MONASH University

Water and Sustainability in Asia

Graduate Research Interdisciplinary Program

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Graduate Research Interdisciplinary Program

Interdisciplinary Research at Monash University

Welcome from the Vice-Provost (Graduate Education)

At Monash University we seek to bring people together to find agile and innovative solutions to the challenges of the future.

Our Graduate Research Interdisciplinary Programs bring together PhD students and academic leaders from various fields with external partners from government and private industry to explore an issue of global significance.

Industry benefits from accessing a unique pool of interdisciplinary expertise. Academics have the opportunity to connect with peers and industry professionals in order to build their networks. Students experience research training in an applied and collaborative context where they have the opportunity to learn from each other, their supervisors and the end users of their research.

This model of doctoral training points the way forward because it helps all parties grapple with the complexity and opportunity associated with real-world problems.

It has been exciting to see the development and success of the Water and Sustainability in Asia program, an initiative that the Monash community celebrates and looks forward to sharing with the rest of the world.

Professor Zlatko Skrbis, Vice-Provost (Graduate Education)

Kay Ng, Josh Nielsen, Vanessa Copa, Wikke Novalia, Pengfei Shen, Adam Charette-Castonguay, Behzad Jamali, Tahmina Yazmin Richard Conn, Natalie Barron, Francesco Gimelli, Martijn Kuller, Erika Duncan-Horner

About the GRIP

Doctoral study with impact

Interdisciplinary research programs with high levels of industry engagement are at the forefront of the Monash University approach to doctoral education.

These programs bring together graduate researchers from two or more faculties who work together in a team environment under the expert supervision of leading academics on issues of global significance. The expertise and skills of graduate researchers is developed through academic mentoring but also opportunities such as industry internships and international field work.

Each program develops and strengthens links to end-users in private industry or government ensuring that research contributes to solving real problems that will transform individuals, communities and nations.

Led by Professors Ana Deletic and Rebekah Brown, and hosted by the Monash Sustainability Institute, the Water and Sustainability in Asia Graduate Research Interdisciplinary Program (GRIP) brings together the faculties of Engineering and Arts to support the transitioning of developing Asian cities to more sustainable, resilient and liveable conditions through the uptake of state of the art water technologies, policy development and social practices.

This unique opportunity for personal development and social contribution saw hundreds of graduates from diverse backgrounds engaged in a highly competitive process for limited positions within the program.

The benefit for industry and government when it comes to participating in these programs comes in the form of access to the latest breakthroughs, increased networks and an opportunity to develop and recruit outstanding graduate researchers.

By supporting and facilitating these new forms of doctoral education Monash is helping to bridge the gap between the academy and industry whilst preparing individuals for future impact in their chosen field.

Contact us

For more information, or to discuss partnership opportunities please email **wsa.grip@monash.edu**

Professor Ana Deletic, FEA, FTSE, ADR

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Ana Deletic is a Professor in Water Engineering and Associate Dean of Research (Engineering) at Monash University. She is Director of Monash Water for Liveability and was instrumental in establishing Australia's federal Cooperative Research Centre for Water Sensitive Cities. She is the world leader in integrated urban water management. Commencing research in Yugoslavia and Scotland (1990s), she moved to Monash University (2003) to focus on removing pollutants from urban runoff, establishing the world's most published group on stormwater management, leading the development of biofilters and raingardens. Ana is Fellow of Engineers Australia and Australian Academy of Technological Sciences and Engineering (ATSE), Deputy Chair of the ATSE's Water Forum and a member of several other committees, review panels, regulatory authorities and forums. In 2012, State Parliament awarded Ana the Victoria Prize for Science and Innovation (Physical Sciences) for her lifelong achievements in stormwater harvesting.

Professor Rebekah Brown

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Rebekah Brown is a Professor of Social Science with a background as a practising and award-winning civil engineer, and Director of Monash Sustainability Institute at Monash University. Combining insights from sociology and the practice of water engineering Rebekah has harnessed the power of interdisciplinary research to understand the social and institutional transformations required to transition to liveable, resilient and sustainable cities, in both developed and developing countries.

Rebekah pioneered the sociotechnical model that became the precursor to the water-sensitive approach and has published in premier journals, including *Nature*, *Science*, *Global Environmental Change* and *Water Research*. She co-established Australia's Cooperative Research Centre for Water Sensitive Cities, is regularly invited as keynote speaker at international conferences, and is on a number of specialist editorial boards.

Technology and Innovation

Natalie is from Melbourne and has a Bachelor of Engineering (Environmental) and Bachelor of Science (Psychology) from the University of Melbourne. She also completed a Masters of Engineering Science (Water Resources) at the University of New South Wales. Natalie worked as an environmental engineer for five years, working on projects across Australia, including infrastructure assessments following the 2011 Queensland floods and environmental impact assessment for Northern Territory mining projects.

Main Supervisor: Dr Belinda Hatt

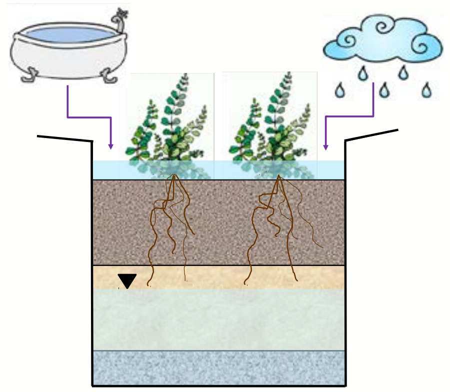
Co supervisors: Professor Ana Deletic

Dr Megan Farrelly

DESIGN, TECHNOLOGY AND DEVELOPING CITIES

HYBRID BIOFILTRATION SYSTEMS FOR CHINA

Zhouzhuang, located within Kunshan, China (http://fancy.com/things/149768238341819215/Zhouzhuang,-China)



Picture 1: Hybrid biofilter depicting source water, ponding zone, vegetation, porous media layers and submerged zone.

Picture 2: Chinese and subtropical plants (https://www.pinterest.com/search/chinaplants, https://www.pinterest.com/search/tropicalplant)

Picture 3: Potential application of multifunctional green technology (http://www.apartmenttherapy.com)

The Topic…

This research will develop novel designs for dual-mode (hybrid) biofiltration technologies to use in subtropical developing cities.

Biofilters are a key piece of green technology that provide onsite treatment of water (see Picture 1). Guidelines have been developed for the optimal design of these systems for stormwater treatment but it is unclear how they should be designed for alternate stormwater/greywater treatment.

The use of biofiltration systems in developing cities would help meet the competing demands of water treatment, water supply, environmental protection and green space.

The Questions…

- What is the best utilisation of hybrid biofiltration technology for a developing city in Asia? Environmental protection or providing clean water for re-use?
- How will the biofiltration system respond to alternate stormwater/greywater inflows?
- What plants endemic to south-east China are effective for removing pollutants?
- What filter media should be utilised?
- What is the ideal operational regime for a hybrid biofiltration system?

The Approach…

An interdisciplinary approach will be used to investigate the role of design in assisting developing cities to more easily adopt green technology for urban water management.

This is important because an engineering solution is primarily focused on the subsurface design of these systems, while the transition to the visual urban space needs to incorporate perspectives beyond technical function.

A large laboratory study will test hybrid biofilter performance through a number of configurations. Fieldwork will be undertaken in Kunshan (China).

Originally from Malaysia, Kay completed a Bachelor of Environmental Science (Honours) at Monash University. Her Honours research project explored the impacts of high temperatures on human health. She also completed an internship at the Forest Trust, an NGO, where she developed a range of technical reports and forestry guidelines in collaboration with other organisations across Asia.

Main Supervisor: Dr Belinda Hatt

Co supervisors: Dr David McCarthy
Dr Megan Farrelly

Biofilters for Urban Agriculture in Asia

Urban Agriculture

- In developing countries, 791 million individuals suffered from chronic hunger in 2014 while the most recent estimates on poverty in 2011 showed that 17% of individuals in developing countries lived on US$1.25 or less a day (FAO et al., 2014; World Bank, 2015).
- There is increasing food insecurity with increasing rates of urban poverty associated with rapid urbanization in developing countries.
- Urban agriculture is a potential solution for food insecurity especially for the urban poor. It also has other social, environmental and economic benefits.
- With increasing pressures on available water resources, stormwater is a potential source of water for irrigation but there are potential health risks associated with heavy metals and pathogens.
- Figure 1 demonstrates the potential use of biofilters in urban agriculture and the multiple benefits that can be achieved.

Fig. 1: The application of biofilters in urban agriculture and its benefits which includes production of fresh vegetables, improving stormwater quality, reducing stormwater quantity and creation of green spaces among others.

Study Aims

- To develop biofilters that are able to produce vegetable yields comparable to traditional vegetable gardens while maintaining treatment reliability and safety of crops through:
  - Identifying the limiting factor in plant growth in biofilters.
  - Determining metal uptake rates by vegetables in biofilters over time and into which plant parts.
  - Identifying the type of filter media that is required to facilitate the retention of pollutants in the soil and reduce pathogen internalization in the plants.
  - Understanding social receptivity towards urban agriculture and the use of stormwater for irrigation.

Methods

- This study will use a series of lab-based column studies to identify the effects of amendments on reducing metal uptake.
- Water quality parameters such as TSS, TN, TP and heavy metals will be monitored.
- Various vegetable species will be tested over multiple growing seasons.
- Pathways for pathogen internalization will be examined.
- Surveys and interviews will be conducted to understand social receptivity towards urban agriculture and the use of stormwater for irrigation.

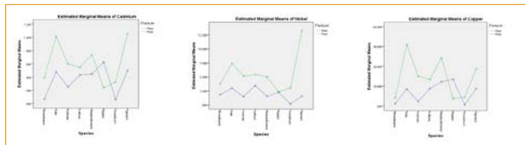


Fig. 1: Metal concentration factor in the above-ground parts (plant) and below-ground parts (root) for cadmium, nickel and copper

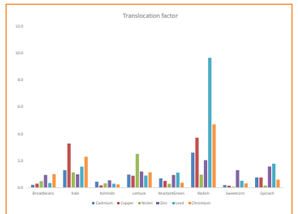


Fig. 2: Translocation factor of vegetables and metals

Table 2: Concentration reduction rate (%) averaged over two sampling rounds

Measure	Concentration reduction rate
Chromium	39%
Copper	94%
Lead	95%
Manganese	83%
Nickel	75%
Zinc	96%
TSS	81%
TP	69%
TN	47%

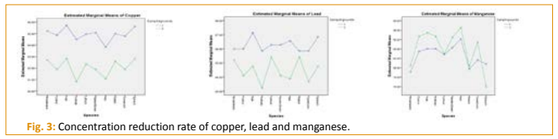


Fig. 3: Concentration reduction rate of copper, lead and manganese.

Results

Level of metal concentration factor in plants vary between species, plant parts and across metal types.

- In general, leafy vegetables often exhibited higher metal concentration factors than legumes and root vegetables.
- Metals are often found to accumulate in the roots instead of shoots of vegetables with the exception of radish (see Figure 1).
- Translocation of metals from roots to shoots varied between species and metal types (see Figure 2).
- Mean metal concentration were reduced by more than 70% except for chromium concentration (see Table 2), with variations between species and sampling rounds (see Figure 3).
- TSS, TP and TN concentration reduction rate were 81%, 69% and 47% respectively (see Table 2).

Conclusion

The use of biofilters in urban agriculture is promising where the treatment reliability of the system is not compromised. Further studies will be conducted to reduce metal uptake by crops, reduce pathogen internalization and understand social receptivity to facilitate the uptake of urban agriculture.

Richard is from Melbourne. He has a Bachelor of Agricultural Science and completed a Masters of Sustainability (Corporate and Environment) at Monash University. His Masters' thesis explored the recovery of food organics waste from the dairy industry. He has worked for the last 20 years as an IT consultant, both in Australia and the UK.

Main Supervisor: Dr Megan Farrelly

Co supervisor: Dr Annette Bos

Innovation in urban waste water treatment in Asia

Optimising the design of experiments that include transnational elements for improved performance outcomes.

The Problem Rapid urbanisation and climate variability have increased the urgency for a paradigm shift to sustainable urban water management (SUWM) in Asia. Innovation through experimentation is a major pathway to SUWM transition. Many developing Asian cities have no conventional wastewater treatment systems or have centralised systems that operate well below capacity or have become abandoned. A hybrid mix of adaptive, multi-functional, centralised and de-centralised wastewater systems are needed to address the uncertainties and complexities of urban waste water management. Not being 'locked-in' to conventional centralised infrastructures provides many developing Asian cities with great opportunity for experimentation with decentralised wastewater innovations. Local experiments on wastewater innovations may involve a diverse mix of actors, institutions and other resources spanning local to transnational geographical scales. However, not much is known about the role and influence of transnational elements in experiments for sustainability at local scale.

The Objectives are 1) to characterise transnational elements that occur in experiments and 2) using strategic niche management framework (SNM) to explore transnational influences on learning, social network formation and shared expectations in experiments.

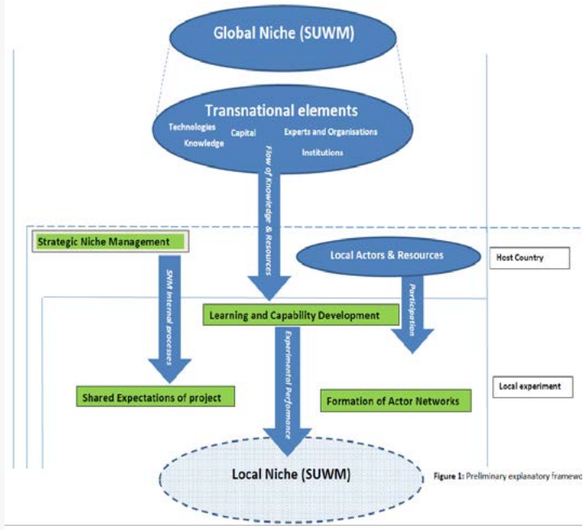


Figure 1: Preliminary explanatory framewo

My Research The aim is to develop an explanatory framework of transnational influences in experiments for sustainability and niche development (see figure 1), and practical guidelines on how transnational elements can support optimisation of experimental design. Effective design may lead to improvement in the emergence and performance outcomes of technological experiments, for the advancement of SUWM and practices.

My Approach Three case studies i.e. demonstration/pilot projects on decentralised waste water innovations in Indonesia. Cases represent diversity in approaches – urban community based sanitation programs, university projects and grassroots social innovation initiatives. Such projects may include transnational influences e.g. financial and/or technical support interventions from foreign donor (e.g. US Aid, Aus Aid) and research and development organisations (e.g. BORDA (Germany), EAWAG (Switzerland)) working in partnership with local authorities, NGOs and local communities.

Erika Duncan-Horner

Erika grew up in Kobe, Japan. She has a Bachelor of Arts from Monash University, with a double major in Geography & Environmental Science and Urban, Regional and International Development. She has also completed a Masters of Sustainability with a double specialisation in International Development and Corporate Sustainability Management. Erika has a diverse range of professional experience, working across the Asia-Pacific as an interpreter, copywriter and marketing assistant. She has also worked in the government and NGO sectors in disaster recovery, economic development and community engagement.

Main Supervisor: Dr Megan Farrelly

Co supervisor: Dr Briony Rogers

From inadequate sanitation to Water Sensitive Cities:
Transforming developing Asian cities with enterprising social innovation

Inadequate Sanitation is one of developing Asia's most complex and persistent social problem and critical driver towards advancing water sensitivity.

- Inadequate sanitation affects the lives of one-third of the global population, mostly poor and marginalised citizens living in developing Asian cities
- Conventional interventions focussed on infrastructure provision and bottom-up behaviour change programs. Yet, undermined by rapid urbanisation, these needs have not been adequately met by existing institutions.
- Addressing the sanitation needs of the poor requires transformative changes in technology, infrastructure design, service delivery, cost recovery and collaboration, taking into consideration the **socio-economic development** of marginalised citizens and **environmental sustainability**.
- Social innovation emerges as a possible avenue to improve sanitation for the poor while contributing to **Sustainable Development Goals** in:
  (a) enabling availability and sustainable management of water
  (b) linking sanitation to energy generation, food production, employment generation
  (c) Empowering and nurturing capabilities for lasting social change

740 million
people lack access to safe drinking water

2 billion
people lack access to clean sanitation

1 billion
people practice open defection daily

(WHO/UNICEF 2014)

SUSTAINABLE DEVELOPMENT GOALS

Figure 1: Inadequate sanitation and the SDGs

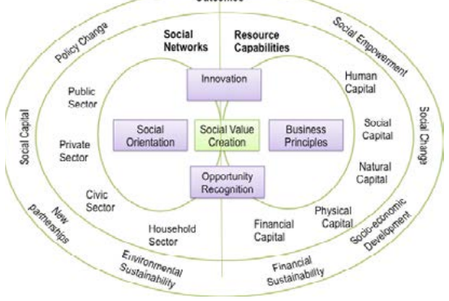


Figure 2: Conceptual framework of enterprising social innovation

What are enterprising social innovations?

- A nebulous concept including **social entrepreneurship and social innovations** – an emerging process whereby an innovation combines a social orientation with market principles to create social value while advancing sustainability and social change
- Gaining worldwide momentum for its ability to tackle complex social and environmental problems currently unmet by existing institution an deliver catalytic changes through social value-creation, opportunity recognition capability empowerment and social networks
- India is regarded as innovation 'hotspot' with its long history of frugal innovations, widespread poverty and inequality, large presence of non-profit organisations, and emerging national innovation ecosystem that supports the development of enterprising social innovations

Research aims & objectives:

To understand and evaluate the role of enterprising social innovations in delivering sustainable and equitable sanitation to the poor in developing Asian cities and transforming towards Water Sensitive Cities

(a) Identify key processes involved in enterprising social innovations aimed at social value-creation

(b) Evaluate the impacts of enterprising social innovations on improving sanitation for the poor and transforming developing Asian cities towards water sensitivity

(c) Develop an explanatory framework to guide future design in sustainable sanitation practices

Pengfei Shen

Pengfei is from China. He has a Bachelor of Engineering and a Masters of Engineering (Environmental), focusing on urban pollution control. Pengfei has worked as a research assistant at the National Engineering Research Centre for Urban Pollution Control in Shanghai, and as a research fellow at the Technical University of Hamburg in Germany, conducting research on urban stormwater management.

Main Supervisor: Dr David McCarthy

Co supervisors: Professor Ana Deletic
Dr Christian Urich

Technology and Innovation

Framework for Real Time Monitoring and Control of Water Sensitive Urban Design Systems

Problem Statement

To treat Adequate treatment of stormwater is essential before discharging into recreational water bodies or harvesting for reuse to minimize public health risks associated with stormwater pathogens. Stormwater biofilters is a promising Water Sensitive Urban Design (WSUD) system to reduce indicator bacteria. To reinforce the treatment effects of biofilters, the optimization of design factors (e.g. type of plants, depth of submerged zone) has been discussed and conducted frequently in previous studies. On the other hand, although some studies have also revealed the importance of operational factors (e.g. temperature, moisture content), the optimization of these factors has hardly been implemented due to the operational difficulties. To solve this problem, real time monitoring and control (RTM/RTC) would be a potential tool. However, although RTM and RTC have been proven to be effective on some related fields like wastewater treatment, no published study has been found on WSUD systems for stormwater treatment so far. Therefore, a framework for RTM and RTC of WSUD systems should be developed.

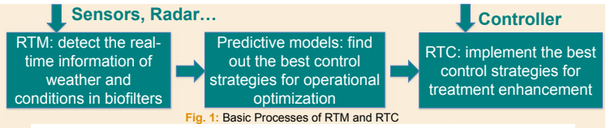


Fig. 1: Basic Processes of RTM and RTC

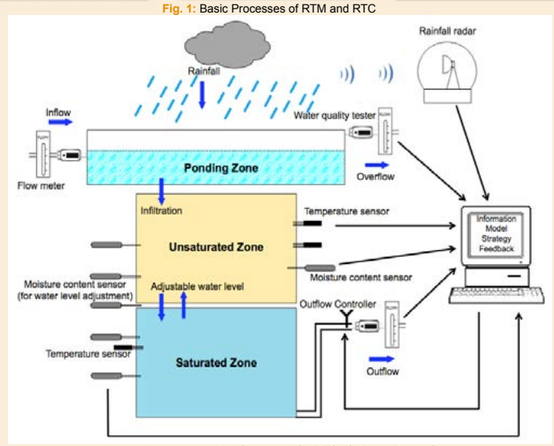


Fig. 2: A basic conceptual framework for RTC of stormwater biofilters

Proposed Research

- Develop and test a predictive model for microbial removal in stormwater biofilters
- Generate and select RTC strategies based on two criteria: (1) total amount of pollutant reduction, and/or (2) peak concentration reduction
- Laboratory validation of selected strategies (also ensure that the enhancement of microbial removal would not jeopardize the treatment of other pollutants)
- Development of novel RTM/RTC biofilters (with novel design, incorporate RTM/RTC facilities from the planning process)
- Field-scale implementation and monitoring

Preliminary Research: develop and test a predictive model

Meet the Requirements:

(1) Represent the transport of faecal microorganisms throughout biofilters; (2) Include governing processes (adsorption, desorption, straining and die-off) and key factors (e.g. temperature, moisture content, infiltration rate); (3) Represent wet and dry periods; (4) Generate accurate prediction with minimum data requirements and simulation time.

Two modules:

- Water flow module: dynamics of water flows through different zones
- Pollutant transport module: a one-dimensional vertical advection-dispersion model

e.g. Pollutant mass balance in the unsaturated zone:

$$\frac{\partial\left(S\cdot n_{usz}c_{usz}\right)}{\partial t}+\underbrace{\left(\underbrace{n_{usz}S\cdot k_{att1}c_{usz}}_{adsorption}-\underbrace{\rho k_{det1}M_1}_{desorption}\right)}+\underbrace{\left(n_{usz}S\cdot k_{str}\varphi c_{usz}\right)}_{straining}$$
$$=\underbrace{\frac{\partial}{\partial z}\left(S\cdot n_{usz}D\frac{\partial c_{usz}}{\partial z}\right)}_{dispersion}-\underbrace{\frac{\partial\left(qc_{usz}\right)}{\partial z}}_{advection}-\underbrace{S\cdot n_{usz}\mu_{f1}c_{usz}}_{die\text{-}off}$$

Test the model with the results obtained from 8-month laboratory experiments:

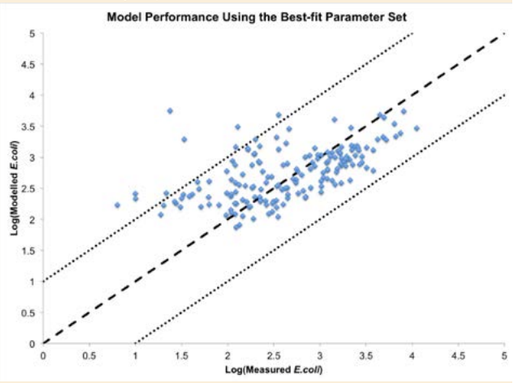


Fig. 3: Model Performance Using the Best-fit Parameter Set (Dashed lines indicate the 1:1 line between modelled and measured *E. coli* concentrations, while dotted lines indicate error bars (+/- one order of magnitude))

Urban Planning and Design

Behzad Jamali

Behzad graduated with a Bachelor of Science (Water Engineering) and Masters of Water Resources Engineering, both from the University of Tehran. Over this time, Behzad has worked as a university tutor and with engineering consultancies in Iran. He has also worked on a number of research projects with both government and academic partners.

Main Supervisor: Professor Ana Deletic

Co supervisors: Dr Christian Urich
Dr David McCarthy
Professor Wolfgang Rauch

Development of Integrated Urban Water Modelling Platform

Modelling complex Urban Water Systems (UWS)

Classic models consider different components of the UWS as isolated entities. However integrated models focus on combined management of these components and cosider feedbacks among them.

There is still no clear understanding of the complex dynamics and feedbacks within the UWS. Additionally current models are in their infancy to fully support the whole urban water cycle and interactions within it.

This study aims to develop a simple and robust integrated modelling platform capable of simulating the main interactions among the key components of UWS while considering the impacts of urban environment upon it. This will be achieved by the integration of well-known existing models (e.g. SWMM, EPANET, MUSIC, CityDrain, Mike-Urban, Urban-Beats) that simulate main components of the UWS in different spatial and temporal scales.

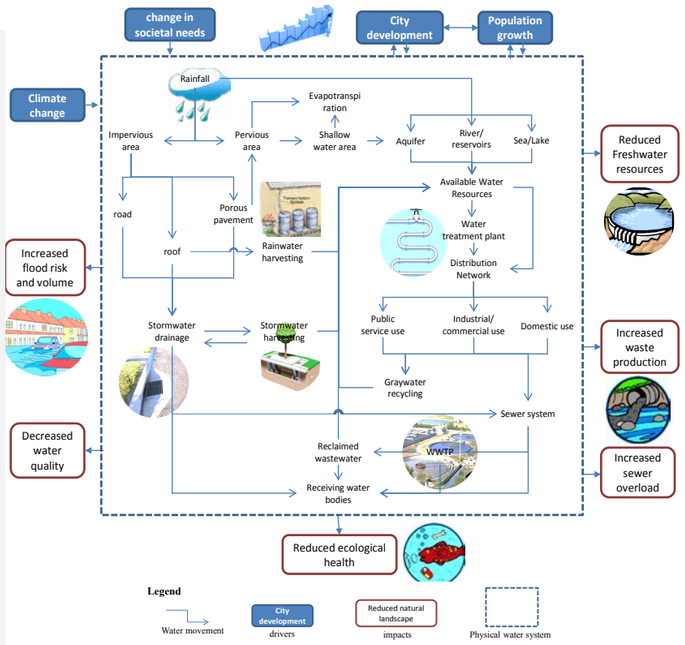


Figure 1. Conceptualised UWS: system boundary and its elements, drivers from surrounding environment and their impacts on the system

Research Objectives

- To conceptualize the complexity of the UWS, its interactions in different spatial and temporal scales select suitable existing modelling tools
- To build a platform for methodological and technical integration of models
- To reduce the complexity of developed integrated platform while keeping its robustness
- To study its performance in two different case studies

Questions

- How can the complexity of UWS and its interactions with other urban systems be conceptualised?
- How can feedbacks between modules be mathematically represented?
- How to solve spatial and temporal resolution incompatibilities among them?
- What is the simplest model structure that does not compromise accuracy of the results

Adam Charette-Castonguay

Originally from Berthierville, Canada, Adam graduated with a Bachelor of Arts in Public Affairs and International Relations from University Laval, Canada. As part of his undergraduate studies, he studied abroad in China, Peru and Finland. Adam completed a Master of Environmental Management at the University of Kiel in Germany. His Masters' research explored the vulnerability, resilience and adaptive capacity of social-ecological systems in the rice terraces of North Luzon, Phillippines. Adam also completed an internship at the Secretariat of the Convention on Biological Diversity in Montreal.

Main Supervisor: Professor Ana Deletic

Co supervisors: Dr Christian Urich
Dr Sayed Iftekhar
Professor Rebekah Brown

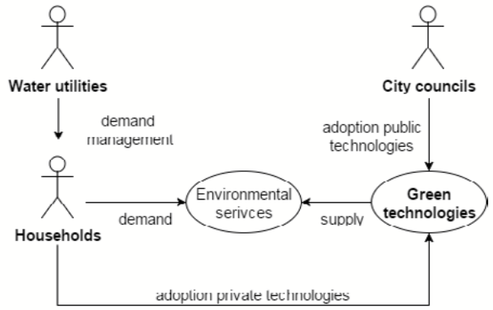
Simulation of water technology adoption:
An agent-based approach

Research problems

- Lack of understanding concerning the wide range of benefits and their value from water technologies.
- Need of tools to observe the behaviour of stakeholders towards different policy instruments.

Objectives

- Quantification of benefits provided by water technologies.
- Monetary valuation for cost-benefit analysis.
- Assessment and simulation of policy options to achieve societal goals.



Schematic representation of interactions between agents and environmental services.

Modelling approach

The simulations are undertaken with the use of an agent-based model. Interactions among stakeholders and between stakeholders and the environment are simulated, based on their objectives and actions. This allows to explore emergent properties and self-organization of the system.

Significance

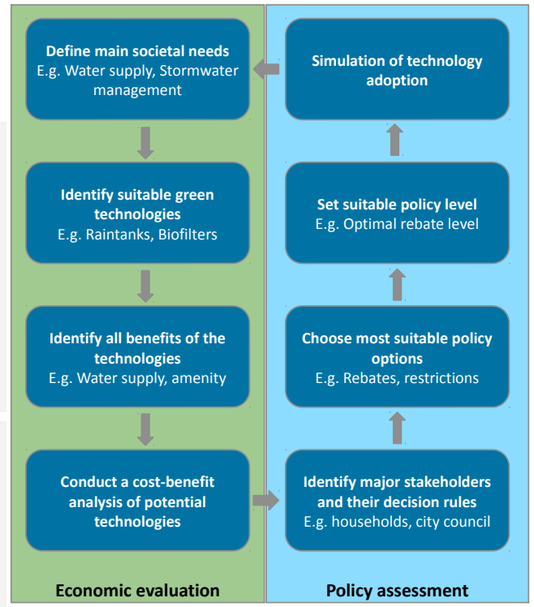
The model is expected to be available to use online and will allow policy makers to visualise the impacts of adopting different environmental policies.

The simulations will demonstrate the long-term effectiveness of policies to reduce environmental pressures such as flooding and water scarcity by targeting the adoption of the most suitable water technologies.

Innovation

The research will classify water technologies, which will enable modelling of technology diffusion.

The study integrates preferences and willingness to pay as the decision rule for technology adoption and allows policy makers to see the evolution of the preferences of households for technologies over time.



Framework for modelling technology adoption based on environmental services valuation.

Martijn Kuller

Martijn was born and raised in the Netherlands. He graduated with a Bachelor Degree in Environmental Economics from Wageningen University. He has also completed a Masters Degree in Urban Environmental Management. As part of his Masters' thesis, he worked in Amsterdam with engineering consultancy Royal HaskoningDHV on a model for rainwater harvesting. Martijn also undertook an internship in Adelaide and has worked with Zero Waste SA and the University of South Australia.

Main Supervisor: Professor Ana Deletic

Co supervisors: Dr Peter Bach
Professor Diego Ramirez

Urban Planning and Design

Water Sensitive Urban Design: A location problem

Increasing urbanisation and climate change increase flooding, water pollution and water scarcity

Planning for the Water Sensitive City required consideration of urban planning, socioeconomic and biophysical factors

Existing decision support tools are useful, but only consider technical criteria

Aim

The main aim of the project is to improve spatial planning decision making for water sensitive urban design (WSUD) through the explicit consideration of spatial implications of relevant planning, socio-economic and biophysical factors.

Spatial integration of this method allows to suit the local context in every location of the city

Multi-Criteria Decision Analysis allows for the inclusion of social, legal, political, economic and other factors

Objectives

Develop a methodology for spatial evaluation of suitability for WSUD within a city.

Design a GIS based Multi-Criteria Analysis tool, assessing spatial suitability for distributed stormwater management, harvesting and wastewater treatment technologies based on user inputs on preferences and values.

Study and compare the potential for WSUD in an Asian and Australian context by the application of the abovementioned tool.

Suitability

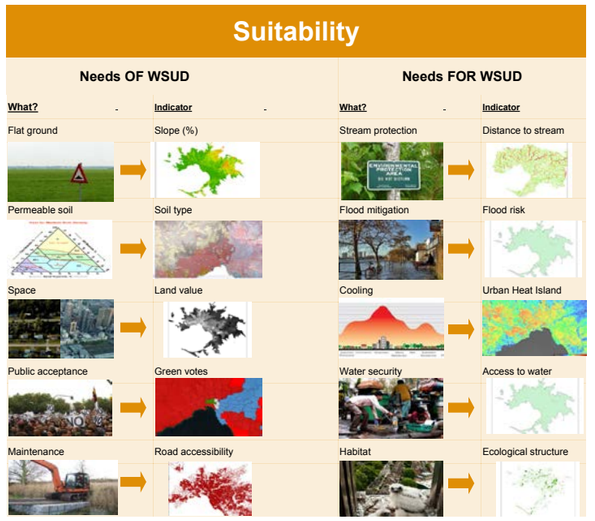


Fig. 1: Suitability of a location can be understood to have two sides: sites that allow good functioning of WSUD (Needs of WSUD) and sites that need the benefits of WSUD (Needs for WSUD). Suitability is calculated by collecting indicators for all relevant factors from both sides of the suitability medal.

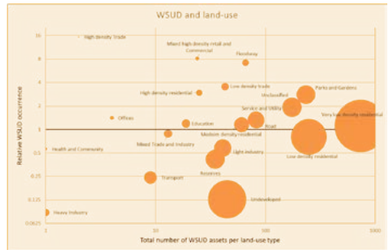


Fig. 3: For the preliminary research, different factors are spatially correlated with WSUD assets around Melbourne. This particular figure shows the relation between WSUD occurance and land-use. The size of the circles represents the total area of a particular land-use in the Melbourne metro area.

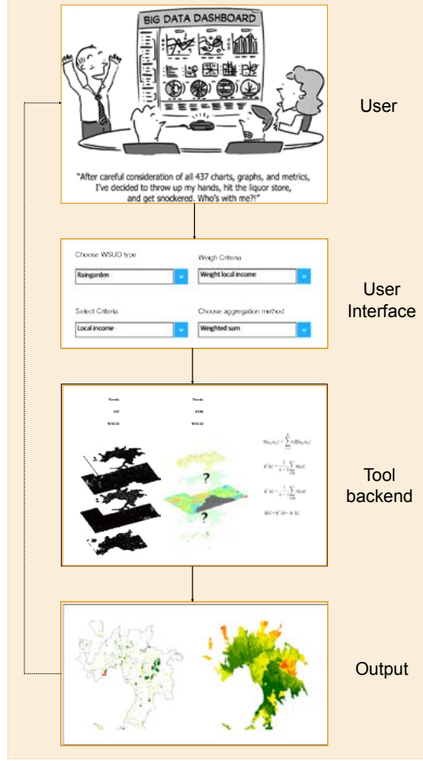


Fig. 2: Structure of the Planning Support Tool. The tool enables users to select the factors they want to take into account, their relative importance and the methods of aggregation. The tool provides suitability maps from this information.

Josh Nielsen

Originally from Central Queensland, Josh has a Bachelor Degree in Landscape Architecture from Queensland University of Technology. He worked as a landscape architect across South-East Queensland, through which he became interested in integrating urban water management with urban design. Josh then went on to complete a Masters of Integrated Water Management, from the International Water Centre at the University of Queensland. His Masters' thesis investigated practitioner perceptions of water sensitive cities.

Main Supervisor: Professor Rebekah Brown

Co supervisors: Professor Diego Ramirez
Professor Tony Wong

Urban Planning and Design

Understanding the Street

Development of an explanatory framework on the dynamics and functionality of streets and their potential to contribute to sustainable cities.

A problem.

There are emerging functions for streets that are based on new political drivers and new recognition of challenges such as climate change and growing urban populations. Across the world's cities, streets generally take up large portions of open space, with figures ranging as high as 36% of total urban land area (UN-HABITAT 2013). There has been a historical fixation on the development of streets purely as transport corridors for mechanised vehicles which saw the development of many streets that are highly adapted for commuting from A to B in a car (Jones et al. 2008). However, the cost of this efficiency has been highly detrimental to a host of other uses including pedestrian and cyclist commuters, sidewalk cafes/culture, as well as broader negative impacts on environmental flows such as fragmentation of animal habitats and increased stormwater pollution (Forman et al. 2002; Li et al. 2010; Deletic 1998).

Understanding the development of water sensitive streets (CannonCorp, 2014)

The Research

This research seeks to understand the socio-political drivers of street design and planning in order to develop a framework that explains the dynamics of streets in terms of their functionality, societal needs over time, and their potential to contribute to more sustainable futures. This can then be used to inform the development of strategies that deliver streets that are resilient to shifting social and political priorities and flexible towards embedding new functions necessary to respond to emerging problems such as climate change and growing urban populations.

Singapore River in Transition - how have shifting socio-politcal priorities influenced the evolution of streets?
Images: Liu, 1999.

Society, Governance and Transitions

Born in Italy and raised in Australia, Francesco completed a Bachelor of Arts, majoring in Studies of Religion, at the University of Queensland. He then completed a Masters of Environment at the University of Melbourne. Over this time, Francesco has worked as a university tutor in both the study of religion and environmental studies. He has also worked as a research scholar with Healthy Waterways in Brisbane, and as an Education Coordinator at an environmental community organisation.

Main Supervisor: Dr Annette Bos

Co supervisor: Dr Samanthi Gunawardana

Just Urban Water Development

Fostering the Capabilities of the Marginalised in India and Bangladesh

The Problem

- Cities in South Asia are rapidly urbanising. Dhaka, the capital of Bangladesh, for example, had a population of 6.7 million in 1990. This had swelled to 17 million in 2014, and is projected to grow to 27.3 million by 2030. India is projected to add 400 million people to its urban population between 2014 and 2050.
- This rapid growth leads to millions of individuals having no or inadequate access to a reliable water source.
- The Indian and Bangladeshi governments have sought to make local development more responsive to the needs of communities by enshrining elements of bottom-up planning in their constitutions. However, the reality is that there are few processes in place to bring this intention into reality, and benefit the marginalised by it. The marginalised, such as the urban poor, slum dwellers, women, and young people – for example – remain marginalised in decision-making.
- Despite stated government intentions NGOs remain the key actors seeking to benefit marginalised communities. These programs seek to ensure both access to water, while engaging in capacity-building work for empowerment of participants as decision-makers. Nevertheless, there is little empirical evidence that these programs have fundamentally moved away from their traditional focus on providing access, which typically comes at the expense of broader empowerment goals.

My Research

RQ: how can urban water development programs effectively develop the capabilities of the marginalised?

The aim of this research is to develop an evaluative Water Justice Framework that can be integrated into mainstream urban water development approaches in cities in the Global South.

My Approach

My research aim will be achieved by meeting three objectives:

1. Identify the urban water development program objectives, policies and processes that seek to develop the capabilities of the marginalised through three case studies in India and Bangladesh;
2. Compare and discuss the capability development approach and activities across multiple urban water development programs, and;
3. Derive policy and practical guidelines to ensure urban water development programs develop the capabilities of the marginalised through a Water Justice Framework.

Water plays a key role in fostering a range of instrumental freedoms required for human flourishing. How can urban water development programs effectively develop these?

Wikke Novalia

Born and raised in Indonesia, Wikke has a Bachelor of Engineering. She also completed a Masters of Civil Engineering, specialising in water management, at Delft University of Technology, the Netherlands. Both of her Bachelor and Masters research projects focused on safe drinking water access and simple water treatment technologies in remote communities in Thailand and Laos. Wikke has also worked as a project engineer with an international consultancy in Jakarta on water supply, stormwater and wastewater projects.

Main Supervisor: Professor Rebekah Brown

Co supervisors: Professor Ana Deletic
Dr Briony Rogers

Leveraging transformative capabilities

Actors navigating Indonesian urban water institutions

Problems

Complexity and uncertainty mark contemporary urban challenges. Yet, developing cities continue to aspire for classical, centralised, water service delivery paradigm that are ill-suited to deal with rapidly changing and highly unpredictable environmental and societal conditions. This ongoing fascination detracts new commitments from alternative solutions, and risks locking the future of those cities into hard-to-amend unsustainable urban water trajectory.

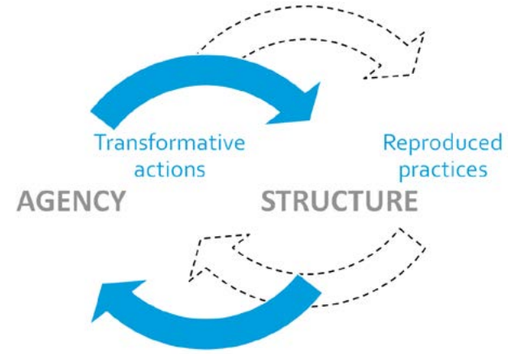
To enact change, we are very much concerned with how structures work and how actors navigate the cycle of institutional reproduction. Social scientists typically focus a great deal of efforts to unpack the structural properties that enable and constrain change in the society. As such, relatively little is known about how actors navigate change processes. What do actors know and how do they enact institutional processes? What are the factors that define the scope for strategic actions? We believe that answers to these questions can add rigour to new governance strategies for developing urban water contexts.

Research Aim

To generate governance recommendations that can leverage various forms of actors' capabilities across institutions for realizing more sustainable urban water practices in developing cities.

Research objectives

- Explore and describe the scope for strategic actions and the conditions that enable and constrain change processes.
- Map and contrast local institutional variations and the potentials for strategic actions in Indonesian urban water contexts.
- Design and trial novel governance strategies that leverage the capabilities of Indonesian urban water actors.



Tahmina Yasmin

Originally from Bangladesh, Tahmina has a Bachelor of Science and a Masters of Science (Geography and Environment), both from Dhaka University. Her Masters' thesis explored adjustment processes of people living in flood prone areas of Bangladesh. Tahmina has a range of professional experience, having worked with the Red Cross and on a range of climate change adaptation and sustainable development projects across both urban and rural parts of Bangladesh.

Main Supervisor: Dr Megan Farrelly

Co supervisor: Dr Briony Rogers

Sustainable Urban Water Management in developing countries: Exploring governance opportunities necessary for sustainability transformation

The Challenge

There are a number of challenges facing cities in developing countries in relation to delivering more sustainable urban water management practices coping with the increased uncertainties around population pressures and climate change futures. As these cities are not technologically constrained by deeply embedded service delivery practices, there are great opportunities for incorporating new service delivery models. However, what remains to be explored is the complex institutional domain which can significantly influence the direction of urban water management. Therefore, this research will draw on contemporary water management practices to explore the level of adaptive capacity within existing institutional structures and practices with an eye to promoting future pathways for change.

The Opportunities

Embracing adaptive governance elements to support the on-ground innovations would influence changes towards sustainable future. Contemporary and current practices of water governance are therefore, needed to understand how these activities interact together to understand the barriers to change and also unpack the pathways for change to achieve sustainable growth in urban water management.

A

B

Fig 1: Water supply and sanitation in Melbourne (A), modern developed cit and in Dhaka (B), newer city of developing country.

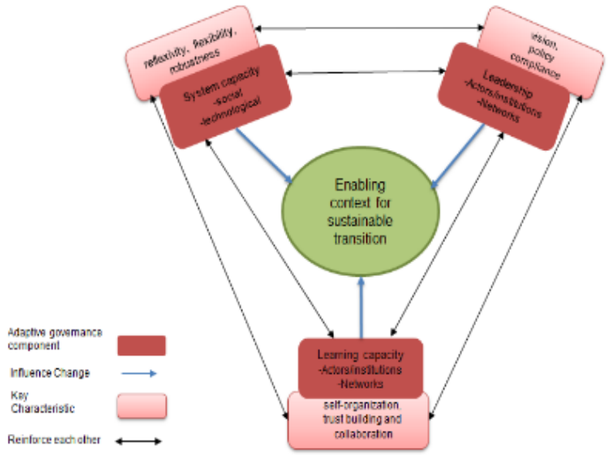


Fig 2: Conceptual Framework for adaptive urban water governance

Conceptual Framework for adaptive urban water governance

Through the lens of adaptive governance, this study will explore the historical development of urban water practices, converging on contemporary water management practices in Bangladesh to identify opportunities for enhancing the effectiveness of existing urban water governance practices. Examining urban water management within Bangladesh is timely for there is rapid urban population growth, a centralized push for greater economic development and a growing reflection of the important role of sustainability in the development trajectory, as well as recognition of the need to improve governance activities. Drawing from the adaptive governance and sustainability transition scholarship, the research also seeks to identify the key characteristics of transitions in a developing context. The research aims will be achieved through an in-depth case study analysis in Bangladesh.

Born in La Paz, Bolivia, Vanessa has a Bachelor of Environmental Engineering and a Masters of Integrated Water Management with the International Water Centre at the University of Queensland. Vanessa worked as an environmental engineer for four years, across both the public and private sector in numerous community development projects in both urban and rural areas of Bolivia. She has also worked as the technical advisor to the Minister of Environment and Water of Bolivia, representing Bolivia at meetings with organisations such as the United Nations and World Bank.

Main Supervisor: Professor Rebekah Brown

Co supervisor: Professor Ana Deletic

Leapfrogging to Water Sensitive Cities

Evolving our Urban Water Needs

Let's End Water Poverty

Access to basic water services remain a challenge in many developing cities (UN-Habitat, 2012). In order to accelerate into a solution, we could learn from industrialised cities' mistakes and experiences without creating a path-dependent linear development trajectory (Markard et al., 2012) and take this opportunity to steer future investment. The benefit will be to live in a city with high liveability & a low ecological footprint.

How? Well, developed countries can facilitate leapfrogging process to promote and enable Sustainable Urban Water Management (SUWM) and developing countries could avoid the lock-in industrialized countries are currently facing (Brown, 2012). Developing cities also have better chance of becoming water sensitive since they have not heavily invested into old single-purpose systems (Fig 1).

So, let's imitate nature and jump like a frog into using innovative technology and efficient socio-political drivers (Fig. 1). Thus, both developed and developing countries can ensure a global sustainable development.

…After all

If not us, who?
If not now, when?

(John F. Kennedy)

"A situation in which a newly industrialised country learns from the mistakes of developed countries and directly implements more sustainable systems of production and consumption, based on innovative and ecologically more efficient technology"
(Binz et al. 2012)

Aim

The overall aim of my research is to develop an explanatory framework for assessing potential conditions to inform leapfrogging strategies in developing cities towards sustainable urban water management.

The underlying ambition is to advance transitions management (leapfrogging) scholarship and analytically inform and urban water strategists, including funding agencies and national governments, through underpinning the development of urban water transitions in developing countries.

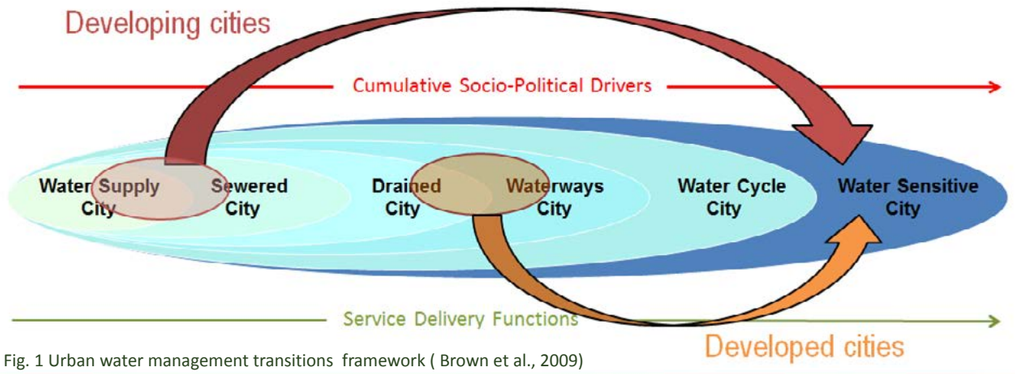


Fig. 1 Urban water management transitions framework (Brown et al., 2009)

Supervisors

Supervisors

Dr Peter Bach

Dr Peter Bach is a research fellow at Monash University's Water for Liveability Centre, Australia. He holds a Bachelor of Civil Engineering and PhD from Monash University. Peter's research interests focus on advancing the science of integrated urban water modelling, understanding interactions between urban planning and urban water management (which also involves ongoing development on the UrbanBEATS planning-support model and Water Sensitive Cities Toolkit), and harnessing big data for urban water systems. He hopes to improve current water infrastructure planning approaches through more effective techniques of integrated model development, application as well as stakeholder and community engagement.

Dr Annette Bos

Dr Annette Bos is a Senior Lecturer at MSI, where she leads the Sustainable Development Education Program. As a social scientist and civil engineer, Annette has developed and led a range of educational and capacity building programs, in both developing and developed countries. She is dedicated to developing new socio-technical understandings of urban water governance and her research provides theoretical insights and practical strategies for operationalising policy and governance reform agendas that embrace learning situations. Prior to joining Monash, Annette was extensively involved in research, capacity building and consultancy activities related to water management in Europe and Africa. Throughout her career, she has worked with industry, government agencies and aid organisations.

Dr Megan Farrelly

Dr Megan Farrelly is a Senior Lecturer within the School of Social Sciences working across Sociology and Human Geography. Megan's research explores environmental and natural resource governance, focusing on transformations within socio-technical systems, urban sustainability experimentation, evaluation and learning, to identify pathways for reform within policy and governance practices.

Megan's interdisciplinary background gives rise to broad research interests including environmental governance, sustainable urban water managment, and soci-technical transitions. Her research aims to understand the various institutional mechanisms and support structures required to develop and apply critical policy and governance reforms that will lead to more sustainable practices.

Dr Samanthi J. Gunawardana

Dr Samanthi J. Gunawardana is a Lecturer in Gender and Development in the Faculty of Arts, and the Course Coordinator for the Master of International Development Practice. Prior to joining Monash University, she held positions at Griffith University, Pennsylvania State University, Trinity College, Connecticut and Cornell University.

Samanthi's research examines the impact of development policy on employment systems, labour, and livelihoods among rural women in South Asia, with a particular emphasis on gender, development and labour in Sri Lanka. She is currently working on a research project with Oxfam-Australia in Sri Lanka on facilitating rural women's participation and recognition in sustainable livelihoods in Sri Lanka.

Dr Belinda Hatt

Dr Belinda Hatt has worked as a researcher in the field of urban water management since 2002 and her research interests include Stormwater Treatment and Harvesting, Integrated Urban Water Management, Water Sensitive Urban Design, and Aquatic Ecology. Belinda has recently lead the development of a new, industry-focused set of design and implementation guidelines for stormwater biofiltration systems (FAWB – Adoption Guidelines for Stormwater Biofiltration Systems). Belinda is now a lecturer in the Department of Civil Engineering. Belinda's PhD project (Filtration Technologies for Stormwater Harvesting) is linked to the Vegetated Filtration Systems/Biofilters theme, within the WSUD Technologies Program.

Dr Sayed Iftekhar (University of Western Australia)

Sayed is an environmental and resource economist with broad interests in the interactions between humans and nature. He has received training on forestry (Khulna University) and biodiversity conservation (Oxford University) and has also worked on coastal zone management in Bangladesh for several years. Sayed uses different economic tools such as agent based modelling, laboratory experiments and simulations to examine environmental issues such as sustainable forest management, ecosystem services, protected areas and environmental conservation from biological and resource management viewpoints.

Dr David McCarthy

Dr David McCarthy is a senior lecturer in the Environmental and Public Health Microbiology Laboratory in the Department of Civil Engineering and Project Leader of Fit-for-purpose water production in the CRC for Water Sensitive Cities. His research focuses on identifying pollutants that accumulate in stormwater and improving stormwater harvesting and reuse by developing sustainable, low-cost, low-energy treatment systems to remove these pollutants. David's research has drawn cooperation from a wide range of water agencies in Melbourne and industry partners.

Professor Diego Ramírez-Lovering

Professor Diego Ramírez-Lovering is Head of the Department of Architecture at Monash University and the co-founder and managing director of Monash Architecture Studio (MAS). His teaching and research examine the contributory role that architecture can play in addressing the significant challenges facing contemporary urban environments –climate change, resource limitations, rapid population growth and changing household demographics.

As an award winning architectural practitioner and researcher, Diego has been commissioned to design a range of projects including affordable housing, commercial projects and public art projects. His research and practice have been published in leading Australian and international publications and he is frequently called upon to talk to the media, present keynote lectures nationally and internationally and participate in adjudication, advisory and review panels for the public and private sector.

Supervisors

Professor Wolfgang Rauch (University of Innsbruck, Austria)

Professor Wolfgang Rauch is the Editor of Water Research, the top journal in the field of water resources. His research encompasses modelling and analysis of the complete urban water infrastructure system by focussing especially on water pollution, drainage and the integrative aspects of urban water management. In 2002 he was appointed Professor for Sanitary Engineering and Head of the Institute of Environmental Engineering at Innsbruck University, Austria. In addition to his active research profile in the fields already mentioned, he has expanded his research interests to include problems in alpine water resource management and biological treatment of waste.

Dr Briony Rogers

Dr Briony Rogers is a Research Fellow with the School of Social Sciences, Monash Water for Liveability Centre and the Cooperative Research Centre for Water Sensitive Cities. Her research explores how strategic planning and institutional change can enable transitions in urban water systems to create more liveable, sustainable and resilient cities.

Prior to joining Monash University, Briony worked as a civil engineer in a large infrastructure services consultancy. She was involved in a range of water infrastructure projects in Australia and Vietnam, with responsibilities for civil engineering design, management of multi-disciplinary design teams, feasibility studies and project management.

Dr Christian Urich

Dr Christian Urich is a Research Fellow with Monash University's Department Civil Engineering, exploring the dynamics of integrated urban systems and their linkages between the city, its water infrastructure and socio-economic systems. His research focuses on how these dynamics and feedbacks can be modelled in an integrated way to explore scenarios for sustainable and robust adaptation strategies. Christian is part of the CRC for Water Sensitive Cities team developing an integrated platform and database for socio-technical modelling to support collaboration and decision-making.

Professor Tony Wong

Professor Tony Wong is Chief Executive of the Cooperative Research Centre for Water Sensitive Cities, a $120million research centre with four research hubs based in Brisbane, Melbourne, Perth and Singapore. He is internationally recognised for his research and practice in sustainable urban water management, particularly in Water Sensitive Urban Design. His expertise has been gained through national and international consulting, research, and academia, and he has led a large number of award-winning urban design projects in Australia and overseas.

In 2010 Tony was named the Institution of Engineers, Australia, Civil Engineer of the Year, and in 2014 he was named a Fellow of the Australian Academy of Technological Sciences and Engineering (ATSE). Tony was one of 50 global high profile thought leaders invited to speak at the Global Café event in Brisbane prior to the G20 Leaders' Summit in November 2015. Tony has over 150 publications, notably Australian Runoff Quality: A Guide to Water Sensitive Urban Design, and has presented over 50 keynote and invited lectures.