Laboratoire DEEP (Déchets Eaux Environnement Pollutions - Wastes Water Environment Pollutions)
INSA-Lyon, France

Iron geochemistry in a contaminated urban soil dedicated to stormwater infiltration

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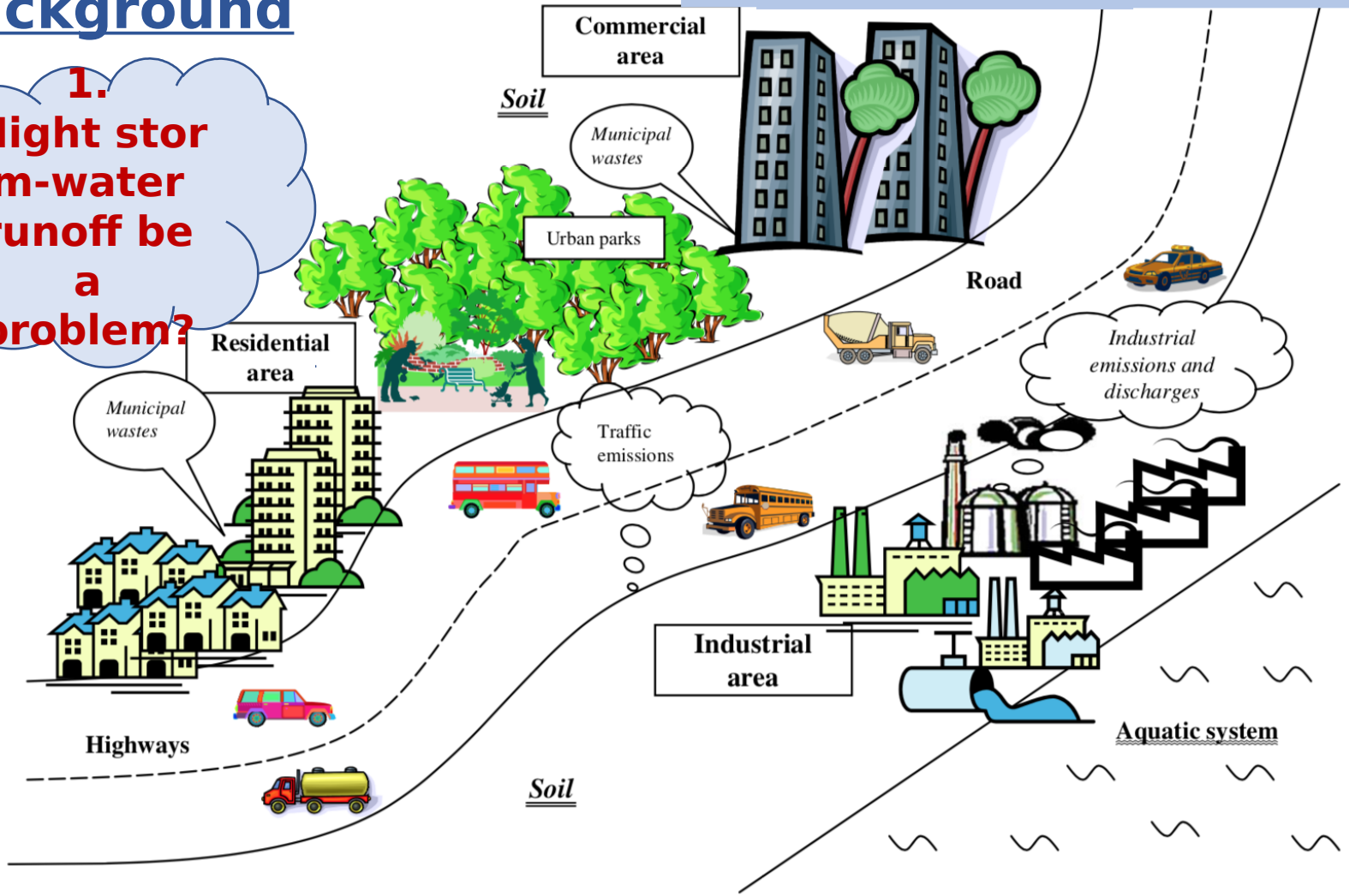
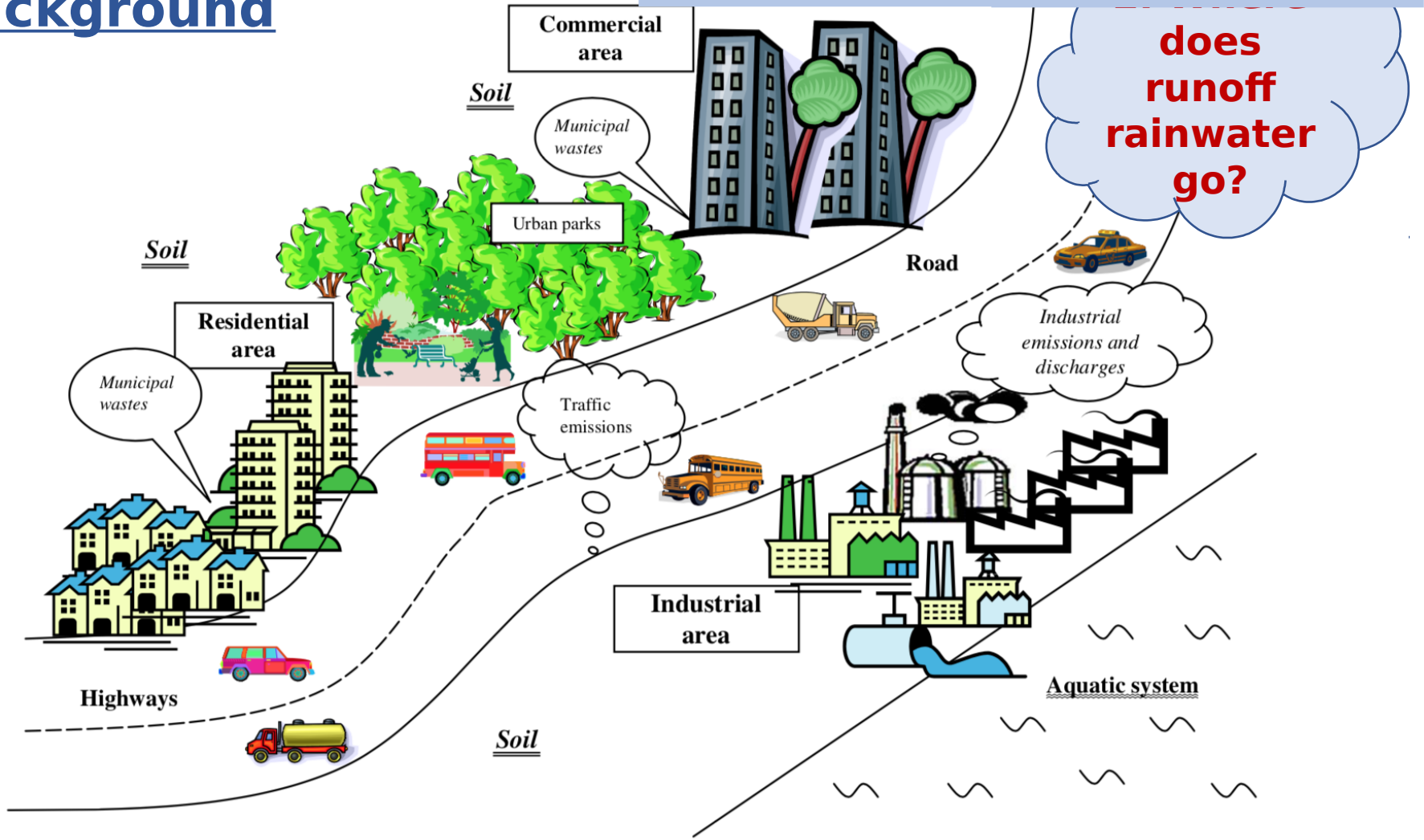
Background

1. Might storm-water runoff be a problem?



The major compartments of an urban environment (*Wong*

Background



The major compartments of an urban environment (*Wong*

Background

Sedimentation basin

Infiltration

Basin combining sedimentation and infiltration

The type of the basin studied

Sedimen ts

Objective

☛ Iron (Fe) - Important concentration (3.91 wt.%) in urban sediments

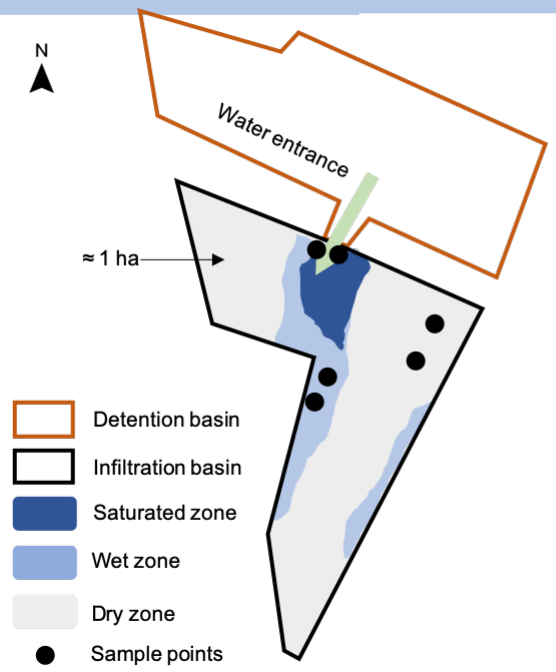
- key role in natural environments (redox-active elements)
  - biogeochemical cycling
  - trace contaminants
  - toxicity

☛ Few studies were dedicated to multi element studies coupling major and trace mineral and reactivity characterization
  - bioavailability

Study the speciation and the potential mobilization of Fe and other heavy metals in urban stormwater sediments accumulated at the surface of an infiltration basin

Site

Catchment in Chassieu, Lyon, France



Location of the 3 areas sampled in the Django Reinhardt infiltration basin

Samples:

- ✓ **3 – 5 kg collected and homogenized**
- ✓ **Passed through a 4-mm sieve**

Methods

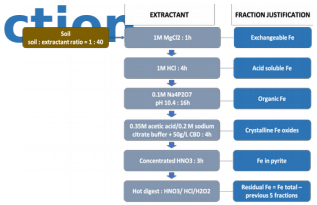
Physico-chemical characterization

- ✓ Particle size distribution (PSD)
- ✓ pH
- ✓ Water content
- ✓ Organic matter
- ✓ Chemical composition – ICP-AES

Mineralogical characterization

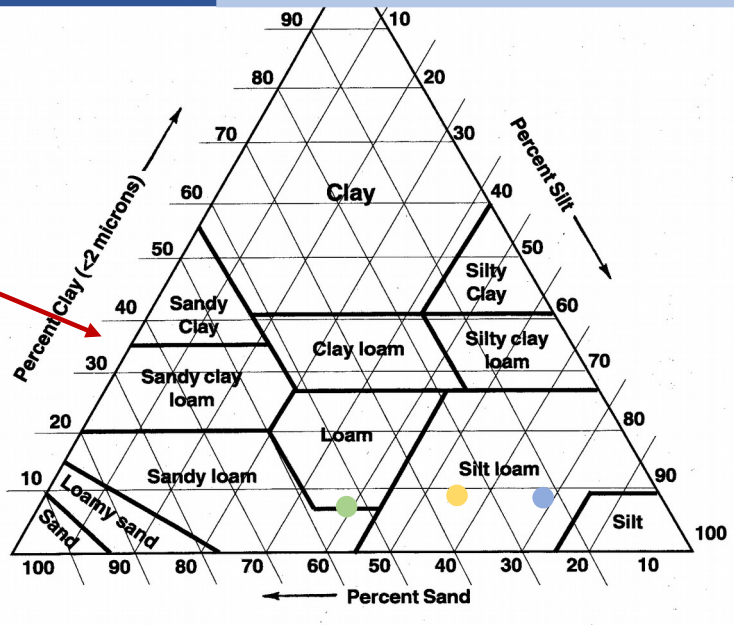
- ✓ X-ray diffraction
- ✓ Optical microscopy and scanning electron microscopy
- ✓ The Fourier transform infrared spectroscopy (FTIR)

Sequential chemical extraction



Physico-chemical characterization

Characteristic	Dry zone	Wet zone	Saturated zone
Granulometry	Texture: Loam D10: 6.64 µm D50: 59.93 µm D90: 506.85 µm	Texture: Silt loam D10: 3.11 µm D50: 22.32 µm D90: 187.39 µm	Texture: Silt loam D10: 3.33 µm D50: 20.38 µm D90: 125.46 µm
pH	7.0	7.0	7.0
Water content (wt.%)	20.9±0.8	52.6±4.6	66.5±0.6
Organic matter (wt.%)	17.5	26.8	22.2



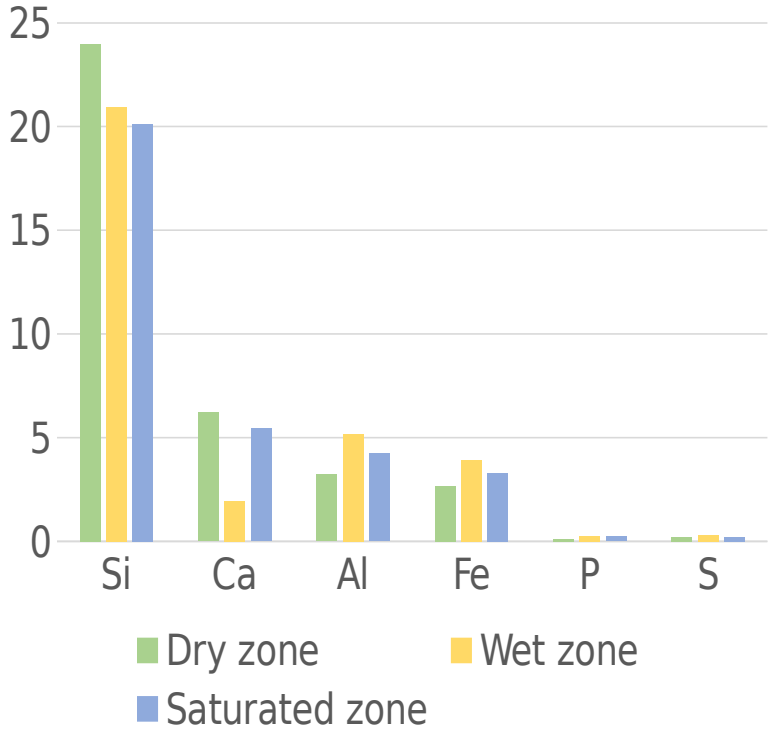
☛ Silts -- easily transported as suspended particles in water

⇒ silts deposits

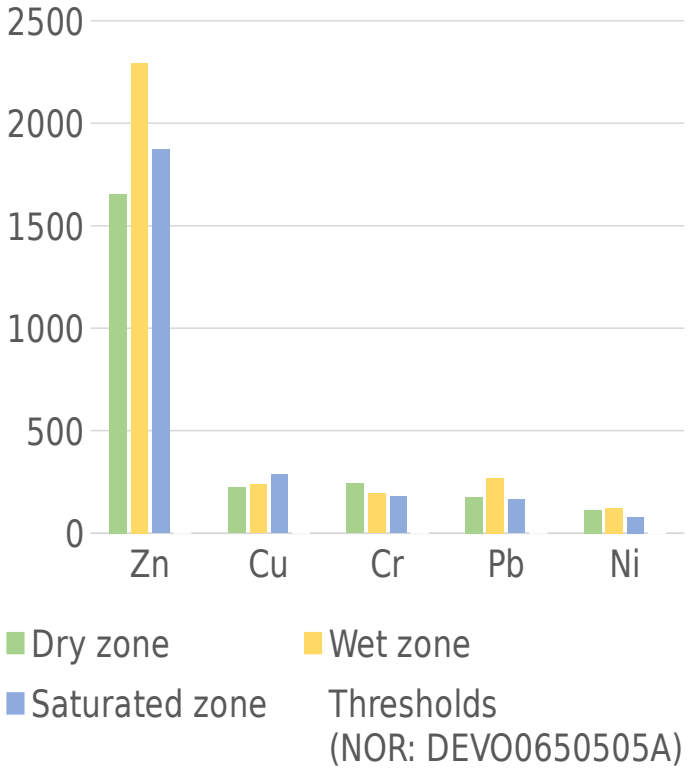
- biofilm development and clogging
- preferential association with OM

Physicochemical characterization

Major elements content in sediments (wt.%)



Trace metals content in sediments (ppm)

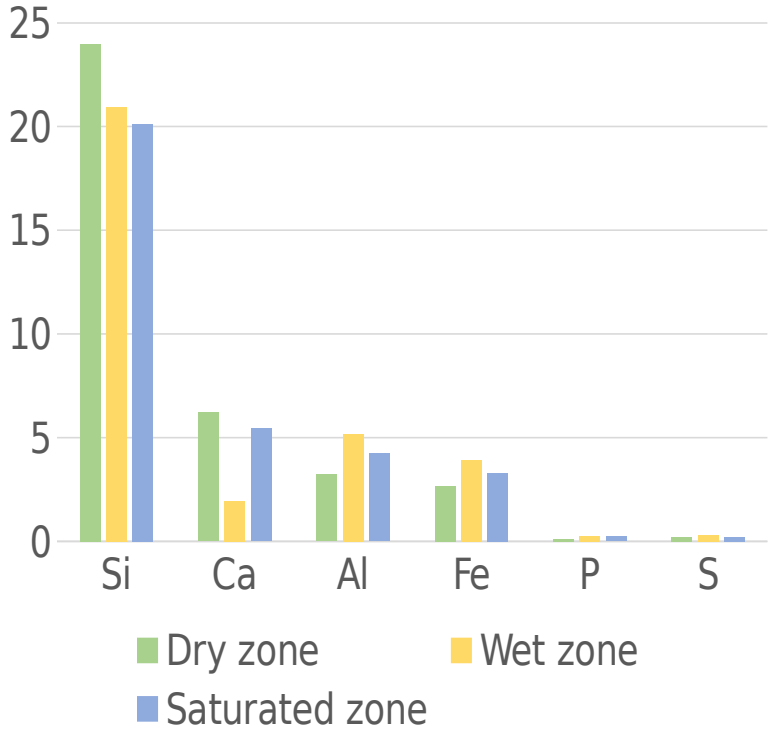


☛ similar total element contents

Physico-chemical characterization

August 2006 concerning the levels to be taken into account for valorization of basin sediment in France

Major elements content in sediments (wt.%)



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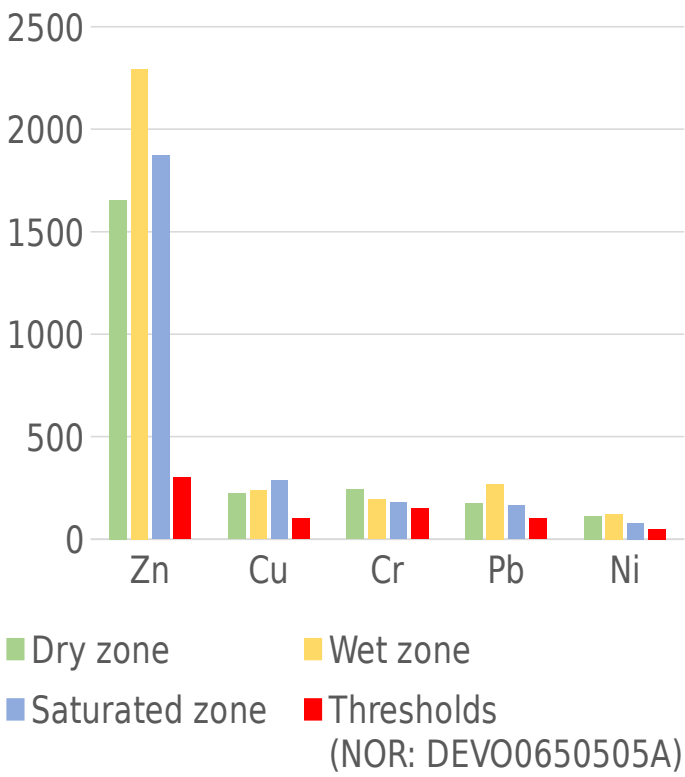
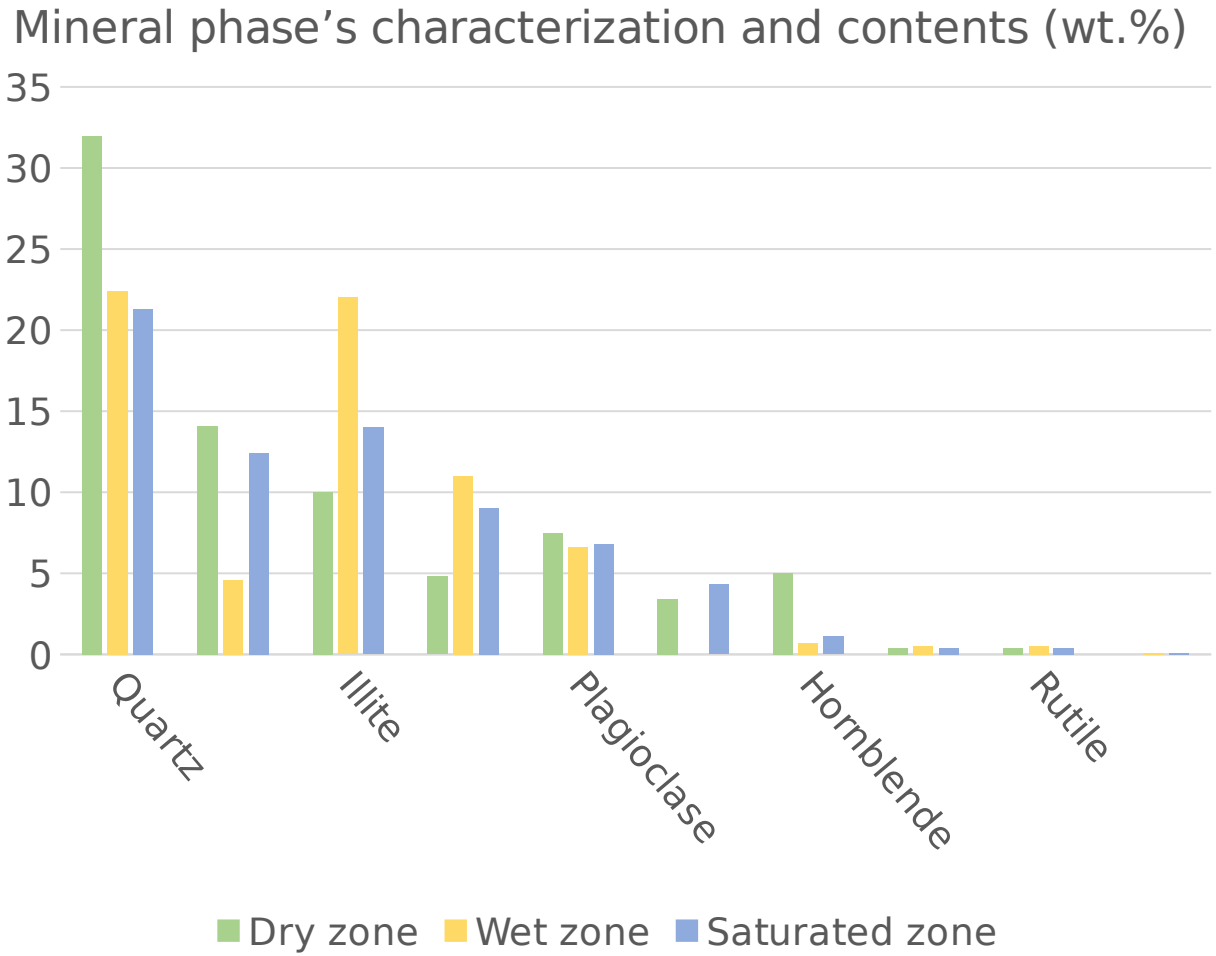


☛ potential source of pollution ⇒ valorization

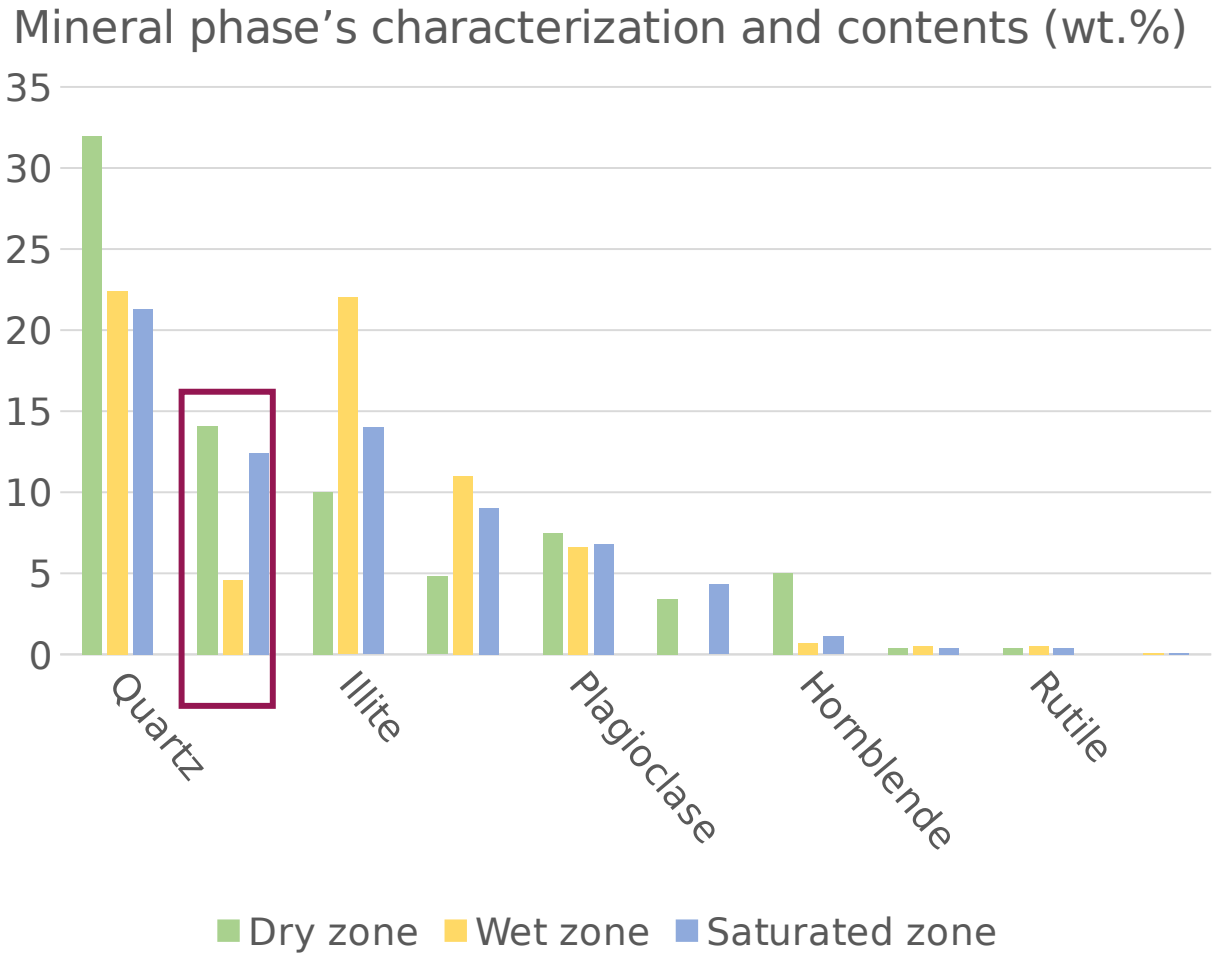
Mineralogical characterization



☛ similar mineral phases

☛ calcite contents ↗ ⇒ calcareous subsoil characteristic

Mineralogical characterization

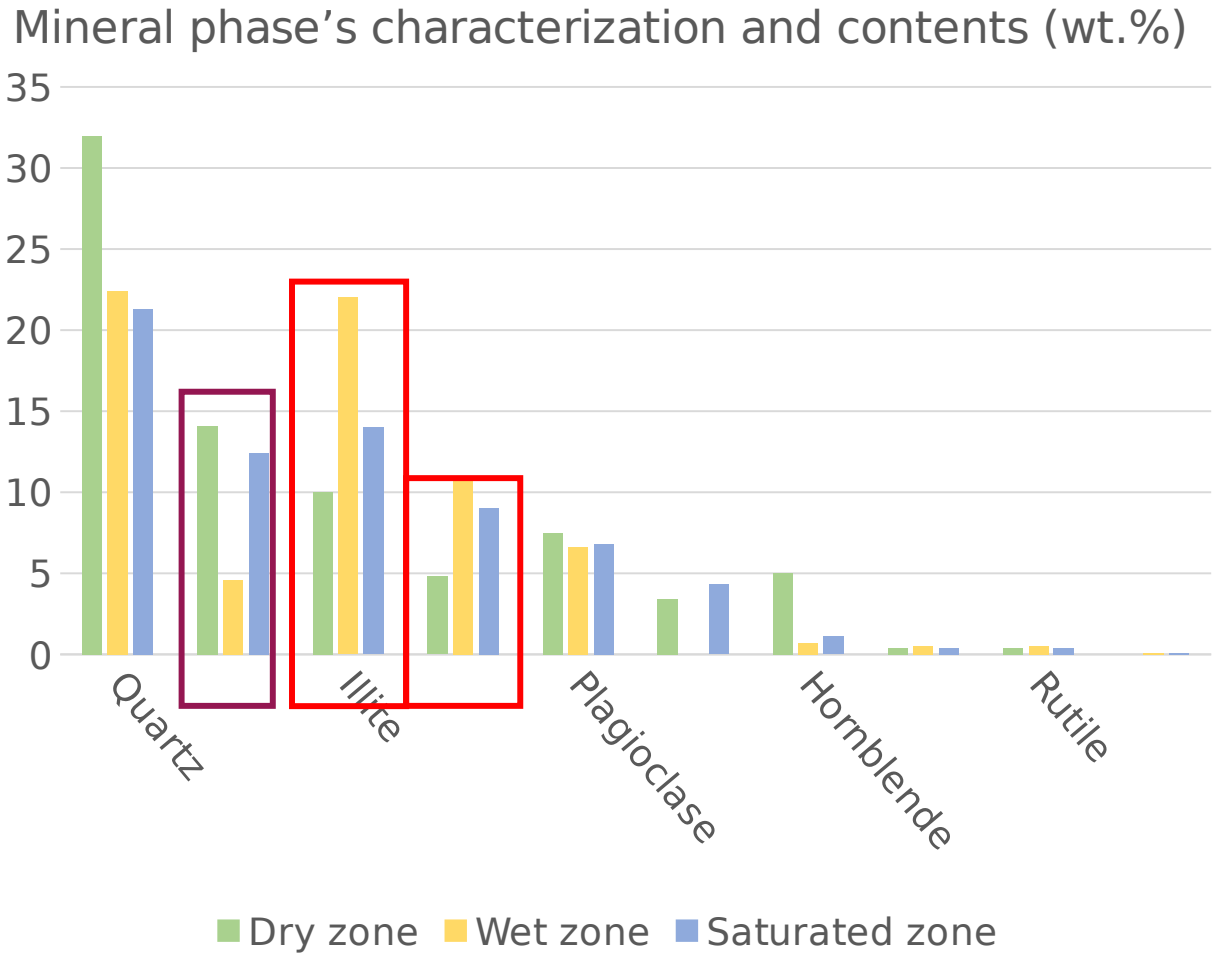


☛ similar mineral phases

☛ calcite contents ↗ ⇒ calcareous subsoil characteristic

☛ calcite in wet zone ↘ ⇒ dissolution with the circulation of water

Mineralogical characterization



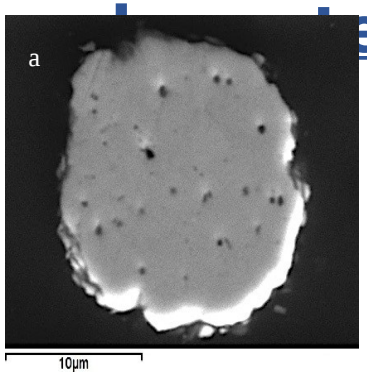
☛ similar mineral phases

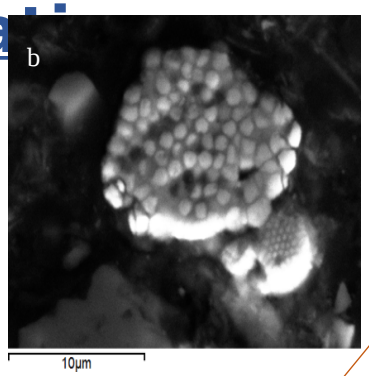
☛ calcite contents ↗ ⇒ calcareous subsoil characteristic

☛ calcite in wet zone ↘ ⇒ dissolution with the circulation of water

☛ chlorite and illite in dry zone ↘
⇒ seasonal change of stormwater
⇒ draining of

Mineralogical characterizati





SEM microscopy images (a) and (b) showing minerals pyrite and framboid pyrite in the wet zone

☛ Occurrence of micrometric pyrite

☛ very close composition of three samples

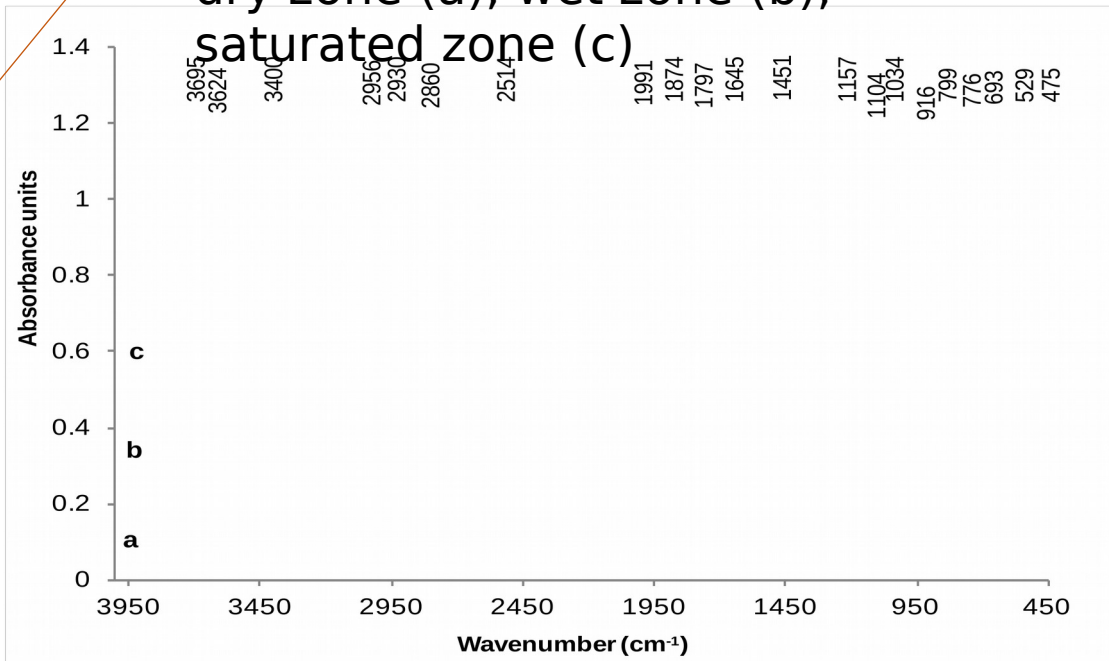
☛ 3400 cm^{-1} -- 3620 cm^{-1} → O-H

⇒ clay minerals

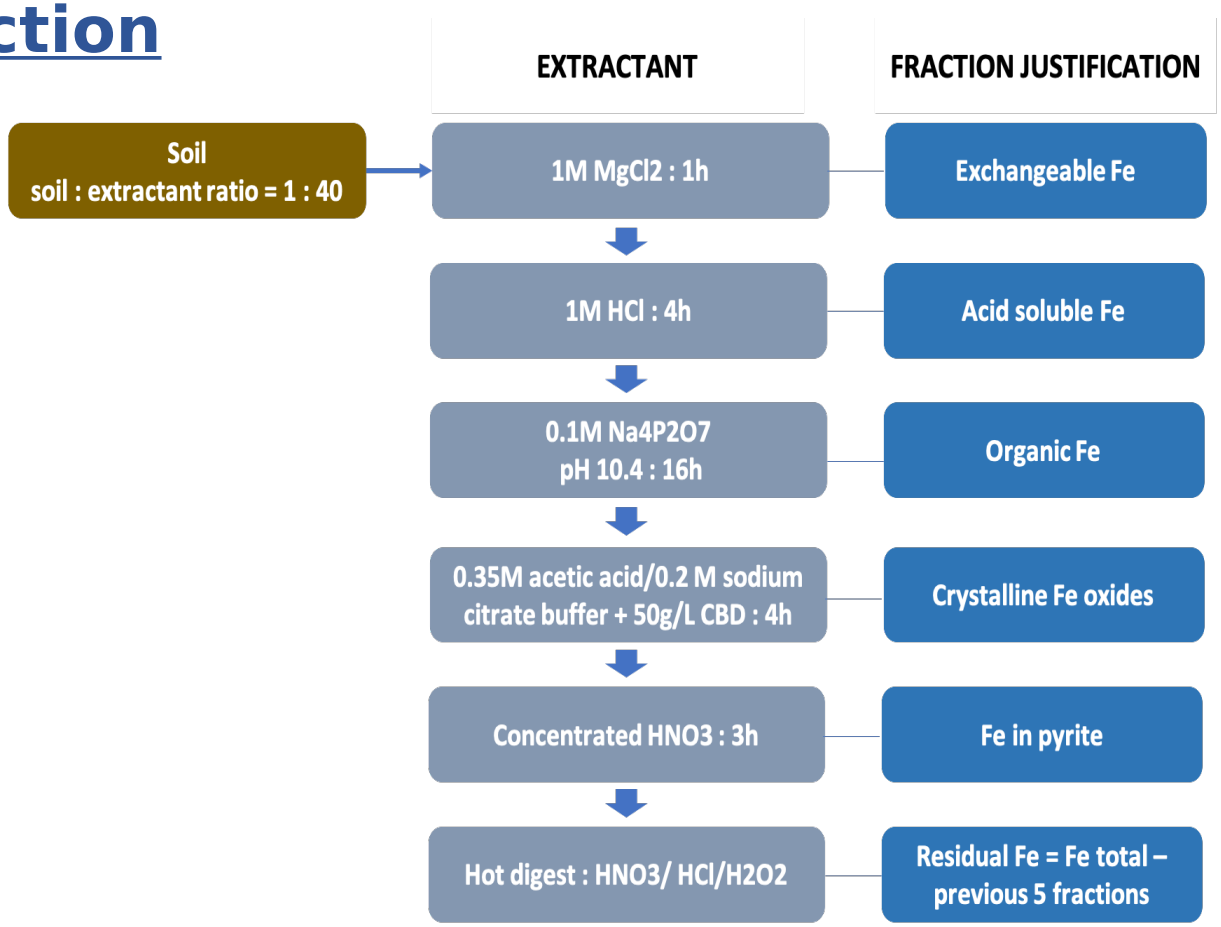
☛ 1645 cm^{-1} → C=C

⇒ aromatic cycles

Typical FT-IR spectra of sediment: dry zone (a), wet zone (b), saturated zone (c)

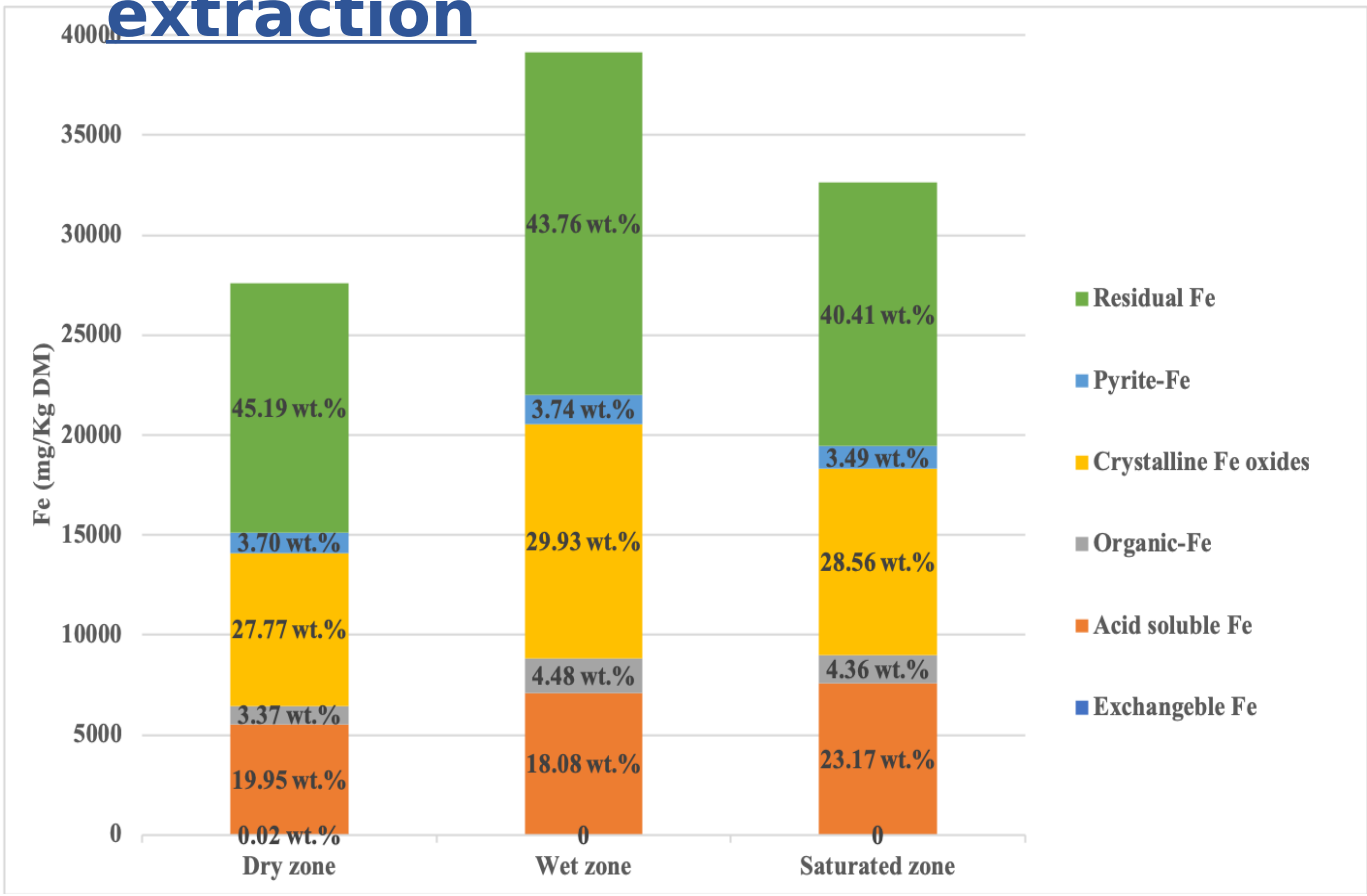


Sequential chemical extraction



Sequential extraction procedure adapted from Claff et al. (2010)

Sequential chemical extraction



Fe content in the sequential extraction phases adapted with the Claff et al.

☛ exchangeable Fe ↘

☛ acido-soluble Fe ↗
⇒ carbonates and poorly ordered sulfides and oxides

☛ organic-Fe ↘

☛crystalline Fe oxide ↗
⇒ periodic freshwater flooding and redox cycling

☛Pyrite-Fe ↘

CONCLUSION:
This study:

- **highlights the significant amount of Fe (up to 3.91 wt.%) found in the sediment of urban stormwater infiltration basin and pyrite (reactive material compound)**
- **provides a basis for the rational interpretation of iron partitioning in the urban sediment**
- **Supports the management of maintenance dredging of the sediment (economize $)**

PERSPECTIVES:
Future work :

- **Particle settling velocity**
- **Isotopes of Fe**
- **Investigation of other basins Generalization**

Thanks for your attention

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