SUDSnet International Conference

3rd & 4th September 2015

"Taking SUDS forward"

Conference Proceedings

Organised by:

Abertay University
Coventry University

Supported by:

ciria
urbanwater TECHNOLOGY CENTRE
Marshalls Creating Better Spaces

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Organised by:

Supported by:

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Contents…

- Welcome message
- Overview programme
- List of abstracts by session
- Delegate list

Welcome Message

We are delighted to welcome you to SUDSnet International Conference 2015 in Coventry. This years' theme is 'Taking SUDS Forward'. The conference presentations cover a broad range of topics relating to SUDS and will be delivered by speakers from academia, industry and practice. This year we have added an exciting session dedicated to 'SUDS out of the Temperate Zone'. Our keynote speakers from Spain and South Africa reflect this new focus and will share their experiences.

SUDSnet continues its' commitment to supporting students studying SUDS and we start the conference with a session dedicated to postgraduate student work.

Other sessions this year include; 'Ecosystem services and SUDS', 'Performance testing', 'Surface Water management' and 'Urban Hydrology'.

Our thanks go to all of the speakers who have offered such interesting papers and to all of the delegates who will add to the lively discussions throughout the conference, helping us collectively to take SUDS forward.

Special thanks also to the conference organisers; Universities of Abertay and Coventry, and to conference supporters CIRIA and the Urban Water Technology Centre (UWTC).

Thank you for attending and contributing to SUDSnet 2015. Enjoy the conference!

Rebecca and Sue

SUDSnet Coordinator at Abertay University: Dr Rebecca Wade
SUDSnet Coordinator at Coventry University: Prof Susanne Charlesworth
Web: http://sudsnet.abertay.ac.uk/
E-mail: sudsnet@abertay.ac.uk

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Organised by:

Supported by:

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Overview Programme

Day 1- Thursday 3rd Sept 2015

09.00 - 09.30	**Registration**
09.30 - 09.40	**Introduction and conference welcome**
09.40 - 12.00	**Session 1 - Post-graduate Session**
12.00 - 13.20	**Networking LUNCH – registration continues**
13:20 - 13:40	**KEYNOTE SPEAKER: Ignacio Andrés Doménech**
13.40 - 15.20	**Session 2 - Eco-system Services and SUDS**
15.20 - 15.40	**Break**
15.40 - 17.20	**Session 3 - Performance Testing**
17.20 - 18.00	**Discussion and Close of Day 1**

Conference Dinner – Evening of 3rd Sept at the Techno-Centre

Day 2 - Friday 4th Sept 2015

09.00 - 09.20	**Registration**
09.20 - 11.00	**Session 4 - SUDS out of the Temperate Zone**
09.20 - 09.40	**KEYNOTE SPEAKER: Kevin Winter**
10:30 - 11:00	**Break**
11.00 - 12.40	**Session 5 - Surface Water Management**
12.40 - 14.00	**LUNCH**
14.00 - 16.00	**Session 6 - Urban Hydrology**
15:00 - 15.20	**Break**
16.00 - 16.30	**Day 2 Final Discussions and Close of Conference**

Organised by:

Supported by:

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Organised by:

Supported by:

SUDSnet 2015 – List of Abstracts by Session

Day 1- Thursday 3rd Sept 2015

Session 1 - Post-graduate Session

Title	Author(s)
Retrofit SuDS: Distribution, Efficiency and Impact	Matthew Badger, Virginia Stovin, James Shucksmith, Kevin McCreath, Adam Brookes
Temporal Changes in Green Roof Hydrological Performance	Simon De-Ville, Virginia Stovin, Manoj Menon
Sustainable Drainage: end-of-life	Anne-Marie McLaughlin, Susanne Charlesworth, Steve Coupe, Eduardo De Miguel
Representing vegetation within a CFD pond model	Mahshid Golzar and Virginia Stovin
Creating a Sustainable Drainage Flood Management Decision Support Tool	Craig Lashford, Susanne Charlesworth, Matthew Blackett, Frank Warwick
Clogging Of Filtration Suds: Evaluation of the long-term performance of Scottish trunk road filter drains	Ged Mitchell
Re-visiting the first flush concept – stormwater runoff from industrial estates	Marta Ibanez, Allan Cundill, Brian D'Arcy, Mark Hammonds, Fiona Napier, Louise Asher, Rebecca Wade

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Retrofit SuDS: Distribution, Efficiency and Impact

Matthew Badger[1], Virginia Stovin[1], James Shucksmith[1], Kevin McCreath[2] and Adam Brookes[3]

[1]Pennine Water Group, Department of Civil and Structural Engineering, The University of Sheffield, Sheffield, S1 3JD, England, United Kingdom
[2]Scottish Water, Castle House, 6 Castle Drive, Dunfermline, Fife, KY11 8GG, Scotland, United Kingdom
[3]Anglian Water, Thorpe Wood House, Thorpe Wood, Peterborough, PE3 6SG, England, United Kingdom

Corresponding author E-mail: matthew.badger@stream-idc.net

Abstract: Replacing or augmenting an existing drainage network with sustainable drainage systems is known as retrofit SuDS. There are many types of SuDS which may be used, and SuDS possess a generic ability to manage urban stormwater run-off from many types of surface within an urban landscape. These two facets should aid and encourage the use of retrofit SuDS, as they act to provide multiple options for distributing retrofit SuDS within an urban area. However, given this range of possibilities, establishing confidence in a retrofit SuDS design distribution is complicated.

This situation necessitates the use of decision support systems to assist practitioners in distributing retrofit SuDS in a logical manner. Existing retrofit SuDS decision support systems of this type have favoured opportunistic (e.g. Digman *et al*., 2012), indiscriminate (e.g. Toronto's Mandatory Downspout Disconnection programme [Waters *et al*., 2010]), constraint-driven (e.g. Scholz, 2006) or land use-driven (e.g. Swan and Stovin, 2002) approaches.

Across these types of decision support system, the spatial distribution of retrofit SuDS with regard to the local sewer system has been neglected or considered subsidiary to other metrics. This can be seen to have hindered retrofit SuDS propagation in the UK as wastewater service providers, responsible for sewer systems, are key stakeholders in many retrofit SuDS use opportunities.

This paper presents a method to understand the relationship between retrofit SuDS distribution and improvements to combined sewer system performance metrics. The method also identifies the type of retrofit SuDS that most efficiently provide benefits to sewer system performance, and limits of efficacy. The method is subsequently tested against a real-world case study location in the UK. The conclusions can be used to inform more efficient retrofit SuDS design, and support retrofit SuDS use where the project objective includes improving or protecting sewer system performance.

References

Digman, C.J., Ashley, R.M., Balmforth, D.J., Balmforth, D.W., Stovin, V.R. and Glerum, J.W. (2012) CIRIA C713: Retrofitting to Manage Surface Water, London

Scholz, M. (2006) Decision-support tools for sustainable drainage *Proceedings of the Institution of Civil Engineers – Engineering Sustainability Issue* ES3 pp. 117-125

Swan, A.D. and Stovin, V.R. (2002) A decision-support framework for the design of retrofit SUDS *International Conference on Sewer Operation and Maintenance* (SOM2002), Bradford, November

Waters, D., Watt, W.E., Marsalek, J. and Anderson, B.C. (2010) Adaptation of a Storm Drainage System to Accommodate Increased Rainfall Resulting from Climate Change *J. of Env. Planning and Management, 46:5, 755-770*

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Temporal Changes in Green Roof Hydrological Performance

Simon De-Ville, Virginia Stovin, Manoj Menon

Department of Civil & Structural Engineering, The University of Sheffield, UK.

Corresponding author E-mail: sde-ville1@sheffield.ac.uk

Abstract:

The two active elements of a green roof, the vegetation and substrate, are subject to a number of processes that have the potential to alter hydrological performance over time. Some of these processes are well understood. For example, the daily changes in evapotranspiration can greatly alter a green roof's retention performance. The effects of other key processes – such as root system development, organic matter turnover and substrate consolidation – are less well understood in a green roof hydrological performance context. There is currently little knowledge surrounding the magnitude of any effects and whether potential changes in performance over time should be considered at the design stage.

Using a long term data record (5+ years), temporal trends and patterns in detention performance of nine different extensive green roofs have been identified. It has been found that for some roof configurations there is a year-on-year decline in detention performance. At a higher temporal resolution, seasonal differences in detention performance can also be seen, with worsened performance in the summer compared with winter.

To understand what is driving these changes it is necessary to look inside of the green roof substrate and determine any changes to its physical properties. This has been achieved using X-Ray Microtomography (XMT). XMT has been used to determine key substrate properties for controlling hydrological performance, such as particle and pore size distributions, porosity and permeability.

Changes in substrate properties have been seen over time, with reductions in total porosity and a shift in particle size distribution to smaller particle diameters. These changes in substrate properties may well be the cause of deteriorating hydrological performance with age. Further controlled experimentation and examination of additional substrate properties is required to confirm the links between substrate properties, hydrological performance and age.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Sustainable Drainage: end-of-life

Anne-Marie McLaughlin, Sue Charlesworth, Steve Coupe, Eduardo De Miguel

Coventry University

Corresponding author E-mail: apx119@coventry.ac.uk

Abstract:

SuDs manage the environmental risks of urban runoff and encourage environmental enhancement where possible. This study aims to focus on the sediment quality aspect of these systems and their resilience to the pollutants they store. The literature on the long term monitoring of SuDs and end-of-life is scarce. End-of-life is defined as the expiration of a device, where the efficiency to treat pollutants has declined. SuDs are efficient at trapping pollutants by reducing sediment run-off and water treatment (e.g. geotextiles in porous paving systems). However, it is not known how long the accumulation of these pollutants will take to affect the treatment efficiency of SuDs and therefore, its design life. As certain pollutants are non-degradable, the buildup of contaminants could possibly be classified as hazardous waste at end-of-life and a potential risk to human health. It is therefore proposed to assess them for their bioavailability. It is not known whether these materials are capable of reaching receiving water bodies if the threshold of the SuDs capacity to hold pollutants is exceeded and thus, deteriorates the water quality of local water courses. As the majority of SuDs systems in this study will still be in operation, it will be important to extrapolate the information to meet the aims and objectives. Furthermore, disposal routes for different SuDs systems will be established as there is scope to possibly recycle certain components of a SuDs device at end-of-life. Therefore, this project provides a comprehensive study on the consequences of pollutant storage in SUDs, the effects it has on end-of-life and the classification of the accumulated waste products.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Representing vegetation within a CFD pond model

Mahshid Golzar and Virginia Stovin

University of Sheffield

Corresponding author E-mail: mgolzar1@sheffield.ac.uk

Abstract:

Storm water ponds, as components of urban drainage systems, play an important role in terms of meeting water quality objectives. Vegetation improves these systems' performance in two ways, first by increasing residence time and second by acting as a habitat for organisms. Efficient design needs basic understanding of vegetation effects on hydrodynamic behaviour of flow within the open and vegetated parts of the pond. For instance, short-circuiting is one of the common problems in ponds, which causes residence times shorter than the nominal residence time and thereby decreasing the pond efficiency. The effects of vegetation on problems such as short-circuiting can be of significant importance.

Computational Fluid Dynamics (CFD) models can be used to investigate and represent these effects. These models allow vegetation stems to be modelled either one-by-one or as a bulk effect through different approaches. A recent laboratory experiment is modelled using the one-by-one modelling method to investigate and compare mixing coefficients with those determined from the lab data.

Two alternative bulk effect approaches will also be compared in this paper. The first one, which considers vegetation as a porous media, has been recently proposed and evaluated by other researchers and has shown promise and partial success. The second one is a novel, preliminary, exploration of the potential to apply lattice Boltzmann method.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Creating a Sustainable Drainage Flood Management Decision Support Tool

Craig Lashford, Sue Charlesworth, Matthew Blackett, Frank Warwick

Centre for Agroecology & Water Resilience, Coventry University, Priory Street, Coventry, CV1 5LW, England

Corresponding author E-mail: craig.lashford@coventry.ac.uk

Abstract:

This research, part of an ongoing PhD project, outlines the process for developing a SUDS decision support tool based on data modelled using the UK industry standard modelling tool: *WinDes*®. The results present an analysis of the effectiveness of different combinations of SUDS devices in a management train, in comparison to conventional drainage. Initial simulation suggest that utilising porous paving and detention ponds at a site can potentially reduce runoff by 574 l/s during the 1 in 100 year 30 minute storm as compared to management trains without the devices. The outputs from the model are further examined for a relationship between rainfall, infiltration, number of SUDS devices and runoff. These steps have let to the development of a decision-support programme using these underlying calculations alongside the runoff values previously simulated to estimate the likely runoff as a result of different combinations and land-take of SUDS management trains under different rainfall and infiltration scenarios. The research has found inaccuracies in the model as contrary to previous work, results suggest that reducing the percentage coverage of swales and replacing them with pipes reduces runoff, and that introducing any form of SUDS device has little impact on the time to peak. A validation of *WinDes*® is therefore currently being completed to determine the accuracy of both the software and the resultant decision support tool.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Clogging of Filtration Suds: Evaluation of the Long-Term Performance of Scottish Trunk Road Filter Drains

Ged Mitchell MA | BSc | MSc | CEng | MICE | CEnv | MCIWEM C.WEM | MIEMA

Abertay University, Bell Street, Dundee, Scotland, DD1 1HG

Corresponding author E-mail: 0406632@live.abertay.ac.uk

Abstract:

Over 50% of the Scottish Trunk Road Network is drained by roadside filter drains. Yet despite their popularity, roadside filter drains are prone to clogging and short-circuiting. This is due to the fact that there is no mechanism for intercepting, removing or storing any of the road-deposited-sediment (RDS) contained in road runoff. Given this it has been estimated that the effective life of a filter drain is approximately ten years (Bruen et al. 2006; Rowlands and Ellis 2007). It has even been suggested that under certain conditions the effective life of filter drains on trunk roads can be significantly shorter than ten years (Bruen et al. 2006).

The actual effective design life of roadside filter drains is currently unknown therefore a five-year programme of field research was undertaken on the Scottish trunk road network to investigate the impact that catchment characteristics, RDS build-up, RDS wash-off and RDS PSD grading envelopes have on clogging. The aim being to develop a more accurate life-cycle for the three filter drain configurations adopted on the Scottish trunk road network e.g. over-the-edge filter drains, filter drains with kerbstone boundaries and gully-pots and over-the-edge filter drains separated from the trunk road by a grass strip.

Findings indicate that RDS originates from a complex inter-relationship between catchment characteristics and the physical characteristics of the road. Together these have a significant impact on RDS PSD grading envelopes and the rate of clogging in roadside filter drains. The size of individual RDS particulates, for example, range from dissolved (<1.0 µm) through to gross solids >10.0 mm. Moreover particles generated from deterioration of the road surface can account for up to 80% of the RDS mass retained in the top 200 mm of the filter drain. It was also noted that RDS concentrations are higher in the top 200 mm of the filter drain. Over-the-edge filter drains are also significantly more likely to clog than filter drains with kerbstone boundaries and gully-pots or over-the-edge filter drains separated from the trunk road by a grass strip.

References

1. Bruen, M., Johnston, P., Quinn, M.K., Desta, M., Higgins, N., Bradley, C., Burns, S. (2006). Impact Assessment of Highway Drainage on Surface Water Quality. Centre for Water Resources Research, University College Dublin.
2. Rowlands, G.E., Ellis, E.B. (2007). Highway filter drain maintenance and re-instatement - a waste management issue. Proceedings of the 6th NOVATECH Conference, Lyon, France, 25 - 28 June 2007.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Re-visiting the first flush concept – Stormwater runoff from industrial estates

Marta Ibanez[1], Allan Cundill[2], Brian D'Arcy[1], Mark Hammonds[2], Fiona Napier[2], Louise Asher[2] Rebecca Wade[1]

[1] Abertay University, Dundee, Scotland UK [2] SEPA, Aberdeen, Scotland, UK

Corresponding author E-mail: r.wade@abertay.ac.uk

Abstract:

The East Tullos Burn is a small but chronically polluted, urban watercourse in Aberdeen, UK. In 2004 the site was incorporated into a national SEPA programme as an exemplar urban/industrial estate diffuse pollution monitoring station (arable farmland and livestock farmland monitoring stations had already been established in exemplar catchments elsewhere). The catchment is dominated by industrial estates, but also includes some retail and housing areas, it is served by a separate sewer network, with foul flows passing to treatment and surface runoff discharging to the burn in culvert.

Conventional routine spot sampling of the watercourse had shown a high degree of variation in quality, the data was unhelpful for understanding and resolving the evident pollution. In 2004 an intensive programme of investigations was initiated comprising three co-ordinated aspects: 1. A pollution audit of industrial commercial premises involving questionnaires and detailed site follow-up inspections; 2. Establishment of a diffuse pollution monitoring station in a secure location on the culverted section of the watercourse, where an autosampler collects samples for chemical analysis, triggered by rainfall (1mm or more); 3.A sonde was also deployed at the monitoring station and recorded continuous data for dissolved oxygen, conductivity, pH, temperature and turbidity, relayed directly to SEPA.

This presentation will report on the analysis of data for 44 storm events between 2004-2014. The maximum values were typically substantially in excess of the environmental quality standard for the pollutant, and were associated with high flow in the burn. For lead the minimum values were at or below the EQS, and were recorded at the lower flow conditions. That pattern is typical of a diffuse source impacted watercourse, where pollutants are scattered across a catchment and mobilised by rainfall. Lead concentration varied with flow during one of the storm events; highest concentrations were associated with high flow in the watercourse. Concentrations as well as loads increased with flow in the watercourse. Consequently, during high flow conditions, significant pollutant loadings were substantially higher than during low flow conditions. Important recommendations for water quality monitoring and design of appropriate BMPs or SUDS arise from this work and are discussed in the full paper (e.g. no dilution for diffuse pollution).

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

SUDSnet 2015 - KEYNOTE SPEAKER - Day 1:

SUDS in the Mediterranean: the successful experience of the Valencian Region (Spain).

Ignacio Andrés Doménech, UPV, Valencia, Spain.

Corresponding Author Email: igando@hma.upv.es

Abstract:

The Valencian Region is a land of contrasts in the Mediterranean coastline of Spain which development has been strongly related to water over centuries. Indeed, nowadays' water systems are often the result of history since the Roman ages. In 2003, the DayWater report (Review of the use of Stormwater BMPs in Europe, Middlesex University) highlighted that SUDS were not widely used in Spain, arguing for the specific Mediterranean climatic conditions (scarce but torrential rainfall) as a major barrier to their development. Certainly, SUDS were not known in the region at that time, when flood issues were the major concern, but almost 10 years later, they are on the agenda. SUDS definitely landed in the Valencian Region in 2008 thanks to an opportunity: the European project Aquaval. This project was the occasion to build and retrofit 7 SUDS sites in the region and to monitor them during one year. Evidence was therefore provided: SUDS feasibility under Mediterranean rainfall conditions was demonstrated. Once SUDS known in the region, another EU funded project, E2Stormed, was the chance to go ahead in 2013. Key stakeholders were actively involved in a Regional Working Group and representatives of the different levels of the Spanish administration were committed to play their role in the transition process towards a better urban stormwater management. A transition framework has been adapted to local specific features and a model of strategic action plan has also been developed. One of the major indicators of the success is the new pieces of regulation recently adopted. At regional level, the new Flood Risk Territorial Plan encourages the use of SUDS as one of its main objectives. At local level, municipalities (e.g. Valencia city) are promoting in their new drainage ordinances the use of SUDS for new developments. Although Spain is still far away from a mainstream paradigm shift, the transition is launched and the Valencian Region is ready to go ahead.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

Session 2 - Ecosystem Services and SUDS

Title	
Assessing the multiple benefits of SuDS: dealing with the uncertainties and a new approach to including flexibility	Richard Ashley, B Gersonius, Chris Digman, Paul Shaffer, A Baylis, Suzanne Simmons
SuDS, Ecosystem Services, Green-blue Infrastructure and the Leeds City Region: getting on the agenda	Louise Walker, Christian Berretta, Viki Hirst, Richard Ashley
The implications of movement of water through an urban catchment on the delivery of a range of ecosystem services	Lian Lundy, D Mike Revitt and J Bryan Ellis
Multiple Benefits from diffuse pollution mitigation	Rebecca Wade
Designing additional benefits beyond water treatment in constructed wetlands and SuDS	Matthew Simpson & David Naismith

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Assessing the multiple benefits of SuDS: dealing with the uncertainties and a new approach to including flexibility

R.M.Ashley[1,2], B Gersonius[2], C Digman[3], P Shaffer[4], A Baylis[5], S Simmons[3]

[1] Ecofutures Ltd., 3 Greendale Court, Honley, HD9 6JW
[2] Flood Resilience Group, UNESCO IHE, Delft, Netherlands
[3] MWH, Red Hall Avenue, Paragon Business Village, Wakefield, WF1 2UL, UK.
[4] CIRIA, Classic House, 174 - 180 Old Street, London EC1V 9BP, UK
[5] Environment Agency, Horizon House, Deanery Road, Bristol, BS1 5AH

Corresponding Author Email: R.Ashley@sheffield.ac.uk

Abstract:

The need to get 'more from less' has focused professional thinking and practice on opportunities to create maximum societal value from routine business as usual practices. Surface/stormwater management has long been seen as a public health and safety issue rather than an opportunity. Only more recently have surface based systems been aligned with green infrastructure with the wider social and ecological benefits being recognised. Valuation tools are available to quantify and assign 'economic' value to a wide variety of benefits that accrue to and from ecosystem services. These tools, in conjunction with valuation evidence, can be utilised to assign value to the added benefits of using surface based stormwater management systems. A new tool to support financial and other benefit valuation of sustainable drainage systems (SuDS) has been developed as part of a project coordinated by the Construction Industry Research & Information Association (CIRIA). As part of the tool development, a comprehensive review has been made of all of the currently available tools and their applicability and usability. Special attention has been given to the potential sources of uncertainty in the benefit valuation processes. These uncertainties and the way in which they can be included, via confidence scoring and sensitivity testing, have been presented in the supporting guidance for the use of the tool. The uncertainties are considered in greater detail in an accompanying report and suggestions as to how these can be included for more extensive projects made, and under what circumstances it may be appropriate to take a more in-depth look at uncertainty explored. As evidence suggests that SuDS are inherently more flexible than traditional piped drainage, a new flexibility index has been included in the valuation tool based on the COFAS flexibility assessment method developed in the SWITCH project. The paper presents the genesis of the tool with emphasis on uncertainty, flexibility and the significance of being able to assess the monetary and other benefits of SuDS in UK practice. Case studies are presented that illustrate the use of the tool and comparisons between traditional options and SuDS options.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

SuDS, Ecosystem Services, Green-blue Infrastructure and the Leeds City Region: getting on the agenda

Louise Walker, Christian Berretta, Viki Hirst, Richard Ashley

University of Leeds, University of Sheffield

Corresponding Author Email: L.Walker@leeds.ac.uk

Abstract:

Since the Ministerial decision taken in December 2014 to make sustainable drainage a material planning consideration in England there has been some consternation over how to get appropriate SuDS properly included in the planning agenda. The development of valuation methodologies for green and blue infrastructure and ecosystem services may help to provide the answer. Political realisation that alternative management of surface water can be more cost effective than conventional piped systems, coupled with the multiple benefits it can provide, is supporting its consideration by decision makers. Further, when viewed in conjunction with green (or green-blue) infrastructure and urban tree planting, the multiple benefits of SuDS become more apparent. This is evidenced in studies from elsewhere, notably the USA.

This paper draws on international examples of sustainable drainage as part of Ecosystem Services evaluation which have enabled change in practice. Taking the Leeds City Region as a case study, it considers how support for the Green Infrastructure North West toolkit has helped re-invigorate consideration of Ecosystem Services including those provided by SuDS in the regional development programme. It describes multi-agency efforts to ensure that Gross Value Added economics takes such valuations seriously into account and embeds them into established appraisal frameworks. Making the case for sustainable drainage is something of an art due to the need to adhere to differing priorities of the multiple stakeholders involved in its delivery, e.g. demonstrating support for economic growth while providing environmental and amenity benefit and reducing flood risk. The use of robust tools to assist in this can help ensure the delivery of high quality SuDS schemes within an integrated planning approach.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

The implications of movement of water through an urban catchment on the delivery of a range of ecosystem services

L Lundy. D M Revitt and J B Ellis

Urban Pollution Research Centre, Middlesex University, The Burroughs, Hendon, London NW4 4BT

Corresponding Author Email: l.lundy@mdx.ac.uk

Abstract:

With the 2000-2015 timeframe for the UN Millennium Development Goals (MDGs) drawing to a close, considerable international effort has focussed on the development of a series of sustainable development goals (SDGs) for the 2016-2030 time-period. The SDGs, currently available in draft format, set out the priorities for international development, building on and strengthening the expiring MDGs. Seventeen focus areas have been identified including, a specific goal to "make cities and human settlements inclusive, safe, resilient and sustainable". The specific targets associated with the urban goal include reducing the number of people affected by water-related disasters and the adverse *per capita* environmental impact of cities. The provision of universal access to safe, inclusive and accessible green and public space is identified together with the adoption by cities of integrated policies and plans towards mitigation and adaption to climate change and disaster risk management at all levels. To assist the implementation of the urban SDG, an ecosystem approach (EsA) provides a potentially useful framework for researchers and decision makers. The collation of data from multiple disciplines and their subsequent co-evaluation supports an integrated assessment of the environment from current and future human wellbeing perspectives, supporting the development of a broader understanding of the impact of our activities on the environment. It is within this policy development and implementation context that this paper sets out to assess the movement of water through an urban catchment in terms of its impacts on the delivery of a range of ecosystem services, goods and benefits (ESGB). Using data from the literature, the contribution of eight urban water compartments and six urban water transfer mechanisms to the delivery of 12 ecosystems services is considered. This benchmarking process indicates both the breadth of the aspects that can be impacted by urban water planning decisions and the scope for using urban water management plans to directly enhance the delivery of ESGB within urban environments. Using this evaluation as a baseline, the application of alternative urban water management scenarios on ESGB are then considered.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Multiple Benefits from Diffuse Pollution Mitigation

Rebecca Wade

Urban Water Technology Centre, Abertay University, Dundee, DD1 1HG, UK

Corresponding Author E-mail: r.wade@abertay.ac.uk

Abstract:

Many policy agendas are now recognising the need to work across disciplines, departments and organisations. Joined up thinking and good communication are needed to tackle urban diffuse pollution and deliver multiple benefits.

The work presented here draws together the findings from several projects which have attempted not only to quantify the multiple benefits from SUDS, surface water management and diffuse pollution mitigation, but also to move research outputs towards the development of a more accessible evidence base useful in addressing contemporary agendas. The means for communicating evidence must be informed by discussions with policy-makers and stakeholders to ensure that the resulting outputs (guidance/tools etc) are both useful and useable within a policy-making context, whilst also retaining meaning and relevance for urban planning, engineers.

The ability to recognise and understand the potential of mitigation systems to provide multiple benefits (or ecosystem services) which can contribute to meeting the requirements of a range of directives/needs is now becoming a necessity for policy-makers increasingly required to 'work smarter'. Evidence is available to support optimisation of benefits that can be gained from the mitigation measures that are currently available; for example the evidence base for the multiple benefits that can be gained from SuDS has increased dramatically in recent years as these measures have become more widespread. However, the subject is not simple, existence of benefits is only the starting point, the translation of recognised benefits into quantities (and potentially costs) and the delivery of this evidence into policy and practice is challenging. There are many potential pathways for the collection, collation and communication of this evidence base. Multiple methods and approaches may be required to deliver decision-specific evidence in a meaningful manner.

This paper will present findings from several research projects which have used differing methods and assessments to contribute to the body of evidence informing the development of policy and supporting implementation of sustainable surface water management with multiple benefits.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Designing Additional Benefits Beyond Water Treatment in Constructed Wetlands and Suds

Dr Matthew Simpson & David Naismith

Wildfowl & Wetlands Trust (Consulting)

Corresponding Author E-mail: matthew.simpson@wwtconsulting.co.uk

Abstract:

Constructed wetlands, or wetland treatment systems (WTS), are designed to simulate the functions and processes of natural wetlands to treat wastewater. The technology is 'mechanically simple but biologically complex', capable of achieving high levels of treatment using little or no energy with relatively low maintenance. Considerable advances in experience and understanding has shown that they are suitable for a wide range of effluents: domestic and industrial wastewaters to large bio-engineering projects, such as groundwater remediation and catchment pollution control.

There is increasing governmental and regulatory interest in natural processes for diffuse pollution control in agriculture, addressing water quality in sensitive catchments to fulfil Water Framework Directive objectives. The lessons learnt from WTS design can benefit the SuDS treatment train and provide multiple additional benefits to people and wildlife as well as enhanced performance and wider environmental improvements.

Some of the additional benefits that well designed systems can deliver include:

- habitat creation for biodiversity;
- storm water attenuation to combat the effects of climate change;
- a source of treated grey water for irrigation or recycling;
- lower installation and operation/ maintenance costs than harder engineered solutions;
- lower energy consumption, and thus lower carbon; and
- educational and recreational benefits.

All of our systems are designed with wildlife in mind, in terms of maximising the potential benefits to biodiversity, and many of them also include the provision of access for people. We have designed several 'SuDS for Schools' projects, in London and Newcastle, funded by Thames Water and Northumbrian Water, to engage students with the environmental issues of flooding and the wildlife that can be found in SuDS habitats. This educational and social benefit, in addition to the biodiversity benefit, is a huge bonus on top of the environmental service that SuDS can provide.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

Session 3 - Performance Testing

Title	Author(s)
The hydraulic, water quality and biological performance of pervious pavement systems with novel sub-base designs	Luis A Sañudo Fontaneda, Stephen J Coupe, Chris Griffiths.
Influence of oil spills in abrasion resistance loss of porous asphalt pavements	Jorge Rodriguez-Hernandez , Valerio C. Andrés-Valeri , Miguel A. Calzada-Pérez, Ángel Vega-Zamanillo, Daniel Castro-Fresno and Daniel Jato-Espino.
Performance of Stormwater Filters with Low Cost Materials (Coconut Fibre/Husks) for Caribbean Small Island Developing States (SIDS)	Kiran Tota-Maharaj and Denver Cheddie
The design, testing and use of geotextile barriers in drainage applications	Anne-Marie Mclaughlin, Stephen J Coupe, Luis A Sañudo-Fontaneda, Daniel Castro-Fresno Elena Blanco-Fernandez
Research on novel highway filter drain designs for the protection of downstream environments	Stephen Coupe, Luis A Sañudo-Fontaneda, Susanne Charlesworth, Gordon Rowlands

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

The hydraulic, water quality and biological performance of pervious pavement systems with novel sub-base designs

[1]Luis A Sañudo Fontaneda, [1]Stephen J Coupe, [2]Chris Griffiths

[1]Centre for Agroecology Water and Resilience (CAWR), Coventry University, Priory Street, Coventry University, CV1 5FB, UK

[2]Marshalls Mono Ltd, Landscape House, Elland, HX5 9HT, UK

Abstract:

Pervious Pavement Systems (PPS) are the most successful type of hard urban Sustainable Drainage System worldwide. They are known to effectively reduce runoff by surface infiltration, to reduce the volume and rate of water leaving a site, filter out urban pollution and treat this contamination within the pavement by aerobic biological action. Nevertheless, the impact of novel sub-base design characteristics on the hydraulic performance and biological treatment of PPS represents an ongoing knowledge gap. With the aim of closing this gap, 13 different combinations of PPS design were built, with overall pavement depths ranging from 250 mm to 500 mm, the presence or absence of a geotextile and the presence and absence of other novel barrier systems, making this laboratory study the largest of its kind in the world. All the rigs were subjected to intense rainfall events, allowing the team to analyse their hydraulic performance by means of hydrographs to monitor the infiltration and discharge characteristics of different designs. In order to assess the water treatment performance of the PPS designs, hydrocarbon pollution in the form of clean mineral oil was applied to the surface of the structures in an increasingly heavy loading, up to a final addition rate of 150 g/m^2. Microbial activity was analysed by measuring the CO_2 levels in the air inside the simulated PPS, showing the levels of biological treatment provided by the systems. The data showed that the presence of various geosynthetic and treatment barriers made a significance difference to the volumes of water discharged in the PPS laboratory models. Research will continue to determine the long-term performance of the PPS designs to find the point at which differences in designs make significant differences in water quantity and quality performance.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Influence of oil spills in abrasion resistance loss of porous asphalt pavements

Jorge Rodriguez-Hernandez [1], Valerio C. Andrés-Valeri [2], Miguel A. Calzada-Pérez [3], Ángel Vega-Zamanillo[4], Daniel Castro-Fresno[5] and Daniel Jato-Espino[6]

[1,2,5,6] GITECO research group. Dept. of Transports and Projects and Processes Technology, Civil Engineering School, Universidad de Cantabria, 39005 Santander, Spain; E-Mail: rodrighj@unican.es (J. R-H.); andresv@unican.es (V.C. A-V.); castrod@unican.es (D. C-F.)

[3,4] GCS research group. Dept. of Transports and Projects and Processes Technology, Civil Engineering School, Universidad de Cantabria, 39005 Santander, Spain; E-Mail: miguel.calzada@unican.es (M.A.C-P.); angel.vega@unican.es (A.V-Z.)

Abstract:

Permeable pavements are one of the most commonly used Sustainable Drainage Systems (SuDS) in urban areas for managing stormwater runoff problems. Porous asphalt is widely used in surface layers of permeable pavement systems, where it can suffer accidental oil spills from vehicles. Oil spills affect bituminous mixes through the solvent action of the hydrocarbons on the bitumen, reducing the abrasion resistance of asphalt pavements. In order to assess the loss of abrasion resistance in porous asphalt pavements the Cantabro abrasion test was performed to 108 test samples after applying controlled oil spills. Three different types of binders were used: conventional bitumen, polymer modified bitumen and a special fuel-resistant bitumen. After analysing the results, it may be concluded that the most suitable bitumen to protect against oil leakages is the polymer modified one, which is far better than the other two types of bitumen tested.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Performance of Stormwater Filters with Low Cost Materials (Coconut Fibre/Husks) for Caribbean Small Island Developing States (SIDS)

Kiran Tota-Maharaj[1*] and Denver Cheddie[2]

[1*] Department of Engineering Science, Faculty of Engineering and Science, University of Greenwich, Medway Campus, Kent, ME4 4TB, UK.
Email: k.tota-maharaj@greenwich.ac.uk

[2] Utilities Engineering Division, The University of Trinidad and Tobago, Point Lisas Campus, Trinidad, West Indies.

Corresponding Author Email: denver.cheddie@utt.edu.tt

Abstract:

Conventional stormwater treatment for many rural areas across the Caribbean is often too complex for long-term operation as well as expensive for most communities to afford. The fibres from shredded coconut (*Cocos nucifera*) husks were assessed for their effectiveness in filtering stormwater pollutants across two towns in the southern Caribbean islands of Trinidad and Tobago. Three stormwater filters utilised local materials that are both widely available across Caribbean small island developing states (SIDS) and inexpensive enough to discard after use, thus eliminating backwashing. The vertical flow multimedia stormwater filters were developed and tested at The University of Trinidad and Tobago (UTT) for pollutant removal efficacies and hydraulic efficiencies. Coconut fibres/husk, sand and gravel were selected as filter media and filled in varying proportions for each filter. The effects of stormwater residence time and flow rate on the removal percentages for water quality parameters were investigated. Experimental results showed that the coconut fibre/husk filters achieved results equal to conventional sand-gravel media filters. The filters exhibited a 97 % total dissolved solids (TDS) removal at high concentrations of inflow water (> 100 mg/l). Each filters also removed nitrates, nitrites and phosphates effectively at low influent concentrations (< 18 mg/l). Removal rates for chemical oxygen demand (COD), turbidity and total suspended solids (TSS) were also found to be good. Based on the estimated annual operation and maintenance (O & M) cost, and experimental water quality results, this system is affordable, low cost and applicable for rural communities in the Caribbean in developing sustainable stormwater filtration systems.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

The design, testing and use of geotextile barriers in drainage applications

[1]Anne-Marie Mclaughlin, [1]Stephen J Coupe, [1]Luis A Sañudo-Fontaneda, [2]Daniel Castro-Fresno and [2]Elena Blanco-Fernandez

[1]Centre for Agroecology Water and Resilience (CAWR), Coventry University, Priory Street, Coventry, CV1 5FB, UK

[2]Construction Technology Applied Research Group (GITECO), University of Cantabria, Santander, 39005, Spain.

Abstract:

The use of geotextiles in Sustainable Drainage Systems (SuDS) has become relatively common. Research into the properties of this type of geosynthetic material, has demonstrated that they can provide multiple benefits to the performance of drainage systems, contributing to the overall sustainability of such schemes. The findings from the testing of geotextiles in SuDS, particularly in pervious paving, has shown that they can be very effective in protecting pervious pavements against the build-up of sediment beneath the laying course. In filter drains, geotextiles prevent the silt, (which in many cases is contaminated with heavy metals and oil residue) from being released into receiving water. Geotextiles are known to immobilise and trap hydrocarbons and to facilitate the growth of extensive, active, stable biofilms, capable of transforming oils and other organic contaminants *in-situ* and do this aerobically, as a 'free service', which can significantly improve the performance of the SuDS system over the lifetime of the asset. Recent developments have included the design of novel geotextiles for use specifically in highway filter drains. The project was conducted in partnership with a major geosynthetics manufacturer and the design parameters were challenging. These were to find a geotextile that was affordable for a relatively low cost use, was structurally sufficient for the site of deployment, sufficiently permeable to allow water to drain through but also able to provide high levels of treatment and be physically and chemically optimal for the growth of biofilm. The data in this paper provides the first attempt to reconcile the design parameters against laboratory scale, controllable simulation models.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Research on Novel Highway Filter Drain Designs for the Protection of Downstream Environments

[1]Stephen J Coupe, [1]Luis A Sañudo-Fontaneda, [1]Susanne M Charlesworth, [2]Gordon E Rowlands

[1]Centre for Agroecology Water and Resilience (CAWR), Coventry University, Priory Street, Coventry, CV1 5FB, UK

[2]Carnell Support Services Ltd, Gothic House, Market Place, Penkridge, Staffordshire, ST19 5DJ, UK

Corresponding Author E-mail: Steve Coupe aa0698@coventry.ac.uk

Abstract:

Highway filter drains are stone-filled roadside drainage trenches of approximately 1 metre depth and 1 metre width and run parallel to significant parts of the UK high speed road network. They are a relatively unknown drainage asset, but with over 7,000 kilometres of filter drain in the UK, they make a significant contribution to the functioning of the national economy as a key piece of the transport infrastructure. Three major contributions that filter drains make to the operation of highways are outlined below:

- Road user safety (by removal of water from the carriageway)
- Pavement longevity (by efficiently eliminating standing water adjacent to the highway sub base and preventing carriageway breakup)
- Runoff water quality (by the filtering of sediments, hydrocarbons and other road surface contaminants through the 1 metre deep stone filter drain, purifying the water before discharge through a pipe at the base)

In addition to the water quality benefits of filter drains, the volume and rate of flow of water from the road is regulated by percolation through the stone, and the high storage volume in the drain, allows a degree of extra capacity in the case of extreme rainfall events. The research in this paper is designed to give an overview of a series of projects that are investigating the fundamental drainage and water quality improving properties of filter drains and suggest ways in which these properties can be optimised, for instance by the use of a geotextile material to improve purification and water management.

Data acquired during a 6-month period of laboratory testing, demonstrated that the hydraulic function of filter drains was not adversely affected by the presence of a geotextile and that the retention of silt by the drain did not significantly delay the discharge rate of water, with or without a geotextile.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

Day 2 - Friday 4th Sept 2015

Session 4 - SUDS out of the Temperate Zone

KEYNOTE SPEAKER: Kevin Winter, UCT, South Africa**.**

Title	Author(s)
An investigation of the potential of using Sustainable Drainage Systems (SUDS) in West Africa using Lagos, Nigeria as a case study.	Margaret Mezue, Susanne Charlesworth, Marion MacLellan, Frank Warwick, James Bennett
Using environmental and energetic criteria for making decisions in stormwater management – Evidence from the Mediterranean Region.	Sara Perales-Momparler, Rebecca Wade, Ignacio Andrés-Doménech, Ignacio Escuder-Bueno, Adrián Morales-Torres

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

SUDSnet 2015 - KEYNOTE SPEAKER - Day 2:

Living on the edge: socially responsive SUDs and other technologies in informal settlements, South Africa

Kevin Winter, Environmental & Geographical Science, University of Cape Town

Corresponding Author E-mail: kevin.winter@uct.ac.za

Abstract:

The South African government is recognising that informal settlements will continue to provide a solution for housing the urban poor. The provision of formal housing is not keeping pace with demand. Informal settlements are unplanned areas on land that has not been surveyed or proclaimed. Typically in these circumstances, surface water management is characterized by uncoordinated efforts to deal with unwanted water while stormwater flow finds the path of least resistance. Drainage is a concern, but it is not a high priority and efforts to self-improve drainage are limited. This paper explores a research innovation project that seeks to determine how designs and materials are used to retrofit makeshift dwellings in order to meet multiple objectives including drainage, and to 'out scale' the resultant opportunities in developing small businesses. The design objectives address: the spread of fire; mitigation of extreme weather; waterproofing; lighting; surface contamination and potential disease vectors; and disposal of unwanted water. Drainage is linked to a least four of these concerns. The research began by testing the performance of readily accessible materials and designs to mitigate extreme temperatures and the threat of fire. Tests were conducted over a four month period in an offsite experiment. Drainage comprised a combination of pitched roofs, micro-gardens and a biofilteration system. A low cost, incremental approach is responsive to the needs of the poor. The assumption is that socially responsive technologies empower people to make their own contribution to improving their living conditions. Currently the project is testing the acceptance of the concept in ten dwellings in an informal settlement. Volunteer residents are learning how to retrofit existing shacks and are showing interest in exploring market opportunities. Early indications suggest that drainage remains a relatively low priority, but that a planned drainage scheme has value if adjacent households can be connected to protect against flooding or pollution from neighbouring structures.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

An investigation of the potential of using Sustainable Drainage Systems (SUDS) in West Africa using Lagos, Nigeria as a case study.

Margaret Mezue[1], Sue Charlesworth[2], Marion MacLellan[1], Frank Warwick[1], James Bennett[2].

[1]Geography, Environment and Disaster Management; [2]Centre for Agroecology, Water and Resilience, Coventry University, UK

Abstract:

Sustainable Drainage Systems have been adopted by some developed and developing countries such as Brazil, Malaysia and India, as a sustainable way of managing flooding, but Sub-Saharan Africa lags behind in sustainably managing its flooding problems. Informal settlements are particularly at risk of flooding since they have drainage infrastructure neither at the building, nor at site, level. This study examines the challenges and management of flooding in four communities in Lagos, Nigeria, as an example of a typical low-lying urban area. ArcGIS was used to map the characteristics of the sites and inform the appropriate SUDS to be installed. Questionnaires were used to ascertain the attitude of the residents to SUDs, the history of flooding in the area, and the steps residents had taken themselves to alleviate flooding.

Flooding in the area ranged from moderate to severe with residents blaming it on the rains and blocked drains. Areas with conventional drainage structures contributed to flooding since they were mainly blocked with rubbish. Residents in one location improvised ways of managing the floods with sand bags and tyres sited around most homes. There was willingness of the residents to change their circumstances by implementing SUDS and to personally manage and maintain the devices without external help. One recommendation is that better waste collection may be an indirect way of improving drainage in informal settlements. Finally, findings showed a shortcoming in the appropriateness of GIS as a decision making tool for SUDS in Lagos; individual buildings and open spaces were not accurately represented on Google Earth maps, and the images were also quite unclear. Hence, fieldwork identified inaccuracies with what was actually present on the ground.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Using environmental and energetic criteria for making decisions in stormwater management

Sara Perales-Momparler[1], Rebecca Wade[2], Ignacio Andrés-Doménech[3], Ignacio Escuder-Bueno[3], Adrián Morales-Torres[3].

[1]Green Blue Management. [2] Abertay University. [3]Instituto Universitario de Investigación de Ingeniería del Agua y Medio Ambiente. Universitat Politècnica de València.

Corresponding Author E-Mail: sperales@pmenginyeria.com

Abstract:

Benefits reported from the use of SuDS for sustainable stormwater management range far beyond water quality and quantity control. These benefits include increased property values, habitat and biodiversity provision, air quality improvement, regulation of urban micro-climates, noise reduction, recreational use, water re-use and cost-savings for surface water management. Therefore, SuDS contribute to the delivery of improved urban ecosystems, providing ecosystem services that produce benefits for inhabitants in urban areas. Furthermore, SuDS can improve energy efficiency in the urban water cycle, this is particularly significant since energy consumption associated with water treatment and supply represents up to 35% of municipal energy use.

The EU-MED Programme E²STORMED project (improvement of energy efficiency in the water cycle by the use of innovative storm water management in smart Mediterranean cities) has developed a Decision Support Tool (DST) that includes energy efficiency and ecosystem services criteria in the decision making process for stormwater management. This tool has been tested in six Mediterranean cities to compare different drainage scenarios combining conventional drainage systems and SuDS. The results of applying this tool allows for a more informed, objective and sustainable stormwater management approach in these urban areas. Local stakeholders have been involved in this process through the creation of regional working groups in each testing city. This paper describes how the DST includes energetic and environmental criteria for making decisions in stormwater management and presents a summary of the specific criteria and weights adopted in the six pilot cities, focusing on ecosystem services and energetic issues.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

Session 5 - Surface Water Management

Title	Author(s)
A Methodology to Assess the Potential Impact of Swales on Groundwater Quality	D Mike Revitt, J Bryan Ellis and Lian Lundy
Potential of Pervious and Macro-Pervious Pavements as Harvesting Systems for Irrigation of Adjacent Lawns and Flower Beds	Alan P. Newman, Ernest O. Nnadi and Fredrick U. Mbanaso
SuDS behaving passively – designing for nominal maintenance	Bob Bray
Surface water management planning in Scotland	Gaye McKay, Neil McLean, Alison Duffy, Chun Cheung
The New SUDS Manual	Bridget Woods Ballard, Helen Udale–Clarke, Suzanne Simmons, Paul Shaffer.

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

A Methodology to Assess the Potential Impact of Swales on Groundwater Quality

D M Revitt, J B Ellis and L. Lundy

Urban Pollution Research Centre, Middlesex University, The Burroughs, Hendon, London NW4 4BT

Abstract:

An important design criterion for sustainable urban drainage systems (SUDS) should be to support the management of water quality in receiving waterbodies and to minimise poor treatment performance for both acute short term and chronic long term situations. The impact assessment procedure described here for discharges from swales to receiving waters follows that which has been previously published (Ellis *et al*., 2012) and which is based on the quantification of pollution hazard indices (PIs) for differing land uses in a runoff catchment area. The procedure employs a simple semi-quantitative approach for the impact assessment of residual water quality that is carried forward to the final receptor body following treatment within a swale. The procedure is now applied to groundwater, as well as surface receiving waters, and is illustrated by reference to standard dry swale systems through consideration of both volumetric and pollutant distributions within the treatment system. Application in respect of TSS, nitrate, chloride, heavy metals (Cd, Cu, Pb, Zn) and hydrocarbons is demonstrated for a swale receiving highway runoff. The analysis shows that for TSS, metals and hydrocarbons between 22% and 34% of the total influent pollutant load is likely to be directed towards the underlying soils whereas only between 4% and 16% of chloride and nitrate might pass forward to sub-surface infiltration. The likelihood of breaching groundwater quality standards is assessed as being minimal or negligible although caution must be exercised where swale infiltration may be located within a sensitive groundwater zone.

Reference
Ellis, J.B., Revitt, D.M and Lundy, L. 2012. An impact assessment methodology for urban surface runoff quality following best practice treatment. *Sci Total Environ*, 416, 172 – 179.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Potential of Pervious and Macro-Pervious Pavements as Harvesting Systems for Irrigation of Adjacent Lawns and Flower Beds.

Ernest O. Nnadi, Andy Shuttleworth, Alan P. Newman, and Fredrick U. Mbanaso

Coventry University, Priory Street, Coventry, CV1 5FB

Abstract:

Pervious pavements have been used as water harvesting systems and studies have shown the value of water derived from pervious pavements as irrigation water for landscaping. An alternative system is a modification known as a *macro-pervious pavement system* (MPPS). These devices infiltrate water through discrete points into a porous subbase offering all the benefits of the pervious pavement system (PPS) along with an ability to use the specially designed infiltration systems as a means of protecting the sub-surface environment from major oil spillages. After a consideration of the essential similarities and differences between the PPS and MPPS, this paper reports the latest results from an ongoing study aimed at assessing the suitability of water derived from both pervious and macro-pervious pavement installations for irrigation use. In particular, it highlights the complications caused by the application of de-icing salts in winter. The latest results are reported from on-going field studies of a 7-year old MPPS and, for comparative purposes, an 11-year old PPS. It also considers the quality of the effluent if, disposed of to a water course and, in the case of the MPPS site, considers changes in water quality since the previous study in 2011/12 and the initial data from a recently instigated pot trial which uses water derived from such parking surfaces to irrigate turf grasses. The chemical analysis results to date indicate that except for problems associated with road salt addition during winter the effluent constitutes an excellent source of irrigation water.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

SuDS behaving passively – designing for nominal maintenance

Robert Bray - SuDS Designer and Landscape Architect

Robert Bray Associates. Sustainable Drainage Consultants and Landscape Architects, 40, London Road, Stroud, Gloucestershire GL5 2AJ

Corresponding Author E-mail: info@robertbrayassociates.co.uk www.sustainabledrainage.com

Abstract:

The maintenance of SuDS has long been perceived as a barrier to the use of SuDS in both Local Authority and private sector landscapes. Integration of SuDS into the designed landscape, without creating new maintenance tasks, can reduce care costs to a minimum.

The management of SuDS has been seen as an obstacle to the acceptance of this approach to managing rainfall since the idea of using the landscape to manage rainfall was first proposed in the UK during the 1990s.

In part this is due to SuDS features being designed as separate features in the landscape, the reliance on conventional pipe conveyance technology and inappropriate proprietary products. This environmental plumbing approach to SuDS was often due to problems with adoption or as a result of a first attempt by SuDS designers with a conventional drainage background.

In response to the demand for low maintenance SuDS landscapes the idea of passive functioning has become one of the important criteria used by Robert Bray Associates in SuDS design.

SuDS can contribute to the aesthetic quality of a site if it is integrated with the landscape design and contributes to the multi-functionality of spaces. The idea that dedicated space is necessary for all SuDS elicits further concern from developers but can usually be avoided through integrated design.

Integrated design also allows maintenance costs to be shared between the general landscape care budget and a small dedicated pot for SuDS.

Critical design elements are:

- Integrating SuDS into available open space
- Deciding how runoff is collected
- The use of source control for water quality reasons
- The principle of multifunctional space
- Effective hard surface and vegetation management
- Evaluation of management implications structures and proprietary gizmos.

This presentation explores this design approach with examples of how this has been implemented in practice using case studies.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Surface water management planning in Scotland

Gaye McKay[2] Neil McLean[3], Alison Duffy[1], Chun Cheung[4]

[1]Urban Water Technology Centre, Bell Street, Dundee, DD1 1HG, UK
[2]Tuil Solutions, 28 Main Street, Limekilns, Fife, KY11 3HL, UK
[3]MWH, Eastfield House, Eastfield Road, Edinburgh, EH28 8LS, UK
[4]Glasgow City Council, West George Street, Glasgow, G1 1RX, UK

Corresponding Author E-mail: A.Duffy@abertay.ac.uk

Abstract:

The Flood Risk Management (Scotland) Act 2009 places duties on named responsible authorities in Scotland to investigate the causes of flooding, to identify actions to address them and develop mitigation measures as appropriate. Surface water management plans (SWMPs) present the opportunity to identify surface water flooding issues on a catchment scale and to address many of these issues using sustainable drainage solutions. Glasgow City Council were one the first local authorities in Scotland to develop such a plan, which would not only address environmental issues, but also safeguard long-term development aspirations and provide a basis for the implementation of future development.

The Glasgow City Centre SWMP recognises the importance of water for sustaining the city; creating blue/green corridors, contributing to biodiversity, improving the environment and benefiting human health.

A fundamental component of the Glasgow city centre strategy was the introduction of integrated urban infrastructure. 'Avenues' were proposed which would be used to link the local districts and encourage sustainable transport, but also offer the opportunity for the introduction of green infrastructure (including novel features such as 'rain ladders'), which could be used to control runoff. The challenge was to identify opportunities to disconnect and then manage surface water from the combined sewer network, in this highly urbanised catchment.

The findings of an Economic Impact Assessment carried out as part of the study, suggested that the costs from flood risk in a 'do nothing' option would be considerable. However, these could be significantly reduced by the SuDS solution proposed.

This paper looks at the original plan and how options were considered to reduce flood risk, as well as explaining more recent thoughts.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

The New SUDS Manual

Bridget Woods Ballard, Helen Udale-Clark, Suzanne Simmons Paul Shaffer

Abstract:

An update on progress and developments in the New SUDS manual.

The SuDS Manual is due for publication this summer. This presentation will set out the design objectives, criteria and standards advocated by the guidance; will describe the changes from the previous Manual, and will illustrate how the document can be used to incentivise inspirational and creative surface water management that delivers cost-effective drainage and environmental protection. The presentation will highlight some of the key challenges in developing the guidance, particularly in the area of water quality protection, and how ongoing research is fundamental to underpin robust design methods.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

Session 6 - Urban Hydrology

Title	Author(s)
A spatial analysis of SUDS Retrofit: Case study of Coventry, UK.	Frank Warwick and Sue Charlesworth
Rainfall-runoff simulations to assess the potential of different SUDS for mitigating surface water flow in urban watersheds	Daniel Jato-Espino, Susanne M. Charlesworth, Joseba R. Bayon, Jorge Rodriguez-Hernandez
Analysing time series rainfall to support the development of a code of practice for the testing of proprietary treatment products	R. Kellagher, B Woods Ballard, J. Bradley, M. Fairley, D. Jarman, S. Ramella
"A relook at how we attenuate run-off for Brownfield and retrofit sites"	Anthony McCloy
Retrofitting rainwater harvesting to maximise SuDS benefit: A catchment scale assessment of a novel RWH configuration	Peter Melville-Shreeve, Seith Mugume, Sarah Ward, David Butler
Incorporating SuDS as part of urban design in the renewal of city landscape	Kevin Barton and Bob Bray and

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

A spatial analysis of SUDS Retrofit: Case study of Coventry, UK

Frank Warwick and Sue Charlesworth

Centre for Agroecology, Resilience and Water, Coventry University, Priory Street, Coventry CV1 5FB

Corresponding author E-mail: Frank Warwick aa4510@coventry.ac.uk

Abstract:

Retrofit of sustainable drainage is often acknowledged to be challenging, with factors such as land take and the location of existing facilities imposing restrictions on possible options (Digman *et al*. 2012). A spatial analysis of an urban area (Coventry local planning authority, 98.7 km^2) aimed to quantify and characterise locations suitable for retrofit SUDS, and to investigate differences in the extent to which different types of SUDS could be retrofitted. The higher number of restrictions imposed on retrofit resulted in a smaller area of the city where SUDS were feasible compared to new developments: source control 68%, infiltration 11%, filtration 64%, conveyance 57% and detention 79%. Overall, smaller parcels of land were available for retrofit (median 35 m^2) than for new development (median 100 m^2). The use of large scale maps of SUDS retrofit feasibility to identify opportunities for SUDS retrofit in conjunction with a range of land covers was investigated. For example, large roofs (> 200 m^2) are regarded as preferred locations for SUDS retrofit because sufficient suitable land should exist nearby for infiltration or detention of runoff (Stovin *et al*. 2007). In Coventry, there was enough nearby greenspace and paving to infiltrate or detain runoff from 92% of the 3863 large roofs in a 100 year storm event. Medium-category large roofs (1501-2000 m^2) were more likely to be close to suitable land. Implications of the findings are discussed.

References

Digman, C.J., Ashley, R.M., Balmforth, D.J., Balmforth, D.W., Stovin, V.R. and Glerum, J.W. (2012) *Retrofitting to manage surface water C713*. London: CIRIA

Stovin, V., Swan, A. and Moore, S. (2007) *Retrofit SuDS for Urban Water Quality Enhancement*. Available from http://retrofit-suds.group.shef.ac.uk

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Rainfall-runoff simulations to assess the potential of different SUDS for mitigating surface water flow in urban watersheds

Daniel Jato-Espino*[1], Susanne M. Charlesworth[2], Joseba R. Bayon[3], Jorge Rodriguez-Hernandez[4]

[1, 4] GITECO Research Group, Universidad de Cantabria, Spain
(E-mails: jatod@unican.es; rodrighj@unican.es)
[2] Centre for Agroecology, Water and Resilience (CAWR), Coventry University, United Kingdom
(E-mail: apx119@coventry.ac.uk)
[3] Department of Project and Construction Management, Donostia City Council, Spain

Corresponding author E-mail: Joseba_Rodriguez@donostia.org

Abstract:

Sustainable urban drainage systems (SUDS) constitute an alternative to conventional sewer systems when managing stormwater in cities, wherein the growing presence of impervious surfaces is increasingly altering the natural hydrologic cycle. One of the main objectives of SUDS is to reduce the impact of urbanization on the amount of runoff generated by a rainfall event. In this context, this paper is aimed at showing the potential benefits of installing different types of SUDS in runoff management with respect to the common situation consisting of sewer networks. Moreover, the impact of these systems on runoff was studied at the spatial scale of an urban watershed using Geographic Information Systems (GIS), which are useful tools when both parameterizing catchment areas and locating suitable sites in which to install SUDS. Thus, a series of rainfall-runoff simulations were run in a real watershed located in the city of Donostia (Spain) using stormwater computer models, in order to compare the flow distributions produced by a design storm in various scenarios, with and without SUDS installed.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Analysing time series rainfall to support the development of a code of practice for the testing of proprietary treatment products

R Kellagher[a], B Woods Ballard[a], J Bradley[b], M Fairley[c], D Jarman[d], S. Ramella[e]

(a) HR Wallingford, (b) Environment Agency, (c) ACO, (d) Hydro International, (e) Polypipe
Corresponding Author E-mail: R.Kellagher@hrwallingford.com

Abstract:

This paper presents a methodology for assessing rainfall and flow rates across the UK for the purpose of defining appropriate flow rates for the testing and certification of proprietary products for surface water treatment.

There has been increasing pressure for the take up of SuDS for the drainage of developments not only to manage flow rates and volumes of surface water runoff more effectively, but also to provide treatment to protect streams, rivers and groundwater bodies from pollution.

Proprietary (manufactured) products can provide efficient quantifiable treatment where insufficient space exists for landscaped SuDS components, and can deliver reductions in specific contaminants as part of a bespoke treatment design. They can be implemented as stand-alone systems or in combination with vegetated components in an integrated sustainable drainage system.

There is currently no standardised test method specification in the UK to enable consistent evaluation and comparison of product performance. Furthermore design of these systems are not linked to UK weather conditions to maximise their treatment effectiveness. Research has been commissioned by British Water with support from the Environment Agency to analyse UK rainfall to support the development of an appropriate testing protocol for products as well as facilitating the analysis of SuDS systems for treatment effectiveness. The research is based on an analysis of time series rainfall data for a recent 7 year period (2005 – 2011) for 9 sites across England which are representative of hydrological conditions across the country. The analysis takes account of regional and seasonal differences and considers all the interrelationships of intensity, duration and frequency, and antecedent dry periods.

The research provides the foundation for designing effective products, setting a testing protocol for certification of products and demonstrating their effectiveness. In addition, it provides the information necessary for the generation of data and tools to assess the performance of SuDS systems in terms of their hydraulic performance for both volumes and flow rates through the year as well as their pollution removal capability.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet International Conference 2015
3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

A relook at how we attenuate runoff for Brownfield and retrofit sites

Anthony McCloy

McCloy Consulting Limited
Corresponding Author E-mail: anthony.mccloy@mccloyconsulting.com

Abstract:

The primary objective for many SuDS / attenuation designs is the attenuation of flows to a defined peak outflow rate. On redevelopment sites the primary requirements are to ensure that peak runoff flows leaving the site are not increased, and where leverage can be gained a reduction in runoff rates is sought. Over the last ten years many parts of the UK have adopted a nominal 50% reduction in peak runoff rates as best practice, an approach commonly termed as 'betterment'.

This paper prompts the question; is this really the best way to approach attenuation design for brownfield of retro-fit sites.

In many parts of drainage catchment the volumes of runoff that we discharge into the drainage system can be as critical, if not more critical than the rate of discharge; particularly if the drainage system is still under stress from pluvial flooding and CSO spill after storage has emptied. In such circumstances the provision of attenuation storage is likely to have minimal beneficial effect.

What if we properly consider the catchment drivers and set criteria not only on the allowable rate of discharge, but also how long flows should be stored for, we could deliver much greater benefits to the catchment.

The paper will use the 'Australia Road urban regeneration scheme' which has integrated SuDS in a retro-fit approach to give the volumes and flow rates context. The analysis being undertaken considers the site proposed with two different flow control arrangements; one which meets the 50% betterment requirements and a second which uses the same volume of storage with outflow controlled to much lower outflow rates.

The paper will demonstrate the difference between the two flow control arrangements (as outlined above) using both design storms and time series analysis. The paper will explore the potential impacts on both the receiving sewerage network and at site level across the range of SuDS deliverables (i.e. quantity, quality, amenity and biodiversity).

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Retrofitting rainwater harvesting to maximise SuDS benefit: A catchment scale assessment of a novel RWH configuration.

Peter Melville-Shreeve, Seith Mugume, Sarah Ward, David Butler.

University of Exeter, Centre for Water Systems

Corresponding Author E-mail: pm277@exeter.ac.uk

Abstract:

Traditional rainwater harvesting (RWH) systems provide alternative water supplies and are frequently cited as providing secondary benefits as a source control option (Burns et al., 2015; Kellagher, 2011; Memon et al., 2009; Campisano et al., 2013). Retrofit of sustainable drainage systems (SuDS) has seen an increased prevalence - both globally and in the UK over the last decade (Digman et al., 2012). An unconventional RWH configuration has been identified that has the potential to offer users (water companies and developers) a method of designing plot-scale source control. The novel configuration was first described by Herrmann & Schmida (1999) and is referred to as "retention and throttle" RWH. Following each storm the system allows for a slow drain-down of the top portion of the tank to occur, akin to a traditional attenuation tank. Other research illustrates that RWH systems in this dual-purpose configuration can successfully function on a plot scale to control stormwater discharges (Huang et al., 2009; DeBusk, 2013; Melville-Shreeve et al., 2014).

The research presented in this paper assesses the widescale implementation of this plot-based RWH system using a catchment-scale hydraulic modelling assessment. RWH systems have been designed following guidance set out in the British Stanadard (BSI, 2013). A baseline hydraulic model has been generated using SWMM v5.1, (Rossman, 2010). Surface water flooding is then evaluated in terms of total flood volume and mean nodal flood duration. The novel RWH configuration has then been introduced as an intervention within the model to mimic a large scale RWH retrofit project. The model simulations are used to illustrate the benefits that could be achieved by utilising the dual purpose RWH configuration. The paper concludes with a simple cost benefit appraisal to allow future work to be undertaken that benchmarks this RWH approach against alternative retrofit SuDS approaches.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater TECHNOLOGY CENTRE, Marshalls Creating Better Spaces

SUDSnet Sustainable Urban Drainage Systems Network

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

SuDS as a part of urban design in the renewal of city landscape

Kevin Barton

SuDS Designer and Landscape Architect, Robert Bray Associates. Sustainable Drainage Consultants and Landscape Architects, 40, London Road, Stroud, Gloucestershire GL5 2AJ

Corresponding Author E-mail: info@robertbrayassociates.co.uk www.sustainabledrainage.com

Abstract:

SuDS evolved in the UK during the 1990s as a better way to manage rainfall using separate SuDS features, linked in a management train, within in a dedicated SuDS landscape. Recently the potential for creating new integrated urban landscapes that also deal with rainfall is firing the imagination of leading urban designers.

This presentation will feature an innovative urban design project at Australia Road, White City, West London to show how urban design principles can be integrated with SuDS to create a refreshed environment for people living in the city and also look at recent raingarden installations which demonstrate the versatility and ease of implementation of these stand-alone SuDS features.

The Australia Road design creates a new streetscene with exciting rainfall collection features that deliver roofwater using overhead structures to raingardens, Permeable pavement over an existing concrete road base also provides reasonably clean water for the SuDS basins that come alive every time it rains. The surrounding housing, school and play spaces overlook this dynamic space and the local community will use the new integrated SuDS space informally everyday as well as for occasional social events.

The raingarden as a technique on its own is an important SuDS retrofit tool that has been used in a number of urban locations to provide cost effective protection to watercourses and the urban sewer network. The urban raingarden is an exciting and reasonably cost effective way of exploiting the green space between development in the city with opportunities to create enhanced space for people that can be managed at modest cost.

The presentation will conclude with a review of some recent raingarden installations illustrating the potential for innovative design that include the traditional ‘gardenesque’ raingarden, habitat creation, childrens’ play and kitchen potager gardening in the urban realm.

Organised by: Abertay University, Coventry University

Supported by: ciria, urbanwater Technology Centre, Marshalls Creating Better Spaces

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Delegate List

SURNAME	FORENAME	ADDRESS	EMAIL
Aboufoul	Mustafa	University of Nottingham,	eng-mustafa2012@hotmail.com
Andrés Doménech	Ignacio	Universitat Politècnica de València	igando@hma.upv.es
Andrés-Valeri	Valerio C.	Universidad de Cantabria	andresv@unican.es
Ashley	Richard	University of Sheffield	R.Ashley@sheffield.ac.uk
Badger	Matthew	University of Sheffield	idp11mb@sheffield.ac.uk
Barton	Kevin	Robert Bray Associates	kevin@robertbrayassociates.co.uk
Bray	Bob	Robert Bray Associates	bob@robertbrayassociates.co.uk
Butler	David	University of Exeter	d.butler@exeter.ac.uk
Caldwell	Alison	Arup	alison.caldwell@arup.com
Charlesworth	Sue	SUDSnet / Coventry University	apx119@coventry.ac.uk
D'Arcy	Brian	C&D Associates / Abertay University	b.darcy@btinternet.com
De-Ville	Simon	University of Sheffield	sde-ville1@sheffield.ac.uk
Duffy	Alison	Abertay University	a.duffy@abertay.ac.uk
Dunderdale	David	Cosmotec	David.Dunderdale@ctgplc.com
Durno	Geoff	Reeds from Seeds, Bryn Polyn Nurseries	info@reedsfromseeds.co.uk
Ebsim	Mahdi	Heriot-Watt University	mahdi.ebsim@gmail.com
Furlong	Ellis	Northumbrian Water	ellis.furlong@nwl.co.uk
Golzar	Mahshid	University of Sheffield	mgolzar1@sheffield.ac.uk
Graham	Andy	WWT Slimbridge	andy.graham@wwt.org.uk
Harrison	Anne	WWT Slimbridge	anne.harrison@wwt.org.uk
Hill	Kirk	ADAS UK Ltd	kirk.hill@adas.co.uk
Hopgood	Rachel	JBA Consulting	rebecca.hartman@jbaconsulting.com
Horvat	Blaz	Vodovod-Kanalizacija	blaz.horvat@vo-ka.si
Howard	James	Cannon Consulting	james.howard@cannonce.co.uk
Ibanez	Marta	Abertay University	1305163@live.abertay.ac.uk
Illman	Sue	Landscape Institute	yvonnem@landscapeinstitute.org
Jackson	Janet	University of Northampton	science.admin@northampton.ac.uk
Jato-Espino	Daniel	University of Cantabria	jatod@unican.es

Organised by:

Supported by:

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

SURNAME	FORENAME	ADDRESS	EMAIL
Kellagher	Richard	HR Wallingford Ltd.	r.kellagher@hrwallingford.com
Littlewood	Graham	BWB Consulting	graham.littlewood@bwbconsulting.com
Lundy	Lian	Middlesex University	l.lundy@mdx.ac.uk
MacLellan	Marion	Coventry University	AB5432@COVENTRY.AC.UK
Manning	Mark	SDS Ltd.	mark.manning@sdslimited.com
Mbanaso	Fred	Coventry University	ab0312@coventry.ac.uk
McCloy	Anthony	McCloy Consulting	anthony.mccloy@mccloyconsulting.com
McKay	Gaye	Tuil Solutions	gaye@tuilsolutions.com
McLaughlin	Anne-Marie	Coventry University	ab6551@coventry.ac.uk
Melville-Shreeve	Peter	University of Exeter	pm277@exeter.ac.uk
Mitchell	Ged	BEAR Scotland	GMitchell@bearscotland.co.uk
Moir	Stewart	Moir Environmental	stewart@moir-environmental.co.uk
Norton	David	Robert Bray Associates	dave@robertbrayassociates.co.uk
Puckmayr	Judith	Robert Bray Associates	judith@robertbrayassociates.co.uk
Reed	Kevin	Graf UK	kreed@grafuk.co.uk
Revitt	Mike	Middlesex University	m.revitt@mdx.ac.uk
Robinson	Janine	University of Portsmouth	janine.robinson@port.ac.uk
Rowlands	E. Gordon	Carnell	egrowlands@gmail.com
Sanudo-Fontaneda	Luis	Coventry University	aa4094@coventry.ac.uk
Schaffer	Paul	CIRIA	paul.shaffer@ciria.org
Simmons	Suzanne	CIRIA	suzanne.simmons@ciria.org
Simpson	Matthew	WWT Consulting Ltd	matthew.simpson@wwtconsulting.co.uk
Stovin	Virginia	University of Sheffield	v.stovin@sheffield.ac.uk
Tota-Maharaj	Kiran	University of Greenwich	K.Tota-Maharaj@greenwich.ac.uk
Totman	Rik	Cannon Consulting,	rik.totman@cannonce.co.uk
Wade	Rebecca	SUDSnet / Abertay University	r.wade@abertay.ac.uk
Walker	Louise	Leeds University	a.k.wilkinson@leeds.ac.uk
Williams	John	University of Portsmouth	john.williams@port.ac.uk
Winter	Kevin	University of Cape Town, South Africa	kevin.winter@uct.ac.za

Organised by:

Supported by:

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Organised by:

Supported by:

SUDSnet International Conference 2015

3rd & 4th September 2015. Techno-Centre, Coventry University, UK.

Thank you for attending

SUDSnet International Conference 2015
"Taking SUDS forward"

3rd & 4th September 2015
Techno-Centre, Coventry University, UK

Contact SUDSnet:

Web: http://sudsnet.abertay.ac.uk/

E-mail: sudsnet@abertay.ac.uk

SUDSnet Coordinator at Abertay University: Dr Rebecca Wade

SUDSnet Coordinator at Coventry University: Prof Susanne Charlesworth

Organised by:

Supported by: