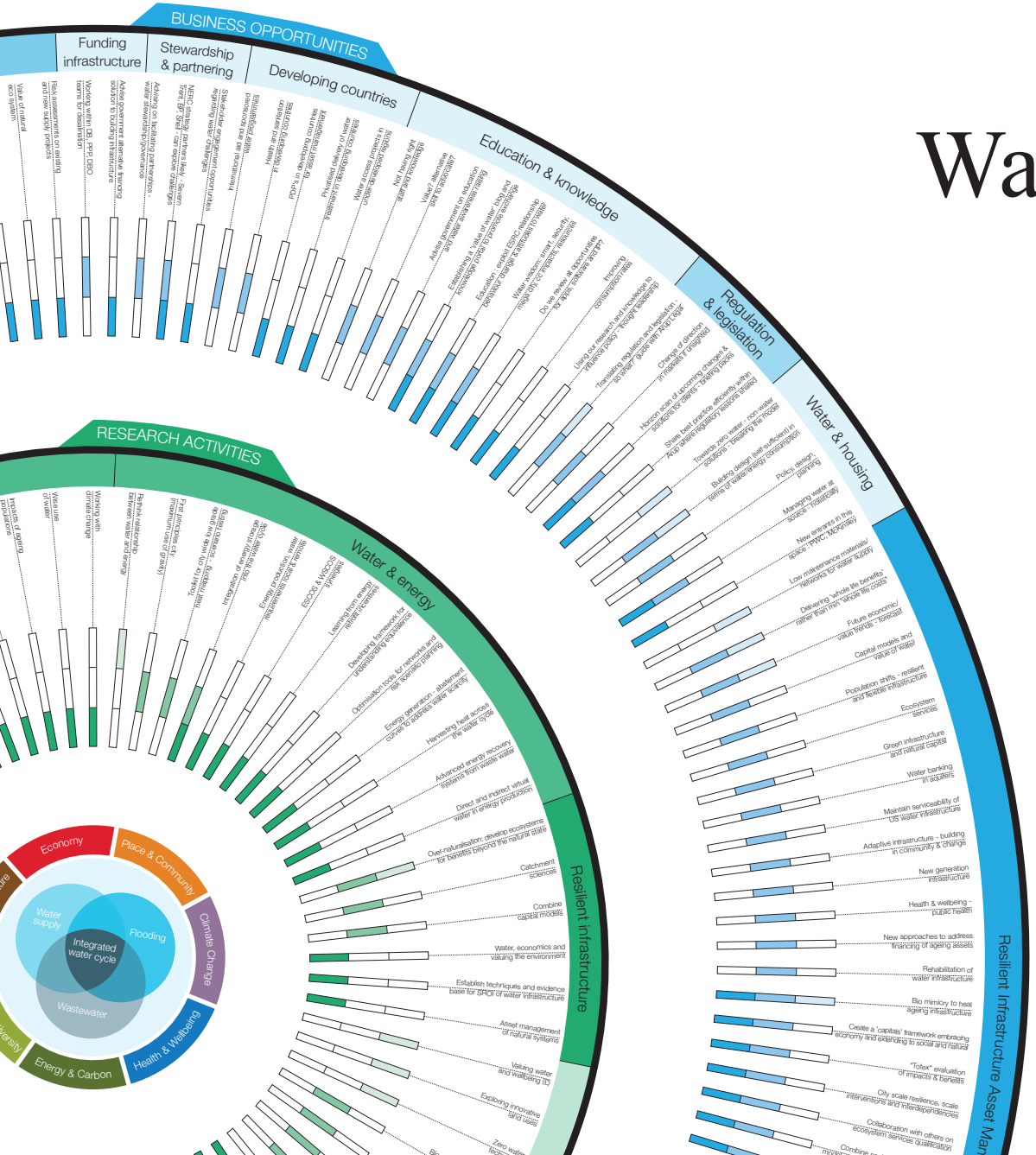
Water Research Review

2014/2015



ARUP

This report has been produced by the Water Skills Network and the Arup Foresight + Research + Innovation team.

The Arup F+R+I team identifies and monitors the trends and issues likely to have a significant impact upon the built environment and society at large. We research and raise awareness about the major challenges affecting the built environment and their implications. We help clients think more creatively about the long-term future and manage risk and uncertainty more effectively.

1. Introduction

The Water Skill Network and the Water Business within Arup have worked collaboratively with our Foresight + Research + Innovation team to review the Water Research portfolio over 2014/2015. The objective of the review was to:

- Capture all water related research undertaken during 2014/15
- Analyse the research undertaken
- Identify lessons learned that can be taken forward to the 2015/16 research programme
- Showcase some of the highlights of the research undertaken

The review was completed by Justin Abbott (Global Water Skills Lead), Marta Fernandez, David Hetherington and Jenna Beckett.

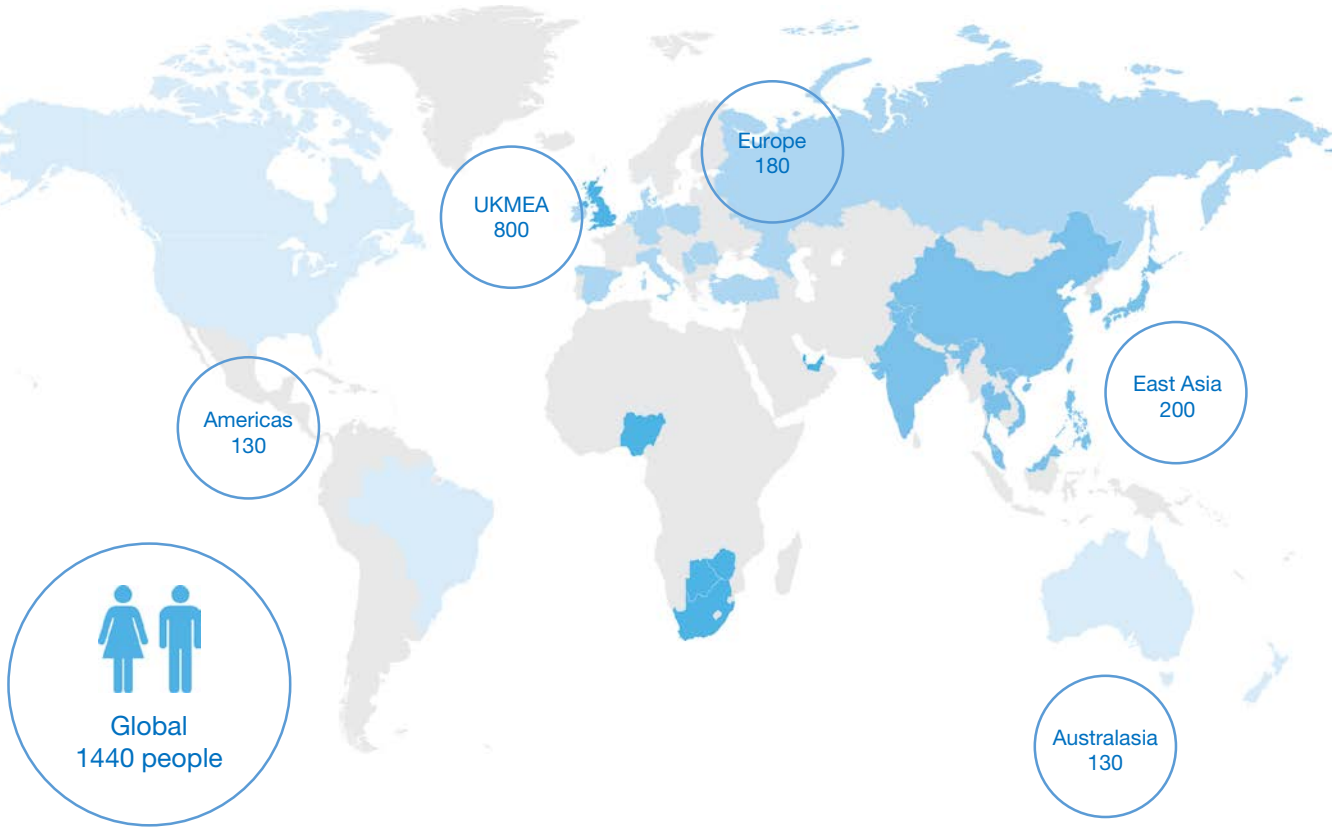
2. Our Skills Network

Water skills are integral to most of Arup's activity; either supporting our work direct with water clients, advising our clients on water resilience in a changing climate; or providing advisory services where water is increasingly recognised as a key risk in decision making. We see emerging themes as:

- **Resilience** to too much and too little water and extreme events.
- **Incremental change** e.g. global sea level rise impacting on communities and livelihoods.
- An increasing focus on **smart water** management and big data.
- The perceived **value of water** within both the urban space and the rural catchment with an increasing interest in **social** and **natural capital**.
- **Asset management** of deteriorating water infrastructure.
- Catchment-based responses to address resilience and **climate change adaptation.**
- Increasing tensions over **allocation of water.**
- The identification and treatment of **"new" pollutants**, e.g. nano-particulates.

Our Network

Our Water Skills Network is currently over 1400 strong. The network forum is very active and reflects a vibrant community of expertise, that allows us to access global knowledge for the benefit of our clients. Our vision is to grow the network, focussing on those areas outside the UK, where network numbers are already healthy



Arup's Water Skills Network (2015)

3. Research Topics

In 2013 the Water Business and Water Skill Network put together a research strategy early in the financial year to identify the priority areas for investment.

This was inspired by the 3 year global research roadmap outcomes and rationalised to respond to immediate business needs.

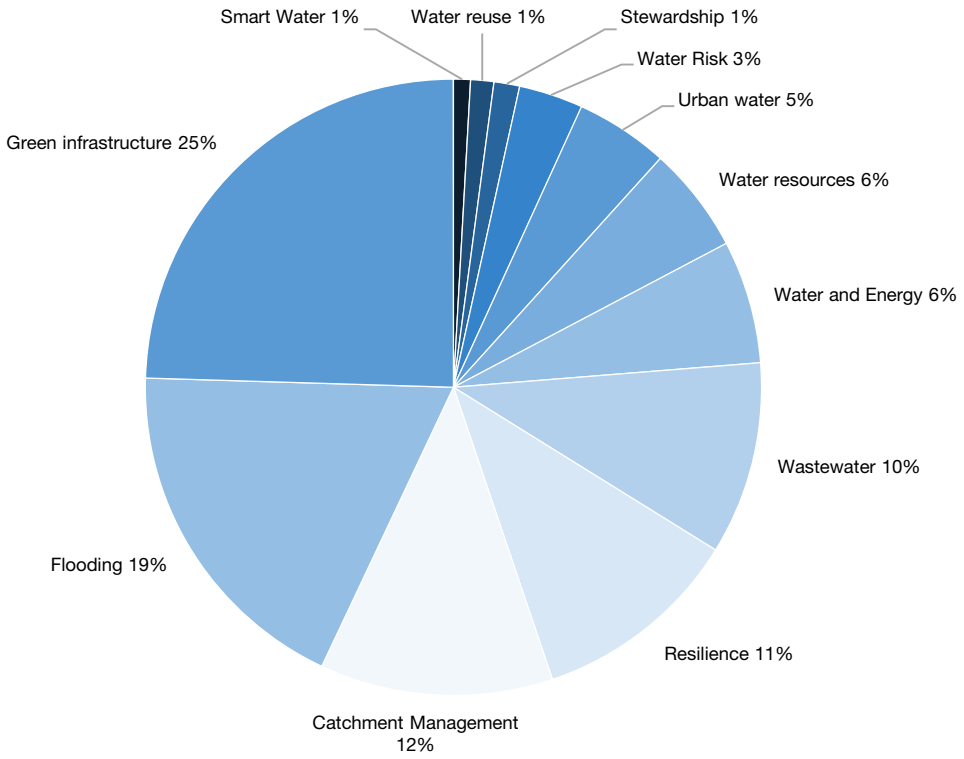
The agenda was shared with the water skill network community to invite applications in the prioritised areas.

Research theme	Research projects	Prioritisation
Resilient infrastructure (inc ecosystems used for functionality)	Improving resilience of coastal and river areas, value of water, economics of resilience	5
SMART Water and SMART Data	Innovative solutions that reduce costs, big data, ideas for efficient cities, GIS database applications	4
Water & Energy	Hazards of underground caverns, HEP, reservoirs, combined utility centres	4
Integrated Water Management	Cost benefits of solutions	4
Water Resources & Eco-system Services	Water security, regional issues eg California	3
Decentralised Water Recycling and Re-use	Strategic Major Opportunities with Operators, business case for industrial water re-use	3
Regulation & Legislation	Governance	2
Pharma Water (inc nano technology)	Applications for graphene	1
Cities & Demographics	Water and people agenda	1
Coastal & Transport	Implications of global sea level rise	0
Funding Infrastructure	Different models inc BOT. DBFO	0
Education & Knowledge	Better knowledge harvesting and water research roadmapping	0
Stewardship & Partnering	Explore third sector and multi-agency issues through Design with Water framework (maybe ESRC)	0
International Water (inc Transboundary)	Large scale water rights issues eg Colorado, Murray Darling	0
Water & Housing	Explore crossover with Public Health research and plumbing	0
Food	Food-Water-Energy Nexus around sewage sludge, food waste and farm slurry	0
Developing Countries	Understand role in disease avoidance of different treatment solutions	0

3. Research Topics continued

Projects have been reviewed to assess which subject of the water research strategy they focused on. A significant area of research this financial year has focused on Flooding. This in part is due to the Global Research Challenge call for 2014 which was titled '*Cities, Flooding and Sea Level Rise*'.

The chart shows the distribution of funding across different topics.



Funding distribution per topic

4. Collaborations

In many cases external engagement with private or public sector partners or academic institutions is needed to speed up development, leverage funding and maximise the value from investments. Collaboration with private sector partners provides an opportunity develop relationships with current and potential clients.

There were 10 collaborative projects and over 50% of those involved public authorities.

The figure maps the types of collaborations and the amount of funding invested for each type of collaboration.

The partners that have been engaged in projects this year include:

Universities

Birkbeck College, UKMEA
Leeds University, UKMEA
Newcastle University, UKMEA
Old Dominion University (Virginia), Americas
Southampton University, UKMEA
Swansea University, UKMEA
UCL, UKMEA
York University, UKMEA

Research Centres

Heinz Centre
Savory Institute

Public bodies

Cities of Birmingham, Bristol, Hull, Norfolk
Wastewater lagoon operators in Australia
National disaster preparedness training centre
Natural Resources Wales

Companies

Argos Analytics
ESA
Sainbury’s plc

Appendix 1. Research projects

ID	Project Title	Fund Name	PD	PM	Region
9859	Sustainable Drainage Design Guidelines - Hong Kong	East Asia Research	Fergal Whyte	Mathew Bamm	East Asia
9934	Arup Scene - online tool for collaborative planning and infrastructure delivery	UKMEA Research	Wayne Dyer	Timothy Durant	UKMEA
9940	Underperforming wastewater lagoons in Australia	Australasia Research	Daniel Lambert	Niruma Akhter	Australasia
9945	Physical vs computational hydraulic models - PHASE 2	UKMEA Research	Rachel Sandham	David Neeve	UKMEA
9958	CSIC - whole-life assessment of infrastructure and future-proofing infrastructure	Global Research	Duncan Nicholson	Heleni Pantelidou	UKMEA
9987	SPLASH I/O	UKMEA Research	Martin Shouler	Kristian Steele	UKMEA
10097	Real-time natural disaster, risk alert system - HazardOwl Phase II	Global Research	Tim Mote	Roland Martin	East Asia
10116	Green infrastructure - develop conceptual model to quantify its value	Global Research	Vincent Lee	Louise Ellis	Americas
10131	Flood Damages Calculation Tool - develop and test update	Global Research	Catherine Wenger	Jo Nelson	UKMEA
10167	Southern Gateway, Birmingham - enhancing project outputs	Global Research	Nigel Ridgway	Faye Beaman	UKMEA
10171	CASE 2014 Accurate and efficient application of CFD free-surface Hydraulic Modelling	Global Research	Mark Fletcher	David Neeve	UKMEA
10215	LEED Rainwater & Waste Water Calculation Tool	Americas Research	Cameron Thomson	Alan Glynn	Americas
10279	App development for geomorphological field surveys	UKMEA Research	Will McBain	Sally German	UKMEA
10318	IBuild and Blue Green cities project support and associated research activities.	UKMEA Research	Andy Mace	David Hetherington	UKMEA
10387	Urban water management in small island states - develop a sust. and resilient framework	Global Research	Justin Abbott	Geoffrey Morgan	UKMEA
10404	Rainwater Harvesting Analytics with GIS (RHAG)	Americas Research	Rowan Roderick-Jones	Kate Tunstall	Americas
10413	Interactive Watershed Planning - version 2	Americas Research	Rowan Roderick-Jones	Bond Harper	Americas
10443	Sheffield interactive flood visualisation	Global Research	Justin Abbott	Llew Hancock	UKMEA
10461	Mapping our green infrastructure capacity in a digital environment	Global Research	Justin Abbott	Michael O'Neill	Australasia
10478	Strategic Flooding Method for Critical Railway/Water Environment Interface Zones	Europe Research	Declan Bowles	Ailis Power	Europe
10503	Investigation of hashtag (#flood) trending for insights	Global Research	Faye Beaman	Alison Caldwell	UKMEA
10504	Retrofitting Rivers Tool - Excel paired with GIS for SUDS locations	Global Research	Faye Beaman	Alison Caldwell	UKMEA
10528	Resilience-based flood design - develop a framework for implementation	Global Research	Ibbi Almufti	Yana Waldman	Americas
10599	Low Carbon Infrastructure	UKMEA Research	Tim Chapman	Heleni Pantelidou	UKMEA
10651	Energy and PH/ESE systems	UKMEA Research	Martin Shouler	Fabio Coelho	UKMEA
10657	Engaging Singapore Government in Smart Cities Initiatives	Australasia Research	Henry Jeens	Alma Banuelos Granda	East Asia
10679	Development of a tool to optimise the location of wastewater outfall	Global Research	Daniel Lambert	Ed Beling	Australasia
10681	Energy Optimisation in WWTP	Australasia Skills	Daniel Lambert	Rhys Anderson	Australasia
10694	ESE BIM tools development	UKMEA Research	Martin Shouler	Kate Fletcher	UKMEA
10701	Natural Flood Management - turning science into implementation	Global Research	Andy Mace	David Hetherington	UKMEA

Appendix 1. Research projects continued

ID	Project Title	Fund Name	PD	PM	Region
10724	SuDS DTX Project - Phase 2 Application	UKMEA Research	Catherine Wenger	Richard Brown	UKMEA
10776	Development of a mapping tool to determine priority locations for Natural Flood Management features	Global Research	Will McBain	Alex Nicholson	UKMEA
10782	Infrastructure BIM - Information Modelling	Global Research	Nigel Wooldridge	Ioan Evans	UKMEA
10878	GRC 2014-Call 2- cities and sea level rise: flood hazard assessment and adaptation toolkits	Global Research	David Wilkes	Donald Daly	UKMEA
10916	Climate Plus: beyond readiness in coastal cities	Global Research	Cole Roberts	Rowan Roderick-Jones	Americas
10924	Ecodistricts Founding Partner: Year 2	Americas Research	Fiona Cousins	Afaan Naqvi	Americas
10946	Easy Sediment Transport Assessment Tool (E-STAT)	Global Research	Andy Mace	David Hetherington	UKMEA
10967	Management of critical interfaces between natural and modified sections of mountain rivers	Global Research	Jacek Zalewski	Tomasz Glixelli	Europe
11003	Intelligent asset management of green infrastructure - predictive analytics	Global Research	Vincent Lee	Jenna Browning	Americas
11046	Bay Meadows post construction stormwater quality testing	Americas Research	Grant McInnes	Jacob Wood	Americas
11078	Hydropower tunnels for hydroelectric schemes - strategy for design capability	Global Research	Jon Hurt	Sean Lee	Americas
11083	Anaerobic treatment of sewage - maximising energy recovery	Global Research	Vincent Glancy	Darryl How	UKMEA
11155	Water Neutral Development - develop a business model	Global Research	Andy Simmans	Andy Simmans	UKMEA
11261	Flood warning and forecasting - review better use weather data	Global Research	Kenneth Kwok	Yuvi Luo	East Asia
11270	Water Stewardship - review of corporate approaches	Global Research	Justin Abbott	Kate Jackson	UKMEA
11282	Arup EngD: The application of ICT tools for water and sanitation in informal settlements	Global Research	Ian Carradice	Vera Bukachi	UKMEA
11300	Urban flood modelling using Flood Modeller Pro - comparison to ISIS-Tuflow	Global Research	Catherine Wenger	Lei Yang	UKMEA
11302	Floating solar PV - develop design of foundation	Global Research	Joe Strydom	Auret Basson	UKMEA
11317	Resilience through Smart City Initiatives	Global Research	Garry Banks	Alison Ball	UKMEA
11337	Working with nature to mitigate extreme hydrological events - case study of Natural Flood Management	Global Research	Catherine Wenger	Candice Constantine	UKMEA
11339	Shale gas production - review of well integrity and deep contamination issues	Global Research	Duncan Nicholson	Michael Chendorain	UKMEA
11429	Assessment of the Integration of Ecosystem Services in the Urban Metabolism approach	Europe Research	Ramon Rodriguez	Susana Saiz	Europe
11431	Sediment systems downstream of reservoirs - develop monitoring methodology	Global Research	Will McBain	Sally German	UKMEA
11432	Field apps - development of post-processing tools	Global Research	Will McBain	Sally German	UKMEA
11461	Real-time monitoring of water quality in urban waterways (to inform of swimmability)	Global Research	Justin Abbott	Michael O'Neill	Australasia
11493	Urban ecosystem services - start a reference and resource guide	Global Research	Gordon Richardson	Rory Canavan	UKMEA
10573	Sewer heat recovery - research, develop and test methodology for resource mapping	Global Research	Justin Abbott	Richard Mizzi	UKMEA
10533	Natural Systems - business case analysis to improve drinking water quality	Global Research	Justin Abbott	Ed Beling	Australasia
10966	Dams and risk - capacity building	Global Research	Rachel Sandham	Mike Dobson	UKMEA
11612	Water Drivers of Change Cards Update	Global Research	Mark Fletcher	Justin Abbott	UKMEA

Appendix 2. Overview of selected research projects from 2014/15

Three projects have been selected for each of the topic areas.
The description provides an overview of the objectives of the project and the findings.

Flooding

Flood Damages Calculation Tool

We developed a GIS tool that uses the latest flood damages evaluation data to calculate whole life damages for properties in multiple flood event scenarios and epochs. The results can also be easily visualised spatially as the calculations are all integrated in GIS software. Whole life calculations are a vital step in the overall understanding of option damages and resilience to climate change. This data underpins the industry best practice method of calculating damage due to flooding, required by our key clients for Flood Risk Management schemes. Being able to extract this data efficiently is vital to completing our appraisals accurately in a timely manner and being able to map the results spatially adds to the team and client's understanding of the flood damages evident.

The updated toolbox meets a key business need by streamlining our analysis, improving the quality of our results and enabling innovative thinking to appraisal projects for key clients.

Project ID: 10131 | PD: Catherine Wenger | PM: Yvonne Murphy

Investigation of hashtag (#flood) trending for insights

We investigated the use of social media for engineering reconnaissance through monitoring the real-time activity of specific hashtags. The study explored the use of the popular hashtags, such as #flood, #flooding and #storm, across different social media platforms (twitter, Facebook etc.) to give an insight into how these hashtags are generated, gain following and trend.

This study focused on the use of hashtags prior to, during and following a disaster, providing insight into how social media is used in disaster management. Additional analysis of users, context of hashtag, frequency of use, geographic projection and variations in social media platforms provides an increased awareness and understanding of hashtags, thereby potentially enabling us to harness the power of social media to benefit clients and projects.

Project ID: 10503 | PD: Faye Beaman | PM: Alison Caldwell

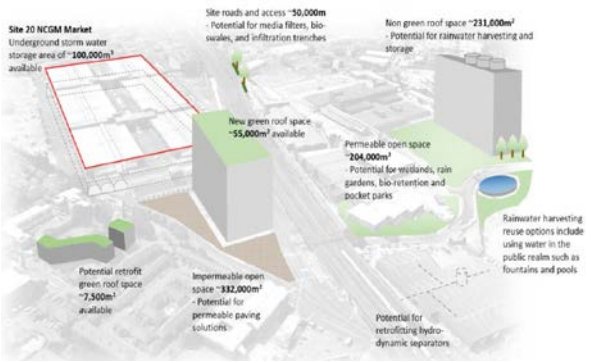
Resilience Plus: beyond readiness in coastal cities

We developed the “resilience-plus” concept adding externally facing knowledge to inform resilience planning for high value and low capacity shorelines. Building on past work, resilience-plus reaches beyond the traditional concept of resilience, i.e. “bouncing back”, rather focusing how communities can achieve aspirational goals and thrive through resilience planning. The project looks at coastal city co-beneficial infrastructure, developed in response to multi-hazards. This research aids curricula for teaching coastal “resilience-plus” approaches to cities and practitioners. The end results of the work also include the development of future IDF curves from global climate models for use in more accurately modelling future flood risk.

“Resilience Plus” research pinpoints Arup as a recognised expert in coastal climate readiness training and provides business opportunities via training to various cities.

Project ID: 10916 | PD: Cole Roberts | PM: Rowan Roderick-Jones

Green Infrastructure



Retrofitting Rivers Tool – Excel paired with GIS and SuDS locations

We identified sustainable flood management strategies and soft engineering solutions, including SuDS for a high risk fluvial environment in the UK. Through the use of GIS, the potential of water management strategies was explored to eliminate, or at least minimise, the need for hard engineering controls at a central London site. Through the partnership of GIS, WaND (Water & Neutral Design Tool) and internal SuDS a competent assessment of existing and proposed conditions, identified the most applicable SuDS for the development.

This assessment provided an insight into the potential of SuDS and water management strategies in sites subjected to significant constraints, including river and surface water flooding, limited space and high commercial value of land.

Project ID: 10504 | PD: Faye Beaman | PM: Alison Caldwell

Assessment of the Integration of Ecosystem Services in the Urban Metabolism approach

We developed a framework methodology for quantifying the “Ecosystem Services” (ESS) provided by the built environment, which identifies their suitability and materiality for their inclusion within the built environment. The framework identifies the objective, spatiality of potential green infrastructure strategies, and the potential issues to be considered. The characterisation and quantification of the ecosystem services is identified by data sources to be used in the LCA and cost optimal analysis tools.

A detailed analysis of Ecosystem Services identifies the information required to evaluate and quantify their potential impacts, whilst exploring the gap between the anticipated benefits and real-life performance. This enables an insight into the design process to help identify optimal green infrastructure for the required service within the urban ecosystem.

Project ID: 11429 | PD: Ramon Rodriguez | PM: Susana Saiz

Working with nature to mitigate extreme hydrological events – case study of Natural Flood Management

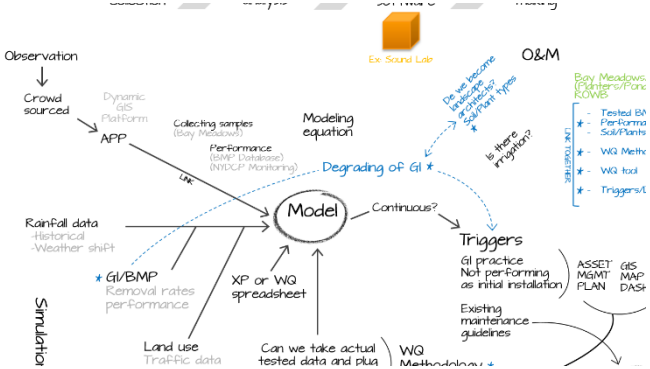
We identified possible sites and a proposal for a paired catchment study to evaluate the effectiveness of Natural Flood Management (NFM) techniques in reducing flood peaks from forested areas during large runoff events. We visited the sites with Natural Resources Wales and collated information on opportunities for and barriers to NFM implementation associated with forestry practices and operations, access, recreational use and funding. We developed a list of possible options and a programme for implementation based on planning forestry activities.

The planned study will fill gaps in NFM literature and modelling capabilities, and will provide a strong case to support the adoption of holistic flood risk management.

Understanding effective NFM techniques strengthens Arup’s position as a lead in flood risk management, and brings together an array of case studies of sustainable practice that are of interest at an international level.

Project ID: 11337 | PD: Catherine Wenger | PM: Candice Constantine

Green Infrastructure

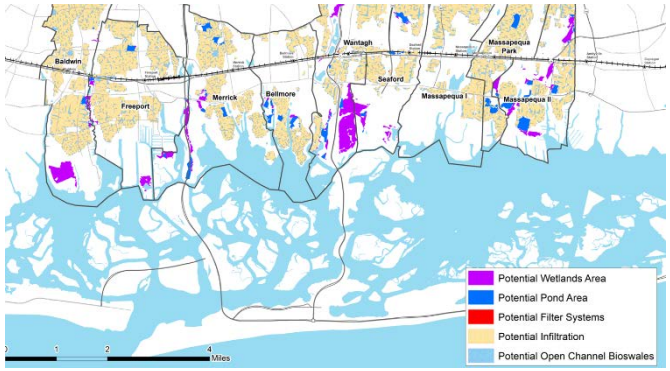


Intelligent Asset Management for Green Infrastructure

As cities adopt green infrastructure practices, stormwater best-management practices (BMPs) are being more comprehensively implemented for at-source stormwater control to treat the runoff, which results in cleaner urban waterways. Many cities are facing the critical question of how to effectively maintain these systems. The aim of this research was to discover ways to input performance data derived from green infrastructure monitoring into a model, such that real-time rainfall data can then be used to monitor and predict scenarios for maintenance, thus ensuring acceptable green infrastructure performance.

The research supports the potential for remote asset management of green infrastructure practices, on small or large scales, enabling these assets to be maintained before they start to decrease from targeted performance levels. This allows for steadier uninterrupted performance and cleaner urban waterways.

Project ID: 11003 | PD: Vincent Lee | PM: Jenna Browning



Green infrastructure - develop conceptual model to quantify its value

Green infrastructure is a network of decentralized stormwater management practices, such as green roofs, trees, rain gardens and permable pavement, that can attenuate or infiltrate rain where it falls, thus reducing stormwater runoff and improving the health of the surrounding waterways. In order to ensure that the optimum performance of each green infrastructure asset is met, it is important that they are located to meet site-specific criteria, for example, soil type, ground water depth, existing topography, well head protection area, etc.

The first aim of this project is to create a tool that provides a menu of green infrastructure strategies for each land parcel based on the existing site criteria. Green infrastructure can generate important social, environmental and economic benefits to local watersheds and communities, in addition to improvements in stormwater quality and a reduction in stormwater quantity. These can include energy consumption, air quality, property prices and recreation. The project is also looking to design an Arup Green Infrastructure Triple Bottom Line Calculator that can be used to assess the TBL of green infrastructure projects at a project planning stage.

Project ID: 10116 | PD: Vincent Lee| PM: Louise Ellis

Water and Energy

Anaerobic treatment of sewage – maximising energy recovery

We developed a strategy for optimising the energy generation from an existing system which anaerobically treats biosolids through characterisation of the feedstock and development of a dynamic model which can inform evaluation of the real-time monitoring and control of algorithms. The model was developed using GPS-X, a leading wastewater treatment simulation package. The study has shown that *mantis2* mathematical model is useful for validating the steady-state operation of a healthy anaerobic digester. With further development, the model has a great potential as a tool for process optimisation together with key instruments identified within the study. Additionally, a business opportunity was presented in recovery of high-value products from digestate through bioconversion.

Research into the optimisation of energy recovery from anaerobic treatment systems places Arup as a market leader in both the industrial and municipal sectors.

Project ID: 11083 | PD: Vincent Glancy | PM: Darryl How

Floating solar PV – develop design of foundation

We conducted a feasibility review and developed a concept design of a floating PV system, specifically the floating foundation to house the PV array, that can be used on water storage reservoirs. Power generation is often associated with negative impacts on water due to cooling requirements and waste disposal facilities. The developed floating PV design is expected to reduce evaporation losses from the reservoirs by reducing the reservoir water temperature, the exposed surface area to direct sunlight, and the wave action.

The developed design aims to be patentable, locking in potential future work for Arup at an international scale, whilst also showcasing Arup's multidisciplinary approach to real world problems.

Project ID: 11302 | PD: Joe Strydom | PM: Auret Basson

Energy Optimisation in WWTP

This project researched energy optimisation techniques and technologies for wastewater treatment plants. Public water authorities are being placed under increasing pressure to reduce capital and operating expenditure. One major cost incurred is electricity consumption in wastewater treatment plants. Building on previous work with South East Water, this project identified pragmatic and innovative opportunities to improve energy efficiency in operating treatment plants without incurring significant capital costs.

Energy optimisation improves sustainability and increases monetary value in projects for clients.

Project ID: 10681 | PD: Daniel Lambert | PM: Rhys Anderson

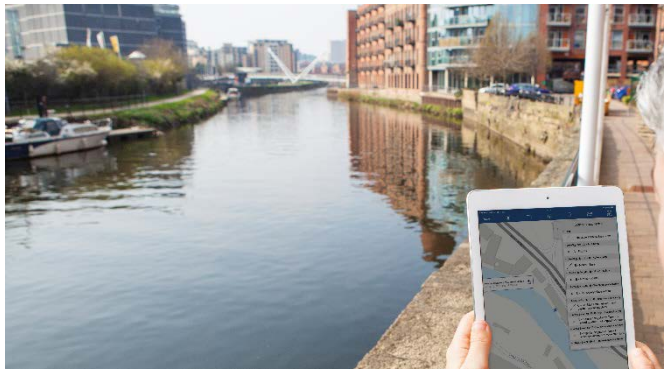
Catchment Management

Sediment systems downstream of reservoirs – develop monitoring methodology

We have developed a monitoring methodology for river sediments which can be adapted to the specific requirements of river restoration sites, to obtain a robust understanding of baseline conditions and be able to evaluate post-construction impacts with confidence. The developed approach was tested using a reach downstream of Swinsty Reservoir, where an Arup designed River Restoration scheme is planned to be built in the summer of 2015.

This methodology will improve our confidence in our river restoration designs to ensure they achieve the expected and desired outcomes required by our clients and EU legislation (WFD). The approach can be developed into a transferable tool for a number of practitioners within Arup, to demonstrate our understanding and findings in order to make stronger proposals to existing and future clients.

Project ID: 11431 | PD: Will McBain | PM: Sally German



Field apps – development of post-processing tools

We have provided additional tools for the already developed Geographical Information field survey tool. The tool includes fluvial audit and MiMAS survey formats and associated bespoke post-processing tools for data collected in the field. This significantly reduces the time needed for data analysis, figure and graph production, and report writing. The new tools have already been adapted to the requirements of clients, including the strategic project for SEPA to undertake surveys of over 3,500km of rivers in Scotland, showing a daily 2 hour reduction in survey time compared to using paper maps and eliminating the need for post-survey digitising.

By extending the field app survey tool the efficiency of geomorphological data collection, post-processing and analysis has been improved. The tools are adaptable to be used by other Arup teams, globally, that are collecting and/or analysing any similar data.

Project ID: 11432 | PD: Will McBain | PM: Sally German

Management of critical interfaces between natural and modified sections of mountain rivers

We assessed practical solutions for repair and management of critical areas on the interface between natural and modified mountain river corridors. The regulation of mountain rivers usually involves heavy modifications to the river bed and cross-sections to try to reduce the extensive damage caused to the river corridor by water energy. These interface areas are prone to cause flood problems. Solutions must be hydraulically assessed to stabilise river corridors and achieve a smooth transition.

This builds on our capability to be associated with the management of mountain rivers to ensure sustainable responses.

Project ID: 10967 | PD: Jacek Zalewski | PM: Tomasz Glixelli

Smart Water

Arup Scene – online tool for collaborative planning and infrastructure delivery

We piloted an internet-based Infrastructure Delivery Planning GIS tool with existing Local Authority clients. The low-cost 'open source' GIS tool combines mapping, spreadsheet, and gantt chart (programme) functions to provide a strategic infrastructure planning tool with multiple benefits, including strategic overviews of development and infrastructure projects for an area, information on funding, phasing, and progress towards delivery. This tool enables access and the sharing of information between partner organisations and across infrastructure sectors.

This project has provided an insight into the opportunities and challenges of encouraging closer cooperation between infrastructure providers and the management of 'big' data. The GIS tool sets Arup apart in the field of Strategic Infrastructure Delivery Planning in the UK, forming a vital part of our 'Smart Cities' offer.

Project ID: 9934 | PD: Wayne Dyer | PM: Timothy Durant

Engaging Singapore Government in Smart Cities Initiatives

We collaborated with the Technology & Research Team in Singapore to engage the Government in smart city initiatives and showcase our capabilities to clients in the private sector, in particular developers and architects.

Knowledge gained locally; internally between the Singapore Technology & Research team and with the wider Smart Cities community, and externally with the Singapore Government, has furthered our Smart City initiatives.

Project ID: 10657 | PD: Henry Jeens | PM: Alma Banuelos Granda

Arup EngD: The application of ICT tools for water and sanitation in informal settlements

We are evaluating, using a systems engineering-based framework, the viability of scale and replication of decision-making ICT based tools for use by local authorities in the provision of Water and Sanitation services in informal settlements. The WATSAN Portal, an ICT based support tool currently used in Kibera, Nairobi, is being used as a comparative case study. The work is analysing the needs and priorities of stakeholders for sustainable and safe access to improved water and sanitation services in informal settlements by identifying the requirements for technology based tools to be met to ensure the tools are sustained, and evaluating the impact on the WATSAN Portal to determine the support needed, specific to informal settlements.

ICT tools for decision-making by local authorities exist, but the ability to scale and replicate this in the water and sanitation sector for urban consumers in low income countries is missing. This research addresses this knowledge gap.

Project ID: 11282 | PD: Ian Carradice | PM: Vera Bukachi

Resilience

Urban water management in small island states – develop a sustainable and resilient framework

We developed a replicable and scalable framework to integrated water resource management for small island states, based on previous and existing work undertaken in the Maldives. The framework aids decision making for water throughout the project lifecycle, ensuring a consistent safe and equitable access to freshwater for island communities, in particular under changing climatic conditions. Previous water supply projects for four Maldive islands (undertaken with the United Nations Office on Project Services, UNOPS) scoped out design, review and quality assurance, alongside other core components, but failed to appreciate the complexity and unique nature of island communities to develop a sustainable resilient solution.

This conceptual framework forms the basis of a replicable service for the firm to use in similar contexts, showcasing our expertise and credibility in water resource management.

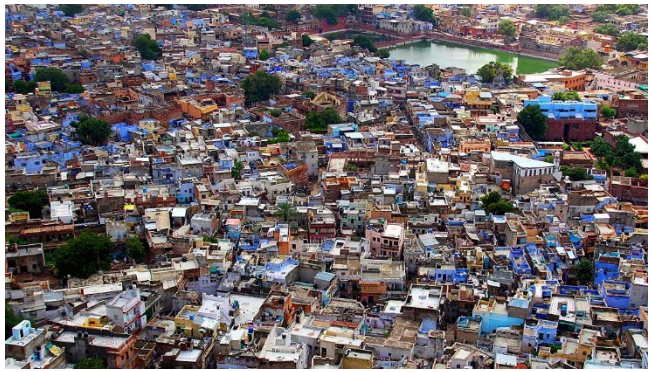
Project ID: 10387 | PD: Justin Abbott | PM: Geoffrey Morgan

Real-time natural disaster, risk alert system – HazardOwl Phase II

We developed the existing HazardOwl tool into a resilient platform which can be used to monitor risk from all natural disasters. HazardOwl is a Real-Time Natural Catastrophe Risk Alert System, which concentrates on building a resilient back-end and integrating the earthquake monitoring system. This project has enabled the addition of other hazard types, such as wind, severe weather, and tidal risk.

The assessment of the potential impact to infrastructure in near real-time is a service that Arup can provide to understand our design performance and proactively advise our clients on the impacts of natural hazards. There is potential for HazardOwl to be sold as a commercial project.

Project ID: 10097 | PD: Tim Mote | PM: Roland Martin



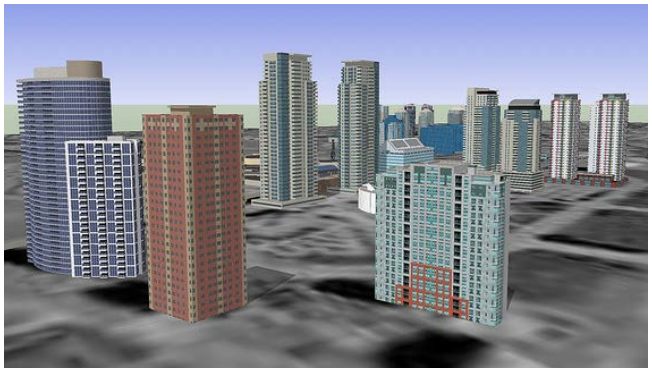
Resilience through Smart City Initiatives

We explored the potential for smart city initiatives to be used to contribute to increased city resilience. We have collaborated with the International Development Team to develop a City Resilience Index that is usable, credible and globally applicable. The index comprises a common set of indicators (what you need to observe) and variables (what you measure), but the metrics within the index vary from city to city (how you measure). We worked with Arup individuals from different cities in varying geographies to identify, develop and review the city indicators.

A City Resilience Matrix provides data opportunities for measuring and addressing resilience in various global cities.

Project ID: 11317 | PD: Garry Banks | PM: Alison Ball

Urban Water



Sheffield interactive flood visualisation – Stage 2

We have improved an existing three-dimensional visual model of Sheffield City Centre, which demonstrates building and environmental effects within a 3D environment. In phase I of this project a desktop application was constructed in a games platform to allow any user to navigate a city model of Sheffield, and view 3D time varying hydraulic model results. Phase II improved the visual look and resolution of the model, in order to showcase Arup's ability in flood modelling.

This project has shown Arup's ability to demonstrate complex time-varying propagation through a city, within an interactive environment.

Project ID: 11331 | PD: Justin Abbott | PM: Llew Hancock

Real-time monitoring of water quality in urban waterways (to inform of swimmability)

A global urban swimmability movement is emerging. In order to engage with this movement, we need data to design urban swimming areas in rivers and creeks, which are safe, accessible and clean. This requires changes in wastewater management and effective communication methods to show residents that swimming in their city's waterways is possible.

This project researched and determined the feasibility of deploying real-time water quality monitoring systems in urban waterways, establishing Arup as a global leader in urban swimmability projects.

Project ID: 11461 | PD: Justin Abbott | PM: Michael O'Neill

Urban ecosystem services – start a reference and resource guide – Stage 1

The Reference and Resource guide presents an authoritative and succinct evidence base of the benefits of urban ecosystem services, by identifying existing and innovative enhancement and management strategies for urban ecosystem services. The guide details the context and necessity (evidence for our reliance on urban ecosystem services within cities), and solutions for integrating and enhancing ecosystem services into the urban landscape.

This concise Reference and Resource guide places Arup at the forefront of urban design. The guide may be used within or outside Arup to inform, enlighten and inspire key stakeholders, for example; planners, architects, designers and local government.

Project ID: 11493 | PD: Gordon Richardson | PM: Rory Canavan

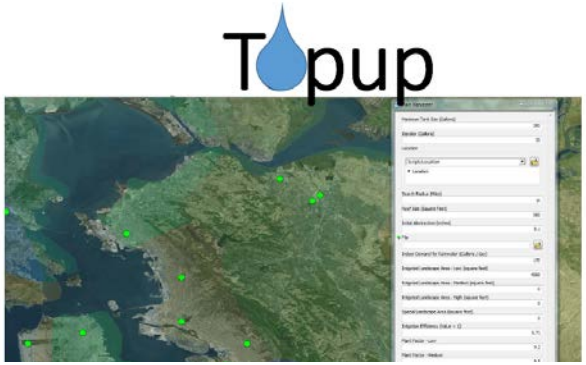
Water Resources

iBuild and Blue Green cities project support and associated research activities

We have continued to support large EPSRC-funded (Engineering and Physical Sciences Research Council) projects and associated research activities. Through our support we provide industrial guidance in steering groups meetings, and attend regular developmental workshops with a range of other project contributors.

The projects include the iBuild project, the BlueGreen cities project. We have generated and steered projects, supported students and researchers, and offered lectures. A key outcome of the Blue Green cities project has been a blue green vision for the city of Newcastle, which will now guide implementation of Blue Green Infrastructure.

Project ID: 10318 | PD: Andy Mace | PM: David Hetherington



Topup

Topup is a GIS based rainwater cistern sizing optimization tool which uses climate data (rainfall depth and evapotranspiration) and project data, (roof size, non-potable demand) and other factors, to develop site specific rainwater cistern optimization curves. This powerful little tool triangulates on NOAA rain gauges to provide an estimated historic daily rainfall record at the building location, which feeds into a daily analysis of cistern fill and drawdown. As Cistern sizing is often the highest single cost item for rainwater harvesting systems, getting this analytic step correct is important to creating effective and efficient systems.

Topup is robust, satisfying technical requirements of design engineers whilst being easy to use for non-engineers. Ultimately Topup will become an internet based tool which can be applied globally to improve drought resilience in water challenged regions.

Project ID: 10404 | PD: Rowan Roderick-Jones | PM: Kate Tunstall

Ecodistricts Founding Partner: Year 2

Arup is a founding member of Ecodistricts, a national 501(c)3 organisation that aims to help cities achieve sustainability goals by providing access to “people, tools, services, and training”. In the prior FY, Arup committed to a 2-year founding membership to support the relationship. The project developed an integrated decision support tool to facilitate decision-making on the retrofitting and renewal of existing districts and its composing buildings. The second year of the project saw the development of the Ecodistrict framework.

This project enables us to tackle the subject of contextualizing a sustainability standard to the local needs and environment of a project in a sophisticated and strategic way. It has also helped develop a strong relationship with Ecodistricts which is a recognized name associated with what is a fast growing national sustainability standard.

Project ID: 10924 | PD: Fiona Cousins | PM: Afaan Naqvi

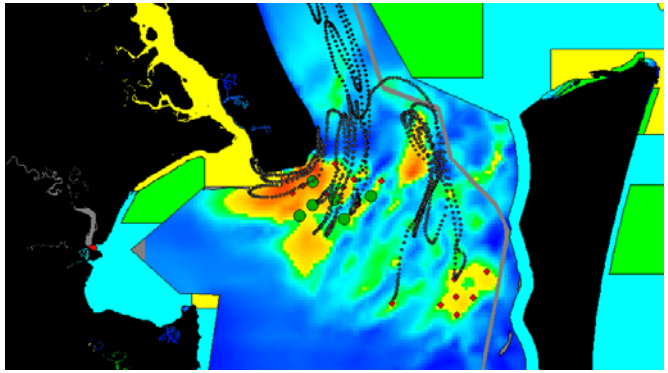
Wastewater

Underperforming wastewater lagoons in Australia

We first developed a register of all wastewater lagoons in Australia, in order to identify the lagoons that are underperforming, with the long-term view to develop a client list that Arup could approach to offer assistance.

This register provides opportunities and analysis of existing lagoon performance.

Project ID: 9940 | PD: Daniel Lambert | PM: Niruma Akhter



Development of a tool to optimise the location of wastewater outfall

This funding has successfully developed a new tool that helps efficiently and robustly identify prime locations for any type of wastewater discharge. The tool takes into account user defined criteria and outfall performance indicators, such as advection dispersion processes, construction cost and pollutant accumulation near environmentally sensitive areas. Key inputs come from hydrodynamic modelling, as well as analysis of other opportunities and constraints that need to be taken into consideration for decision-making and evaluation.

The tool provides confidence in solutions to stakeholders, such as water utilities and industries, whilst also helping to differentiate Arup's service offering. Already, through our initial application of the tool to Moreton Bay, we are now discussing further work with a major local utility, Unitywater, to further develop the tool and its application to the bay.

Project ID: 10679 | PD: Daniel Lambert | PM: Ed Beling

Water Risk

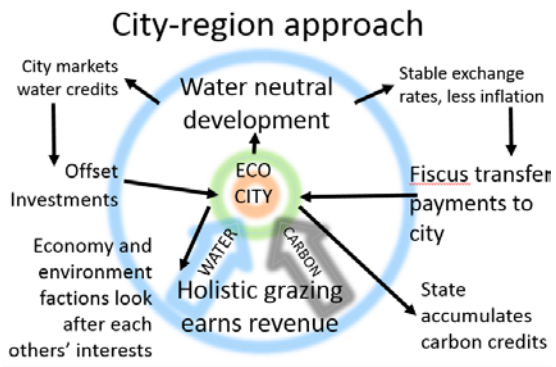
SPLASH I/O

We have developed a water stress/risk footprinting tool. The activity of water footprinting and measuring water stress (of a region, at organisational level, or of a discrete asset or supply chain – e.g. fruit for a supermarket) is a service that our clients would value. We have recently moved our capability forward with the development of a pilot consumptive/non-consumptive water stress footprint tool. The new methodology developed will be aligned with our BEACON tool, enabling water stress impacts to be assessed whilst conducting carbon footprinting, and providing an efficient and effective tool to assess water and carbon impacts together.

This tool provides a new service offering, new research and knowledge opportunity, and the potential new development of relationships for the firm.

Project ID: 9987 | PD: Martin Shouler | PM: Kristian Steele

Water Reuse

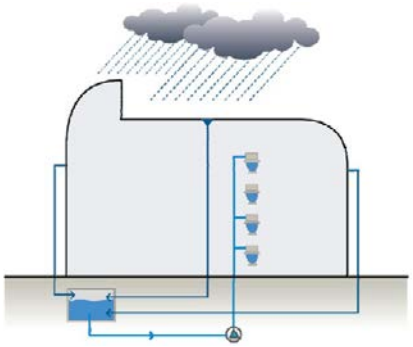


Water Neutral Development – develop a business model

We developed an economic model for future human settlements, based on extensive research on sustainable urban and rural development. The model covers issues of water scarcity, economic integration of ecosystems, catchment management (grazing practices) and eco-city initiatives (integrated development management).

This research and model development will result in the delivery of a proposal to the Department For International Development (DFID) for funding towards a pilot Water Neutral Development project, in Tanzania. Arup will be an integral player in the planning, design, and implementation of the Water Neutral Development.

Project ID: 11155 | PD: Andy Simmans | PM: Andy Simmans



LEED Rainwater & Waste Water Calculation Tool

We created an excel-based tool for concept-stage building design that answers several critical questions regarding LEED Water Efficiency credit points, and the size of the infrastructure required to achieve them. The calculation tool can quantify the amount of harvested rainwater that can be used to offset a buildings potable water demands for flushing toilets. The tool can 'communicate' with the LEED Water Efficiency calculator sheet, to determine baseline and proposed water usage allowing achievable LEED credit points to be estimated. Users can create sizing charts, by tabulating and plotting the results from changing parameters. Future versions of the tool might incorporate a greywater harvesting system analysis.

The tool has already been successfully used in multiple projects to help demonstrate annual water reductions.

Project ID: 10215 | PD: Cameron Thomson | PM: Alan Glynn

Water Stewardship

Water Stewardship – review of corporate approaches

We produced an internal Arup document to evaluate the performance and appropriateness of publically available data sources, tools, and methodologies, which are used to assess corporate water risk and shape corporate approaches to water stewardship.

The project enables Arup staff to provide cutting edge advice and intelligence on the management of water risks to clients in the corporate sector, thereby enhancing Arup's competitive positioning in the area of water stewardship.

Project ID: 11270 | PD: Justin Abbott | PM: Kate Jackson

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