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SUSTAINABLE URBAN DRAINAGE

D Michael Revitt

Urban Pollution Research Centre
Middlesex University
Hendon, London,
UK

Abstract
Traditional urban water management (UWM) incorporates inherent risks and limited sustainability in the context of global environmental and urban changes. As change pressures increase, most cities throughout the world will experience difficulties in efficiently managing scarcer and less reliable water resources whilst at the same time being required to satisfy increasing numbers of water users/services and greater effluent disposal demands. Stormwater provides cities with a valuable resource and therefore it is important that its management plays a central role within sustainable urban water management plans. Sustainable urban drainage systems (or Best Management Practices; BMPs) are becoming increasingly common in developed countries throughout the world but the transfer of this technology to Southern and developing countries is not necessarily a straightforward process given the possible environmental impacts and operational constraints under different climatic and socio-economic conditions. It is for these reasons that the work packages on 'Technological options for stormwater control under conditions of uncertainty' (WP 2.1) and 'Environmental change studies for stormwater control and reuse options' (WP 2.3) are making important contributions to the overall SWITCH project.

Keywords: Best management Practices, stormwater control, reuse options

1 Introduction

The primary objectives, which are aimed at achieving sustainable USWM require the holistic integration of the control and treatment of a) runoff flow quantity (runoff conveyance, capture and flow attenuation), b) runoff flow quality (for both surface and groundwaters) and c) the protection and/or enhancement of habitat/amenity uses within the receiving water channel and adjacent riparian corridor. WPs 2.1 and 2.3 are both designed to address these issues through the use of sustainable approaches. WP 2.1 aims to identify and develop control technologies which complement existing drainage systems in the adaptive provision of both quantitative and qualitative control of stormwater. WP 2.3 contains a number of related objectives which are all focussed on improving the potentials for stormwater control and associated reuse options as climatic conditions start to change.

Both green and brown roof systems are being investigated in WP 2.3 with regard to their hydrological impacts on the quality and quantity of urban drainage as well as in terms of the ecological benefits they can bring to urban biodiversity. Modelling applications involve assessing the impact of direct and indirect discharges of stormwater to groundwater and to downstream systems as well as the use of GIS as a tool to identify the best locations for the installation of treatment systems. This work package also aims to develop efficient and cost effective treatment methods for the removal of heavy metals from stormwater using novel adsorption techniques.

Both WPs 2.1 and 2.3 are also closely linked to WP2.2 (Decision-making processes in integrated stormwater management), which is incorporated in the 'Water Sensitive Urban Design' task group, and concentrates on evaluating the different stormwater management strategies and decision-making processes which exist and on highlighting the problems and opportunities available. This ensures that the concerns and priorities of the diverse range of stakeholders, involved either directly or indirectly in stormwater management, are fully considered to enable optimal stormwater strategies to be identified. The findings for stormwater deriving from both the Sustainable Urban Design and the Water Sensitive Urban Design task groups are being compared to those obtained for other urban water components within the SWITCH project to enhance and develop our overall understanding of UWM.

2 SWITCH contributions to Sustainable Urban Drainage

In working towards the objectives of WP 2.1, emphasis has been placed on contributing to integrated urban water management through the clear links which exist with the protection and safe use of water supplies (Natural Systems for Treatment task group), the efficient disposal of wastewater and the support of agricultural practices (Decentralised Wastewater Management task group), and the preservation/improvement of environmental quality and public health. The completed outputs from WP 2.1 include a report (D2.1.1a) outlining the current technologies (both structural and non-structural) for stormwater control as part of an integrated urban water management scenario, with a focus on the impacts of extreme climatic/hydrological events, socio-economic end-point conditions and public health threats.

Through working closely with four Learning Alliances (LAs), the identification of 'threats and uncertainties' which pose the greatest concern for stormwater control has been achieved and guidelines have been developed to support identification of 'likelihood of occurrence' and 'severity of impact'(D.2.1.1b). Selected LA facilitators have discussed these guidelines with their LAs, but this task has taken time to complete as a group exercise and therefore one-to-one contacts with interested members of the Birmingham and Belo Horizonte LAs have been established to move this task forward and to enable the completion of the risk matrices for these cities. SWITCH scientific workshops (D2.1.1c) describing the completed stormwater research were held as part of the 11th Diffuse Pollution Conference, Belo Horizonte, Brazil during August 2007 and in association with both the Lodz, Belo Horizonte and Birmingham LAs during January 2007, September 2007, and October 2008, respectively. Future workshops are planned with the Lodz LA in December 2008.

In connection with Deliverable 2.1.2, the relevant stormwater BMP design guidelines for the UK, USA, Malaysia, Australia, Brazil, Germany and Switzerland have been compiled into a single review and reports on retrofitting these drainage options and the potential of BMPs to contribute to other sectors of the urban water cycle have been prepared. The latter is particularly relevant to the Water Sensitive Urban design task group. Ongoing work is developing stochastic rainfall series to determine the impact of climate change scenarios on urban hydrology. This work will inform our ability to predict rainfall patterns in the city of the future and hence provide relevant information for the majority of the task groups within the SWITCH project. It will also inform the modelling work which has commenced in WP2.1 with the objective of identifying and targeting the most appropriate stormwater solutions at a catchment scale. The existing STORM hydraulic model is being linked with a pollutant source apportionment model and a GIS approach developed in WP 2.3 (see later) to enable prediction of the best site locations for BMPs to achieve effective quantity and quality control of stormwater. Discussions have taken place with the City Water (Tool and Model) task group about the integration of this model within the developing decision support system.

The research being carried out within WP 2.3 involves specific case studies performed within the selected demonstration cities (Birmingham, Belo Horizonte and Beijing). As well as contributing to the Sustainable Urban Drainage task group, the results are directly relevant to Water Sensitive Urban Design and Natural Systems for Treatment task groups. Experimental green and brown roof facilities have been installed on the University of Birmingham campus and are being monitored for ecological development variables, climate variables, and water flows, storage and discharge quality (D 2.3.1.1). In addition, demonstration roofs have been constructed at two sites in Birmingham and are being equipped with monitoring equipment (Task 1). An identified objective of WP 2.3 is to develop GIS applications which are able to support the investigation of the hydrological impacts of various stormwater management approaches. A GIS tool has been produced which supports both the identification of BMP installation sites within a catchment and also identifies the most appropriate types of stormwater BMPs for use at a particular site in relation to site-specific conditions (e.g. soil type; depth to groundwater). Work is currently underway to develop and link this with an urban runoff flow prediction model at a sub-catchment scale, as described above. Modeling undertaken to investigate the feasibility of aquifer storage recovery and roof top rainwater harvesting to supply the new City Park water features in the Eastside development region of

Birmingham have highlighted the difficulties associated with instances when discharge volumes from the roof are too low (Task 2).

The GIS approach, described above, also incorporates a tool for assessing the removal potential of a wide range of pollutants, including heavy metals, by various types of stormwater BMPs. Experimental studies into pollutant removal from stormwater runoff have been initiated including innovative research into the removal of several dissolved heavy metals (Cr(VI), Cr(III), Cu, Cd, etc.) by adsorption on iron oxide coated sand (IOCS; a waste product from urban drinking water treatment) and granular ferric hydroxide (GFH) substrates (Task 3).

3 Outputs from SWITCH

The principles embodied in the research work being carried out in the Sustainable Urban Drainage and the Water Sensitive Urban Design task groups provide an important basis for the on-line SWITCH stormwater training course which ran for the first time starting in January 2008 and will be repeated in January 2009.

The following conference proceeding papers cover some of the work which has been completed in these two task groups:

N Nascimento, L Heller, B Ellis, M Revitt, L Scholes and J Champs. 2007. Towards a paradigm SWITCH: Integrating urban water management in Belo Horizonte, Brazil. Presented at NovaTech 2007, 6th International Conference on Sustainable Techniques and Strategies in Urban Water Management, 25-28 June 2007, Lyon, France.

JB Ellis, L Scholes, DM Revitt, N Nascimento, L Heller, and J-R Champs. 2007. A paradigm switch in urban stormwater and waste management: Achieving integrated strategic approaches; the Belo Horizonte example. UNESCO International Symposium on New Directions in Urban Water Management, 12-14 September 2007, Paris, France.

C Viavattene, L Scholes, DM Revitt and JB Ellis. 2008. A GIS based Decision Support System tool dedicated to the implementation of Sustainable Urban Drainage Systems. Proceedings of the 11th International Conference on Urban Storm Drainage, 31 August – 5 September 2008, Edinburgh, Scotland.

B Shutes, DM Revitt, J B Ellis and L N L Scholes. 2008. The role of constructed wetlands in cities of the future. A strategy for creating ‘utopia’. Paper submitted to the 11th International Conference on Water Systems for Water Pollution Control, 1-7 November, 2008, Indore, India.