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Selected stormwater priority pollutants — a European perspective

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Abstract

The chemical characteristics of stormwater are dependent on the nature of surfaces (roads, roofs etc.) with which it comes into contact during the runoff process as well as natural processes and anthropogenic activities in the catchments. The different types of pollutants may cause problems during utilisation, detention or discharge of stormwater to the environment and may pose specific demands to decentralised treatment. This paper proposes a scientifically justifiable list of selected stormwater priority pollutants (SSPP) to be used, e.g., for evaluation of the chemical risks occurring in different handling strategies. The SSPP-list consists of 25 pollutant parameters including eight of the priority pollutants currently identified in the European Water Framework Directive. It contains general water quality parameters (organic and suspended matter, nutrients and pH); metals (Cd, Cr, Cu, Ni, Pb, Pt and Zn); PAH (naphthalene, pyrene and benzo[a]pyrene); herbicides (pendimethalin, phenmedipham, glyphosate and terbutylazine); and other representative industrially derived compounds (nonylphenol ethoxylates, pentachlorophenol, di(2-ethylhexyl)phthalate, PCB-28 and methyl *tert*-butyl ether). Tools for flux modelling, enabling calculation of predicted environmental concentrations (PECs), and for ranking the susceptibility of a pollutant to removal within a range of structural stormwater treatment systems or best management practices (BMPs) have been developed, but further work is required to allow all SSPPs to be addressed in the development of future stormwater pollution control measures. In addition, the identified SSPPs should be considered for inclusion in stormwater related monitoring campaigns.

Keywords: BMP treatment; Chemical hazard screening; Hazardous substances; Stakeholder involvement; Stormwater runoff

1. Introduction

The use of decentralised systems for treatment, utilisation, and detention of stormwater and snowmelt is increasing due to water shortages, flooding, and the costs associated with the combined treatment of storm- and waste-water. Structural best management practices (BMPs) or sustainable urban drainage systems (SUDs) are widely used to reduce the urban runoff peak flows as well as the amount of stormwater based pollutants entering the receiving water environment. Structural BMPs can be categorised into four main groups: filter strips and swales; infiltration systems (soakaways, infiltration trenches and infiltration basins); storage facilities (detention basins, retention ponds, lagoons,

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constructed wetlands, storage tanks, roof storage); and alternative road structures (porous paving, porous asphalt surfaces) (Scholes et al., 2005c). The utilisation of collected stormwater and treatment in BMPs is influenced by the concerns associated with possible risks in handling water of poor quality. The quality of the stormwater and the characteristics (physical, chemical or microbial) of the pollutants present are dependent on the types of surfaces the stormwater encounters (roads, parking lots, roofing material, recreational areas etc.). Other sources of pollutants are the ambient air quality as well as the anthropogenic activities within each specific catchment. The stormwater constituents may constitute risks to exposed humans, animals or plants, as well as technical and aesthetic problems.

Studies have shown that a large number of constituents, both organic and inorganic, may be present in stormwater (Makepeace et al., 1995; Eriksson, 2002), both in their dissolved and colloidal forms and associated with particles. The measured concentrations may vary from runoff event to event and from site to site (see e.g. Kayhanian et al., 2003; Gromaire-Mertz et al., 1999; Sriyaraj and Shutes, 2001). The scientific literature within this field has focussed on pollutants such as nutrients, heavy metals, organic and particulate matter and polycyclic aromatic hydrocarbons (PAHs) (e.g., Marsalek et al., 1997; Sansalone and Buchberger, 1997; Morrison et al., 1990; Mikkelsen et al., 1994; Krein and Schorer, 2000). This list of pollutants will need to be expanded in the future with the implementation of the EU Water Framework Directive (WFD) (European Commission, 2000a), which additionally provides a clear statement on the need to tackle non-point source pollution. The development of a scientifically justifiable list of stormwater priority pollutants therefore gives valuable support to stormwater managers regarding the comparison of various stormwater management strategies. In fact, the aim of a recent European 5th Framework Project named DayWater (see e.g. Thévenot and Förster, 2005), was to develop an adaptive decision support system for the integration of stormwater source control into sustainable urban water management strategies to support stormwater managers. In this project three different work packages collaborated round the issue of stormwater pollution (Risk and impact assessment; Multi-criteria analysis of structural and non-structural Best Management Practices (BMPs); and Sources and Flux Models) (Thévenot and Förster, in press).

The objective of this work was to propose an appropriate list of selected stormwater priority pollutants (SSPP) which is able to provide input to the various tools being developed within the DayWater project. In addition to outlining the procedure for deriving a relevant SSPP-list and assessing the sources of the identified pollutants and their reported occurrence, this paper compares the SSPP-list with the lists derived in the context of the European Water Framework Directive (European Commission, 2000a) and illustrates it's potential use in developing tools for risk assessment of stormwater discharges as well as methodologies for assessing the removal of pollutants in a range of structural stormwater treatment systems or best management practices (BMPs).

2. Methodology to identify relevant priority pollutants

2.1. The CHIAT methodology

In this study, an adapted version of the Chemical Hazard Identification and Assessment Tool (CHIAT; Eriksson et al., 2005; Ledin et al., 2006) was used as a road map. CHIAT is a development of the approach advocated by the European technical guidance document (TGD) for risk assessment of chemicals (European Commission, 2003a) as well as the approaches used in the environmental risk assessment of chemicals by governments, chemical industry, scientific communities, environmental organisations, and institutions responsible for issuing eco-labels (Eriksson et al., in press). It consists of five steps involving 1) source characterisation, 2) recipient, exposure targets and criteria identification, 3) hazard and problem identification, 4) hazard assessment and 5) stakeholder involvement (see Fig. 1). In the present paper, the focus is on describing and explaining the iterations leading up to the commonly agreed SSPP list with particular relevance to the needs of urban stormwater managers and engineers.

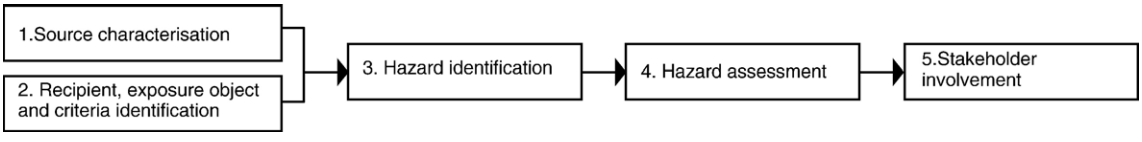

Fig. 1. Diagrammatic representation of the CHIAT approach showing the progressive steps in the procedure. (Adapted from Eriksson et al., 2005).