Source-control infiltration practices: How to avoid creating "polluted sponges"?
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Source-control infiltration practices: How to avoid creating “polluted sponges”?

Context & objectives

Generalization of “source-control” stormwater management (Fletcher et al., 2015).
Dissemination of decentralized, infiltration-based techniques in urban areas (Zhou, 2014).
• Accumulation of contaminants in soil?
• Required maintenance to enhance long-term pollution control?

Comprehensive assessment of soil pollution by trace metals and polycyclic aromatic hydrocarbons in 11 devices of the Paris region.

Main results

Horizontal distribution of contaminants

• Significant buildup in the inflow area, followed by a marked decrease in contents with increasing distance.
• Precise, “time-integrated” signature of two distinct phenomena:
  o settling of particle-bound contaminants,
  o non-uniform infiltration fluxes at the soil surface (for common rainfall events).
• At the annual scale, the greatest part of the pollutant flux is intercepted by the first permeable surface reached by runoff.

Vertical distribution of contaminants

• Almost uniform profiles in the reference zone and marginally influenced by runoff infiltration.
• Metal and PAH accumulation is limited to the upper 5 to 40 cm of soil, even in the most contaminated part of the facilities.
• Retention results from 2 distinct mechanisms:
  o physical processes (settling and filtration),
  o physicochemical processes (sorption and precipitation of solute species).
• Dissipation mechanisms (e.g., biodegradation) are likely to affect PAH contents at the surface.

Experimental methods

Fig. 1 – Schematic representation of the two-step methodology for soil sampling and analysis (adapted from Tedoldi et al., 2017a).

Fig. 2 – Spatial distribution of zinc [mg/kg] in the surface soil of (a) an infiltration basin and (b-c) two grassed swales (top view). The coordinates are given in meters. The arrows indicate the water inflow (Tedoldi et al., 2017b).

Fig. 3 – Vertical distribution of copper, zinc, and PAH [mg/kg] in two study sites. “Zone 1” and “Reference” respectively correspond to the most and the least contaminated areas of the devices (Tedoldi et al., 2017a).

Maintenance needs

• The two-step experimental methodology provided a tri-dimensional vision of the extent of soil pollution, with a suitable representativeness.
• The soil may act as an efficient filter towards runoff-derived metals and PAH, but this may in turn result in high contents in the upper horizon.
• However, understanding the typical distribution of contaminants may reduce the cost and efforts of maintenance operations to be undertaken.
• In 7 sites out of 11, an average of ~15 m³ of polluted soil material per hectare of urban area had to be managed after ~10 years of operation.

CONCLUSIONS

Table 1 – Estimated volume of polluted soil (Vp,0) with unacceptable metal contents for residential land uses; normalized value per unit surface of drainage area (Vp,0/Sp).  

<table>
<thead>
<tr>
<th>Basin</th>
<th>Vp,0 (m³)</th>
<th>Sp (m²)</th>
<th>Vp,0/Sp (m³/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cell</td>
<td>9.4 m³</td>
<td>1.9 ha</td>
<td>4.9 m³/ha</td>
</tr>
<tr>
<td>Swales</td>
<td>4.0 m³</td>
<td>2.1 ha</td>
<td>1.9 m³/ha</td>
</tr>
<tr>
<td>Filter strips</td>
<td>27.5 m³</td>
<td>3.5 ha</td>
<td>7.8 m³/ha</td>
</tr>
</tbody>
</table>

REFERENCES


