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Using a systematic, multi-criteria decision support framework to evaluate sustainable drainage designs

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Abstract

The conventional drainage design approach does not address sustainability issues. Moving forward, an alternative approach using green infrastructures is recommended. In addition to flow and flood management provided by the conventional methods, green infrastructures can bring multiple benefits such as increased amenity value and groundwater recharge. Unlike the traditional practice, the new approach lacks supporting technical references and software. Stakeholders are discouraged by the uncertainty of performance and costs associated with green infrastructures. We aim to bridge this knowledge gap by providing a systematic decision support framework. This paper provides an overview of the evaluation framework with some application examples.

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Keywords: Sustainable drainage design, multi-criteria evaluation framework; green infrastructure; cost-benefit analysis.

1. Introduction

In the past, drainage network capacity and conveyance were the primary design criteria. The drainage industry relied heavily on regulation, technical guidance and best practice examples to determine the optimal size and slope

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of underground drainage infrastructures such as pipes and storages required to provide sufficient capacity and conveyance. For that purpose, HR Wallingford (1981) first described the iterative methodology in the Wallingford Procedures. The procedures had been successful and well-received by the drainage industry and government in United Kingdom. The systematic approach was appealing to decision makers, especially drainage engineers and planners. Related computer software packages became available in early 80’s and most of the time-consuming tasks had been automated to streamline the workflow. After years of practice and refinement, computer-aided pipe and storage design became the industry standard.

Despite years of success, the traditional approach did not consider the long-term sustainability issues as key design criteria. Although it had been a valid and widely accepted approach in the past, we have to factor in the sustainability considerations from now on. An alternative approach using a combination of grey (e.g. pipes and storage) and green infrastructures (e.g. ponds, swales, wetlands) is being recommended to stakeholders and the public. Figure 1 below shows examples of traditional and sustainable drainage systems commonly found in UK.

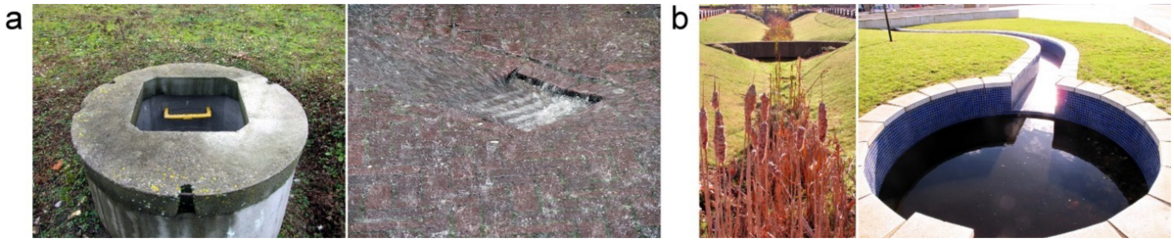

Fig. 1. (a) Traditional drainage systems; (b) Sustainable drainage systems. (Photo’s courtesy of Micro Drainage Limited.)

The main advantage of the sustainable approach is the additional benefits such as environmental improvement, natural groundwater recharge, runoff reduction as well as energy savings. In UK, we generally regard sustainable drainage systems as SuDS (Woods-Ballard et al., 2007). Similar green drainage systems are called Low Impact Development (LID) or Best Management Practices (BMPs) in United States (USEPA, 2006). Water Sensitive Urban Design (WSUD) is the term commonly used in Australia (Brown et al., 2007). We continue to use the term SuDS in this paper for consistency.

1.1. Challenges in Implementing the Sustainable Design Approach

In UK, the additional benefits of using green infrastructures have already been communicated to government, drainage industry and the public (Hydro, 2013). Yet, there are still some key challenges we need to overcome in order to make the sustainable design approach practical.

Unlike the traditional pipe and storage based approach with sufficient technical guidance and computer software packages available for decision support, the sustainable approach lacks the equivalent supporting documentation and software tools. The additional benefits of SuDS can be overlooked as the evaluation procedures are unclear and the long-term performance of SuDS is still uncertain to stakeholders. Although some software packages have already include hydraulic and water quality modelling modules for SuDS, the additional benefits such as amenity value and long-term cost-benefit are still missing from the practice.

1.2. Our Vision

We decided to bridge the knowledge gap in the market by carrying out a research project on developing a new decision support system for sustainable drainage design. The key objectives of our research are:

1. To replace the time-consuming process of repetitive checking and optioneering with a set of straight forward, easy-to-understand key performance indicators (KPIs) and graphics.
2. To develop a systematic, multi-criteria evaluation framework based on the KPIs.