Abstracts submitted for the British Hydrological Society's Peter Wolf Early Career Hydrologist's Event 2016

Bristol, 26-27 May 2016

British Hydrological Society

University of BRISTOL
Cabot Institute

Organising Committee

Miss Fanny Sarrazin, Dr Susana Almeida, Mr Joost Iwema (Department of Civil Engineering, University of Bristol)

Front Cover: Sheepdrove Farm, Lambourn, Berkshire, UK. Photograph reproduced with kind permission from Sheepdrove Farm

Table of Contents

Programme 26th May: Symposium at Engineer's House

9.00 - 9.30	**Tea/coffee, presentations upload and posters setup**
9.30 - 10.00	**Welcome and introduction** *Nigel Goody* *Nevil Quinn*
10.00 - 10.50	**Session 1** **Keynote: *Andreas Hartmann* - Parameter estimation and model evaluation in karst regions – a balance of data availability and process representation?** *Padraig Kelly and Divesh Mistry* - Catchment Management: Using sensitivity maps to target sources of nitrates in groundwater and metaldehyde in surface water
10.50 - 11.20	**Tea/coffee and Poster session**
11.20 - 12.20	**Session 2** *Rebecca Alexandre* - Global scale hydrological and hydraulic modelling of fluvial flood risk *Bettina Matti* - Flood events across the North Atlantic region - are they changing consistently? *Gianni Vesuviano* - Reducing uncertainty in small-catchment flood peak estimation *Giuseppe Formetta* - Estimating the index discharge with continuous hydrological models: an application in Great Britain
12.20 - 13.30	**Lunch**
13.30 - 14.50	**Session 3** **Keynote: *Michael Norton* - Global water security: THE career opportunity!** *Iskra Mejia Estrada* - Numerical modelling of heavy rainfall over Newcastle in 2012 *Yang Song* - High Temporal Resolution Rainfall Intensity Retrieval Based on Tipping-Bucket Rain Gauge Measurements by Applying Artificial Neural Networks Approach *Barnaby Dobson* - Classification and uptake of reservoir operation optimization algorithms
14.50 - 15.20	**Tea/coffee and Poster session**
15.20 - 16.20	**Session 4** *Lucy Barker* - Can standardised drought indicators help inform monitoring and early warning for water resource management? *Victoria L. Coates* - Modifications to the Soil-Vegetation-Atmosphere Continuum by Hedgerows - Observations from a field site in Northern England *Mhari Barnes* - Trees: the solution to flooding in the UK? *Ludovica Beltrame* - Simulating the risk of Liver Fluke infection using a mechanistic hydrological-epidemiological model
16.20 - 18.30	**Poster session**
19.00 -	**Dinner at The TownHouse,** 85 Whiteladies Road, Bristol BS8 2NT

Programme 27th May: Field Trip to Sheepdrove Organic Farm

8.30	**Departure from Bristol** Meeting point: Merchant Venturers Building, 75 Woodland Road, Bristol
10.45	**Coffee & tea at Sheepdrove Organic Farm Eco Centre**
11.15 - 12.00	**Indoor presentations** *Dan Bull (Farm Manager)* - Sheepdrove Organic Farm *Rafael Rosolem* - NERC funded University of Bristol AMUSED research project conducted at Sheepdrove Organic Farm
12.00 - 13.00	**Lunch at the Eco Centre**
13.00 - 16.00	**Presentations outside in the field** *Dan Bull (Farm Manager)* - Sheepdrove Organic Farm Q&A *Joost Iwema* - AMUSED measurement setup
16.00	**Departure from Sheepdrove Organic Farm**
17.30	**First drop-off point:** Swindon railway station
18.45	**Second and third drop-off point:** Bristol Bus and Coach Station & Bristol Temple Meads railway station
19.00	**Arrive at final drop-off point:** Merchant Venturers Building

Keynote Speakers

Andreas Hartmann is an expert in karst hydrology, with a particular interest in water resources and how their availability may change in the future. He obtained his PhD in 2013 at the University of Freiburg, Germany, for his research on modelling karst hydrology and hydrochemistry in different climates and at different scales considering uncertainty. He then worked as a post-doctoral researcher at the University of Freiburg, McGill University and the University of Bristol. His present research focus is the large scale assessment of water resources availability in karst regions and human water security under current and potential future conditions. Andreas is an active EGU and AGU member and a contributing member of the Commission on Karst of the International Association of Hydrogeologists IAH. Since 2014, he is a lecturer at the Chair of Hydrology, University of Freiburg, Germany. His current projects include the AWSEK-DB project, which aims to create a global karst database.

Parameter estimation and model evaluation in karst regions – a balance of data availability and process representation?

Karst regions cover ~25% of the UK and provide a significant contribution to the national water supply. Karst develops due to the dissolution of carbonate rock, creating amazing surface and subsurface landforms characterized by dolines, Karren fields, caves and large springs. However, karstification is also the reason why karst systems show pronounced surface and subsurface heterogeneity of their hydrological flow and storage behaviour.

Consequently, water resources management that often relies on simulation tools faces particular challenges in karst regions. This lecture will begin with an overview of the hydrological particularities of karst regions and of established simulation approaches. Focus will be set on the availability of different types of data that varies across study sites and across simulation scales by presenting 3 case studies at the plot scale, catchment scale and continental scale. Each case required a different calibration and evaluation strategy based on data availability and modelling purpose. Due to data limitations the resulting model structures show a decreasing degree of process representation with increasing simulation scale. Strength and weaknesses of the selected approaches at each scale will be discussed, and consequences and future ideas for karst research and general hydrology will be provided.

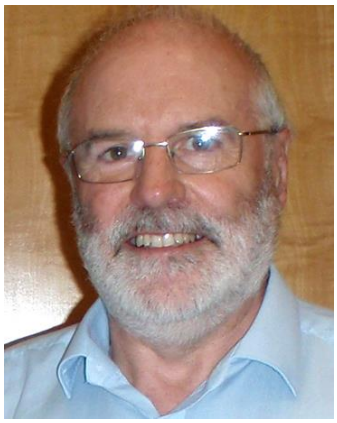
Michael Norton is a civil engineer with over 40 years of professional experience in the fields of water resources, urban water, and the environment. He is an internationally recognised expert on water, and his current focus is on providing thought-leadership in the fields of water scarcity and water security. Michael has authored a number of papers on water security and is a regular speaker at conferences on related topics. He has led major water studies and projects in Europe, Latin America, Middle East and Asia. Michael is a Fellow of the Institution of Civil Engineers (and former Chair of the Water Expert Panel) and Fellow of Chartered Institution of Water and Environmental Management. He is Research Collaborator at Bristol University and has served as Professor Associate at Brunel University, Chair of Programme Advisory Committee, Cranfield University School of Water Science, and visiting lecturer at Oxford University School of Geography. He worked with the World Economic Forum's water initiative from 2008 to 2011. Michael was Chair of the Water Security Programme Advisory Group of the Natural Environment Research Council. After 30 years in senior roles at Halcrow (now Ch2MHill) and AMEC Environment & Infrastructure, Michael now runs his own specialist company Michael Norton Water Consultancy. He was awarded the MBE by the Queen in 2009 in recognition of his services to water and to international trade. Michael's current projects include a review for the Global Green Growth Institute of financial instruments applicable to water investment in Peru, specialist technical advice to the Inter American Development Bank relating to a major wastewater treatment plant in Panama, and a master plan for urban drainage for the city of Montevideo.

Global water security: THE career opportunity!

Michael's presentation describes the combined effects of population growth, urbanisation, dietary change and climate change that together are precipitating a global water scarcity crisis. The concepts of green water, blue water, virtual water and water footprint are explained. Relative industrial, agricultural and domestic water withdrawals are compared. The challenge of water security is framed, and main solutions to future agricultural water demand, improved crop yields and better irrigation efficiency, are described. The importance of an integrated approach to water planning and management is outlined. Finally, the need for water professionals to emerge from the "water box" is explained and why this represents an opportunity for a rewarding career.

Guest Speakers

Nigel Goody



Nigel Goody scraped a BSc in Environmental Science from UEA in 1976 and started work immediately with Anglian Water as a field technician, monitoring the rainfall, river flows and groundwater levels in south Norfolk/north Suffolk. After a brief period undertaking the quality control of flow data and assessing the impacts of individual small abstractions, and then modelling the impacts of a proposed major public water supply for Ipswich, he moved from the slowest rivers in the country to the fastest when the opportunity arose in 1985 to move into low-level management of a 4-man Hydrometry team in the north of Scotland. Nigel now manages a unit of more than 50 staff maintaining the national hydrometric network of >400 rain gauges and 408 river, loch and tide gauges for the Scottish Environment Protection Agency, with an asset base of >£15M and an annual budget of c.£2M. Nigel has been on BHS Committee since 2006, including a 4-year period as Honorary Treasurer and the past 4 years as President Elect, President, and currently Past President; which position he will hold until the AGM in September.

Nevil Quinn

Nevil Quinn is BHS Editor for Hydrology Research (http://hr.iwaponline.com/) and an Associate Professor in Applied Hydrology at the University of the West of England (UWE), Bristol. His PhD in environmental hydrology was obtained at the University of Natal, South Africa and involved developing ecological models for the management of freshwater inflow to estuaries. He subsequently spent several years working as a consultant and contract researcher, before becoming programme director for a Master's programme at the Centre for Environment and Development at the University of KwaZulu-Natal. He joined UWE in 2004, appointed to set up new programmes in river and coastal engineering for the Environment Agency.

Rafael Rosolem

Rafael Rosolem has been a lecturer in Water and Environmental Engineering at the University of Bristol since 2013. His research focuses on understanding and improving physical and physiological mechanisms associated with the water, energy, and biogeochemical cycles. He is also involved in the development and dissemination of a new measurement technique which provides soil moisture at intermediate spatial scales from cosmic-rays. Rafael Rosolem obtained his PhD in Hydrology in 2010 at the University of Arizona where he also worked as Research Associate and Research Assistant Professor on the COsmic-ray Soil Moisture Observing System project. He is leading the AMUSED (A MUlti-scale Soil moisture-Evapotranspiration Dynamics study) project which aims to monitor soil moisture using cosmic-rays sensors in combination with land surface modelling, satellite remote sensing, and model diagnostics and data assimilation methods (http://www.bristol.ac.uk/news/2014/august/soil-moisture-and-cosmic-rays.html).

Abstracts

S. M. Kabwe	A risk based approach to water resource management in Zambia under a changing climate	University of the West of Scotland	30
P. Kelly and D. Mistry	Catchment Management: Using sensitivity maps to target sources of nitrates in groundwater and metaldehyde in surface water	Mott MacDonald	31
D. Kim	Uncertainty estimation of hourly extreme rainfall in S. Korea	University of Bristol	32
W. Knoben	Towards methodical modelling: Differences between the structure and output dynamics of multiple conceptual models	University of Bristol	33
D. Kvocka	Flood hazard assessment in areas prone to flash flooding	Cardiff University	34
M. Kwon	An assessment of Advanced Microwave Scanning Radiometer 2 (AMSR2) soil moisture products with in-situ observation	University of Bristol	35
J. Liu	Study on the Basin Initial Water Rights Allocation based on Projection Pursuit Model	University of Bristol Hohai University	36
B. Matti	Flood events across the North Atlantic region - are they changing consistently?	Coventry University	37
I. Mejia Estrada	Numerical modelling of heavy rainfall over Newcastle in 2012	University of Bristol	38
Nanding	Application of rainfall estimates using radar-raingauge merging techniques for hydrological simulations	University of Bristol	39
M.C. Oliveira	Assessing the uncertainties related to the temporal evolution of the rainfall velocity field in radar nowcastings	University of Bristol	40
A. Rudd	Hydrological Outlook UK; seasonal river flow forecasts using rainfall forecasts	Centre for Ecology & Hydrology	41
F. Sarrazin	How much does subsurface heterogeneity alter the impact of climate and land use changes on groundwater recharge?	University of Bristol	42
B. Smith	Investigating Flooding From Multiple Sources: A coupled model and high resolution national datasets	Newcastle University	43
Y. Song	High Temporal Resolution Rainfall Intensity Retrieval Based on Tipping-Bucket Rain Gauge Measurements by Applying Artificial Neural Networks Approach	University of Bristol	44
S. Turner	The UK's National Hydrological Monitoring Programme Hydrological Summary	Centre for Ecology & Hydrology	45
G. Vesuviano	Reducing uncertainty in small-catchment flood peak estimation	Centre for Ecology & Hydrology	46

J. Zhang	Response of Runoff Modelling on Spatial Variability of Rainfall Input Data in the Brue catchment, UK	University of Bristol	47
L. Zhuo	Terminology gap in hydrological cycle	University of Bristol	48

Exploration of a dynamic merging scheme for optimal precipitation estimation over ungauged urban catchment

Sherien Al-Azerji*, Dawei Han, Miguel Angel Rico-Ramirez

Department of Civil Engineering, University of Bristol, Bristol, UK

*sa12372@bristol.ac.uk (corresponding author)

Abstract

Merging rain gauge-radar data improve the accuracy of quantitative precipitation estimation for urban areas. However, in practice, the rain gauge network around ungauged catchment is fixed, and the relevant research question is about the optimal merging area that produce the best merged rainfall estimation inside the catchment. To test this hypothesis, the distance from the centre of the study area and the number of merging gauges around it were gradually increased. Meanwhile, merging with an expanding domain of radar data was then performed. The performance of the dynamic merging scheme was compared with a gridded interpolated rainfall from four experimental rain gauges installed inside the study area for validation. The result of this analysis shows that there is indeed an optimum distance from the centre of study area and consequently there is an optimum number of rain gauges that produce the best merged rainfall data inside the study area. This study is of important and practical value for estimating rainfall in an ungauged urban catchment. Although there have been many studies on merging radar and rain gauges, the dynamic searching of their optimal merging by varying the merging area is novel and has not been reported in the literature.

Global scale hydrological and hydraulic modelling of fluvial flood risk

Rebecca Alexandre*, Helen Smith

JBA Risk Management Limited, Skipton, UK

*rebecca.alexandre@jbarisk.com (corresponding author)

Abstract

Re/insurance industries need reliable tools in order to assess their potential exposures in a region should a flood occur. From country to country huge variations can be found in flood mapping availability, practices, and resolution. Therefore, consistent, reliable global flood datasets are essential for the successful operation of such industries. Recognising this gap has led to the development of JBA Risk Management Limited's global flood hazard maps. This presentation focuses on the methods used to model main rivers in rural areas, where main rivers are defined as those draining catchments greater than 500 km^2. It will explore the innovative techniques customised for broad-scale hydrological and hydraulic modelling and explain how consistent high resolution river flood maps are created for the globe. The methodology established by JBA allows the design flood hydrographs for 6 return periods to be predicted at any point on the river network at any location world-wide. Initially, a variety of GIS tools analyse the flow directions and accumulations over digital terrain data and identify main river locations. Statistical rainfall-runoff models based on 110-year long monthly rainfall totals were developed in order to estimate river flow volumes. Calibration using observed river discharges was used to transform design rainfall to design flood peak. The calibration was applied globally with parameters varying by location in order to reflect regional differences in climate and river regime. Flooding was then simulated across the 30m resolution digital terrain model using JFlow, an in-house developed 2-D hydrodynamic model. From this, indicative flood hazard maps are calculated encompassing over 5.7 million km of river for (168) countries. Validation against documented flood maps, historical flow records, observed flood extents and aerial imagery prove the maps to be robust. Finally, the challenges associated with such large-scale modelling are addressed, including terrain data preparation and computational requirements for processing large, complex datasets. The greater implications of this dataset will be reviewed. Primarily such information has proven to be invaluable to our stakeholders as it allows them to make more informed decisions regarding flood vulnerability.

Can standardised drought indicators help inform monitoring and early warning for water resource management?

Lucy Barker*, Jamie Hannaford

Centre for Ecology & Hydrology, Wallingford, UK

*lucybar@ceh.ac.uk (corresponding author)

Abstract

Drought is a complex natural phenomenon driven by both physical and anthropogenic factors. The many possible manifestations (meteorological, hydrological, agricultural, environmental etc.) and wide range impacts makes a drought event challenging to identify, plan and prepare for. A plethora of drought indicators, including the Standardised Precipitation Index (SPI) and Standardised Streamflow Index (SSI), have been developed in attempts to identify and quantify droughts. However, there is little understanding of what these indicators mean in terms of observed drought impacts. The international DrIVER (Drought Impacts and Vulnerability Thresholds in monitoring and Early warning Research, https://www.drought.uni-freiburg.de/) project aims to improve the understanding of the relationship between drought indicators and drought impacts to inform drought monitoring and early warning (M&EW). Drought monitoring and planning are built into the current UK water resource management framework. Many management and regulatory bodies use precipitation deficits, streamflow percentiles and reservoir levels to inform their drought monitoring and management strategy. However, there is little use of standardised indicators, like the SPI and SSI, in the UK despite the fact they allow comparison across space and time and give an indication of both drought severity and probability. The need to evaluate how standardised drought indicators like SPI and SSI relate to drought management decisions was raised at a DrIVER workshop attended by a wide range of stakeholders at CEH in March 2015. Our presentation delivers preliminary results from DrIVER research aimed at this knowledge gap. We examine linkages between standardised drought indicators, drought impacts and management decisions in the UK, both at the national/regional scale and for more localised case studies. We conclude with an appraisal of how these linkages could be used to inform drought planning and M&EW in the future.

Trees: the solution to flooding in the UK?

Mhari S. Barnes[1*], James C. Bathurst[1], Paul F. Quinn[1,2], Stephen J. Birkinshaw[1]

[1]School of Civil Engineering & Geosciences, Newcastle University, Newcastle upon Tyne, UK

[2]Arup Group, Newcastle upon Tyne, UK

*m.s.barnes1@ncl.ac.uk (corresponding author)

Abstract

After the 2013-14, and the more recent 2015-16, winter floods in the UK there were calls to 'forest the uplands' as a solution to reducing flood risk across the nation. At present, 1 in 6 homes in Britain are at risk of flooding and current EU legislation demands a sustainable, nature-based solution. However, the role of forests as a natural flood management technique remains highly controversial, due to a distinct lack of robust evidence into its effectiveness in reducing flood risk during extreme events. Furthermore, there is a need to analyse the extent to which land management practices, and the installation of runoff attenuation features (RAFs), such as woody debris dams, in headwater catchments can attenuate flood-wave movement, and potentially reduce downstream flood risk. This project aims to improve the understanding of the impacts of upland afforestation on flood risk at the sub-catchment and full catchment scales. This will be achieved through an integrated fieldwork and modelling approach, with the use of a series of process based hydrological and hydrodynamic models to scale up and examine the effects forestry can have on flooding. The proportion of a catchment or riparian reach that would need to be forested in order to achieve a significant impact on reducing downstream flooding will be defined. Additionally, the consequential impacts of a corresponding reduction in agriculturally productive farmland and the potential decline of water resource availability will be considered in order to safeguard the UK's food security and satisfy the somewhat insatiable global demand on water resources.

Simulating the risk of Liver Fluke infection using a mechanistic hydrological-epidemiological model

Ludovica Beltrame[1*], Toby Dunne[1], Hannah Rose[2], Josephine Walker[3], Eric Morgan[2], Peter Vickerman[3], Thorsten Wagener[1,4]

[1]Department of Civil Engineering, University of Bristol, Bristol, UK
[2]School of Veterinary Sciences, University of Bristol, Bristol, UK
[3]School of Social and Community Medicine, University of Bristol, Bristol, UK
[4]Cabot Institute, University of Bristol, Bristol, UK
*lb14459@bristol.ac.uk (corresponding author)

Abstract

Liver Fluke (Fasciola hepatica) is a common parasite of livestock, responsible for considerable economic losses throughout the world. Risk of infection is strongly controlled by climatic and hydrological conditions, which characterise the host environment for parasite development and transmission. Despite on-going control efforts, increases in fluke outbreaks have been reported in recent years in the UK, and have been often attributed to climate change. Currently used fluke risk models are based on empirical relationships derived between historical climate and incidence data. However, hydro-climate conditions are becoming increasingly non-stationary due to climate change and direct anthropogenic activities such as land use change, making empirical models unsuitable for simulating future risk. In this study we introduce a mechanistic hydro-epidemiological model for Liver Fluke, which explicitly simulates habitat suitability for disease development in space and time, representing the parasite life-cycle in connection with key environmental conditions. The model is used to assess patterns of Liver Fluke risk for a catchment in the UK under current and potential future climate conditions. Comparisons are made with a widely used empirical model employing different datasets, including data from regional veterinary laboratories.

Integration of rain gauge measurement errors with the overall rainfall uncertainty estimation using kriging methods

Francesca Cecinati[1*], M. A. Rico-Ramirez[1], D. Han[1], A. Moreno Ródenas[2], M. ten Veldhuis[2]

[1]Department of Civil Engineering, University of Bristol, Bristol, UK
[2]Water Management Department, Technische Universiteit Delft, The Netherlands
*francesca.cecinati@bristol.ac.uk (corresponding author)

Abstract

In many studies rain gauges are used as a reference measurement for rainfall, because they can reach very good accuracy. In some applications rain gauge uncertainty is assumed to be small enough to be neglected. Unfortunately, in many operational networks the importance of accurate rainfall data and of data quality control can be underestimated; budget and best practice knowledge can be limiting factors in a correct rain gauge network management. In these cases, the accuracy of rain gauges can drastically drop and the uncertainty cannot be neglected. This work proposes an approach based on kriging methods to integrate rain gauge measurement errors in the overall rainfall uncertainty estimation. The study area is the Eindhoven catchment, contributing to the river Dommel, in the southern part of the Netherlands. The area, 590 km^2, is covered by high quality rain gauge measurements by the Royal Netherlands Meteorological Institute (KNMI), which has one rain gauge inside the study area and six around it, and by lower quality rain gauge measurements by the Dommel Water Board and by the Eindhoven Municipality (six rain gauges in total). The integration of the rain gauge measurement error is accomplished in all the cases increasing the nugget of the semivariogram proportionally to the estimated error. Using different variogram models for the different networks allows for the separate characterisation of higher and lower quality rain gauges. For kriging with external drift, radar composites from the KNMI are used. These are produced by two single-polarization radars, 70 km and 170 km away from the area of study, with a spatial resolution of 1 km by 1 km and a temporal resolution of 5 minutes. The overall uncertainty is then estimated observing the kriging variance. Results for the three approaches with and without the rain gauge measurement errors are then compared.

The classification and degrees of intervention in water heritages

Otto Chen*, Dawei Han

Department of Civil Engineering, University of Bristol, Bristol, UK

*anneeotto@gmail.com (corresponding author)

Abstract

The world is paying a high attention to the conservation of cultural and natural heritage, while water heritage playing such a significant role among them is largely ignored. Compared with architectural or monumental heritage, water heritage usually possesses more dynamic, nature-related, and technologic culture value. The paleohydrology of water heritage not only enhances value of heritage for the past, but also helps build sustainable or even disaster resilient environment for the future. Hence instead of merely focusing on protecting the integrity and authenticity of a heritage structure, the sustainability of water heritage also relies on the harmony of human demands and water environment of the present and future generations. Therefore, in order to conserve water heritage and adapt to the evolving water environment simultaneously, interventions are usually inevitable. The 'degrees of intervention' on water heritage nowadays becomes more complicated and controversial than on any other cultural heritage. It is worth to further understand water heritage by discussing its classification and the conception of degrees of intervention, so as to propose an applicable method specifically for sustainable water heritage maintenance as a bridge for linking the relevant professionals and the public who care about the environment, no matter built or natural.

Big Data and Hydroinformatics

Yiheng Chen*, Dawei Han

Department of Civil Engineering, University of Bristol, Bristol, UK
*yc0290@bristol.ac.uk (corresponding author)

Abstract

Over the past five years, big data has become an increasingly hot concept in the area of computer science, e-commence, and bioinformatics, because more and more data has been collected by the internet, remote sensing network, wearable devices and the Internet of Things. The big data technology provides techniques and analytical tools to handle large datasets, so that creative ideas and new values can be extracted from them. However, the hydroinformatics research community are not so familiar with big data. This poster provides readers who are embracing the data-rich era with a timely review on big data and its relevant technology, and then points out the relevance with hydroinformatics in three aspects.

Modifications to the Soil-Vegetation-Atmosphere Continuum by Hedgerows – Observations from a field site in Northern England

Victoria L. Coates*, Ian Pattison

School of Civil and Building Engineering, Loughborough University, Loughborough, UK
*V.L.Coates@lboro.ac.uk (corresponding author)

Abstract

UK farming practices have changed significantly over the past 100 years. This is evident in arable fields, where the use of larger machinery has led to the removal of hedgerows. In the River Skell catchment, in Yorkshire, UK this has led to a doubling in field size since 1892. The national-wide change is responsible for longer slope lengths, increased runoff velocities and greater potential for connectivity, which may be responsible for an increase in flood risk at the catchment scale. However there is a lack of physical evidence to support this theory. Hedgerows are a widespread, man-made boundary feature in the rural UK landscape. They play an important ecological role in providing shelter, changing the local climate, reducing erosion and have a strong influence on local soil properties. Their impact on hydrology has not been widely studied but it is hypothesised that their presence could alter soil moisture levels and the soil structure, therefore affecting runoff.

This paper presents observations of a hedgerow on the Soil-Plant-Atmosphere Continuum, through 15 months field monitoring conducted in the River Skell catchment. Firstly, to assess soil moisture levels TDR probes were installed at different depths and distances from the hedgerow. To assess the soil quality and therefore its infiltration capacity, soil cores were collected to determine soil horizons and root density. Also, laboratory tests were undertaken to determine the soil type and the porosity. Secondly, to assess the physical impact of the hedgerow plant on the partitioning of rainfall, gauges were installed to capture the spatial distribution of rainfall, along a transect perpendicular to the hedgerow, as well as stemflow. Throughfall gauges were also installed within the hedgerow and leaf area index calculated. Thirdly, to assess the impact of the hedgerow on the micro-climate, temperature sensors and four leaf wetness sensors were installed to determine evapotranspiration and interception rates.

Results from the TDR probes show that soil moisture levels next to the hedgerow rise earlier and fall quicker, than the probes further from the hedgerow, where levels rise gradually and fall slowly. Higher soil porosity (5-15%) next to the hedgerow, compared to 1-10m away from the hedgerow and roots extending 1m horizontally from the structure help the soil to drain better. Throughfall experiments along the hedgerow length showed large variations in leaf area index (4.5-0.8) correlating with 33-94% total rainfall capture. Results from the leaf wetness sensors show that the interception of rainfall occurs 10-30 minutes later on leaves inside the hedgerow, in comparison to leaves on the perimeter and that leaves dry much quicker (2-3 hours) inside the hedgerow.

Improving inundation forecasting using data assimilation

Elizabeth Cooper*, Sarah Dance, Javier Garcia-Pintado, Nancy Nichols, Polly Smith

University of Reading, Reading, UK

*e.s.cooper@pgr.reading.ac.uk (corresponding author)

Abstract

River flooding is a costly problem in the UK and worldwide. Real-time, accurate inundation forecasting can help to mitigate damage caused by such events by warning people where and when flood water is likely to affect them. A number of numerical inundation models exist, all of which solve the shallow water equations in order to predict the movement of water in space and time and thereby produce a flood forecast. However, the equations driving the models contain uncertain parameters describing e.g. friction, and this uncertainty acts to reduce the quality of the forecasts. Data assimilation is a sophisticated and powerful mathematical technique which can be used to combine a numerical inundation model with satellite derived observations in order to improve the quality of the model's forecast. Uncertain model parameters can also be corrected as part of the same data assimilation process. We present results of applying data assimilation using an ensemble Kalman filter to a model of an idealized river flood situation with synthetic observations. The effect of simultaneously correcting the Manning's coefficient which describes channel friction is shown to greatly improve the forecast ability of the mathematical model in this case.

Potential reciprocal effect between land use / land cover change and climate change

Afrah Daham*, Dawei Han, Miguel Rico-Ramirez

Department of Civil Engineering, University of Bristol, UK
*ad14446@bristol.ac.uk (corresponding author)

Abstract

Land use/land cover (LULC) activity influences climate change and one way to explore climate change is to analyse the change in LULC patterns. Modelling the Spatio-temporal pattern of LULC change requires the use of satellite remote sensing data and aerial photographs with different pre-processing steps. The aim of this research is to analyse the reciprocal effects of LUCC (Land Use and Cover Change) and the climate change on each other in the study area which covers part of Bristol, South Gloucestershire, Bath and Somerset in England for the period (1975-2015). LUCC is assessed using remote sensing data. Three sets of remotely sensed data, LanSAT-1 Multispectral Scanner (MSS) data obtained in (1975 and 1976), LanSAT-5 Thematic Mapper (TM) data obtained in (1984 and 1997), and LandSAT-7 Enhanced Thematic Mapper Plus (ETM+) acquired in (2003 and 2015), with a time span of forty years were used in the study. One of the most common problems in the satellite images is the presence of cloud covers. In this study, the cloud cover problem is handled using a novel algorithm, which is capable of reducing the cloud coverage in the classified images significantly. This study also examines a suite of possible photogrammetry techniques applicable to detect the change in LULC. At the moment photogrammertic techniques are used to derive the ground truth for supervised classification from the high resolution aerial photos which were provided by Ordnance Survey (contract number: 240215) and global mapper for the years in (2001 and 2014). After obtaining the classified images almost free of clouds, accuracy assessment is implemented with the derived classified images using confusion matrix at some ground truth points. Eight classes (Improved grassland, Built up areas and gardens, Arable and horticulture, Broad-leaved / mixed woodland, Coniferous woodland, Oceanic seas, Standing open water and reservoir, and Mountain; heath; bog) have been classified in the chosen study area. Also, CORINE Land Cover (CLC) maps are used to study the environmental changes and to validate the obtained maps from remote sensing and photogrammetry data. On climate change, different sources of climate data were used in this research. Three rainfall datasets from the Global Precipitation Climatology Centre (GPCC), the Climate Research Unit (CRU) and Gridded Estimates of daily Areal Rainfall (CEH-GEAR) in the study area were compared at a resolution of 0.5 degrees. The dataset were available for the operational period 1975-2015. The historically observed rainfall datasets for the study area were obtained from the Met Office Integrated Data Archive System (MIDAS) Land and Marine downloaded through the British Atmospheric Data Centre (BADC) website, which includes the rainfall and the temperature, are collected from all the weather stations in the UK in the last 40 years. Only four gauging stations were available to represent the spatial variability of rainfall within and around the study area. The monthly rainfall time series were evaluated against a dataset based on four rain gauges. These data are processed and analysed statistically to find the changes in climate of the study area in the last 40 years. The potential reciprocal effect between the LULC change and the climate change is done by finding the correlation between LUCC and the variables Rainfall and Temperature. In addition, The JULES land surface model will be used to study the potential reciprocal effect between LUCC and climate.

Classification and uptake of reservoir operation optimization algorithms

Barnaby Dobson[1*], Francesca Pianosi[1], Thorsten Wagener[1,2]

[1]Department of Civil Engineering, University of Bristol, UK
[2]Cabot Institute, University of Bristol, Bristol, UK
*bd0495@bristol.ac.uk (corresponding author)

Abstract

Reservoir operation optimization algorithms aim to improve the quality of water supply management decisions. They achieve this by creating and optimizing the reservoir operating policy; a function that returns decisions based on the current system state. A range of mathematical optimization algorithms and techniques have been applied to the reservoir operation problem of policy optimization in research. However in practice the uptake of these algorithms is limited. These algorithms are typically classified in reviews by their mathematical algorithm features. Our hypothesis is that this emphasis on mathematical algorithm features rather than applicability to the real world limits the practitioner's ability to select appropriate algorithms.

In this work, we propose a classification of reservoir optimization algorithms by focusing on the formulation and difficulties of the target water management problem. We believe that decision makers and water managers will find it easier to navigate a classification system based on the problem characteristics, something they can clearly define, rather than the mathematical algorithm features.

We are currently interviewing decision makers and water managers across the UK. We aim to assess the present state of reservoir operation in practice, validate our hypothesis and determine if additional support beyond the classification system is required to improve uptake.

Techno-Economic Evaluation of SuDS Performance at the Full Scale

Mohamad El Hattab*, Ana Mijic

Department of Civil and Environmental Engineering, Imperial College London, London, UK
*mohamad.el-hattab13@imperial.ac.uk (corresponding author)

Abstract

Rapid Urbanisation and increasing densification are major driving forces for developing more sustainable urban stormwater management practices. The regulations of the UK Flood and Water Management Act specify that source-based sustainable urban drainage systems (SuDS) should comprise the primary mitigation controls for identified critical drainage areas.

Counters Creek is one of the lost rivers of London and is situated on the boundary of the London Borough of Hammersmith and Fulham and the Royal Borough of Kensington and Chelsea. This former river and its catchment is now part of the sewerage network, draining surface water from buildings and roads, as well as foul water from toilets, bathrooms and kitchens.

Following the severe flood in July 2007, Thames Water Utility Ltd. (TWUL) started its investigation to understand the extent of sewer flooding in Counters creek and the underlying causes. One of the main causes was identified to be the inadequate capacity in the sewers where the water levels within the sewer network rise up rapidly in response to a certain storm event which leave the sewer with insufficient capacity to accommodate the foul water. One of the appraised solutions by TWUL is to retrofit SuDS solutions into densely populated areas that are prone to flooding along with other larger scale solutions.

Three typical London streets each with a nearby control street were chosen by TWUL to construct different types of SuDS devices. Key outputs from these SuDS pilots, such as monitoring how well they attenuate rainwater before entering the sewers under different rainfall conditions, and adequate modelling approach that accurately simulate the performance of SuDS will be used to inform future SuDS schemes across London and ultimately across other cities.

Exploring new climate change guidance and the impact on consultancies and developers

Sarah Foreman*

WSP | Parsons Brinckerhoff, Bristol, UK

*sarah.foreman@wspgroup.com (corresponding author)

Abstract

New climate change guidance brought in by the Environment Agency on the 19th February 2016 will require changes to the way consultancies assess future flood risk and to how they design surface water management systems. Embedded in the National Planning Policy Framework, the new guidance will be applicable to all new planning applications. The new guidance introduces a range of new climate change allowances for peak river flow, rainfall and sea levels; the allowances reflect the location and statistical probability of being exceeded; the choice of an appropriate allowance based on a site specific, risk based approach should take into account the vulnerability of any proposed development to allow for a more accurate assessment of the impact of climate change on flood risk. This poses a challenge to consultancies who will now have to assess climate change on a more explicit site specific basis. This project investigates the potential impact of these new climate change allowances on consultancies and developers from an industry perspective, at this early stage of its introduction.

Estimating the index discharge with continuous hydrological models: an application in Great Britain

Giuseppe Formetta*, Ilaria Prosdocimi, Lisa Stewart, Vicky Bell

Centre for Ecology & Hydrology, Wallingford, UK

*giufor@ceh.ac.uk (corresponding author)

Abstract

Estimation of peak discharge for an assigned probability of exceedance is a crucial issue in engineering hydrology. It is required for designing or managing hydraulic infrastructures such as dams, reservoirs, and bridges. In the UK the Flood Estimation Handbook (FEH) prescribes the use of the index flood method to estimate the designed flood as the product between the local scale factor (index flood, IF) and a regional dimensionless growth factor. For gauged catchments the IF is usually estimated as the median annual maximum flood, while for ungauged catchments it is computed through multiregression models on an appropriate set of morpho-climatic indices of the basin. Here we estimate the IF using output from the Grid-to-Grid Model, a physically based hydrological model. Using rainfall and potential-evapotranspiration as input, it estimates runoff, soil-moisture and river flows continuously on a 1km grid across Britain. It uses spatial datasets of topography, soil, and land cover, and has been evaluated using observed river flows for the period 1960-2011 in simulation-mode (no catchment calibration). Modelled IFs across Britain were estimated using the median of the modelled discharge annual maxima (AMAX) at every location. The IF were compared against corresponding FEH estimates for 550 catchments, and a linear regression model was fitted with an R^2=0.92 and a factorial standard error FSE=1.46. The FSE measures the uncertainty in the IF estimation and this value is comparable to the FEH multiregression model (1.43). It is shown that model performance is robust and independent of catchment features such as area, mean annual rainfall, and urbanization. A trend analysis of AMAX with time was performed to assess the ability of the model in reproducing the observed AMAX trend. Results are encouraging and highlight the prospect of using this methodology to estimate the IF for ungauged catchments and under conditions of non-stationarity.

COSMOS-UK: Handling field scale soil moisture and meteorological data in near real time

Olivia Hitt[1*], J.G. Evans[1], H.C.Ward[2], J.R.Blake[1], E.J.Hewitt[1], .R.Morrison[1], M.Fry[1], L.A.Ball[1], L.C.Doughty[1], J.W.Livre[1], D.Rylett[1], R.J.Ellis[1], A.C.Warwick[1], M.Brooks[1], M.A.Parkes[1], G.M.H.Wright[1], A.C.Singer[1], D.B.Boorman[1], A.Jenkins[1]

[1]Centre for Ecology & Hydrology, Wallingford, UK,
[2]Department of Meteorology, University of Reading, Reading, UK
*olihit@ceh.ac.uk (corresponding author)

Abstract

The COsmic-ray Soil Moisture Observing System (COSMOS-UK) is a network of soil moisture and meteorological sensors operated by the Centre for Ecology and Hydrology (CEH) established in 2013 and currently still expanding across the UK. The network is based around the Cosmic-ray soil moisture sensor, a technology developed in the USA. These sensors have the advantage of a large measurement footprint (around 400m) and operate continuously providing area-averaged near-surface volumetric soil water content. Data from the COSMOS-UK network so far have been compared with the Joint Land Environment Simulator (JULES) 10cm soil moisture layer to diagnose model performance and assess the potential for assimilation of these data into hydro-meteorological models. These measurements of soil moisture at an intermediate scale are vital for our understanding of hydrological processes, land-surface coupling, biogeochemistry and ecohydrology. The network currently consists of 34 sites across England, Scotland and Wales with each site providing soil moisture and meteorological data at hourly and half hourly resolutions and one minute resolution precipitation data. Sites are mostly co-located with other scientific research sites such as those of The James Hutton institute and Natural England. Data are transmitted hourly from on-site loggers via telemetry to a central PC at CEH Wallingford. R and Python scripts which also run hourly then load this data to an Oracle database and it is then visible on the website. During this process the data are subject to quality control (QC) which automatically removes values that fail the QC tests. These include: checking the values are within an acceptable range and spikes where readings drop or increase suddenly for short period of time. Additionally, to handle any other potential issues not picked up by the QC, data plots are checked daily to catch any potential instrumentation faults.

Key Impact Factors of Life Loss Due to Dam Failures

Dongjing Huang[1,2*], Dawei Han[1]

[1]Department of Civil Engineering, University of Bristol, UK,
[2]Department of Hydrology and Water Resources, Hohai University, Nanjing, China
*dongjing.huang@bristol.ac.uk (corresponding author)

Abstract

China has a long damming history for over 2,500 years, as well as a long history of human beings struggled with dam failures. During the last 60 years from 1954 to 2013, there were as high as 3,544 dam break cases occurred in China bringing about a large number of people death in the flood. From the perspective of protecting human life, there is an important need to reduce the life loss caused by dam failures and reveal the relationship between mortality as the consequence and dam failure as the cause. Twelve impact factors which affect facilities were collected and introduced here, i.e., severity of dam break food, evacuation condition, population at risk, understanding of dam break, warning time, dam break time, buildings vulnerability, average distance from affected area to dam, dam break mode, water storage, weather at dam breaking and preventive actions by government. Throughout the single factor with the rate of fatality trend analysis, the individual relationship for each factor is preliminary set up. And by multi-factor interaction analysis, key factors which affect life loss most are synthetically filtered out. Compared among different fatalities that caused by various dam break cases, the degrees of priority and significance of factors are determined which will make a foundation for the analysis and prediction approach to lower the risk of life loss.

FIELD TRIP PRESENTATION

Hydrology in action: the creation of soil moisture data

Joost Iwema*

Department of Civil Engineering, University of Bristol, UK
*Joost.Iwema@bristol.ac.uk (corresponding author)

Abstract

The goal of the field presentations is to show an example of how soil moisture data is created and what kind of challenges come forward during the process. During the field visit the Cosmic-Ray Neutron Sensor (CRNS) and other sensors will be explained, a number of measurement/sampling demonstrations will be given, and the site characteristics will be discussed.

Under the A Multi-scale Soil moisture Evapotranspiration Dynamics study (AMUSED) research project a collection of soil and surface sensors has been installed in three distinct fields at Sheepdrove Organic Farm (Berkshire). Sheepdrove Organic Farm is located on top of the UK Chalk aquifer; an important fresh water source for London and other cities. The CRNS is an above-ground sensor which provides soil moisture content estimates indirectly by measuring cosmic-ray neutron radiation. The advantage of the CRNS is that it provides these soil moisture estimates with a footprint (represented area) the size of an average agricultural field. Compared with traditional in-situ soil moisture sensors, this scale matches better with grid cell sizes of hydrological models, and with the scales at which land surface interactions of interest occur. Besides the fixed sensors soil sampling campaigns and other measurement campaigns are undertaken regularly to support the AMUSED research project.

A risk based approach to water resource management in Zambia under a changing climate

Susan Mwila Kabwe*

University of the West of Scotland, Paisley, UK
*susanmwila.kabwe@uws.ac.uk (corresponding author)

Abstract

Zambia is a fast developing country and water is a crucial resource sustaining the economy in terms of agriculture, manufacturing and energy production. Despite Zambia having a historical climate variability, there has been a growing water scarcity problem in the past three decades due to climate change related conditions and social-economic development. While simulation models have been used for more than four decades, analysing hydrological uncertainties remains a challenge, due to lack of reliable historical observations. This has contributed to poor water resource management. Therefore, this project will aim at developing better methods of integrated simulation modelling and estimations of risks and their uncertainties associated with water resource availability under a changing climate and develop a new risk based approach to decision making and planning of current and future water resources. Based on the project objectives, this study will first critical analyse water risks and vulnerabilities and quantify current water resource availability using a rainfall runoff model. Historical rainfall and average temperature data obtained from the Metrological Department of Zambia will be used to carry out a Generalised Likelihood Uncertainty Estimates (GLUE) based on the local and regional approaches. Secondly, social-economic drivers which have indirect effects on future climate change will be accommodated in the analysis using a scenario based approach so as to establish potential risks and prioritise them accordingly using the Bayesian rule. Furthermore, adaptation options such as rainwater harvesting infrastructure which help to control urban floods, will be evaluated using system dynamics and their relative contribution to drought risk quantified so as, to establish water resource adaptation options that will withstand future climate changes. Thereby, a new risk-based framework for integrated water resource management will be developed.

Catchment Management: Using sensitivity maps to target sources of nitrates in groundwater and metaldehyde in surface water

Padraig Kelly*, Divesh Mistry

Mott MacDonald, Cambridge, UK

*Padraig.Kelly@mottmac.com (corresponding author)

Abstract

Catchment management is being used to reduce nitrate and metaldehyde concentrations in waters used for public water supply in the UK. Diffuse nitrate sources are primarily from agricultural fertilisers and livestock waste. Metaldehyde is a molluscicide, it is widely used across the UK in the form of slug pellets. Unlike most pesticides, metaldehyde is not effectively removed by standard water treatment processes. The allowable limits in drinking water are 50mg/l for nitrate and 0.1µg/l for metaldehyde. There is also a European Union Water Framework Directive (WFD) requirement to reduce pollutants in water bodies to achieve 'Good' ecological and chemical status. Under the WFD, water companies are not allowed to install additional treatment (and this includes blending of source waters) and so it is necessary to solve these issues at the source, using techniques such as catchment management. The source-pathway-receptor model has been applied to pollutant transport in both groundwater and surface water where the source of the pollutant is the diffuse application of nitrate and metaldehyde primarily on arable land cover, and the receptor is the abstraction from groundwater and surface water bodies. Metaldehyde is transported along surface water pathways which include rainfall runoff from the soil surface and also field drains; both flow directly to surface water bodies with a rapid response to rainfall. Nitrate is transported along groundwater pathways including percolation through the unsaturated zone to the water table, advective transport in the saturated zone and migration through surface waters into the aquifer. Ultimately, the most significant difference between these pathways is the time duration: in groundwater it could be decades, while in surface water it could be a few hours. This presentation will use case studies from the Severn Trent Water region to compare and contrast how sensitivity maps are used to target nitrate sensitive areas in a groundwater catchment and metaldehyde sensitive areas in a surface water catchment. Using this targeted approach, catchment management measures can be most efficiently targeted to achieve an effective result.

Uncertainty estimation of hourly extreme rainfall in S. Korea

Dongik Kim*, Dawei Han

Department of Civil Engineering, University of Bristol, Bristol, UK
*dk15461@bristol.ac.uk (corresponding author)

Abstract

A lot of old cities of South Korea have suffered from urban floods. Dongducheon is one of these cities and it needs the countermeasure against these hazards. Identification of exact hourly rainfall depth by the return period from 41 year observation data will be the first step to estimate the design flood in this city. However, it is clear that rainfall frequency may include an amount of the uncertainty due to the sampling error, uncertainty from estimation methods or others. From this concept, it is essential to explore the uncertainty of rainfall frequency. In this research, uncertainty estimation was conducted by Markov Chain Monte Carlo (MCMC) and random sampling with placement (Bootstrapping) method.

Towards methodical modelling: Differences between the structure and output dynamics of multiple conceptual models

Wouter Knoben[1*], Ross Woods[1], Jim Freer[2]

[1]Department of Civil Engineering, University of Bristol, Bristol, UK,
[2]School of Geographical Sciences, University of Bristol, Bristol, UK
*wk14463@bristol.ac.uk (corresponding author)

Abstract

Conceptual hydrologic models consist of a certain arrangement of spatial and temporal dynamics consisting of stores, fluxes and transformation functions, depending on the modeller's choices and intended use. They have the advantages of being computationally efficient, being relatively easy model structures to reconfigure and having relatively low input data demands. This makes them well-suited for large-scale and large-sample hydrology, where appropriately representing the dominant hydrologic functions of a catchment is a main concern. Given these requirements, the number of parameters in the model cannot be too high, to avoid equifinality and identifiability issues. This limits the number and level of complexity of dominant hydrologic processes the model can represent. Specific purposes and places thus require a specific model and this has led to an abundance of conceptual hydrologic models. No structured overview of these models exists and there is no clear method to select appropriate model structures for different catchments. This study is a first step towards creating an overview of the elements that make up conceptual models, which may later assist a modeller in finding an appropriate model structure for a given catchment. To this end, this study brings together over 30 past and present conceptual models. The reviewed model structures are simply different configurations of three basic model elements (stores, fluxes and transformation functions), depending on the hydrologic processes the models are intended to represent. Differences also exist in the inner workings of the stores, fluxes and transformations, i.e. the mathematical formulations that describe each model element's intended behaviour. We investigate the hypothesis that different model structures can produce similar behavioural simulations. This can clarify the overview of model elements by grouping elements which are similar, which can improve model structure selection.

Flood hazard assessment in areas prone to flash flooding

Davor Kvocka*, Roger A. Falconer, Michaela Bray

Hydro-environmental Research Centre, Cardiff University, Cardiff, UK
*kvockad@cf.ac.uk (corresponding author)

Abstract

Contemporary climate projections suggest that there will be an increase in the occurrence of high-intensity rainfall events in the future. These precipitation extremes are usually the main cause for the emergence of extreme flooding, such as flash flooding. Flash floods are among the most unpredictable, violent and fatal natural hazards in the world. Furthermore, it is expected that flash flooding will occur even more frequently in the future due to more frequent development of extreme weather events, which will greatly increase the danger to people caused by flash flooding. This being the case, there will be a need for high resolution flood hazard maps in areas susceptible to flash flooding. This study investigates what type of flood hazard assessment methods should be used for assessing the flood hazard to people caused by flash flooding. Two different types of flood hazard assessment methods were tested: (i) a widely used method based on an empirical analysis, and (ii) a new, physically based and experimentally calibrated method. Two flash flood events were considered herein, namely: the 2004 Boscastle flash flood and the 2007 Zelezniki flash flood. The results obtained in this study suggest that in the areas susceptible to extreme flooding, the flood hazard assessment should be conducted using methods based on a mechanics-based analysis. In comparison to standard flood hazard assessment methods, these physically based methods: (i) take into account all of the physical forces, which act on a human body in floodwater, (ii) successfully adapt to abrupt changes in the flow regime, which often occur for flash flood events, and (iii) rapidly assess a flood hazard index in a relatively short period of time.

An assessment of Advanced Microwave Scanning Radiometer 2 (AMSR2) soil moisture products with in-situ observation

Moonhyuk Kwon*, Dawei Han

Department of Civil Engineering, University of Bristol, Bristol, UK

* mk15217@bristol.ac.uk (corresponding author)

Abstract

Remote sensing technology is an important complimentary tool for observing and monitoring hydrological components around the globe, especially where observation data are scarce or not available. Global soil moisture products retrieved from various remote sensing sensors are becoming available with a near-daily temporal resolution. However, due to differences in spatial resolution, measurements uncertainty, etc., validation of satellite data with in-situ observation and/or modelled data such as Global Land Data Assimilation System (GLDAS) is not always straightforward. In addition, there are uncertainties with in-situ observation, so proper assessment methodology is also required to identify unreliable observation data. In this study, a comprehensive assessment of the reliability of soil moisture estimations obtained with AMSR2 is carried out by in-situ data and GLDAS data.

Bias correction of the AMSR2 data using Quantile mapping and linear regression method is applied to address systematic differences between remotely sensed data and observation data. It can be seen that bias correction using ground network data improved the applicability of remotely sensed soil moisture. However, further studies are required for better understanding of the AMSR2 soil moisture products.

Study on the Basin Initial Water Rights Allocation based on Projection Pursuit Model

Jinhua Liu[1,2*], Dawei Han[1]

[1]Department of Civil Engineering, University of Bristol, Bristol, UK

[2]Business School, Hohai University, Nanjing, China

* jhua.liu@bristol.ac.uk (corresponding author)

Abstract

The basin initial water rights allocation is a typical nonlinear, abnormal and multidimensional system decision-making problem which involves various resource distribution, economic, social and environment objectives. It is usually difficult to solve the decision-making problem by using the traditional methods because of the large subjectivity of weight determination. Projection Pursuit (PP) is adopted to the dimension reduction of the decision-making problem in the basin initial water rights allocation process. The model is driven directly by the sample data, and the optimum projection values of various schemes were calculated according to the optimum projection direction so as to realize the goal of the basin initial water rights allocation in low-dimensional space. The method owns the advantages of complying with basin initial water rights allocation mechanism and meeting the control requirements of water quantity, water quality and water utilization efficiency, which help to achieve effective allocation of water resource.

Flood events across the North Atlantic region - are they changing consistently?

Bettina Matti[1*], Helen E. Dahlke[2], Bastien Dieppois[1], Steve W. Lyon[3], Damian M. Lawler[1]

[1]Centre for Agroecology, Water and Resilience, Coventry University, Coventry, UK
[2]Department of Land, Air and Water Resources, University of California, Davis, USA
[3]Department of Physical Geography, Stockholm University, Stockholm, Sweden
*mattib@uni.coventry.ac.uk (corresponding author)

Abstract

Flood events have a large impact on humans, both socially and economically. An increase in winter and spring flooding across much of northern Europe in recent years opened up the question of changing underlying hydro-climatic drivers of flood events. Predicting the manifestation of such changes is difficult due to the fluctuations in northern hydrological systems caused by large-scale atmospheric circulations, especially under altered climate conditions. Improving knowledge on the complexity of these hydrological systems and their interactions with climate is essential to be able to determine drivers of flood events and to predict changes in these drivers under altered climate conditions. This is particularly true for the North Atlantic region where both physical catchment properties and large-scale atmospheric circulations have a profound influence on floods. This study explores changes in streamflow across northern North Atlantic catchments over the past century. An emphasis is placed on high-flow events, namely the timing and magnitude of flood events, and selected flood percentiles were tested for stationarity by applying a flood frequency analysis using a moving window approach. Results indicate that flood return periods are highly variable which has to be taken into account interpreting trends in flood percentiles. A multi-temporal approach and long time series thus are desired to cover flood cycles present in the records. The lack of an overall regional pattern suggests that how catchments respond to changes in climatic drivers is strongly influenced by their physical characteristics. A better understanding of hydrological response to climate driver and accounting for non-stationarity in flood response caused by large-scale atmospheric circulation patterns is challenging but essential especially for forecasting and management purposes.

Numerical modelling of heavy rainfall over Newcastle in 2012

Iskra Mejia Estrada*, Paul Bates

School of Geographical Sciences, University of Bristol, Bristol, UK
*pm15021@bristol.ac.uk (corresponding author)

Among the different types of floods (coastal, pluvial, fluvial), flash floods are particularly dangerous due to the short lead time between the start of the rain and the sudden rise of water levels that can then flow at high speeds in a given area. Understanding the meteorological setting that leads to a flash flood event, such as the spatial and temporal distribution of heavy rainfall, is crucial to how an urban catchment responds to high precipitation rates, to plan actions to reduce flood risk and to improve the forecast of similar events. This topic is particularly relevant given the recent findings on the possibility of future increase in the frequency of extreme precipitation during summer in the UK. Considering the above, the present work deals with modelling the rainfall that led to a flash flood event in the area around Newcastle upon Tyne in June 2012 when precipitation recorded in one day was around double the normal monthly value. The modelling was carried out using a meso-scale numerical weather prediction tool developed by the National Center for Atmospheric Research, namely the Weather Research and Forecasting (WRF) model, to produce an ensemble of downscaled precipitation scenarios with a high resolution in the area of interest. A reduced computational cost was procured at all times while choosing parameterisations schemes that best describe the physics of the event. Final outputs of the modelling process comprise precipitation maps every 30 minutes over a 2 km grid around the area of interest, so that a qualitative comparison with rainfall radar imagery was possible. Upcoming work includes point validation with data from rain gauges to obtain skill score parameters that quantitatively describe the model performance to ensure that the results represent a robust contribution to a flash floods historical database.

Application of rainfall estimates using radar-raingauge merging techniques for hydrological simulations

Nanding*, Miguel Rico-Ramirez, Dawei Han

Department of Civil Engineering, University of Bristol, Bristol, UK

*n.nanding@bristol.ac.uk (corresponding author)

Abstract

Hydrological forecasting is highly considered as one of the most important application of radar rainfall estimates. This is due to its capability for providing more detailed information on the spatial variability of precipitation distribution with a high resolution in space and time, which is unable to obtain through the raingauge point observations. However, the potential of radar rainfall estimates has often been limited by a variety of source of errors. More recently, research has proven that by combining radar rainfall estimates with raingauge measurements it is possible to obtain better rainfall estimates that are also able to capture the spatial precipitation variability. However, the impact of using merged rainfall products as compared with conventional raingauge inputs, with respect to various hydrological model structures and catchment areas, remains unclear and yet to be addressed. In the study presented by this paper, we analysed the flow simulations of different sized catchments across Northern England using rainfall inputs from different radar-raingauge merging techniques, such as Kriging with radar-based correction (KRE) and Kriging with external drift (KED). Rainfall was estimated at an hourly timescale and therefore rainfall estimates obtained from different radar-gauge merging techniques at hourly resolution are incorporated into hydrological models so that direct comparison of streamflows can be explored. The main purpose of this paper is to examine whether these merged rainfall estimates are useful as input to rainfall-runoff models over near-natural rural catchments, focusing on the improvement of rainfall estimates by radar-raingauge merging techniques for runoff predictions rather than on the rainfall estimates themselves in relation to the catchments sizes and storm events.

Assessing the uncertainties related to the temporal evolution of the rainfall velocity field in radar nowcastings

Mayra C. Oliveira*, Miguel Rico-Ramirez

Department of Civil Engineering, University of Bristol, UK
*mayra.codo@bristol.ac.uk (corresponding author)

Abstract

Flooding is a very common natural disaster, putting local population at risk and heavily affecting the economy. Due to climate change, its frequency and intensity is expected to increase. In urban areas, the impact is even higher, once there is a greater area of impermeable surfaces and the large concentration of people. Being so, to accurately predict extreme rainfall events hours ahead is very important, permitting to effectively respond to emergency situations. However, rainfall forecasting are subject to different sources of uncertainties.

Nowcasting models are short-term rainfall forecasts capable of producing predictions a few hours ahead with high spatial and temporal resolution. Nonetheless, nowcasts are subject to uncertainties due to radar errors, temporal development of velocity fields and temporal evolution of rainfall. The assumption that the temporal development of velocity fields are stationary contribute to uncertainties in the forecast after 1h lead-time.

This work attempts to address the uncertainties related to the temporal development of rainfall velocity fields, adding noise in realistic way to generate ensembles. Radar data from the UK Met Office was used. Radar data from 20 events with stratiform and convective rainfall from 2008 were selected. The rainfall velocity fields were calculated through the nowcasting model. Rainfall forecasts are generated using motion fields from the last few forecasts to produce ensembles that take into account the uncertainty in the motion fields. Rainfall velocity fields are calculated using radar scans that are 5, 10 and 15 min apart from each other. Each velocity field can produce a new ensemble. Preliminary results show that there is a strong influence of the rainfall velocity fields in the forecast with a few hours of lead-time. This poster presents the results of this new method to generate ensembles assessing their value compared to deterministic rainfall forecasts.

Hydrological Outlook UK; seasonal river flow forecasts using rainfall forecasts

Alison Rudd[1*], Victoria Bell[1], Helen Davies[1], Adam Scaife[2]

[1]Centre for Ecology & Hydrology, Wallingford, UK,
[2]Met Office, Exeter, UK
*alirud@ceh.ac.uk (corresponding author)

Abstract

Hydrological predictions in the UK are strongly influenced by both rainfall and antecedent soil conditions. The Flood Forecasting Centre (FFC) and Scottish Flood Forecasting Service (SFFS) operationally issue flood alerts and warnings, however these typically apply only days to weeks ahead. There was a desire to produce a more long-term (seasonal) forecast of the water situation for flooding and drought periods similar to that produced in countries such as the USA and Australia. The Centre for Ecology & Hydrology (CEH) along with a number of partners have developed a long-range hydrological forecast for the UK. The Hydrological Outlook UK (www.hydoutuk.net) is the first operational forecast system for the UK that delivers monthly outlooks of the water situation for both river flow and groundwater levels. It brings together information on current and forecast weather conditions, soil moisture, river flows and groundwater levels, and uses a number of modelling approaches to explore possible future hydrological conditions. It is based on merging three complementary methods: (i) a statistical method based on river flow analogues and persistence, (ii) a Streamflow Ensemble Prediction System applied to selected catchments and boreholes; and (iii) a national hydrological forecast driven by an ensemble of 1 and 3 month-ahead rainfall forecasts from the UK Met Office's GloSea5 model. Here we focus on the national scale hydrological forecasts, showing an example of the seasonal river flow forecasts and how they contribute to the Hydrological Outlooks UK monthly summary. The output from the different modelling methods and the summary are publicly available and used each month by government agencies, practitioners and academics alongside other sources of information such as flood warnings, meteorological forecasts and water situation reports.

How much does subsurface heterogeneity alter the impact of climate and land use changes on groundwater recharge?

Fanny Sarrazin[1*], Andreas Hartmann[1,2], Francesca Pianosi[1], Thorsten Wagener[1,3]

[1]Department of Civil Engineering, University of Bristol, Bristol, UK

[2] Faculty of Environment and Natural Resources, University of Freiburg, Freiburg, Germany

[3]Cabot Institute, University of Bristol, Bristol, UK

* fanny.sarrazin@bristol.ac.uk (corresponding author)

Abstract

Karst aquifers are an important source of drinking water in many regions of the world, but their resources are likely to be affected by changes in climate and land use. In fact, climate characteristics control the supply of water to karst systems and the evaporative demand, while land use characteristics control the actual evapotranspiration losses. Understanding karst hydrology and estimating karst groundwater resources at a large-scale is critical for preventing threats to water supply in a changing world. Hartmann et al. (2015, Geosci. Model Dev.) introduced a parsimonious karst recharge model, called VarKarst-R, which allows for large-scale simulations of groundwater recharge while explicitly taking into account karst heterogeneities, i.e. preferential flow paths. The first objective of the present study is to introduce vegetation processes into the VarKarst-R model to better estimate evapotranspiration losses depending on the land use characteristics. We test the model at Fluxnet sites located in carbonate rock areas. Secondly, the VarKarst-R model so modified is used to assess the relative influence of changes in climate and land use on aquifer recharge. We establish a sensitivity analysis framework to analyse the interactions between climate descriptors (e.g. mean precipitation, precipitation seasonality), vegetation parameters (e.g. canopy storage capacity, rooting depth) and soil parameters (e.g. soil storage).

Investigating Flooding From Multiple Sources: A coupled model and high resolution national datasets

Ben Smith*, Geoff Parkin

Water Research Group, Newcastle University, Newcastle upon Tyne, UK
*B.A.H.Smith2@Ncl.ac.uk (corresponding author)

Abstract

In the UK, approximately 122,000-290,000 properties are at risk of groundwater flooding. Furthermore, as high antecedent groundwater conditions increase the risk of flooding from pluvial and fluvial sources, it is not surprising that almost 1 million properties around the UK are at risk of multisourced flooding. Despite this, due to a lack of research in the field of groundwater flooding, not much is known about the risk posed by multisource flooding in the UK. My PhD will continue the development of a coupled groundwater-surface water model. The model consists of the groundwater module of the physically based, spatially distributed hydrological SHETRAN model loosely coupled with the High-Performance Integrated hydrodynamic Modelling System (HiPIMS). This allows the broad movement of groundwater to be input into HiPIMS for high resolution surface routing, hopefully increasing the accuracy and realism of flood risk estimations. This work aims to: (1) determine in what areas, and under what conditions, a multisourced assessment of flood risk is appropriate. (2) Test the coupled model on a range of case study catchments across the UK, calibrating against both river level and borehole data. (3) Investigate whether assessing flooding from multiple sources alters our understanding of flood risk and consider the effect of climate change from a multisourced perspective. Currently addressing my first aim, I am conducting multiple lines of analysis on the national river level dataset. These include wavelet analysis and the recently coined 'base level separation' to try and estimate the relative influences of groundwater and surface water on river catchments around the UK.

High Temporal Resolution Rainfall Intensity Retrieval Based on Tipping-Bucket Rain Gauge Measurements by Applying Artificial Neural Networks Approach

Yang Song*, Dawei Han, Miguel A. Rico-Ramirez

Department of Civil Engineering, University of Bristol, Bristol, UK

*ys14464@bristol.ac.uk (corresponding author)

Abstract

Disdrometer is important in detailed rainfall process restoring by providing high temporal resolution rainfall information. Tipping-Bucket rain gauges are commonly used to derive rainfall rate, however, temporal variation is usually being neglected especially in the low rainfall intensity periods. This study explores the artificial neural networks (ANN) approach along with the conventional Cubic Spline Algorithm (CSA) and Multivariate Linear Regression method (MLR) for retrieving high temporal resolution rainfall rate for the period of 2007 to 2009 at Chilbolton, U.K. The Supervised Levenberg-Marquardt backpropagation algorithm and the K-folds cross-validation method are integrated in a feed-forward neural network as to implicitly discover complex nonlinear relationships and to prevent model from overfitting. Results indicate ANN performs as well as CSA after training, but with poor generalisation in test due to low correlation between input and target data, besides the curse of dimensionality in optimum model complexity selection. MLR can be an optional method in estimating rainfall rate though it highly depends on the data quality.

The UK's National Hydrological Monitoring Programme Hydrological Summary

Stephen Turner*

Centre for Ecology & Hydrology, Wallingford, UK

*stetur@ceh.ac.uk (corresponding author)

Abstract

The National Hydrological Monitoring programme (NHMP) aims to provide a respected and influential review of hydrological conditions across the United Kingdom. The programme is undertaken jointly by the Centre for Ecology & Hydrology and the British Geographical Survey and aims to conduct a wide range of analysis of National River Flow Archive (NRFA) data in order to document, identify and interpret current and past hydrological conditions. One method the NHMP uses to accomplish its aims is the Hydrological Summary. This is a regular monthly report that describes the preceding month's conditions analysing four main areas; rainfall, river flows, reservoir levels and groundwater. In order to do this a wide range of information and data from a variety of sources needs to be quality and sense checked, analysed and interpreted so it can be summarised into a clear and accessible report. The Summary is used by a variety of academic, commercial, and media audiences as well as appealing to wider public interests. The Summary is deemed to be of use to many decision makers at many levels but is most notably referred to in times of flood and drought. As well as the data being shown in the report, a commentary is produced which examines any notable hydrological events for that period and summarises the national hydrological status in the UK. The poster's aim is to describe the Hydrological Summary production processes, mapping the various data sources, processing, and analysis used in order to produce the report. The outputs of the Hydrological Summary are also discussed in terms of what data is chosen to feature and how the data is condensed into an accessible, and informative report every month.

Reducing uncertainty in small-catchment flood peak estimation

Gianni Vesuviano[1*], Lisa Stewart[1], Tracey Haxton[2], Andy Young[2], Tim Hunt[3], Peter Spencer[3], Mark Whitling[3]

[1]Centre for Ecology & Hydrology, Wallingford, UK
[2]Wallingford HydroSolutions, Wallingford
[3]Environment Agency, Bristol, UK
*giaves@ceh.ac.uk (corresponding author)

Abstract

Every year in the UK, many flood risk assessments are carried out on small catchments, typically draining areas of less than 25 km^2. Standard hydrological practice in all UK catchments is to apply the methods presented in the Flood Estimation Handbook (FEH) and its subsequent updates. FEH methods are practical, relatively easy to apply and based on extensive statistical analyses. However, uncertainties can be large, especially in atypical catchments and small catchments can present unique challenges in terms of heavy urbanisation and rapid flood responses. Compared to larger catchments, small catchment flood data are limited. In this study, we use a dataset of annual maxima and digital catchment descriptors at 205 small catchments to benchmark the QMED (median annual flood) and Q100 (1-in-100 year flood) estimation estimation performance of current UK flood estimation methods: the FEH statistical method, ReFH2 and MacDonald and Fraser's method, in rural and urbanised catchments separately. All methods perform similarly in rural catchments overall, although MacDonald and Fraser's method underestimates QMED in urbanised catchments. The methods show a larger factorial standard error against this small catchment dataset than they do against typical datasets of mixed-size catchments. Further work will evaluate the performance of ReFH2 in combination with the latest FEH13 rainfall model.

Response of Runoff Modelling on Spatial Variability of Rainfall Input Data in the Brue catchment, UK

Jun Zhang[1*], Dawei Han[1], Jim Freer[2], Thorsten Wagener[1,3]

[1]Department of Civil Engineering, University of Bristol, Bristol, UK
[2]School of Geographical Sciences, University of Bristol, Bristol, UK
[3]Cabot Institute, University of Bristol, Bristol, UK
*jun.zhang@bristol.ac.uk (corresponding author)

Abstract

Due to the spatial variability of rainfall, the corresponding runoff is supposed to be unevenly distributed across the whole catchment. The coefficient of variance (Cv) and Moran's I are adopted to assess the spatial variability in the Brue catchment, UK. Models with varied hydrological response units (HRU) are employed to test the performance in rainfall events of different spatial variability. The results show that the most complex model (with 27 HRUs) generally performs better than the other models with fewer HRUs. However, it is also concluded that for simple events, a simple model is sufficient to obtain acceptable simulated results with less computation load and time. For rainfall events with complex spatial distribution, it is recommended to choose a complex model capable of dealing with more spatial information.

Terminology gap in hydrological cycle

Lu Zhuo*, Dawei Han

Department of Civil Engineering, University of Bristol, Bristol, UK
*lu.zhuo@bristol.ac.uk (corresponding author)

Abstract

Water is central to life on Earth. People have been trying to understand how water moves in the hydrosphere throughout the human history. In the 9th century BC, the famous Greek poet Homer described the hydrological cycle in Iliad as ‘okeanos whose stream bends back in a circle’ with a belief that rivers are ocean-fed from subterranean seas. Later, Aristotle (4th century BC) claimed that most of the water came from underground caverns in which air was transformed into water. It was only until 1674, French scientist Perrault developed the correct concept of the water cycle. In modern times, scientists are interested in understanding the individual processes of the hydrological cycle with a keen focus on runoff which supplies water to rivers, lakes, and oceans. Currently, the prevailing concepts on runoff processes include ‘infiltration excess runoff’ and ‘saturation excess runoff’. However, there is no term to describe another major runoff due to the excess beyond the soil water holding capacity (i.e., the field capacity). We argue that a new term should be introduced to fill this gap, and it could be called ‘holding excess runoff’ which is compatible with the convention. This new term is significant in correcting a half-century misnomer where ‘holding excess runoff’ has been incorrectly named as ‘saturation excess runoff’, which was introduced by the Xinanjiang model in China in 1960s. Similar concept has been adopted in many well-known hydrological models such as PDM and HBV in which the saturation refers to the field capacity. The term 'holding excess runoff' resolves such a common confusion in the hydrological community.

Practical information for field trip on 27th May

We will be outside for several hours. The fields of Sheepdrove Farm are very much exposed to wind, rain, and sunshine. Please bring suitable clothing:

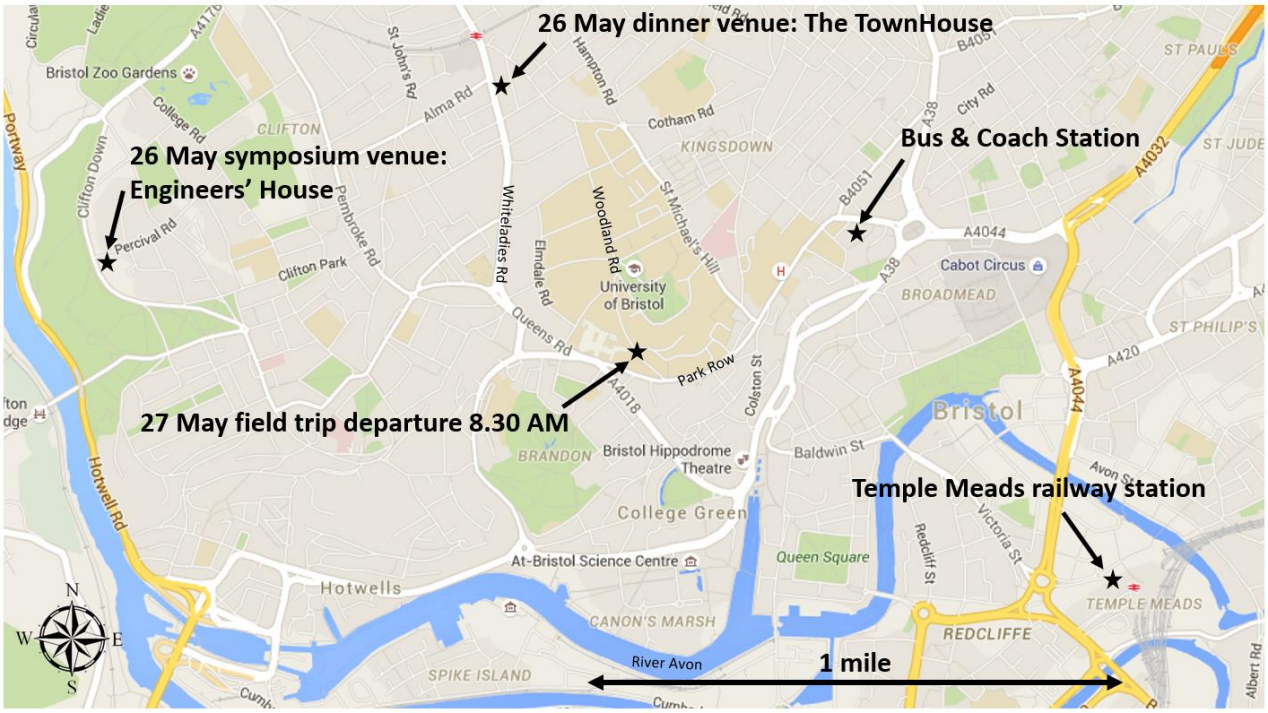
- Rain proof clothing
- Clothes that may get dirty
- Sun protection
- Walking shoes or boots
- An extra pair of shoes to wear on the bus

Only lunch will be provided. Please arrange for breakfast, snacks, and water yourselves.

Map for Field Trip to Sheepdrove Organic Farm on the 27th of May

Map of Bristol, addresses, and directions

Map of Bristol City Centre



Addresses

Bristol Bus & Coach Station

Marlborough Street, Bristol BS1 3NU

26 May Symposium venue: Engineers' House

Address: The Promenade, Clifton Down, Bristol BS8 3NB

26 May dinner venue: The TownHouse (dinner starts 19:00 o'clock)

85 Whiteladies Road, Bristol BS8 2NT

27 May field trip departure (8:30 AM) and final drop-off point (19:00 o'clock)

In front of the main entrance of Merchant Venturers Building (75 Woodland Road, Bristol) on Woodland Road.

Route descriptions

From Bus & Coach Station to Engineers' House (Symposium venue) (4 minutes' walk + 20 minutes bus)

Walk to Rupert Street bus stop (4 min):

- Exit the coach station through the entrance/exit facing 'Café Refectoire'
- Continue walking with 'Café Refectoire' on your left hand
- Turn onto the path through St James' Park
- Cross the road (A38/Lewins Mead/The Haymarket)
- Turn right onto Bridewell Street (which continues as Rupert Street)

Take bus 8 to Clifton (20 minutes, every 15 minutes)

- Leave the bus at Percival Road bus stop (8th stop)
  This bus stop is located at the T-junction of Clifton Down and Percival Road.

You will see Engineers' House across Clifton Down.

From Temple Meads railway station to Engineers' House (35 minutes bus)

- Leave Temple Meads railway station through the main exit (where the taxis are)
- Continue onto the pavement on the right side of the road
- After 40 m you arrive at bus stop Temple Meads Ta

Take bus 8 to Clifton (35 minutes, every 15 minutes)

- Leave the bus at Percival Road bus stop (14th stop)
  This bus stop is located at the T-junction of Clifton Down and Percival Road.

You will see Engineers' House across Clifton Down.

From Engineers' House to The TownHouse (dinner venue) (20 minutes' walk)

- Walk south-east on Clifton Down towards Observatory Road
- After 0.2 mi turn left onto Harley Pl
- After 410 ft continue onto Clifton Park
- After 0.3 mi turn left onto Pembroke Road
- After 300 ft turn right onto Oakfield Road
- After 0.3 mi turn left onto Whiteladies Road
- Continue for 0.1 mi on Whiteladies Road
- The TownHouse is located on the right hand side of the road