NATIONAL REPORT ON IHP RELATED ACTIVITIES
AUSTRALIA

1. ACTIVITIES UNDERTAKEN IN THE PERIOD November 2014 to June 2015
Australia was elected to the IHP Intergovernmental Council in Nov 2011. Ian White was elected Vice President of the Inter-Governmental Council of IHP in Paris in June 2014.

1.1 Meetings of the IHP National Committee
IHP activities in Australia are carried out under the guidance of the national UNESCO Science and Technology Network. In order to facilitate the implementation of UNESCO activities in Australia and the region, a national IHP Australian Network was established in 1995 and this network acts as the IHP National Committee for Australia. There are no formal meetings of the IHP Australian Network. Activities are conducted largely between the members by telecommunications (e-mail).

The Australian National Commission (NATCOM) for UNESCO (www.dfat.gov.au/intorgs/unesco) has 12 members, two parliamentary representatives and four honorary members.

1.1.1 Decisions regarding the composition of the IHP National Committee
The IHP Australian Network includes the following members. Summary details of all current members are listed below. Dr Dasarath Jayasuriya is the principal focus point for the National committee.

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<tr>
<th>Name</th>
<th>Expertise</th>
<th>Organization</th>
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<tr>
<td>Dasarath Jayasuriya</td>
<td>Flood and Seasonal Forecasting</td>
<td>Bureau of Meteorology</td>
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<tr>
<td>Tony Falkland</td>
<td>Island Hydrology</td>
<td>University of Adelaide</td>
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<tr>
<td>Trevor Daniell</td>
<td>Urban, Low and High Flow Hydrology</td>
<td>Australian National University</td>
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<td>Quentin Grafton</td>
<td>UNESCO Chair in Water Economics and Transboundary Water Governance</td>
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<td>Tariq Rana</td>
<td>Hydrology, Water Policy and Planning</td>
<td>MDBA</td>
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<td>Peter Martin</td>
<td>Public Relations</td>
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<td>Ian White</td>
<td>Hydrology/Water Quality</td>
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<td>Jeff Camkin</td>
<td>Ecohydrology</td>
<td>University of Western Australia</td>
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<td>Ian Cordery</td>
<td>HELP Coordination</td>
<td>Centre for Excellence for Ecohydrology</td>
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<td>Peter Dillon</td>
<td>Flood/Drought Hydrology</td>
<td>University of New South Wales</td>
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<td>Anne Jensen</td>
<td>Groundwater</td>
<td>CSIRO Land and Water</td>
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<td>Ray Volker</td>
<td>Ecotones</td>
<td>Wetlands Care Australia</td>
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1.1.2 Status of IHP-VIII activities
The IHP Australian Network brings together many of the key hydrological research groups within Australia. As such, Australia is able to contribute towards IHP activities through the research programs currently existing in Australia. A description is provided below of some activities pertinent to IHP-VIII.

As yet all the activities being carried out in Australia have yet to be mapped against IHP VIII Themes.

The Australian Bureau of Meteorology and CSIRO Water Information Research and Development Alliance (WIRADA) undertakes research of direct relevance to the activities of the IHP.
Theme 1: Water-Related Disasters and Hydrological Change
Theme 2: Groundwater in a changing environment
Theme 3: Addressing Water Scarcity and Quality
Theme 4: Water and human settlements of the future
Theme 5: Ecohydrology, engineering harmony for a sustainable world
Theme 6: Water Education, key for Water Security

Australia faces major challenges in ensuring sustainable water supply in the face of drying climate and rising demand for water. In response, the Australian Government’s initiative, Water for the Future (http://www.environment.gov.au/water/australia/index.html) is built on four key priorities of taking action on climate change; using water wisely, securing water supplies and supporting healthy rivers.

Theme 1: Water-Related Disasters and Hydrological Change
Focal Area 1.1: Risk management as adaptation to global changes
Focal Area 1.2: Understanding coupled human and natural processes
Focal Area 1.3: Benefitting from global and local Earth observation systems
Focal Area 1.4: Addressing uncertainty and improving its communication
Focal Area 1.5: Improve scientific basis for hydrology and water sciences for preparation and response to extreme hydrological events

A subset of the hydrological data collected by the State and Territory water agencies and the Bureau of Meteorology is contributed to international data centres for use in global and regional studies.

The Indian Ocean Climate Initiative (IOCI) (http://www.ioci.org.au), a partnership of research organisations, is researching the impact of climate variability and climate change on the water resources of the southwest region of Australia. CSIRO (http://www.csiro.au/), Australia’s national research organisation, has research programs addressing global and regional climate change, climate change impacts on natural resources including water and climate change adaptation strategies.

Australian National University (ANU) together with Ecowise Environmental have been researching vulnerability and adaptation to global change in small island countries and have contributed to AusAID’s Pacific vulnerability and adaptation project. The ANU, Ecowise Environmental and the University of Adelaide have been investigating the vulnerability of water supply catchments in the Australian Capital Territory to global change.

A number of major programmes will be highlighted in detail later.

The Water Information Research and Development Alliance (WIRADA) brings together CSIRO’s research and development expertise in water and information sciences and the Bureau of Meteorology’s operational role in hydrological analysis and prediction. The Alliance has covered fields of data interoperability, hydrologic modelling, water accounting and water resource assessment. The Water data transfer standards project is defining and developing transfer standards and procedures for supply of specified data from water information providers and has contributed significantly to the development of an international data exchange standard named WaterML. Among the other significant contributions has been in improving the seasonal streamflow forecasting area using the Bayesian Joint Probability method which has been operationalised using the Bureau operational systems and now well accepted in the industry.

One further development is the Australian Hydrological Geospatial Fabric which is a specialised Geographic Information System (GIS). This identifies the spatial relationships of important hydrological features such as rivers, lakes, reservoirs, dams, canals and catchments and makes working with geodata in a hydrological context much easier.
Theme 2: Groundwater in a changing environment

Focal Area 2.1: Enhancing sustainable groundwater resources management
Focal Area 2.2: Addressing strategies for management of aquifers recharge
Focal Area 2.3: Adapting to the impacts of climate change on aquifer systems
Focal Area 2.4: Promoting groundwater quality protection
Focal Area 2.5: Promoting management of transboundary aquifers

The National Centre for Groundwater Research and Training (http://www.groundwater.com.au) has an extensive research program including research on groundwater/surface water interaction and is investigating how better to manage groundwater resources. CSIRO is researching use of aquifer storage and recovery with urban stormwater and recycled water to sustain depleted groundwater resources (www.clw.csiro.au/research/urban/reuse). The ANU is researching artesian groundwater processes and modelling of groundwater changes in the lower Great Artesian Basin and in south eastern Australia.

ANU, with Ecowise Environmental, are investigating shallow groundwater recharge, socio-cultural aspects of groundwater management and impacts of climate variability in low coral islands as a follow up to a UNESCO-IHP initiated project. Hydrological extremes in sensitive and stressed biomass and hydroclimatic zones are being researched in small island developing states.

Global change and feedback mechanisms of hydrological processes in stressed environments.

- The Murray Darling River Basin and GEWEX related research activities
  Changing global dynamics in aquatic environments: degrading ecosystems, especially those susceptible to sea level change, coastal sediment balance and pollutant accumulation.
- Crosscutting Program Components – FRIEND and HELP
  Collaboration in the Asian Pacific FRIEND project by provision of data, hosting a node of the Internet based Water Archive, and assisting in research activities. HELP basins include the Lower Murrumbidgee catchment in the Murray Darling River Basin (coordinated by Awadesh Prasad, Murray Darling Basin Authority), Tully Basin (coordinated by Jim Williams, CSIRO), Lower Burdekin River Basin (coordinated by Keith Bristow, CSIRO), Fitzroy River basin (coordinated by Chris Carroll, Queensland Department of Environment Resources and Mines) and the Ord River Basin (coordinated by Jeff Camkin University of Western Australia and Dick Pasfield). Overall coordination in Australia is through Prof. Jeff Camkin, University of Western Australia.

The Murray-Darling Basin Plan developed by the Murray-Darling Basin Authority(MDBA) in collaboration with Basin States was adopted on 22 November 2012, provides a coordinated approach to water use across the Basin’s four States and the ACT. The Basin Plan encompasses is a large body of work that the MDBA will develop, coordinate and implement through to 2024. This work can be mapped against Focal areas 2.1, 2.4 and 2.5. See also Theme 3 below

The Basin Plan is developed under the Water Act 2007 and represents one more step in the ongoing journey of managing both surface water and groundwater resources. It limits water use at environmentally sustainable levels by determining long-term average Sustainable Diversion Limits for both surface water and groundwater resources. It aims to achieve a balance between environmental, economic and social considerations. It allows for further improvements in outcomes through a sustainable diversion limits adjustment mechanism and a constraints management strategy. Also under the Basin Plan, Water Resource Plans have a fundamental role in ensuring the limits on the quantities of surface and groundwater that can be taken from the Basin will operate from 2019 and beyond. Further, the Water Quality and Salinity Management Plan provides a framework for action to protect and enhance water quality for environmental, social, economic and cultural uses.

The Basin Plan includes:
- an environmental watering plan to optimise environmental outcomes for the Basin
- a water quality and salinity management plan
- requirements that state water resource plans will need to comply with, if they are to be accredited
· a mechanism to manage critical human water needs
· requirements for monitoring and evaluating the effectiveness of the implementation of the Basin Plan. Further details of the Basin Plan can be found here: 

**Theme 3: Addressing Water Scarcity and Quality**

Focal Area 3.1: Improving governance, planning, management, allocation, and efficient use of water resources
Focal Area 3.2: Dealing with present water scarcity and developing foresight to prevent undesirable trends
Focal Area 3.3: Promoting tools for stakeholders involvement and awareness and conflict resolution
Focal Area 3.4: Addressing water quality and pollution issues within an IWRM framework - improving legal, policy, institutional, and human capacity
Focal Area 3.5: Promoting innovative tools for safety of water supplies and controlling pollution

**The Murray-Daring Basin Plan** developed by the Murray-Darling Basin Authority (MDBA) in collaboration with Basin States described under Theme 2 can also be mapped against Focal Area 3.1, 3.2, 3.3 and 3.4

An AusAID project has been approved to facilitate development of water quality guidance for managed aquifer in India. UNESCO Delhi office is assisting in project establishment. An IAH Commision on MAR project has commenced to produce a monograph on clogging in MAR and the international publication is being led by an Australian editorial team from AGT and CSIRO. This addresses an important constraint on the effectiveness of recharge enhancement.

Non-conventional water resources: brackish water use and waste water re-use.

- A major new research project on storing wetland treated stormwater in a brackish aquifer for recovering potable water. This will be an icon project with much on HACCP that will be transferable to developing countries. This now has partners in China, India and Singapore.

Access to water for food security in environmentally stressed zones.

The National Land and Water Resources Audit (http://www.nlwra.gov.au/) and http://audit.ea.gov.au/ANRA/atlas_home.cfm) and the Water and the Economy study have produced a considerable body of data and information about the value, use, distribution and quality of water within Australia. Research on property rights of water and the structure, operations and social and economic impacts of water trading markets continues to receive a lot of attention in Australia and is a potential resource for similar projects in other countries. The ANU, the French agency CIRAD and Ecowise Environmental has undertaken research on the use of multi agent systems and companion modelling to support negotiations and reduce conflict over groundwater use in low atolls.

**Theme 4: Water and human settlements of the future**

Focal Area 4.1: Game changing approaches and technologies
Focal Area 4.2: System wide changes for integrated management approaches
Focal Area 4.3: Institution and leadership for beneficiation and integration
Focal Area 4.4: Opportunities in emerging cities in developing countries
Focal Area 4.5: Integrated development in rural human settlement

Culture, ethics and legislation for wise stewardship of water.

- Indigenous water knowledge and understanding
- Pacific Island countries culture and water issues
• A framework for integrating water policy for managed aquifer recharge into water resources management was developed and is being taken up by those states where the need is most pressing (http://www.nwc.gov.au/publications/waterlines/robust-policy-design-for-managed-aquifer-recharge).

Good Governance, capacity development and stakeholder participation. Empowerment of human resources.
• CSIRO with NCGRT and IceWARM are providing training on MAR (management of aquifer recharge) including technical aspects, management policies and guidelines for health and environment protection.
• Frameworks for determining sustainable yield of aquifers.
CSIRO and SKM are each developing a thematic paper on groundwater governance for GEF-FAO (on groundwater recharge/discharge and aquifer equilibrium and on surface water-groundwater interaction, respectively).
• French-Australian Initiative on Water and Land Management through the UNESCO Chair in Water Economics and Transboundary Water Governance at ANU conducted “Food and Water Security shaping Land-use Futures” 12-14th June 2013 which has developed a continuing program of research on relevant issues in this focal area.

Affordability, poverty alleviation and assured financing, for effective IWRM. Include ‘water’ in national PRSP.
• Implementation of IWRM in the Pacific Island Countries (assistance to SOPAC).
• Australian National Water Initiative.

Shared Water resources and conflict.
• Water markets and water trading approaches.
• International exchange of data.

As a result of a National Water Initiative (NWI) agreed by Australian federal and state governments all Australian water agencies are required to develop comprehensive water management plans. The plans are being developed through a process of extensive stakeholder consultation and watershed modelling. The process being employed and the resultant plans provide a valuable resource for similar projects elsewhere in the world.

The WIRADA water resources assessment and water use accounting project is developing methods and technologies, to enable the Bureau to provide integrated surface and groundwater resource assessments, water accounts and water resource outlooks. The first 5 year agreement finished in 2012 and was extended for a period of 3 more years.

Theme 5: Ecohydrology, engineering harmony for a sustainable world
Focal Area 5.1: Hydrological dimension of a catchment – identification of potential threats and opportunities for a sustainable development
Focal Area 5.2: Shaping of the catchment ecological structure for ecosystem potential enhancement — biological productivity and biodiversity
Focal Area 5.3: Ecohydrology system solution and ecological engineering for the enhancement of water and ecosystem resilience and ecosystem services
Focal Area 5.4: Urban Ecohydrology – storm water purification and retention in the city landscape, potential for improvement of health and quality of life
Focal Area 5.5: Ecohydrological regulation for sustaining and restoring continental to coastal connectivity and ecosystem functioning

Australia is developing policy and programs to support ecosystem enhancement through ecosystem service production.
Australia has three UNESCO Ecohydrology Program Demonstration sites (Ord River, Western Sydney and water planning in Australia, with all three featured in the 2012 UNESCO document “Ecohydrology for Sustainability”.

The ANU and Ecwise Environmental have ongoing projects in conjunction with UNESCO-IHP investigating shallow groundwater recharge, water quality, impacts of land-use and extraction and socio-cultural aspects of groundwater management and impacts of drought in low coral islands. The ANU together with NSW Department of Primary Industry has been investigating estuary policy and management strategies to improve the health of estuaries. Research into hydrological process in and the sustainable management of wetlands is being undertaken in a number of universities and eWater Cooperative Research Centre and the ANU in conjunction with UNSW and the NSW Sugar Industry has been investigating the use of constructed wetlands to treat drainage from farm lands. The urban environment and water sensitive urban design are also areas of current research. The Bureau has been given a new responsibility under the National Plan for Environmental Information, which is the first step on a long-term commitment to reform Australia’s environmental information base and build this critical infrastructure for the future. It is initially a four-year program, and the first phase is a joint initiative between Commonwealth Department of Sustainability, Environment, Water, Population and Communities and the Bureau. The needs driving this initiative include looking at prioritising of investments in Natural Resource Management, identifying and predicting the impact of climate change, understanding environmental management decision impacts on the economy and society, activation of markets for environmental goods and services, improvement of the quality and transparency of environmental assessments for major projects and driving more sustainable resource management.

**Theme 6: Water Education, key for Water Security**

- **Focal Area 6.1** - Enhancing tertiary water education and professional capabilities in the water sector
- **Focal Area 6.2** - Addressing vocational education and training of water technicians
- **Focal Area 6.3** – Water education for children and youth
- **Focal Area 6.4** – Promoting awareness of water issues through informal water education
- **Focal Area 6.5** – Education for transboundary water cooperation and governance

Many universities and other research centres have educational and training programs. Some of the research centres are listed separately below.


The purpose of the centre is to provide research, education and specialist services for Australian and International land and water industries with the objective of improving the management of resources affected by groundwater processes.

**Centre for Environmental Applied Hydrology** ([http://www.civag.unimelb.edu.au/ceah](http://www.civag.unimelb.edu.au/ceah))

The Centre for Environmental Applied Hydrology is a research centre within the Departments of Civil and Environmental Engineering and Geography and Environmental Science at the University of Melbourne. Specific expertise covers all aspects of surface and groundwater hydrology, hydraulics and geomorphology.

**Fenner School of Environment and Society, Australian National University** ([http://cres.anu.edu.au](http://cres.anu.edu.au))

conducts research and postgraduate training in spatial-temporal variability and characterisation of climate, integrated catchment management, groundwater modelling and hydrology, floods and droughts, coastal hydrology and land use, salinity, cultural and indigenous water issues, water and land policy and related socio-economic interactions, ecological economics.

**The International Centre of Excellence in Water Resource Management (ICE WaRM)** ([http://www.icewarm.com.au/](http://www.icewarm.com.au/)) is made up of a consortium of universities and has a strong focus on education and training. It promotes itself to international water resource management students to further their education in Australia and is also developing online courses for delivery in Australia and overseas.

**International Water Centre** ([www.watercentre.org/](http://www.watercentre.org/)) is a joint venture between University of Queensland, Griffith University, Monash University, University of Western Australia,
International RiverFoundation, Moreton Bay and Catchments Partnership and the Queensland Government. The Centre aims to take Australia's expertise in whole of water cycle management to organizations in the rest of the World through Applied Research, Education and Training and Knowledge Services.

Professor David Waite, Director of the Centre for Water and Waste Technology & Dr Ashish Sharma, from School of Civil & Environmental Engineering at UNSW, are collaborating with Hohai University of Nanjing to develop joint research & Masters' level training programs in WATER MANAGEMENT through the Australia China Consortium for Water Research (ACCWR)

• The University of Western Australia has entered into a Memorandum of Understanding with the International Centre for Coastal Ecohydrology (under the auspices of UNESCO). Prof. Jeff Camkin, who coordinates HELP in Australia, has designed and delivered new components of the Erasmus Mundus MSc in Ecohydrology course in 2010, 2011, 2012. These courses have involved UNESCO HELP network participants from Australia, New Zealand, Malaysia, Philippines, France, Portugal, Spain, providing a bridge between UNESCO Ecohydrology and HELP programs and basins.

• Crosscutting Program Components – FRIEND and HELP

Collaboration in the Asian Pacific FRIEND project by provision of data, hosting a node of the Internet based Water Archive, and assisting in research activities. Australia currently has five UNESCO-IHP HELP basins (Ord, Murray Darling, Fitzroy (QLD), Burdekin and Tully. Further details are below.

1.2 Activities at a national level in the framework of the IHP

1.2.1 National/local scientific and technical meetings 2014/2015

• 35th Hydrology and Water Resources Symposium 2014 (HWRS 2014) Perth, Western Australia was held 17-23 February 2014 at the Pan Pacific Hotel. Website: http://www.hwrs2014.com/


• FENNER CONFERENCE FOR 2013 Shine Dome, the Australian Academy of Science, Canberra 10, 11 October 2013 “Population, Resources And Climate Change – Implications For Australia's Near Future”

• Stormwater 2014 - National Conference on Urban Water Management Hosted by the Stormwater Industry Association 13th - 17th October 2014, Hilton Adelaide, South Australia

• OZWATER’14 Brisbane Jan, 2014

• Floodplain Management Association National Conference held in Brisbane on the 19 – 22 May 2015

• 2015 Stormwater Victoria Conference, 5 - 7 May 2015 • RACV Cape Schanck Resort

• 2015 Stormwater Queensland Conference, Hosted by Stormwater Queensland, Wednesday, 15th - Friday, 17th July, 2015, The Armitage Centre - Empire Theatre, Toowoomba, Queensland

• 2015 International Riversymposium "Healthy Rivers – Healthy Economies", Brisbane, Australia | 21-24 September 2015


• Website: www.wsud2015.org

• Australian Groundwater Conference in Canberra, 3-5 November 2015.

• International Conference on Sustainable Water Management; 29 November to 3 December 2015 at Murdoch University, Western Australia

• 36th Hydrology and Water Resources Symposium in Hobart from 7-10 December 2015.

• 12th Conference on Hydraulics in Water Engineering on 9-11 Feb 2016, in Melbourne, Australia

• International Water Reuse & Desalination Symposium, 4-5 November 2015, Brisbane

• Ozwater’16, 10-12 May 2016, Melbourne
• A number of meetings of the National Committee on Water Engineering, Institution of Engineer's have been held during this period. Some of the key purposes of these meetings are to coordinate and organise hydrology and water resources symposia and conferences, to coordinate the ongoing revision to the national hydrological design guidelines Australian Rainfall and Runoff, prepare Position Papers on key hydrological issues and to manage the publication of Australian Journal of Water Resources. Position Papers are now all available on the Institution of Engineers, Australia web site: (http://www.eng.newcastle.edu.au/~ncwe/ncwePosPaper/ppHome.htm).

1.2.2 Research/applied projects Pacific Islands (Information supplied by Ian White and Tony Falkland) This was included in 2014 report but is still relevant.

The Pacific is a key element in the Earth's water and energy cycles and supplies 75% of the world's tuna stock. The red circles show the position of Kiritimati, Kiribati and Kosrae, Federated States of Micronesia

1.2.2.1 Context
The recent UN General Assembly Third International Conference on Small Island Developing States (SIDS) in Apia, Samoa held on 1-4 September 2014 concluded in the Outcomes that SIDS face numerous challenges to water resources:
- pollution
- overexploitation of surface & groundwater & saline intrusion,
- drought & water scarcity,
- Soil erosion & impacts on coral ecosystems & reefs,
- Lack of water & wastewater treatment, sanitation & hygiene.
- Changes in rainfall patterns related to climate change & impacts on water supply

In the Pacific (Figure 1), where many island states fall within the Least Developed Nations category, these challenges are exacerbated by limited resources and capacity. The SIDS are insignificant contributors to greenhouse gas emissions, yet will experience a disproportionate impact of climate change, especially the projected impacts of sea-level rise (Figure 2).
The above significant challenges coupled with resource and capacity limitations, mean that PICs as a whole will not meet the 2015 Millennium Development Targets for water and sanitation (Figure 3).

Figure 1. Pacific Island Countries (PICs) and their vast oceanic economic exclusion zones.

Figure 2. The regional distribution of projected sea-level rise for the period 2081–2100 relative to 1986–2005 from emissions scenario RCP4.5. The uncertainty is indicated by the contours (in centimetres). [BoM & CSIRO (2014). Climate Variability, Extremes and Change in the Western...
Figure 3. Progress towards meeting the 2015 Millennium Development Targets in water and sanitation in Pacific Island Countries, East Asia and the Pacific and the World (UNICEF). The failure to meet those targets is reflected in alarming health statistics, particularly amongst infants (Figure 4) and the elderly. These emphasise that water and sanitation are a vital issue in Pacific Island Countries.

Figure 4. Under five infant mortality rates in Pacific Island Countries (UNICEF). For Australia, the infant death rate is around 4 deaths per 1,000 live births (UNICEF, year?).

1.2.2.2 Australian Activities in Pacific Island Countries

Threats to Water Security
An analysis was carried out by Tony Falkland for the Australian Government of the threats to water security in 14 diverse Pacific Island Nations, Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Nauru, Niue, Palau, Papua New Guinea, Republic of the Marshall Islands, Samoa, Solomon Islands, Tonga, Tuvalu and Vanuatu (Figure 1) and included Timor Leste, to the year 2030. The analysis included projections of changes in future climates and sea-level out to the year 2030.

The study (Falkland, A. 2011-14, Water security and vulnerability to climate change and other impacts in Pacific Island countries and East Timor) concluded that the highest risks to water security out to the year 2030 were:

- increasing water demands due to population growth and urbanisation,
- pollution of water resources,
- saline intrusion into fresh groundwater due to over extraction,
- leakage from urban pipe systems,
- impact of natural hazards,
- poor water governance, management and monitoring,
- inadequately resourced agencies with restricted capacity,
- financially unsustainable water supply systems,
- vandalism and conflicts arising from property rights disputes between land owners and governments.

Crowded urban and peri-urban locations, remote communities and low-lying areas were considered most at risk.

Strategies for reducing the above risks included:

- improved water governance,
- increased assessment and monitoring of water resources,
- designing appropriate water supply systems,
- improving demand management,
- improving drought and flood planning,
- capacity building and training, and
- improving community education, awareness and participation.

1.2.2.4 Water Policy and Planning Development


- develop the general capacity of a society to cope with change by building up its institutional structures and human resources while
- maintaining and enhancing the integrity of ecosystems

The building up of institutional structures includes the development of national water and sanitation policy and implementation plans. Previously Australian IHP has assisted the governments of the Republic of Kiribati and the Republic of Nauru to develop national water, sanitation and hygiene policy and implementation plans.

In collaboration with the Applied Geoscience and Technology Division of the Secretariat of the Pacific Community, SPC, under the GEF Funded Pacific Islands Integrated Water Resource Management Program, Australian IHP Committee has assisted the government of Solomon Islands (Figure 1) through its National Intersectoral Water Coordination Committee to develop its 2014 National Water and Sanitation Policy and Implementation Plan.

1.2.2.5 Pacific Regional Program: Practical Climate Resilient Approaches for Food and Water Security and Coastal Zone Management

The overall aim of this program is to strengthen the national capacity of participating Pacific Island Countries to build their climate resilience and manage climate-related risks. The principal aims of the water sector contribution to Component 2, carried out by the Australia IHP Committee are to:
• carry out an initial risk assessment and analysis that identifies where gaps in water resources information represent a significant impediment to the management of current and emerging risks associated with climate variability and climate change; and

• to Identify practical opportunities in which participating countries can be assisted to strengthen their collection, management, analysis, communication and effective use of water resources information in order to achieve improved water security in the face of climate change.

The project is supported by the World Bank and coordinated by SPC and examined pilot sites in Kiritimati Atoll in the Republic of Kiribati and Kosrae island in the Federated States of Micronesia.

Pilot sites
In terms of climate, geography and geomorphology, these islands are at opposite ends of the spectrum. Kiritimati, a low, limestone atoll, lying on the edge of the equatorial dry zone, with very poor soils, has the lowest mean, and most variable, annual rainfall of any permanently settled atoll in the Pacific. Kosrae, a high volcanic island on the northern edge of Pacific warm pool (PWP) and within the path of the intertropical convergence zone (ITCZ), with highly productive soils has one of the wettest coastal zones in the world with low rainfall variability. Kiritimati relies heavily on scarce highly vulnerable groundwater lenses overlying seawater for its water sources. Kosrae has abundant rainfall and perennial streams as well as groundwater. Paradoxically, the high island of Kosrae is much more vulnerable to sea level rise, because of the clustering of its settlements around the coastal fringe and its geographic position in the northwestern equatorial Pacific cyclone zone, than the low atoll of Kiritimati in the central eastern equatorial zone outside the cyclone zone. In Kiritimati the discrete freshwater lenses are at slightly higher elevation than in other atolls.

Issues in Common
Despite the vast differences in governance, geography, geology, cultures and climate, the study found that Kiritimati and Kosrae share common issues which increase risk in the water supply and sanitation sector.
1. Inadequate monitoring of water resources with major implications for management and planning
2. Inadequate storage of water resource data
3. Lack of capacity and resources to use data to improve management
4. Lack of capacity and resources to critically assess aid projects in the sector
5. Almost no connection with the local meteorology office
6. Poor communication and cooperation between water agencies.
7. Poor systematic communication between water agencies and island government
8. Decaying infrastructure with inadequate maintenance
9. Lack of resources to treat water
10. Lack of capacity and resources to plan or implement plans
11. Aid projects being implemented in the sector which are not whole island solutions and will not address future development needs.
12. Sub-optimal use of rainwater harvesting
13. Potential to increase the use of renewable energy in water supply systems.
14. Sanitation is scarcely mentioned.

Pilot projects were designed in each site to address these issues, particularly to enhance monitoring and analysis of climate and water parameters, to increase the use of seasonal forecasting, to enable development of safer locations and to engage local communities.

1. Rainfall Harvesting and Storage in Funafuti Tuvalu
Water resources in low-lying coral atolls are amongst the most vulnerable in the world due to the high permeability of the coral sands and the thin fresh groundwater lens, the main storage, which overlies seawater. In some atolls the coral sands are so permeable that no fresh groundwater exists. These atolls must rely on rainwater harvesting or desalination to supply their water needs.

Funafuti atoll (Figure 5), the capital atoll of Tuvalu has no fresh groundwater and rainfall harvesting is the principal source of fresh water.
Figure 5. Funafuti atoll, Tuvalu has no fresh groundwater and must rely on rainwater harvesting and desalination for water supply (NASA Shuttle Mission STS104, Jul 2001). It is extremely vulnerable to drought. In an AusAID funded project through SPC, Australian IHP has carried out an analysis of the risk of failure of rainwater harvesting systems in Funafuti. The study identified that the three principal contributors to the failure of rainwater harvesting in Funafuti are the large demands in large family dwellings, the limited roof areas and rainwater tank storage volumes and inadequate guttering. It was found that there is a critical roof area to rainwater tank capacity ratio that needs to be supplied to reduce the risk of failure. The AusAID project is aimed at decreasing the risk of failure by improving rainwater harvesting infrastructure and its management.

Water Supply Improvements, Kiritimati (Christmas Island), Republic of Kiribati
Kiribati consists of 33 islands scattered across 5 million km² with an population of about 100,000 living in 20 low-lying coral atolls and islands. It is a least developed country with a GDP per capita of about US$1,300. Kiritimati is the largest coral atoll in the world with a total area of about 640 km². About 60% of this area is land while the remainder consists of lagoons. Kiritimati comprises 70% of the total land area of Kiribati and is the second most populated island in the nation with a growing population of about 6,000 (2010 Census). The Government of Kiribati has designated Kiritimati as the main potential growth island in Kiribati. As a result of the government's strategy, Kiritimati population growth forecasts predict an annual growth rate of 8%.
Figure 6. Satellite image of Kiritimati atoll, Kiribati.

Kiritimati is located within the equatorial dry zone of the Pacific Ocean and its climate is dominated by long drought periods associated with La Niña periods and high rainfall periods associated with El Niño events. The mean annual rainfall is just less than 1,000 mm and the coefficient of variation, Cv, of annual rainfall is 0.72, which is very high. The average annual rainfall is lower and more variable than on other populated Pacific Island countries. Most other Pacific Island countries have average annual rainfalls between 1,500 mm and 3,000 mm and Cv's of annual rainfall between 0.15 and 0.25.

The freshwater resources of Kiritimati consist of groundwater and limited rainwater. The fresh groundwater occurs as 'freshwater lenses' which are fresh groundwater aquifers overlying seawater. These freshwater lenses have formed in favourable locations under the surface of the atoll. The soils are too permeable to support any fresh surface water resources.

The current Kiritimati Improved Water Supply Project, funded by the European Union and managed by the Water and Sanitation Programme of SPC, is focused on water supply improvements for the second largest village of London and a nearby settlement Tennessee. The overall objective of the Project is to improve livelihoods and enable human, social and economic development on Kiritimati Island.

Main activities of this project are:

- Install, rehabilitate and operate monitoring bores for the freshwater lenses used to supply London and Tennessee and revise assessments of sustainable yields.
- Undertake urgent improvement works to the existing water supply system, including rehabilitation of infiltration galleries and solar and wind powered pumps, install flow meters and refurbish water disinfection facilities.
- Undertake detail design work of the proposed water supply upgrade works and construct new facilities (including infiltration galleries, pipeline, storage tanks).
- Provide training to local water supply personnel in water supply system management, operation and maintenance and in vital water monitoring activities.
- Implement consumer education and awareness regarding the wise use of the limited available water resources.

1.2.3 Hydrology for Environment, Life and Policy (HELP)

Australia continues to contribute to the projects established under the HELP banner: the Lower Murrumbidgee catchment in the Murray Darling River Basin (coordinated by Awadesh Prasad, Murray Darling Basin Authority), Tully Basin (coordinated by Jim Williams, CSIRO), Lower Burdekin River Basin (coordinated by Keith Bristow, CSIRO), Fitzroy River basin (coordinated by
Chris Carroll, Queensland Department of Environment Resources and Mines) and the Ord River Basin (coordinated by Jeff Camkin University of Western Australia and Dick Pasfield). Overall coordination in Australia is through Prof. Jeff Camkin, University of Western Australia.

Prof. Jeff Camkin was an invited keynote presenter at the IHES/UNESCO Symposium Restoring Rivers for Future, South Korea (April 2011) and invited member of the Steering Committee for the UNESCO-IHP HELP 2nd International Symposium Building Knowledge Bridges for a Sustainable Water Future in Panama, November 2011.

The HELP Program, and HELP network participants from Australia and other countries, has featured in new modules developed for the Erasmus Mundus MSc in Ecohydrology delivered at the University of Algarve through a collaboration between the International Centre for Coastal Ecohydrology (under the auspices of UNESCO), the UWA and Technical University of Lisbon.

Activity in the Murray Darling HELP Basin has focussed on the development of a Basin plan, the largest ever water reform in the Murray Darling Basin.

1.2.4 Collaboration with other national and international organizations and/or programmes

As President of the WMO Commission for Hydrology Network, Mr Bruce Stewart provided a link between the UNESCO IHP and WMO’s Operational Hydrology Programme. Mr Tony Falkland and Prof Ian White are members of the Water Working Group of the Science, Technology and Resources Network of the South Pacific Applied Geoscience Commission. Prof Ian White is a member of the Asian Pacific Association of Hydrology and Water Resources. Mr Trevor Daniell is the past Chairman of the FIGCC and was editor of the FRIEND 2014 Conference papers. Dr Peter Dillon chairs the IAH Commission on Managed Aquifer Recharge. University of Western Australia has entered into a Memorandum of Understanding with the International Centre for Coastal Ecohydrology (under the auspices of UNESCO). Prof. Jeff Camkin, who coordinates HELP in Australia, has designed and delivered new components of the Erasmus Mundus MSc in Ecohydrology course in 2010 to 2014 and further work is being developed under the MoU.

1.2.5 Major activities of BoM

The National Water Account is Australia’s most comprehensive water information report and the report for 2014 was released in May 2015. It provides a picture of water resources management for the previous financial year for ten nationally significant water regions: Adelaide, Burdekin, Canberra, Daly, Melbourne, Murray–Darling Basin, Ord, Perth, South East Queensland and Sydney. The National Water Account discloses information about water stores and flows, water rights and water use. It also reports on the volumes of water traded, extracted and managed for economic, social, cultural and environmental benefit. Ref http://www.bom.gov.au/water/nwa/2014/overview/index.shtml

Key findings
- Continued dry conditions across much of Australia through 2013–14 contributed to a second consecutive year of reduced inflows to storages and increased demand on the available resources in many regions.
- Surface water storage volumes in the nine National Water Account regions decreased during the year—from approximately 30,978,800 ML (or 75% capacity) at 1 July 2013, to approximately 29,922,900 ML (or 72% of capacity) at 30 June 2014.
- Water use was approximately 13,251,000 ML across the nine regions, a 21% decrease on use in 2012–13.
- Surface water, including inter-region transfers, accounted for 84% of water used, while groundwater accounted for almost 15%. Other sources, including desalinated water, contributed just over 1% of the volume of water used.
• The Murray–Darling Basin accounted for 80% of water used in National Water Account regions—primarily for irrigated agriculture, which is the major use of water in Australia.

Water security in urban areas has been improved through investment in desalination plants. Coastal urban regions can produce desalinated water to meet a portion of urban demand. In 2013–14, Adelaide and Perth relied on desalinated water for almost 40% of urban supply, an increase of more than 30% from 2012–13. In comparison, good surface water availability in Melbourne, South East Queensland and Sydney meant little or no desalinated water was produced in these regions.

To celebrate National Water Week in 2014, the Bureau of Meteorology released the Australian Groundwater Explorer at Australian Parliament House.

Parliamentary Secretary to the Minister for the Environment, Simon Birmingham, launched the valuable tool which provides a comprehensive picture of Australia’s groundwater resources.

National Water Week is a great time to increase community awareness around water issues and how best to use our valuable water resources.

The Australian Government’s Improving Water Information Programme, led by the Bureau and supported by water agencies across the country, is helping to improve our national understanding of all water resources, including groundwater.

3D model of Murray Basin
A 3D hydrostratigraphy model has been developed for the Murray Basin in southeastern Australia. The model can be viewed as an interactive PDF in the new Australian Groundwater Explorer, so you can view the data in 3D, including the ability to zoom in and out, pan and turn layers on and off.

The model has nine layers, which represent the aquifers and aquitards in the Murray Basin. Layers for the New South Wales section were produced by the Bureau of Meteorology using hydrostratigraphy logs interpreted by the NSW Office of Water. Victorian layers were provided by the Department of Environment and Primary Industries and South Australian layers by the Department of Environment, Water and Natural Resources.

The dataset, including ESRI georasters and geovolumes, is available by email request to groundwater@bom.gov.au
Water data at your fingertips
Water Data Online provides a single access point to nationally consistent, timely data from thousands of water monitoring stations across Australia.

As a water manager, policymaker, researcher or industry professional, you can better understand Australia’s water resources by viewing or downloading data and reports. You can now find standardised watercourse level and watercourse discharge data from approximately 3500 water monitoring stations around Australia.

Water Data Online displays information collected by the Bureau of Meteorology from lead State and Territory water agencies under the Water Regulations 2008. Over time, more stations and parameters will become available and linkages will be made from the Geofabric.


Key Points made in this report (http://www.bom.gov.au/state-of-the-climate/)
• Australia’s mean surface air temperature has warmed by 0.9°C since 1910.
• Seven of the ten warmest years on record have occurred since 1998.
• Over the past 15 years, the frequency of very warm months has increased five-fold and the frequency of very cool months has declined by around a third, compared to 1951–1980.
• Sea-surface temperatures in the Australian region have warmed by 0.9°C since 1900.

1.2.6 WIRADA

The Water Information Research and Development Alliance (WIRADA) is a partnership between the Bureau of Meteorology and The Commonwealth Scientific and Industrial Research Organisation. WIRADA brings together CSIRO's leading expertise in water and information sciences and the Bureau’s operational role in hydrological analysis and prediction to deliver value-added water information products and tools.

The initial $50 million investment during 2008 to 2013 delivered significant scientific and research innovation required by the Bureau to fulfill its national water information mandate. A snapshot of the outstanding achievements made by WIRADA previously is available for download. Details on the achievements of WIRADA are also in annual reports under the Key Documents list below.


Highlights and achievements include:
• A final standard (WaterML2.0 Part 2) for adoption by the Open Geospatial Consortium to describe, share, and access rating tables, stream gaugings and cross-sections.
• Work towards new standards for the exchange of groundwater features (aquifers, boreholes, wells, construction components, etc.) and observations.
• A new version (v5.0) of the Australian Water Resources Assessments (AWRA) modelling system that successfully couples landscape and river modelling components. The model incorporates improvements to the landscape modelling component, and an extended river model for catchment headwaters. The Bureau is currently implementing the models operationally into a unified system based on the Python language.
A new staged error-modelling approach that corrects long-term biases, updates model forecasts using recent prediction errors, and describes the distribution of residual errors. The Bureau is adopting this error-modelling approach as it transitions the new 7-day streamflow forecasts service to produce ensemble forecasts.

An improved and simplified Forecast Guided Stochastic Scenarios (FoGSS) model for seasonal streamflow predictions, which now requires fewer parameters. Its performance has been successfully evaluated in 63 catchments including a number of intermittent systems. Computer code for the model is now with the Bureau for operational deployment.

1.2.7 Australian Rainfall and Runoff

Climate Change Guidelines

ARR launched its Interim Climate Change Guidelines at the Engineers Australia Convention 2014 in Melbourne in November. These guidelines were led by Dr Bryson Bates from CSIRO. This draft discussion paper draws on the most recent climate science, particularly the release of the IPCC Fifth Assessment Report on the Physical Science Basis in September 2013 (IPCC, 2013) as well as the new climate change projections for Australia (CSIRO and BoM, 2014), and outlines an approach to address the risks from climate change in projects and decisions that involve estimation of design flood characteristics. For consistency with the revised IFD design estimates for Australia, the Interim Guideline is intended to be applied to current-day rainfall intensities with a probability of one exceedance per year or annual exceedance probabilities (AEPs) from 50% to 1%.

Workshop at Conference 2015

ARR ran a workshop on the latest updates at the Engineers Australia Hydrology and Water Resources Symposium Hobart in December 2015.

1.3 Educational and training courses

The National Centre for Groundwater Research and Training (a joint venture between 9 research/educational institutions, government water management organizations and private consultants) organises a wide range of groundwater related training courses. Details of courses can be found at the web site http://www.groundwater.com.au/conf/content.asp. The centre has established strong links with institutions in the region, particularly in Indonesia, Malaysia, Thailand and China.

1.4 Publications

There are numerous Publications from various conferences and Journals. Some of Particular interest are:

As a submission to the RSC history document, Australia IHP committee prepared a document entitled "International Hydrological Programme (IHP) History of Australia in Asia Pacific Region", August 2015. This was then included in the "Celebrating 50 years of Water Leadership in Asia and the Pacific Success Stories from the Field" UNESCO publication October 2015.

Both Tony Falkland and Trevor Daniell received awards for their contribution to IHP in the region at a meeting in Medan, Indonesia, October 2015.

Recent publications of National Water Commission


Australia’s water blueprint: national reform assessment 2014
20 Oct 2014

Urban water futures 2014
14 Oct 2014

Over the past 10 years, the Australian urban water sector has weathered new extremes in drought and flood and, as a result, has changed significantly.

Annual report 2013-14
This is the National Water Commission’s report to parliament on our performance in 2013–14. It reports on our performance against our outcome, deliverables and key performance indicators as outlined in our Portfolio Budget Statement.

1.5 Participation in international scientific meetings

There have been numerous individuals participating in many meetings for IHP, APFRIEND, WMO, SOPAC, HELP.

The Groundwater Governance 'Shared Global Vision for 2030', 'Global Framework for Action' and 'Global Diagnostic' involved participation from many Australian researchers at different consultation meetings and in the final expert panel meeting. These documents were presented and discussed at a special side event at the 7th World Water Forum in Daegu, Korea early in 2015.

1.6 Other activities at a regional level

A project titled: Enhanced Application of Climate Predictions in Pacific Island Countries is currently in progress to meet the general goals of improving weather and climate services and products. The AusAID funded project is developing a climate prediction capacity in participating countries, and in particular, is providing a framework for incorporating climate prediction information into planning across a broad range of agencies and industries. The climate prediction system being provided under the project is based upon the seasonal climate prediction system of the Australian Bureau of Meteorology, which has successfully issued climate predictions for some years. (www.bom.gov.au/climate/pi-cpp/)

Dr Peter Dillon of the CSIRO, Water Recycling and Diversified Supplies, Urban Water Theme, Water for a Healthy Country Flagship Program, CSIRO Land and Water, has been active in Managed Aquifer Recharge across the region and beyond. www.clw.csiro.au/research/urban/reuse

1.6.1 Institutional relations/co-operation

No information available at this time.

1.6.2 Completed and ongoing scientific projects

Refer section 1.2.3 re ongoing Pacific Island projects.

2. Future Activities

2.1 Conference Activities in 2016

Stormwater 2016, Hosted by Stormwater Australia, Monday, 29th August - Friday, 2nd September, 2016, Hilton Hotel, Brisbane, Queensland

2.2 Activities Planned for 2016/17

• Transference of the outcomes of update of ARR to the International Community.
• Continuation of assistance to Pacific Island Projects.
• Continuation of involvement in Asian Pacific FRIEND and Global FRIEND
• Continuation of involvement in HELP
• Participation in the IHP Intergovernmental Council of 2014/2016

2.3 Activities envisaged in the long term

No information available at this time.