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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:
 - settling of particle-bound contaminants,
 - 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.

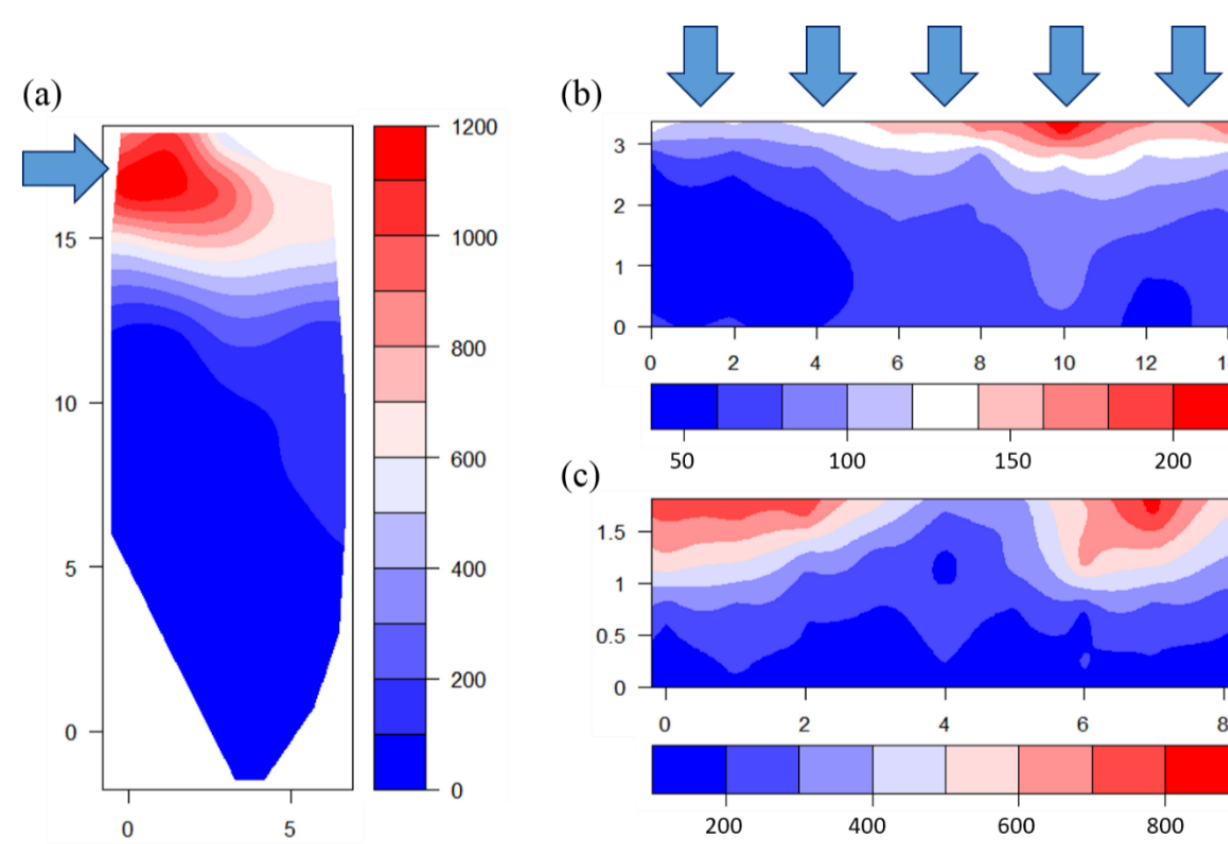


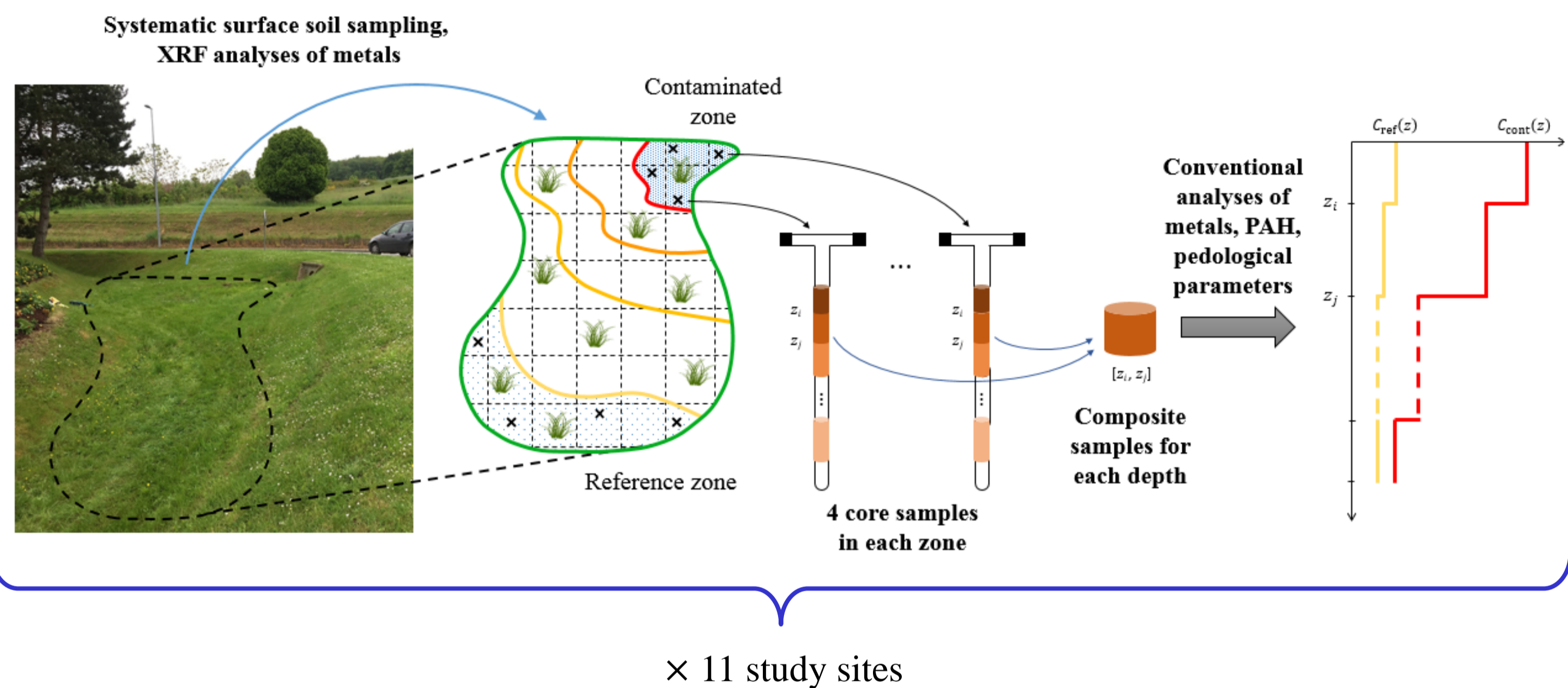
Fig. 2 – Spatial distribution of zinc [mg/kg] in the surface soil of (a) an infiltration basin and (b-c) two grassed swales (top view). The coordinates are given in meters. The arrows indicate the water inflow (Tedoldi *et al.*, 2017b).

Vertical distribution of contaminants

- Almost uniform profiles in the reference zone \Rightarrow 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:
 - physical processes (settling and filtration),
 - 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).



× 11 study sites
Diversity of morphologies, soil types, urban environments...

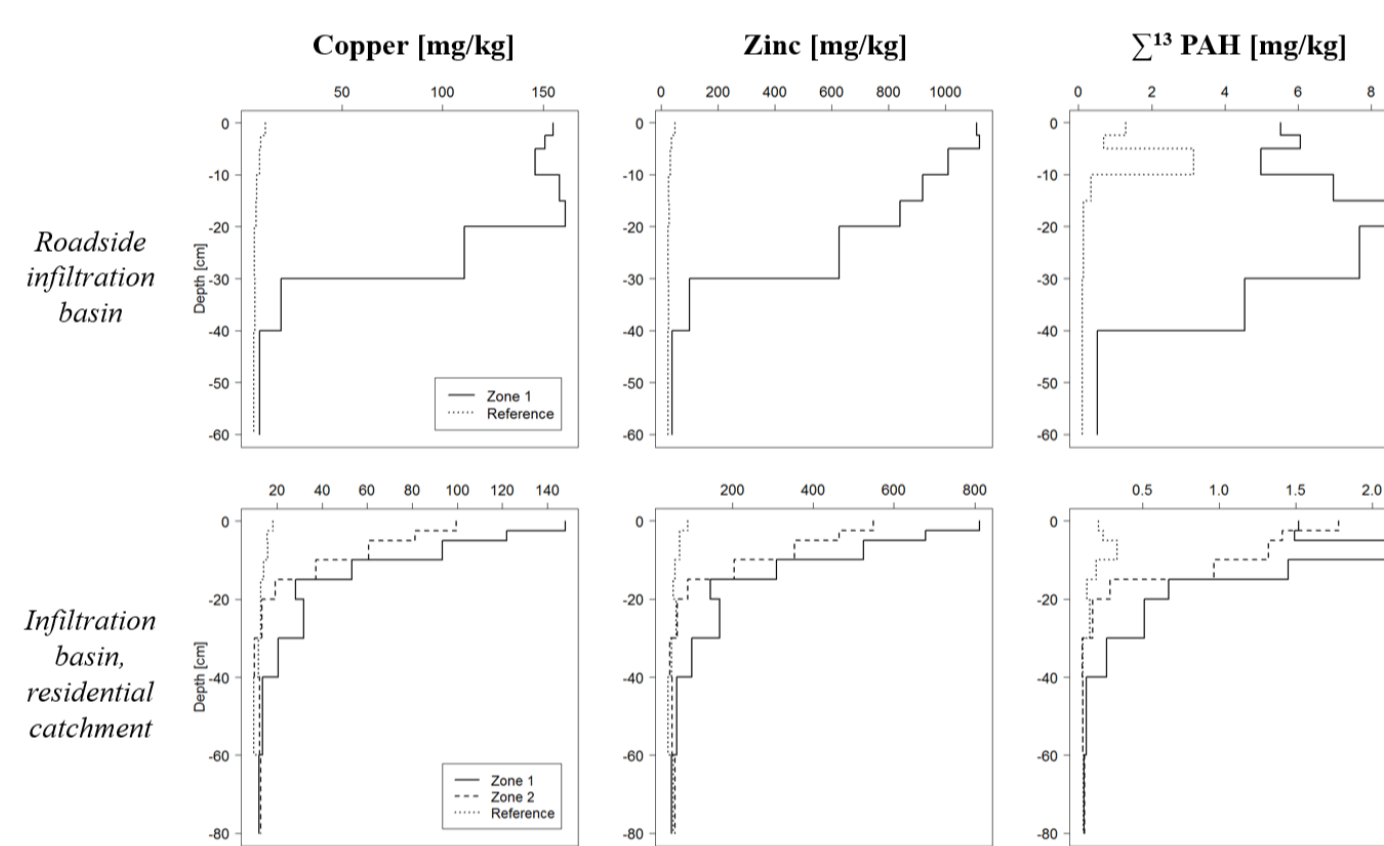


Fig. 3 – Vertical distribution of copper, zinc, and PAH [mg/kg] in two study sites. “Zone 1” and “Reference” respectively correspond to the most and the least contaminated areas of the devices (Tedoldi *et al.*, 2017a).

Contamination levels

- Inter-site variability \Rightarrow both a catchment-related and a soil-related component.
- “Intervention thresholds” for copper and zinc (1st quartile of international soil clean-up standards for residential land uses, red lines on Fig. 4) are locally exceeded in 7 sites.
- The volume of polluted soil material which should undergo either excavation or remediation was estimated (Tab. 1).

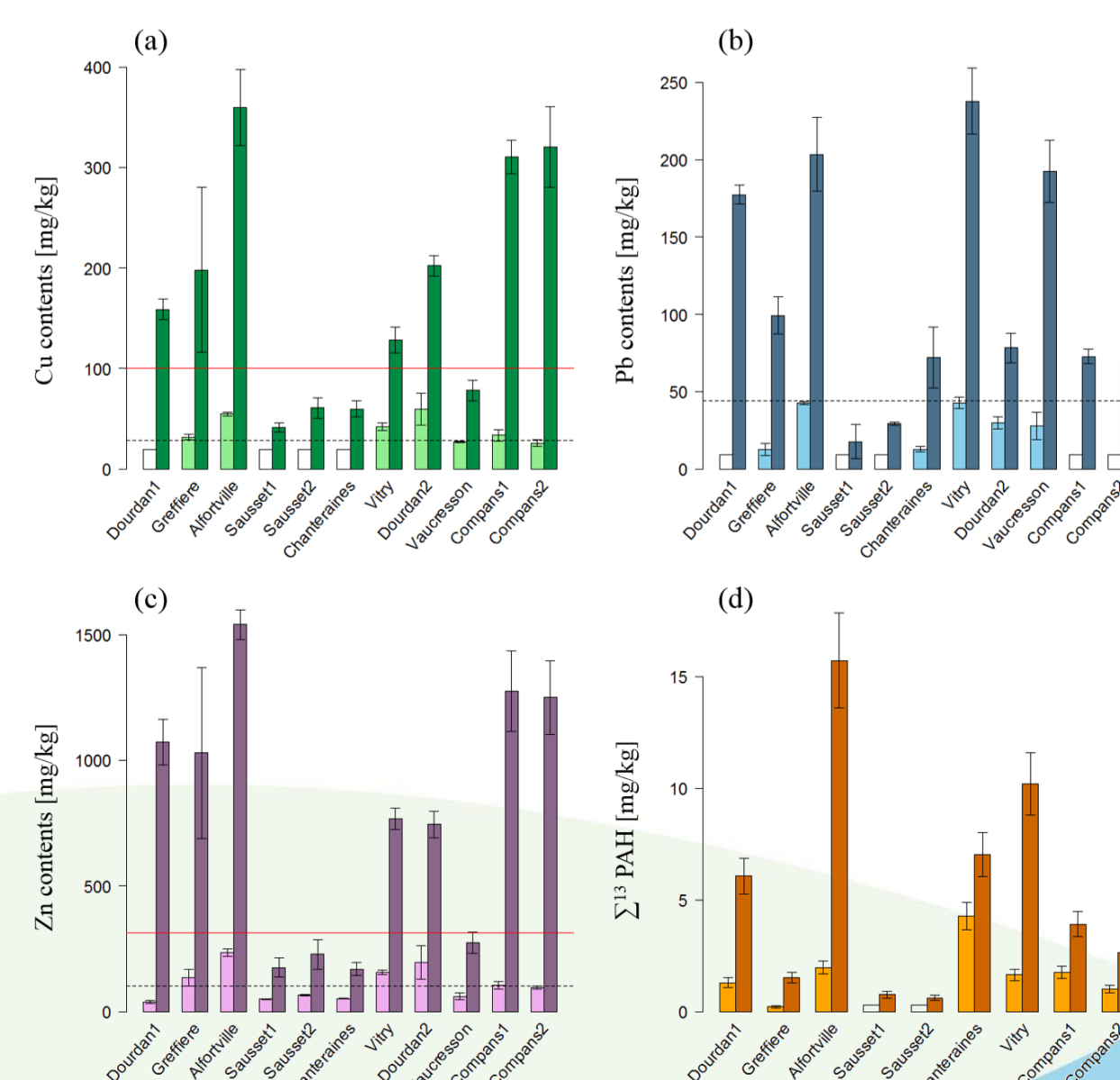


Fig. 4 – Contents of (a) copper, (b) lead, (c) zinc, and (d) PAH [mg/kg], measured at the surface of the most and the least contaminated areas in each device.

Maintenance needs

Tab. 1 – Estimated volume of polluted soil (V_{soil}) with unacceptable metal contents for residential land uses; normalized value per unit surface of drainage area ($V_{soil}/S_{drainage}$).

	V_{soil}	$V_{soil}/S_{drainage}$
Basins	9.4 m ³	13 m ³ /ha
	4.0 m ³	13 m ³ /ha
	27.5 m ³	14 m ³ /ha
Swales	0.3 m ³	9 m ³ /ha
	> 0.6 m ³	> 5 m ³ /ha
Filter strips	0.6 m ³	25 m ³ /ha
	0.3 m ³	14 m ³ /ha

CONCLUSIONS

- 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.

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