Institution: Abertay University

Unit of Assessment: 12 - Engineering

Title of case study: Changing policy and practice to enhance societal and environmental benefits from sustainable urban drainage systems and green/blue infrastructure

Period when the underpinning research was undertaken: 2003–2019

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

Names:	Roles (e.g. job title):	Periods employed by submitting HEI:
Dr Rebecca Wade	Senior Lecturer in Environmental Science	2002 – present
Dr Ken Scott-Brown	Senior Lecturer in Psychology	2001 – present
Prof. David Blackwood	Professor of Sustainable Development	1985 – 2019

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

Sustainable Drainage Systems (SuDS) are water management strategies that, contrary to conventional pipe drainage systems, mimic natural hydrological and greenspace processes. SuDS deliver ecosystem services including decreasing flooding, increasing biodiversity, improving water quality and enhancing community wellbeing.

Our SuDS research has had impact in the UK, Europe and South America. We have:

1. Developed and supported a community of practice that has directly led to statutory legal change to policy and practice in Wales (2019) requiring building developers to implement sustainable drainage solutions into new construction projects.
2. Influenced practice in seven Mediterranean municipalities (2014-20) by co-developing Transition Manuals and Strategic Action Plans to stimulate adoption of sustainable drainage approaches, and informed strategic planning and funding allocation criteria in Malta.
3. Influenced the development of new laws in three municipalities in Belo Horizonte, Brazil that now require all new municipal developments to observe newly introduced criteria that restrict land use to promote environmental sustainability (2019-20).

2. Underpinning research

SuDS are sustainable water management options which provide economic and societal benefit in the form of reduced flood and drought, enhanced biodiversity and habitat provision, atmospheric regulation, water and air pollution and recreational opportunities. SuDS integration into existing infrastructures is challenging and requires a holistic, multi-stakeholder approach to sustainability planning. Our SuDS research links urban water engineering and infrastructure to the delivery of multiple environmental and societal benefits and has led to interdisciplinary translational research projects (UKRI (ESRC) and EU funded) and has delivered research outputs **[3.1-3.5]** that underpin our impact.

We have explored the relationship between greenspace and urbanisation, analysing trends in the provisioning, regulation and use of greenspaces in urban environments **[3.1]**. Key findings include that during the last three decades urban greenspace access and condition has declined. Urban blue (water) and green (land) ecosystem services could be significantly enhanced to improve climate mitigation and adaptation, and trade-offs and synergies in ecosystem goods and services are complex, with spatial and temporal scale a major issue in decision-making. For example, an increase in vegetation cover in urban areas improves stormwater management, but

incurs maintenance costs, and can increase allergies from pollen. Our research (funded by EPSRC-NERC-ESRC 2008-2010) demonstrates that effective water management within urban settings requires a multidisciplinary approach spanning social, ecological and physical sciences **[3.2]**. Managing water within urban spaces is an essential infrastructure requirement, but has historically been undertaken in isolation from other urban requirements. We provide a framework for synthesising provisioning, regulating and cultural ecosystem services associated with differing types of urban water bodies and demonstrate framework use with a case study.

Building upon the need for a holistic approach to managing environmental change, we analysed the robustness of different response options, such as designated conservation areas, precision farming and water demand management, in the face of specific climate and socioeconomic scenarios defined by UKNEA (e.g. high/low international trade barriers, de/centralised ecosystem stewardship) **[3.3]**. We showed that resilience and adaptation to change are best met by an orchestrated suite of response options that span social, economic, regulatory and environmental needs at a range of scales. We then extended this work with a much wider range of response options structured by sector (agriculture, water etc.) **[3.4]**. Findings include that the most effective response options in agriculture are those that develop and disseminate knowledge, technology and practice, because they support the delivery of ecosystem services under all scenarios, to a greater or lesser extent. Additionally, analysis showed that SuDS were among the most robust options for the water sector since SuDS can provide a range of ecosystem services and are flexible to adapt to a variety of future conditions.

We then focused on how natural capital and its associated ecosystem services can be understood within the wider context of the urban environment including community wellbeing **[3.5]**. Our research focused on the city of Belo Horizonte, Brazil and on how different ecosystem services can be incorporated into sustainable urban development and planning, as a natural asset that can reduce people's risk and vulnerability, and improve wellbeing. Our research integrated SuDS into the wider infrastructure of natural and semi-natural blue and green areas (blue/ green networks). Our work combines environmental infrastructure assessment (biophysical structures, ecosystem services and disservices (e.g. pollution)) with community use of urban space (via interviews & questionnaires) to explore provision and use of ecosystem services. We found that green spaces are sites of intersecting inequalities: deprived groups are more likely to value green spaces for air quality and depend on these spaces for income; privileged residents find green spaces less valuable and use them for recreation. We identified that local land use planning does not pay suffiicent attention to urban green space development and their benefits. Planning must also take account of ecosystem disservices and their mitigation, e.g. trees providing shade also provide cover for illicit activities and should be mitigated by street lighting. Finally, women were found to be less likely to access, value and feel safe in green and blue spaces; planning should address gendered inequalities.

3. References to the research

3.1 UK National Ecosystem Assessment (2011) Chapter 10 Urban Ecosystems. Davies, L (coordinating author) Wade, R, Scholes, L et al. (lead authors) (2011). The UK National Ecosystem Assessment Technical Report. UNEP-WCMC, Cambridge. http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

3.2 Lundy L and Wade R. (2011) Integrating Sciences to Sustain Urban Ecosystem Services. Contribution to a Special Issue for the Journal *Progress in Physical Geography*. Special Issue title: Ecosystem Services. Volume 35 Issue 5 (October 2011) pp. 653 - 669. https://doi.org/10.1177/0309133311422464

3.3 Brown I, Berry P, Everard M, Firbank L, Harrison P, Lundy L, Quine C, Rowan J, Wade R, Watts K (2015). Identifying robust response options to manage environmental change using an Ecosystem Approach: A stress-testing case study for the UK. *Environmental Science & Policy* Volume 52 (October 2015) pp. 74-88. https://doi.org/10.1016/j.envsci.2015.05.005

3.4 Brown I, Harrison PA, Ashley J, Berry PM, Everard M, Firbank LG, Hull S, Lundy L, Quine CP, Rowan JS, Wade R, Walmsley S, Watts K, Kass G (2014). UK National Ecosystem Assessment Follow-on. Work Package Report 8: Robust response options: What response options might be used to improve policy and practice for the sustainable delivery of

ecosystem services? Chapter: Work Package Report 8. 2014.UNEP-WCMC, LWEC, UK. http://uknea.unep-wcmc.org/Resources/tabid/82/Default.aspx

3.5 Bradshaw S, Linneker B, Nascimento NI, Caballero I, Costa H, Oki Y, Brittes R, Juntti M, Lundy L, Scott-Brown K, and Wade R. (2017) Guidance for Engendering Ecosystem Services for Urban Transformation. January 2017. Project: ADEPT: developing the ecosystem approach to drive positive urban transformations in the context of intersecting vulnerabilities. *Can be supplied by the HEI on request.*

3.1 and **3.2** fed into UK Government policy via the UK National Ecosystem Assessment (UKNEA) 2011, the first analysis of the UK's natural environment in terms of the benefits it provides to society and continuing economic prosperity. The UKNEA provided part of the evidence base for the UK Government's White Paper on the Natural Environment - 'The Natural Choice: securing the value of nature' (2011). **3.3** and **3.4** contributed to UKNEA Follow on (UKNEAFO) 2014, (http://uknea.unep-wcmc.org/) which furthered understanding in four areas: Economic analysis, Cultural ecosystem services, Future ecosystem changes, and tools and supporting materials to communicate the messages and findings from the UKNEA and UKNEAFO to different audiences. **3.5** is the Final Project Report for the Newton Fund Grant: ES/M011631/1 [ESRC funded].

4. Details of the impact

4.1 Legislation for new construction projects in Wales

We have taken a UK-wide role in influencing practitioners and policy makers to adopt a holistic, multi-stakeholder approach since 2003, which led to us initiating a community of practice, *SuDSnet* that includes our research collaborators. *SUDSnet* (initiated by an EPSRC award 2003-07), has grown into an international self-sustaining community of practice with ~1000 members (70% practitioners) managed by Dr Wade, Abertay University and co-led with Coventry University. *SUDSnet's* holistic approach to urban ecosystem service provision in the face of climate change has been instrumental in UK Government policy development via UKNEA (2011 **[3.1, 3.2]**, 2014 **[3.3, 3.4]**). Outputs have led to new statutory instruments in Wales (2019) that **require new development constructions to use SuDS for surface water management**. Phil Chatfield, Former Water Policy Advisor, Welsh Government states: "*Abertay researchers… have undertaken research into the multiple benefits possible from SuDS for over a decade and have directly influenced the UK community of practice via SUDSnet events and discussions, they have shaped the national and international knowledge-base which has subsequently influenced practice and policy. Having a focus for SuDS in the Abertay University-led SUDSnet has been, in my view, invaluable in informing policy development and providing access to a network of experts who have provided advice as the policy and standards in Wales have been developed.*" **[5.1]**.

The new legislation requires a change in drainage practice such that SuDS implementation is **now a legal requirement for planners and developers in Wales for the first time**. "*The legislation informed by Abertay and SUDSnet is in the form of five statutory instruments and a set of statutory standards. This legislation requires designers and developers to shift water-management from below-ground, piped drainage infrastructure and single-point storage towards open and green forms of water conveyance, treatment, storage and disposal. It specifically considers the multiple benefits possible from SuDS.*" **[5.1]**. The legislation spans: Approval and Adoption of SuDS **[5.2]**; Procedural matters relating to SuDS approval and adoption **[5.3]**; Fees Regulations **[5.4]**; Enforcement of the requirement for approval by the SuDS Approving Body **[5.5]**; and Appeals against decisions of the SuDS approving body **[5.6]**.

Specifically, "*From 7th January 2019, all new developments of more than 1 dwelling house or where the construction area is 100 square meters or more, will require sustainable drainage systems (SuDS) for surface water. The SuDS must be designed and built in accordance with Statutory SuDS Standards published by the Welsh Ministers and SuDS Schemes must be approved by the local authority acting in its SuDS Approving Body (SAB) role, before construction work begins*" Welsh Government guidance **[5.7]**.

4.2 Sustainable water management planning in the Mediterranean

Abertay researchers partnered with the Universitat Politecnica de Valencia on E^{2}Stormed (2013-2015), an EU funded knowledge exchange project with seven municipalities across six countries in Mediterranean Europe. This project drew on our research findings **[3.1 - 3.4]** on the cost/ benefits of SuDS and conventional urban water management solutions to inform pathways to SuDS adoption in seven EU municipalities: Ħaż-Żabbar (Malta), Benaguasil (Spain), Pisa and Dronero (Italy), Hersonnisos (Greece), Cetinje (Montenegro), and Zagreb (Croatia). E^{2}Stormed integrated >15 years of SuDS expertise, and in particular SuDS transitioning expertise, with (i) pilot study models (e.g. green roofs, swales) in each region comparing conventional drainage and SuDS in the Mediterranean region and (ii) a decision support tool to support transitioning from conventional to SuDS drainage solutions. Findings from the pilot studies were used to parameterise a decision support tool for each region based on a generic framework. E^{2}Stormed evidenced economic and resource savings potential with sustainable, aesthetic solutions.

Prior to E^{2}Stormed, SuDS approaches had rarely been used in Mediterranean countries, and these regions did not have direct experience of sustainable drainage in a contemporary context. By leveraging **Abertay's extended expertise in SuDS transitioning we accelerated SuDS adoption in those municipalities**. Transition planning and capacity building were delivered directly to municipal leaders during project visits. E^{2}Stormed's key deliverable in directing policy and practice was a portfolio of municipality-specific Transition Manuals (2015) setting out how to move from existing conventional pipe-based drainage approaches to sustainable drainage solutions. These **Transition Manuals were used to develop regional Strategic Action Plans** (2015-2050), written in both English and the home language. As part of our approach to embedding knowledge, these Transition Manuals and Strategic Action Plans were co-designed with local professionals and municipal leaders in groups established as part of the project and designed to build-in a legacy impact. Further, as part of our activities in raising awareness of SuDS we provided training in Spain, Italy, Malta and Montenegro for >120 professionals.

As an example of region-specific impact Stephen Bonello, Director General of the Works Dept, Malta states: "*Abertay University and the E^{2}Stormed project were instrumental in instigating a greater interest in blue and green infrastructure in Malta to the extent that we are now embedding this approach in our planning policies. The sustainable solutions were economically viable over the lifetime of the structure, taking into account both capital and operational expenditure, and further were able to determine societal and ecological benefits that could be gained from these approaches, as compared to conventional drainage engineering.*" **[5.8]**.

In reference to the Transition Manuals and Strategic Action Plans, Mr Bonello confirms **impact on strategic planning and funding criteria**: "*We used this evidence, together with our own experience and local knowledge, to undertake strategic planning for short (2015-2020), medium (2015-2030) and long term (2015-2050) actions, with target values and success criteria agreed*" and "*in 2020 the Planning Authority issued revisions to the Development Planning Fund whereby a greater emphasis is now being placed on blue and green infrastructure."* **[5.8]**.

4.3: New laws in Belo Horizonte, Brazil

ADEPT (2015-16) was a translational research collaboration with Federal University of Minas Gerais (UFMG), Brazil and Middlesex Universities **[3.5]**. Abertay's research was extended to a South American context, culture and climate. Our research was used to **inform and justify the inclusion of extensive green spaces for sustainable water management with multiple benefits**, within the Belo Horizonte (Brazil) Metropolitan Zone urban plan. We used a gendered lens and governance approach to understand community experiences of urban green spaces in the context of ecosystem service delivery. Our recommendations were relevant for hard-to-reach groups in communities with complex socio-economic challenges. **This research has been translated into legal instruments which will deliver change for those communities**.

As noted by Prof. Monte-Mor, General Coordinators of the Metropolitan Planning Process "*The ADEPT project influence occurred at an important period in the metropolitan planning process in*

Belo Horizonte. […] The ADEPT project report and guidance provided recommendations on what local authorities and community organisations can do to ensure that the existing environmental assets are valued and protected and the beneficial services are maximised and made accessible to all, while the dis-services are minimised, as set out in the 2016 publication **[3.5]**. *These outputs have been used, along with other evidence, to shape the blue green network inclusion in the laws for 3 Belo Horizonte Municipalities. We hope that more municipalities will adopt this approach in the future.*" **[5.9]**. A further 8 municipalities have equivalent bills yet to translate into law.

As stated by Prof. Heloísa Soares de Moura Costa, UFMG, "*the new municipal laws establish criteria for land use and occupation of the territory in which environmental aspects are reinforced. Above the traditional zoning criteria there is now a layer related to the blue and green network. This new layer of criteria establishes more strict land use and occupation restrictions (some in line with SUDS) and stimulates changes in land use such as agroecological agriculture, preservation areas, mining upgrading and recovery areas, etc. All new developments now need to observe those criteria. As a result, more local blue and green networks can be established at geographical scale more close to everyday life - small creeks, gardens, etc.*" **[5.10]**.

5. Sources to corroborate the impact

5.1 Approval and Adoption (The Sustainable Drainage (Approval and Adoption) (Wales) Order 2018) (https://www.assembly.wales/laid%20documents/sub-ld11779/sub-ld11779-e.pdf);

5.2 Procedural matters relating to approval and adoption (The Sustainable Drainage (Approval and Adoption Procedure) (Wales) Regulations 2018) (http://www.assembly.wales/laid%20documents/sub-ld11777/sub-ld11777-e.pdf);

5.3 Fees (The Sustainable Drainage (Application for Approval Fees) Wales Regulations 2018) (http://www.assembly.wales/laid%20documents/sub-ld11778/sub-ld11778-e.pdf);

5.4 Enforcement of the requirement for approval by the SuDS Approving Body (The Sustainable Drainage (Enforcement) (Wales) Order 2018) (http://www.assembly.wales/laid%20documents/sub-ld11775/sub-ld11775-e.pdf);

5.5 Appeals against decisions of the SuDS approving body (The Sustainable Drainage (Appeals) (Wales) Regulations 2018) (http://www.assembly.wales/laid%20documents/sub-ld11776/sub-ld11776-e.pdf).

5.6 Testimonial from Phil Chatfield, former Water Policy Advisor, Welsh Government regarding the Law in Wales, UK (2019). The (SuDS) Act came into effect in Wales in January 2019 for new developments, with the commencement of a series of five statutory instruments.

5.7 Sustainable Drainage (SuDS) Statutory Guidance 2019, Welsh Government. https://gov.wales/sites/default/files/publications/2019-06/statutory-guidance.pdf

5.8 Testimonial from Stephen Bonello, Director General of the Works Department, Malta, relating to the developed Transition Manuals for strategic planning with sustainability.

5.9 Testimonial from Roberto Monte-Mór, the General Coordinator of the Metropolitan Planning Process, relating to the new Laws in Belo Horizonte, Brazil (2019):

- Complementary Law No 59 20/12/2019. PREFEITURA MUNICIPAL DE SÃO JOAQUIM DE BICAS ESTADO DE MINAS GERAIS - DAS DISPOSIÇÕES PRELIMINARES E PRINCÍPIOS DO PLANO DIRETOR *(Translation: MUNICIPALITY OF SÃO JOAQUIM DE BICAS, STATE OF MINAS GERAIS Mayor's office COMPLEMENTARY LAW No. 59 OF DECEMBER 20, 2019. PROVISIONS ON THE DIRECTOR'S PLAN OF THE MUNICIPALITY OF SÃO JOAQUIM DE BICAS AND OTHER PROVIDENCES*.)
- Lei Complementar Nº 195 – 19/12/2019 'Dispoe sobre o plano Diretor do Municipio de Jatuba e da outra providencias. *(Translation: COMPLEMENTARY LAW No. 195 OF DECEMBER 19, 2019. PROVISIONS ON THE DIRECTOR'S PLAN OF THE MUNICIPALITY OF JUTUBA AND OTHER PROVIDENCES.)*
- Rio Manso Lei_Complementar_81_2019. *Translation: COMPLEMENTARY LAW No. 81, 2019. PROVISIONS ON THE DIRECTOR'S PLAN OF THE MUNICIPALITY OF RIO MANSO AND OTHER PROVIDENCES.*

5.10 Testimonial from Prof. Heloísa Soares de Moura Costa, Especialista em planejamento urbano, Federal University of Minas Gerais.