Institution: Middlesex University

Unit of Assessment: 14 – Geography and Environmental Studies

Title of case study: Working with nature to enhance urban liveability: the multi-functional role of urban blue green infrastructure

Period when the underpinning research was undertaken: 2000 to 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
David Ball	Professor of Risk Management	1997- current
Bryan Ellis	Emeritus Professor	2011 - current
Meri Juntti	Senior Lecturer in Sustainable Environmental Management and Sustainable Development	2008 - current
Lian Lundy	Reader in Sustainable Water Management / Professor of Environmental Science	2003 - current
Mike Revitt	Professor; Emeritus Professor	2011 - current

Period when the claimed impact occurred: 2014-2020

Is this case study continued from a case study submitted in 2014? No

1. Summary of the impact

Blue green infrastructure (BGI), the integration of green spaces and water management, is seen as essential to solving urban and climate challenges. Our research has directly contributed to the recognition of sustainable urban drainage systems (SuDS) as core components of BGI and providers of multiple ecosystem services within urban areas.

Our work has delivered impacts on:

- **National legislation and guidelines** – research directly informed Best Practice Guidelines to tackle urban flooding, used by all Local Authorities in England.
- **Policy development** – based on our research on diffuse pollution mitigation, use of our road pollutant hot spot screening tool is considered best practice in London. Our work on urban stormwater is fully embedded within the ISO Guidelines for Stormwater Management in Urban Areas (2020).
- **Environment, society, quality of life and the economy** - our data has evidenced the contribution of SuDS/BGI to sustainable urban development from social, technical and environmental perspectives.

2. Underpinning research

Our field and desk-based (modelling) research has established the performance of SuDS/BGI to treat a range of contaminants (conventional and those of emerging concern) transported by urban stormwater runoff. This includes the development of a novel approach to mitigate impacts of road runoff on receiving water quality at a catchment and local scale [3.1 and 3.2]. Our contribution to the development of extensive data sets, demonstrating the performance of SuDS/BGI in a range of contexts and on the use of risk-benefit analysis [3.3 and 3.4], have made major contributions to the development of national best practice by the Construction Industry Research and Information Association (CIRIA) [3.2] and the ISO DIS 20325 Guidelines for Stormwater Management in Urban Areas (2020) [3.1 and 3.2], also adopted as BSI DIS 20325 in the UK.

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. [3.1] This need was driven by the EU Water Framework Directive (WFD)'s

requirement to mitigate both diffuse and point source pollution. Our insight into how to robustly 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. Our approach to evaluating the pollution hazard of different types of land use and the type of treatment required [3.2] underpins the approach set out in the water quality management chapter of the CIRIA SuDS manual (2015; Chapter 26 page 562). This approach also informed the development of a road pollution hotspot screening tool recommended for use by the Greater London Authority, Transport for London and Environment Agency in identifying where and how road runoff should be treated using SuDS/BGI on its networks [3.1 and 3.2].

Our research on the wider range of benefits provided by SuDS/BGI has enabled us to broaden our research expertise in the field of urban ecosystem services. Specifically, we developed an interdisciplinary approach to better understand how blue-green spaces function as a part of the broader urban socio-economic context, yielding potential benefits to liveability and wellbeing [3.5]. We also explored how knowledge of experienced ecosystem services can be integrated within the planning system to support environmentally just outcomes [3.6]. Findings indicate both the value of integrating lay perspectives with urban development in terms of contributing to human health objectives and the tensions that may arise if this socio-environmental community relationship is overlooked.

3. References to the research

3.1 L Scholes, DM Revitt and JB Ellis (2008) A systematic approach for the comparative assessment of stormwater pollutant removal potentials. Journal of Environmental Management 88, 467-478. DOI:10.1016/j.jenvman.2007.03.003.

3.2 JB Ellis, DM Revitt and L Lundy (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.

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

3.4 D Ball and L Ball-King (2011) Pubic safety and risk assessment: improving decision-making. Abingdon: Earthscan. 204 pp.

3.5 M Juntti, H Costa and NO Nascimento (2019) Urban environmental quality and wellbeing in the context of incomplete urbanization in Brazil: integrating experienced ecosystem services into planning. Progress in Planning 143, 100433. DOI: 10.1016/j.progress.2019.04.003.

3.6 M Juntti and L Lundy (2017) A mixed methods approach to urban ecosystem services: experienced environmental quality and its role in ecosystem assessment within an inner-city estate. Landscape and Urban Planning 161, 10-21. DOI: 10.1016/j.landurbplan.2017.01.002.

4. Details of the impact

National legislation and guidelines - impact

The average annual cost of flooding in the UK is £1.3 billion, rising to £1.6 billion in relation to the winter 2016/2017 floods. Part of the UK's response to tackling urban flooding on this scale was the adoption of the Flood and Water Management Act (2010) requiring the use of SuDS in all new and re-developments. When the Act's requirement proved unenforceable in England, our research contributed to the development of National Best Practice guidelines (The SuDS manual; CIRIA, 2015) to support consistent interpretation and implementation of this requirement (5-1). For example, our research directly informs the chapters on water quality (Chapter 26) and health and safety (Chapter 36). These National Best Practice guidelines are used by all 343 Local Authorities in England and surface water management

practitioners (covering a population of 55.9 million). Specifically, our papers on designing SuDS to address water quality and the use of risk-benefit analysis to support the assessment of risks to public health and safety underpins the water quality and risk assessment approaches in the revised manual, respectively. Our research also contributed to the Welsh Statutory SuDS standards relating to water quality enhancement (5-2): "*In developing these standards, we drew directly on the research findings of Middlesex University in relation to Standard S3 – water quality. This part of the standards adopts a simplified version of approach set out in Ellis et al., 2012..*" *(Welsh Government Water Policy Lead 5-2).*

Policy development - impact

Our research is currently informing policy development in two key areas: the mitigation of diffuse urban pollution using SuDS/BGI and its use within urban planning. In this REF period, our SuDS/BGI work has informed the thinking of environmental regulators and practitioners throughout the UK (5.1, 5.2, 5.3, 5.4). 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 >£2.2million), our research on diffuse pollution mitigation using SuDS/BGI has underpinned the role of SuDS as water quality measures. It continues to inform policy e.g. the Greater London Authority, Transport for London and the Environment Agency released a joint statement promoting our road pollutant hot spot screening tool as best practice in identifying locations for the introduction of road-side SuDS/BGI within London (5-3): *"This study will help us to work out where both we and the other authorities responsible for roads in London could intervene to make runoff cleaner and improve water quality in rivers for everyone" (Transport for London Head of Transport Strategy and Planning, 5-3)*. Our research into using SuDS/BGI to manage urban stormwater above ground – in contrast to the traditional piped approach - is fully embedded within the ISO Guidelines for Stormwater Management in Urban Areas (2020), also adopted as BSI DIS 20325 in the UK): *"In my role as chair of the BSI committee, I used their research in the development of the ISO Guidelines for Stormwater Management (2020). Specifically, their research on pollution control using SuDS contributed to the inclusion of blue-green infrastructure as an evidence-based approach for mitigation urban stormwater within the guidelines"; (5-4; Brian Smith Yorkshire Water Head of Drainage Strategy (2013-2019) and current BSI Committee Chair).*

The environment, society, quality of life and the economy – impact

With regard to urban planning, our novel work integrating lay perspectives within development of SuDS/BGI zones and identifying opportunities for its integration within planning processes has led to the approach being adopted within urban planning legislation of three municipalities within the metropolitan Area of Belo Horizonte (BH), Brazil (5.5). Our input ensured that the role of SuDS/BGI in contributing to the delivery of human health and wellbeing objectives (including environmental justice) is identified in Belo Horizonte planning policy and the inclusion of blue-green spaces must be considered in all new developments. In relation to societal impact at a national level "*the work of Middlesex University – via their contribution to the Welsh SuDS Standards – directly contributes to more and better outcomes in enhancing surface water quality in Wales. This approach to diffuse pollution mitigation would have not been possible without your work on diffuse pollution, providing a better understanding of the sources and types of diffuse water pollution and of the pollutant removal processes which underpin the design and operation of SuDS" (5-2 –a; Welsh Government Water Policy Lead 2008-2018; 5-2-a).*

Whilst the discreet economic impact of our research is impossible to quantify on a standalone basis, the use of SuDS/BGI is identified as a key way to increase the resilience of urban areas to flooding (causing estimated damages of £1.3 billion per year). Our research has helped to articulate the value of SuDS/BGI in terms of its contribution to diffuse pollution mitigation and supported the recognition and subsequent assessment of SuDS/BGI as providers of multiple ecosystem services. More recently our research has embraced opportunities to contribute to understanding the wider societal benefits provided by SuDS/BGI as part of the delivery of sustainable urban planning (4.5).

5. Sources to corroborate the impact

5.1 CIRIA (2015) The SuDS manual e.g. see Chapter 26 (pages 564 and 589-593; **5-1-a**) and Chapter 36 (pages758 and 771; **5-1-b**) which specifically refers to how our methodology and underpins the approach used to address water quality. As a corresponding member (see page vi), L Lundy commented on various draft sections providing a further mechanism through which our research contributed to support this revision of the CIRIA SuDS manual.

5.2 The Welsh Statutory Standards for SuDS (2018; **5-2**) requires the use of the simple index approach (CIRIA, 2015) when assessing impacts on water quality. CIRIA (2015; The SuDS manual) states that the simplified water quality impact assessment approach identified is based on our research (see Chapter 26, Section 26.7.1; page 564), with our full method given as Annex 5. Our contribution to developing the Welsh Statutory Standards is also corroborated in a testimonial from the Welsh Government Water Policy Lead 2008-2018 (**5-2-a**)

5.3 Greater London Authority press release 'First study of its kind shows road pollution is contaminating London's rivers' (https://www.london.gov.uk/press-releases/mayoral/study-shows-road-pollution-is-polluting-rivers ; 23/12/20; **5-3**) which describes the use of Middlesex research by the Greater London Authority and Transport for London.

5.4 Yorkshire Water: Head of Drainage Strategy (2013-2019): testimonial describing the use of Middlesex research in the ISO Guidelines for Stormwater Management in Urban Areas (2020; **5-4**)

5.5 Letter of support from the General Coordinator of the Belo Horizonte Metropolitan Planning Process (Brazil; **5-5**)