



Early Career Women in Water 2021 Conference

Book of Proceedings

8th March 2021

Cranfield University



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Early Career Women in Water 2021 Conference. Book of Proceedings. Cranfield Water Science Institute, Cranfield University. URL: <http://dspace.lib.cranfield.ac.uk/handle/1826/16400>..... 44



Summary

Conference overview

The 100-year anniversary of Women in Engineering and Sciences in the UK was celebrated throughout 2019. Despite the recognised need for diversification in STEM-related roles, statistics show that only 12% of professional engineers, 21% of all academic professors and 20% of the UK water sector's workforce identify as women. This under-representation of women has resulted in a loss of talent within these sectors, with diversity recognised as being crucial for a more holistic approach in research, especially when providing solutions that aim to serve societies. However, change is on the horizon, and there is a need to continue to raise the profile of 'Women in Water' and encourage women to aspire to exciting careers within academia and industry.

The technical sessions of the conference have provided a platform for female early career researchers and young water professionals to promote their work and research around all aspects of the water cycle from the catchment to the tap, through to the treatment of wastewater and governance in water-related industry. Our inspirational, highly successful 'Women in Water' keynote speakers Professor Elise Cartmell and Lila Thompson, along with a specific session on career development and a panel discussion have highlighted the progress of women in the water sector and the way forward to promote successful careers for women within the water sector.

With the overall aim of providing solutions for a reliable supply of clean water for people and the environment, the conference included 2 keynote speakers presentations, 9 presentations and 24 posters from scientists and professionals across the UK and 6 from overseas. The engagement of the water sector has been remarkable with 181 participants by Friday 5th of March and multiple sponsors and institutions involved in promoting the event.



Organisation

Organising Committee

- Olivia Brezal de Frutos, PhD candidate in Water Science and Engineering
- Samuela Guida, Strategic Programmes Officer at International Water Association
- Natalia Jawiarczyk, PhD candidate in Water Science and Engineering
- Dr Andrea Momblanch, Lecturer in Water Systems Modelling
- Dr Dolores Rey Vicario, Lecturer in Water Policy and Economics
- Dr Chysoula Sfyntia, Senior Researcher at Imperial College London
- Dr Rachel Whitton, Drinking Water Inspector at DEFRA
- Tania Rice, PA to Paul Jeffrey - Director of the Water Theme

Supporting Academics

- Prof Ana Soares, Professor of Biotechnology Engineering
- Dr Jitka MacAdam, Lecturer in Water Science Education
- Prof Bruce Jefferson, Professor of Water Engineering
- Prof Paul Jeffrey, Director of the Water Theme

Sponsors

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Abstracts

Presentations

In order of presentation

Keynote Presentation

Elise Cartmell, Chief Scientist at Scottish Water

Elise Cartmell is the Chief Scientist at Scottish Water, responsible for sampling, laboratory and scientific services for research and innovation.

Elise joined Scottish Water in April 2016 following a career in academia at Cranfield University, where she was Professor of Water Technology and Environmental Technology Director. Here she specialised in wastewater treatment with particular reference to trace contaminants and anaerobic processes.

Elise is a chemist with a BSc (Hons) from the University of Edinburgh and a PhD from Imperial College, London. Before joining Cranfield in 2000, she was a research scientist at WRc plc. She is a fellow of the Royal Society of Edinburgh and Royal Society of Chemistry and is on the Board of UKWIR

From geomorphology to archaeology: disentangling river changes over different timescales

Kim Vercruysse, Desk Officer Freshwater Resources at Join For Water

Rivers and the land that surrounds them are naturally dynamic landscape features, providing a wide range of ecosystem services. However, these dynamics and services are strongly altered across the world as a result of human (and natural) disturbances within river catchments. To help minimize negative impacts of these disturbances on river systems, it is important to understand how river systems change in response to different disturbances. Yet, due to the complex natural and human processes and interactions occurring within the land-river interface, it is often difficult to disentangle the impacts of different disturbances acting over multiple temporal and spatial scales. This study aims to systematically assess the impact of short-term disturbances and long-term dynamics on river planform change. To this end, a multi-timescale assessment of river planform changes was performed. The study was applied to the Sutlej-Beas River system (India). The primary data used in the study were Landsat images (5 to 8), processed in Google Earth Engine, which were used to extract the river planform from 1989 to 2019. This data was combined with historic maps (1847) and supporting environmental data. The results illustrate the dynamic nature of the river system as a result of the rainy season, which cause seasonal incision and aggregation of the river planform. However, the shape and dynamics of the rivers have changed significantly as a result of dam construction over the last 100 years. Furthermore, large local changes are also observed as a result of sand mining activities along the river banks. The findings illustrate the value of comparing river planform changes over different timescales to gain insights into how river systems respond to various disturbances, which will help to develop integrated river management solutions.

Exploring approaches to adaptive pathways applied in Flooding and Coastal Erosion Risk Management

Leonie Constantine, Consultant – Environmental Policy and Economics at Wood.

The future is highly uncertain and presents significant challenges for Risk Management Authorities that seek to address flood risk in the UK. To address these risks the Environment Agency (EA) have commissioned Wood to conduct a Rapid Evidence Assessment (REA). This work assessed the current state-of-knowledge and best practices covering adaptive pathway approaches applied in risk management. A robust methodology has been implemented to understand the enablers, barriers and limitations of adaptive pathways.

The primary research question aimed to identify the context in which different adaptive pathways yield measurable outcomes which could support risk management authorities. Secondary research questions concerned identifying barriers, enablers and limitations of adaptive pathways and the monitoring and evaluation of approaches and/or techniques required to realise potential benefits. How adaptive pathways are compared to conventional approaches and to what extent stakeholder engagement has been undertaken is also assessed. Two phases of evidence assessment were undertaken to collect evidence and the relevant data extracted. Real and hypothetical case studies were identified, with a focus on flood and coastal erosion.

Key preliminary findings indicate that different approaches to adaptive pathways exist ranging in complexity particularly regarding representation of different climate change scenarios, that academic sources provide less detail on the enablers than barriers for adaptive pathways and that stakeholder engagement techniques are mostly conducted through interviews at the initial stages and through workshops during the development of adaptive pathways. These results are supported by case studies spanning geographical locations and sectors including Thames Estuary 2100 and the Netherlands Delta Programme.

These results will be used in the development of the national Flood and Coastal Erosion Risk Management (FCERM) strategy aiming to progress and embed adaptive approaches in national and local polices. Ultimately this increased understanding will lead to enhanced resilience of the environment to future flooding and drought.

Delving into the future of drinking water: chemical free drinking water treatment and distribution experimentations

Natalie Lamb, National Water Industry Account Manager at QCL Scientific

The use of chemicals for drinking water treatment and distribution can have unintended consequences. Chlorine leakages, for instance, can cause damage to biota, including death, deformities and reproductive damage (Department of the Environment, 2014). Chemicals are expensive to dose and these prices will continue to increase in future, as supplies diminish. In 2008, the UK water industry used 12,243 tonnes of phosphate, which came to a total cost of £12.24 million but since then, as FAO (2015) said, global phosphate demand is currently growing at 2.1% every year, meaning that today's figures, and those in future, are likely to be much greater (Knowledge Transfer Network, 2008).

Although there is the interest to reduce chemicals, the full implications of reducing or removing these chemicals are not known. There is concern that doing so would raise public health concerns and alter the current biological stability of pipe networks. This PhD will provide the water industry with the steps that will help to manage potential risks for the adoption of chemical free water treatment in the UK in the Anglian Water region.

This research is being completed through a trial into how the microorganisms within the pipes are affected by the presence of different chemicals. This involves using a bespoke pipe line testing facilities, informed by an international best practice review of countries that use fewer chemicals than the UK. This testing facility will allow the impacts of different chemical dose to be studied on both the microbiology of the bulk water and the attached phases.

This presentation will discuss the big questions underpinning chemical free water treatment, why it is important, if it is possible and explain the next steps of the PhD research.

Transforming slow sand filtration for drinking water supply

Tolulope Elemo, EngD Researcher at Cranfield University

Slow sand filtration (SSF), one of the oldest water treatment techniques, is also one of the most efficient in the removal of contamination. This is because it incorporates physical and biological processes within one treatment step, ensuring the removal of particulate and microbial contaminants. Its simplicity makes it robust enough that it can be operated in different ways, while still maintaining the desired effluent quality. In addition, it has low energy requirements (gravity fed) and minimal waste generation. The use of large scale municipal SSF, despite having diminished significantly worldwide, is still utilised in countries such as Brazil, Japan, Netherlands, Sweden, United Kingdom and United States of America. One of the major challenges with SSF operation is the time and personnel management required for routine maintenance activities, such as the cleaning. Traditional methods of cleaning a SSF involves draining the bed, scrapping the top layer where the bulk of head loss develops, and then gradually bringing the filter back into service. This method is time consuming, due to the draining and refilling periods and the downtime associated with bed ripening. Different alternative cleaning approaches have been explored, for example in-situ sand washing. However, there were different issues associated with water quality and filter bed integrity. Another cleaning approach, wet skimming – which eliminates the need to drain the bed – is being explored. Its successful implementation may give benefits such as reduced bed ripening time and consequently less asset downtime. Due to the change in filter manipulations, different aspects of the SSF are being studied to ensure that water quality and filter bed integrity are not compromised. These include head loss development, particle penetration, dissolved oxygen consumption and changes to the microbiome.

Rooting out resilience

Elisabeth Lawson, Research Engineer at University of Exeter

It is now without doubt that global threats such as climate change, increasing urbanisation and rapid population growth will continue to pose major challenges for the global water sector over the coming decades. Questions over supply, delivery and demand on resources and services all form a central part of this argument with the themes of sustainability and resilience often included in the response. Recent events, both on a global scale and localised to England and Wales, along with reactive changes to national legislation and policy, have resulted in a need for the notion of resilience to develop from a theoretical concept to a tangible operational method.

This project aims to develop a resilience based user decision tool which is based on the Safe & SuRe resilience framework and incorporates a mixture of qualitative and quantitative data collection and analysis methods. This project will be carried out in collaboration with an England based water company. The tool will help users to visualise the relationships and interdependencies that exist within a system and between system threats, failure modes, impacts and consequences and corresponding intervention measures. This project will especially focus on the need to acknowledge both the social and technical aspects of the system and the interdependencies that exist between the two. Interviews and workshops will be carried out with staff members on the current level of resilience understanding that exists within the business as well as to help identify a path for implementation. It is hoped that the results from this study will be able to inform the future development of resilience based tools in the water industry, as well as methodologies for how new concepts are introduced and disseminated across a business.

The route map to net-zero carbon emissions for the UK water sector by 2030

Ellie Russell, Graduate Process Engineer at Mott MacDonald

The water industry accounts for over 2% of the UK's total greenhouse gas emissions. England's water companies agreed a Public Interest Commitment (PIC) to achieve net-zero by 2030, making it the first of the UK's infrastructure sectors to make such a commitment in this timeframe. Working in partnership with Ricardo, Mott MacDonald are helping industry bodies UKWIR (UK Water Industry Research) and Water UK develop a route map to net-zero carbon by 2030 for English water and wastewater companies.

The current baseline for the industries carbon emissions must first be defined. Currently, process emissions account for around half of the sectors footprint whilst one third is from grid electricity. The remainder comprises transmission and distribution, transportation, fuel emissions and business travel. Following identification of the carbon sources, the proposed route map will be developed, providing real-life case studies where available. Examples of opportunities include switching to renewable energy, biogas recovery and biomethane production, and adoption of electric vehicles, as well as introducing less established technologies such as gasification and pyrolysis. Tools and guidelines will be developed to define company specific route maps along with a framework for assessing and validating their progress towards net-zero carbon.

With the increasing awareness and importance of driving down carbon emissions, early career professionals across the water industry will play a vital role in ensuring the achievement of this target. The target requires a fundamental change to the way the water sector operates. A truly innovative and collaborative approach will be required from water professionals across both industry and academia. Achieving the 2030 target will demonstrate that the water sector is collectively taking its role seriously and provide leadership in the delivery of a net-zero UK economy.

Keynote Presentation

Lila Thompson, Chief Executive at British Water

Lila is the Chief Executive of British Water, a dynamic trade association with a varied membership of companies covering all water and wastewater industry sectors. British Water works to bring a coherent voice on behalf of the industry and ensure its members have access to information and contacts that they need to enhance their business development and best practices.

Lila was formerly responsible for delivering British Water's international services, which included leading scoping and business development visits to a wide range of markets, including Saudi Arabia, Libya, Morocco, Russia, Romania, Bulgaria, China and India, to help companies grow their business overseas.

Lila has a BSc (Hons) from Birkbeck, the University of London in Economics & Social Policy and a Diploma in International Trade. Lila has over 20 years of international experience supporting business growth, policy development and stakeholder engagement in a variety of industry sectors.

Keeping your head above water!

Jo Cullen, Water Resources Manager for Welsh Water and Senior Technical Advisor for the Environment Agency

A career is a very personal journey and what one person calls a success will be different from another. Success isn't necessarily about the pay grade or reaching the top but about being interested, feeling that you've made a difference and being proud of the work you do whilst also balancing your responsibilities and interests outside of work. When facing decisions, rest assured there's no right or wrong way, but make sure you've got a plan and you know which direction you are heading in. Be honest with yourself, decide what you want and then go for it!

We are most productive and effective at work when we are fully focussed and can concentrate unhindered. This is only possible though if we have space to juggle all the other priorities and interests that we have outside of work. I am lucky to work for two really supportive businesses; both the Environment Agency and Welsh Water are fully committed to the Equality Diversity and Inclusivity (EDI) journey. I am an EDI Ambassador and a STEM Ambassador for Welsh Water and have been really impressed by their dedication and ambition with regards to diversity. We are working to create a culture of inclusion and tolerance where every employee feels safe and able to be themselves at work.

It's a well-known fact that the more diverse a workforce is, the more effective it will be. We need as many people as we can from a range of different backgrounds to think outside of the box and come up with new and innovative ideas. Regardless of age, disability, ethnicity, beliefs, gender and/or sexual orientation, we should give people the space and the support they need to be brilliant.

More than just a Technical Analyst – a Yorkshire Water perspective

Anne Newton, Lead Costing Analyst at Yorkshire Water

- Background

Former research chemist in pharmaceutical industry. Cranfield graduate; clean water microbiologist with Severn Trent Water. 20 year career break from full time technical role and what I did during that time. Work/life balance and family decisions made.

- Current role

Asset Management: provide robust cost and carbon benchmark figures to evaluate multi-million pound capital investments in to delivery, while meeting regulatory requirements. Use water treatment process knowledge, financial skills, data modelling. Work with internal and external colleagues. Using skills gained from previous employment and from activities "round the edge" of my paid role.

- Institute of Water

Experience of CPD submission and current CPD Assessor. External mentoring within water industry. Member of Northern Area committee. Networking, professional registration opportunities.

- STEM Ambassador

YW Volunteer co-ordinator: tripled the number of active STEM Ambassadors in the company; part of national network. Developed support materials to promote technical careers in general; particularly water industry and YW. Supported colleagues attending careers events, classroom activities, mock interviews. Instigated Company presence at Bradford Science Festival in 2018 and 2019.

- Yorkshire Water initiatives

FL STEM Inspired Leadership programme – selected to be part of first cohort.

Women's leadership in WASH: do we understand the barriers in developing countries?

Ameerah Anathallee, Project Manager for European Innovation Programmes at University of Oxford

Despite the importance placed on gender mainstreaming and women's roles in the WASH sector, there is limited empirical evidence on the experiences of women leaders. The limited evidence on women's leadership that is used as evidence often stems from other sectors and is almost exclusively from developed countries. This study aimed to contribute to this gap in the literature by engaging women leaders in one country, Uganda, to understand how their experiences compare to international experiences.

Drawing from data collected during interviews with women leaders in Uganda in June 2017, this research examines through a gender lens the cross-cultural variations in the development and implementation of gendered leadership. Women leaders were identified through recommendations from WASH professionals, not just by job title. The research follows the approach of the Science of the Individual to highlight the importance of locally grounded data in a patriarchal, conservative society like Uganda. Based on the evidence, I argue that some specific measures issued from western studies can have adverse effects on women's leadership in developing countries, and bottom-up solutions, tailored to the country's socio-economic context are essential.

This research helps to inform how we seek to ensure women have a voice in the WASH sector, and is a resource for early career women as it tracks different career path and coping mechanisms that women have employed, while balancing families and societal expectations, to achieve recognition for their leadership in WASH.



Abstracts

Posters

In alphabetical order

Sanitation needs of a growing slum population, who should be concerned? A SAD and DPSIR analysis for the adaptative management of wastewater contamination of Makoki, Nigeria

Sakinat Ahmad, University of Bologna (Italy)

Lagoons are unique coastal areas with very high human-environmental interactions hence the unsustainability and ineffectiveness of disjointed management measures. This has made it imperative to manage lagoons as Socio-Ecological Systems. This study adopts System Approach Framework (SAF) and the Driver-Pressure-State-Impact-Response (DPSIR) framework for the adaptive and sustainable management of wastewater contamination of Makoko lagoon in the economic capital of Nigeria-Lagos. SAF was used to identify the issue, discuss its extent and identify concerned stakeholders. DPSIR on the other hand was used to reveal the cause-effect relationship to an extent that it can be understood easily by non-scientists and policy makers. Results obtained from the SAF revealed the Lagos State Government, Lagos Mainland Local Government and some of their agencies, the Federal Government Maritime and Environmental agencies, residents, community leaders, religious leaders, Universities, research institutes, the market sellers' Association (led by Iya Loja), Non-Governmental Organizations and International Organizations as concerned stakeholders. We also found need for basic sanitation for a growing population as the driver of the problem while the pressures are wastewater and domestic sewage disposal into the lagoon. The state of the Lagoon is such that it is contaminated, septic and hypoxic. This study recommends increased sanitation literacy, installation of a wastewater treatment plant and waste collection facility, civilized slum regeneration project, enforcement of environmental regulations and routine monitoring of the lagoon as sustainable management measures.

Co-developing strategies to promote inclusive water governance in Malawi

Sydney Byrns, University of Stirling

Poor water governance has frequently been highlighted in Malawi as the main cause of the population's limited access to clean drinking water. Stakeholder engagement remains a critical for effective and inclusive water governance. However, often the engagement falls short of what is needed by policy makers to effect change in practice. This is exemplified in Malawi, with continuing challenges in sector coordination at central and decentralised levels, lack of consistency of approach at district level, and donor-driven responses to water access and management. For tackling intractable challenges such as meeting Sustainable Development Goal 6, new ways of engagement are needed across multiple levels of the governance system.

The overarching aim of this study is to explore how novel methods of stakeholder engagement can enable more inclusive water governance in Malawi. The objectives are to:

1. Identify the key multi-level actors with a stake in water governance in Malawi (including professionals in national water agencies, local authorities, non-governmental organisations, businesses and civil society) and explore their current roles, values and interactions with other actors using stakeholder mapping and social network analysis;
2. Further characterise key breakdown points in the system, particularly inefficient or absent information feedback loops, through systems analysis such as Causal Loop Diagramming and Bayesian Network Analysis, among others;
3. Co-design and trial novel methods to improve citizen interest and participation in water governance in Malawi through participatory methods that may include citizen-led water quality monitoring and citizen advisory boards and/or accountability monitoring.

Findings will inform recommendations for changes to policy and practice in Malawi, including national policies and guidelines, local authority engagement with communities and NGOs, and prioritisation of donor investments including those made by Scottish Government.

Mapping the locations and designs of Leaky Wooden Dams

Chloe Carter, University of Hull

The magnitude and frequency of flooding and the associated risks to society are known to be increasing, owing to changes in rainfall and storm intensity, combined with the pressures of increased urbanisation and building on flood plains. There has been a shift to work with natural process to protect the natural function of river catchments, which has led to an increased application of natural flood management (NFM) methods. Leaky wooden dams are an example of NFM, they are in-channel wooden structures made of logs, placed perpendicular to flow and pinned into the banks, in the aims of slowing the flow of flood peaks with their leaky design, however this design varies greatly. Leaky wooden dams have become commonplace in many NFM projects in England owing to their low installation cost and simple design, which are usually installed by volunteer groups. A consequence of this widespread implementation is there is minimal design and limited critical assessment of best practice in both design and construction. Some designs can block the whole channel resulting in significant scour, or can be unstable and wash away, others can interfere with pool riffle sequencing because of poor spacing. There is also a lack of documentation on the designs and locations of leaky wooden dams. This research aims to collate information about different NFM projects utilising leaky wooden dams, including collecting photos of different dams to investigate the variety of designs, their geographical spread and how the dams change over time. This data will be used to inform an interactive map of photos and information about different leaky wooden dam designs and behaviours, which can be used to inform best practice for future implementation of leaky wooden dams with the identification of the most effective designs.

What accumulates in our drinking water storage tanks?

Anastasia Doronina, University of Sheffield

Drinking water storage tanks are essential assets used to maintain our drinking water supply. Overtime, material (organic and inorganic) accumulates in these vessels, either from internal (e.g. corrosion) or external (e.g. ineffective removal at treatment) sources. These deposits can provide nutrients for microbial growth including opportunistic pathogens, and impact water quality, for instance, by decreasing disinfection efficacy. If re-suspended, this material poses a risk to water safety and regulatory compliance. To address this, storage tanks are regularly cleaned, yet the collection and analysis of accumulated material is never considered, making it difficult to determine optimal cleaning frequencies by assessing deterioration rates, and also quantify any risks involved in material remobilising and entering the downstream network. To investigate these missed opportunities, material has been collected from UK storage tanks and analysed for its composition and water quality impacts.

This work concludes that:

- Material that accumulates in storage tanks is not high in organic content, which suggests a low microbial presence.
- This same material, however, exerts a high chlorine demand, thus posing a safety risk to the surrounding water quality.

Developing site-selection guidelines for water harvesting structures in sub-Saharan Africa

Jessica Eisma, Purdue University (US)

Sand dams, a water-harvesting structure commonly employed by rural communities, capture and store water for use during the dry season in arid and semi-arid regions. Non-governmental organizations (NGOs) in sub-Saharan Africa construct new sand dams every year at a cost of \$12,000 per sand dam and three months of construction time. Sand dams sometimes rejuvenate the surrounding area by raising the local water table and supplying domestic and agricultural water to the community throughout the dry season. However, the NGO and community often invest their time and money only to construct a poorly functioning sand dam. These sand dams are low-functioning due to improper siting, siltation, seepage, and high rates of evaporation from shallow sand reservoirs. These issues can be addressed through the development and implementation of better site-selection guidelines for new sand dams. This study aims to develop such guidelines through analysis of an integrated surface and subsurface flow model created using data gathered during a field study in Tanzania. The model analysis considers the effect of geomorphological factors such as channel width, depth, slope, and channel/riparian zone connectivity in addition to riparian zone soil texture and vegetative cover. The impact of seasonal rainfall patterns on sand dam performance is also considered. The results of this study are a set of guidelines on selecting sites to construct a sand dam with high potential for capturing and storing water throughout the dry season. By utilizing such guidelines in the sand dam planning process, NGOs and community groups can maximize a sand dam's positive impact on local water security.

An analysis of the natural capital value of urban trees in Reading and an investigation of how this information can be used to influence tree planting for catchment management

Georgia England, University of Reading

Urban trees provide a variety of benefits to people, including amenity, carbon storage, reduction in storm water run-off and removal of air pollutants. The value of urban trees as assets and the benefits they provide can be assessed as "natural capital", which is determined by the ecosystem services that they provide. Natural capital is of relevance to the water sector for understanding benefits to the water environment that could be achieved through catchment management and land use change and providing an approach for wider valuation to support the case for capital expenditure.

This study investigates the natural capital value of urban trees and the ecosystem services they provide, using Reading Borough as an example. The study compares three different approaches to data collection and analysis. The first is a Capital Asset Value for Amenity Trees (CAVAT) survey, which is an assessment intended to quantify the amenity value of urban forests. The second is an I-Tree Canopy assessment, which estimates the canopy cover of a given region and includes tree benefit estimates, which give economic values to carbon storage and removal of air pollutants. The final analysis is a Natural Capital Eco-metric Tool, developed by Natural England, which can be used to value the ecosystem services provided by woodland habitats.

The results from each assessment method will produce data on the asset value of urban trees, by considering the ecosystem services they provide along with other factors. The approaches could be relevant to catchment management in prioritising certain ecosystem services, identifying significant urban trees/woodlands that provide these specific services, or identifying areas where tree planting would be particularly beneficial to improve ecosystem service provision in the local area or region.

Groundwater Vulnerability Assessment Using DRASTIC: A case study Deveh Area in Latakia, Syria

Rasha Hassan, Universidad de Cadiz (Spain)

Groundwater contamination is a widespread problem worldwide that has certain characteristics including persistency, difficult to remediate due to aquifers large storage, long residence times and physical inaccessibility. Thus, there is a need to study indispensable groundwater drinking sources in detail and their associated vulnerabilities so that precautionary measures can be taken in advance in order to reach a better resources management. Deveh Spring is a main drinking water source for approximately 15000 people in Latakia Syria. However, this drinking source was polluted in 2006 which led to deprivation of water for nearly a month which was a catastrophic event for people. Hence, there is a need to understand the vulnerability of the Deveh area in order to protect this spring by better management. This study aims to provide a spatial analysis of the parameters and conditions under groundwater may be contaminated in Deveh area, and to create vulnerability assessment map by overlapping the layers by means of ArcGIS. The study area (170 km²) was classified to three zones according to their vulnerability and were presented in an ArcGIS map. The area of high vulnerability groundwater zone is (82km²), which resembles (48%) of the study area. The Deveh Spring is located in the moderate vulnerability zone which its area is (40km²) accounting for (23%) of the total study area. However, the recharge area of Deveh Spring is in a high and moderate vulnerability zones which increase the need for management. The source that was linked to the pollution incident is located in the high vulnerability zone. Moreover, the results of the study show that there is a hydrogeological link between Earth's surface and the aquifer; which maybe the answer of the incident in 2006. Finally, DRASTIC is a tool which final product can be used easily by policymakers and managers.

Applying a 1D hydraulic drainage model to design a 500ha wetland

Rebecca Haw, Envireau Water

As quarries are only temporary within the landscape, a key aspect of assessing its impact is the restoration which will take place once it reaches the end of its working life. One of the many options for restoration is creation of new habitats. Needingworth Quarry opted to pursue an ambitious project to deliver new wetland habitats which will form the largest man-made wetland in the UK.

The proposed wetland required an in depth understanding of the hydraulic properties of the wetland system to aid in the design process. The proposed wetland provided challenges to the design due to its size (700ha) and a top up inflow rate of $5\text{m}^3/\text{s}$ over a short (two week) duration into a sealed, closed loop system. Through the innovative application of a 1D hydraulic model the characteristics (flooding, conveyance and storage) of the wetland could be explored and integrated into its design.

The modelling method provides a fast, cost effective method for simulating flows within a wetland system enabling both design and management scenarios to be assessed. This application is suited to all constructed wetlands of any size and complexity but really comes into its own on medium to large scale wetlands, wetlands in flood zones risk and wetlands for water treatment.

Reservoir Inundation Mapping: an Arcadis Approach

Kathryn Hooley, Arcadis

The Reservoirs Act 1975 exists to protect communities from the dangers of uncontrolled release of water from large raised reservoirs. As the enforcement authority for Wales, Natural Resources Wales (NRW) ensures that registered reservoirs are inspected and maintained. This includes modelling the worst-case flooding scenario for the surrounding area if a reservoir dam were to be breached. The Act initially applied to reservoirs with a capacity of $\geq 25,000\text{m}^3$ but an amendment, enacted 1st April 2016, reduced registration threshold in Wales to a capacity of $\geq 10,000\text{m}^3$. This has increased the number of reservoirs that now qualify for registration under the Act and NRW has therefore commissioned the mapping of around 170 reservoirs across Wales. Arcadis secured the contract to undertake this inundation modelling and mapping project and is now working on batches of reservoirs following the successful delivery of the pilot phase in Autumn 2019. Modelling of the reservoirs under different scenarios is undertaken to produce reservoir flood inundation maps. All project work is being completed according to the Environment Agency Reservoir Flood Mapping Specification (version 1.1.2), adopted for use by NRW with minor modification. In line with the Specification different types of reservoirs (e.g. Impounding, Service, Flood Storage) and dam construction (e.g. earth filled embankment, concrete, arch) are modelled differently: with specific equations to generate the flows resulting from a breach of each type.

Through this project Arcadis is demonstrating its capabilities in reservoir studies by utilising its expertise in modelling and innovative processes. Collaboration is fundamental to the success of the project, and Arcadis has integrated the wealth of knowledge and data, from NRW and Government appointed Panel Engineers, into highly bespoke hydraulic models. Although the project is being led by the Flood Risk and Hydrology team, collaboration with the GIS team at Arcadis has enabled the use of innovative task automation. Computer scripts have been used to enhance data management and model file production in addition to aiding in the production of deliverables (summary spreadsheets and maps) for the large number of reservoirs. The successful delivery of the pilot batch was a key milestone of the project and we at Arcadis are pleased to continue helping NRW in their mission to ensure that the environment and natural resources of Wales are sustainably maintained, sustainably enhanced and sustainably used, now and in the future. The poster will provide an overview of the project and focus on the data management, modelling, mapping and collaboration roles

that we are undertaking to support the project team and to produce the outputs NRW and emergency responders need in terms of flood risk to property and infrastructure.

Wastewater collection and treatment for Prishtina, Kosovo

Besime Kajtazi, University of Tirana (Albania)

Wastewater treatment is a growing problem in Kosovo. Pollution from urban wastewaters poses the greatest pressure on Kosovo rivers and their better management represents an important area of improving their ecological status. Country is lacking behind in terms of achieving certain goals and implementing European Environmental Directives, especially the Urban Wastewater Treatment Directive and the Industrial Emissions Directive. The lack of wastewater treatment plants prior to their discharge into receiving waters presents a gap in the water sector which needs to be addressed in order to meet European standards. Main sources of water pollution in Kosovo remain untreated urban and industrial water discharges, accompanied by solid waste, fertilizers and pesticides. Wastewater collection rate is 65% and currently only 0,7% of the entire population has access to wastewater treatment services. Even though Prishtina is the capital of Kosovo and is home to 330,000 citizens, there is no wastewater treatment services available. Consequently, all raw untreated wastewater eventually drains into the Sitnica river. Sitnica further flows to north of country and joins Morava in Serbia which later confluences with Danub river. The rivers provide some natural settlement and treatment of wastewater well before the flows reach the larger recipient rivers. The pollution of recipient Sitnica was monitored for a period of time at a point/profile where already the wastewater from main urban areas are discharged. The monitoring was done by taking water samples and analysing the main parameters on monthly basis. The results were showing pollution coming from sewage despite that river was doing some self purification. But river Sitnica is a small lowland river with very variable flow, being very low during summer 0,5 m³/s while during winter reaches up to 328 m³/s. For the planning of wastewater treatment facilities for the study area, specifically the municipalities of Prishtina, Fushë Kosovë and Obiliq a number of strategic development options were studied. The study sets several recommendations which provide controlled sewage collection, its transportation to WWTP location and wastewater treatment. All this will include the adaptation to climate change and will significantly improve public health. Moreover, the preservation of surface water quality – recipient of the treated sewage is another mayor achievement that study promotes.

Water poverty index of selected communities in southwest Nigeria: An assessment and implications for water security

Barakat Layi-Adigun, Federal University of Agriculture (Nigeria)

Inadequate access to safe and reliable water supply has been linked to destitution, low productivity and sometimes death. Goal 6 of the Sustainable Development Goals is premised on access to clean water and sanitation; the latter of which is only achievable through water availability. This study examined the level of water poverty in 10 rural communities in Southwest Nigeria using the Water Poverty Index (WPI) approach. The WPI comprised of five components: resources, access, capacity, use, and environment. Resource, access and capacity were measured in terms of availability, adequacy and safety while water use and environment were evaluated based on productive use and sanitation. A maximum score of 20% is obtainable by each component bringing the total obtainable WPI score to 100%. The resulting WPI score were ranked as Safe, Moderately Safe, Low Safe and Unsafe. Communities with WPI above 62% were considered safe and communities with WPI below 47.9% were considered Unsafe. Of the 10 communities under review, nine were in the unsafe category and only one was in the Low Safe category. The maximum WPI obtained was 55.3% while the lowest was 28.8%. Communities in the Unsafe category were characterized by fewer water sources with increased occurrence of water stress and conflicts, poor water quality and low productivity; as productive hours are spent sourcing for water. In the Low safe community, more water sources are available but inadequate, fewer cases of conflicts occur and distance walked to obtain water is lower than obtainable in communities in the Unsafe category. Government's failure at providing safe and affordable water is responsible for the absence of communities in the Safe category, as residents are forced to rely on self-supply water sources, ownership of which is affordable by a few. The study reviewed the role of self-supply sources and the implications of water poverty on water security, and recommends increased involvement of government and donor organizations in provision of adequate and safe water for all.

The resilience of cross-basin transfers to extreme droughts with changing spatial characteristics

Anna Murgatroyd, University of Oxford

Faced with the prospect of climate change and growing demands for water, water resources engineers are increasingly examining the potential for inter-basin water transfers to alleviate water shortages. However, under climate change water transfers are increasingly vulnerable to large-scale spatially coherent droughts which may lead to water shortages in neighbouring river basins at the same time. Indeed, increasingly severe droughts are also expected to have greater spatial extent. In this work we use state of the art climate, hydrological and water resource modelling to explore the utility and resilience of new transfer schemes between two neighbouring water companies in Southern England when simulated under an extended historical record and large ensemble of climate change driven future flows. The analysis examines meteorological, hydrological and water resource drought events and how the spatial characteristics of these droughts may change with different transfer arrangements. Results indicate that all drought types examined are expected to increase in frequency and intensity throughout the 21st century, but notwithstanding this spatial dependence, a new transfer can still increase the resilience of water supplies. The analysis also highlights the importance of testing new water infrastructure against drought events not available from historic records, demonstrating the value of scenario-based approaches to adaptive water resource planning.

Valorisation of nitrogen deficient wastewater treatment systems using sludge enriched with nitrogen fixing bacteria

Carolina Ospina, Newcastle University

Nitrogen-based fertilisers are causing environmental problems; furthermore, the increasing cost of nitrogen fixed by the Haber Bosch process has raised interest in alternative obtaining methods to meet agricultural demands. In this study, we developed a new strategy of nitrogen fixation by enriching free-living nitrogen fixing bacteria (NFB) found in the activated sludge from wastewater treatment plants in reactors fed with low nitrogen wastewater, usually found in effluents from paper mill industries. Our reactors fixed appreciable quantities of nitrogen with a rate of 11.7 mg of N per L per day. The enrichment of NFB, quantified using qPCR of the *nifH* and 16S rRNA genes, indicated a one log increase when compared to initial inocula. 16S rRNA community sequencing of reactors showed that the microbial community was dominated 20% by *Clostridium* sp. This sludge enriched with NFB could be potentially used as a biofertiliser, adding value to the treatment system.

Assessment of natural capital benefits of the Manor Road Park restoration

Marine Poncet, Cranfield University

River restoration projects are undertaken to restore degraded ecosystems, comply with Water Framework Directive and allow people to benefit from river Ecosystem Services. The evaluation of stream restoration is a powerful tool for legitimate results, brings satisfaction to a variety of stakeholders and supports restoration design. However, the assessment of urban river restoration projects lacks the consideration of Cultural Ecosystem Services (CES). This project aimed at identifying river CES, evaluated changes in their repartition in post-restoration situation and compared public and stakeholders' views on river rehabilitation at Manor Road (Luton, UK). Survey and interviews were administrated to public and project stakeholders. This study recognised an increase in visit frequency and a surprising decrease in visit duration in post-restoration. The main CES provided by Manor Road Park were identified as being creative, regenerative, intuitive and communicative. A slight increase of those CES are due to a time-lag. Moreover, categories such as cognitive and regenerative were reported although underrepresented in the literature. Finally, the main divergence between stakeholders and public views regarded cognitive CES and future maintenance responsibility. The present findings might help to design river restoration schemes by means of a better understanding of public vision and consequences of river rehabilitation on CES provision. The creation of a common vision together with the development of the systematic classification of CES and a deeper investigation of CES are essential to future success in river restoration projects.

An investigation into sewage pollution in an urban watercourse

Eleanor Raper, Envireau Water

Envireau Water was commissioned to investigate continued pollution of an urban watercourse flowing through the grounds of a residential property. The spring fed watercourse receives inputs from a number of combined sewer outfalls (CSOs), however, concerns were raised over frequent sewage pollution outside of storm events.

Continuous flow and water quality monitoring took place over a 3 month period. Regular peaks in flow were identified outside of storm events with corresponding peaks in ammonia (5-13 mg/L), a key indicator of sewage contamination. Two days of intensive water quality sampling were then conducted to provide a robust data set to confirm the presence of sewage and understand the patterns in water quality. Samples were analysed for a range of water quality indicators including ammoniacal nitrogen, biological oxygen demand (BOD), Enterococci, E. Coli, Total Viable Counts (TVC) and Caffeine. Water quality data showed regular peaks in ammonia (11 mg/L), BOD (13 mg/L), and turbidity (65 NTU). High TVC (1600 cfu/ml at 37°C), E.Coli (> 100 cfu/100ml) and Enterococcus (> 100 cfu/100ml) counts were indicative of sewage contamination further supported by the presence of Enterococcus faecium, faecalis and casseliflavus. The presence of caffeine (37.6 µg/L) confirmed the human nature of inputs to the watercourse. It is believed that water quality trends may be attributed to lifestyle cycles of the catchment area population.

The local water supplier provided event duration monitoring data that demonstrated no discharges occurred from the CSOs during the identified pollution events. As a result of the comprehensive data collection and analysis, the local water supplier is currently investigating possible misconnections and leakages within the sewage network, and the watercourse is also being included within their next Asset Management Planning cycle to further investigate the source of contamination and put in place a solution to stop the continued pollution of the watercourse.

Sources of Environmental Antibiotic Resistance in UK Landscapes

Katie Robins, Newcastle University

Antimicrobial Resistance (AMR), is a global problem and poses a substantial threat to human and animal health. It is increasingly recognised that a 'One Health approach' offers the opportunity to understand the human, animal and environmental dimensions of antibiotic resistance (AR) and how these interact. In environmental settings, common sources of AR include the release of antibiotic resistance genes (ARGs) from community wastewater treatment plants into waterways, or manure sourced from livestock exposed to antibiotics, that has been subsequently spread on to agricultural fields as fertiliser. Widespread pollution of this nature in rural and urban communities within the UK mean that the sources of environmental AR are often difficult to define and vary seasonally. This research aims to investigate the contribution of sources to environmental AR using two river catchment case studies in the UK: the Eden catchment in Cumbria and the Coquet catchment in Northumberland. Both river catchments are predominantly agricultural with some rural and urban settlements. Water samples were collected at 10-12 sites which reflect different levels of human impact along the Eden and Coquet river in Autumn and Winter in 2020/2021. These were subsequently analysed for total bacteria, human fecal markers and animal fecal markers using quantitative polymerase chain reaction (qPCR). These results will be used to select 4-5 sites with different sources of AR for more in depth analysis which will include: further sampling, quantification of all major classes of ARGs through high-throughput qPCR (HT-qPCR) and using SourceTracker to quantify the source inputs. Ultimately, this project will produce information that can be used to highlight the importance of sources of AR to the environment. Research is conducted under the support from the Environment Agency (EA) and the Department for Environment, Food and Rural Affairs (DEFRA).

Evaluation of the approaches in simulating IWS with EPA-SWMM and development of a new method

Dondu Sarisen, University of Exeter

Currently, 1,313 million people are known to use Intermittent Water Supply (IWS), representing 18% of the world's population (7,301 million). With the increase in population and predicted water scarcity caused by climate change, IWS applications seem to continue. Hydraulic modelling is a significant engineering tool for the process of planning, design, rehabilitation, and operation of water distribution systems. The ability of simulating transient flows of EPA-SWMM which is developed for the analysis of urban drainage systems, made some researchers consider analysing IWS with it. Different approaches have been developed to make EPA-SWMM suitable for simulation of IWS. This research evaluated the methods available in the literature and proposed a new method to address daily demand fluctuations caused by supply interruptions.

Water utility behaviour and WMS to meet climate targets

Suzanna Soleil Toh, MICS

The provision of quality water at affordable prices has recently become a goal of the international water utility sector aiming to provide better utility services to the public health sector, as well as aiming to prepare decision-making that has formerly been implicit in the sustainable water business in the times of drought and for climate change. This paper water utility business models, and the current pricing policies within the water sector, considering specific European national statistics. This analysis extends the interest to understand utility economics behaviour, with relevance to climate targets, climate policy, and the financial risk management considering the risk for network expansion in the utility sector.

BankSand-Ceramic Filter as Removal of Escherichia coli in Household Contaminated Water

Anfaresi Shofi Latifah Nuha, AiKite (Indonesia)

Ministry of Health Indonesia stated that nutritional status of Indonesian children is still low, with a prevalence of short or stunting toddlers of 36%. This indicator rises due to lack of adequate and clean drinking water availability. Water that is cooked by children's mother is not necessarily safe to be consumed due to the possibility of harmful microorganisms, such as Escherichia Coli bacteria. In fact, 47% of the Indonesian population drink water contains germs after cooking and thus affected 340 children died every week because of diarrhea. E-Coli bacteria is a microorganism that can cause infections in the digestive tract. Therefore it is needed to innovate a technology that can reduce the amount of bacteria E-Coli in drinking water. Ceramic filter is one of the alternatives that can be used as filter media for drinking water especially to those who are needed in household scale. Silver and activated carbon were chosen for this research because their ability to kill bacteria. Ceramic filters with rice husk and clay base material, mixed with activated carbon. Silver (Ag) coating is made to filtrate kill E-coli bacteria so it is safer to be consumed. This research was conducted to test the E-Coli bacteria rate on river water with and without BankSand ceramic filter. The ceramic filter is used with additive affordable materials (for only £0,5/filter dose), named Bangka Sand (BankSand) and 300 gr of activated carbon. Based on the results of the laboratory test, Ceramic filter can only reduce E-Coli bacteria levels by 31%, the same percentage number also is shown by the filtration using a ceramic filter that has been added with Bangka Sand (BankSand) and activated carbon. While the maximum result is given by ceramic filter that only added with Bangka sand which can reduce 48% the E-Coli bacteria.

Keywords : Bangka sand, Ceramic filter, Escherichia Coli

Antiscaling 3D printed feed spacers for membrane distillation

Navya Thomas, Cranfield University

Fouling, particularly scaling, is one of the main impediments to the industrial and commercial adoption of membrane distillation (MD) technology. The surface modification of feed spacers in the membrane module rather than the membrane can serve as a potential antiscaling strategy without compromising the functionality of the MD membranes. The conventional feed spacers consist mainly of two layers of polymeric filaments arranged in a two-plane grid forming a mesh structure. In this study, an antiscaling polyamide 3D printed spacer was developed for MD application. The 3D printed spacer geometry was based on mathematically created triply periodic minimal surfaces unlike the conventional mesh design. The surface of the 3D printed spacer was coated with fluorinated silica (FS) nanoparticles synthesized via a sol-gel process. The performance of the FS coated 3D printed spacer surface was evaluated against other coating materials of different chemical properties. The coated surfaces were characterized using water contact angle measurements, ATR-FTIR, Raman, FESEM-EDX, atomic force and 3D microscopes. The antiscaling performance of uncoated and FS coated spacers was then assessed in a direct contact MD process, using a scale-inducing aqueous solution of calcium sulfate as the feed. The scalant attachment on the FS coated spacer was 0.24 mg/cm^2 , 74% lower than on the uncoated 3D spacer (0.95 mg/cm^2). The presence of the antiscaling FS coated spacer also reduced the membrane scaling by 60%. Microscale roughness-induced hydrophobicity and reduced surface-free energy, which weakened the scalant's interaction with the spacer surface, were considered the predominant factors that helped minimize scaling with FS coating. The nanomaterial coating discussed in this study is a promising approach to minimize spacer-induced fouling, a significant problem in membrane-based water and wastewater applications.

Combination of computational modelling and 3-D printing to engineer biofilm and shear interaction

Erifyli Tsagkari, University of Glasgow

Biofilms play a key beneficial role in membrane filtration systems in treating water and are closely linked to the hydrodynamics of flow through a filter; yet engineers rarely engineer this interaction. We performed engineering of surface geometries to promote biofilm formation. A 2-D computational model was developed and linked directly to a 3-D printer to rapidly design different filter media geometries in silico that will passively induce oscillations in the 3-D print designs. A flow channel was designed and an object with varying geometry, which represented the filter medium, within it acted as an obstacle in the flow shedding a von Karman vortex street. A slide was attached to each wall of the channel and represented the available surface for biofilm formation. The experimental results indicated that the thickest, densest and most extended biofilms were formed for the highest scale of oscillations induced in the flow channel. The flow visualization experiments validated the model results for the formation of vortices within the flow channel. The biofilm experiments proved that our computational model in combination with 3-D printing can be successfully used to passively induce oscillations that promote biofilm formation without the need of mechanical forcing.

Harnessing microbially mediated redox processes for sustainable water treatment

Maggie White, Newcastle University

The international community is under pressure to provide universal access to safe and affordable drinking water for all by 2030, alongside efforts to reduce greenhouse gas emissions. In this context, water and wastewater treatment (WWT) are essential as they ensure environmental and human health. However, conventional WWTs only partially remove many emerging organic micropollutants but advanced oxidation processes (AOP), which mainly rely on the production of hydroxyl radicals ($[\text{rad}]\text{OH}$), have been suggested as the future of WWT due to their success in treating micropollutants. Yet, most AOPs are expensive energetically and chemically. Thus, this study aims to harness naturally occurring biogeochemical redox processes to develop a low-cost, low-carbon footprint and sustainable WWT system to effectively treat micropollutants. Pertinently, recent studies have shown that naturally occurring minerals such as iron-bearing clay minerals can also effectively generate $[\text{rad}]\text{OH}$ for micropollutant oxidation. However, to maintain $[\text{rad}]\text{OH}$ production for pollutant degradation over time, iron (Fe) within the clay structure must be reduced from Fe(III) to Fe(II) and then oxidised. Microbially-mediated Fe reduction in clay minerals is well known but so far characterised only in isolation from subsequent oxygenation. This study will investigate the feasibility of exploiting indigenous microbial communities to mediate Fe reduction within clay minerals in order to sustain a novel AOP for micropollutant removal, over multiple treatment cycles. To this end, mesocosm flow experiments will be used to establish how many treatment cycles are possible, how efficiently micropollutants are degraded and how microbiological communities are affected during treatments.

Law and Water

Teagan Williams, Severn Trent

The Water Industry is widely associated with engineering, forgetting the other types of roles within water. I am training as a lawyer at Severn Trent Water, which means a lot of the work I do focuses on Water and Waste Water.

Currently I am working with the environmental lawyers that deal with incoming cases. I focus on protecting our assets by regulating two main areas: trade effluent and Fats, Oils and Greases compliance. Under the Water Industry Act as a water and sewage undertaker we have the power to prosecute companies that pose a threat to the public through polluting our sewage network. This ensures public health standards are met accordingly and not breached, by ensuring companies work within their consent limits.

Severn Trent are regulated by two main regulators which can prosecute us if we fail to meet their standards.

1. Environment Agency. Deals with any threat to the environment as a result of our sewage sites polluting into the environment. In these cases I help with our defence by assisting witness interviews, writing reports and reviewing CCTV etc.
2. Drinking Water Inspectorate. This ensures the water available for public consumption fits a particular standard. Water that is odorous or discoloured for example is monitored by the DWI and prosecuted if appropriate. In these cases I also assist writing witness statements, attending site visits, reviewing photographic evidence and preparing bundles to go to court.

My job requires me to have clear knowledge of the wastewater processes and how water becomes consumable. I have been on many site tours to understand this process first hand so in turn, i can give advice when things go wrong.

My apprenticeship is for the duration of five years so by the end, I will extensive legal knowledge regarding the water industry.

Sediment origins across the terrestrial-aquatic continuum: water quality threat mitigation

Katy Wiltshire, Cranfield University

Accelerated soil erosion due to human activity and changes in climate results in significant loss of soil, nutrients and organic carbon (OC) from land to freshwater. Sediments, OC and associated nutrients have a significant impact on the ecological status of waterbodies. Fine sediment is a major cause of water quality deterioration as it impacts both physical and biological components of river systems.

The link between areas of sediment loss and OC load in waterways is not simple. The idea that anthropogenic actions, such as conversion of natural landscape to agriculture, accelerate soil erosion is generally accepted, however, the role of soil OC transported by erosional processes in fluxes of C between land, water and atmosphere is still debated. Tracing sediment pathways, connections to streams and depositional areas leads to better assumptions about control processes and better estimation of OC fluxes.

In this innovative study fingerprinting studies of OC reaching a catchment's waterbodies is combined with OC stocks and erosion modelling of the terrestrial catchment. Initial results show disconnect between catchment OC loss erosion modelling and fingerprinting results, which could be due to failure to model connectivity between the land and river channel. The current soil erosion model RUSLE (Revised Universal Soil Loss Equation) calculates only the spatial pattern of mean annual soil erosion rates. Through using the WaTEM SEDEM model which includes routing (and possible en route deposition) of eroded sediments to river channels we aim to determine the dominant source of OC within catchment streams by identification of both the land-use specific areas with the highest OC loss and the transport pathways between the sources and river channel.



Cite as

Early Career Women in Water 2021 Conference. Book of Proceedings. Cranfield Water Science Institute, Cranfield University. URL:
<http://dspace.lib.cranfield.ac.uk/handle/1826/16400>