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An integrated model for management of stormwater micropollutants

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Abstract
Urban water management has moved towards a holistic approach that boosts the use of integrated models as essential elements in the assessment of strategies aiming to achieve the desired water quality standards. Diffuse pollution loads deriving from separate system and stormwater treatment have received little attention from modellers, as the existing integrated models mainly focus on traditional water quality parameters (total suspended solids- TSS, nutrients, general organic matter) with limited examples dealing with stormwater micropollutants (MP - heavy metals, organic compounds).

This study presents an example of an integrated dynamic model for estimating micropollutant fluxes through separate stormwater systems. The integrated model is composed of submodels that represent the elements of the stormwater system (catchment, drainage network and treatment unit). The various submodels have been developed in order to maximize the use of existing information (e.g. GIS data, substance inherent property data) and to exploit easily measurable data (flow, TSS). The release of MP is estimated according to a catchment classification based on land usage. Transport through the sewer system is simulated by an accumulation-washoff approach. MP removal in stormwater treatment units is modelled by using a multi-compartmental approach, which estimates MP fate based on the pollutant's inherent properties. Given the high level of uncertainty affecting stormwater quality models and monitoring of stormwater MP, the estimation of uncertainty bounds is essential to allow a wide application of the integrated model. The model uncertainty bounds are thus estimated by using the Generalized Likelihood Uncertainty Estimation technique (GLUE).

The model was applied in an industrial-residential catchment in Alberstlund (Denmark) in order to (i) quantify the MP loads released from the catchment and subsequently (ii) released to the aquatic environment after treatment in a retention pond. Furthermore, the model can be used to assess (iii) compliance with discharge regulations (e.g. Figure 1 – left), and (iv) the relative efficiency of different pollution control strategies, based both on source control and end-of-pipe treatment (e.g. Figure 1 – right). The model was applied to simulate heavy metals (e.g. copper – Figure 1) and polycyclic aromatic hydrocarbons (PAH). The results of this study represent the first application of an integrated stormwater quality model for these pollutants, and it can provide an important support in the evaluation of stormwater pollution control strategies.

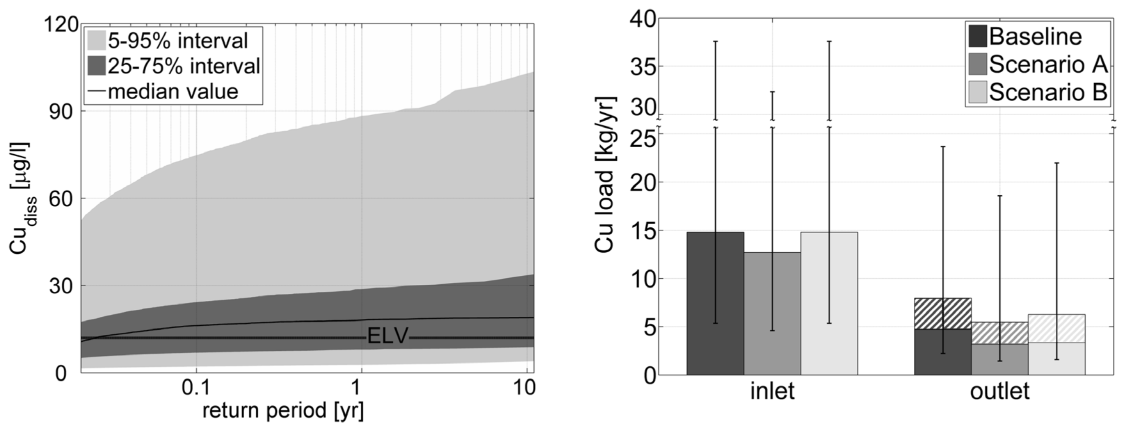

Figure 1. Example of outputs from the integrated model. Left: outlet dissolved copper concentrations a retention pond and comparison with an Emission Limit Value (ELV). Right: comparison of Cu loads at the pond inlet and outlet for different scenarios involving source control (Scenario A) and improvement of existing treatments (Scenario B). Hatched areas represent the dissolved fraction.

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