WATER INFORMATICS SCIENCE & ENGINEERING
EPSRC CENTRE FOR DOCTORAL TRAINING

Engineering and Physical Sciences Research Council

WISE CDT & WET Networks Bristol Event

12th February 2020

The EPSRC Water Informatics Science and Engineering Centre for Doctoral Training (WISE CDT) carries out research into topics at the interface of Water Engineering, Water Management, Environmental Science, and Informatics Technology. The WISE CDT is a collaboration between the GW4 Alliance: the Universities of Exeter, Bath, Bristol and Cardiff University, with around £12M of funding. Discover more about the WISE CDT from our website http://www.wisecdt.org.uk/

The WISE CDT Industry Day will showcase about 40 current research projects in themes such as Enhancing Infrastructure Resilience, Water Resources: Supply and Quality, Coastal and Marine Processes, and Flood Risk and Prevention. The event will also explore ways in which organisations can engage with the WISE CDT to tackle the challenges they face. The aim is to stimulate new partnerships, leverage for collaboration on research, and routes to impact and implementation for current and future research. About 60 WISE CDT research students and academics will be available for discussions and to develop new partnerships.

We are also delighted that this event will be joint with WET Networks Bristol, delivered by ARUP and WRc. Events in the WET Networks series provide the chance to hear about some of the latest technologies in the water sector whilst also presenting the perfect opportunity to network with some of the water industry's key influencers. In addition, WET Networks events also provide a platform where innovative technology companies may present their ideas to potential investors and water professionals.

Programme:

15:00	**Registration**
15:15	**Welcome & Introductions – Tom Arnot (WISE CDT) & Philip Wiltshire (WET Networks)**
15:30	**The EPSRC WISE Centre for Doctoral Training – David Butler, University of Exeter**
15:40	**WET Networks Keynote – Dan Green, Wessex Water**
16:00	**Networking & WISE CDT poster presentations with refreshments**
17:50	**WET Networks Introduction – Philip Wiltshire**
18:00	**Elevator pitch presentations from four Technology SMEs**
19:00	**Charity presentation**
19:10	**Closing remarks**
19:30	**Networking over drinks and canapes**
20:30	**Close**

ARUP wrc

WET NETWORKS | Bristol
12 February 2020

BRITISH WATER · HYDRO-NATION WATER INNOVATION SERVICE · THE UK WATER PARTNERSHIP · water industry forum · Future Water Association Informing, Innovating, Influencing

Contents

Enhancing Infrastructure Resilience

1. *Sewer Systems of the Future - Olivia Bailey*

Supervised by Prof. Jan Hofman, Dr. Tom Arnot, Prof. Zoran Kapelan, Prof. Jan Vreeburg
Research Visit: TU Delft, NL – Prof. Jan Peter van der Hoek, Dr. Ljiljana Zlatanovic

Rising water scarcity, pressure for sustainability and the need for water efficiency will drive down water consumption significantly. Consequently, the inflow to sewer networks will be reduced. Anglian Water strives to reduce water consumption below 80 L capita^{-1} day^{-1} and UKWIR pushes for halving water abstraction by 2050. How will water conservation impact the sewer system and the way we dispose our wastewater?

This work focuses on the generation of a new stochastic sewer model that can be used to predict both hydraulic and pollutant loading for future water saving scenarios. The stochastic sewer model is based on integration of the stochastic water demand model SIMDEUM® with the InfoWorks ICM® (Sewer Edition) hydraulic model and software. The stochastic sewer model has been tested and validated on several real catchments in the Wessex Water area of the UK and has also been used to predict wastewater changes in the Netherlands. This model offers a high-resolution tool in which to assess the effect that appliance-specific changes in the household will have on the sewerage system.

Olivia is a PhD researcher within the Chemical Engineering Department of the Water Innovation & Research Centre (WIRC) at the University of Bath. Her research is focused on developing a sustainable design for future sewer systems, currently focusing on opportunities for water conservation/wastewater concentration and the consequences for the sewerage system. Olivia has just returned from a six-month research visit with TU Delft and WaterNet, the water company of Amsterdam, where she focused on validating the water quality aspect of the sewer model and extending the model to include drinking water networks. Olivia's work has been presented at international conferences in Italy (UDM18), Philippines (Efficient 2019) and soon Denmark too (SPN9).

Prior to joining the WISE CDT Olivia graduated with a First Class MEng degree in Chemical Engineering (2015). During her first degree she undertook the design of a small-scale biorefinery for wastewater treatment as well as working to develop photo-amperometric algal biosensors. Olivia completed her industrial placement at the European Centre for Nuclear Research (CERN) where she conducted a comprehensive fire and environment risk assessment of an underground facility.

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Publications:

Journal: Bailey, O., Arnot, T. C., Blokker, E. J. M., Kapelan, Z., Vreeburg, J., Hofman, J. A. M. H.., 2019. Developing a stochastic sewer model to support sewer design under water conservation measures. Journal of Hydrology, 573: 908-917. DOI: https://doi.org/10.1016/j.jhydrol.2019.04.013
Conference Proceedings: Bailey O., Hofman J.A.M.H., Arnot T.C., Kapelan Z., Blokker M., Vreeburg J. (2019) Developing a Stochastic Sewer Input Model to Support Sewer Design Under Water Conservation Measures. In: Mannina G. (eds) New Trends in Urban Drainage Modelling. UDM 2018. Green Energy and Technology. Springer, Cham. DOI: https://doi.org/10.1007/978-3-319-99867-1_13

Prizes:

IChemE Water Special Interest Group 30th Anniversary Young Process Engineer Prize (Runner-up)

Keywords: *Sewer Design; Stochastic Sewer Modelling; Water Conservation; Wastewater Quality Modelling*

2. *Biosensors for water quality monitoring: sensor development and signal processing – Dolores Gonzalez*

Supervised by Dr. Mirella Di Lorenzo, Dr. Petra Cameron and Prof. Jan Hofman

The increasing amount of chemicals used in industry and agriculture are polluting the water bodies by runoff, diffusion and leaching processes. These pollutants are a threat both to human health and the environment. Consequently, the Water Framework Directive has identified 33 priority substances that have to be controlled and limited. Among these, there are several compounds used in agriculture as pesticides and herbicides. These substances are currently monitored using analytical methods, such as chromatography or mass spectroscopy. These methods are expensive, require sample collection and cannot provide a continuous, online measurement. Therefore, there is a need to develop an online, continuous and real time sensors for water quality monitoring. Biosensors based on biofuel cells are rising as a promising deployable and self-powered technology for online and in-situ monitoring. The project scope is to develop a biofuel cell-based sensor capable of detecting the components of interest, to assess its suitability for field monitoring and to improve the signal processing.

Dolores is a Chemical Engineer undertaking the PhD at the Chemical Engineering Department of University of Bath. She is part of the WISE CDT, WIRC and BRI research groups. Her previous experience focuses on the development of innovative solutions for wastewater treatment of urban and industrial effluents, both in industry and academia.

During the first year of the PhD, Dolores has set the proof of principle on the use of biofuel cell biosensors for detection of atrazine. This work was submitted to Frontiers : “Effect of electrode properties on the performance of a photosynthetic microbial fuel cell for atrazine detection”.
Dolores was also recipient of a scholarship for a Summer School in biofilm characterisation at SCELSE, Singapore.

She is now working on the prototype for in-field applications of the self-powered biosensors for water quality monitoring. The preliminary results of this work was presented as a proceedings article in an international conference on Fuel Cells this summer as: “Investigating the use of Photosynthetic Sediment Microbial Fuel Cells for pesticide detection in water”.

3. *Manipulation and modelling of microalgae for improved wastewater phosphorus removal - Aidan Barry*

Supervised by Dr James Doughty and Dr Tom Arnot

Phosphorus is a key cause of eutrophication in freshwater ecosystems and there are increasing legislative pressures to reduce its release from wastewater treatment plants. Microalgae offer a potential alternative to traditional chemical phosphorus removal processes with relatively low energy requirements and the potential to reduce phosphorus levels below detection. By gaining an understanding of the mechanisms and processes involved in microalgal phosphate uptake through molecular investigation followed by the application of mathematical models and directed evolution, the robustness and land footprint of the ponds could be improved and the viability of HRAP's improved.

Aidan is based at the University of Bath. His research focusses on the bioremediation of wastewater using microalgae. His research aims to better understand the processes through which microalgae consume phosphorus via a combination of informatics and molecular studies with the goal of optimising or improving microalgal uptake capacity and versatility.

Before joining WISE, Aidan began his studies for a Bachelors degree in Biochemistry (BSc Hons) at the University of Bristol in 2010. In this time he took modules in microbiology, molecular biology, and pharmacology, with a final year focus on synthetic biology and biotechnology techniques. His undergraduate project focused on the application of bioinformatics techniques to finding the interactions between epithelial proteins in the nematode *C. elegans*. The project required the design and production of a variety of transgenic *E. coli* strains containing composite plasmids for both transformation of the worms and RNA interference studies. He graduated in 2013 with a 2:1.

Outside of his PhD, Aidan is also interested in rock climbing, board games, and occasionally running.

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Keywords: *Water treatment, microalgae, microbiology, bioinformatics, mathematical modelling, nutrient removal, phosphorus, bioremediation.*

4. *Methodology for effective operational blockage reduction – Sabrina Draude*

Supervisors: Professor Zoran Kapelan, Professor Edward Keedwell and Dr Emma Harris

At present, water companies across the UK are facing detrimental environmental and social problems arising from blockages within sewers. Blockages can cause increased flooding and pollution events and are therefore important to prevent. For example blockages account for 80% of sewer flooding incidents in the UK and more than 3,000 properties per year are flooded as a result. There are approximately 366,000 sewer blockages throughout the UK every year, of which up to 80% are caused by fats, oils and grease (FOG), wipes, sanitary waste and other un-flushable items (water UK, 2017). In the UK, water and sewerage companies (WaSCs) are regulated by Ofwat (The Water Services Regulation Authority). WaSCs are measured on their service incentive mechanism (SIM) score, which measures their ability to provide good service to their customers. Blockages cause a decrease in SIM score, and are therefore they are important for WaSCs to prevent and regulate.

Traditionally WaSCs have addressed the operation of sewer systems on a crisis (reactive) based approach, which can be costly, and cause more frequent sewer failures than necessary. For example in the UK alone, £88 million is spent annually on reactive clearance, with further unaccounted costs on clean-ups after flooding events. Therefore in the UK and globally, WaSCs are moving towards more proactive and optimised approaches to manage sewer assets by addressing problems before they occur and to plan for their long term renewal sustainably.

Therefore this project aims to create an optimised maintenance schedule for when operational cleansing tasks such as jetting should be performed. In order to create an optimised schedule, this project aims to improve the understanding between cleansing operations and blockage occurrences and also assess the impact that weather and customer behaviour have on the formation of blockages. This should allow a methodology for effective operational blockage reduction to be created.

Sabrina is a PhD student currently completing her research at Exeter University in the centre for water systems. Her research is focused on developing a proactive maintenance schedule for DCWW (Dwr Cymru welsh water). She has recently presented her work orally at the 9th International Conference on Sewer Processes and Networks (SPN9), and produced a conference paper for it. She has also presented a poster at the recent International Computing & Control for the Water Industry Conference (CCWI) in Exeter. Sabrina will be conducting a research visit at the University of Auckland from January to April 2019, funded by the WISE CDT programme. She will be part of a team working on similar research in New Zealand.

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Keywords: *wastewater networks, automation, cost benefit analysis, decision support, water management*

5. *Post event response planning for smart water networks - Eirini Nikoloudi*

Supervised by Prof. Zoran Kapelan, Prof. Fayyaz Ali Memon, Dr Michele Romano

The water industry in the UK and worldwide faces considerable challenges in making use of the real-time data that is collected in water distribution networks. The industry has a pressing need to use this data to improve response to various events in pipe networks (e.g. pipe bursts or equipment failures).

What is currently lacking is the methodology for the response to these events. The aim of my project is to develop a new automated decision support system for an effective near real-time response. In the context of the new decision support system, a new visualisation technology is expected to be developed, which will support decisions made by the control room operators.

The focus of my project will be on answering the following key questions:

1. *What is the best way to respond to various events that may occur in a water distribution system? How can optimal operational interventions be identified and in a timely and automated way? What company data and resources (systems and people) need to be used in the process and how?*
2. *How should the identified response strategies be presented to the control room operator so that he/she can make an effective ultimate decision on how to deal with each event?*
3. *What are the likely benefits and costs of new technology? How will the technology be effectively delivered in to the control room (people, processes and systems)?*

Eirini is based at the Centre for Water Systems at University of Exeter, but spends enough time in the industry as well. Before joining the WISE Centre for Doctoral Training in 2016, Eirini had her internship at the environmental consulting firm 'Geoveta AB' in Stockholm, Sweden. During her internship, Eirini learnt sampling methods in soil, water and constructions. She also learnt to take river flow measurements in order to estimate the river capacity and the possibility of a flood event. The finally gained skills were field experience, knowledge of sampling methods, environmental data analysing methods, learning of environmental legislation and understanding of the role of a consultant.

Eirini holds a MEng in Civil Engineering from National Technical University of Athens (NTUA) in 2015. During her studies, she attended modules and completed projects related to Applied Hydraulics, Hydrology, Urban Hydraulic Design (Water Distribution Systems) and Environmental Engineering.

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Research Interests: *Decision support systems, Water supply/quality in the Distribution Systems, Control of water quality in natural water sources*

6. *Assessing risk to water security in complex coupled catchment-reservoir systems - Jack Waterhouse*

Supervised by Dr Thomas Kjeldson, Dr Lee Bryant

In recent years, security of water supply – both quantity and quality, has come into global concern. The implications of possible future challenges to the UK drinking-water utilities industry, under pressures from population growth, land-use and climate change, pose a serious threat. A better grasp of the dynamics of complex hydrological systems directly involved in water abstraction and supply is required. Knowledge of the relationships, and extent of interaction that exist within more extensive coupled catchment-reservoir systems is increasingly vital to understanding surface and groundwater responses to these increasing pressures.

Water supply reservoirs are a significant source of abstraction for UK drinking-water companies, and therefore tools that can help us understand water quality and quantity runoff influx, and the internal biogeochemical processes within reservoirs are paramount to efficient and cost-effective management. Reservoirs are especially at risk of significant algal blooms from nutrient loading in upstream catchment runoff, and elevated manganese levels.

The main aim of the project is to fully develop and test a dynamic coupling of two models; a 1D comprehensive hydrodynamic/water quality catchment-level model – SWAT, and a 2D reservoir water quality model – CE-QUAL-W2. This model coupling will simulate the complex interactions between upstream catchment runoff and the internal biogeochemical processes within the reservoir to an extent that a single model application could not, to evaluate possible future land-use & climate scenarios and the threats these pose to the whole system dynamics and water-security threat.

Jack is a WISE CDT PhD student at University of Bath, in the WEIR (Water Environment & Infrastructure Resilience) Group. Prior to starting the WISE program, he graduated with a first class BSc in Geography from Lancaster University, specialising in hydrology and water resources management. In his final year, his dissertation was focused on ADZ modelling of several Welsh upland streams to investigate the impact that dead-zone interactions had on internal nutrient dynamics.

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Keywords: *Water Security, Water-resources Management, Nutrient Dynamics, Land-use Change, Catchment Modelling, Reservoir Modelling*

7. *Viability of low head hydropower in developing countries under current and future conditions – Simbi Hatchard*

Supervised by Professor Paul Bates, Dr Sam Williamson, and Dr Francesca Pianosi

Lack of access to power in rural areas of the Zambezi basin is one of the many challenges facing the region. Significant quantities of untapped hydropower resources exist in the basin and present a means of improving livelihoods through better energy access. It is, however, crucial that hydropower installations properly assess the trade-offs between the social, environmental and economic effects of hydropower projects. Large hydropower projects have a mixed track record of both negative and positive socioeconomic and environmental impacts, particularly in developing countries. Small run of the river hydropower plants are widely regarded as being more environmentally benign, although the possible cumulative environmental impacts of numerous projects have not been addressed in detail. Such schemes also lack several of the ancillary benefits of reservoirs.

A key objective of this study is to understand the relative environmental and social impacts of few large hydropower reservoirs, compared to extensive small run of the river hydropower implementation, particularly considering future climate and population changes. To investigate this, this research seeks to create a large scale hydrodynamic model of the Zambezi Basin suited to small hydropower estimation and siting, analysing the trade-offs between the socioeconomic, environmental and social consequences of different hydropower configurations through multi-objective optimisation, as well as forecasting impacts into the future.

Simbi is a PhD student based in the Hydrology Group at the University of Bristol. His research focuses on modelling the current and future impacts of small hydropower across large data sparse regions.
Prior to undertaking the WISE CDT, Simbi obtained a BSc in Physics from the University of Warwick (2009) and completed an MSc in Civil Engineering at the University of Southampton (2011).

Simbi worked for four years in industry between his MSc and the start of his PhD, as a Graduate Engineer in the Transport Planning team of WSP Group, and as a Flood Risk and Drainage Engineer at WYG Group. Additionally, Simbi undertook an internship with CH2M Hill during the summer of 2017.

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Keywords: *hydrodynamic modelling, hydropower, remote sensing, WEF nexus, sustainable development, climate change*

8. *Planning resilient water systems in areas at risk of multiple hazards – Anna Lo Jacomo*

Supervised by: Professor Dawei Han, Professor Alan Champneys

The social and economic impact of natural hazards is increasing, showing that there are limitations in the current approach to disaster risk reduction. One important aspect into the future will be to design urban infrastructure in a way that avoids locking in risk and minimises disruptions in a disaster. Water supply especially is crucial for all aspects of city life, including recovery post disaster, and is the focus of this project. Using global hazard data, we sample the relative susceptibility of cities to various hazards and identify clusters of cities belonging to similar hazard environments. This is implemented in a tool which helps users quickly identify cities which face similar hazards as their city of interest. This is a first step towards defining guidelines for adapting water systems to be resilient given the possible range of hazards that they might experience.

Anna is a PhD student at the University of Bristol, in the Water and Environmental Engineering group. Her research interests include urban resilience, multi-hazard approaches and hydro-informatics tools. She works on methods and tools which can help make informed engineering decisions regarding water infrastructure and systems planning in cities prone to various hazards, and on improving the design of water systems in cities to make it more risk informed. She focuses on a case study area in a mountain area in China prone to landslides, earthquakes and floods, to understand what could improve the resilience of the water system in the municipality of Dechang. This includes understanding how resilience can be defined in the context of multiple hazards to provide useful guidance for engineering decisions.

She graduated with a first class MEng in Civil Engineering from the University of Bristol. During her studies she spent a year at the Polytechnic University of Valencia in Spain. She worked on a range of projects in her undergraduate, including a research project on the energy use of waste collection systems, and a feasibility study for a ground source heat pump. She gained industrial experience during a placement as an assistant civil engineering at Dover Harbour. Since joining WISE she has been acting as a student representative and managing the social media account of the water group. She also helped convene and chaired a session at the 2018 European Geosciences Union conference in Vienna.

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Keywords: *Urban resilience, hazards, water systems*

9. *Modelling of geotechnical instability within earthworks arising from coastal storms surges and prolonged flood inundation events – Richard Rees*

Supervised by Professor Shunqi Pan

Earth based sea defences around the UK are typically hundreds of years old and constructed without modern day engineering knowledge and techniques. Historical and recent storms have demonstrated the vulnerability of these structures to prolonged and sustained assault, with the human and economic cost of failure being exposed. The expectation is that with climate change, there will be increased sea levels with storm systems increasing in their power, duration and frequency, consequently current and future defences will be subjected to these conditions. Therefore, it is critical to understand the behaviour of the structures at present, especially with any future modifications in mind.

The aim of the PhD is to further understand more thoroughly the effects climate change on sea defences stability, with attention being paid to dynamic pore water pressures generation, potentially an underestimated instability factor. The results acquired will be used to generate dynamic stability curves providing asset managers with the ability to assess the probable condition of the sea defence in respect to upcoming storms, allowing proactive action to be undertaken.
The initial stages of the PhD numerical investigation into how differing slope angles, material compositions and differing water regimes effect stability of the embankments. This is currently being achieved with Geo-Slope software.

Richard is a PhD student on the WISE CDT scheme based at Cardiff University School of Engineering and is part of the Coastal Research Group. Richard undertook a BSc in Environmental Earth Science from Aberystwyth University (2010 – 2013) and achieved a distinction in his MSc on the Applied Environmental Geology (2013 -2014) at Cardiff University.

Prior to joining the WISE CDT programme, Richard worked for Network Rail Western Route (Geotechnics) to devise a geotechnical remote condition monitoring strategy, assessing the current and future RCM technologies to be used an risk mitigation measure for earthworks vulnerable to adverse weather events. This also extended to scour, drainage and structural monitoring for the different management disciplines, consequently, Richard was involved in the route national weather resilience strategies. This translated into one tender being developed for the route and submitted to market. After leaving Network Rail, he joined ITM Monitoring, a contractor tasked with installing sensors on Western Route.

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Keywords: *Sea defences, geotechnics, sea level rise, dynamic pore pressures, fragility curves.*

10. *The combined effects of changes in Land Use/Land Cover and Climate over Brazil on the Hydrological Cycle - Jamie Brown*

Supervisors: Dr Rafael Rosolem and Dr Ross Woods

Brazil holds at any time between 12-16% of the entire world's freshwater. It is the most water rich country in the world putting the country on economic, political and social agendas, worldwide. However, in recent years there has been an increase in droughts. The 2014-17 Brazilian drought affected over 50% of the population of Brazil and is the worst recorded in the last 100 years. Understanding the consequences and mechanisms of the hydrological cycle is key for the implementation of successful climate mitigation and adaptation strategies worldwide. As the Brazilian landscape continues to change at an alarming rate, and the future of climate change points towards rising CO_2 and temperatures, understanding these mechanisms become even more important to understand the future risk to water resources and hydrological extreme events. This project focuses on how key climate drivers affect the hydrological processes over Brazil using regional hydrological models.

The aim of the PhD is to understand how three key climate drivers can be more accurately modelled to assess future changes to Brazil's hydrological cycle using regional models: (1) changes in "meteorological/climatological forcing" (e.g., precipitation, temperature), (2) "land cover/use changes", and (3) the direct effects of atmospheric CO_2 concentration particularly on vegetation ("CO_2 physiological forcing"). The third driver ("CO_2 physiological forcing") is still largely unexplored in hydroclimatology despite the fact that its contribution can be as high as the "meteorological forcing". The overall objective of this PhD research is to quantify the individual and mutual contribution of climate and land cover/use changes on key hydrological processes (e.g., evapotranspiration, runoff) associated with the future of Brazil's water resources or the development of hydrological extreme events.

Jamie is a PhD student on the WISE-CDT scheme based at The University of Bristol School of Water and Environmental Engineering. Jamie graduated with a MEnvSci (Hons) in Environmental Science from the University of Sheffield in 2014. His first three years of study combined Physical Geography with Biology leading to his third-year research project looking at vegetation genetic defence mechanisms under different climatic pressures. His Masters' dissertation and research project focused on Palaeobiology and Palaeoenvironments during the Upper Carboniferous era.

After graduating Jamie worked in the Water Resources department for Essex and Suffolk Water (Northumbrian Water) for a year. On and off for the past 5 years, Jamie has also worked at Hydrology.UK as an Assistant Hydrologist, and most recently, an Environmental Hydrologist. During his time at these companies, he was involved in a wide range of tasks based on forecasting the risks of drought to UK catchments by naturalising river flows over a 100year period.

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Keywords: *Tropical hydrology, hydroclimatology, CO_2 and meteorological forcing, land use/cover change.*

Water Resources: Supply & Quality

11. *A dynamic risk assessment model for the contamination of water resources from hydraulic fracturing in the UK – Olivia Milton-Thompson*

Supervised by Professor Akbar Javadi and Professor Zoran Kapelan

Research

Hydraulic fracturing is a viable method for extracting a wealth of natural gas from shale rock and has recently begun production in the UK. The process took off in the US but brought with it controversial debates over environmental protection. To feel confident in applying this technique to an apprehensive population in the UK, it is important to consider the science and engineering involved in the process. This project focuses on assessing the risks to groundwater contamination to help determine if the process is sufficient for use in the UK and the most suitable locations.

The project highlights the potential contaminant pathways for gas reaching aquifers during the stages of an active well's life. These pathways are developed from conceptual models and quantified using event tree analysis. The over-arching theme has focused on well integrity issues during well stimulation and production. The event tree branches are quantified using failure probability values from literature, fuzzy logic inputs for geological and well construction properties and fuzzy fault tree analysis. Fuzzy fault trees are developed using expert knowledge to understand cement failure in a gas well over time. Expert opinions were gathered from academics and industry in Canada. The event tree branches leading to contamination are quantified to obtain a probability of contamination. A fuzzy inference system is developed to understand the changes in risk to groundwater for a producing well using a mathematical model developed on the understanding of gas migration during well integrity failure. The risk model is built and validated using well data and expert opinions from British Columbia, Canada. Final discussions focus on how this can be applied to a UK context.

In September 2018, Olivia spent 3 months at the University of British Columbia (UBC) in Canada working within the Energy and Environment Research Initiative (EERI) under Dr Aaron Cahill and the BC Oil and Gas Commission (BCOGC). She collaborated with MSc and PhD students within the EERI group to improve understanding of gas migration and well construction; academics within the mechanical engineering departments to develop cement failure fault trees; and Dr Laurie Welch at the BCOGC to obtain data from wells in BC. Canada is the main case study for her research project.

Biography

Olivia has a BSc in Chemistry from Durham University and an MSc in Environmental Water Management from Cranfield. Olivia worked as a laboratory analytical chemist focusing on analytical methods such as LCMS, GC and HPLC methods. A summer placement as a research assistant at the University of Nevada, Reno in the Environmental Chemistry department ensured her interest in hydraulic fracturing and groundwater contamination where Olivia undertook work on inorganic contamination from fracking from the Pennsylvania Wells in the USA.

Papers

Developing a fuzzy logic-based risk assessment for groundwater contamination from well integrity failure during high-pressure injection – currently under review.

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Keywords: *Hydraulic fracturing, risk assessment, fuzzy logic, groundwater contamination*

12. *Applying machine learning techniques for water demand forecasting using smart metering and weather input – Maria Xenochristou*

Supervised by Profs Zoran Kapelan, Slobodan Djordjevic, and Prof Hofman

Accurate forecasts of demand are a key input to understand future supply-demand balance. The current research aims to utilise a combination of statistical methods and machine learning techniques (Random Forests) in order to identify patterns and establish relationships between water demand and a variety of factors that are suspected to influence it.

In order to achieve this, an extensive dataset comprising of high-resolution consumption data (derived from smart meters), household characteristics, socio-economic factors, and weather variables became available. The methodology adopted is based on a systematic approach that evaluates the relationship between water consumption data and explanatory factors for different temporal and spatial scales and aggregations of households (based on household characteristics and socio-economic data).

Maria is currently based at the Centre for Water Systems at Exeter University, while collaborating closely with the industry. As part of her PhD, she also did a 3 month placement at the National Technical University of Singapore and a 1 month placement at KWR water research institute in the Netherlands.

Before joining the Centre for Doctoral Training in Water Informatics, Science and Engineering (WISE CDT) in 2015, she graduated from the National Technical University of Athens (NTUA) with a MEng in Civil Engineering. While at university, she completed a year-long internship as a research assistant at the Berlin Centre of Competence for Water (Kompetenz Zentrum Wasser Berlin) in Germany, where she worked on project SEMA (SEwer deterioration Model for Asset Management strategy). Based on the work she performed during her internship, Maria wrote a dissertation assessing the accuracy of sewer deterioration models and therefore the potential to use them for asset management strategies. Following her return to Greece, she also completed a four month internship as a data analyst for a Greek start-up company.

Her research interests lie in the intersection between civil and software engineering and include water demand pattern recognition and forecasting, statistical analysis and machine learning.

Publications

- M. Xenochristou, Z. Kapelan, C. Hutton, and J. Hofman (2017): CCWi2017: F42 'Identifying relationships between weather variables and domestic water consumption using smart metering'.
- M. Xenochristou, Z. Kapelan, and C. Hutton (2018): HIC2018: 'Smart water demand forecasting: Learning from the data'.
- M. Xenochristou, M. Blokker, I. Vertommen, J.F.X. Urbanus, and Z. Kapelan (2018): CCWi2018: 032 'Investigating the Influence of Weather on Water Consumption: a Dutch Case Study'.
- M. Xenochristou, Z. Kapelan, and C. Hutton (2019): 'Using smart demand metering data and customer characteristics to investigate the influence of weather on water consumption in the UK'. J Water Resources Planning and Management (in press).

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Keywords: *water demand forecasting, smart meters, machine learning, demand behaviour*

13. *Decision-making for water resources planning under uncertainty – Damian Staszek*

Supervised by Professor Dragan Savic and Professor Guangtao Fu

Various Supply-Demand Balance (SDB) models are utilised by companies as decision support tools, in order to choose an optimal or near-optimal combination of capital investment programs and operational strategies. Traditionally, water companies use separate models for water resource planning and for water resource investment planning. Deployable output is estimated in a water resources model. The project scope is to deliver an integrated model for water resources and investment planning, where any investment selected affects the forecasted deployable output. Management of water resources can be a challenge, mostly due to uncertainties affecting Water Supply Systems (WSS). The main sources of the uncertainty in WSS are due to: imperfect knowledge about socioeconomic drivers, climate variability and climate change, as a result of changing system dynamics, or are related to a regulatory framework or legal aspects.

The aim of this research is to develop a better understanding of supply-demand balancing problems for water resources management under uncertainty. This aim will be achieved by developing and then optimising an integrated SDB model, based on the input generated by new risk-based methods. In subsequent steps, the impact of uncertainty on decision making will be investigated by implementing and testing various scenarios. Uncertainty, including deep uncertainty, will be examined for each and every point of data input to the model. This project also proposes a resilience-based methodology for water resources planning modelling.

Damian is based at the Centre for Water Systems at the University of Exeter. He has been working for Bristol Water since 2006. His job title is Senior Water Resources Statistician. Previously based in the Change and Regulation Department, and in the Strategic Assets Management Department, he is currently in the Water Resources and Environment Department. Damian's main responsibilities are building and running an SDB model and its simulations and providing statistical and econometric analysis used in business plans and annual regulatory submissions. He participates in industry meetings (Water Statistics User Group and UKWIR) and is a member of the steering group for UKWIR projects. Damian is conducting a research visit at the University of Waterloo, Canada, from June until August 2019 - funded by the WISE CDT programme.

Damian holds an MSc in Econometrics from the Faculty of IT and Econometrics, University of Lodz, Poland (1999-2004); specialisation: Econometrics. His MSc dissertation topic was: Usage of Computable General Equilibrium Models for Economy and Ecology Simulation. He attended an Environmental Protection course, University of Lodz, Poland (2003-2004). While working at Bristol Water, he has gained a Higher National Certificate in Water Operations with Supervision and Management, Glasgow Clyde College (2011-2013).

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Key words: *supply demand balance model, sensitivity analysis, uncertainty, water resources management, Water Resources Management Plan, decision support tools.*

14. *Enhanced demand forecasting and leakage detection utilising high-resolution loggers – Paul Wills*

Supervisors: Professor Fayyaz Memon[1], Professor Dragan Savic[1] and Paul Merchant[2]
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[2] South West Water, Exeter, UK

To predict future demand, identify leakage and improve water efficiency, the upcoming adoption of smart metering for residential properties, will allow data analysts to employ end-use segregation to determine how and why water is being used.

End-use segregation of water consumption (otherwise known as micro-component analysis), breaks down the water consumption data into separate end uses, (e.g. shower, washing machine, taps). A current obstacle of end-use segregation software is the requirement of human identification in the training of model, with component parts being labelled manually and the software imitating the human identification. The current research is focusing on using clustering techniques to group together repeated patterns of water usage, as events, based on average flow, total volume, and total duration.

The data can be visualised to identify the clusters and for analysing the data, but the plan is to develop algorithms that can automate this process and classify events on a larger scale. The study uses data from around 1000 homes in Devon and Cornwall and has a long-term goal of building a predictive model from the end-use segregation to interpret the future demand possibilities. The model should also be able to detect and predict leakage within the residential properties.

Current work is based around development of a low cost sensor for verification of flow events, with potential for using the sensor to measure flow and detect leakage.

Paul is based at the Centre for Water Systems in the University of Exeter, working in collaboration with an industry partner, South West Water. Prior to starting his PhD, Paul completed a MSc in Robotics at Plymouth University in 2016 and a BSc in Computer Science and Philosophy from Keele University in 2006.

Between studying, Paul has worked as a teacher, network/systems administrator and a web developer and was seeking a fresh challenge, so decided to return to university. After completing his MSc, Paul decided to use his skills in a positive way, so the global problem of this PhD research was very appealing.

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Keywords: *End-use Segregation, Clustering, Machine Learning, Residential Demand, Leakage.*

15. *Pattern in routinely collected, hig-frequency water quality data in rivers supplying drinking water treatment works - Josie Ashe*

Supervised by Professor Dragan Savic and Professor Richard Brazier

Routine high-frequency monitoring of water quality indicators is an integral part of operational control at drinking water treatment works. However, due to the volume of data, the complexity of process driven patterns and the prevalence of signal artefacts (as a result of system and operational design, basic sensor errors, and process driven unexpected structure), the information content is typically poorly synthesised. This study investigates the value of high-frequency water quality data recorded as part of routine operations for drinking water supply (e.g. intake protection monitoring and raw water supplying works). The frequency and volume of these archived data increases the visibility of previously hidden patterns in raw river water supplying works. By extracting the water quality signal for rainfall-runoff events, the analysis of hysteresis in signal relationships for raw river water provides additional insight into hydrochemical behaviour in rivers. This enhances the capability and capacity to utilise existing sub-hourly water quality data in catchment investigations; provides an improved understanding of both landscape and in-stream processes which can affect drinking water resources; and, alongside targeted research through the wider partnership, supports research into the impact of catchment management interventions on water quality.

Josie's research with the Centre for Doctoral Training in Water Informatics: Science and Engineering (WISE CDT) supports work with South West Water's Upstream Thinking Partnership. Josie also works closely with the Mires Partnership research group at Exeter University based in the College of Life and Environmental Science. This involves working with the University's high density hydrological monitoring in upland catchments as part of an ongoing assessment of the effect of landscape restoration on water storage, water quality and wider ecosystem services. Before joining the WISE CDT in 2014, Josie worked for the University of Exeter as research technician on the Mires Project. Between 2009 and 2013 she spent 4 years as an analyst at the renewable energy agency Regen SW, and prior to completing her MSc she worked as a geo-environmental engineer at Scott Wilson/URS. Josie received a first class grade in Water Informatics through the postgraduate WISE CDT. She holds an MSc in Environmental Monitoring and Analysis, and a BSc in Environmental Earth Science from the University of Wales, Aberystwyth. Josie's WISE CDT PhD studentship at the University of Exeter is supported by EPSRC.

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Keywords: *high-frequency; water quality; multivariate; catchment management; drinking water.*

J. Ashe, E. Grand-Clement, D. Smith, R.E. Brazier and D.A. Savic (2018) "Extracting value from complex high-frequency multivariate water quality data: exploring routinely collected operational data" G. La Loggia, G. Freni, V. Puleo and M. De Marchis (editors). EPiC Series in Engineering, 13th International Conference on Hydroinformatics, Palermo, Italy, July 2018, vol 3, pp. 103—110.

J. Ashe, E. Grand-Clement, D. Luscombe, H. Graham, D.A. Savic, R. E. Brazier (2019) "Patterns in routinely collected, high frequency water quality data in rivers supplying drinking water treatment works." Geophysical Research Abstracts, EGU General Assembly, April 2019, Vol. 21, EGU2019-15056.

16. *A comparative hydrology approach to understand groundwater recharge variability across the African continent – Charles West*

Supervised by: Thorsten Wagener and Rafael Rosolem

Large-scale hydrological models are now used regularly to address issues related to the potential change of water availability given climate and other global environmental change. Despite their increasing use, these models are generally based on strongly simplified representations of natural processes, which often do not represent key features of real systems that might influence how change will manifest itself in hydrological variables, such as soil moisture or groundwater availability. Where modellers have tried to include more realistic representations, then it usually came at the cost of heavily over-parameterized models. The current situation limits our ability to investigate how climate change will impact future water availability, especially in data poor regions of the world where such impacts will be most critical. Charles is interested in learning how we can more realistically (and parameter efficiently) represent groundwater fluxes in large-scale hydrological models. Potential groundwater utilization is still under-explored and we need better tools to assess its potential (Gleeson et al., 2015, Nature Geoscience). He is looking to investigate different options to represent groundwater connected to existing land surface schemes (such as NOAH) and test it in the context of water resources management in developing countries.

Charles is a PhD student in the Civil Engineering department at the University of Bristol. Prior to joining the WISE CDT programme, he completed an MSc in Hydrology and Water Resources at Imperial College London and a BEng in Civil and Environmental Engineering at Cardiff University.

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Keywords: *Groundwater recharge, comparative hydrology, Africa, hydrological classification*

17. *Groundwater processes in conceptual hydrological models – Sebastian Gnann*

Supervised by Dr Nicholas Howden and Dr Ross Woods

Understanding and modelling baseflow and groundwater processes is crucial for various issues related to water quantity and quality and of global importance as baseflow and groundwater are major water resources. This project aims at identifying and quantifying the major controls on catchment scale groundwater processes, such as climate forcing (e.g. precipitation, potential evapotranspiration) and catchment form (geology, vegetation, soils, topography, etc.). We try to describe and model how these controls interact (i.e. how catchments work as natural systems) in a process-based way. This implies identifying the key processes and describing them in an adequate way (ideally simple, but not too simple).

Process-based models are required for extrapolation, i.e. predicting beyond the range of what we have observed. This is necessary in the face of environmental change (land use change, climate change) and for predictions in ungauged catchments. Ideally, parameters used in these models should be linkable to physical (observable) attributes, which would allow to define them a-priori (if the relevant information is available) and thus make them transferable to ungauged catchments. One way to approach these challenges is to analyse large samples of catchments to find (dis-)similarities and patterns that might be synthesised to catchment-scale theory (comparative hydrology).

This approach is employed in one research project, which focuses on the influence of long-term climate and landscape characteristics on annual baseflow generation. Using many catchments located in the US and the UK, we explore how variations in annual baseflow can be attributed to aridity and catchment form. Besides a better understanding of the environment and more robust predictions, improved process understanding might help to constrain and improve hydrological models (i.e. getting the right answers for the right reasons).

Sebastian is based at the University of Bristol, in the Water and Environmental Engineering group. He graduated from the University of Tuebingen, Germany, with a B.Sc. in Environmental Science and a M.Sc. in Applied & Environmental Geoscience. During his masters he chose the specialisations Hydrogeology and Environmental Physics & Modelling. He focused mainly on groundwater-related modelling and programming, including numerical modelling of flow and solute transport as well as corresponding field work. In his master's thesis he focused on multivariate geostatistics and stochastic modelling of environmental variables.

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Key words: *hydrology, hydrogeology, conceptual models, environmental modelling*

18. *Drinking Water Reservoir Resiliency in a Changing Climate - David Birt*

Supervised by: Jun Zang, Lee Bryant, Rupert Perkins and Danielle Wain

The project seeks to develop a coupled model of hydrodynamics and biogeochemistry for artificially mixed drinking water reservoirs including the Welsh Water reservoir Llandegfedd. Some aims of the project include: (1) Determining the impact of engineering interventions used by utilities, such as mixers, on surface water quality. (2) Assessing the future resiliency of British reservoir infrastructure in the face of a warming climate, when increased summer heating will lead to stronger thermal stratification and diminished transport of oxygen in the water body. (3) Determining the role of forced versus natural mixing in determining transport and transformation of nutrients and metals within the different reservoir system within a changing environment. In this way, we can predict the severity of future colour, odour, and taste problems within our water supplies. The project will apply existing reservoir models to characterize biogeochemistry and hydrodynamics. This will include collecting data to calibrate and validate models.

David has completed an MSci in Physical Oceanography from Bangor University. His 4th year Research Project investigated the movement of water via internal waves across the shelf edge while his 3rd year dissertation looked at melting Greenland Ice Sheet effect on the Ocean Overturning Circulation. During his time at Bangor, he undertook a year-long internship at the National Oceanographic Centre in Liverpool. This role primarily involved working as a research assistant; processing data for the Shelf Sea Biogeochemistry project whilst also undertaking research assignments. David was given the opportunity to present data at a variety of events, including the Liverpool Marine Symposium, in 2016 and the Young Coastal Scientist and Engineers Conference in 2016.

He has attend numerous foreign workshops during his time in the WISE CDT. This includes the Physical Limnology block course in Magdeburg, Germany, and the Active transport in the Ocean: Turbulence, Chemistry & Biology summer school in Wimereux, France. He is soon set to attend the Physical Processes in Natural Waters 2019 in Yichang, China.

Research Interests:

- Fluid dynamics
- Hydrodynamic models
- Stratified environments
- Climate change

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19. *Hydroinformatics of smart cities: real-time water quality prediction model using a hybrid approach - Elisa Coraggio*

Supervisors: Professor Dawei Han, Dr Theo Tryfonas and Professor Weiru Liu

Water is one of the most important resources for human society. The world is currently undergoing a wave of urban growth, and pollution problems are of great impact. Monitoring water quality is vital for the future of both the environment and the human species.

Over the past few decades, lots of effort has been put on monitoring and predicting water quality using traditional approaches based on manual collection and laboratory-based analysis, which are slow and laborious. This study proposes a new methodology for implementing a water quality prediction model using Artificial Intelligence techniques and comparing the results obtained with different algorithms. Furthermore, a physically based model will be created for the hydrodynamics and water quality using Delft3D Flexible Mesh, and simulation results will be used as a training dataset for the Artificial Intelligence algorithm. This study derives the methodology and demonstrates its implementation based on information and data collected at the floating harbour in the city of Bristol.

Elisa is currently in her second year of the WISE CDT programme, based at the University of Bristol in the Water and Environmental Engineering group. More recently, she has successfully completed a course on environmental modelling using Delft3D Flexible Mesh. Prior to join the WISE CDT project, she graduated in 2015 with a BSc in Civil and Environmental Engineering at the University of Cassino and Southern Lazio in Italy. In 2017 she graduated with a MSc in Civil Engineering at the same university. During her master's degree, Elisa undertook an 11 month scholarship as part of the Erasmus Programme at the Budapest University of Technology and Economics, where she also worked on her final year dissertation project that is titled: 'The effect of wind on Lake Balaton's sediment transportation.'

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20. *Improved leakage related modelling, configuration and operational management of intermittent water supply - Vasileios Koukoravas*

Supervisor: Professors Raziyeh Farmani and Zoran Kapelan

Academics:

I graduated from the School of Civil Engineering of the National Technical University of Athens, acquiring MEng from the Department of Water Resources and Environmental Engineering. I developed an interest in applications of probabilities and statistics in water resources management and water related subjects. My thesis focused on developing a probabilistic precipitation model which was applied on the Mediterranean basin. Spatial and temporal variability of precipitation was correlated with the corresponding large scale weather systems and thus a precipitation forecasting model was developed based on that.

Currently I am part of the WISE CDT programme, based at University of Exeter and my research will be focusing on water supply related topics, applications of optimization methods and water resources management models. My research revolves around Intermittent Water Supply (IWS) systems which are usually found in developing countries but also in developed ones due to various factors (e.g. water scarcity, excessive leakage, incapacity of the water distribution network etc). This project aims at improving the hydraulic modelling of such systems in order to provide a better understanding of the complex interrelation between demand – leakage and pressure. A robust hydraulic model will further help to develop configuration strategies and operational management techniques which ultimately aim at reducing leakage, preserving network infrastructure and providing a better level of service for customers. Future plans involve visiting a current case study of IWS in Zimbabwe, collecting data and having a closer look at the configuration and operation of the system.

Work Experience:

I had worked at the Athens Water Supply and Sewerage Company (EYDAP S.A.) during my internship and was assigned duties in the gauges' department. Duties included handling customers' requests, coordinating external tasks concerning metre reactivation/replacement and keeping record of replaced gauges' total outflow and life span.

Research interests:

- Hydraulic modelling
- Water Supply systems & supply scheduling
- Predictive and stochastic analysis applied on environmental engineering
- Developing decision support tools for water related problems
- Software developing
- Machine learning (A.I.)
- Smart water systems
- Alternative water sources

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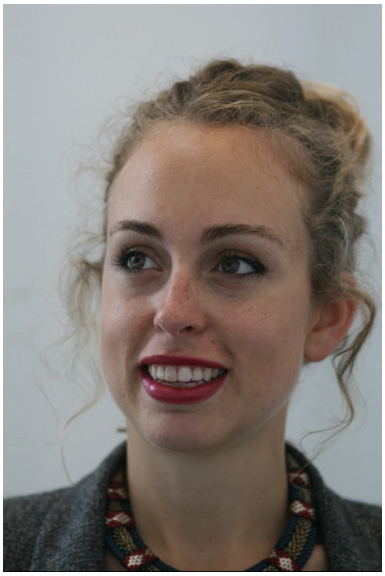

21. *Assessment of drought effects in water resources availability - Paula Arce Vicente*

Supervisors: Professors Raziyeh Farmani and Dragan Savic

Due to the fast population growth, the current centralised water supply system is not viable in the long term. Climate change projections show that water scarcity will increase in the future. Thus, decentralised water systems have been identified as a tool to increase water security and minimise environmental impacts. Paula's research will focus on Rain Water Harvesting (RWH) as the main decentralised intervention to overcome water scarcity in arid and semi-arid regions. Water harvesting methods depend largely on the local conditions: amount of rainfall, its distribution, topography, soil type and socio-economic factors.

Paula is a Water Informatics: Science and Engineering (WISE) CDT student based at the University of Exeter. She was awarded a junior research grant by the India UK Water Centre (IUKWC) to undertake her proposed project in India during March 2019. This project was entitled 'Freshwater resources analysis from Water Harvesting Structures in the Sambhar Salt Lake region, Rajasthan' where she looked at water quality of different water sources in rural areas near Dudu Block, Rajasthan. A State of Science brief and an activity report of this project will be published on the iukwc.org website. During this work, Paula collaborated with Water Harvest UK, an NGO working with rural communities in India to implement low-cost, sustainable solutions combining technical expertise with traditional wisdom, to capture and store monsoon rain.

Paula's academic background includes an MA in Urban Design from Oxford Brookes University in 2016 and a BSc and MSc in Environmental Science from the University of Leon, Spain (2008-2013). During these five years, she was granted both a national and Erasmus international mobility scholarship at the Technical University of Valencia, Spain during 2011-2012 and at the University of Gothenburg in 2012-2013 respectively. As part of her dissertation project at the University of Gothenburg, she developed a GIS map showing the seasonal risk of flood prone areas in the Västra Götaland County of Sweden. Before joining the WISE CDT Programme, Paula worked as a Graduate Waste and Minerals Planning Consultant at WYG in Southampton. This role involved preparing planning applications, environmental impact assessments and environmental permit applications for minerals and waste management sites. She also coordinated and undertook environmental monitoring of landfill gas, soil, groundwater and surface water quality on a series of locations and RSPB sites.

Currently and in addition to her research, Paula is working as a Postgraduate Teaching Assistant at University of Exeter where she undertakes tutorials, demonstrations and practical sessions on modules in statistics, natural science and management science.

Research Interests

- Water resources management
- Water harvesting
- Arid and semi-arid regions
- Water quality
- Food-Energy-Water Nexus

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22. *Fish response to flow alterations in riverine systems - Stephanie Müller*

Supervisors: Dr Catherine Wilson and Dr Pablo Ouro

Barriers to fish migration are presented in various forms in riverine systems - some arise naturally, others are anthropogenic such as dams or turbines. However, all these obstructions may have an impact on fish population, e.g. by reducing passage freedom or nursery habitat.
Based on this problem, two anthropogenic obstacles, including woody debris dams (used in natural flood measurement) and vertical-axis turbines, have been chosen to investigate their impact on fish migration.
A combination of laboratory experiments using Acoustic Doppler Velocimitry and numerical large eddy simulations using Hydro3D are used to characterise the flow in the vicinity and the near wake field of different dam and turbine (array) configurations.
The knowledge gained from the hydrodynamic analysis will subsequently be used to draw conclusions on fish behaviour and habitat preference which is analysed in separate fish experiments using target species such as rainbow trout (Oncorhynchus mykiss) and salmon (salmo salar). Beside the usage of camera systems to record fish behaviour, motion tracking algorithms will be applied to enable the extraction of further fish kinematics such as tail beat frequency and body undulation as well as the movement tracking in space.
Linking hydrodynamics with fish swimming performance, habitat choice and passage behaviour is one of the main targets of this project.

Stephanie is a PhD student on the WISE CDT program, based at the Hydro-Environmental Research Centre at Cardiff University.

She completed a BSc in Environmental and Energy Process Engineering in 2015 with a dissertation titled 'Simulation of the fluid-structure-interaction of a flexible, oscillating aerodynamic profile with the open source toolbox OpenFOAM extend'. During her Bachelor studies she also started working as student assistant at the Laboratory of Fluid Dynamics and Technical Flows and continued working during her Master studies where she became involved in a research project called "Fish-friendly Weir" (research action "Wachstumskern Flussstrom Plus"). In 2017, she graduated with an MSc in Sustainable Energy Systems at the Otto-von-Guericke University Magdeburg in Germany. Her Masters dissertation was titled: 'Numerical investigation of the flow in vortex power plant in consideration of river continuity'.

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Publications:
Müller, S., Cleynen, O., Hoerner, S., Lichtenberg, N. and Thévenin, D., Numerical analysis of the compromise between power output and fish-friendliness in a vortex power plant. J. Ecohydraul. DOI: 10.1080/24705357.2018.1521709, (2019) 1-13

Keywords: *natural flood management, woody debris dams, small-scale hydropower, riverine system, fish migration, fish behaviour, large eddy simulation, Hydro3D*

23. *Developing a Hydro Turbine for Shallow Water River Systems - Bikash Ranabhat*

Supervisors: Dr Reza Ahmadian, Dr. Alan Mason-Jones and Professor Roger Falconer. Mentor: Prof. Allan Kwan

Bikash graduated from Tribhuvan University (Nepal) with a B.E. in Civil Engineering in 2003. He completed his MSc in Civil and Water Engineering with Distinction from Cardiff University where his dissertation focused on assessing the movement of fine sediment particles in gravel bed spawning habitat due to hydro-peaking by numerical modeling.

Following his first year in Exeter as part of the WISE programme, Bikash is working on his research project titled: 'Developing a Hydro Turbine for Shallow Water River Systems' at Cardiff University.

Work Experience

Bikash is a highly experienced engineer having worked for various hydropower design consultancies in both the UK and Nepal over the past 12 years. Apart from involving himself in 10 schemes totaling a capacity of more than 310 MW at various stages of development, he was also a resident engineer for the construction supervision of 4MW Khudi hydropower project in rural Nepal; at the time when the country was going through the heightened level of insurgency. Most recently, he has worked as a Senior Hydropower Engineer at Hydroplan where he was responsible for identification, through pre-feasibility and feasibility, to the overall detailed design and design coordination of hydro projects. Some of the hydro sites he identified in Scotland are now fully implemented and generating electricity. Bikash also worked alongside the All Reservoir Panel Engineers for the design of dams in Loch Dungeon, Burnhead and Loch Rannoch, Ardtornish.

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Research Interests

- Eco-hydraulics and hydropower development
- Flood modelling
- Sediment transport dynamics
- River basin management
- Hydro-informatics

Publications/ Conferences Presentation:

Poster Presentation: 6th The Partnership for Research in Marine Renewable Energy (PRIMaRE) Conference, Cardiff University. 3rd & 4th July 2019. https://www.primare.org/- : Best Poster Award

24. *A new microbubble method for dissolved air flotation - Bert Swart*

Supervisors: Dr Jannis Wenk and Dr John Chew

Bert Swart is student currently in his second year with the WISE CDT in Bath and carries out his research at the University of Bath. Bert also completed his undergraduate degree at the University of Bath where he achieved a master's degree in Chemical Engineering.

PhD Proposal

Bert is in the first year of his PhD focusing on a new microbubble method for dissolved air flotation. In a DAF facility air is dissolved in the water under high pressure and then released into a basin at ambient pressure. The microbubbles that are subsequently formed attach to the surface of suspended solids and rise to the top, thereby separating the solids from the liquid. The aim of this project is to investigate the suitability of a recently developed alternative microbubble production method and compare to conventional DAF.

The work is supervised by Dr Jannis Wenk and Professor John Chew at the University of Bath and has an experimental part and a modelling part. The experimental part will be conducted with a dissolution type microbubble generator at the labs in Bath. The modelling section will be integrating experimental results into computational fluid dynamics modelling approaches to model and describe adsorption behaviour of single microbubbles and bubble populations to dispersed solids.

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Academic Interests

- Waste Water Treatment
- Dissolved Air Flotation
- Computational Fluid Dynamics
- Interested in linking work to developing countries either during or after the PhD.

25. *Constructed wetlands: a wastewater treatment solution for the removal of emerging contaminants - Zara Visanji*

Supervisors: Professors Fayyaz Memon and David Butler

Academics

Zara Visanji is a PhD student as part of the Water Informatics Science and Technology CDT at the University of Exeter. She has a BSc in Physical Geography and Geology from the University of Plymouth in 2015 and an MSc in Water Engineering from the University of Exeter in 2017. Whilst carrying out her masters, Zara also worked for the Sewers Adoption team in the Developer Services department at South West Water. Her Masters dissertation focused on determining sustainable treatment technologies suited to the removal of emerging pollutants from wastewater in India. Zara is also interested in volunteer work, previously she has helped to build a rainwater catchment tank in Fiji and in August 2018 she travelled to Uganda to build a spring water well.

Zara's PhD research will be part of the Fate and Management of Emerging Contaminants (FAME) project which will investigate emerging contaminants in the major Indian rivers and wastewater treatment works, as well as creating novel and affordable treatment solutions for urban and rural India. She hopes to develop a new model that will simulate the removal of emerging contaminants through a horizontal flow constructed wetland.

Journal Paper Publications:

- **Visanji Z.,** Sadr S.M.K., Johns M.B., Savic D., and Memon F.A, 2019. Optimising wastewater treatment solutions for the removal of contaminants of emerging concern (CEC): A case study for application in India, Journal of Hydroinformatics (accepted)
- **Visanji Z.,** Sadr S.M.K., and Memon F.A., 2018. An Implementation of a Decision Support Tool to Assess Treatment of Emerging Contaminants in India, Journal of Water Resource and Protection, vol. 10, no. 04, p. 422, Apr. 2018. Article ID:84268, 19 pages DOI: 10.4236/jwarp.2018.104023

Conference Papers:

- **Visanji Z.,** Sadr S.M.K., Johns M.B., Savic D., and Memon F.A., 2018. Emerging pollutants in developing countries: Optimising sustainable treatment solutions, in: EPiC Series in Computing. Presented at the HIC 2018 13th International Conference on Hydroinformatics, Italy, pp. 2204–2215. https://doi.org/10.29007/txmw
- **Visanji Z.,** Sadr S.M.K., and Memon F.A., 2017. Sustainable Treatment of Emerging Pollutants in the Context of India, in International Conference on Sustainable Development in Civil Engineering, Pakistan, 2017.

Conference Presentations:

"A Decision Support Tool for the Management of Emerging Contaminants in India", Emerging Contaminants Summit, Westminster, Colorado, March 2018 (DOI: 10.13140/RG.2.2.21897.54884).

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26. *Mathematical Modelling for the Identification of Mechanisms Driving Cholera Outbreaks in Endemic Regions - Deborah Shackleton*

Supervisors: Professor Fayyaz Memon and Dr Albert Chen

Cholera is endemic in Bangladesh and causes an average of 4500 preventable deaths in the country every year. Cholera incidence in the region is hugely affected by weather and climate, and the relationships are nonlinear and interrelated. In endemic regions, long-term approaches to cholera prevention are needed, and these require a holistic understanding of the mechanisms which drive cholera spread and the complex way in which they interact. Debbie is developing a mathematical model based on systems thinking to explicitly describe individual climate mechanisms and their relationships. Intended applications are the simulation of long-range (decadal) cholera forecasts and comparisons of the effectiveness of potential intervention options.

Academic Background

Debbie is currently undertaking a PhD as part of the WISE Centre for Doctoral Training at the University of Exeter. She also completed her undergraduate studies at Exeter with an MEng in Civil Engineering in 2015. For her masters project she worked in conjunction with Shelterbox on the design of a lightweight and compact membrane water treatment system designed for rapid deployment in disasters. In parallel to this she also lead the engineering team of a student project creating biochar from plant waste for use as a soil amendment in Ethiopia.

After graduating from Exeter, Deborah spent one year at the Harbin Institute of Technology studying Mandarin Chinese followed by a three month internship in Kerala, India working with students on Finite Element Modelling projects. She has also spent six months working as a structural engineer at a London-based consultancy.

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Research Interests

- Infectious Disease Modelling
- Data management
- Bayesian Statistics
- Environmental Modelling

27. *Impact of Land-Use Changes on Hydrological Regimes - Jessica Penny*

Supervisors: Prof Slobodan Djordjevic and Dr Albert Chen

Jess is currently researching Land Use Change, with the view to model historical, current and future change. In particular, she will be investigating changes in agricultural development and urban growth, and how this will affect hydro-meteorological extremes, specifically extreme droughts. Her ultimate goal is to develop vulnerability and risk maps for drought for the Mun River basin. With the potential to provide adaption strategies for drought risk reduction via water management in the basin.

This year, in February, Jess was one of five members of Exeter University (including Dr Albert Chen and Prof Slobodan Djordjevic) that took part in an inception workshop at the Asian Institute of Technology conference centre for the project ENRICH – Enhancing Resilience to future Hydro-meteorological extreme in the Mun river basin in Northeast of Thailand . In total 67 participants took place including members from governmental agencies, academics and international/regional organisations. The objective of the day was to; fine tune the scope of the project, receive feedback on the most critical issues related to the project, and to identify opportunities and synergies for collaboration in terms of data and experience

In March Jess took part in research visit with the aim to meet with local stakeholders to discuss the problems associated with drought and flooding and the adaption strategies either that are already in place or could potentially be put in place in the future. In addition, a brief field study took place too Lamtakong Jolabha Vadhana Pump-storage Hydro Power Plant Nong Mai Phai Sub-District in Korat and Lim Tong Village and Kok Plong Village in Burirum Province. Here a community was observed to be using solar power to pump groundwater to use as drip irrigation for agriculture and a community using a small reservoir for water management.

Academics:

Prior to joining the WISE CDT Jess graduated with a BSc (Hons) in Marine Geography from Cardiff University in 2015, with her final years dissertation titled: ‘A comparison of the UK December 2013 – February 2014 storm characteristics with particular reference to the SW and E Coast of England, and in the context of past storms’. Which findings were presented to the FFC (Flood Forecasting Centre) within the MET office. This was followed by an MSc in Water Engineering from the University of Exeter in 2017. Her dissertation was titled: ‘The use of the WCA2D model to analyse the current and future pluvial flood risk to the London catchment of Wallington’.

Coastal & Marine Processes

28. *Soft artificial reefs and mega-nourishment in a coastal protection context – Benjamin Beylard*

Supervised by Professor Shunqi Pan and Professor Roger Falconer

In recent decades, the socio-economic development in coastal zones has continued to grow, leading to an unprecedented trend of coastal migration. However, due to global climate change, those areas are become increasingly vulnerable under extreme events. Extreme storm conditions can cause significant damages to coastal infrastructures and defences due to coastal erosion and flooding. In the UK, coastlines have been well protected, commonly by hard engineering structures such as seawalls, breakwaters and groynes. Recently, soft engineering approaches have been widely used in coastal protection including beach nourishment, such as the Mega-and-Engine project in the Netherlands as well as many schemes in the UK. Within the beach nourishment approach, accurately predicting its impact on beach morphology is the key for sustainable coastal management, but the sediment transport dynamics of the mixed sediments is yet to be fully understood and accurately modelled at the scheme scale for engineering applications.

This project is to further develop an in-house process-based hydro-morphodynamic model: COAST2D, with the implementation of the newly developed modules for a better presentation of mixed sediment transport under combined wave and tide conditions, particularly during storm events. The model development will be supported by the laboratory experiments and field survey data through both national and international collaborations. The improved model will provide detailed information of both short and longer term beach morphological chnges where nourishments are deployed.

Benjamin is a PhD student based at the School of Engineering at Cardiff University. Built on the work of Pan *et al.* (2007) and Pan (2011), Ben's research is to further develop the process-based COAST2D model to further improve the algorithm of modelling mixed sediment transport with applications of the improved model for the beach nourishment schemes such as the mega-nourishment project at the Bacton gas terminal (Norfolk, UK).

After a BSc (Hons) in Earth and Environmental Sciences from the University of Bordeaux in 2009, Benjamin obtained an Erasmus Mundus MSc in Marine Environment and Resources from the University of Bordeaux, the University of Basque Country and the Southampton University in 2014. For his Master's degree, Benjamin covered a wide range of topics from sedimentology to coral reefs and deep-sea ecology. He specialises in physical oceanography and coastal dynamics, seen in his Master Thesis. This opportunity remains until now his most significant professional experience. The results of this experiment has been summarized in the paper: "Laboratory Investigation of Wave-Driven Dune and Beach Morphology Change under High Storm Surges", and presented by Benjamin at the IAHR world congress 2015, which took place at The Hague, The Netherland.

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29. *Assessment of the Carno-Bordas losses within the a bulb-turbine diffuser coupling far-field and near-field CFD models – Arthur Hajaali*

Supervised by: Professors Thorsten Stoesser and Shunqi Pan

The United-Kingdom and France possess more than 80% of the European tidal energy potential, leading to considerable interest in the R&D of ocean and tidal energies. Indeed, UK is endowed with various tidal range sites including the third highest tidal range site in the world. The Severn Estuary with spring tides exceeding 14m and an average tidal range of 8m is the source of numerous impoundment tidal projects including Swansea, Newport and Cardiff lagoons as well as the great Severn Barrage are under consideration and have triggered multiple studies by the UK government.

The vast majority of these lagoons consider integrating bulb-turbines technology to their infrastructure as it is a well-established versatile low head (1.5-30m) turbine that has been installed in more the 200 river sites by the major companies such Andritz, Voith and GE. It also stars in the two largest tidal barrages of La Rance (240MW) and Shiwa (254W) respectively located in France and South Korean. Over the last decade the companies claim to have improved the unit output by no less than 40% due to the extensive research performed on the electrical and mechanical components including the generators and runner blade. Further improvement on the bulb unit can be achieved by optimising its diffuser.

This PhD project aims to analyse and further the general understanding on cross-flows interactions and behaviours at the mouth of a mini/small tidal hydropower plant and a river known as the Borda and Carnot losses. Although, the study of these interactions could benefit and find applications in multiple hydraulic problems, this project concentrates its focus on the influence of the transposed turbulences generated by the cross-flow into the diffuser. These turbulences affect the overall performance and efficiency of the bulb-turbines impacting on the pressure recovery. The Ph.D work entails the modelling of the complex turbine unit geometry as well as the modification in the code of the boundary condition to represent accurately the flow behaviour prior to the diffuser.

Arthur graduated with a BEng in Civil Engineering from Cardiff University prior to his integration to the WISE CDT program. Throughout the completion of his degree Arthur attached a particular interest in fluid mechanics and its multiple applications in water and coastal engineering. His growing curiosity for the marine renewable energies led him to take part into the development of a vertical tidal turbine during the summer between his 2nd and 3rd year with the hydro-environmental research team lead by Prof. T.Stoesser. He also had a first-hand approach to hydraulic modelling for the completion of his 3rd year research project that led him to attempt to model the possible flooding impact due to installation of water mill in Canterbury using the 1D modelling software HEC-RAS.

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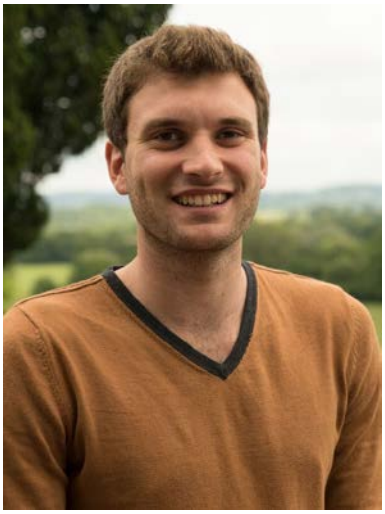
Key words: *hydraulic modelling, turbulence, bulb turbines, renewable marine power*



30. *Coastal protection and near-shore evolution under sea level rise - Paul Bayle*

Supervised by Dr Chris Blenkinsopp, Dr Alan Hunter, Professor Gerd Masselink

Global mean sea level is rising at increasing rate, and this represents one of the main long term coastal hazard. Existing hard engineering coastal defences are neither designed nor efficient against Sea Level Rise (SLR), and therefore are likely to be overtopped and breached during this century.

A recent soft engineering technique named "dynamic revetment" or "cobble berm" has been implemented in some coastal places to protect the hinterland against storm wave and erosion. This type of revetment is not static and moves under wave's action while dissipating the wave's energy. By optimising the design of the dynamic revetment as well as the deployment area, this structure is supposed to self-maintain its relative position to sea level under SLR. The pebbles composing such a protection are expected to move landward under SLR, thus keep protecting the hinterland against future extreme wave climate.

The performance of the revetment was tested in the GWK large scale flume, Hannover, Germany, through the 'DynaRev' experiment in 2017. The experiment was designed to assess the behaviour and the capacity of the revetment to adapt and protect sandy beach against waves attack and SLR. The experiment was also designed to provide a large range of morphodynamics data required for a better understanding of general coastal processes under SLR. In January 2019, the dynamic revetment of North Cove, Washington State, the USA, was monitored for 10 days when high energetic condition were happening around the spring tide. Surface measurements of the revetment were recorded using a LiDAR in order to assess the behaviour of the structure in real environment.

Paul is a PhD student based at the department of Architecture and Civil Engineering at the University of Bath. He is part of the Water, Environment and Infrastructure Resilience (WEIR) research group, and the Water Innovation and Research Centre (WIRC). Paul's research is focused on physical, numerical and computational modelling to better understand beach profile evolution under sea level rise. He is also interested in general coastal protection with a specific expertise in submerged artificial reef. He is also trained in operational oceanography and survey management.

Before joining the Water Informatics and Science of Engineering (WISE) Centre for Doctoral Training (CDT), Paul completed a two-year degree in Civil Engineering at the University of Paul Sabatier in Toulouse, then a BSc degree in Earth and Environment Science at the University of Bordeaux and an MSc degree in Oceanography at the University of Southampton. His MSc thesis was completed at the Griffith Centre for Coastal Management (Australia) on beach morphodynamics impacted by artificial submerged reef, under the supervision of Rodger Tomlinson and Darrell Strauss. Paul also led and managed a Hydralab+ project, running the DynaRev experiment at the GWK large scale flume.

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Publications:

- *Bryan et al. (2019). Breaking Wave Imaging using Lidar and Sonar. IEEE Journal of Oceanic Engineering (99), pp: 1-11.*
- *Bayle et al. (2019). Performance of a Dynamic Cobble Berm Revetment for Coastal Protection. Coastal Engineering. (in submission)*

31. *3-D Modelling of Offshore Sandbank Dynamics – Stephen Clee*

Supervisors: Dr Shunqi Pan and Dr Catherine Wilson

Sandbanks, such as those found in the North Sea and along the Flemish coast, are large, common bedform features. They have been observed in broad, shallow seas where intense tidal currents, typically of a magnitude of 0.5-2ms^{-1}, supply an abundant source of sediment with which to form sandbanks. Sandbanks are highly dynamic and mobile features. Highly energetic sea conditions can cause erosion and transportation of sediment from sandbanks as well as sediment exchange between neighbouring banks causing migration over long periods of time.

Sandbanks have many significant roles in the engineering sector. Primarily, they act as a natural dissipater of wave energy, causing a reduction in wave heights inshore of the bank. This in turn provides a form of defence for the coastline from coastal erosion and flooding. With between 500-600 ships passing through it every day, the Dover Strait is the world's busiest shipping lane connecting the North Sea and Baltic Sea with the Atlantic Ocean. The presence of sandbanks, especially those close to the surface, can present a significant navigational hazard to the vast number of shipping vessels that pass through the region on a daily basis. The North Sea has also attracted a lot of attention from the renewable energy sector particularly for the development of offshore wind farms. The location of these turbines and other subsea structures such as undersea pipelines can alter the sediment transport pathways which can have a knock on effect of the sandbank systems.

The aim of this research is to develop a model that includes the effects of 3D hydrodynamics, wave and tidal processes and sediment transport to determine the effects of these processes on sandbanks within the North Sea region. Modelling can occur over the short term (spanning several tidal cycles), medium term (spanning several months) and long term (spanning several years or decades). In order to achieve this the TELEMAC suite will be used coupled with modules to account for tidal processes and sediment transport processes.

Stephen is a PhD student currently on the WISE CDT course based in Exeter and completing his research with Cardiff University. Stephen graduated from Cardiff University in 2013 with a MEng in Civil and Environmental Engineering. He completed his dissertation entitled "An Analysis of the CO2 reduction potential of Wave Energy Systems". During the undergraduate course he completed several projects including designing a hotel, designing a car park and a wind turbine. Stephen also completed coursework related to the remediation of contaminated land, alternative energy systems and wave analysis. He has also completed modules in other fields such as environmental law, business, accounting, economics and management in industry.

As part of the MEng course he undertook a 7 month placement with Wedge Galvanisers working to create a map of their drainage system and sample the waste to ensure that it complied with national and EU standards for contaminants.

Whilst studying at Exeter, Stephen has completed modules including Software Programming, Mathematical Modelling of Wastewater Treatment Processes, Computational Fluid Dynamics and Environmental Processes. He has completed several projects such as writing a genetic algorithm, designing and calibrating a water supply network and optimising a reservoir.

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Keywords: *Offshore sandbanks, North Sea, Waves and tides, Sediment transport, TELEMAC3D, Morphodynamic modelling*

32. *Using Large-Eddy Simulation to model near-bed and pore space turbulent flow in gravel riverbeds - Alex Stubbs*

Supervised by: Michaela Bray and Shunqi Pan

Prior to attending university, Alex worked as a Chainboy for MWH Treatment UK (now part of Stantec) on a £45+ million sewage treatment works upgrade scheme at Claymills in Burton-upon-Trent.

In 2012 Alex started reading for a Bachelor's in Civil Engineering (BEng) at Cardiff University. Whilst there Alex volunteered for the charity Mothers of Africa as a finance coordinator for a project to install solar panels at a rural health post in Zambia. This was a nine-month project where Alex facilitated the sourcing and purchasing of all the required materials and organised the logistical side of the project culminating in travelling to Zambia for two weeks in September 2014. Whilst at university Alex also worked as a Junior Site Engineer for MWH Treatment UK (now part of Stantec). This role focussed on putting together a successful tender bid for a £7.5 million biological filter bed remedial scheme. Alex also undertook internships with Ch2m (now part of Jacobs) and Network Rail based in asset management teams prior to graduating in 2015 with a 2:1.

Upon joining the WISE EPSRC CDT programme in 2015 Alex chose Master's level modules in management concepts, urban drainage, and wastewater management gaining a 1st overall for this postgraduate school element of the WISE programme.

Alex started his formal PhD at Cardiff University in June 2016, focusing on numerical modelling of near-bed and pore space turbulent flows in gravel riverbeds. As part of this research Alex created an artificial riverbed for experimental verification of a simulation developed using the finite volume LES code Hydro3D. From September to December 2018 Alex spent time in New Zealand collaborating with the University of Canterbury and Aqualinc Research Ltd to further his expertise and contribute to a wider project proposal.

Outside of academia and industry, Alex has a wide range of interests including being a qualified swimming teacher, rock climbing and undertaking the restoration of classic cars.

Future Plans

Alex is actively seeking industrial or academic roles that will further develop his coding, numerical and analytical skills.

Publications

Stubbs, A; Stoesser, T; Bockelmann-Evans, B. 2018. Developing an Approximation of a Natural, Rough Gravel Riverbed Both Physically and Numerically. Geosciences 8(12), 449. DOI: 10.3390/geosciences8120449.

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Keywords: *Hydraulic modelling; Nutrient and sediment transport; Flooding and river restoration*

33. *Continuous real-time long term monitoring of beach erosion and recovery using LiDAR – Gwyn Hennessey*

Supervised by: Dr Christopher Blenkinsopp & Dr Nick McCullen

In recent years' extreme storms occurring around the globe served as a reminder of the dangers faced by people, the natural environment and infrastructure in coastal areas. Combined with predictions that these storms will only increase in severity and sea level rise the effect of these storms can only be exacerbated. Natural beaches are widely accepted as the best method of protecting coastal areas, providing a buffer zone which protects the coastal areas from extreme waves and water levels.

Beaches accrete in calm wave conditions and erode in large wave storm conditions, however this process is not yet quantitatively understood. The result of short-term reductions in width and volume of the beach system caused by erosion during storms dramatically increases the risk of coastal flooding and damage to coastal infrastructure. In some case the sand volumes can take considerable time to return, which results of this leading to a prolonged period of vulnerability.

Therefore, a fundamental challenge for Coastal Engineers & Scientists is to determine whether existing sand volumes are adequate to protect coastal areas. A major focus of current research is to develop and improve numerical modelling tools that can be used to undertake this assessment. Development of such models has been hampered by a lack of field data which quantifies morphology change before storm events, during storm events and during the slower and much less studied post-storm recovery phase.

The aim of this project is to investigate a variety of issues related to morphological change during storm erosion and recovery and use the knowledge gained to underpin development in predictive modelling tools. This project will investigate beach morphodynamics at timescales ranging from seconds to week for the following:

- *Obtain beach morphology data capturing both erosion and recovery processes using a building-mounted Lidar system at two differing sites.*
- *Gain new insight into the understudied topic of beach recovery including the rate and patterns of morphological changes following storms.*
- *Investigate coherent patterns of change across the beach face and the relationship with forcing conditions.*
- *Investigate the relationship between surf-zone bars and swash-zone morphology.*
- *Comparison of morphology change at two site under similar conditions.*
- *The existence of a beach face equilibrium condition and the potential for the development of a behavioural model of beach response and/or an early warning system.*

Gwyn is a PhD Student on the WISE Centre for Doctorial Training based at the University of Bath in the Department of Architecture and Civil Engineering and is part of the Water, Environment and Infrastructure Resilience (WEIR) research group. Prior to joining the WISE CDT Gwyn graduated with a Bachelor of Engineering in Civil and Environmental Engineering from Cardiff University in 2012 followed by a Masters of Science in Environmental Engineering from Queens University Belfast in 2015.

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Keywords: *Erosion, Recovery, Beach Profile, Morphology, Morphodynamics, LiDAR, Behavioural Modelling*

34. *Hydro-Environmental modelling of wake dynamics of turbines and sluices in tidal range energy schemes - Catherine Leech*

Supervisors: Dr Reza Ahmadian and Professor Roger Falconer

Academics:

Catherine is a WISE CDT student based at Cardiff University. With interests in sustainable energy and the environmental impacts of hydraulic structures, the working title of her thesis project is: *Hydro-Environmental Characteristics and Modelling of Wake Dynamics of Turbines and Sluices in Lagoons and Barrages*, supervised by Professor Roger Falconer and Dr Reza Ahmadian.

Catherine previously studied an undergraduate degree in Environmental Geoscience at Cardiff University, producing a dissertation on the effects of human management on river flow characteristics. Following on from this she chose to stay at Cardiff to complete an MSc in Sustainable Energy and Environment, focusing on the impacts of the proposed Severn Barrage. It was this project that lead to Catherine's current interest in the Swansea Bay Lagoon which is the focus of her postgraduate research.

With the increasing urgency for generating energy from renewable sources, tidal range schemes are an attractive option, being both predictable and reliable, as well as being sourced close to areas of demand. Therefore it is important to answer questions around the environmental uncertainty of tidal range structures (TRSs) so that they can be safely developed in the UK to help meet future energy demand. This research seeks to address questions around flow structures initiated by TRSs, which impact both the technical and environmental performance of a scheme, by focusing on experimental and numerical modelling of turbine and sluice spacing in TRSs.

To diversify her career, Catherine took time out of academia to train as a teacher and from 2012 to 2016 taught Mathematics in a secondary school in Blackpool. During this time she completed a Masters in education to better understand the efficacy of the interventions utilized in teaching GCSE Maths. Whilst thoroughly enjoying her time teaching young people, Catherine chose the WISE CDT as an opportunity to return to research and engage with some of the questions facing the sustainable management of our water resources.

Research Interests:

- Sustainable Energy
- Environmental engineering
- Environmental and hydrological modelling
- Data management and analysis

35. *Modelling of wind wave interaction under extreme waves - Nefeli Makrygianni*

Supervised by: Dr Michaela Bray and Professor Shunqi Pan

Accurate prediction of storm waves is highly challenging, not only because of the large spatial scale to be considered, but also due to the strong interaction between wind and waves generated by wind as the surface forcing (Hristov et al., 2003). The nonlinearity of the wave-induced surface friction can affect both the wind distribution near the sea surface and the surface waves generated by wind. To better describe the strong interaction between wind and waves, this study aims to implement a better description of the wave boundary layer (Du et al., 2016; Du et al., 2019) in an atmosphere – wave modelling framework (OpenIFS).

The project is expected to 1) improve the understanding wind-wave interaction under storm/extreme conditions; 2) implement the improved algorithm to the integrated modelling framework; 3) validate the modelling framework with the experimental and field data; 4) improve the prediction of the extreme waves; and 5) apply the improved modelling system to both offshore and nearshore structures.

Nefeli is a second year PhD student on the WISE programme at Cardiff University; with the research on modelling of wind wave interaction under extreme conditions. She obtained a BSc in Geography from the Harokopio University of Athens (2013). Her dissertation project was focused on severe weather phenomena over the Greek seas. After her undergraduate studies she continued her MSc course at Harokopio University in Applied Geography and Spatial Planning, Stream C: Geinformatics (2017), with a dissertation project entitled *'Simulation of the Saharan dust advection towards the Mediterranean: Region of Interest Cyprus'.* In December 2017 she completed her second MSc in Applied Meteorology at University of Reading on *'the role of ocean wave coupling simulations of an extratropical cyclone*.'

During the last term of her bachelor degree Nefeli had an internship with the Hellenic Centre for Marine Research (HCMR), where she used statistics tools to analyse weather data, focusing on wind wave data. During her master at Harokopio Nefeli worked in an internship at Cyprus Institute, on the forecasts with the WRF-chem model.

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Research Interests: *Modelling of wind wave interaction, Meteorology/climatology, Oceanography*

Flood Risk & Prevention

36. *A global approach to robust flood estimates in ungauged catchments using hydrological process knowledge – Lina Stein*

Supervised by: Dr Ross Woods, Dr Francesca Pianosi

River flooding is a common hazard which causes severe damages to people and property. Appropriate flood protection measures greatly reduce the risk of flooding, however the scaling of designs relies heavily on long time series of streamflow data, which in many places is not available. The current methods for flood estimates in ungauged catchments often produce results that are highly uncertain and unsuitable for planning purposes. The aim of this work is therefore to develop a new robust approach for flood estimates in ungauged catchments. We developed a global flood classification that employs the increasing amount of hydrological and remote sensing data available around the globe to yield a deeper understanding of hydrological processes causing floods in different regions. The consideration of these processes allows a more accurate transferal of information from gauged to ungauged catchments, thus improving the estimates

Lina is a PhD student in the Water and Environmental Engineering Group at Bristol University with a focus on data analysis and flood modelling.

Lina completed her undergrad in Environmental Science with a minor in Environmental Hydrology at Albert-Ludwigs Universität Freiburg in 2015. During this time she spent two semesters at the National University of Singapore, where she focused on natural hazards in South East Asia. Her experience from this period was applied during an internship at the German Society for International Development (GIZ) in the department for Water Policy and Infrastructure. She finished her undergrad with a thesis in water balance modeling of a small catchment in the West Bank. It encouraged her to pursue a MSc in Hydrology at the Albert-Ludwigs Universität Freiburg, where she focused on hydrological modeling and data management as well as hydrological hazards. In her final thesis she successfully applied a recently developed solute transport model for the first time to a hydrological complex Karst catchment.
Lina is co-chair for Equality and Diversity in the Young Hydrologic Society and co-chair for the Gordon Research Seminar Catchment Science 2021.

Conference presentations:

- Poster presentation, European Geoscience Union General Assembly 2018
- Poster presentation, American Geoscience Union Fall Meeting, 2018
- Oral presentation, European Geoscience Union General Assembly 2019
- Oral presentation, Gordon Research Seminar Catchment Science 2019
- Poster presentation, Gordon Research Conference Catchment Science 2019

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Keywords: *Hydrological modeling, Flood hazards, Hydroinformatics, Data management, Data analysis*

37. *National scale hydrological modelling of UK River flows and flood peaks under climate change, with uncertainty analysis – Rosanna Lane*

Supervised by Professor Jim Freer and Professor Thorsten Wagener

Climate change projections indicate an intensification of the hydrological cycle and more extreme rainfall events, which could exacerbate UK flood risk. Climate change impact assessments are therefore needed to quantify potential changes to river flows and flooding, providing information for policy and planning decisions such as long term flood defence planning. National scale impact assessments have the potential to be particularly useful as they enable comparison between places and identification of the areas which are most at risk. However, the majority of the literature focuses on hydrological climate change impacts globally, for whole continents or for specific catchments and relatively little work has been carried out on national hydrological modelling across the UK.

This PhD aims to address these research gaps through three key objectives. The first objective is to evaluate the performance and predictive capability of four commonly used conceptual hydrological models across the UK, to explore current capabilities for national modelling and identifying areas of the UK which are particularly easy or hard to model. The second objective is to apply a distributed hydrological model, Dynamic TOPMODEL, across the UK, exploring the questions of how to effectively parameterize a hydrological model and how to represent hydrological modelling uncertainties at the national scale. The third objective is to model climate impact on river flows nationally by 2100, with uncertainty assessment.

Rosanna Lane is a PhD student in the Hydrology group at the University of Bristol, with a focus on national scale hydrological modelling. During the PhD, Rosanna has completed a 3 month placement working with Jan Seibert at the University of Zurich. This placement focused on the impact of the UKCP18 climate projections for UK hydrology, and how best to use hydrological models under changing conditions.

Rosanna previously completed an MSci in Geography from the University of Bristol. During this degree she specialised in hydrology, environmental change, statistical modelling and environmental policy. Her final year project was modelling the impact of climate change on flood hazard in 3 UK catchments, with a particular focus on hydrological modelling uncertainty.

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Key words: *hydrological modelling, uncertainty analysis, flood hazard, climate change.*

38. *Sensitivity, uncertainty and refinement in a global flood modelling - Cain Moylan*

Supervised by: Dr Jeff Neal and Prof Jim Freer

Unlike national scale methodologies which use regional data, a global flood model (GFM) is dependent on globally consistent remotely sensed data. An example of the required remotely sensed data is the digital elevation model. This raw data however requires processing to make it suitable for use as input for a flood inundation model, hence the need for novel parameterizations, and extreme value estimation of peak flows through the use of a regionalised flood frequency analysis.

This approach is useful for modelling in data scarce regions. However, it has meant the entire modelling chain contains many parameters unusual in tradition flood inundation modelling, and therefore their effect on the output of the model isn't well understood. Sensitivity analysis can be used to screen out unimportant parameters, and also help determine the behavior of the parameters. Understanding this will be understanding how the uncertainties of the parameters will affect the output and following this we can begin to understand the effect of the uncertainties of the input data.

Successful analysis of the GFM means acknowledging the behavioral variability of the model with respect to location. As the different climates and landscapes are characteristically different, we hypothesize that the parameter sensitivities of the model will not be homogeneous. Hence the aim is to understand which geo-climatic features are correlates of different variations in model sensitivity. If this becomes well understood, there exists the possibility of being able to say a priori what the most important parameters are in a given region, simplifying the process of calibration or optimization.

Cain is a PhD student working in the School of Geographical Sciences at Bristol with Dr Jeff Neal and Prof. Jim Freer. His focus is on the analysis of global flood models, an emerging field in the hydrological sciences, and he is using sensitivity analysis to understand how improvements to the current methodology. Having come from an engineering background, he is interested in making sure that his research will remain coherent and applicable outside of an academic setting.

Cain holds an MEng in Civil Engineering from Cardiff University and finished a training year at the University of Exeter's Centre for Water Systems with a first equivalent. Involvement with multiple NGO's active in Africa, continuing to work with another in South East Asia, and an ex committee member of Engineers without Borders (Cardiff) highlights he has a lasting interest in applying his skills from a developmental perspective.

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Key words: *Sensitivity Analysis, Uncertainty Analysis, Global flood modelling, Bayesian inference, Hydrological characterization*

39. *Towards the representation of groundwater in the joint UK Land Environment Simulator - Stamatis Batelis*

Supervised by: Dr Rafael Rosolem and Dr Shams Rahman

Land Surface Models (LSM) are based on physics principles and simulate the exchange of energy, water and biogeochemical cycles between the land surface and lower atmosphere. Such models are typically applied for climate studies or effects of land use changes but as the resolution of LSMs and supporting observations are continuously increasing, its representation of hydrological processes, such as the groundwater, need to be addressed adequately.

The representation of groundwater in LSMs is quite crude because they use a shallow soil column depth, about 3-5 metres, with a free drainage one-way flux at the bottom to represent groundwater. This simplistic representation can be applied only in shallow aquifers and not in areas with deeper groundwater aquifers. In these cases, models are unable to capture the interactions between the unsaturated zone and the water table that can regulate the surface runoff, the soil moisture and the evapotranspiration fluxes.

In this project, we apply, and we test a new groundwater representation scheme by coupling the recently-developed GW model by Rahman et al. (2019) with the JULES LSM. We hypothesize that the new scheme can model the baseflow component more accurately than the JULES Default does now. This can be very useful to test water management policies under climate scenarios in the future.

Stamatis is a PhD researcher in the water and environmental engineering group at University of Bristol.

Stamatis holds a Diploma (MEng) in Rural and Surveying Engineering (National Technical University of Athens, Greece) and a MSc, with distinction, in Science and Technology of Water Resources with specialization in Hydrology and water resources management (National Technical University of Athens, Greece). Also, he achieved a First Class grade from the Water Informatics Postgraduate School at the University of Exeter.

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Keywords: *Flood forecasting, Land Surface Models, Sensitivity Analysis, Groundwater*

40. *Real-Time Flood Forecasting Using Artificial Neural Networks - Laura Wignall*

Supervised by Prof Slobodan Djordjevic and Dr Albert Chen

This research intends to explore flood forecasting, initially focusing on possibilities for real-time flood forecasting in different contexts.

The Gandak River in Northern India was identified as an initial case study in order to contribute to an existing research project: 'Coupled Human and Natural Systems Environment (CHANSE) for water management under uncertainty in the Indo-Gangetic Plain (IGP). The aim for this case study is to establish a real-time flood forecasting model for a large catchment where the data availability is limited.

The River Gandak originates in the Nepal Himalaya, entering India at Triveni in the district of Bihar and eventually joining the River Ganges near Patna. The region is classified as highly flood-prone, and has one of the highest rural population densities in India. Additionally the area receives rainfall from both south-west and north-east monsoons, with between 1100–1500 mm/year. In order to overcome data limitations, alternative data driven methods have been used. A 1D hydrodynamic river model has been set up using DHI MIKE 11 software, and current focus is implementing a data-driven hydrological model to couple with the river model.

An Artificial Neural Network (ANN) Model has been used to map between a dataset of numeric inputs (precipitation) and a set of numeric targets (streamflow).
Once the ANN has been trained and fit to the data, it forms a generalisation of the input-output relationship. This can then be used to generate outputs for inputs that haven't been used in training.
A second ANN will then be used as a surrogate for the hydrodynamic model, in order to establish a more computationally efficient system suitable for real-time forecasts.

Laura Wignall is part of the Water Informatics, Science and Engineering PhD programme, and is currently based in the Centre for Water Systems at the University of Exeter.

Before moving to Exeter, Laura graduated from the University of Reading with a BSc (Hons) in Human and Physical and Geography. After several years living and working abroad, Laura returned to the UK to complete an MSc in Water and Environmental Management at the University of Brighton, graduating with a distinction. Her dissertation was titled "A critical evaluation of household level drinking water treatments promoted for use in emergency settings by the Red Cross".

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Key words: *Flood Forecasting, Flood Modelling, Hydrodynamic Modelling, Hydroinformatics, Artificial Neural Networks*

41. *Flood modelling and hazard assessment for extreme events in riverine basins – Giovanni Musolino*

Supervisors: Professor Roger Falconer and Dr. Reza Ahmadian

Natural hazards, such as flooding, can have a significant impact on people's lives and on sustainable development processes. Numerical models are used by engineers and planners; to understand, predict and assess the extent of flood events. However, those models need to be developed and adapted for different conditions, events and characteristics.

The main area of Giovanni's research is on numerical modelling. In detail, 2D and 1D/2D coupled flood modelling. The aim of his research will be to produce an improved, fully conservative 1D/2D coupled model that includes shock capturing algorithm (SCA), to predict hydrodynamic processes in river and estuarine water. In particular, where short steep catchments are drained.

Although 1D models are more suitable for predicting flood conditions in smaller rivers, which are more common in short steep catchments, for this kind of catchment a SCA is needed to have good and robust results. 1D models and 1D/2D coupled models require less resources in terms of computational time and power respect to 2D models. They are therefore more suitable for real time predictions and early warning systems that could be used to manage and assess the impact of flooding on short steep catchments. For floods generated in such topographic conditions, the flow is generally fast and destructive and it is crucial to have accurate predictions, with sufficient amount of time in advance, in order to assess the danger posed by such floods.

Giovanni is based at the Hydro Environmental Research Centre (HRC) at Cardiff University. The main area of his research is focused on numerical modelling, specifically 2D and 1D/2D coupled flood modelling. *At the same time, Giovanni's work is focus on flood risk assessment, especially on human instability in flooding water, evacuation plans and resilient flood alleviation schemes.*

Prior to the WISE programme, his academic background included a MSc in Analysis and Mitigation of Hydro-Geological Risk at University "Sapienza" of Rome, Italy. A MEng in Civil Engineering with specialization in Water, River and Coastal Engineering and a BEng in Civil Engineering both at University "Mediterranea" of Reggio Calabria, Italy.

Giovanni also has extensive experience working both in academia and industry. In academia as a Research Fellow at the University of Malta, where he was involved in a project regarding geophysical methods and measurement applied to the evaluation of the coastal cliff stability and the evaluation of site effects and soil structure resonance. He also worked as a Freelance Engineer for several different companies in Italy, in the sector of water and environmental engineering.
Outside of academia and industry, Giovanni has various interests, including: playing guitar, swimming, wildlife photography, trekking and cooking.

42. *Process-based flood frequency analysis using storm-tracking - Andy Barnes*

Supervised by: Dr. Thomas Kjeldsen and Dr. Ilaria Prosdocimi

Traditional flood frequency analysis is conducted by fitting simple statistical distributions to observations. However, this approach neglects that flood events are generated by different hydrological and atmospheric processes. Combining skills in hydrology, statistical extreme value analysis, and big-data analytics this project will develop a new process-based approach to flood frequency analysis through a novel combination of existing long-term flood flow observations with new open-source storm tracking systems. Using the HYSPLIT system, storm-tracks of historical events will be analysed to understand moisture sources and large-scale climate patterns associated with extreme floods. The outcome of this analysis will be a new set of flood typologies, such as, for example, atmospheric rivers or convective flash floods. Trends in the occurrence and magnitude of the different event-types will be investigated to assess climate change impacts. Finally, the different types of flood events will be combined into a single flood frequency framework using statistical mixture models.

Academic Background

Prior to WISE Andy gained a first-class honours degree in computer science from the University of Plymouth; his work focussed on computational neuroscience and artificial intelligence. During his final year Andy published his dissertation titled "*Genetic Optimisations for Satisfiability and Ramsey Theory*" which focussed on heuristic methods for solving the Satisfiability problem with and application to Ramsey Theory.

Industry Background

Andy has significant experience working as a software engineer in which he designed, built, tested and deployed enterprise scale cloud systems in various organisations including HM Land Registry and the BCS (British Computer Society). Throughout this experience Andy has successfully utilised a range of programmatic tools ranging from the languages Python, C, Java and C# to deployment and infrastructure tools such as Docker, AWS and Kubernetes. Further to this, Andy has gained a variety of experience teaching in both further and higher education, this experience has covered the following subjects: Hydraulics, Advanced Mathematics, Distributed Systems, Data Science and A-Level Computer Science.

Publications

Barnes, A., Santos, M., Carijo, C., Mediero, L., Prosdocimi, I., McCullen, N., Kjeldsen, T. (2019). *Identifying Origins of Extreme Rainfall using Trajectory Classification*. [Submitted]
Barnes, A. (2017). *Genetic Optimisations for Satisfiability and Ramsey Theory*. Plymouth Science Journal.
Barnes, A., Brake, C., Perry, T. (2016). *Digital Voting using Blockchain Technology*. The Economist.

Invited Talks

Big Data: Beyond the definitions. Workshop on Computational Resources in Research (03/2019).
Identifying the Origins of Extreme Rainfall using Trajectory Classification. CWPW 2019.

Contact: a.p.barnes@bath.ac.uk

Key Words: *Computational statistics, Extreme value analysis, Machine learning and big data.*

43. *Improving Estimates of Flood Magnitude using better Information on Spatial and Temporal Variability of Rainfall - Giulia Giani*

Supervisors: Dr Miguel Rico-Ramirez and Dr Ross Woods

Academics

Giulia is in her first year of the WISE programme here at Exeter and is looking to study at the University of Bristol in order to complete her research project. Prior to this, she graduated with an MSc (Hons) double degree in Environmental and Land Engineering from the Polytechnic University of Turin and the Polytechnic University of Milan in early 2017. As part of her MSc, Giulia spent 6 months at the University of Bristol working on her final dissertation project, which was titled: 'Improved flood estimation using hydrological process knowledge.'

Giulia's other academic achievements include:

- Italian professional qualification of Environmental Civil Engineering in September 2017 from the Polytechnic of Turin.
- Academic Diploma in "Alta Scuola Politecnica" from the Polytechnic University of Turin and the Polytechnic University of Milan in 2017. *Final group project*: 'DREAM-Drone technology for water resources and hydrologic hazard monitoring.'
- BSc in Environmental and Land Engineering from the Polytechnic University of Turin in 2014. *Final project*: 'Advantages and disadvantages of harvesting methods for microalgae cultured in open pond systems: experiments in flocculation with cationic starch.'

Work Experience

Most recently, Giulia undertook an internship at an engineering consultancy firm in Italy called SERTEC S.r.l. This role involved the verification of small hydraulic construction as well as flood risk and management. Furthermore, she also undertook a 2-month internship at ARPA Piemonte (Regional Environmental Agency) in Turin, within the Forecast System Department – Hydrology and Soil Effects. Here she was tasked with carrying out literature analyses regarding evaluation and verification methods related to hydrological risk forecasts, and the application of these methods to weather and flood bulletins published by the Piedmont Functional Centre.

Research Interests

- Hydrology
- Flood forecasting, in particular, the study of rainfall runoff process and dynamics

Email: gg16916@bristol.ac.uk

Postgraduate School Candidates: 2018-19 Cohort

Please note that these students have recently completed the Postgraduate School at Exeter, and are in the early stages of their PhD programmes. We have provided short CVs and a summary / bullet points in terms of research interests and project titles. Why not have a conversation and see whether your organization can become involved with their research projects?

44. *Artificial neural networks for the model predictive control of urban drainage networks & wastewater treatment plants - Ari Cooper-Davis*

Supervisors: Professors Slobodan Djordjevic and David Butler

Background

Ari graduated from the University of Exeter in 2018 with an MSci in Natural Sciences. During his degree he explored his academic interests in computer science, catchment hydrology, and environmental science. For his masters research project he worked with the Exeter Reflectance Transformation Imaging (RTI) Group as a computer scientist to improve the accuracy and efficiency of this novel 3D imaging technique.

Through outdoor pursuits such as surfing, kayaking, and caving, Ari has developed a keen interest in maintaining the quality of natural water resources. He intends to use his PhD to support these interests; by providing forecasts of discharge and pollutant load to wastewater treatment plants he hopes to reduce the frequency and severity of combined sewer overflows. Using powerful open source machine learning libraries combined with industry standard hydrodynamic catchment models he hopes to produce a real time control tool for exploitation in industry.

Research Interests

- Machine Learning & AI
- Factors effecting water quality
- Urban drainage and catchment hydrology
- Hydrodynamic modelling

Contact: asc223@exeter.ac.uk

45. *Assessment of past and future hazards and drivers of cliff erosion - Cristina Corti*

Supervisors: Dr Steven Palmer and Professor Akbar Javadi

Background

Cristina will undertake her WISE CDT PhD project at the University of Exeter with interests in coastal change and flood risk management, remote sensing, resilience to climate change and the application of new technologies.

She previously studied an MSc in Applied Marine Science at Plymouth University where her dissertation involved understanding how a change in the main wave approach angle over the past century caused beach rotation at Slapton Sands, Devon. Cristina also has a BSc in Environmental and Land Planning Engineering from Politecnico di Milano. Her BSc dissertation was entitled 'Geophysical surveys with the Ground Penetrating Radar at Palazzo Te (Mantua, Italy).'

Work Experience

Prior to joining the WISE CDT programme, Cristina spent a few years working as a Coastal Process Scientist at the Plymouth Coastal Observatory. This involved carrying out beach and coastal asset surveys with an RTK-GPS and Terrestrial Laser Scanner, as well as processing and analysing multiple data types such as topographic, LiDAR, bathymetric, aerial photography and wave data. Cristina was also involved in the development of the organisation's website. As a result, Cristina has developed a strong professional network with stakeholders from Academia, Industry and Local Authority, including the Environment Agency, which she hopes to be able to implement during the course of her PhD.

Research Interests

- Coastal change
- Flood risk management
- Resilience to climate change
- Remote sensing
- Prevention of natural disasters
- Development of new technologies

Contact: cc876@exeter.ac.uk

46. *Power enhancing features of tidal stream turbines – Ceri Howells*

Supervisors: Professors Shunqi Pan and Tim O'Doherty

Background

Ceri has undertaken both his undergraduate and postgraduate degrees at Cardiff University, graduating with an MSc in Sustainable Energy and Environment and a BEng in Integrated Engineering. His MSc thesis consisted of investigating and modelling the effects of power extraction, thrust and excessive loading on a near surface tidal turbines.

Throughout the postgraduate school Ceri has undertaken numerous postgraduate teaching assistant roles under the supervision of Dr. Corrina Cory. All of his roles were to assist the University of Exeter's project-based learning programme for undergraduate engineers. The programme encourages undergraduates to apply their knowledge acquired throughout their degree, to a real-world application, enhancing and improving their transferable skills and likelihood of employment upon leaving university. Ceri has also held virtual reality (VR) demonstrations throughout the year to promote and advertise the possibilities of VR within engineering to undergraduate and postgraduate students, as well as to visitors and partners of the university, resulting in him acquiring a stand at the Educational conference at the University of Exeter (EduExe) 2019.

Ceri will undertake his WISE CDT PhD project at Cardiff University, which is entitled "Analysis of Bi-directional ducted tidal stream turbines, operating near the surface" and will work in conjunction with Cardiff University's Marine Energy Research Group (CMERG) that is operated by Professor Tim O'Doherty and his team. Ceri's research will focus on increasing the power output from a tidal stream turbine by introducing power enhancing features as well as conducting a holistic sustainability report to determine his solutions impact on the economy, environment and society.

Research Interests

- Renewable energy
- Tidal stream turbines
- Low carbon technologies
- Environmental impact assessments

Contact: HowellsC8@Cardiff.ac.uk

47. *Microplastics in wastewaterisy – Daisy Harley-Nyang*

Supervisors: Professors Fayyaz Memon and Tamara Galloway

Background

Daisy graduated in April 2018 with an MSc in Water and Environmental Engineering from the University of Surrey, gaining a Distinction. Her dissertation involved carrying out sanitary hazard surveys and water quality testing of three different water supplies at a remote village in The Gambia. She also has a BSc in Geology and Geography from the University of Birmingham.

Work Experience

Between her studies, Daisy has worked as an Assistant Scientist at the National Laboratory Service in Starcross, Devon which involved the water quality testing of bathing water samples via micro-filtration. Most recently, she's worked as an Assistant Scientific Officer at the Animal and Plant Health Agency also in Starcross, which primarily involved diagnostic laboratory testing.

Daisy's WISE PhD project will be in collaboration with the UK Water Industry Research (UKWIR) and is themed 'Microplastics in Wastewater'.

Research Interests

- Geology/Hydrogeology
- Climate change
- Microbiology/bacteriology- specifically of water
- Small/private water supplies
- Wastewater treatment
- Environmental and public health

Contact: da383@exeter.ac.uk

48. *Identifying hydrological and environmental signatures from cosmic-ray soil moisture estimates - Dan Power*

Supervisors: Dr Rafael Rosolem and Dr Miguel Rico-Ramirez

Background

Dan graduated in 2017 from the University of Birmingham with an MSc in River Environments and their Management. His dissertation was entitled 'Climate Change in the Himalayas: Using a conceptual model to understand future impacts on Hydrological Drought in highly glaciated catchments.' Dan also has a BSc in Environmental Conservation from Sheffield Hallam University.

Between his degrees, Dan spent three years travelling in Europe, South East Asia, India, Nepal and Australia. This experience allowed Dan to encounter different people and cultures and has ultimately lead him to pursue a career in the Geosciences field, with a particular interest in hydrology.

Work Experience

Upon returning from travelling, Dan has worked as a Research Assistant at the University of Birmingham comparing catchment-scale observations and global-scale models in their ability to identify human influence on drought. Prior to joining the WISE CDT PhD Programme, he worked as a Data Quality Analyst at Bristol Water using data from the PR19 project.

Project

Dans project will attempt to improve our understanding of soil moisture dynamics and processes by using Cosmic Ray Neutron Sensor (CRNS) soil moisture estimates. This global scale dataset will be utilised to improve our understanding of soil moisture processes and to understand how it may be changing through human influence. It is anticipated that improved understanding will be practically useful in a multitude of areas including hydrological modelling, agricultural and ecological management, as well as other uses not yet recognised.

Research Interests

- Soil Moisture Dynamics
- Remote sensing
- Human influences on the environment
- Big Data Analytics
- Hydrological Modelling

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49. *Understanding and estimating uncertainty in Global Flood Risk Models - Georgios Sarailidis*

Supervisors: Dr Francesca Pianosi and Professor Thorsten Wagener

Background

Georgios graduated with an MSc in Management of Hydro-Meteorological Hazards – Hydrohazards from Universite Grenoble Alpes and the University of Thessaly in 2017. As part of his Erasmus Internship, Georgios worked on a research project entitled 'Analysis of Drought Variability in Sicily using SPI and SPEI drought indexes'. Prior to this he completed his MEng in Civil Engineering at the University of Thessaly. During this programme he worked on a research project entitled 'The quantification of the threshold level method on low flow studies.'

Work Experience

Before joining the WISE CDT PhD Programme, Georgios has worked as both a Meteorological Observer and a Hydrologist at the Regional Meteorological Centre in the Hellenic Air Force as part of his Greek Military Service. This project was entitled 'Statistical frequency analysis of extreme rainfall in Greece.' He has also gained a Diploma in Meteorology from his time in the Hellenic Air Force.

Research topic

My research will focus on understanding and estimating uncertainty in global flood risk models (GFRM). It is widely acknowledged that GFRMs are subject to many sources of uncertainty, including uncertainty in processes representation, model parameters and input data, the relative importance of which is not well understood. Currently, no evidence exists on which uncertain input factor mostly control the final uncertainty in predicted losses in different places and circumstances. The objective of this PhD thesis is to investigate the sources and implications of uncertainty in global flood risk models predictions, by pursuing the following tasks:

1. To develop an appropriate methodological approach for sensitivity analysis of a flood risk model, where input uncertainties can exhibit complex spatially-distributed and spatially-structured (correlated) patterns and vary significant between places.
2. To apply the method to a global flood risk model in order to analyse the relative importance of different input factors on flood losses predictions across a range of test regions with different physical and socio-economic characteristics.

Research Interests

- Hydrology
- Hydrological extremes
- Flood risk
- Hydrological modelling

Contact: g.sarailidis@bristol.ac.uk

50. *Underwater micro-gliders for autonomous lake inspection - James Rand*

Supervisors: Dr Alan Hunter, Dr Lee Bryant, Dr Andy Hillis and Dr Danielle Wain

Background

James is a Chartered Engineer with over twenty years of experience, at sea and ashore, as a Marine Engineer Officer in the Royal Navy (RN). This included Senior Engineering posts at the RN Marine Engineering School, Technical Advisor to Foreign Navies, Waterfront Representative for the UK Government to the Saudi Royal Navy, Sea-Going Engineering Head of Department (Chief Engineer) jobs, as well as various specialist technical postings.

After leaving the Royal Navy, James taught Mathematics at a secondary school in Southampton for several years before going self-employed as a jobbing builder and odd job man. Having decided he needs more of a challenge by returning to his engineering roots (and to update his technical knowledge especially in computing and informatics) James will be undertaking his WISE PhD project at the University of Bath.

His academic qualifications include an MSc in Mechanical Marine Engineering from University College London and a BEng in Mechanical Engineering from Portsmouth Polytechnic.

An active member of the IMarEST throughout his engineering career, James was instrumental in reforming the Benelux Branch of the IMarEST and was the branch chairman for several years whilst on a job Exchange with the Royal Netherlands Navy as their Gas Turbine Technical expert.

James will be undertaking his PhD research into the design, build and deployment of low cost, micro underwater gliders for use on extended duration data gathering and near real time monitoring missions. Initially, the micro glider will be aimed at gathering routine reservoir water quality data over weeks or months in a deploy and forget type arrangement. Other potential applications include pollution monitoring and source identification, investigating lake turn over and sediment contamination release, monitoring aeration and mixing effectiveness, reservoir taste and odour contaminant monitoring, military applications and long term environmental compliance monitoring (for example following mineral extraction).

Contact: M.J.Rand@bath.ac.uk

51. *Improving urban water security by sectorisation of the urban area and decentralization of water infrastructure - Juliana Marcal*

Supervisors: Professor Jan Hofman & Dr Junjie Shen; Professor David Butler (University of Exeter).

Background

Juliana graduated in 2015 with an MSc in Environment and Natural, Industrial and Urban Risks from the National Institute of Applied Sciences in Lyon, France. Prior to this, she undertook a double degree exchange programme in Civil Engineering between the University of Campinas, Brazil and Ecole Centrale de Nantes, France.

Work Experience

Before joining the WISE CDT PhD Programme, Juliana completed her undergraduate dissertation on the evaluation of a decentralized wastewater treatment system in Brazil. She has gained a range of experiences in industry working on the modelling of water supply networks and micro drainage projects. More recently, she has worked as a junior research engineer at Lhoist Business Innovation Centre in Belgium, on soil treatment techniques for hydraulic works.

As a WISE PhD candidate, Juliana will work on developing a tool to evaluate the sustainability of small-scale decentralized systems with case studies in developing countries.

Research Interests

- Water and wastewater treatment
- Water and sanitation in developing countries
- Water management
- Sustainable water systems

Contact: J.Marcal@bath.ac.uk

52. *Understanding the impacts of hydrological uncertainties on large scale flood-mapping in data sparse regions - Laura Devitt*

Supervisors: Dr. Jeff Neal, Prof. Thorsten Wagener, Dr. Gemma Coxon

Background

Laura completed her MScR at the University of Bristol in 2018. Her research project was titled 'Evaluation of a flexible hydrological modelling framework (DECIPHeR) in large and data scarce river basins: Upper Niger case study'. Prior to this she graduated with a BSc in Geography also from the University of Bristol. Her degree covered a large range of topics, however in her final year she chose a research project which focused on hydrological modelling uncertainty. Her dissertation was entitled 'Investigating model structural uncertainty using a two-dimensional evaluation criterion for extreme hydrological behaviour: Strom Desmond case study'.

Laura will undertake her PhD research project at the University of Bristol. Her project will aim to improve our understanding of the impacts of hydrological uncertainties on large scale flood-mapping, with a particular focus on data sparse regions. The main research objectives of her project are:
1) a review of flood estimation methodologies that are currently used within global flood modelling frameworks, and the implications of their differences on flood inundation predictions.
2) quantification and attribution of the uncertainties in global flood estimation, with a particular focus on data sparse regions.
3) integration of objective 1 and 2 to develop a new approach to the coupled flood estimation and inundation modelling problem assessed at the global scale.

Research Interests

- Large scale modelling in data scarce basins
- Making predictions in ungauged basins
- Hydrological modelling uncertainty
- Hydrological extremes
- Data visualisation

Contact: laura.devitt@bristol.ac.uk

53. *Multi-level inversion and uncertainty quantification for groundwater flow and transport modelling - Mikkel Bue Lykkegaard*

Supervisors: Dr David Moxey and Prof Timothy Dodwell

Mikkel is working with Dr David Moxey and Prof Timothy Dodwell on developing a faster and more accurate approach to inversion of the groundwater flow problem. State-of-the art multi-level Markov Chain Monte Carlo techniques are used in conjunction with the Spectral/hp Element Method to obtain accurate representations of the subsurface at minimal computational cost. Possible applications are groundwater resource management and pollution control and remediation.

Academic background

Bachelor of Engineering (Honours), Civil and Structural Engineering / Arctic Technology

Mikkel studied civil engineering at the Arctic Technology Centre in Sisimiut Greenland – a small research centre belonging to the Technical University of Denmark (DTU). The degree was concerned with engineering management and construction technology under the extreme conditions that remote settlements in the Arctic are facing.

Master of Science (Distinction), Environmental Science

After working as a construction technician (see below), Mikkel decided that he wanted more challenge and embarked on a programme in Environmental Science at the University of Aberdeen, where he discovered a passion for statistics and data analysis.

Work Experience

Mikkel worked as a construction technician for Ístak hf. at a major hydropower plant project in the mountains close to Brønnøysund, Norway, immediately after completing his Bachelor degree. The work consisted mainly of environmental management and quality control in the earthworks division of the company.

Research Interests

- environmental hydrology and hydroinformatics;
- uncertainty quantification and data analysis;
- groundwater flow and transport modelling;
- waste water processing and reactor kinetics; and
- the environmental fate of pollutants.

Contact: m.lykkegaard@exeter.ac.uk

54. *Near and Far Field Hydro-Environmental Modelling of Marine Renewable Energy Schemes - Nick Hanousek*

Supervisors: Dr Reza Ahmadian and Professor Roger Falconer

Background

Nick has recently graduated with an MEng in Civil Engineering from Cardiff University. His third year project analysed various tidal range power scheme options that have been proposed for the Severn estuary area using a 2D depth averaged numerical model.

Nick will continue to study at Cardiff University on his WISE PhD project.

Work Experience

As part of his degree, Nick undertook a year in industry at HR Wallingford where he worked within the coastal structures team; primarily building and testing physical models of coastal developments in 2D wave flume, and 3D wave basin models. He was also involved the official testing of flood protection products for the BSI Kitemark, and research testing of historic breakwaters. Nick also undertook work experience at Halcrow in Exeter which ultimately led to him pursue a career in civil engineering.

Research Interests

- Numerical and physical modelling of water
- Renewable energy
- Coastal structures

Contact: Hanousekn@Cardiff.ac.uk

55. *Composite beaches and dynamic revetments – coastal protection inspired by nature - Ollie Foss*

Supervisors: Dr Chris Blenkinsopp and Dr Jun Zang.

Background

Ollie is a recent Mathematics graduate; undertaking both his MSc and BSc degrees at Swansea University. His undergraduate dissertation was entitled 'Tidal Forces and the Earth-Moon System'.

He will now undertake his WISE PhD project at the University of Bath with interests in the numerical modelling of physical systems, in particular the effects of climate change on coastal erosion.

Ollie is also a keen rower having previously represented Swansea University and competed in the Welsh Indoors Rowing Championship.

Work Experience

During his Master's degree, Ollie worked as a Student Ambassador representing Swansea University at open days as well as other roles within the Mathematics department.

Research Interests

- Numerical modelling of physical systems
- Climate change
- Coastal erosion

Contact: O.Foss@bath.ac.uk

56. *Analysing the expression of climate change within big continental-scale short-duration rainfall datasets - Roberto Quaglia*

Supervised by: Dr Katerina Michaelides, Dr Rafael Rosolem and Dr Michael Singer

Background

Roberto completed the first year Postgraduate School at the University of Exeter, as part of the WISE CDT PhD programme, and he is now commencing his research at the University of Bristol. He previously graduated in early 2018 with a Master's degree in Environmental Engineering from the University of Bologna. His thesis project compared the performance of two different rainfall-runoff models over a large dataset of Austrian catchments, with a focus on the optimization algorithms used to perform the calibration procedure. Ultimately, this experience encouraged him to pursue further research in the theme of water engineering and hydroinformatics. Prior to this, Roberto received a Bachelor's degree in Environmental Engineering from the University of Trento.

Research Interests

- Precipitation extremes
- Climate Change
- Hydrological modelling

Contact: hm18903@bristol.ac.uk

57. *Investigating the influence of geologic bombs and reservoir management on biogeochemical cycling of trace metals and resultant water quality - Sally Pearl*

Supervisors: Dr Lee Bryant, Dr Thomas Kjeldsen and Dr Pedro Estrela

Background

Sally graduated in September 2017 with an MSc in Environmental Sciences from the University of East Anglia. Her dissertation was entitled 'Assessing the effectiveness for roadside sediment traps at mitigating sediment pollution in the River Wensum'. She also has a BSc in Marine Biology from Newcastle University.

Sally published a paper in the Journal of Environmental Management as a result of her MSc.

Cooper R. J., Battams Z. M., Pearl S. H. and Hiscock K. M. (2019). 'Mitigating river sediment enrichment through the construction of roadside wetlands'. *Journal of Environmental Management*, 231, pp. 146-154. doi:10.1016/j.jenvman.2018.10.035

Work Experience

Prior to joining the WISE CDT PhD Programme, Sally worked as a Marine and Coastal Adviser for Natural England. She has also previously worked in roles that focused on policy development, scientific research and land management, including several years in pharmaceutical development and time spent working on a wetland nature reserve.

Research Interests

- Water quality
- Riverine sediment pollution
- Wetlands as a pollution management tool
- Reservoir management

Contact: S.H.Pearl@bath.ac.uk

58. *Modelling of water resources and the hydro-environment in the Thames and Medway estuaries - Sam Rowley*

Supervisors: Professor Shunqi Pan and Dr Zhihua Xie

Background

Sam has recently graduated from Cardiff University with a BSc in Physics. His final year project was entitled 'Water Vortices 2 – The Ranque-Hilsch Effect in Water' and involved analysing heat flows in a variety of water vortices, using thermal imaging and computer analysis. He will continue to study at Cardiff University on his WISE PhD project.

Work Experience

During his undergraduate degree, Sam has juggled various jobs in the hospitality industry. In addition, he has undertaken various placements and internships in Physics and Aerospace Engineering with both The Ogden Trust and Nuffield Trust.

Research Interests

- Hydrodynamic modelling of estuaries

Contact: sjr241@exeter.ac.uk

59. *Numerical modelling of turbulent interfacial flows and fluid-structure interaction - Santiago Martelo Lopez*

Supervisors: Dr Zhihua Xie and Professor Shunqi Pan

Background

Santi is a Naval Architect and Ocean Engineer and has graduated with a Masters degree in Industrial Mathematics. As a student he underwent internships at the Astican Shipyard and the Hydraulics Institute of Cantabria, where he acquired experience working as a Junior Engineer in repair and conversion of oceangoing ships and offshore structures, as well as R&D projects with FEM/CFD software and other numerical methods for modelling hydro-mechanics of marine renewable devices.

A key aspect of his PhD project is improving efficiency and developing simulation technologies in CFD software packages for modelling turbulent flows, waves, wind and current effects on both fixed and floating offshore structures; for instance, adaptive mesh and turbulence models; Immersed Boundary and Galerkin Discontinuous methods. Among practical case studies where to apply the skills gained during his PhD are ensuring reliability when designing marine artefacts, checking what key systems may be prone to failure due to structural loading from wind and waves, increasing operational time of crane vessels, floating platforms for wind turbines, TEC (Tidal Energy Converters) and WEC (Wave Energy Converters) units under rough weather conditions.

Overall goals

- Increase accuracy and reliability of marine structures simulations.
- Decrease computational time of CFD numerical methods.
- Provide a competitive tool in Hidro3D for integral design of acquaculture and marine renewable energy structures.

Research Interests

- Applications of artificial neural networks to CFD simulations.
- Performing multi-body simulations for studying the interaction between floating artefacts.
- Optimisation methods and integral design of floating platforms for marine renewables.
- Scouring effects around supports of heavy lift vessels for the installation of wind turbines.
- Assessing performance of floating cages of offshore aquaculture.
- Development of neutrally buoyant underwater oceanic turbines.

Contact: sl753@exeter.ac.uk

60. *Optimisation of deep-water offshore wind energy systems - Vivien Maertens*

Supervisors: Dr Jun Zang, Dr Chris Blenkinsopp, and Prof Paul Milewski

Background

Vivien will undertake her WISE CDT PhD project at the University of Bath with interests in hydro-renewable energies. She graduated in 2017 with an MSc in Modern Applications of Mathematics with a Distinction, also from the University of Bath. Her dissertation was entitled 'Optimising the power output of wave energy converters' which was conducted in collaboration with Quintessa Ltd. Vivien also has a BSc (Hons) in Mathematics with Advanced Proficiency in French from the University of Exeter.

In her free time, she has also been active volunteer of The Cinnamon Trust.

Research Interests

- Fluid dynamics
- Hydro-renewable energies
- Numerical modelling

Contact: vm423@bath.ac.uk

61. *An investigation of the accumulation and movement of pathogens and pollutants associated with flood waters in an urban environment - Will Addison-Atkinson*

Supervisors: Dr Albert Chen and Professor Fayyaz Memon

Background

Will has recently graduated with an MSc in Water: Science and Governance from King's College London. His dissertation investigated the impact of the Syrian Civil War on drought. Prior to this he completed his Bachelors degree in Environmental Management from Kingston University London.

Will has also travelled extensively, particularly throughout Africa and Asia. These experiences, along with his studies, have ultimately led him to pursue a career in water management with a particular focus on the UK and developing countries in Africa. Will is now undertaking his WISE PhD project at the University of Exeter.

Work Experience

Prior to undertaking his degrees, Will worked in various roles including as a: Sustainability Intern for numerous companies, Volunteer Environment & Development Worker in Western Zimbabwe and Distillation Plant Operator for Highlands Natural Products Ltd in Inverness Scotland.

Research Interests

- Hydrological modelling
- Geographical information systems
- Water quality
- Flood risk assessment and management

Contact: wa259@exeter.ac.uk

Cohort 1 – The Graduating Class

We have also provided profiles of Cohort 1, our first intake, who have graduated / are graduating with their PhDs. Some of this group already have jobs, but others may still be looking.

62. *Simulating the risk of Liver Fluke infection in the UK through integrated mechanistic hydrological-epidemological modelling – Ludovica Beltrame*

Supervised by Prof Thorsten Wagener and Prof Eric Morgan

Liver fluke (Fasciola hepatica) is a widespread parasite of livestock causing disease and production losses costing the farming industry approximately $3bn per year, globally. Risk of infection is strongly influenced by climatic and hydrologic conditions, as large part of the parasite life-cycle takes place in the environment, outside of the host. Despite on-going control efforts, increases in disease prevalence have been reported in recent years in the UK, which have been often attributed to climate change. Currently used liver fluke risk forecasting models are based on empirical relationships derived between historical climate and prevalence data. However, our environment is becoming increasingly non-stationary due to climate change and direct human activities, making these models unlikely to be robust for simulating future risk. Moreover, empirical models do not allow for what-if analyses, which are valuable for disease management decision support.

In this project, we developed a new mechanistic hydro-epidemiological model, which simulates the risk of liver fluke disease in connection with key hydro-climate conditions, and we tested it over two case study catchments employing different datasets, including data from regional vet labs. Current work involves, first, using the new model, together with sensitivity analysis tools, as a formal framework to guide farmers' mitigation or adaptation measures, based on understanding of the causes of disease and accounting for uncertainties. Secondly, applying the model at the national scale to investigate the role of hydro-environmental processes and landscape characteristics in mediating climate change impacts on future risk of infection across the UK. This will be crucial to help targeting active disease surveillance and prioritising intervention.

Ludovica is part of the Water and Environmental Engineering group at the University of Bristol, where her work lies at the interface between hydrological processes and infectious disease. Before joining the WISE CDT in 2014, she worked 4 months for a management consulting firm in Milan (Italy) as a risk and compliance intern. In 2013, she spent 5 months as a visiting student at the Singapore University of Technology and Design, working at her MSc dissertation, which focused on investigating the effects of El Niño Southern Oscillation on catchment-scale hydrology to develop seasonal streamflow forecasts. She received a first class grade in Water Informatics through the WISE CDT postgraduate school and holds a BSc and MSc (cum laude) in Environmental Engineering from Politecnico di Milano, Italy.

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Keywords: *hydro-epidemiology, integrated mechanistic modelling, global environmental change*

63. *Assessment and mitigation of storm runoff loads from an informal settlement - Olivia Cooke*

Supervised by Dr Lee Bryant[1], Dr Thomas Kjeldsen[1] and Prof Wesaal Khan[2]

[1] University of Bath, UK; [2] Stellenbosch University, South Africa

One of the biggest global health problems today is that posed by urban conditions, most significantly in developing countries, where informal settlements are prevalent. Within informal settlements, the lack of infrastructure including sanitation and sewage facilities, can generate serious problems for health and the environment. Contaminated water is one such problem which can lead to major health issues, most significantly diarrhoea and diarrhoeal diseases, with 1.7bn cases of diarrhoeal disease every year where 88% of these cases are the result of water contamination. Stormwater runoff is a major influence in water pollution as it impacts the mobilisation and transport of pathogens and chemicals and it is necessary to understand the processes and characteristics of runoff to mitigate the risks from it. The aim of this PhD is to investigate how stormwater runoff, both quality and quantity, in informal settlements is influenced by anthropogenic and environmental factors and to understand the links between hydrology, geochemistry and microbiology in a peri-urban informal settlement. This research is based in Enkanini, an informal settlement near Stellenbosch, South Africa. During the first fieldwork season in 2016, 5 sample sites were identified and sampled, whilst during the second fieldwork season in 2017, 7 sample sites were identified and sampled within Enkanini informal settlement. The process of identification of the sample sites within the informal settlement was done through QGIS analysis. To measure water quantity, a tipping bucket rain gauge was installed within the settlement, along with other hydrology measurements being undertaken. To examine water quality, water samples were collected, with subsequent analysis to examine microbial and chemical parameters. Microbial analysis includes indicator organisms, DNA extraction and Polymerase Chain Reaction analysis, whilst chemical analysis includes ICP-AES (Inductively coupled plasma atomic emission spectroscopy) and ICPMS (Inductively coupled plasma mass spectrometry) analysis. This research was performed in collaboration between the University of Bath and its international partner Stellenbosch University.

Olivia is a PhD Student on the WISE CDT based at the University of Bath in the Department of Architecture and Civil Engineering. She is part of both the Water, Environment and Infrastructure Resilience (WEIR) research group and the Water Innovation and Research Centre (WIRC). Olivia studied Geography at Aberystwyth University and gained a First Class (Honours) BSc. During her third year, Olivia studied for a term at UNIS (University Centre in Svalbard) in the Arctic. Her post-graduate study was a Master of Research in The Science of Natural Hazards at the University of Bristol. Fieldwork included studying the natural hazards in Guatemala, followed by research in Ecuador for her dissertation on volcano risk at Cotopaxi Volcano. Since graduating from Bristol, she has gained further experience by working on a multi-disciplinary research project in Naples, looking at volcanic deposits and four months spent as a Research Assistant at the Centre of Exchange and Research in Volcanology at the University of Colima, Mexico undertaking data collection, analysis and report writing on a number of volcanoes in the region. During her PhD Olivia lived in Stellenbosch in South Africa in 2016 and 2017 for a total of 8 months and worked collecting data in Enkanini informal settlement, whilst based at Stellenbosch University in the Microbiology Department. Olivia contributed to a review paper written by Philip Collender and Professor Justin Remais at University of California, Berkeley, on modelling microbial transport and fate during flood events which was published in 2016. Currently Olivia is working on two further papers on results from her thesis research.

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Keywords: *Water quality & quantity, pathogen transport, stormwater runoff, informal settlement*

64. *Uncertainty in modelling and optimising operations of reseroir systems – Dr Barnaby Dobson*

Supervised by Dr Francesca Pianosi and Prof Thorsten Wagener

There are more than 33,000 large reservoirs in the world that have been constructed to supply water for domestic, industrial, energy generation, flood control and agricultural needs. However, many of these reservoirs do not come close to delivering the benefits that were envisaged during their design. One explanation for this is that the reservoirs are not managed and operated as effectively as they could be. Therefore, it is common for researchers to create computational models of reservoir systems that water managers could use to improve the operation and management of dams. These models enable the reservoir operators to anticipate how different decisions would affect the objectives that they aim to fulfil. In research it is also common to apply mathematical techniques (optimisation) to determine which decisions will be the most effective, however this is not yet common in practice. The first piece of work in Barney's PhD was a review of the existing reservoir operation optimisation literature, which has been published in Advances in Water Resources – detailed below.
Barney then performed a survey of water managers about how they operate their reservoir systems to identify barriers of uptake for reservoir operation optimisation methods. He found that a key reason that they do not use optimisation is that they do not trust the models that represent their reservoir systems. Consequently, the remainder of the work in his thesis focused on the assumptions required to create models of reservoir systems. To test these assumptions, he created a model of a reservoir system in the UK that is operated by two water companies. He found that the most important modelling assumption is how much the two companies coordinate their decisions. If the companies do not represent each other in their simulation models, then the outputs of optimisation (for example, estimates about the cost of pumping) will be very variable (with differences of up to £200/day in our case study, about 25% of the total pump cost). Another important modelling assumption identified was around how to represent the reservoir inflows statistically (where small changes can impact estimates of the amount of water to be supplied by external sources by 2 megalitres/day). Barney hopes the methods created in his thesis will give reservoir operators greater confidence that the outputs of optimisation will be beneficial when applied to real systems and not just in the models used to demonstrate them on.

Barney graduated his PhD with no corrections in 2019 and is currently working at the School of Geography in the Environment Change Institute at the University of Oxford. He is working on national scale water resource supply modelling in collaboration with the Environment Agency.

Publications:
- Dobson, Barnaby; Wagener, Thorsten; Pianosi, Francesca; How important are model structural and contextual uncertainties when estimating the optimized performance of water resource systems?; Water Resources Research; 2019
- Dobson, Barnaby; Wagener, Thorsten; Pianosi, Francesca; An argument-driven classification and comparison of reservoir operation optimization methods; Advances in Water Resources; 2019
- Dobson, Barnaby A; Miles-Wilson, Jolyon J; Gilchrist, Iain D; Leslie, David S; Wagener, Thorsten; Effects of flood hazard visualization format on house purchasing decisions; Urban Water Journal; 2018

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Keywords: *reservoir operation optimization; water resources modelling; uncertainty*

65. *Regional Flood Models and Digital Elevation Model (DEM) Uncertainty – Dr Laurence Hawker*

Supervised by Professor Paul Bates & Dr Jeffrey Neal

Hydrodynamic models are a key tool in delineating flood hazard but need data to drive them. For many parts of the world, high-quality data at a high-resolution does not exists. Data-scarcity is partially characterised by a lack of high-resolution (<30m) topographic data, with elevation data previously shown to be a key control on the propagation of a flood. The thesis first investigated the ability of an intermediate scale (270-1000m) hydrodynamic model to estimate flooding in a large river delta (Mekong). Results demonstrated that uncertainty in topography from a global Digital Elevation Models (DEM) had a large influence on flood predictions. However, current flood modelling studies where global DEMs are the best source of topographic information are characterised by only a single DEM being used that leads to spuriously precise flood predictions. To overcome this challenge, a geostatistical technique was developed to simulate plausible versions of the SRTM and MERIT DEMs in floodplain locations. By using an ensemble of simulated DEMs, probabilistic flood hazard maps could be produced. Moreover, a novel method to quantify river-floodplain connectivity across scales and DEM products, with the quantification of river-floodplain connectivity shown to be a useful indicator of the appropriateness of a DEM to be used in a hydrodynamic model.

Laurence is currently a Research Associate at the University of Bristol. He is currently involved in two projects:

HYFLOOD - Next Generation Flood Hazard Mapping for the African Continent at hyper-resolution
This NERC SHEAR Catalyst project aims to develop a hyper-resolution (90m) flood inundation model of the African continent with river bathymetry calibrated with a novel technique. The project focuses on the Congo Basin, with collaboration with the Congo Basin Water Resources Research Centre (CRREBaC) at the University of Kinshasa, DR Congo. Produced flood forecast exposure estimates in collaboration with the University of Reading and ECWMF for a rapid response situation for cyclones Idai and Kenneth in Mozambique.

An Interdisciplinary Approach to Understanding Past, Present and Future Flood Risk in Vietnam
Laurence will build a hyper-resolution flood inundation model of the Central Highlands in Vietnam as part of an interdisciplinary project that will use household surveys and remote sensing to assess socio-economic dynamics and their relation to flooding. This project is funded under the NERC Hydrometeorological Hazards in South East Asia programme.

Keywords: DEMs; Hydrodynamic Modelling; LISFLOOD FP; Flood; Floodplain Connectivity; Topographic Uncertainty; Simulating DEMs; Dissemination

Hawker, L., Bates, P. D., Neal, J. C. & Rougier, J. (2018). Perspectives on Digital Elevation Model (DEM) Simulation for Flood Modeling in the Absence of a High-Accuracy Open Access Global DEM. *Frontiers in Earth Science*, *6*(233). doi:10.3389/feart.2018.00233
Hawker, L., Rougier, J., Neal, J. C., Bates, P. D., Archer, L. & Yamazaki, D. (2018).Implications of Simulating Global Digital Elevation Models for Flood Inundation Studies. *Water Resources Research*, *54*. doi:10.1029/2018WR023279

66. *Investigation and prediction of pollution in coastal and estuarine waters, using experimental and numerical methods - Jonathan King MEng GMICE*

Supervised by Dr Reza Ahmadian and Professor Roger Falconer

As a result of the EU revised Bathing Water Directive (2006/7/EC) a new, and more stringent, water quality classification system for bathing waters was introduced in November 2015. In order to ensure these targets are met it is important to understand the processes that determine the concentration of certain indicator organisms used to determine compliance, including, in particular, intestinal enterococci and Escherichia coli. This will also enable the study of specific events to predict compliance or failure of bathing waters under a range of scenarios and the likelihood of bather infection.

Keywords: *Water quality, bathing water directive, bacterial transport, faecal indicator organisms, TELEMAC, numerical modelling*

Conference proceedings: *Jonathan King, Reza Ahmadian, Amyrhul Abu Bakar, Roger A. Falconer. Modelling the impact of microbial sources on water quality: A study on the designated sampling point in Swansea Bay, UK. 36th IAHR World Congress. Kuala Lumpur, Malaysia. 2017*

Jonathan was awarded is PhD from the Hydro-environmental Research Centre at Cardiff University in June 2019 and is now completing final minor corrections. He is a graduate member of the Institution of Civil Engineers (ICE) and formerly the president of the International Association of Hydro-environment Engineering and Research (IAHR) Young Professionals Network (YPN) Cardiff.

Since October 2018 he has been working for JBA Consulting as a civil engineer and hydraulic modeller on a range of projects throughout Wales, focussing on fluvial and coastal flooding.

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67. *Modelling the impact of marine renewable energy structures and devices on flood risk and water quality - Nejc Coz*

Supervisors: Professor Roger A. Falconer and Dr Reza Ahmadian

With increasing demand for renewable energy sources the potential for marine renewable energy production is attracting much interest in many parts of the world. The exceptional tidal range of the Severn Estuary in the UK presents a major source of renewable energy. In the past decade much research has been undertaken on harvesting this power. There have been a number of proposals for power generation structures, including: the Severn Barrage, Newport and Cardiff lagoons and Swansea Bay Lagoon. The sheer size of these projects will have a large scale impact on the environment. Therefore it is crucial to have an in-depth understanding of the challenges before any of the projects comes to life. One of the primary focus points are the near and far-field effects on the tidal range as the receding intertidal mudflats and marshlands have a direct impact on the estuarine wildlife. Changes in the tidal range can also significantly affect the level of flood protection and efficient power production. Because of a very high nutrient load, any significant change in the flow velocity and concentration of suspended sediments could make the estuary more susceptible to eutrophication.

Nejc is based at the Hydro-environmental Research Centre (HRC) at Cardiff University. His research is based on studying the impacts of extracting marine renewable energy, with a particular focus on the Severn Barrage and lagoons in Severn Estuary. In the past decade or so the HRC has done much research in this field and Nejc is now building on the work done by his predecessors. To assess the environmental impacts of the structures on the estuarine environment he is using an open-sourced CFD model, namely Delft3D. This model was developed by Deltares in the Netherlands. The integral part of his research focuses on the near and far-field effects of structures on the tidal range, flood risk – both up and downstream of these structures - and any changes in water quality.

Before joining the WISE CDT programme, Nejc did his undergraduate degree at the University of Ljubljana, Slovenia. He graduated in Civil Engineering, with a thesis on dam-break flow analysis of four embankment dams in Slovenia, using simplified computer models. In 2010 he spent a summer as an intern at the Slovenian Environment Agency, in the Hydrometry office, where he was involved in testing the measuring equipment and collecting and analysing data from observation stations.

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Keywords: *hydraulic structures, Severn Barrage, lagoons, marine renewable energy, tidal power, Delft3D.*

68. *Investigating conceptual model structure uncertainty: Progress in large-scale sample hydrology – Dr Wouter Knoben*

Supervised by Dr Ross Woods and Prof. Jim Freer

The main goal of this work is improving the hydrologic community's ability to perform large-sample model comparison studies. This started with investigating the global hydro-climate, so that we might quantify how representative any given sample of catchment types is. This resulted in a new hydrological climate classification and an overview of where regions with two rainfall seasons can be found globally. We followed this with a detailed investigation of conceptual model structures and the development of a novel model comparison coding framework. This modelling framework is extensively documented and available as open-source code. We then used this framework for a large-sample model comparison study which led to new insights about the differences between model structures and therefore can inform future model development work.

Before starting work towards a PhD at the University of Bristol, Wouter obtained a BSc in Civil Engineering and an MSc in Water Engineering & Management from the University of Twente, Netherlands. Both his Bachelor's and Master's thesis have been well-received, the first being in co-operation with the Dutch engineering consultancy firm HKV Lijn in Water (flood safety of the Dutch river delta) and the second in co-operation with the Polish Institute of Geophysics (making a hydrological model climate-change proof). He has been active as a student representative within the WISE programme, for the American Geophysical Union Hydrology Section Student Subcommittee, and for the Young hydrologic Society which focuses on early career scientists. Wouter's work has been presented on various global conferences and he has been actively involved in organizing sessions and workshops during these conferences. He has given several invited seminars and an invited workshop based on his PhD outcomes. He also spent 3 months at the University of Melbourne (AUS) for a scientific collaboration with Dr Murray Peel and Dr Keirnan Fowler. This has resulted in one accepted publication and another one currently being prepared. Wouter has worked several years as a waiter and briefly as a data specialist for a yoghurt factory. He likes free yoghurt, board games, sports and cooking. He dislikes disorganized travel and Brussels sprouts.

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Key words: *hydrology, conceptual models, model structure uncertainty, climate classification, catchment characteristics*

Publications:

Knoben, W. J. M., Woods, R. A., & Freer, J. E. (2018). A quantitative hydrological climate classification evaluated with independent streamflow data. Water Resources Research, 54, doi:10.1029/2018WR022913

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Knoben, W. J. M., Freer, J. E., Fowler, K. J. A., Peel, M. C. and Woods, R. A. (accepted): Modular Assessment of Rainfall-Runoff Models Toolbox (MARRMoT) v1.2: an open- source, extendable framework providing implementations of 46 conceptual hydrologic models as continuous space-state formulations. Geoscientific Model Development, doi:10.5194/gmd-2018-332

69. *An investigation of the biomass potential from livestock waste and its viability in anaerobic digestion plants in the UK – Dr Mariano Marinari*

Supervised by Dr. Tom Arnot and Prof. Marcelle McManus

The research investigates the current utilization of livestock waste arising from manures, slurries and crop-based feedstocks via Anaerobic Digestion (AD) in England with a focus on the quantification of the technical biomass resource potential and the economics. The technical potential refers to slurries and manures that are stored and not immediately spread to land, hence available to use in AD systems. A GIS tool has been developed that evaluates the availability of livestock waste and compare it with the actual utilisation of manures by operational biogas plants to quantify the latent biogas potential from unused livestock. The GIS tool was applied to a region in the South West of England in order to analyse the impact of policies setting out minimum target of 25% and 50% utilization of the biomass technical potential in AD plants.

An Excel-based biogas calculator has been developed that enables economic assessment of on farm AD projects. Operational and financial data has been gathered via interviews and questionnaire from eight case studies representative of on farm biogas installations utilizing agricultural feedstocks. This dataset has been used to evaluate the predictions of the biogas calculator and estimate the four parameters of the underlying first order kinetic model via non-linear curve fitting in Matlab.

Across England there are approximately 29 million tonnes of manures and slurries per annum that could be used to feed anaerobic digestion systems. Only about 5% of this potential is utilized. An additional 32.7M GJ year^{-1} of renewable energy could be generated as biogas if the unutilised 95% of agri-biosolids was used as feedstock in AD systems. In the region examined 40 additional AD plants with capacities ranging between 100 to 198 kWel and 131 additional AD plants with capacities ranging between 61 to 190 kWel are needed if the policy target of respectively 25% and 50% of total biomass potential from livestock waste are to be met. This confirms that manures and slurries are underutilized substrates for anaerobic digestion and there is still considerable potential for further development in England. This study also lays the foundation for the creation of a fully integrated biomass resources management tool.

Mariano graduated in Environmental Engineering in Italy. After graduation, he started his career in the Renewable Energy Industry to look at the Environmental Impact Assessments of mini hydro power plants. He moved to the solar industry, first as designer of domestic scale medium-large scale as well as on ground photovoltaic systems and then as Managing Officer in a consultancy delivering small medium and large size photovoltaic systems. He then spent five months for an internship at Wagner Solar UK Ltd in the UK to learn solar thermal technologies and programming skills by developing an Excel based tool in Visual Basic for Application to make commercial quotations of solar systems. In Glasgow, he achieved his Master by Research in Contaminated Land and then moved to Exeter as a PhD candidate in the WISE CDT. He studied biomass resources the achieved a PhD from Chemical Engineering at the University of Bath is now based in the Department of Chemical Engineering of the University of Bath to explore the potential of anaerobic digestion of livestock manure as a measure to mitigate eutrophication of surface waters due to nutrients run-off from agricultural land. In February 2019 he moved back to Italy and since then he has worked in secondary schools as Maths teacher.

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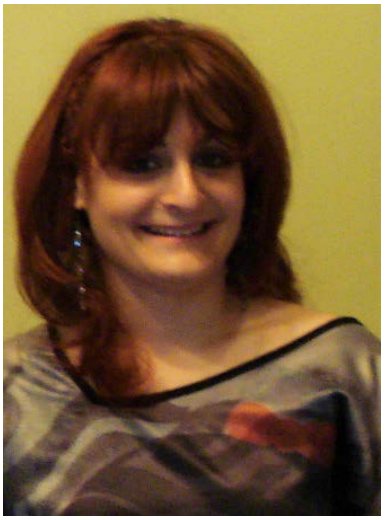
Keywords: *Anaerobic Digestion, Livestock Manure, Bio-energy, Circular Economy*



70. *The effect of small-scale turbulence on plume dynamics - Elli Mitrou*

Supervised by Professor Thorsten Stoesser and Dr. Bettina Bockelmann-Evans

The mixing and transport properties of bubble plumes make them an interesting and unique component of environmental and engineering systems. Bubble plumes have important practical applications in industrial, environmental and ocean engineering techniques and devices, such as nuclear reactors, destratification and aeration of lakes or reservoirs, injection of CO2 in the deep ocean and/or the prediction of gas release from accidental well blow-outs or from natural vents.

The major difficulty in predicting multiphase turbulence is the wide range of length and time scales on which turbulent mixing occurs. Understanding the dynamic interactions among the dispersed and continuous phase in bubbly flows in order to predict more accurately the transport of mass, momentum and heat for diverse engineering and environmental applications is required. Consequently, an integrated approach of the physical mechanisms of turbulent energy dissipation and transport by small-scale bubbles in a bubble plume is required. Most Computational Fluid Dynamics models have difficulties solving and/or modelling this small scale turbulence, either because of the model initial assumptions or the tremendously high computational cost. A novel application of computational methodology, which is expected to provide a good compromise between accuracy and computational performance, will be developed.

Elli is based at Hydro-environmental Research Centre at Cardiff University. Elli's research focuses on bubble plume dynamics. Building on previous work conducted at Cardiff University, a more sophisticated large-eddy simulation model is developed in order to predict improved results compared to previous approaches and reproduce all the turbulence generated at the bubble scale.

Before joining the Hydro-environmental Research Centre, Elli worked as project engineer at the construction of Sewerage, Wastewater Treatment Plant & Sewage Pumping Station of Orchomenos village in Greece. Elli holds a Diploma in Civil Engineering (University of Patras, Greece) and a MSc in Science and Technology of Water Resources with specialization in Coastal Zone Management (NTUA, Greece).

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Keywords: *Bubbly flows, Small-scale turbulence, LES, Hydro3D*

71. *Automatic analysis of faults in sewer networks using CCTV footage – Dr Joshua Myrans*

Supervised by Professor Zoran Kapelan & Professor Richard Everson

Sewer networks require regular inspection to prioritise maintenance and repairs. As most pipes are too small manual inspection, surveys are performed using CCTV footage. These surveys require a camera to travel the length of the pipe, enabling the collected footage to be analysed by a qualified engineer. This process is costly, time consuming and highly subjective. A system capable of automatically detecting faults, using only the raw CCTV footage would dramatically reduce time and costs of such surveys.

The developed methodology analyses collected footage frame by frame in order to extract segments of footage containing a fault. Once identified a faults are further classified according to the industry standard WRc guidelines. This process of automation dramatically reduces the volume of footage a surveyor is required to inspect. Furthermore, by it's very nature, this automated process reduces annotation subjectivity common among human operators.

Josh is currently continuing the development of his PhD in the form of a Knowledge Transfer Partnership (KTP) between South West Water and Exeter University. This project aims to bring the developed methodology to life, building it into a functional tool, useful for surveyors across the water industry. Outside of his project, Josh's areas of interest include machine learning, image processing and optimisation, focussing on the application of all three to real world problems.

Before his PhD Josh completed his BSc in Computer Science and Mathematics at the University of Exeter, and continued to expand his studies in the Water Informatics Postgraduate School.

Publications:
Google Scholar: https://scholar.google.co.uk/citations?user=X0UER-kAAAAJ&hl=en&oi=ao
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Keywords: Sewers, Machine Learning, Image Processing, CCTV, Automation

72. *Advanced hydraulic modelling for flood risk analysis – Ioanna Stamataki*

Supervised by Dr Jun Zang, Dr Thomas Kjeldsen and Dr Eugeny Buldakov

In this research, flash floods are of particular interest as they are a destructive natural hazard with one of the highest mortalities. They remain a global problem and due to their dynamic nature combined with their limited spatial and temporal scales, observation and accurate modelling of these events continues to be a challenge.

Inspired by the 2004 Boscastle flash flood, experimental work was undertaken in a hydraulic flume at University College London modelling a simplified case of the event offering physical understanding of flash floods and their impact and providing a dataset for computer model validations of extreme events. A dam break experiment was therefore carried out on a sloped channel. Model buildings were positioned downstream on the floodplain constituting different urban settlements and creating different obstructions to the flow. The flume was instrumented measuring different parameters and the experiments were repeated for different urban settlements, flood intensities and roughness layers (vegetated and non-vegetated slope). The experiment provided high quality dataset for the calibration of numerical models and provided understanding of the interaction of flash floods with the built environment.

Whilst exploring different methods used to model extreme events such as flash floods, the experimental set-up was replicated numerically using an open-source software OpenFOAM. The experimental results were compared with theoretical processes and 2D/3D numerical results obtained using OpenFOAM's RAS turbulent model providing a unique possibility to model efficiently and robustly flood simulations whilst taking into account the three-dimensionality of the event.

This provides an inclusive understanding of such events and such understanding can help not only providing predictions of water pathways but also offering design and policy recommendations for safe design of buildings in high-risk areas.

Ioanna Stamataki is a PhD student in the Civil Engineering Department of the University of Bath and is part of the WISE CDT and the WEIR and WIRC Research Groups. She received her Civil Engineering degree (MEng Civil Engineering) from the University of Bath, in 2014, and during her degree, she completed a dissertation on a hydraulics based project involving the study of flow over complex weirs such as Pulteney Weir in Bath. In 2014 Ioanna delivered and published her first conference paper entitled "Study of flow over weirs such as Pulteney Weir" at the 11th ICHE conference in Hamburg.

A summer placement with Edenvale Young Associates who specialise in the fluvial and maritime environment ensured her interest in hydraulics and modelling. The work included hydraulic modelling projects, design of river protection works, flood forecasting schemes, flooding probability and flood risk assessments.

Her main research interests are the analysis and modelling of flash floods through laboratory experiments and CFD modelling.

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Keywords: *Hydraulic modelling, Flash floods, Flood risk analysis, Physical model, Experimental data, Urban flood, Extreme events, Structure interaction, Computer model validation*

73. *Application of fast option screening for surface water flood management – Dr James Webber*

Supervised by: Professor David Butler and Dr Guangtao Fu

Surface water flooding in urban areas has become a pressing issue due to changing precipitation patterns, expanding urban areas and aging drainage infrastructure. Floods can be managed using a large range of strategies (conveyance upgrades, SuDS, green infrastructure, property level protection, flood resilience, etc), however option selection is computationally demanding and time consuming, leading to a lack of evidence for decision support.

A new framework for fast analysis of surface water flood management has been developed. The benefits of fast screening include analysing hundreds of options at an early stage of strategic design and evaluating performance across a wide range of design standard and resilience based 'extreme' scenarios. Assessing many options enhances the evidence available for decision support and includes novel management strategies within design. Work is being developed in collaboration with various partners, including: the University of Melbourne, University of Stanford, City of Melbourne Council, Melbourne Water, Arcadis and Water Technology.

James is based across the Centre for Water Systems and the Land, Environment, Economics and Policy Institute at the University of Exeter. His research focuses on regional surface water management and building resilience to extreme events. He has developed a rapid framework for assessing flood management strategies and has applied this to academic, industry and government case studies in the UK, US and Australia.

Before joining the university, James worked within an engineering consultancy in the fields of asset management, flood risk management and urban water planning. During his time in consultancy James developed and implemented large scale asset flood resilience studies for the UK water industry and worked as part of team in the strategic and detailed design of surface water drainage systems. He holds a first class honours in Physical Geography (Reading) and achieved a first class grade in the Water Informatics Postgraduate School (Exeter).

If you're interested in the advantages of fast flood management, please send James an email.

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Keywords: *Surface water management, Urban flooding, Flood resilience, Cost-benefit analysis, Strategic design, Decision support.*