Institution: Middlesex University

Unit of Assessment: 17

Title of case study: Changing perspectives and policies in urban drainage practice

1. Summary of the impact

For over 40 years, the Urban Pollution Research Centre has undertaken pioneering work in understanding the sources, behaviour and fate of urban diffuse pollution and its mitigation using sustainable urban drainage systems (SUDS). Relevant impacts claimed here include the adoption of SUDS into UK practice and legislation, the role of SUDS as key components in achieving EU Water Framework Directive (WFD) requirements and the embedding of our research within national best practice guidelines. In response to recent policy drivers, we are collaborating with Arup to commercialise SUDSloc and are informing policy developments in the fields of diffuse pollution mitigation and urban ecosystem services.

2. Underpinning research

Building on our initial laboratory and test-scale systems (e.g. Nature Conservancy Council: 1989-1992, £40,000), our research has established the performance of field-scale SUDS to treat a range of surface water runoff types including highway (Environment Agency for England and Wales (EA); £45,000, 1999-2003), residential and mixed catchment runoff (EPSRC CASE award; 1995-1998), as well as evaluating their applicability to manage airport runoff (NERC CASE award; 1995-1998) (Adeola *et al*. 2009). Our contribution to the development of extensive data sets demonstrating the performance of SUDS in a range of contexts and on the use of risk-benefit analysis have made major contributions to the evidence base underpinning the development of national best practice by the Construction Industry Research and Information Association (CIRIA) and the EA (Adeola *et al.* 2009; Ellis and Revitt 2008; Ellis *et al.* 2012; Ball and Ball-King 2012).

Kick-started by the award of an NERC/EPSRC/ESRC seminar grant 'Integrating Social Science into Urban Environmental Systems' (ISSUES - £23,000, 2007-2009), our research on the wider range of benefits provided by urban water bodies (including SUDS) enabled us to develop new research expertise in the field of urban ecosystem services. Specifically, this has explored the innovative application of an ecosystem services approach to re-evaluate a series of co-located but independent studies undertaken by a range of disciplines within a single framework (Lundy and Wade 2011). Findings indicate the value of this in underpinning a more holistic assessment of the processes through which urban water bodies may contribute to human health.

Responding to demands from a range of practitioners, including Local Authorities and environmental regulators, our research has addressed the need to support practitioners in selecting appropriate SUDS based on their pollutant removal ability in the absence of robust field data (Scholes *et al.* 2007). This need was driven by the EU WFD's requirement to mitigate both diffuse and point source pollution. Our insight into how to combine empirical data and expert judgement underpinned the development of a novel theoretical approach to assessing the relative potential for removal of all WFD priority (hazardous) substances by 15 types of SUDS (EU FP5 DayWater (€275,000; 2002-2005) and EU FP6 ScorePP (€400,000; 2006-2009)). With the University of Leeds, we developed an innovative unit area loading model for diffuse pollution based on the spatial distribution of pollutants at a catchment scale (Ellis and Revitt 2008).

Research undertaken within the EU FP6 SWITCH (€1,001,369; 2006-2011) and ScorePPP projects enabled us to integrate several of our SUDS tools within a single GIS platform (SUDSloc), a highly innovative approach to selecting the most appropriate type of SUDS for a particular site.

SUDSloc involves scoring the performance of 15 types of SUDS against site, technical, environmental and socio-economic criteria. A recent development is the linking of SUDSloc to 1D/2D stormwater models to enable the flood alleviation impacts of installing SUDS at alternative locations to be quantified (Ellis *et al.* 2012). This paper was nominated as best technical paper by the Institution of Civil Engineers in 2012. To date, the approach has been trialled by Birmingham City Council (within SWITCH) and Coventry City Council (£4500; 2010) within the development of surface water management plans.

This research was undertaken by Revitt (Professor), Garelick (Principal Lecturer/Professor), Ellis (Professor), Jones (Senior Lecturer), Ball (Professor), Watt (Senior Lecturer/Reader), Lundy (Senior Research Fellow/Reader), Adeola (PhD student) and Viavattene (Research Fellow/Senior Research Fellow). Studies were competitively funded following rigorous peer review and supported by advisory committees. Findings were published in leading peer reviewed journals in the field.

3. References to the research

Adeola, S., Revitt, D. M., Shutes, R. B. E., Garelick, H., Jones, H. and Jones, C. (2009). Constructed wetland control of BOD levels in airport runoff. International Journal of Phytoremediation 11(1); 1-10. DOI: 10.1080/15226510802363220.

Ellis, J.B. and Revitt, D. M. (2008) Quantifying Diffuse Pollution Sources and Loads for Environmental Quality Standards in Urban Catchments. Water Air and Soil Pollution: Focus 8 (5-6), 577-585. DOI: 10.1007/s11267-008-9175-9.

Ellis, J. B., Revitt, D. M. and Lundy, L. (2012) An impact assessment methodology for urban surface runoff quality following best practice treatment. Science of the Total Environment 416, 172-179. DOI: 10.1016/j.scitotenv.2011.12.003

Ball, D. and Ball-King, L. (2012) Safety Management and Public Spaces: Restoring Balance. Risk Analysis 33(5); 763-71. DOI: 10.1111/j.1539-6924.2012.01900.x.

Lundy, L. and Wade, R. (2011) Integrating sciences to sustain urban ecosystem services. Progress in Physical Geography 35; 5, 653-669. DOI: 10.1177/0309133311422464.

Scholes, L., Revitt, D .M. and Ellis, J. B. (2008) A systematic approach for the comparative assessment of stormwater pollutant removal potentials. Journal of Environmental Management, 88 (3), pp 467-478. DOI:10.1016/j.jenvman.2007.03.00

Ellis, J. B., Viavattene, C., Chlebek, J. and Hetherington, D. (2012) Integrated modelling for urban surface water exceedance flows. Water Management 165, 10, 543-552. DOI: 10.1680/wama.12.00029.

4. Details of the impact

National guidelines - impact

The 2007 floods are estimated to have cost the UK £3.2 billion. Part of the UK's response to tackling urban flooding on this scale was the adoption of the Flood and Water Management Act (2010). This requires SUDS to be considered on all new and re-developments and states that Local Authorities are responsible for their adoption and maintenance. National best practice guidelines are required to support consistent interpretation and implementation of this requirement across England and Wales. Our research on the water quantity, quality and risk management of SUDS is incorporated within the on-going revision of national best practice guidelines for surface water management (1, 2, 3) by CIRIA which will be used by all 478 Local Authorities in England and Wales and surface water management practitioners (covering a population of 56.6 million). Our paper on the use of risk-benefit analysis to support the assessment of risks to public health

and safety (underpins the risk assessment approach in the revised manual; 1, 3) was selected by the Society for Risk Analysis for a media outreach campaign; it subsequently attracted global attention (4).

Policy development - impact

Our research is currently informing policy development in 2 key areas; the mitigation of diffuse urban pollution and the application of an ecosystems approach. The seminal diffuse pollution behaviour work undertaken throughout the 1970s and 1980s informed the thinking of environmental regulators and practitioners throughout the UK (1, 2, 3, 5, 6, 7, 8, 9). As practitioner-demand for knowledge shifted from understanding to managing the issue (evidenced by the award of EU, Research Council, EA and industry funding of >£2.2m), our research on diffuse pollution mitigation has underpinned the role of SUDS as water quality measures and continues to inform policy development through its use by bodies appointed to advise e.g. Defra, the EA and DCLG (6, 7, 8). As a result, our diffuse pollutant unit area loading model was trialled by the EA (2006-2007), utilised within the Defra Integrated Urban Drainage studies (7) and contributed to the identification of SUDS as appropriate urban diffuse pollution mitigation measures in all 11 river basin management plans developed for England and Wales under the EU WFD (2). Our research on the impacts of catchment urbanisation is cited as informing the 2010-2015 United Utilities wastewater business plan (9). With regard to ecosystem services policy, our novel work on SUDS as multiple ES providers led to our invitation to co-author the urban chapter of the UK National Ecosystem Assessment (NEA; 11). Our input ensured that the role of SUDS is identified within the UK NEA with its findings cited as informing the development of the recent Environment White Paper. This directly led to our involvement in the Defra NEA 'follow-on' project (£7500; 2012-2013) which aims to operationalise an ecosystems approach within all UK Government sectors. Our research on their multifunctional role is also informing the development of Scottish policy. For example, a direct quote from Lundy and Wade (2011) was used to frame a key research call issued to underpin pertinent Scottish policy development (12). We subsequently successfully applied to undertake this research (CREW; £7000; 2012-2013).

Best practice and pedagogic outreach - impact

Our research also informs best practice at an international level. Our participation in Learning Alliances and International Advisory Boards (e.g. within the EU FP 6 SWTCH, ScorePP and the EU TEMPUS I-WEB (2012-2015)) projects) led to our research being utilised by practitioners to support, for example, the development of integrated urban water management visions in the UK, Brazil and Poland. It is leading to commercial impact through our on-going collaboration with Arup to bring our SUDSloc tool to market (10; £6800). Within the context of international pedagogic initiatives, our research contributed to the development and delivery of the first Bologna-compliant water resource management Masters programmes in Russia currently being delivered at 4 Russian universities (EU Tempus NETWATER; 2010-2013). Building on this success, we were recently awarded further EU TEMPUS funding (I-WEB; €928,266) to lead the development and implementation of Bologna-compliant integrated water management MSc and PhD programmes at 3 universities in Kazakhstan. Teaching materials include training on water quantity, quality and amenity aspects of SUDS and, in combination, involves the retraining of 132 staff and the training of 70 students.

Whilst the discrete economic impact of our research is impossible to quantify on a stand-alone basis, a Defra report calculated that the costs of mitigating diffuse urban and transport pollution in line with EU WFD requirements to be in the region of £2.7 million per year (equivalent annual value). It also identified SUDS as appropriate low cost, effective options for the treatment of such diffuse pollution, broadly indicating the magnitude of costs associated with the field in which we demonstrate we are recognised leaders at a national and international level (1, 2, 3, 5, 8, 9).

5. Sources to corroborate the impact

1. Construction Industry Research and Information Association
2. Welsh Assembly Government (formerly with the Environment Agency for England and

Wales)
3. HR Wallingford Ltd
4. Email from the Society for Risk Analysis' Communications Committee, dated 13/1/13.
5. Penny Anderson Consultants
6. Technical report on surfacing options and cost benefit analysis for the Department for Communities and Local Government; available at: http://www.communities.gov.uk/publications/planningandbuilding/permeablesufacesreport
7. TR344 – River Ribble Strategic Studies Report (2008) http://archive.defra.gov.uk/environment/flooding/manage/surfacewater/urpilotaire.htm
8. J Ellis and DM Revitt are members of the Defra Expert Committee on Non-Agricultural Diffuse Pollution; DM Revitt is an advisor to OfWat; JB Ellis was an expert witness to the Thames Tunnel Commission; L Lundy is a corresponding member supporting revision of the CIRIA SUDS manual.
9. United Utilities Water Business Plan 2010 – 2015. Chapter C4 – Appendix 1 Wastewater Supply/Demand Management Plan. http://www.unitedutilities.com/Documents/C4_Appendices.pdf
10. Memorandum of Understanding between Middlesex University and ARUP re: development of SUDSloc.
11. UK National Ecosystem Assessment. Chapter 10: Urban. Available at: http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx
12. Research call from the Centre of Expertise for Waters (Call 1) at www.masts.ac.uk/crew/