related to soil and river health in research, training and capacity building for Australia and India for the next 5-10 years?

There is no point in just looking at a snapshot or short-term thinking for river and catchment management. The management and improvement of river health management requires a long term approach of 10 years or beyond.

Wastewater is a key pressure on river systems in both countries, particularly in India. Research is needed into grey water systems, decentralised grey water systems within households and communities. Grey water can help to address water demand and generational wastewater.

In the Northern Indian system, little is known about the groundwater resources. Research is needed to understand how deep the water is, how much water there is, and how it flows. Tools and processes are needed to understand how to manage that resource sustainably.

Topics areas that need further research and sharing of information include:

- Solid waste management: Waste management needs to attention at policy level, at citizens' level and also at the corporate level.
- Monsoon water: Current systems in India are designed to get rid of the monsoon water as soon as possible, to avoid flooding, but it should be managed as a resource.
- Water productivity in dairy production systems: What practices can help to regenerate the water system such as the treatment and reuse of dairy water into the shed.
- Incentivising efficient water practices for farmers: Farmers should be encouraged to implement practices that are good for soil health.

Question 2: How do we grow and sustain significant collaboration between Australia and India for research, training and capacity building in soil and river health? Discuss this with regard to engagement with researchers, NGOs, public and private sector.

There are many institutes which are already providing training, research and capacity building, but there are not opportunities to apply that knowledge and expertise to actual projects.

Capacity building can now be delivered through online training, and short courses such as courses for managing the wastewater to recycling, targeting the diversity of stakeholders.

Case studies on wastewater, from both in Australia and India, would be a useful component of capacity building.

WORKSHOP 2 – SOIL AND WATER MANAGEMENT FOR FOOD SECURITY

OPEN FORUM - REMARKS

Dr Anupama Kumar
Research Team Leader, Environment Protection and Technologies, CSIRO, Land and Water

Australia is working continuously towards improving water quality. The regulatory framework is strong, but quality issues arise from drought, from bush fires, from the runoff from flooding that releases contaminants into the environment. The contaminant problem in India is from different factors, but the comparison is useful and we learn from each other.

Engineering solutions through infrastructure alone will not fix river health. We need interdisciplinary teams that include hydrologists, soil scientists, computer scientists, biologists, toxicologists, water scientists, wastewater management scientists.

We need to engage with industrial representatives and demonstrate the benefits of river health. New chemicals are constantly coming onto the market. Chemical contaminants in water present challenges, because we don't know what to measure, when to measure, how to measure. Should we prioritise contaminate monitoring? We must address the source not the symptom. Land use mapping would assist in prioritising what is monitored. We can do a lot at the source level by segregating streams, treating them separately, not discharging them, and reusing within the treatment process.

There are micro pollutants present in water that is being used for irrigation. Bio solids are applied on land, but our studies show that some of the treated wastewater and bio solids contain micro pollutants. The bio solids are rich in organic matter and the micro pollutants bind to the bio solids. We need to ensure that that there are guidelines and frameworks for using bio solids, and that we are not recycling problems by taking a problem from one end and moving it to other end.

Pharmaceuticals present another problem. It is estimated that by 2030, antimicrobial use will increase by 82% in India and 22% in the US. This has led to antimicrobial resistance problem, and we can only deal with it by coordinated government, private sector, industry, and general public working together. Plastics, microplastics and pesticide contaminants are growing challenges.

We need to improve our practices and quality science can make a big difference to the effectiveness and efficiency of environmental regulation in dealing with contaminants of emerging concern. There is policy and there is also practice, because it is not enough to change the regulation, you also need to make a change at a grassroots level.

OPEN FORUM - DISCUSSION

Moderated by Professor Basant Maheshwari. Mr Rajiv Ranjan Mishra and Professor Brajesh Singh joined Dr Anupama Kumar for this discussion.

Participants raised a variety of issues for the panel to address, including:

- Science communication
- Links between soil health, river health and food security
- The use of pesticides and agrochemicals

RESEARCHER NETWORKING

Technical specialists hosted about 15 researchers in three networking sessions covering key areas relating to water, soil and food security:

- Soil Health
- River Health
- Water Management for Food Security

SUMMARIES OF WORKSHOPS

WORKSHOP 3 – WASTEWATER REUSE MANAGEMENT AND SUSTAINABILITY

SUMMARY STATEMENT

Both Australia and India rely heavily on recycled water, but more information and education is needed for communities to get the best out of these water schemes.

OPENING REMARKS

Professor Alistair Rendell
Vice President & Executive Dean, College of Science and Engineering, Flinders University

The importance of water to our communities is self-evident and particularly true in South Australia. The technical exchange program provides an opportunity to share our expertise and experience in this, to sustainably manage water resources for social health and economic benefits for our communities. The College of Science and Engineering at Flinders University hosts the National Centre for Groundwater Research and Training. NCGRT conducts translational research in the utilisation and management of groundwater reserve resources, much of it with international collaborators. This workshop on wastewater reuse provides an opportunity to develop and establish collaborative research and training between India and Australian experts to address water resource management issues common to both countries.

PRESENTATIONS

Dr Lakshmi Narayana Rao
Principal at RMCG Consulting

Large scale recycling of wastewater – A case study from Bangalore city

Background: The KC Valley recycling project is one of the biggest recycling projects in India, with nearly 2 million people as direct beneficiaries of this scheme. The project commenced in 2018, when the Kolar and Chikkaballapur Districts, neighbouring districts of Bengaluru, had suffered 10 years of continuous drought. The State Government of Karnataka introduced an initiative which took water from Sewage Treatment Plants (STPs) and pumped it through a pipe network to tanks in Kolar and Chikkaballapur that date back to the early settlement of the districts.

Soon after the project started, it ran into legal problems, but restarted in February 2019. Now water flows continuously through 137 tanks, providing irrigation to 24,000 hectares of land.

A major portion of Kolar district is served with treated water. The treated water is restored 24 hours a day, 365 days of a year. The water stored in the tanks is for indirect recharge of the groundwater table. Precautions are taken to educate people that this treated water should not be consumed directly, but should be consumed only after collection from the borewells near the storage tanks.

When the project started, the standard set for discharging treated water from STPs was higher than when the two STPs were built in 1980s, so the STPs were not meeting the current discharge standards. Adjustments were made to ensure that the STPs could meet the discharge standards.

WORKSHOP 3 – WASTEWATER REUSE MANAGEMENT AND SUSTAINABILITY

Outcomes: The project has had a very positive impact on the water table and the economy. Ground water levels have significantly improved. The project has helped provide farmers and houses with a secure water source and improved farmers' livelihoods and economic outcomes. Instead of producing one crop each year, farmers produce three crops each year. They are growing flowers, vegetables, fruits, pulses and cereals - even paddy, a water-intensive crop.

This project is a good example of the circular economy as the fruits and vegetables are sold in cities including Bengaluru, grown from treated city wastewater. There has also been a reverse migration outcome as people living in cities return to the villages and tourism has increased.

Initially, there was apprehension about this project; about the quality of the treated water, the impact on underground water levels and underground water quality. But four years into this project, the benefits have led to strong popular support.

Open questions: Dr Rao concluded with a series of open questions: How do you efficiently manage and distribute this treated water? What is the optimum recharge rate? What is the quality of the water? What is the affluent discharge standard for such secondary treated water applications, which is indirect recharge of ground? What are the long term impacts of such use of treated water in these tanks? What is that effect on the overall structure of the tank? What is the effect of that on the recharge rates? What is the effect of that on your underground water raised? What standard do you want to treat and what is the objective that you want to achieve? What is the long term impact overall on farming, watertable and on the tanks?

Dr Anne-Maree Boland
Principal at RMCG Consulting

Opportunities for using recycled water in Australian agriculture

Australian agriculture has a large and significant irrigated agriculture sector from either rivers, surface water or ground water.

There are large irrigation schemes: the total volume of irrigated agriculture water used from 2019 to 2020, was 7,230 gigalitres (GL). This has been declining over time, particularly with a lot of that water moving to higher value crops. From 2014/15 to-date, there has been a significant decrease in the amount of water extracted from the environment and delivered in irrigation systems.

About 312GL of treated effluent is supplied, and of that only about 86GL is going to agriculture. The value of reuse water is quite high. It's important in peri-urban areas, where there are competing users, and for fit-for-purpose use. The quality can be suitable for end use, depending on the contaminants at the source.

The use of recycled water in Australia is highly regulated. The states' Departments of Health monitor and set standards for microbial pathogens and contaminants such as PFAS and other chemicals. There are strict guidelines around what can and cannot be done.

Water from effluent water is treated to high standards and there is a system of class A, B, C, and D. For products such as vegetables, the highest standards of class A are applied.

Using recycled water from treatment plants or from dairy processing or wineries, requires additional management. From an agronomic point of view, salinity is the most significant issue. We also need to manage the nutrients, mainly nitrogen and phosphorus. In addition, we need to consider on-farm storage.

Over the last 15-20 years, guidelines have been developed to assist farmers when using recycled water. High value crops in horticulture need a reliable and secure source of water, fit-for-purpose and high quality. Vegetable farmers needed to have certainty around the quality of water for 5 to 10 years into the future.

WORKSHOP 3 – WASTEWATER REUSE MANAGEMENT AND SUSTAINABILITY

There are many successful recycled water schemes in Australia. Interest in recycled water intensifies during periods of drought but we need to be prepared for the next drought. Although recycled water is a relatively small contributor, it is a really important contributor for production agriculture and horticulture, but also for green space and amenity horticulture. Although it is not large, recycled water is an important reliable and secure source of water. The quality of recycled water will very much depend on the waste stream.

Recycled water requires different management practices depending on the contaminants. Australia has strict regulations and guidelines on managing recycled water. Ongoing attention is given to new and emerging contaminants.

The framework for use of recycled water helps to understand the feasibility of a recycling scheme and the blockers to establishing a scheme.

It is also important to understand social perceptions and levels of community acceptance of recycled water. Most people are comfortable with the use of recycled water in agriculture. The barriers to acceptance have greatly changed over the last 15 years, and will continue to evolve.

BREAKOUT ROOM DISCUSSIONS

Question 1: What are the key issues, challenges and opportunities related to wastewater reuse in research, training and capacity building for Australia and India for the next 5-10 years?

The top priority is monitoring the pathogenic risk including contaminants of emerging concern, plants uptake and bio accumulation and magnification through the top of the food chain.

It is important to share information about the constant monitoring of wastewater reuse schemes and use that information to help people understand the safety aspects and benefits of recycled water. Awareness campaigns should provide regular updates and easily accessible information, utilising videos, social media and local community meetings.

It is important to change the mindset of people to accept the applicability of recycled waste water through good community education. Information must be backed up by monitoring data.

As we learn more about recycled water use, guidelines must be updated and new guidelines developed. Australia and India can also learn from other countries and regions facing water scarcity such as California and Israel. Guidelines and policies can be informed by their schemes, policies and management.

More information should be made available on water saving devices and technologies to improve water efficiency.

There should be a long term assessment of using recycling water with a particular focus on human health and groundwater or surface water contamination. This should include a long term cost benefit analysis to ensure that good systems that are technically feasible are also economically viable and socially beneficial.

Question 2: How do we grow and sustain significant collaboration between Australia and India for research, training and capacity building in wastewater reuse? Discuss this with regard to engagement with researchers, the private sector, NGOs and government departments & agencies. Australia and India should:

- Establish more joint PhD programs with relevant institutions in India. These joint programs bring academics and students together, and promote research collaboration after PhD completion on different problems.
- Introduce mentoring schemes similar to the Young Water Professionals program
- Develop case studies that share the lessons from wastewater projects
- Deliver a series of webinars managed by students, and support student-centred engagement in both countries towards the development of future young water professionals.

WORKSHOP 3 – WASTEWATER REUSE MANAGEMENT AND SUSTAINABILITY

OPEN FORUM - REMARKS

MN Thippeswamy
Former Chief Engineer, Bangalore Water Supply and Sewerage Board

Supplying water to Bangalore City's population of more than 12 million people across 800 square kilometres is a gigantic task. The city depends on the Cauvery river (1,440 megalitres) and groundwater extraction (500 ML) for residential, commercial and industrial allocations. There is no further groundwater availability due to the rocky terrain and the Cauvery river has reached its limit, with water only available through the existing schemes.

About 1,500 ML of sewage is generated from the city and the Bangalore Water Supply and Sewerage Board (BWSSB) has 1,525 ML capacity sewage treatment plants. In addition, there are more than 2,600 decentralised wastewater treatment plants installed by residential housing complexes, hotels, educational institutions and commercial complexes and industries in the city. These decentralised wastewater plants are treating approximately 150 ML. The reason they are rising in popularity is the high water sanitary tariffs imposed by BWSSB for commercial and industry users, and the unmet demand for housing complexes.

There are many challenges for government agencies trying to meet the demand of water for growing populations. There is an urgent need more resources and schemes to augment water supply.
We have to seriously look at wastewater as one of the important resources for augmenting water supply.
We are exploring wastewater programs in other cities including as San Diego, Los Angeles and Texas, which are going for direct potable reuse.

Government agencies need to consider waste water, which is regarded as 'black-gold' in Australia, for either direct or indirect potable use. Similar to other developed countries, such as Singapore, Brisbane, San Diego. There is no ground water availability in Bengaluru since the city population has grown significantly. Using all forms of water is inevitable, such as grey water and waste water. Conservation of water and efficient management measures are needed. Recovery of not only water, but also untapped resources, is a must.

Professor Howard Fallowfield
College of Science and Engineering,
Flinders University

Wastewater treatment for rural communities is quite different from metropolitan and urban areas. The issues for rural communities in India and Australia are similar. Rural communities are closely linked to water resource management and the water cycle and appreciate the idea of reusing water and not wasting a drop. The critical point is that rural communities cannot sustain complex waste water treatment systems.

We also need to consider the energy components of wastewater treatment and greenhouse gas emissions and CO2 emissions from reuse. We should not overlook the fugitive emissions from wastewater, and also from waste water reuse when we enrich poor organic content soils with more organic carbon.

Those issues are being recognised and there is an interest in moving to extensive treatment systems that are more nature-based, low input, low energy, perhaps taking longer to affect treatment, but that are appropriate for the conditions. In remote communities, there may be opportunities to base these on decentralised power sources such as solar power and battery systems. Another consideration is waste collection without reticulated water systems and flushing toilets, for example from pit latrines.
With waste water reuse, comes also a consideration of reuse of the bio solids in waste water treatment, and how we can effectively and safely use those.
We tend to focus on wastewater as a replacement source of liquid for irrigation. Wastewater often has high nutrient contents depending on the degree of treatment received before you start to reuse it which are of value for agriculture. We underestimate the value of nitrogen and phosphorus in agricultural uses which has value as a fertilizer replacement.

Water has to be fit-for-purpose. It can have different qualities depending on its end use. The end use determines what level of treatment is required.
Wastewater can also contribute to green space irrigation and urban irrigation for minimizing the heat island effect in urban settings and creating places for recreation and sport.

WORKSHOP 3 – WASTEWATER REUSE MANAGEMENT AND SUSTAINABILITY

Risk management is an issue when we reuse wastewater. Australia has a proud history in managing risk. Australia was the first to adopt the Hazard Analysis and Critical Control Points (HACCP) system for food safety based on multiple barrier controls which we use for drinking water and wastewater, and which was later adopted by the World Health Organisation. WHO also provides good resources, like the sanitation safety planning manual, which includes case studies to show how risk management has been used to implement safe wastewater reuse.

OPEN FORUM - DISCUSSION

Moderated by **Professor Okke Batelaan. Dr Lakshmi Narayana Rao** and **Dr Anne-Maree Boland** joined **MN Thippeswamy** and **Professor Howard Fallowfield** for this discussion.

Participants raised a variety of issues for the panel to address, including:

- **Rural aspects of wastewater treatment**: The urban centres have the treatment plants but the agricultural production of crops is in rural areas. What technologies are feasible for rural communities?
- **Wastewater collection**: The priority for India is to invest in the good collection system. In sewage systems there are two key components: the sewer network and the treatment. More attention is given to treatment than the conveying system. Asset management of the sewer system, quality of material and quality of the infrastructure are critical. It is important to have separate underground drainage networks, as in Indian cities such as Bengaluru the storm water mixes with and dilutes the sewage and overloads the system.

RESEARCHER NETWORKING

Technical specialists hosted about 15 researchers in three networking sessions covering key areas relating to wastewater:

- Recycled water for agriculture
- Direct potable reuse and indirect potable reuse
- Social and cultural issues related to recycling

SUMMARIES OF WORKSHOPS

WORKSHOP 4 – WATER INFORMATICS FOR SUSTAINABLE WATER FUTURES

SUMMARY STATEMENT

Transdisciplinary approaches can be used in the collection, storage, analysis, and in the communication and dissemination of water data and information for better decision making, policy advising and implementing water initiatives and infrastructures.

OPENING REMARKS

Professor Scott Sheppard
Deputy Vice-Chancellor (International and External Relations), Queensland University of Technology

QUT, a founding partner of the Australian India Water Centre, is pleased to support these workshops. Water informatics are crucial to policy planning, decision making. QUT hosts the Center for Agriculture and the Bioeconomy, which is focused on global food security and helping farmers grow more food with less resources, and using less water. This research center looks at ways to improve productivity and biodiversity through better management of crops, soil, energy and water. The recent visit by the Indian High Commissioner to Australia was an opportunity to showcase their research, including in tropical crops. Collaborative research with India supported by the Australia India Strategic Research Fund is developing crop resistant bananas and drought resistant crops. QUT is committed to building collaborative networks with India along with the next generation of researchers through a joint PhD program with IIT-Delhi, that's now in its 10th year, and a similar program with IIT-Madras, where doctoral students to undertake research studies at both institutions.

PRESENTATIONS

Ms Janice Green
Technical Lead, Hydrology, Australian Bureau of Meteorology

Water Data – Saving the world one drop at a time

Data collected by Australian Bureau of Meteorology (BOM) is from many sources across the country. There are 10 categories and 55 sub-categories of water data supplied by 180 data providers. Some of the information includes watercourse (level and flow), groundwater (level and pressure), dam storage (level and volume), meteorological observations, water quality (surface and some groundwater), water use and extractions and allocations. Currently there are over 42 million files, with 15,000 files added each day, there have been over 4 billion observations and more than 850,000 groundwater bores included in the database.

Information is used for awareness of the current situation and to help with foresight and enhancing decisions across all time scales. Information collected over different periods of time can be used in various contexts for decision making.

The following are applications of information collected:

Hours > emergency management	**Days** > river diversions and environmental flows
Weeks > water allocation	**Months** > water restrictions
Years > flood plain management	**Decades** > supply augmentation

Information is used for balancing supply and demand responsibly. Supply is managed through increasing water by dams, desalination and aquifer storage. Demand is managed by water restrictions, providing alternatives such as rainwater and stormwater harvesting, improving efficiency of appliances and influencing the market by pricing, trading and regulation.

WORKSHOP 4 – WATER INFORMATICS FOR SUSTAINABLE WATER FUTURES

Australia is now far better placed to analyse how much water is available, allocated, used, lost or traded. The data records how the changing climate is impacting on our rivers and aquifers; how the rate and pattern of water use is changing and the outlook for future water availability.
Australia's highly variable rainfall and streamflow makes it difficult to manage water resources. Impacts of climate change will make management of water resources even more difficult. High quality, consistent water data and information is essential to good water resource management now and into the future. We can no longer rely just on historic records, we need to consider climate and hydrologic change projections.

Q&A:

- Seasonal forecasts have a 3-month lead time, and are dynamic reports that are updated monthly. Accuracy varies depending on location, season and climate models. Digital terrain models (DTMs) for flood inundation mapping are done at state or council level.
- What allows the data collection to work well is that it is required under the Water Act and managed by the central National Water Information Agency.
- Data collection organisations undertake their own quality controls and BOM checks the data. There is still work to be done to ensure quality.
- Citizen science can play a role in data collection, for example, in collecting rainfall data. CSIRO have a successful citizen science program on water quality. Citizen science data is useful tertiary information.
- In the future, BOM is exploring ways to centralise the data to provide a single data hub and also a water data transfer format that will allow smaller organisations who collect data in spreadsheets or tother electronic formats to also contribute their data.

Dr AK Lohani
Scientist G and Head Surface Water Hydrology Division, National Institute of Hydrology, Roorkee

Hydroinformatics in India: Past, Present & Future

Before 1995, data on hydrologic use and management was stored on paper and was not maintained in a good condition. Collecting the data requires resources, so it is important to ensure that the data is able to be stored and then available for current and future use. Hydrologic data is required for different purposes it is important to consider how the data will be applied to water resources issues in space and time.

1995-2003 Hydrologic Data Storage Phase 1 (HP-I)
This Phase aimed to develop a Hydrological Information System (HIS) that was comprehensive, accessible, reliable, user-friendly and sustainable. It introduced procedural standards to ensure consistency across all levels of the system in procedures for recording, validation, processing and storage of the data.

As a result, there is now dedicated data entry systems that are easy to use, where people can easily access the information based on location and timing. This system was applied in 9 states in India involving 6 central agencies. Software was developed for surface water and ground water. Facilities were created that included river gauge stations, observation wells, hydro-meteorological stations, data centre and data storage centres. Protocols were developed on how and when to store the data. Systems were then developed on how to process and disseminate that data.

2006-2014 Phase 2 of the project (HP-II)
In this phase, which included 13 states and 8 central agencies, data became available online. At same time conventional and automatic gauges were upgraded and installed at various locations.

WORKSHOP 4 – WATER INFORMATICS FOR SUSTAINABLE WATER FUTURES

The objective of HP-II was to extend and promote the use of HIS to all potential users concerned with the water resources planning and management, both public and private, thereby contributing to improved productivity and cost effectiveness of water related investments. Achievements under HP-II include: A. construction of data centres; B. strengthening of meteorological stations; C. strengthening of hydrological stations; D. strengthening of groundwater monitoring; E. strengthening of water quality stations; F. Development of Web-based data management system.

Phase 3 of the project (HP-III)

In the third phase, HP will be rolled out across all Indian states and union territories. A Decision Support System has been developed for the planning and management of the water resources. This system has a knowledge base, surface water and groundwater planning, flood assessment, drought assessment and water quality. Data can be downloaded at a national level that allows for water resources development planning and improved decision making.

Q&A:

- Meta-data is available via the India-WRIS platform; quality is checked prior to entering data into the system.
- Farmers are not currently using this data but mobile apps are being developed so that they can use the data about rainfall, water release into canals, etc.
- Citizen science, where ordinary people can contribute, will also be useful to the National Hydrology Project such as the manual data collection stations in remote areas where there is no internet connection, canal assessment management systems, embankment management systems. Mobile apps have been developed with geotagging and will be integrated into the India-WRIS.
- Water quality data is collected by the Central Pollution Control Board.

BREAKOUT ROOM DISCUSSIONS

Question 1: What are the key issues, challenges and opportunities related to water informatics in research, training and capacity building for Australia and India for the next 5-10 years?

The key issues identified were the limited amount of data and quality of data that is collected due to availability of data collection facilities generally and especially in remote areas. The key challenges include the usability of the technology (it is not user friendly) and data collected in different formats or data inconsistency. There are opportunities to include citizens in data collection and to make more telemetric stations available.

- India Water Resource Information System (IndiaWRIS) is limited, it should be more user friendly and kept up-to-date with the latest data
- Need more telemetric stations
- Data collection centres need regular maintenance and upkeep
- More parameters to be included in the data collection – both Australia and India are large countries with diverse climates and accessibility issues so they need to develop systems that produce quality information and insights

WORKSHOP 4 – WATER INFORMATICS FOR SUSTAINABLE WATER FUTURES

Question 2: How do we grow and sustain significant collaboration between Australia and India for research, training and capacity building in water informatics? Discuss this with regard to engagement with researchers, the private sector, NGOs and government departments & agencies.

Collaboration can be grown by providing training programs for academic, industry and community members. This capacity building could be done face to face, online and by providing recorded training resources. Working relationships can be developed and maintained by people using informal methods, rather than rely on published papers, conferences and official work events.

- Develop an exchange program where people can learn about data collection and analysis by working in an organisational and community environment
- Provide funding for capacity building activities that can be delivered live and made available through recorded formats. Offer capacity building programs where people can learn how to train others in data collection
- Continue sharing information and communicating. Networking event such as this workshop series this need to be replicated and continued. Encourage individuals to take initiative and responsibility to ensure relationships and communication continues
- Training needed on processes for collaboration and networking
- People share ideas and information, but especially the process for communication and networking

Dr Manish K Nema
Scientist D, National Institute of Hydrology Roorkee

India is a diverse country presenting many challenges to water data collection:

- Water is a state matter so data collection is decentralised and mechanisms are localised
- Rivers flow across state boundaries which creates water conflict
- The terrain makes accessibility to data monitoring sites difficult
- Seasonal flow variations can be extreme
- Maintenance of equipment is made more difficult by extreme weather events
- Uniformity in measuring standards and collection format is a work in progress
- Data sharing with neighbouring countries

Opportunities include:

- The use of information and communication technology tools
- Citizen science in data collection
- Adoption of smart and innovative water technologies to minimise operational inefficiencies and maximise investment outcomes
- Making all data available to prospective users. To this end, in 2019, the Government of India has established the National Water Informatics Centres under the Department of Water Resources.
- Capacity building for different sectors and users eg. the municipal, agricultural and industrial sectors
- Develop water informatics to inform the public or the community about decisions which being made on their local water sites or catchments

Mr Tim Westwood
Research Economist, Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)

ABARES provides analysis of water markets in Australia. The focus is on the southern Murray-Darling Basin (sMDB) because that is where the majority of water trade in Australia occurs. The sMDB is spread across three states: New South Wales, Victoria, and South Australia. Each of these states individually manages its own water resources.

The Australian Commonwealth Government is involved in helping to manage the shared water resources between states, and also in the implementation of the Murray-Darling Basin plan.

WORKSHOP 4 – WATER INFORMATICS FOR SUSTAINABLE WATER FUTURES

ABARES's involvement is focused on analysing the effects that simulated changes in market conditions will have. This is done via the water trade model. The findings from this model are used to provide a robust economic information base that policy makers can use in decision-making.

ABARES relies on consistent time series of information, regional data and data about irrigation activity. The historic data dates back 20 years. The regional data reflects the nine regions that comprise the southern Murray-Darling Basin which enable exploration of the different regional effects that policies can have. The different irrigation activities relate to different kind of commodities. Data is needed on each of these (eg. rice, cotton, almonds), in order to examine the effects that the policy change or a climate shock would have on each commodity group.

The data includes demand data (where people are using the water, what the water is used for and how much is used) and supply data (where the water is located, how much is available, and where it is going). The analyses are various. For example, if we wanted to analyse the effects of a drying climate, we could go into the supply data and essentially take water out, and run the model. We could then compare those answers to the current state. The model would identify the regions that will be affected most and the commodity groups, or farmers, who are going to bear the brunt of this. Policy needs that kind of information to base their decisions on and how they're going to respond.

Dr Sudeep Nair
Hydrologist, eWater

eWater is not for-profit Australian and state government-owned company that undertakes development, research operationalisation, software development, capacity building, and support. eWater does not collect data , but develops software for hydrological modelling.

eWater developed Source Hydrological Modelling which is now the national hydrologic modelling platform.

India is the second highest user of Source modelling. eWater's MUSIC (Model for Urban Stormwater Improvement Conceptualisation) is a leading tool for water sensitive urban design. eWater is focused on producing good quality results and analysis from the input data, and displaying results in various formats.

OPEN FORUM - DISCUSSION

Moderated by Professor Basant Maheshwari. Dr AK Lohani was joined by Dr Manish K Nema, Mr Tim Westwood and Dr Sudeep Nair for this discussion.

The Panel was asked to comment on what one thing they would change to make water informatics more useful in policy decisions and program implementation.

- A broader range of data collection, all linked into a main database, and made accessible to all
- Marry the hydrology with the economics to produce more accurate modelling and insights into policy questions
- Data that is easily accessible to the general public
- A single agency or single web-based system for all water-related data that is visualised so that it is accessible to all people

RESEARCHER NETWORKING

Technical specialists hosted about 15 researchers in three networking sessions covering key areas relating to water informatics:

- Water data/Information to Knowledge
- Application of water informatics
- Water planning

APPENDIX 1

AGENDA

TIME	OPENING REMARKS
2.30pm AEST 10.00am IST	Welcome by **Dr Karen Barker**, Executive Manager and Head of Government Projects, Australia India Institute
	Remarks by **The Hon Lisa Singh**, CEO, Australia India Institute
	Remarks by the **Professor T. G. Sitharam**, Director, Indian Institute of Technology Guwahati
	Remarks by **Ms Lyn O'Connell** the Deputy Secretary, Australian Government Department of Agriculture, Water & Environment
	Remarks by **Dr David Atkins**, Assistant Secretary, International, Australian Government Department of Education, Skills and Employment
TIME	**PRESENTATIONS**
3.00pm AEST 10.00am IST	**Dr P. Nandakumaran** The road to groundwater sustainability and some thoughts on how to reach there faster...
3.20pm AEST 10.50 am IST	**Dr Peter Dillon** Managing the risks of aquifer recharge with urban wastewaters in Australia and India
TIME	**BREAKOUT ROOMS**
3.40 pm AEST 11.10 am IST	**QUESTIONS FOR THE BREAKOUT ROOMS** 1. What are the key issues, challenges and opportunities related to groundwater in research, training and capacity building for Australia and India for the next 5-10 years? 2. How do we grow and sustain significant collaboration between Australia and India for research, training and capacity building in groundwater? Discuss this with regard to engagement with researchers, the private sector, NGOs and government departments & agencies.
TIME	**REPORTING BACK**
4.10 pm AEST 11.40 am IST	• Participants welcomed back from breakout rooms • Reporters from each room are invited to summarise discussions
TIME	**OPEN FORUM**
4.30 pm AEST 12.00 pm IST	Remarks by **Mr Sunil Kumar**
	Remarks by **Hon Karlene Maywald**
	Moderated Q&A – **Professor Basant Maheshwari** **Mr Sunil Kumar** **Hon Karlene Maywald** **Dr P Nandakumaran** **Dr Peter Dillon**
5.00PM AEST 12.30 PM IST	**WORKSHOP CLOSE/RESEARCHER NETWORKING**

APPENDIX 1

TIME	RESEARCHER NETWORKING
5.00 pm AEST **12.30 pm IST**	Participants self-select a networking room with a relevant research theme: 1. Managed aquifer recharge using treated wastewater 2. Participatory groundwater monitoring and management 3. Groundwater quality 4. Groundwater sustainability in urban area 5. Water literacy
5.30 PM AEST **1.00 PM IST**	**NETWORKING CLOSE** **END OF EVENT**

SPEAKERS	
Dr Nandakumaran P. Chairman (Retd.), Central Ground Water Board	Dr Nandakumaran P completed his Doctoral Degree in Ground Water Management from University of Madras in 2007. Dr Nandakumaran joined Central Ground Water Board (CGWB), Ministry of Jal Shakti, Government of India, in 1986 as a Junior Hydrogeologist and worked in different parts of India in various capacities. In 2017, he was promoted as Member, CGWB and subsequently held key positions dealing with policy planning as well as design and coordination of various scientific activities of Central Ground Water Board and Central Ground Water Authority. In July 2021, he took over as Chairman, Central Ground Water Board, Department of Water Resources, River Development & Ganga Rejuvenation, Ministry of Jal Shakti, Government of India. Widely travelled, Dr Nandakumaran has versatile experience of dealing with various facets of ground water management including Ground water exploration in alluvium & Hard rock areas, assessment of ground water resources, sustainable development and management of ground water and Managed Aquifer Recharge. He also has vast experience in resolving ground water related issues in different terrains of India and has undergone international training on ground water management and climate change impacts. He has played a key role in framing policies related to sustainable management of ground water in India.
Mr Sunil Kumar Chair, Central Ground Water Board, Ministry of Jal Shakti	Shri Sunil Kumar is an alumni of the University of Roorkee (now IIT, Roorkee) graduating with an MTech in Applied Geology in 1985. He started his career in Central Ground Water Board in 1987 as Scientist (Junior Hydrogeologist) and has since handled wide range of responsibilities in various capacities in different parts of India including leadership positions as Regional Director, Rajiv Gandhi National Ground Water Training and Research Institute, Raipur, Chhattisgarh and Director (Administration) at Headquarters. In 2019, Shri Sunil Kumar joined as Member and subsequently he has held the key position in Administration & Human Resources as Member (HQ) and then Member (CGWA). In February 2022, he took up the role of Chairman, Central Ground Water Board, Ministry of Jal Shakti, Department of Water Resources, River Development & Ganga Rejuvenation, Government of India.

APPENDIX 1

SPEAKERS	
The Hon Karlene Maywald Deputy Chair of the International Centre for Excellence in Water Resources Management and former South Australian Minister for Water Security and the River Murray	Karlene Maywald is Managing Director of Maywald Consultants Pty Ltd, providing specialist advice to the private and public sector. Karlene's time as a Cabinet Minister with the SA Government has given her extensive experience in high level strategic planning, oversight of major infrastructure planning and delivery, reform of governance and organisational structures, budget oversight, change management, problem solving across a broad range of high risk sectors and driving the delivery of major policy reforms. She has an intuitive ability to analyse and identify key information to support decision making and a very good understanding of the importance of good governance. She is a skilled negotiator and communicator with strong media skills. It is her ability to focus with drive and energy towards key objectives that achieves results. She uses her inquiring mind to seek innovative solutions to overcome obstacles and generate improvements to service delivery. She displays her leadership ability by her courage to take calculated risks, to show initiative, to mentor, to enthuse others, and to accept responsibility. Karlene has a recognised capacity to engender strong support from stakeholders and a strong focus on building leadership and developing people strategies. Establishing solid relationships with key stakeholders at the local, state, national and international levels has been crucial to her achieving success in delivering so many major initiatives.
Dr Peter Dillon	Peter Dillon is an engineer by training with a PhD from University of Adelaide in 1985 and led CSIRO research on groundwater quality protection, water recycling and Managed Aquifer Recharge for 29 years until he retired in 2014. He led the team that produced the Australian Guidelines for Water Recycling on Managed Aquifer Recharge in 2009. These are still the world's only risk-based guideline for MAR and have been applied in many countries. He and his team also developed a water quality guide for MAR in India, published by UNESCO and CSIRO in 2014, to deal with cases with insufficient data to realistically manage risk. He was a founding co-chair of the IAH Commission on Managing Aquifer Recharge from 2002 to 2019 and has published more than 300 peer reviewed publications mostly on technical, and governance aspects of MAR. He has had the pleasure of being part of Professor Basant Maheshwari's MARVI project that started in Rajasthan and Gujarat in 2010 and continues to gather momentum to enable farmers to measure, understand and manage their groundwater systems in drought-prone areas. He is an active member of IAH and AGGG, and is fortunate to have collaborated with outstanding Indian colleagues in groundwater research, investigations and management.

APPENDIX 2

AGENDA

TIME	OPENING REMARKS
2.35 pm AEST **10.05 am IST**	Welcome by **Dr Karen Barker**, Executive Manager and Head of Government Projects, Australia India Institute
TIME	**PRESENTATIONS**
2.45 pm AEST **10.15 am IST**	**Professor Brajesh Singh** Integrating soil health for sustainable agriculture and food security Followed by Q&A (5 minutes)
3.10 pm AEST **10.40 am IST**	**Professor Kevin Dunn**, Pro Vice-Chancellor Research, Western Sydney University
3.15 pm AEST **10.45 am IST**	**Mr Rajiv Ranjan Mishra** Ganga: Reimagining, Rejuvenating, Reconnecting Followed by Q&A (5 minutes)
TIME	**BREAKOUT ROOMS**
3.45 pm AEST **11.15 am IST**	**QUESTIONS FOR THE BREAKOUT ROOMS** 1. What are the key challenges and opportunities related to soil and river health in research, training and capacity building for Australia and India for the next 5-10 years? 2. How do we initiate and sustain significant collaboration between Australia and India for research, training and capacity building in soil and river health? Discuss this with regard to engagement with researchers, NGOs, public and private sector.
TIME	**REPORTING BACK**
4.10 pm AEST **11.40 am IST**	• Participants welcomed back from breakout rooms • Reporters from each room are invited to summarise discussions
TIME	**OPEN FORUM**
4.30 pm AEST **12.00 pm IST**	Remarks by **Dr Sasha Jenkins*** Remarks by **Dr Anupama Kumar** Moderated Q&A – **Professor Basant Maheshwari** **Mr Rajiv Ranjan Mishra** **Professor Brajesh Singh** **Dr Anupama Kumar** **Dr Sasha Jenkins**
5.00PM AEST **12.30 PM IST**	**WORKSHOP CLOSE/RESEARCHER NETWORKING**

*** Dr Jenkins was unable to attend the event.**

APPENDIX 2

TIME	RESEARCHER NETWORKING
5.00 pm AEST **12.30 pm IST**	Participants self-select a networking room with a relevant research theme: 1. Soil Health 2. River Health 3. Water Management for Food Security
5.30 PM AEST **1.00 PM IST**	**NETWORKING CLOSE** **END OF EVENT**

SPEAKERS	
Mr Rajiv Ranjan Mishra Chief Advisor and Chairman of Strategy & Policy Unit, National Institute of Urban Affairs and former Director General for the National Mission for Clean Ganga	Rajiv Ranjan Mishra is Chief Advisor and Chairman of Strategy & Policy Unit at the National Institute of Urban Affairs in India, and additionally acts as an advisor for the Centre for Ganga River Basin Management and Studies at the Indian Institute of Technology (IIT) Kanpur. He recently retired from his position as Director General for the National Mission for Clean Ganga (NMCG), during which he transformed the Namami Gange programme into an integrated, multi- sectoral model framework for river rejuvenation in India. As Additional Secretary for India's Ministry of Housing and Urban Affairs, he steered several policies in housing sector, urban SDGs, New Urban Agenda and sustainable technologies, and played a pivotal role in the enactment of the landmark Real Estate (Regulation & Development) Act, 2016-RERA. Mr. Mishra is the co-author of 'Ganga: Reimagining, Rejuvenating, Reconnecting', a change-maker's account of the enormity of the challenges, institutional processes and reforms which developed momentum and positively impacted a river's health and the sustainability of those impacts. He has published several articles, papers and opinion columns in several journals, magazines, as well as editing a special issue on river rejuvenation in the Journal of Governance and working as editor and contributor on 'Managing Urban Rivers: from Planning to Practice', a set of articles by national and international experts being published by Elsevier.
Professor Brajesh Singh Director, Global Centre for Land-Based Innovation. Western Sydney University	Professor Brajesh Singh is Director, Global Centre for Land-Based Innovation at Western Sydney University and an internationally recognised expert in the field of functional ecology and soil biology. Through his fundamental research, his work identifies the quantitative relationships between soil biodiversity and ecosystem functions and how natural/anthropogenic pressures such as global change affect this. His applied research harnesses the knowledge gained in fundamental research to achieve increased farm productivity, sustainable development, environmental protection and food security. His research has advanced critical areas of ecosystem science, particularly linking soil biodiversity (microbial and faunal) to key ecosystem functions and services and has developed tools to improve farm productivity and environmental sustainability. This includes climate adaptation tools for the agriculture industry, management solutions to increase soil organic matter, increased export market access for agriculture produces, and training for farmers, consultants and policy advisors in sustainable agriculture and the Sustainable Development Goals.

APPENDIX 2

SPEAKERS	
Dr Anupama Kumar Research Team Leader, Environment Protection and Technologies, CSIRO, Land and Water	Dr Anu Kumar is the Research Team Leader of the Environment Protection and Technologies Team at CSIRO, Land and Water located in Adelaide. She has over 20 years' research experience in the field of environmental toxicology and risk assessment. She develops and applies risk-based frameworks for identification and prioritisation of contaminants of concern. Her current research has focused on making effective use of new approach methods (NAMs) to measure and characterise biological changes in response to emerging contaminants and in developing waste management guidelines and practices. Anu has implemented her research into policy by developing best practices for waste management in industrial in urban, industrial and agriculture sectors and global outreach on water quality issues.
Dr Sasha Jenkins Lecturer, University of Western Australia	Dr Sasha Jenkins has over ten years of research and teaching experience in the application of microbial biotechnology for sustainable agricultural waste management. Her research focuses on the optimisation of low-cost waste treatment technologies for the recapture of bioenergy, nutrients and water and development of novel fertilisers and feeds from the recovered resources. In recognition of her research, in 2012, she won the National Science and Innovation Awards for Young People in Agriculture, Fisheries and Forestry.

APPENDIX 3

AGENDA

TIME	OPENING REMARKS
2.35 pm AEST **10.05 am IST**	Welcome by **Dr Karen Barker**, Executive Manager and Head of Government Projects, Australia India Institute
2.40 pm AEST **10.05 am IST**	Opening remarks, **Professor Alistair Rendell**, Vice President and Executive Dean, College of Science and Engineering, Flinders University
TIME	**PRESENTATIONS**
2.45 pm AEST **10.15 am IST**	**Dr. Lakshmi Narayana Rao** Large scale recycling of wastewater – A case study from Bangalore city Followed by Q&A (5 minutes)
3.15 pm AEST **10.45 am IST**	**Dr Anne-Maree Boland**, Principal at RMCG Consulting Opportunities for using recycled water in Australian agriculture Followed by Q&A (5 minutes)
TIME	**BREAKOUT ROOMS**
3.45 pm AEST **11.15 am IST**	**QUESTIONS FOR THE BREAKOUT ROOMS** 1. What are the key challenges and opportunities related to wastewater reuse in research, training and capacity building for Australia and India for the next 5-10 years? 2. How do we initiate and sustain significant collaboration between Australia and India for research, training and capacity building in wastewater reuse? Discuss this with regard to engagement with researchers, NGOs, public and private sector.
TIME	**REPORTING BACK**
4.10 pm AEST **11.40 am IST**	• Participants welcomed back from breakout rooms • Reporters from each room are invited to summarise discussions
TIME	**OPEN FORUM**
4.30 pm AEST **12.00 pm IST**	Remarks by **Mr MN Thippeswamy**, Former Chief Engineer, Bangalore Water Supply and Sewerage Board
	Remarks by **Professor Howard Fallowfield**, Professor at the College of Science and Engineering, Flinders University
	Moderated Q&A **Professor Okke Batelaan** **Dr. Lakshmi Narayana Rao** **Dr Anne-Maree Boland** **MN Thippeswamy** **Professor Howard Fallowfield**
5.00PM AEST **12.30 PM IST**	**WORKSHOP CLOSE/RESEARCHER NETWORKING**

APPENDIX 3

TIME	RESEARCHER NETWORKING
5.00 pm AEST **12.30 pm IST**	Participants self-select a networking room with a relevant research theme: 1. Recycled water for agriculture 2. Direct potable reuse and indirect potable reuse 3. Social and cultural issues related to recycling
5.30 PM AEST **1.00 PM IST**	**NETWORKING CLOSE** **END OF EVENT**

SPEAKERS	
Dr Lakshminarayana Rao Assistant Professor, Indian Institute of Science	Lakshminarayana Rao received his PhD degree from the Department of Chemical Engineering, McGill University, Montreal, QC, Canada, in 2007, for his thesis on the development of superior plasma torch electrodes. He is currently working as an Assistant Professor with the Centre for Sustainable Technologies, Indian Institute of Science, Bengaluru, India. He is a chemical engineer by training. He has over 9 years of industrial experience working in the field of plasma technology. Over the past 14 years, he has worked in various areas of plasma research, decentralised wastewater treatment, wastewater quality and recycling, and has developed technologies. He has worked in various aspects of plasma technology development starting from concept building to commercial products. He is currently working on the generation and characterisation of plasma-activated water and applications of plasma-activated water. He has six granted U.S. patents and authored or co-authored over 35 peer-reviewed international journal articles, 25 conference proceedings, and 2 book chapters.
Dr Anne-Maree Boland Principal at RMCG Consulting	Anne-Maree has 25 years' experience in dealing with natural resource and water management in agricultural industries. This has included research and development and consulting in the areas of sustainable management practices, water use efficiency, recycled water and environmental management systems. Anne-Maree has been a Non-Executive Director for GWRDC and IAL, is a Churchill Fellow and recipient of the University of Melbourne Chancellors Prize. She has extensive experience as a knowledge broker and establishing partnerships with diverse stakeholder groups including government, water and agricultural industries.

APPENDIX 3

SPEAKERS	
Prof Howard Fallowfield Professor at the College of Science and Engineering, Flinders University	Professor Fallowfield is an aquatic microbial ecologist. His research focus is health aspects of water quality, which has been conducted across a range of aquatic environments including drinking water, wastewater and recreational waters. Howard has some 25 year's research experience in the UK and Australia, designing, constructing, operating and evaluating the performance of pilot plants for both drinking water and wastewater treatment. Successful research projects include the design and operation of high rate algal ponds (HRAPs) for the treatment of abattoir wastewater; construction and evaluation of new HRAP designs for the treatment of wastewater from rural communities in South Australia. The application of HRAPs for the treatment of wastewaters and on-site biomass energy production is also a current research project. A further research interest is the remediation of drinking water and groundwater contaminated with inorganic nitrogen, pharmaceuticals and personal care products using biological filters.
Mr MN Thippeswamy Former Chief Engineer, Bangalore Water Supply and Sewerage Board	MN Thippeswamy worked in Bangalore water supply and sewerage board for 34.5 years, retiring as chief engineer in 2005. In his subsequent work as independent consultant he was adviser to/for/on: • Indian Institute of Science Bangalore for implementing management contract for water and wastewater system across the campus • integrated urban water management to Mulbagale in Kolar district • CH2m HILL for projects in India • HYFLUX India • EMPRI ,GOK, for implementing water safety plan project in Bangalore • ENZEN for innovative projects • CSD for water-related projects and conducting conferences at national and international level • Stem Consultants for preparation of lake rejuvenation projects and conducting water workshops • Ms Senapathy Whitelay and Ms Laxman Isola companies to establish recycling plants • CES for ADB and JNNURM funded projects for Trivandrum and Kollam on water and wastewater • GLOBAL pipe engineering company associated with German manufacturing companies • GTZ on water supply projects • IIHS Bangalore Mr Thippeswamy has also been faculty at an engineering staff college Hyderabad and at an L&T training center.

APPENDIX 4

AGENDA

TIME	OPENING REMARKS
2.35 pm AEST **10.05 am IST**	Welcome by **Dr Karen Barker**, Executive Manager and Head of Government Projects, Australia India Institute
2.40 pm AEST **10.10 am IST**	Remarks by **Professor Scott Sheppard**, Deputy Vice-Chancellor (International and External Relations), Queensland University of Technology
TIME	**PRESENTATION 1**
2.45 pm AEST **10.15 am IST**	**Janice Green**, Technical Lead, Hydrology, Australian Bureau of Meteorology Accounting for Australia's Water Resources Followed by Q&A (5 minutes)
TIME	**PRESENTATION 2**
3.15 pm AEST **10.45 am IST**	**Dr AK Lohani**, Scientist G and Head Surface Water Hydrology Division, National Institute of Hydrology, Roorkee Hydroinformatics in India: Past, Present & Future Followed by Q&A (5 minutes)
TIME	**BREAKOUT ROOMS**
3.50 pm AEST **11.20 am IST**	**QUESTIONS FOR THE BREAKOUT ROOMS** 1. What are the key challenges and opportunities related to **Water Informatics** in research, training and capacity building for Australia and India for the next 5-10 years? 2. How do we initiate and sustain significant collaboration between Australia and India for research, training and capacity building in **Water Informatics**? Discuss this with regard to engagement with researchers, NGOs, public and private sector.
TIME	**REPORTING BACK**
4.20 pm AEST **11.50 am IST**	• Participants welcomed back from breakout rooms • Reporters from each room are invited to summarise discussions
TIME	**OPEN FORUM**
4.30 pm AEST **12.00 pm IST**	Remarks by **Dr Manish K Nema**, Scientist D, National Institute of Hydrology Roorkee
	Remarks by **Mr Tim Westwood**, Economist, Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)
	Remarks by **Dr Sudeep Nair**, Hydrologist, eWater
	Moderated Q&A – **Professor Basant Maheshwari** **Dr AK Lohani** **Dr Manish K Nema** **Mr Tim Westwood** **Dr Sudeep Nair**
5.00PM AEST **12.30 PM IST**	**WORKSHOP CLOSE/RESEARCHER NETWORKING**

APPENDIX 4

TIME	RESEARCHER NETWORKING
5.00 pm AEST **12.30 pm IST**	Participants self-select a networking room with a relevant research theme: 1. Water data/Information to Knowledge 2. Application of water informatics 3. Water planning
5.30 PM AEST **1.00 PM IST**	**NETWORKING CLOSE** **END OF EVENT**

SPEAKERS	
Janice Green Technical Lead, Hydrology, Australian Bureau of Meteorology	Janice Green is the Manager of the Water Accounting and Regulations Section at the Bureau of Meteorology with responsibilities for the annual publication of the National Water Account and administration of the Water Regulations. She has 30 years' experience in hydrology, hydraulics, and water resource management and has worked in the public sector, at both state and federal levels, and also in private industry. Janice's main area of expertise is in in the estimation of design rainfalls and floods and she has undertaken numerous flood studies and published widely on her work. She was responsible for the Bureau's derivation of new design rainfalls across Australia as part of the 2016 edition of Australian Rainfall and Runoff.
Dr AK Lohani Scientist G and Head Surface Water Hydrology Division, National Institute of Hydrology, Roorkee	Dr Anil Kumar Lohani is Scientist G and Head of Surface Water Hydrology and Head of the Centre for Flood Management Studies at the National Institute of Hydrology, Roorkee. He is also Coordinator at the Centre for Flood Management Studies at NIH Guwahati, Coordinator for Central India Hydrology in Bhopal and Training Coordinator for the National Hydrology Project. He is a member of Indo-Australia Joint Working Group convened by the Government of India and Government of Australia. Dr Lohani specialises in Surface Water Modelling with a focus on rainfall-runoff modelling, Flood Management, Dambreak Flood Analysis, Glacial Lake Outburst Modelling (GLOF), Flood Forecasting, Design Flood estimation, Application of Soft Computing Techniques in Water Resources. He has a BTech from GB Pant University of Agriculture and Technology in Pantnagar, (UK), an MTech from IIT Kharagpur and PhD from IIT Roorkee. In 2021 he received the Institution of Engineers (India) Excellence Awards for industrial research. He is Editor of **Advanced Tools and Technologies in Flood Forecasting and Management**, **Frontiers in Climate Services**, and a member of the Editorial Boards of the journal **Current World Environment** and the **Hydrology Journal of Science** Publishing Group.

APPENDIX 4

SPEAKERS	
Dr Manish K Nema Scientist D, National Institute of Hydrology Roorkee	Dr Nema is a water resources engineer and currently serving as a Scientist - D in the Water Resources Systems Division of the National Institute of Hydrology, Roorkee, Uttarakhand (INDIA). He has a rich experience of 16 years+ in R&D with a specialisation in the field of water resources. His areas of research are Hydrologic Modelling, Impact studies of Climate Change, Experimental Hydrology, Assessment of Water Availability, Evapotranspiration, Water Audits, carrying capacity studies and Application of advanced tools such as ANN, Remote Sensing, GIS, etc. He has handled various technical and administrative responsibilities independently. He is leading the function as an Officer-In-Charge of Remote sensing and GIS Lab of NIH Roorkee and Nodal-officer for the Soil Moisture Indian Network. He served as Scientist-In-Charge of the Western Himalayan Regional Centre of NIH in his previous assignment at Jammu. He has a BTech in engineering from Jawaharlal Nehru Krishi Vishva Vidyalaya (JNKVV), Jabalpur (MP), MTech from GB Pant University of Agriculture & Technology (GBPUAT), Pantnagar, (UK), and a PhD from Indian Institute of Technology (IIT) Roorkee (UK). He has been involved in more than 20 consultancies and sponsored research projects, guiding the 08 MTech thesis. Published over 45 papers in peer-reviewed International/National Journals and conferences and 12 technical reports. Dr Nema has published more than 18 technical articles in Hindi. He has organised 10 training courses for researchers, faculty members and water resources practising engineers. He also delivered more than 50 lectures on various topics at different forums and training events. Dr Nema visited the United Kingdom and Indonesia for scientific works.
Mr Tim Westwood Economist, Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES)	Mr Westwood is a research economist at the Australian Bureau of Agricultural and Resource Economics and Sciences (ABARES) and works in the Natural Resource Economics section. He has a research background in forestry and international commodity markets. Currently his research is focussed on the Murray-Darling Basin Plan and Australian water markets. He has a bachelor's degree in applied economics from the University of Canberra.
Dr Sudip Nair Hydrologist, eWater	Dr Sudeep Nair is a water resources engineer with experience in urban water systems modelling. Sudeep has been part of projects related to water-energy nexus modelling, sustainability assessment of urban water systems and life cycle assessment. He has advanced skills in simulation and optimisation modelling of integrated urban water systems, which encompass centralised and decentralised water supply systems. Sudeep is also skilled in data analysis and interpretation using various tools to enable decision making in the water sector. He has strong knowledge and interests in water and wastewater management and agricultural engineering.

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