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Environmental impacts of stormwater management and pollutant discharges



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Introduction

Stormwater management is an essential part of urban systems to protect people and assets from flooding. Possible solutions range from underground pipes and basins to local and multi-functional solutions, e.g. rain beds or retention lakes. We compare the environmental sustainability of these approaches using Life Cycle Assessment. As a novelty we include the impacts from local emissions stemming from pollutants discharged with the runoff.

Methods

Besides the global emissions arising from the life cycle of the system, we include runoff discharges in the inventory as local

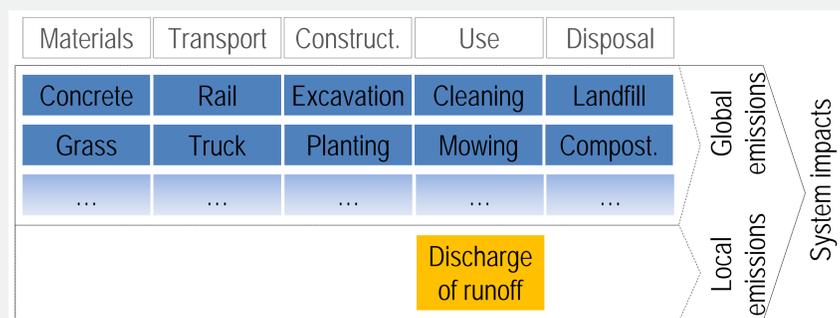


Figure 1. System boundaries and inventory of the assessment

The inventory of local emissions consists of mass flows calculated using average pollutant concentrations, which are based on an extensive literature review. Potential ecotoxicity and eutrophication impacts are calculated using the ILCD recommended methods.

Table 1. Collected concentration data for copper and zinc, and average concentrations calculated using the successive principle, exemplary for 250 assessed pollutants (metals and organic compounds)

	Min. concentration:	Max. concentration	Calculated average
Copper	5.0E-02µg/l	1.6E+02µg/l	6.3E+01µg/l
Zinc	2.0E-01µg/l	1.3E+03µg/l	5.2E+02µg/l

Case study

We exemplarily assess two different solutions to manage stormwater in the Nørrebro catchment in Copenhagen, Denmark:



1. Above surface system, based primarily on green infrastructure, e.g. channels and planted areas, where runoff is discharged to freshwater directly or after simple treatment;



2. Below surface system, consisting of pipes and underground retention basins, where runoff is treated at a wastewater treatment plant before discharge to freshwater.

Results

The below surface system causes significantly higher potential ecotoxicity impacts than the above surface system, with the relative contribution of local emissions being low (5%). The relative contribution of direct emissions is high for surface systems without treatment (83%), but can be reduced significantly by simple treatment (to 18%). The main drivers for ecotoxicity are emissions of heavy metals, especially copper and zinc.

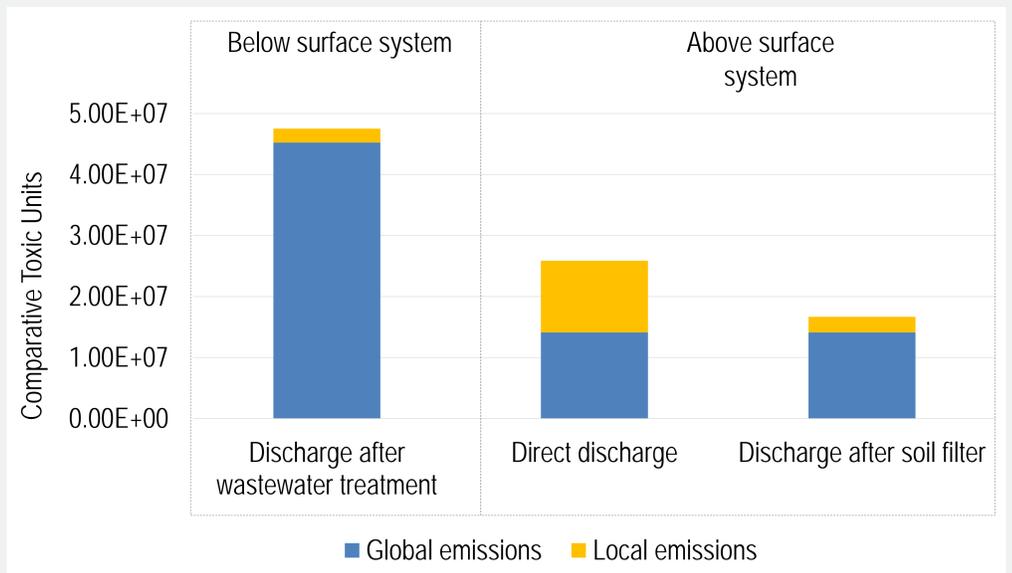


Figure 2. Potential freshwater ecotoxicity impacts for the different solutions

The relative contribution of local emissions to both freshwater and marine eutrophication is insignificant for all systems (0.02% - 2.51%).

Table 1. Potential eutrophication impacts (and relative contribution of local emissions)

	Below surface system:	Above surface system:	
	Wastewater treatment	Direct discharge	Discharge after soil filter
Freshwater eutrophication	2.4E+03 kg P eq. (0.04%)	2.0E+02 kg P eq. (2.51%)	2.0E+02 kg P eq. (2.51%)
Marine eutrophication	3.9E+04 kg N eq. (0.02%)	1.3E+04 kg N eq. (0.33%)	1.3E+04 kg N eq. (0.27%)

Conclusion

This first comprehensive take on local emissions from stormwater management shows that polluted runoff can cause significant ecotoxicity impacts if discharged directly. The impacts can be reduced even by simple treatment like soil filters.

However, the total environmental impacts are dominated by the global emissions resulting from the life cycle of the system.