Water Forum
2015

Tuesday, 18 August
Wednesday, 19 August

Water for Cities
Water for the Environment
Water-resilient Communities
Water for Productive Economies

Dedicated to a better Brisbane
Global Change Institute
2015 Water Forum
18 & 19 August
Level 2, Building 20 Staff House Road
University of Queensland’s St Lucia Campus

PROGRAM

Tues, 18 August 2015

09.45 – 10.00  Registration

10.00 – 12.00  Session 1 – Water for the Environment

Sponsors

Session 1 – Water for the Environment

Formal introduction
Prof. Ove Hoegh-Guldberg, Director, GCI

Opening welcome
Sarah Jones – Healthy Waterways (session sponsor)

Discussion starter
Prof. Ove Hoegh-Guldberg, Director, GCI

SPEAKERS

- Helen Ross (SAFS) – Social and cultural values towards waterways
- Chris Greig (UQEI) – The energy-water nexus: An array of extreme risks laced with opportunity
- Susanne Schmidt (SAFS) – Riparian reforestation rapidly promotes water infiltration
- Joshua Larsen (GPEM) – How much water does the world have?
- Ka Leung Lam (Chem Eng) – Crisis response results in long-term reductions in urban water consumption and energy use in a water supply system
- Matthew Hayes (SBS) – Mangroves are groundwater dependent ecosystems
- Craig Froome (GCI) – Small Island Developing Nations – The Water Energy Nexus
- Jane O’Sullivan (SAFS) – Aquatic food production: Tensions between human needs and environmental impacts
- Wayne Hall (CYSA) – Ethical and legal issues in using wastewater to monitor illicit drug use in the general population and in special settings such as schools and prisons.
- Matthew Adams (Chem Eng) – Oxygen: an important and highly dynamic water constituent in aquatic ecosystems

12.00 – 1.00  LUNCH (complimentary – RSVP essential)

1.00 – 3.00  Session 2 – Water for Productive Economies

Sponsor

Session 2 – Water for Productive Economies

Discussion starter
Ian Callow
Research Manager – Water in Mining, SMI (session sponsor)

SPEAKERS

- Wayne Bryden (SAFS) – Food: How often do you have a liquid lunch?
- Greg Keir (CWMI) – Estimating groundwater use in Queensland’s coal seam gas basins
- Jim Undersultz (CCSG) – Estimating baseline conditions of hydrocarbon in groundwater
- Laura Wendling (SAFS) – Wealth from waste: the beneficial reuse of low-cost materials as substrate in water treatment wetlands
- Lynda Lawson & Danellie Lynas (SMI) – Buruli Ulcer: Water, Mining & Community Health
- Sue Vink (SMI) – Environmental Flow Framework for Peru
- Franziska Curran (EPRG) – Understanding causal structures of energy and water impoverishment to enhance development interventions
- Trang Huynh (SMI) – Monitoring bioavailability of metals and metalloids in river water receiving mine water discharge
- Liam Byrnes (SAFS) – Incorporating the energy-water-food nexus for communities ‘in transition’

To RSVP, visit https://www.surveymonkey.com/s/72LB2J6
For further details, contact Nina Hall at n.hall2@uq.edu.au or 3443 3104
Wed, 19 August 2015

7.30 – 9.30  **VIP Water Breakfast, featuring Queensland Chief Scientist, Dr Geoff Garrett AO (invitation only)**

10.00 – 12.00 **Session 3 – Water for Cities**
Introduction by
Prof. Eva Abal
Director, Sustainable Water Program, GCI
Welcome by Paul Heaton
Director, Gold Coast Water (session sponsor)
Discussion starter
Dr Sandra Hall
Engagement & Business Development Manager
Advanced Water Management Centre

**SPEAKERS**
- Angela Dean (ISSR) – Engaging communities in water-related issues
- Yvette Bettini & Brian Head (ISSR) – Delivering public good through urban water management: a review of governance and practice in Australian Cities
- Declan Hearne (IWC) – Social contracts: A framework for building reliable urban water supply services in Eastern Indonesia?
- Bruce Mortimer (UQBS) – Dominant stories and their influence on strategic decision-making for the water industry
- Steve Kenway (Chemical Eng) – Urban metabolism analysis will help find pathways for energy-efficient water systems
- Jochen Mueller – A new approach for identifying chemical hazards in water

12.00 – 1.00  **LUNCH (complimentary – RSVP essential)**

1.00 – 3.00  **Session 4 – Water-resilient Communities**
Discussion starter
A/Prof. Kelly Fielding
ARC Future Fellow
Institute for Social Science Research

**SPEAKERS**
- Paul Jagals (SPH) – Water and Wellbeing: Investing in the Environmental Health of Communities in Developing Country Settings
- Amy McMahon (SSS) – Water Security, Gender and Climate Change in Bangladesh
- Annika Kearton (IWC) – Pacific Adaptation to Climate Change for Water Sanitation and Hygiene
- Mark Moran (ISSR) – When solutions became the problem: Adaptive responses to complex problems
- Peter Hill (SPH) – Are we diluting water in the proposed Sustainable Development Goals?
- Regina Souter (IWC) – Community-based sanitation markets in Melanesia.
- Sylvie Shaw (HPI) – What role if any should religious organisations have in relation to waterways management?
- Timothy O’Rourke (SA) – Water for Aboriginal yards in dry landscapes
- Sara Dolnicar (UQBS) – We can clean it, but they don’t want to drink it!
- Danielle Barrington (IWC) – Achieving sustained water, sanitation and hygiene (WaSH) services in informal settlements of the South Pacific
Dr Matthew Adams
Chemical Engineering
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Oxygen: an important and highly dynamic water constituent in aquatic ecosystems

Daily fluctuations in water constituents can substantially influence the health of aquatic ecosystems. Oxygen, in particular, increases in the water column during the day and decreases during the night due to the balance between the ecological processes of photosynthesis and respiration. Daily variation in oxygen concentration can induce a daily cycle between oxygen supersaturation and undersaturation, which in turn affects the efficiency of ecological processes. The oxygen exchange between the water column and the ecosystem also varies during the day in a “hysteric” pattern: there is higher net oxygen production in the morning than in the afternoon, a pattern which has yet to be explained. In this talk, I show that the daily changes in oxygen concentration of the water column in a seagrass ecosystem in Lake Macquarie (New South Wales, Australia) demonstrate (1) a daily oscillation between oxygen supersaturation and undersaturation, and (2) a hysteretic pattern during the day that can be explained by daily variations in ecosystem respiration in response to light history. Overall, our results indicate that the daily variation in ecosystem respiration importantly contributes to oxygen dynamics in the water column and requires further consideration of its impact on ecosystem health.

Danielle Barrington
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Achieving sustained water, sanitation and hygiene (WaSH) services in informal settlements of the South Pacific

International development agencies, governments and charities have been working together for many years to provide improved access to water, sanitation and hygiene (WaSH) facilities and services for communities in developing countries. Yet this has not always been as effective as intended, and there is a growing concern amongst WaSH practitioners and scholars that current practices may not always lead to sustainable community wellbeing. We have partnered with informal, peri-urban South Pacific communities and enabling actors (e.g. government agencies, non-governmental organisations (NGOs), water utilities) to investigate how WaSH products and services are currently obtained through a mixture of exchange mechanisms, and to identify and foster emerging exchanges which have the possibility of providing more community members with better WaSH access. This has been conducted through participatory action research (PAR) methods where the communities and enabling actors have engaged as researchers alongside academics and NGO practitioners to develop WaSH exchange systems which are locally driven and appropriate to context.

Prof. Wayne Bryden
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How often do you have a liquid lunch?

Food is fundamental for human existence and health but many of the world’s inhabitants experience ongoing hunger. The challenge of preventing hunger and malnutrition will become even greater as the global population grows from the current 7 billion people to nearly 10 billion by 2050. Not only is the global population increasing, we are living longer and becoming more affluent. As incomes increase, diets become more energy-dense and meat becomes a larger proportion of the diet. These changes in population and cuisine have led to a tremendous rise in the demand for animal-source protein. To meet this increased demand, we will need to be less dependent on resources that are
becoming scarce, like arable land and water, or more costly, like energy and petrochemical-based inputs, including fertilizers. Some would argue that it is how we manage the nexus between food, water and energy that is our biggest challenge for global food security.

The past decade has seen prolonged and severe drought over much of Australia. The major effect of the decrease in rainfall has been to put pressure on the use of freshwater for agriculture. If the animal industries are to respond adequately to freshwater scarcity, then it must have a reasonable basis for calculating the cost in freshwater to produce animal products. Therefore, calculating the cost in freshwater for each kilogram of beef steak has never been more urgent, or more controversial. The amount of daily drinking water required by beef cattle is in the range of 5–10% of body weight per day, that is, 15–30 L per day for a 300-kg steer. The current debate about the amount of water required for livestock production cites values such as 50 000 L or 100 000 L per kilogram of beef. The calculations are based on the annual evapotranspiration rate from pasture measured as 15 ML (or 15 000 000 L) per hectare, and then assessed against an annual weight of dressed steak (300 kg) per hectare. Clearly, these calculations place livestock products such as beef well above cereal (e.g. 1000 L per kg of maize grain) in terms of water requirements. However, one has to question whether it is biologically and environmentally reasonable to calculate water consumption of grazing livestock by such methodology. If the calculation is based on just the water consumed by a 300-kg steer on a daily basis (i.e. 15–30 L), then the annual intake is 5400–10 800 L. This steer should yield approximately 150 kg carcase weight that might dress out at 65%, which means a total of 97.5 kg of steak. By this methodology the water used per kg steak would be 5400 or 10 800/97.5 = approximately 55–111 L per kg steak, that is, as much as three orders of magnitude less than values often cited. Naturally this type of methodology does not account for the total water used by the enterprise or the water returned as urine, nor the water that enters metabolism or is produced during energy metabolism, or the water that enters lean tissue turnover pool. Obviously, net water use by livestock is a major gap in the knowledge of assessing the environmental footprint of the meat and livestock industry. Nevertheless, whichever methodology we choose, the food you consume has a major “liquid” component.

Liam Byrnes
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Incorporating the energy-water-food nexus for communities “in transition”

The research project considers rural communities in transition. Transition can be driven by urbanisation, industrial development (e.g. the introduction of mining) or major sectoral shifts including moving from an agrarian/marine based economy to an urban one. Communities in transition have to manage substantial challenges relating to changing social context, planning and infrastructure requirements, and ensuring adequate food, water and energy are available. Currently, governments and communities address these challenges haphazardly which can exacerbate existing issues and create new challenges. They also fail to address the interconnections between food, water and energy effectively. Complementary approaches that consider this nexus as a central component as well as the broader social context are needed. The project is an applied study that develops complementary solutions for communities that are in transition. This requires consideration of the interrelationship between energy, water and food, as well as the social factors driving adaptation of behaviours and technology adoption. Planning and architecture are also considered to facilitate more efficient and complementary use of resources. It examines how existing technologies can be used in new ways to help communities manage their
transition more effectively. The research outcomes build applied understanding of how communities can incorporate approaches that directly consider the interconnections between energy, food and water, facilitate more efficient use of resources and improve livelihoods.

**Water: Drought, crisis and management in Australia and Brazil – a comparative framework**

Despite huge differences related to income and development levels, Australia and Brazil have some temporal convergences among their water management systems. In the past 20 years, both countries have made essential changes to their water policies and practices. The Brazilian National Water Resource Policy, drawn up in 1997 under Federal Law 9433, has been gradually implemented and reflections on its effectiveness have been made in various areas of debate. Over these years, some nuances have been associated with the profile of governmental bodies and National Water Resource Management System (SINGREH) management committees, in a participatory approach, also established by Law 9433. However, the historical drought period from the last 2 years has been challenging the system, which has not been able to address the main issues properly, in terms of avoiding a major water crisis. On the other hand, Australia came from a severe drought period (2002-2006) which pressured the changes in water supply and consumption scheme, affecting the regulatory board. Ten years later, some studies have pointed out the balance between measures and consequences, bringing elements and lessons, which can be interesting for comparative researches. This paper aims to present a comprehensive and comparative framework about Australian and Brazil’s contemporary water management focused on water crisis and related regulatory issues.

**Understanding causal structures of energy and water impoverishment to enhance development interventions**

People are limited in their ability to contribute to an economy unless their basic human needs are satisfied, including access to improved water and energy sources. Approximately 2.7 billion of the world’s population rely upon traditional biomass for household cooking and just under 1 billion lack access to improved water sources. The energy and water impoverished are often required to walk long distances to collect fuelwood and water to satisfy household needs, consuming time that could otherwise be used for gaining an education or generating income. This project aims to understand the causal connections between water and energy in low income countries, and explores how these connections can be leveraged to facilitate sustainable development and lead to economic growth. The structure of many of these systems leads to detrimental impacts on the health of individuals, through physical burden, illness from contaminated or improperly contained water and respiratory issues from combustion of biomass in unventilated homes and by use of unimproved cook stoves. Through investigation of the structures linking water and energy impoverishment via system dynamics, the potential for concentrated and collaborative development approaches overlapping these two sectors is highlighted.
**Engaging communities in water-related issues**

Sustainable urban water management requires community acceptance of changes in policy, practice and technology. Supported by the “CRC for Water Sensitive Cities”, we identify strategies that promote engagement in water-related issues, targeting knowledge, attitudes and behaviours. Current projects include: 1. Knowledge: A nationally representative survey assessed water-related knowledge (n=5172). Although most respondents knew that household activities can impair waterway health, less than 33% knew that stormwater isn’t treated before entering waterways, and that wastewater and stormwater are carried via separate pipes. Higher knowledge was associated diverse factors, including exposure to information. 2. Engagement typologies: we developed a data-driven typology of water-related engagement, based on knowledge, identity, support for recycled water, water-saving behaviours, and pollution-reduction behaviours. We identified five key groups differing in their engagement. Determinants of group membership included demographics, home-ownership, and diverse life experience, reinforcing the need to consider individual and contextual factors when cultivating engagement. 3. Motivating engagement in stormwater issues: focus group discussions highlighted that community perceptions of stormwater relate to flooding and drainage, rather than pollution or waterway impacts. Discussions reinforced the importance of ‘visibility’ when motivating engagement: individuals engage more readily when both the problems and solutions are visible (e.g. management of litter vs sediment).

**We can clean it, but they don’t want to drink it!**

The presentation will give an overview of some of the key findings that resulted from a five year research project into public acceptance of water from alternative sources in Australia, including attitudinal inertia despite changed circumstances, styles of media reporting undermining improved understanding of water issues, promising communication strategies to increasing acceptance and who the public perceives the most trustworthy communicators of water messages to be.

**Removal of Persistent Organic Contaminants via Electro-chemically activated Sulfate**

The electro-chemical advanced oxidation processes (EAOPs), especially when employing boron-doped diamond (BDD) anodes, are capable of effectively oxidizing toxic trace organic contaminants such as pesticides and pharmaceuticals which are inefficiently removed in conventional wastewater treatment systems. Persulfate is reported to be produced in sulfate-based BDD-EAOPs; however, no mechanism of its interaction in such systems have been outlined. This work addresses the potential formation of SO4•- radicals through the step of formation of persulfate as well as its decomposition and investigates the contribution of such radicals to the degradation of the toxic organics. Results show faster degradation rates and complete removal of the toxic organics in sulfates compared to nitrates, where higher rates were reported at higher sulfate concentration and current density. Chemical oxidation of these organics showed no oxidation power of pure persulfate, holding SO4•- radicals responsible for the faster oxidation rates.
**Small Island Developing Nations – The Water Energy Nexus**

There are many small island nations that rely on fossil fuels (particularly black oil or diesel) for their electricity generation. Much of this electricity is then utilised to run desalination plants to provide potable water. These nations are also the most susceptible to the effects of climate change and have aspirational goals to change current practices for a sustainable future. In many cases both the electricity and water utilities are owned by the one entity, which is privately held with no sovereign connection and therefore driven by commercial outcomes rather than public benefit resulting in higher consumer costs. Renewable energy is providing an option to break the cycle and through utilising solar energy, provide water when the sun is shining. The ability to provide a level of energy security that has never existed in the past will allow these small nations to meet the aspiring environmental and economic goals they are seeking.

**The energy-water nexus: An array of extreme risks laced with opportunity**

Energy and water resources and services are critically interdependent and vital for economic prosperity and even human survival. When coupled with projections for population growth and risks associated with climate change, these interdependencies between energy and water present society with extreme risks. At an individual regional level, there could well be winners and losers but globally the implications are likely to be very negative. Amidst these extreme risks there are opportunities for better decision making which can reduce the consequences of such risks. Such opportunities need to be carefully assessed to avoid social and environmental unintended consequences. This presentation will explore the most vulnerable regions and highlight opportunities for decision making to reduce the risk exposure. In all cases these decisions require consideration of both energy and water resources at a system level, in determining the configuration of services to be provided. From an Australian perspective the presentation will highlight the risks and opportunities in terms of water resources for power generation and unconventional gas extraction.

**Ethical and legal issues in using wastewater to monitor illicit drug use in the general population and in special settings such as schools and prisons**

Wastewater analysis (WWA) of drug residues promises to overcome some of the limitations of traditional survey methods of monitoring illicit drug use in the population. It does not require the time and expense to obtain good response rates in surveys of drug use in large representative population samples. It can report on population use of illicit drugs in a timely fashion that can be repeated periodically to monitor trends in use. We briefly discuss technical, ethical and policy issues that may be raised by (1) current applications of WWA to monitor use in large scale populations; and (2) future uses of this method (e.g. to detect new and emerging illicit drug use; monitor population alcohol use; and by to monitor illicit drug use in special settings such as prisons, schools and sporting venues. Our analysis indicates that WWA does not raise major ethical concerns when it is used to monitor illicit drug use in large populations. The method produces information of considerable public health value with very little risk of harm because individuals are not identified and the prospects of harming people who reside in these catchment areas is remote. WWA could also be used without ethical concerns to monitor population use of alcohol, tobacco and pharmaceutical drugs. These uses of WWA also have considerable public benefits and do not raise any special ethical concerns over and
above those raised by currently used methods to monitor illicit drug use in the population. When WWA is used in smaller catchment areas (entertainment venues, prisons, schools or workplaces) we may need to exercise more care in how the results are reported to minimise the small risk of indirectly harming occupants of these settings. Researchers will need to take care in reporting results of such studies to reduce media misreporting. Fears about possible use of WWA for mass individual surveillance by drug law enforcement officials are unlikely to be realised but they will need to be addressed to ensure that they do not undermine public support for waste water epidemiological research.

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Mangroves are groundwater dependent ecosystems

The roots of mangrove trees are periodically submerged by seawater, yet evidence for tree use of groundwater and fresh atmospheric water sources, which results in benefits for growth, is strong. Groundwater that is fresher than seawater and enriched in nitrogen often emerges on the coasts at sea level providing a resource to support the metabolic function and growth of mangrove forests. We assessed the effect of groundwater on biomass allocation and decomposition of a common and widespread mangrove, Avicenna marina, through changes in seasonal water use, nutrient availability and salinity across an intertidal gradient. Using analysis of 818O and 82D isotopes in tree stem water we also assessed use of differing water sources. We found groundwater use by trees changed by season and the proportion of groundwater use or use of seawater varied over the intertidal zone. We found the proportional use of groundwater increased aboveground growth but had no effect on belowground growth. Belowground growth was influenced by nutrient availability across the intertidal zone, increasing with decreasing nutrient availability. Our research shows that groundwater can influence nutrient availability and salinity in intertidal sediments and that biomass allocation to roots will be higher in the low intertidal zone where root growth is high and rates of root decomposition low. The strong dependence of mangrove trees on groundwater gives insight into their vulnerability to local disturbances of hydrological flows and indicates that changes in groundwater availability as result of climate change or groundwater extraction will have a large effect on the functioning of mangrove forests.

Prof. Brian Head & Dr Yvette Bettini
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Delivering public good through urban water management: a review of governance and practice in Australian cities

Managing water in Australia’s cities delivers many benefits additional to potable supply, including watering public open space, reducing flood risk, and protecting urban waterways and amenity. Governance structures for delivering water services are based on corporatised models, where Government-owned utilities are licenced and regulated to deliver safe and secure drinking water, remove and treat wastewater, and in some jurisdictions manage stormwater quality and quantity, while returning a dividend to government. Social and environmental benefits provided through the operations of water utilities cannot be easily costed within the business models of these corporatised organisations. Moreover, water utilities can be reluctant to deliver additional benefits through their operations due to financial and regulatory risks. Nevertheless, urban water management needs to deliver a broader range of water benefits to support healthy people, environments and economies in cities. This research examined legislative and regulatory provisions for water utilities in Perth, Melbourne and Brisbane with a view to identifying water management practices that extend beyond supply, sewerage, drainage services to deliver broader public good outcomes. Semi-structured interviews with key informants in three water utilities revealed the practical
implications of these arrangements in the business operations of the organisation. The project aims to develop a better understanding of how governance of corporatised public utilities can deliver services and outcomes in the public interest, and to identify mechanisms that work to ensure the governance of urban water is more conducive to integrated water management practices.

Declan Hearne  
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Social contracts: A framework for building reliable urban water supply services in Eastern Indonesia?

In a decentralised system, trust is an important factor when making investment decisions. A lack of trust between local water utilities, governments and customers is a factor underlying lack of investment in water supply services. Building functional trust requires attention to the external environment in which a water utility operates. The challenges associated with the internal management and operational constraints are well documented. However, there is less understanding of the role of the external environment and how the functionality of key relationships can affect service delivery. In Eastern Indonesia, a three-stage process of building trust among key urban water supply actors was piloted in 2010. The first stage included identifying stakeholder expectations for water services, in the second stage the agreement was signed forming a ‘social contract’ between the implementing parties. A third stage saw implementation of commitments in 2011-12. This paper reports findings from a comparative case study of three water utilities, two with a social contract and one without. A positive correlation was found between the functionality of relationships and reported levels of service improvement. The findings indicate that an iterative process of negotiation, participatory planning, and agreement on achievable tasks, helped in these cases to reinforce understanding of roles and responsibilities, and to shift government and customer expectations associated with water utility performance. This improved understanding provided greater opportunities for water utilities to progress key operational reforms including the review of tariffs.

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Are we diluting water in the proposed Sustainable Development Goals?

In 2001, the Millennium Development Goals (MDGs) included water as one target under MDG7: Ensure Environmental Sustainability. By 2012, the target of halving the proportion of people without sustainable access to safe drinking water had been achieved—exceptional for the MDGs. In the proposed Sustainable Development Goals (SDGs), SDG6: Ensure availability and sustainable management of water and sanitation for all includes eight ambitious targets, and water is implicated in multiple other goals among the 17 SDGs and 169 targets—food production to combat hunger, water-borne diseases in health, links to gender, sustainable cities, consumption and production, climate change and oceans and marine resources. This paper examines how water is represented in the SDGs, and asks whether this complexity and its consequences for global monitoring and governance is strategic to retaining the centrality of water and its management to sustainable development.
Monitoring bioavailability of metals and metalloids in river water receiving mine water discharge

The release of coalmine water into rivers in the Fitzroy River Basin (FRB), during recent wet seasons has raised concerns about the impact of heavy metals on the aquatic biota in FRB, coastal catchments and eventually into the Great Barrier Reef. The ecological risk associated with heavy metals in water is currently assessed using the total and dissolved concentrations (ANZECC, 2000). In fact, the biological response of organisms to metals in water is proportional to the free-ion activity of the metals rather than to their total or dissolved concentrations (Templeton et al., 2000). Determining the bioavailable fractions of metals in water is recognised as a necessary step for assessing their effect on biota and for assessment of water quality by researchers and regulators (Batley et al., 2004). The Diffusive Gradients in Thin film (DGT) technique has been reported as a surrogate for mussel bioaccumulation (Cu, Cd, Pb and Zn) (Webb and Keough, 2000) and rainbow trout (Cu) (Luider et al., 2004). Copper toxicity on Daphnia magna could be predicted from DGT measurements (Tusseau-Vuillemin et al., 2004). This study validate a real-time integrated and in-situ method for determining labile metal concentrations in river water before, during and after mine water release.

Water and Wellbeing: Investing in the Environmental Health of Communities in Developing Country Settings

The extent to which a supply service provides water that is available, accessible and suitable for use, to all people in households and communities across the continuums of human development (affluent to poor from urban to deep rural) is often inequitable and unsustainable even within the same country setting. As a societal service - even in its simplest form – this condition places a substantial environmental health burden on community wellbeing which makes it very difficult for many ‘developing’ communities globally to be water resilient. I use some scenarios from Africa and the South Pacific to show that sustainable water-wellbeing requires investment in a service that supports sustained good health through supportive ecologic and anthropological environments, matching social ability, economic benefit supported by affordable and sustainable application of technology.

Pacific Adaptation to Climate Change for Water Sanitation and Hygiene

Climate change is a serious threat to freshwater resources throughout the Pacific. Sea level rise, saltwater intrusion, increasing evaporation rates and changing precipitation patterns are already affecting the water cycle: with evidence of increasingly frequent droughts, floods and other extreme events. This 3-year collaborative research project is working with Pacific governments and communities to understand existing WASH systems and adaptation approaches, and to identify and plan sustainable adaption responses to further climate change impacts. It particularly focuses on vulnerable freshwater resources in atolls, with case studies in the Marshall Islands, and on flood-prone areas, with case studies in the Solomon Islands. To better incorporate issues of water security, water quality and climate change in WASH interventions in the Pacific, there is a case for broadening the focus of WASH to encompass a whole of catchment and more integrated understanding of the water cycle. Critically, there may be a number of places within the water cycle where interventions can improve the availability and quality of water resources. These interventions may in turn reduce risks within WASH systems.
**Estimating groundwater use in Queensland's coal seam gas basins**

Thousands of groundwater bores, mainly used for agricultural purposes, are located in Queensland’s Surat Basin, with hundreds more in the southern Bowen Basin. To extract CSG, producers must pump groundwater from coal seams in these basins. This depressurisation can affect water levels and supply from existing bores in these coal-bearing formations, but also potentially in other hydraulically connected aquifers. To assess this potential impact of CSG production, numerical groundwater flow models are used that account for the inputs of water to the regional groundwater system (recharge), as well as the outputs of water from the system. These outputs include natural discharge, as well as extraction from CSG bores and water supply bores. However, less than 5% of water supply bores have flow measurements taken, leading to uncertainty in groundwater model impact predictions. Our research aims to reduce this uncertainty by: (i) coupling advanced spatiotemporal statistical methods and analytical methods to better estimate flow from unmetered bores; and (ii) conducting independent surveys and metering of selected landholder bores to improve the training and validation data for our statistical models. By the end of 2016, we will produce basin-wide estimates of groundwater use, made publicly available for use in numerical groundwater modelling.

**Urban metabolism analysis will help find pathways for energy-efficient water systems**

This presentation summarises work of the water-energy carbon group at UQ. The topics include (1) evaluating the water mass balance (metabolism) of cities, and relevance for energy-efficient urban water. 2 Quantifying water-related energy and how this indicates that urban water influences around 10% of Australia's total energy use creating great scope for co-efficiency. And (3) Research and Policy Pathways for water and energy efficient cities.

**Crisis response results in long-term reductions in urban water consumption and energy use in a water supply system.**

Water shortage, increased demand and rising energy costs are major challenges for the water sector worldwide. Here we use case studies of drought in two different regions to demonstrate how responses to water shortage determine long-term system-wide water and energy consumption patterns. In Australia, South East Queensland (SEQ) encountered an acute drought from 2001 to 2009, while Perth has experienced a chronic decline in rainfall since the 1970s. This longitudinal study quantifies the urban water consumption and the energy use of the water supply systems in SEQ and Perth during the period 2002 to 2013. It then compares the water and energy consequences of the two regions responding to different water stress situations. In 2002, Perth had a similar per capita water consumption rate to SEQ and a slightly higher per capita energy use in the water supply system. By 2013, Perth had significantly higher per capita water consumption than SEQ and almost five times of the per capita energy use. This comparative study suggests that times of water stress may be windows of opportunity to induce changes in water use patterns, thereby shifting the region to lower long-term “water-energy” trajectories.
Dr Joshua Larsen  
School of Geography, Planning & Environmental Management  
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**How much water does the world have?**

This presentation will highlight the considerable uncertainty surrounding the deceptively simple question about how much water the world has, and ways we can improve our understanding and the sensitivity of these resources to land use and climate change.

Lynda Lawson & Danellie Lynas  
Sustainable Minerals Institute  
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**Buruli Ulcer: Water, Mining & Community Health**

Water is an indispensable resource in mining. In artisanal mining (ASM) water from streams is used to for gold processing. This same water source is fundamental to agricultural activities and essential for the health and sanitation for the communities living and working along these water bodies. Miners spend long periods of time in water polluted by mercury, made turbid by waste rock and primitive processing methods, and a number of health problems result. A significant and particularly debilitating water related condition is Buruli Ulcer. The environment that supports this necrotizing bacterium is unclear. Studies conclude that water quality is in some way closely related to this disease, and new hydrology studies indicate that trace metals such as arsenic which is present in higher concentrations in mining pits and stagnant water bodies is involved in the preferential growth of the organism. Mycobacterium ulcerans releases mycolactone, a toxin that damages surrounding tissue from the point of infection and inhibits the auto-immune responses resulting in buruli ulcers. In the Western region of Ghana ASM is a major source of livelihood. Buruli Ulcer is also commonly found in this area. This presentation provides a snapshot of current research in this area.

Amy McMahon  
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**Water Security, Gender and Climate Change in Bangladesh**

Climate change and a range of other environmental changes, are impacting on food and water security in southwest Bangladesh. Gendered divisions of labour around agriculture mean that men and women are facing differing challenges in terms of water use, with men focusing on water for agriculture, and women focusing on water from drinking, cooking and cleaning. Adaptation initiatives and governance around water are limited, and lack coherence. Community responses are largely ad-hoc, and do not take into account future climate change projections.

Prof. Mark Moran  
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**When solutions became the problem: Adaptive responses to complex problems**

Developmental approaches to complex problems are generally implemented in ways that assume a linear predictable process, where explicit models and designs are mapped neatly onto project and organisational arrangements. Frontline practitioners are assumed to the rational, comprehensive and structured means to implement effectively in evidence-based ways. In contrast, the reality for frontline workers is one of ‘muddling through’ or ‘gaming’ the system, overcoming hurdles and inventing adjustments as the deal with the unexpected. Two parallel narratives then typically ensue; one is as expressed in the daily interactions between participants and frontline workers; the other, an administrative story against the accountability requirements of multiple funding silos. A marked mismatch has ensued, which limits local innovation, and feedback on how well programs and policies are actually working. The challenge then for development evaluation is how to take this current ad hoc standard of practice, to a more proactive and transparent alignment with policy. This would require performance frameworks that flexibly wrap around the evolving and learning adaptations of local organisations and projects, including a healthy degree of stating assumptions and trialling ideas germinated locally. They would encourage a different relationship between fund administrators and
Climate change adds to the complexity of business environments making strategic decision-making more challenging. Business performance increasingly correlates with the capacity of strategic decision-makers' abilities to address such contexts. In the decade between 2004 and 2014 South East Queensland faced what climate scientists find to be the impacts of climate change – more extreme weather (severe drought and devastating floods) more often. Responding to these extreme conditions has been a strategic decision-making challenge for the water industry. Research offers little guidance for decision-makers in such situations. The literature conceptualizes strategic decision-making as a linear, cognitive process, encouraging research into correlations among specific attributes of its antecedents, process steps and results. There are few consistent findings, leading some scholars to suggest the field is in crisis. By contrast the sensemaking literature finds that non-cognitive factors such as emotions and beliefs inevitably trump cognition, often leading to poor decisions in dynamic and complex environments. The emerging narrative literature suggests that stories are a tool for sensemaking in organisations. We reconceptualise strategic decision-making as the emergence of beliefs about the external environment held collectively by strategic decision-makers and imbedded in their dominant stories. Stories reveal how strategic decision-makers in the regional water industry made sense of changes in their environment as a basis for important decisions. Metaphors such as “the millennium drought” and “the Armageddon situation” emerged, were contested and subsequently were woven into stories to explain decisions about the recycled water scheme and the desalination plant – infrastructure that now is under-utilised. We also uncover stories from within water businesses in which the physical and social environment is sensed as threatening, thus favouring heroic technical solutions.
yards can improve household sustainability, which will be further challenged by climate change. We examine different approaches to building the capacity of communities to achieve and maintain water-efficient and culturally appropriate yards. This includes giving people more control over their yards, in combination with resources, appropriate technology and garden exemplars.

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Aquatic food production – tensions between human needs and environmental impacts

When we talk about feeding the world, we often focus on the land and ignore the contribution of the seas and waterways. Fish and seafood already provide more protein to human diets than beef, pigs or chicken. They are more efficient at converting feed into food, and generate less greenhouse gas and nutrient pollution. But most wild fisheries are already over-exploited, and most farmed fisheries need fishmeal and fish oil from wild fisheries for feed. Local environmental impacts of aquaculture development can be severe. What are the constraints on the expansion of aquatic food production, and what contribution can it make to feeding the next two billion people sustainably?

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Social and cultural values towards waterways. Studies of people’s values towards the environment and especially waterways, are relatively rare

This project compares non-Indigenous and Aboriginal values towards the rivers of South East Queensland and Moreton Bay, using a framework of ‘relational values’ by Stephen Kellert (1996, 2012). The study contributes to the monitoring and evaluation of Moreton Bay Marine Park, and proposed inclusion of social monitoring in Healthy Waterways monitoring for rivers and Moreton Bay. The analysis of values includes 60 semi-structured interviews with non-Indigenous people (30 from the upper catchments, and 30 from the lower catchments and Moreton Bay), 12 individual interviews and two focus groups with Aboriginal Traditional Custodians. We have found that South East Queenslanders are passionate about their waterways. Kellert’s framework represents their values expressed very effectively. Interestingly, the values are not discrete: people hold several each, and a number of them are held by over half of those interviewed. There many commonalities, but also are subtle differences between Aboriginal and non-Aboriginal people, and non-Aboriginal people from the upper and lower catchments. The diverse set of values brings a new complexity to environmental management, which favours utilitarian versus moralistic and ecological values for conservation, to the neglect of seven other values held by the public.

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Riparian reforestation rapidly promotes water infiltration

Our field study in Maleny tested how pasture, reforested sites and rainforest facilitate water infiltration into soils. This is relevant because run-off, rather than infiltration, increases sediment and nutrient loads into water ways. We show that riparian reforestation increases water infiltration within three years of planting tree seedlings. We discuss the benefits of reforestation in context of water movement in landscapes.

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What role if any should religious organisations have in relation to waterways management?

Through interviews with religious leaders representing the diversity of religions in the region, our study found that a majority of interviewees are interested to participate as stakeholders in waterways policy and management. Our study analysed the religious leaders’ perceptions and experiences of local waterways through the lens of the values they hold
towards the natural environment and Creation. It presents a multifaceted account of the ways religious leaders interact with waterways, their personal and spiritual connections with these aquatic places, the understandings they have regarding waterways management and water quality, and the rituals and other activities they perform as part of their religious praxis and sacred duty.

**Community-based sanitation markets in Melanesia**

In international development, the current paradigm around achieving water, sanitation and hygiene (WASH) for many communities is to take a demand-led, marketing-based approach. This recognises the failures of past approaches that provided infrastructure to communities, assuming it suited each community’s social and environmental context, and would be maintained by the community. Sanitation marketing is an approach involving the establishment of micro-enterprises in communities to meet local demand for toilets. This demand-led, marketing-based approach is being implemented with rural communities, and urban communities that don’t have access to existing formal service providers, for example, informal or squatter settlements. We are adapting the typical “sanitation marketing” approach to suit Melanesian society and environment. In particular, we are exploring the feasibility of community-owned social enterprises that deliver toilets and other benefits to local communities. International Water Centre is working with local NGOs to take an evidence-based approach to fostering community-owned enterprises. We have adapted market research tools to capture data relevant to such enterprise and will share the results of market research around informal communities in Papua New Guinea.

**Estimating baseline conditions of hydrocarbon in groundwater**

Early in the development cycle of onshore gas resources, such as coal seam gas (CSG), regulatory agencies and operating companies need to consider the potential for gas development impacts on other resources including groundwater. To a large degree, the effectiveness of these assessments depends firstly on our ability to forecast the volume of associated water anticipated to be co-produced and secondly, on our ability to forecast the continuity and performance of seals (top, intraformational and fault seal) within the stratigraphic succession. Unfortunately, this is also when there is the least amount of data to constrain the problem and history shows that we tend to overestimate the volume of associated water and overestimate the hydraulic continuity of the strata. We use a hydrocarbon systems analysis approach to identify the migration of hydrocarbons and non-hydrocarbon gases through the strata at different geological times. These fingerprint migration and leakage pathways relate to the seal performance on a geological time-scale and therefore help us to understand hydraulic connectivity. Outcomes from this approach can be explored within a risk assessment framework for resource interaction on a human time-scale that will inform the development of an effective measurement, monitoring and verification strategy.
**Environmental Flow Framework for Peru**

A research team from UQ, Griffith U joined specialists from the Peruvian National Water Authority (Autoridad Nacional del Agua -ANA) to develop a framework for conducting environmental flows assessments in Peru. Peru is undergoing water reform in response to rapid development in a number of sectors including agriculture and mining. Provision of environmental flows has been identified as a critical component of the water reforms. This talk will provide background and results from a case study conducted in a river basin in which fisheries and agriculture are threatened by development of a dam.

**Wealth from waste: the beneficial reuse of low-cost materials as substrate in water treatment wetlands**

Safeguarding of existing water resources and investigation of alternatives to potable water supplies are critical to ensure long-term water resource sustainability. Extensive changes in land use such as urbanisation and intensive agriculture have substantially increased pollutant loads to aquatic environments in many regions. Effective treatment of pollutants including metals, nutrients, and organic contaminants in urban stormwater is essential for the long-term management of aquatic ecosystems and pivotal to efficient water reuse. Conventional wastewater treatment systems are largely unsuitable for stormwater treatment as only water entering sewer networks can be treated in municipal facilities. Wetlands, permeable reactive barriers and similar engineered structures for passive wastewater treatment are widely recognised as a cost-effective means of attenuating diffuse water pollution. A number of low-cost materials including mining and industrial by-products have shown potential for beneficial reuse as substrate in constructed water treatment wetlands or in similar engineered structures for the treatment of wastewater and stormwater. Herein, we briefly examine the potential use of largely unexploited by-products as “designer” contaminant adsorbents. This research is underpinned by a wealth from waste strategy aligning the productive use of by-products to treat water previously untreated, discarded, or treated by less efficient or more costly means.
THE GLOBAL CHANGE INSTITUTE

The Global Change Institute (GCI) is a collaborative hub at The University of Queensland that catalyses expertise across the university to deliver high-impact, ‘game changing’ research that provides solutions to global change challenges facing the world. GCI responds to these challenges by identifying community and industry needs and brokering collaborative research and communication for interdisciplinary solutions within the four themes of:

- sustainable water
- food systems
- healthy oceans
- clean energy

The institute researches problems in a coordinated and collaborative manner, using The University of Queensland’s expert knowledge base, and externally through national, regional and international partnerships. GCI seeks to advance discovery, create solutions and influence decision-makers in addressing the challenges of a changing world.

GCI Sustainable Water Program

Vision: The vision of the GCI Sustainable Water Program is to address the complexities of the global water challenge through innovation, education and engagement. This will be achieved through identifying opportunities for cross-disciplinary team-building around important gaps to make a significant contribution to the development and successful implementation of socially, environmentally and economically sustainable long-term water policies for Australia and the region.

The result will be that the Sustainable Water Program catalyses The University of Queensland to become Australia’s leading university for research, education and engagement on water issues, knowledge and expertise.

Mission: The GCI Sustainable Water Program will achieve its vision by bringing together researchers and others ‘enablers’ on water-related challenges for new, bigger-picture, cross-disciplinary projects. Existing and specific research expertise will be promoted but not replicated. Emphasis will be placed on developing a path to impact and change from the research outputs, and bringing together end-users with researchers and funders at each crucial stage of the project. This will ensure appropriate and maximum adoption, dissemination and uptake of the research outputs, and effective translation of the outputs to policy and adoption outcomes.

Through the above approach, the Sustainable Water Program will deliver the university’s water research strengths in:

- Research and expert services,
- Education, training and capacity-building,
- Strategic research partnerships nationally and internally, and
- Adoption of research into planning and policy.

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