Institution: Queen Mary University of London (QMUL)

Unit of Assessment: C17 (Geography, Environmental Studies and Archaeology)

Title of case study: Assessment, restoration and management of urban rivers

1. Summary of the impact

Angela Gurnell's research on the geomorphology, hydrology and plant ecology of urban water courses has led to the development of important new tools for the biophysical assessment and improved management of urban rivers. Known as the Urban River Survey (URS), these tools are accessed by the Environment Agency and River Trusts across London, and their application is supported with workshops and guidance provided by Gurnell and her team. The URS has been used to deliver morphological quality indicators for rivers across London; to appraise river restoration schemes; to develop catchment management plans; and to assess long-term changes in rivers. It is currently being developed to quantify and set targets for river improvement schemes in relation to their impact on river ecosystem services. Gurnell's work has made a distinct contribution to urban river improvements in Britain and Europe, particularly through her leadership in developing a European framework for assessing hydromorphology.

2. Underpinning research

Over 50 per cent of the world's human population lives in cities. For these people, rivers are a source of drinking water, sanitation, transport, open space, relaxation and recreation. At the same time, river corridors within cities provide important resources for wildlife. However, centuries of urban and industrial development have led to severe degradation of urban water courses, seriously threatening their ability to deliver ecosystem services beyond the drainage and disposal of flood and waste waters. River management agencies are faced with balancing these pressures, making optimal decisions about river improvements, and restoring rivers to a healthier state. The need to improve urban water courses has intensified with the implementation in 2000 of the Water Framework Directive (WFD), which requires these 'Heavily Modified Water Bodies' to reach 'Good Ecological Potential' (GEP).

There are five research projects concerned with the geomorphology, hydrology and plant ecology of urban water courses, supervised by Gurnell, which have led to the development and testing of a survey for the biophysical assessment of urban rivers. These projects include a NERC studentship (1998-2001, GT24/98/10/URGE) to Dr Angela Boitsidis; a £46k subcontract from EU grant LIFE02 ENV/UK/000144 (2002-2005); a NERC studentship (2007-2011, NE/F014597/10 to Dr Chris Cockel; and an ESRC / NERC, interdisciplinary studentship (2008-2011: ES/F012314/1) to Dr Lucy Shuker. The research continues at European level through the FP7 collaborative project REFORM (2011-2015: Grant agreement 282656).

These projects have led to the development of the Urban River Survey (URS), a modification and extension of the Environment Agency's River Habitat Survey that assesses river dynamics as well as form and is applicable to heavily-modified urban rivers. It is used to estimate a range of environmental indicators for urban river reaches (Davenport et al., 2001, 2004), assess reach quality according to biophysical criteria (Boitsidis et al., 2006), and arrange reaches along semi-quantitative environmental gradients (Gurnell et al., 2007; 2012). These analytical tools allow comparison of physical habitat quality between reaches, across river networks, and through time, notably tracking trajectories of change associated with river restoration (Shuker et al., 2011). Many elements of the research are being incorporated into 'a process-based European framework for hydromorphology' for application across Europe within the REFORM project (www.reformrivers.eu).

The international excellence of the research is evidenced by its publication in six refereed journal papers (see section 3) and seven technical reports, demonstrating that urban rivers are morphologically diverse and dynamic and that local rather than extensive reinforcement of river

channels can provide important hydraulic and physical habitat complexity and induce habitat turnover. Two papers provide an up-to-date overview of the science by describing: (i) the elements of the URS methodology and how it may be used in urban river assessment (Shuker et al., 2011); and (ii) multivariate analysis of URS data from four cities to reveal the key environmental gradients that discriminate between urban river reaches (Gurnell et al., 2011).

3. References to the research

Boitsidis, A.J., Gurnell, A.M., Scott, M., Petts, G.E., Armitage, P. A. (2006) Decision support system for identifying the habitat quality and rehabilitation potential of urban rivers. *Water and Environment Journal*, 20, 130-140, DOI: 10.1111/j.1747-6593.2005.00005.x.

Davenport, A.J., Gurnell, A.M., Armitage,P.D. (2001) Classifying urban rivers. *Water Science and Technology,* 43, 9, 147-156, ISSN: 0273-1223.

Davenport, A.J., Gurnell, A.M., Armitage,P.D. (2004) Habitat Survey And Classification Of Urban Rivers*. River Research and Applications,* 20, 687-704, DOI: 10.1002/rra.785.

Gurnell, A.M., Lee, M., Souch, C. (2007). Urban rivers: Hydrology, Geomorphology, Ecology and Opportunities for Change*. Geography Compass* 1, 1118–1137, DOI: 10.1111/j.1749-8198.2007.00058.x

Gurnell, A.M., Shuker, L., Lee, M., Boitsidis, A.J. (2012) Gradients in the biophysical structure of urban rivers and their association with river channel engineering. *River Research and Applications* 28, 908-925, DOI: 10.1002/rra.1487.

Shuker, L., Gurnell, A.M., Raco, M. (2011). Some simple tools for communicating the biophysical condition of urban rivers to support high-level discussions regarding river restoration. *Urban Ecosystems* 15: 389-408, DOI: 10.1007/s11252-011-0207-2

All papers have been published in international, peer-reviewed journals.

4. Details of the impact

PROCESSES LEADING TO IMPACT

Practical implementation of the research commenced from 2002, when Gurnell moved to London (and to QMUL in 2009) and built contacts within London's river management agencies, benefitting from active collaboration between the Environment Agency (EA), Natural England (NE), the Greater London Authority (GLA) and local NGOs in relation to London's river conservation and restoration. An additional crucial driver was the implementation of the EU Water Framework Directive from 2000, which requires the ecological potential of 'Heavily Modified Water Bodies' to be assessed, and so provides a clear practical niche for the URS.

Communication of the URS methodology was pursued by Gurnell through presentations at conferences and workshops and meeting with potential users. Uptake of the work by the EA, NE, Naturalist and London River Conservation Trusts resulted from:

(i) *2008 to 2011*: Involvement of researchers from QMUL Geography with river restoration in London led to application of the URS in the high profile Mayes Brook Park restoration scheme (EA and QMUL, 2010) as a pre- and post-project appraisal tool, and component of an ecosystem services assessment (Everard et al., 2011).

(ii) *2011 to 2012*:

a. Following a free training day in 2011, for NGO, Local Authority, EA and University users (20 attendees), the URS was adopted by the Wandle Trust and Natural England (NE) and the EA Thames area started to promote the survey.

b. Significant development of a prototype URS web-based information system, funded by NE (£13k), transformed it into a training, data management, and communication tool (www.urbanriversurvey.org) with key URS indices output to the Greenspace Information for Greater London (GIGL) GIS.

c. Further workshops, funded by NE (£2k), trained 70 river managers (eg BAA; Environment Agency, Conservation Trusts: Bristol, BTCV, GIGL, London Wildlife, QWAG, Thames21, WWT; London Boroughs – Brent, Bromley, Harringay, Hillingdon, Lewisham, Richmond; NE, River Restoration Centre, Royal Parks, Zoological Society of London, Universities – Cranfield, King's College London, Plymouth, Roehampton, Sheffield) and delivered c.450 URS surveys.

(iii) *2012 to present*:

a. In the first year of full implementation, the URS web-based information system attracted 3,189 visits from 1,530 unique visitors.

b. The Wandle Trust used URS data to develop their catchment management plan, evaluate river biophysical condition, and demonstrate the benefits of restoration. This was seen by the EA as a demonstration of the utility of URS data in assessing GEP for the WFD.

c. The EA's National Environment Assessment Service (NEAS) then commissioned re-surveys of 15 stretches of the River Tame (Shuker et al., 2011; £5k), demonstrating decadal scale improvements in the structure of almost all reaches and significant improvements in a 'restored' reach. NEAS then commissioned the design of landscape, amenity and heritage extensions to the URS (£29k) to produce a fully integrated ecosystem services tool (ECOSTATUS) for conducting pre- and post-project appraisal of river schemes and setting targets for ecosystem improvements. This project is close to completion: the first set of five surveyors have been trained and have tested the methodology and the supporting software is anticipated by early 2014.

d. The six million euro REFORM project is developing guidance and tools to make river restoration and mitigation measures more cost-effective. Gurnell leads the workpackage developing a 'process-based European framework for hydromorphology' which is incorporating elements of the URS.

NATURE OF IMPACT

(i) Delivery of river quality indicators for rivers across London as a data layer in iGIGL (Geographical Information for Greater London), a resource for many users in London, particularly the GLA and EA. A Biodiversity Technical Specialist at the EA confirms: 'The survey and its associated indicators provide an incredibly useful summary of the condition of London's rivers, particularly now that the data are assimilated into iGiGL, enabling URS data to be integrated with other green-space information.' (22.3.13)

(ii) Application of the URS survey to project appraisal and ecosystem services assessment of the Mayes Brook park restoration scheme, East London. An Environment Monitoring Officer at the EA confirms: 'the high utility of the URS and the indicators derived from it for the work of the Environment Agency. … [T]he survey is contributing significantly to the appraisal of river restoration and rehabilitation schemes following the very successful application of the URS in both the pre-project biophysical assessment and ecosystem services assessment of the Mayes Brook Park restoration' (11.3.13).

(iii) Analysis of URS data for the assessment of GEP and the design of a catchment management plan for the River Wandle, London. The data were particularly useful for habitat assessment and for indicating the relative quality status of different segments of the river. The Director of The Wandle Trust writes: 'The URS data were crucial for characterising the river along the main stem and both of the headwater tributaries and the data also underpinned our proposals for achieving Good Ecological Potential in response to the requirements of the Water Framework Directive' (9.3.13).

(iv) Analysis of repeat URS surveys to assess biophysical change in restored and

unrestored reaches of the river Tame, Birmingham (2002-2012) for the EA, showed a gradual improvement in all reaches following reduction in 'maintenance' of reinforcement, with marked improvement at restored sites where reinforcement had been removed. The Head of the National Environmental Assessment Service at the EA writes: '[t]his work has clearly demonstrated how the URS provides an important high-level assessment tool that is well-suited to the work of the Environment Agency' (11.3.13).

(v) Incorporation of the URS into EA routine practice via the National Environment Assessment Service (NEAS). Following completion in November 2013, the ECOSTATUS methodology will allow NEAS (a) to describe and quantify the impact of river improvement schemes on river ecosystem services within affected river reaches (b) to assess the aggregate impact of schemes on the ecosystem services provided by entire urban river systems. The Head of the National Environmental Assessment Service writes: 'This will provide a methodology for the integrated pre- and post-project assessment of river improvement schemes in urban areas in line with developing Agency and Defra policy' (11.3.13).

5. Sources to corroborate the impact

Web links:
The Urban River Survey has its own website to which data can be submitted and from which it can be interrogated (www.urbanriversurvey.org).

Individual users to corroborate impact:

i. Research scientist – Hydromorphology, Environment Agency (impact i)
ii. Biodiversity Technical Specialist, Environment Agency (impact i)
iii. Environment Monitoring Officer, Analysis and reporting, Environment Agency (impact ii)
iv. Trust Director, The Wandle Trust (impact iii)
v. Head, National Environmental Assessment Service, Environment Agency (impacts iv and v).