EGU Conference , 19th – 30th April 2021

DANG Du Phuc Tho, BECHET Béatrice, JEAN-SORO Liliane

GERS, LEE

Size fractionation highlights the mobility of copper from urban stormwater to river

Université Gustave Eiffel

Copper in the land-sea continuum

Agricultural area:

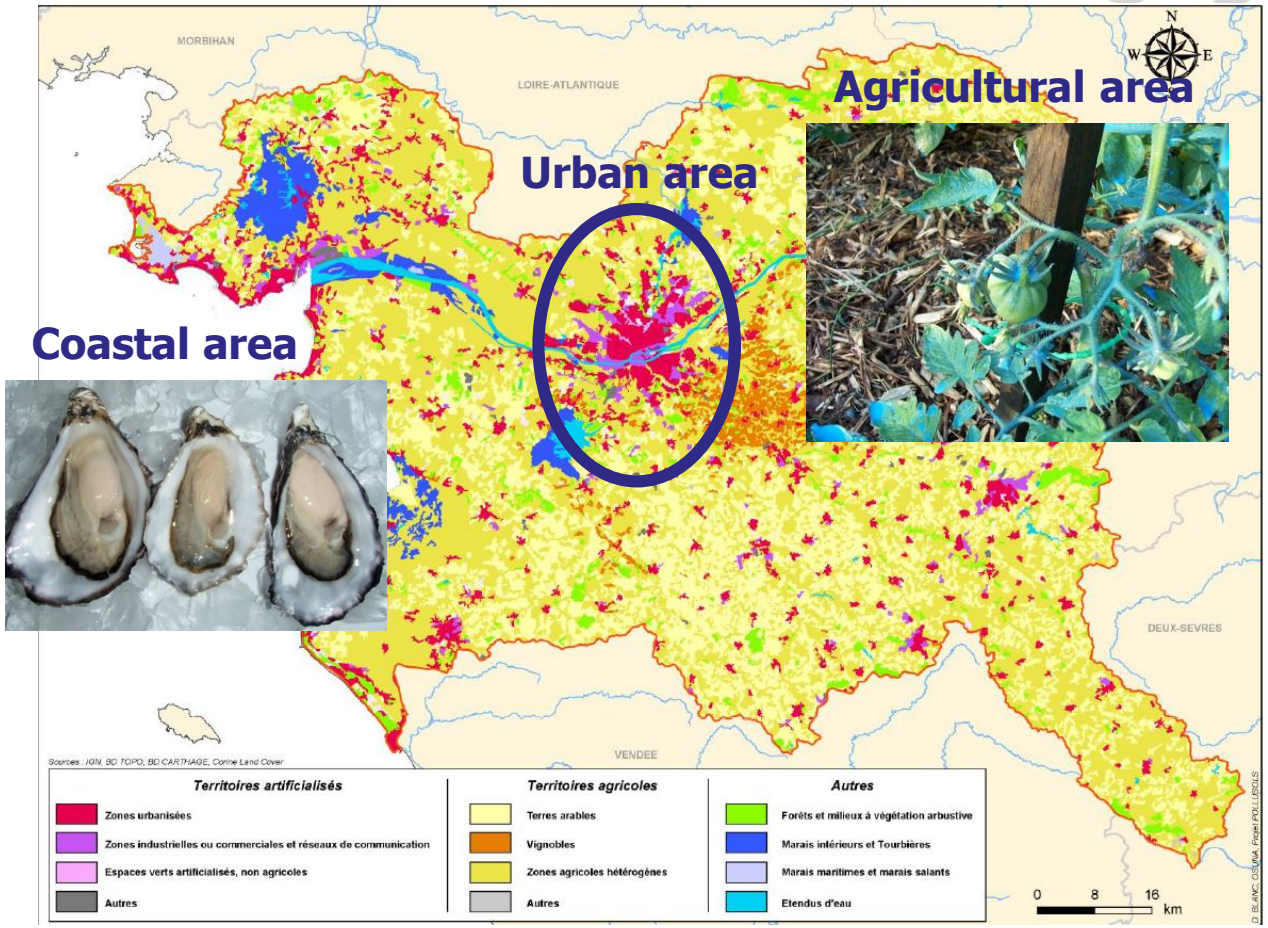
fungicide uses (ex: $CuSO_4$) → soil, underground water

Urban area:

traffic, habitat → waterways

Coastal area:

→ Shellfish culture (~ 200mg Cu in 1kg DM of oyster (Ifremer, 2017))

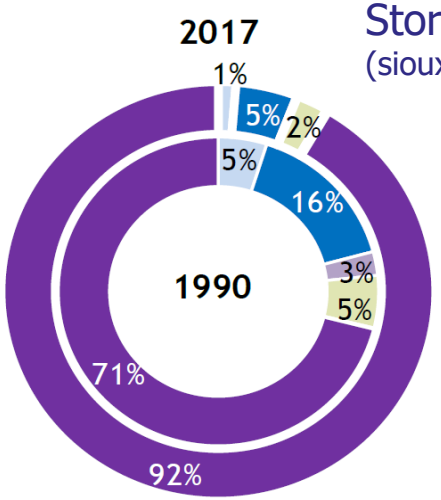


Map of the land-use distribution in Pays de la Loire, France

Ifremer, 2017. Qualité du milieu marin littoral. Bulletin de la surveillance 2016. Département de Loire Atlantique et Vendée (partie Nord).

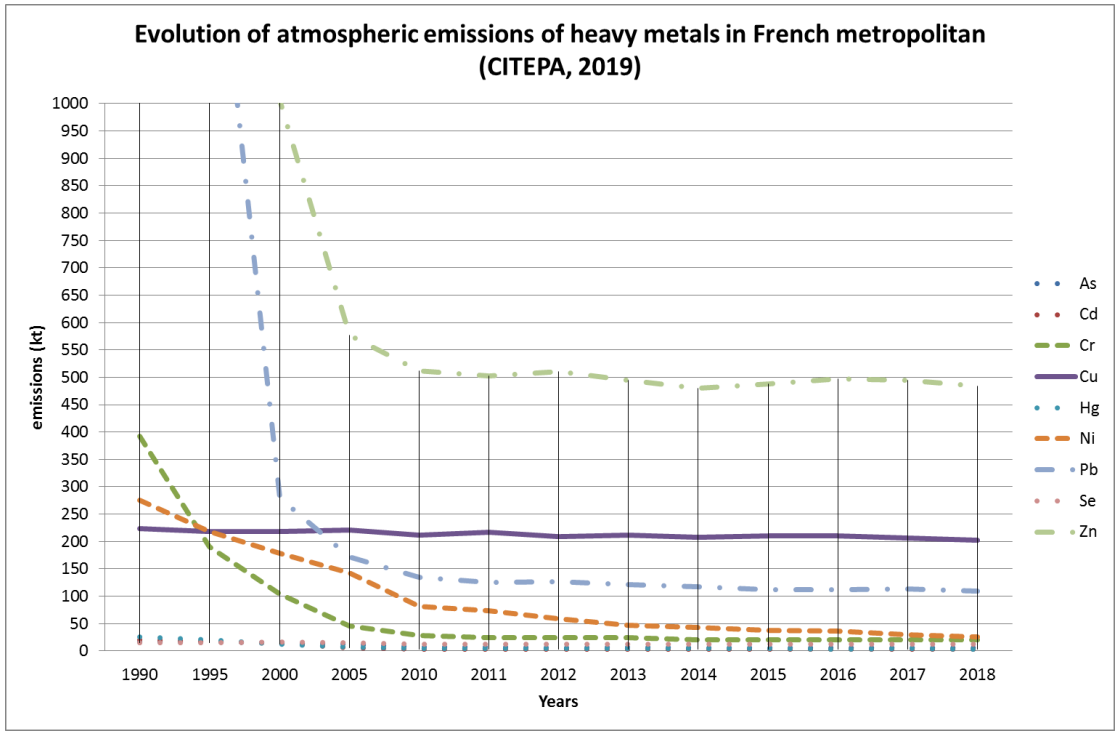
Copper in urban areas

Stormwater runoff flow paths
(sioux-city.org)



Transformation énergie	Industrie manufacturière	Déchets (centralisé)
Résidentiel/tertiaire	Agriculture/sylviculture	Transports

CITEPA-ML-secteur-d/Cu.xlsx
Source CITEPA / format SECTEN - avril 2019



Low variation of copper atmospheric emissions in French metropolitan (CITEPA, 2019)

92% of these emissions provide from traffic.

Air emissions

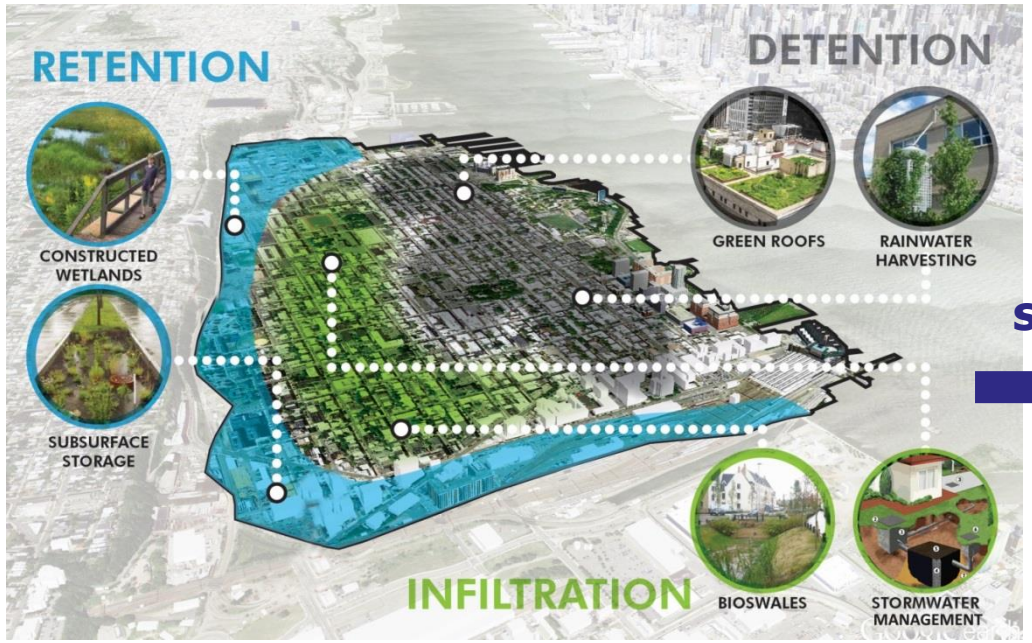
30-50%
(Wu et al., 1998)

stormwater

Wu, J.S., Allan, C.J., Saunders, W.L., Evett, J.B., 1998. Characterization and pollutant loading estimation for highway runoff. J. Environ. Eng. 1998.124:584-592.

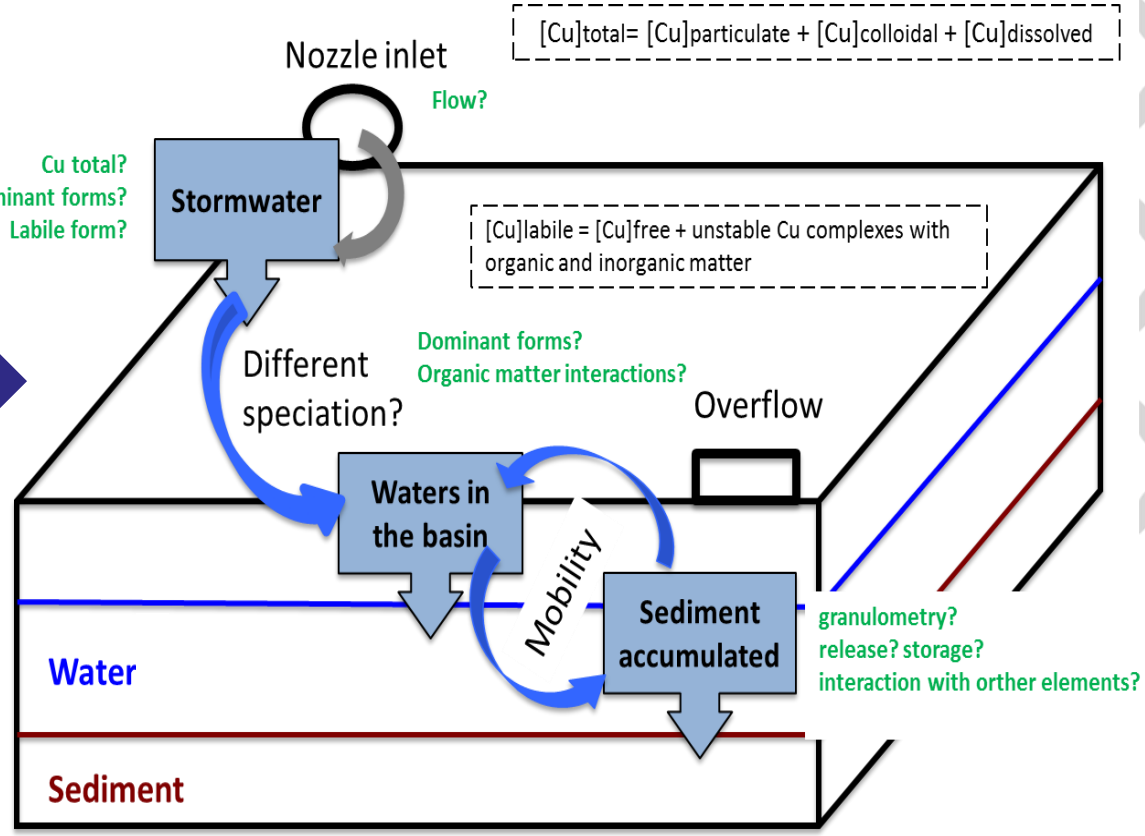
Université Gustave Eiffel

Stormwater management in urban areas



Green corridor, retention, detention and infiltration systems (polocentre.org)

Our study



Objectives:

- Copper flux from urban stormwater to river
- Influence of speciation on copper dynamics in a retention-infiltration basin (physical and chemical)

Université Gustave Eiffel

Study area

Cheviré bridge, Nantes, France
(Nathalie Bourreau, nantes.maville.com, 2015)

Daily average traffic: 87 021
(May 2020 – March 2021)

Two retention and infiltration basins (North and South)

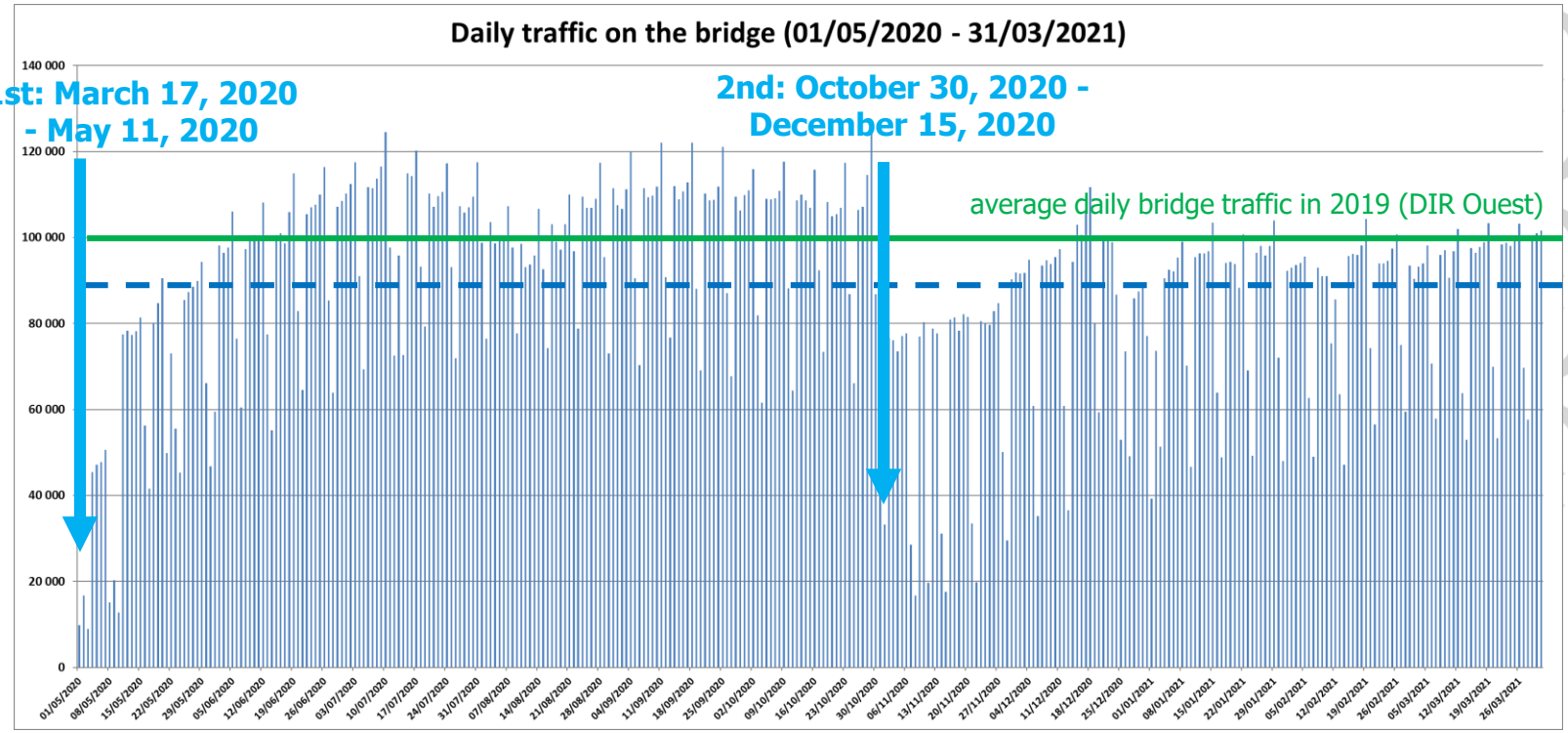
South basin

Contributive surface : ~18 961m²

Surface area: 780m²

Depth: 1.8-2.0m

Maximum water depth: 1.20m



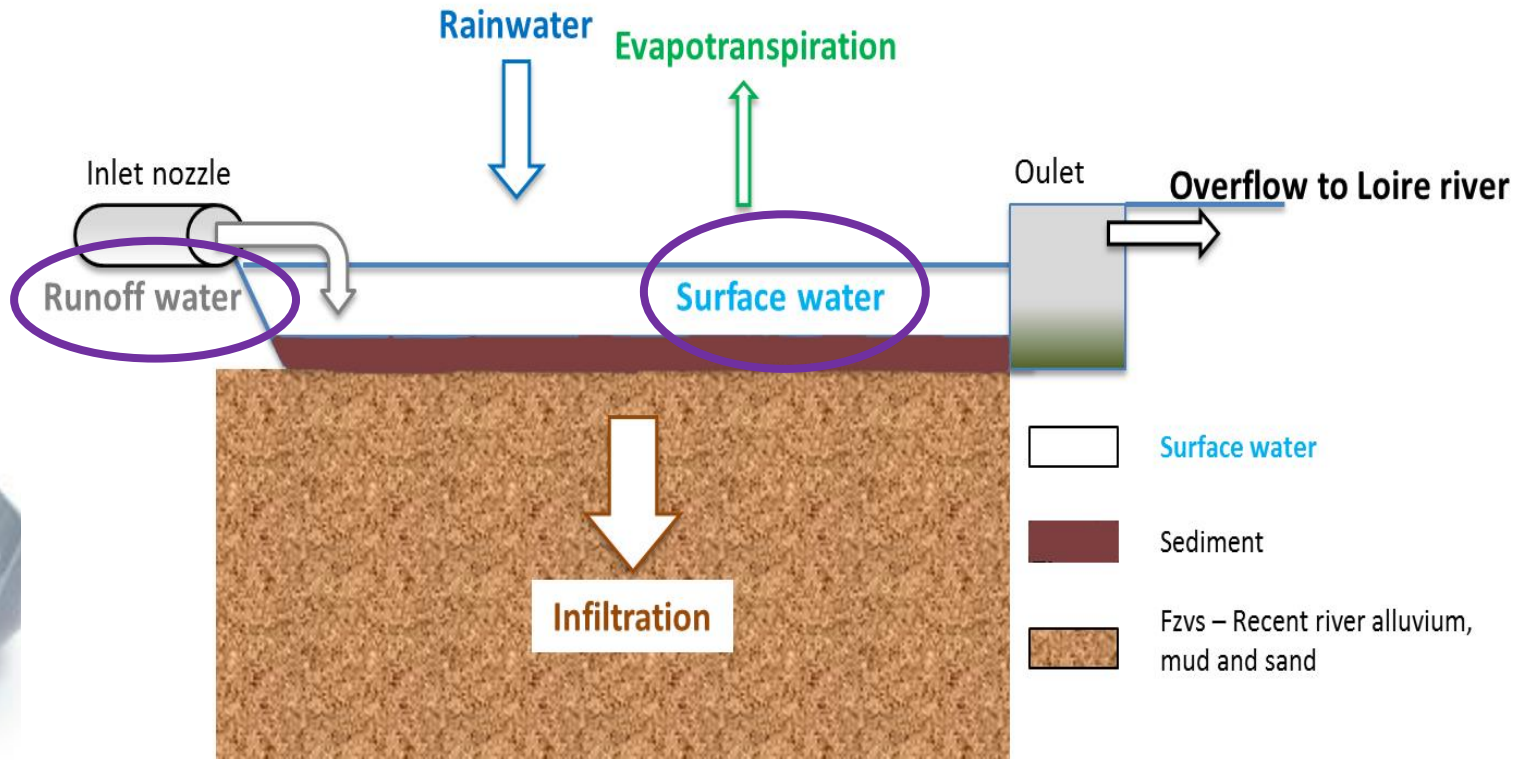
Evolution of the traffic on the Cheviré bridge during the **differents lockdowns** in France

Université Gustave Eiffel

Materials and methods: Instrumentation and sampling

Runoff water:

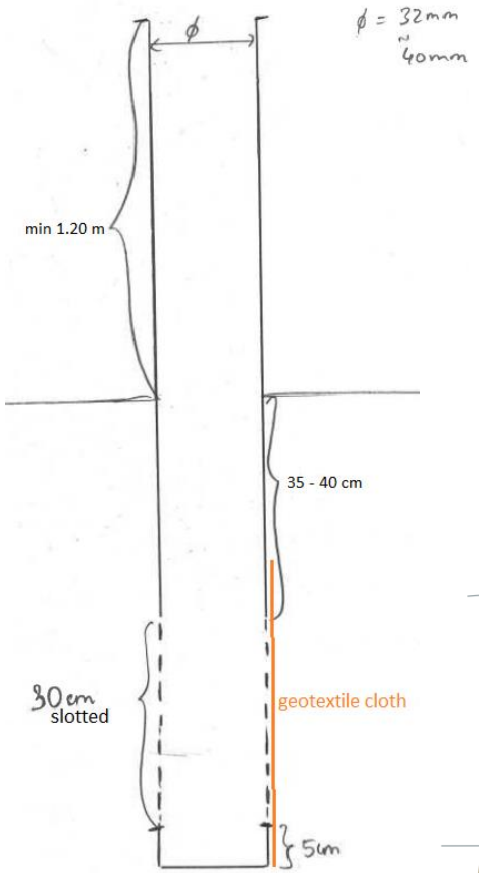
- AS950 portable sampler
- Every 15-30min per event



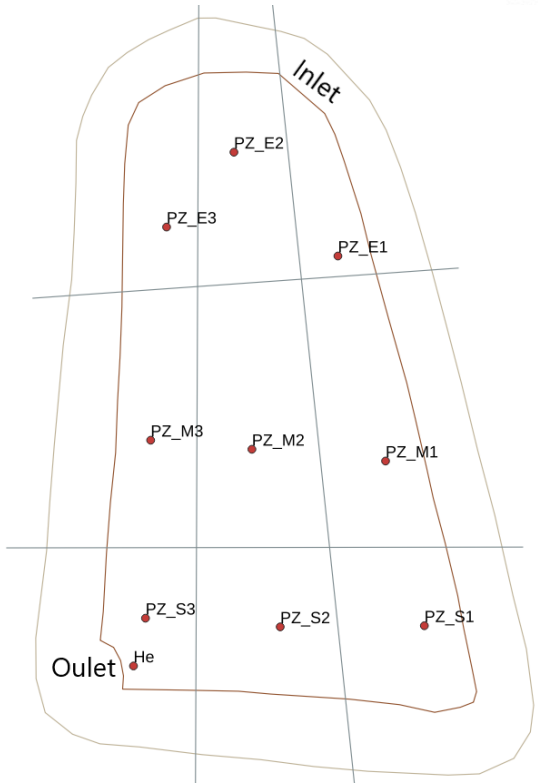
Surface water:

- ~ 48h after event

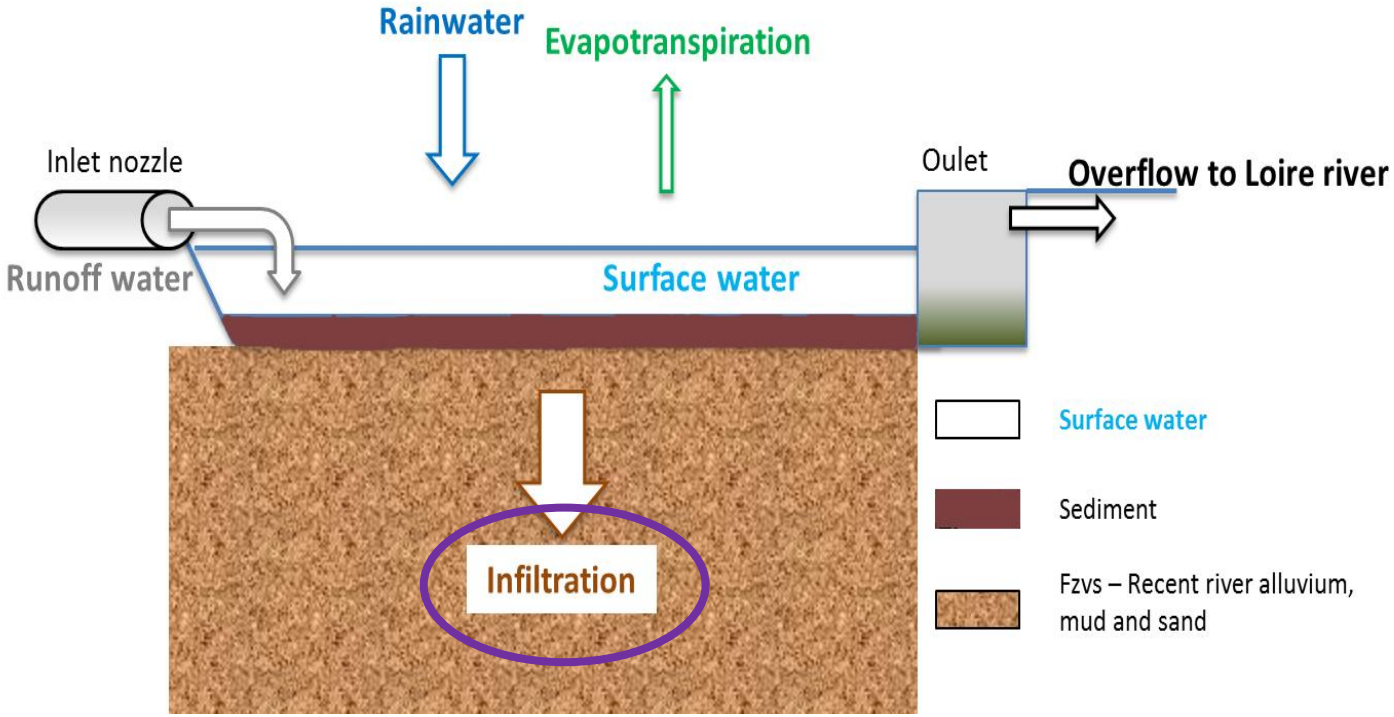
Materials and methods: Instrumentation and sampling



Mini piezometer



Location of the piezometers in the basin



Infiltration water:

- Mini piezometers/ opening size of geotextile cloth: 90 µm
- ~ 48h after event

Université Gustave Eiffel

Materials and methods:
Size fractionation

- **Runoff water**
  - Total elemental concentration of samples
  - Elemental concentrations in fractions of composite samples
- **Surface water**
- **Infiltration water**

=> Total concentration and fraction concentration of elements in samples

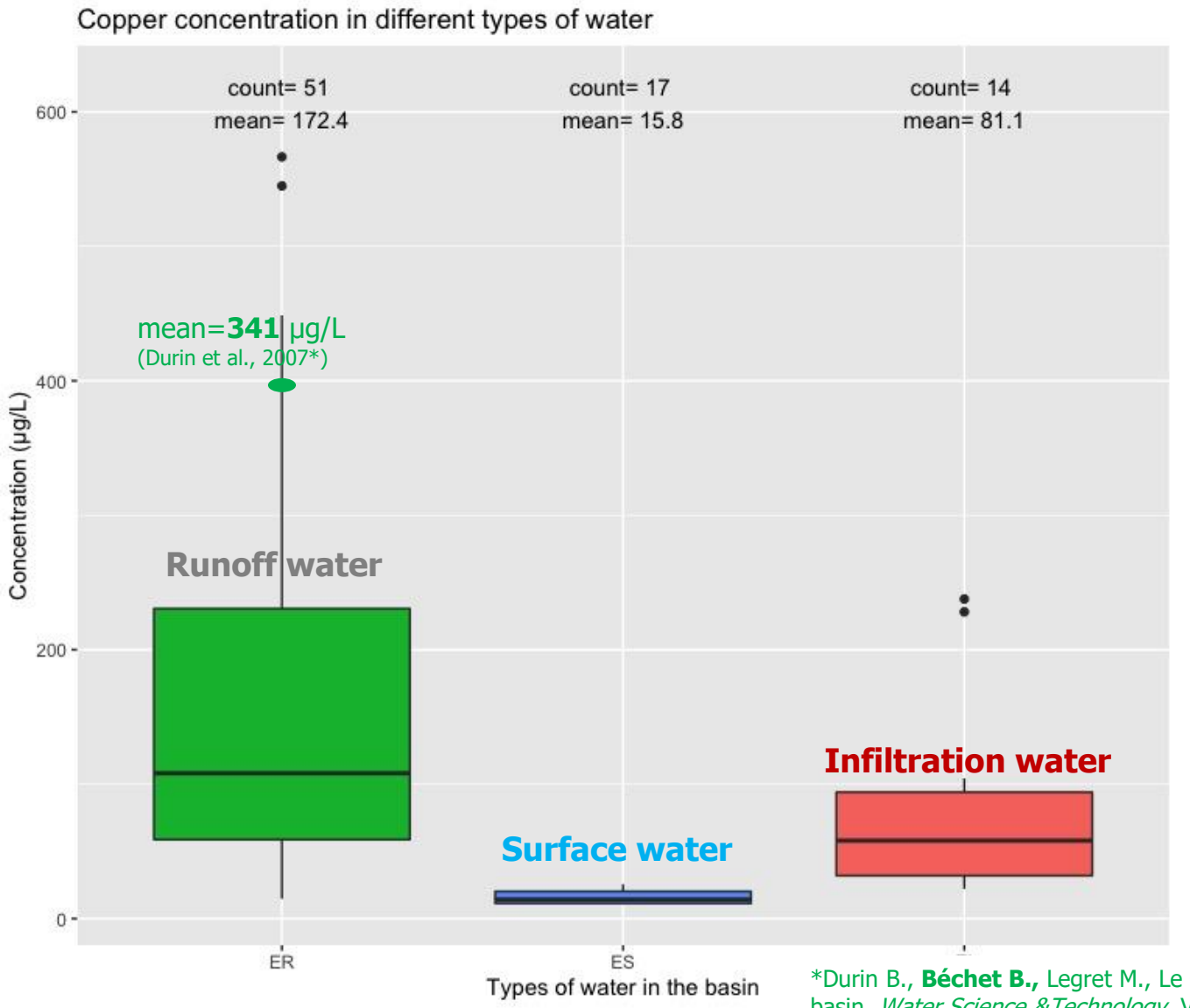
Fractionation sizes:

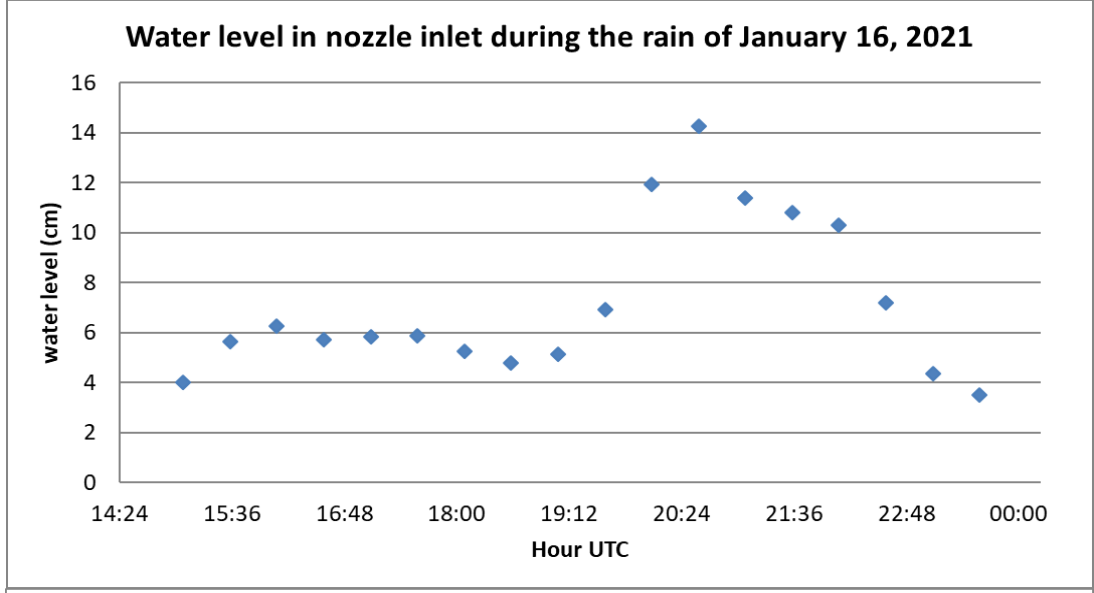
filtration
-] ; 8 µm] → particulate
-] 8 µm ; 1.2 µm] → colloidal
-] 1.2 µm ; 0.45 µm] → colloidal
-] 0.45 µm ; 5 kDa] → colloidal

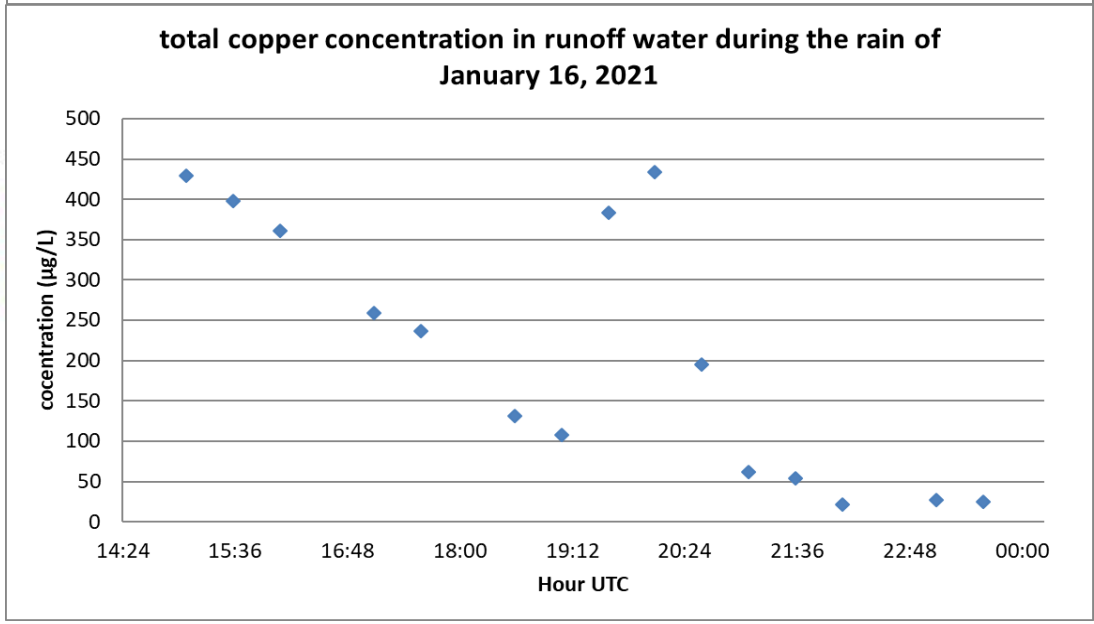
ultrafiltration
-] 5 kDa ; [→ dissolved

Université Gustave Eiffel

Results :
Total copper concentrations in water samples



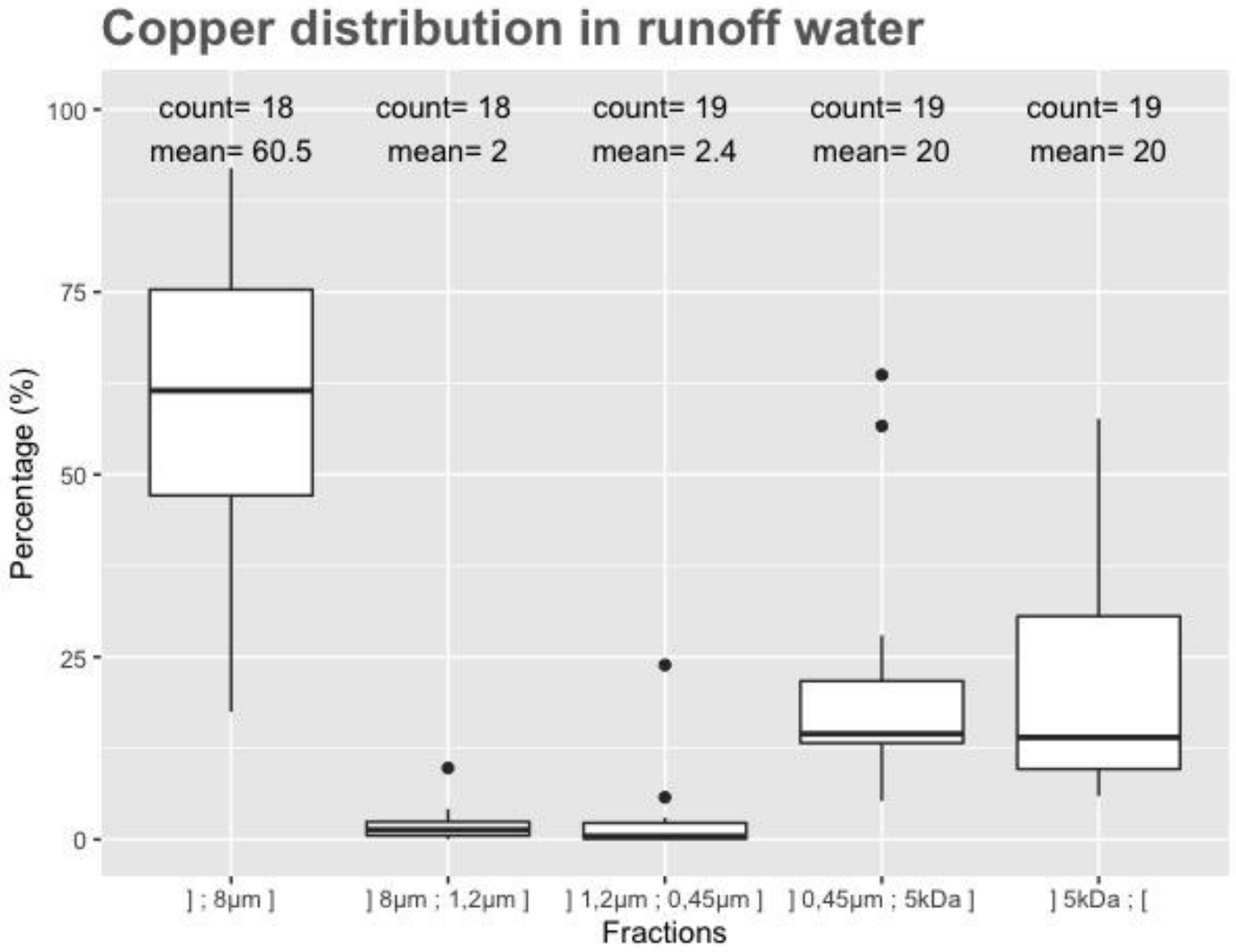




First-flush phenomenon → large variation of copper concentration in runoff water

*Durin B., **Béchet B.,** Legret M., Le Cloirec P., **2007**, Role of colloids in heavy metal transfer through a retention-infiltration basin, *Water Science &Technology*, Vol.56, N°11, 91-99. doi.10.2166/wst.2007.762

Results:
Size fractionation of copper in runoff water



Copper arriving in the basin is mainly in particulate form] ; 8µm] (over 60% of total copper).

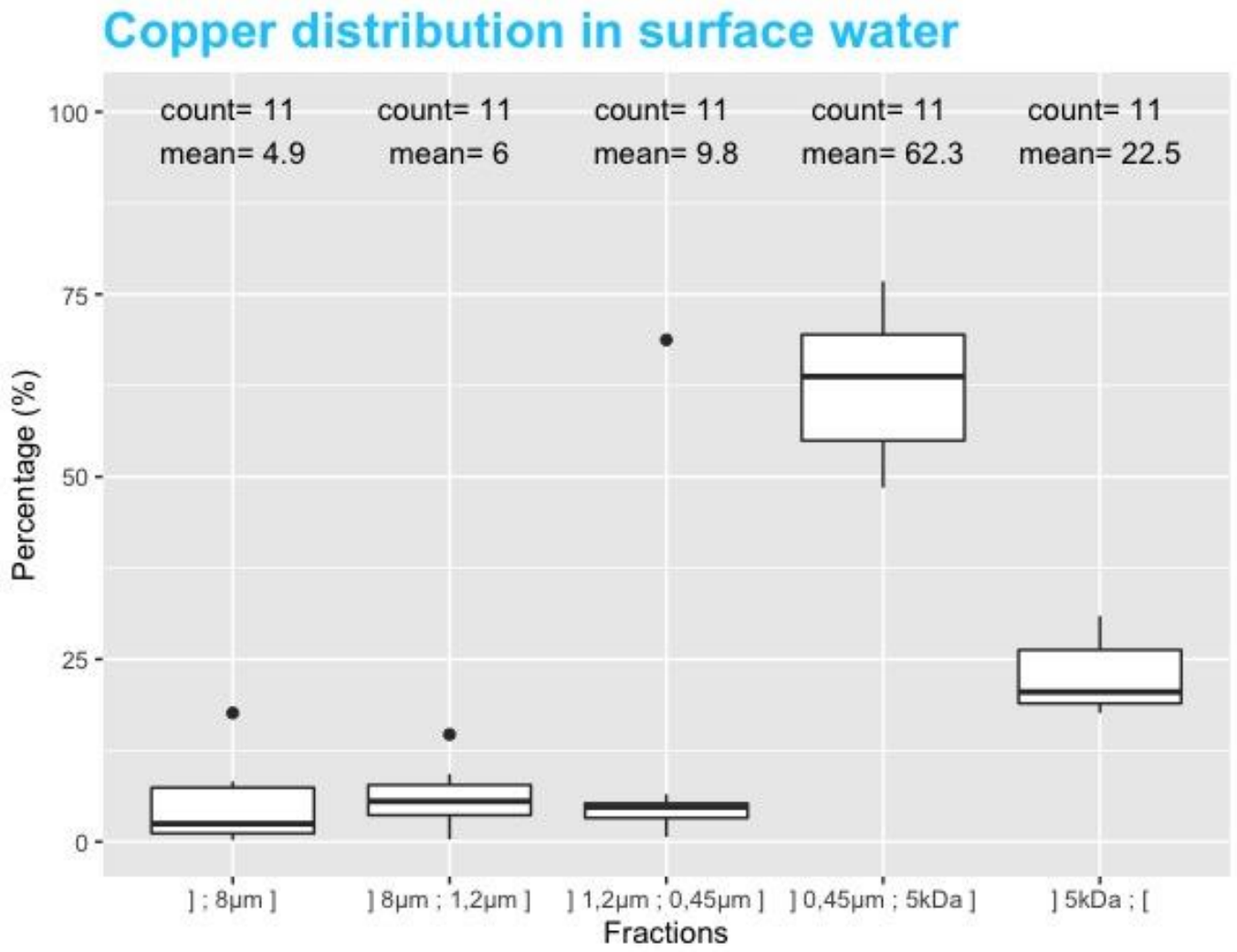
Dissolved copper] 5kDa ; [about 20% of total copper.

Colloidal copper : over 20% of total copper.

=> ~ 40% of total copper in runoff water as mobile forms in basin.

Université Gustave Eiffel

Results:
Size fractionation of copper in surface water

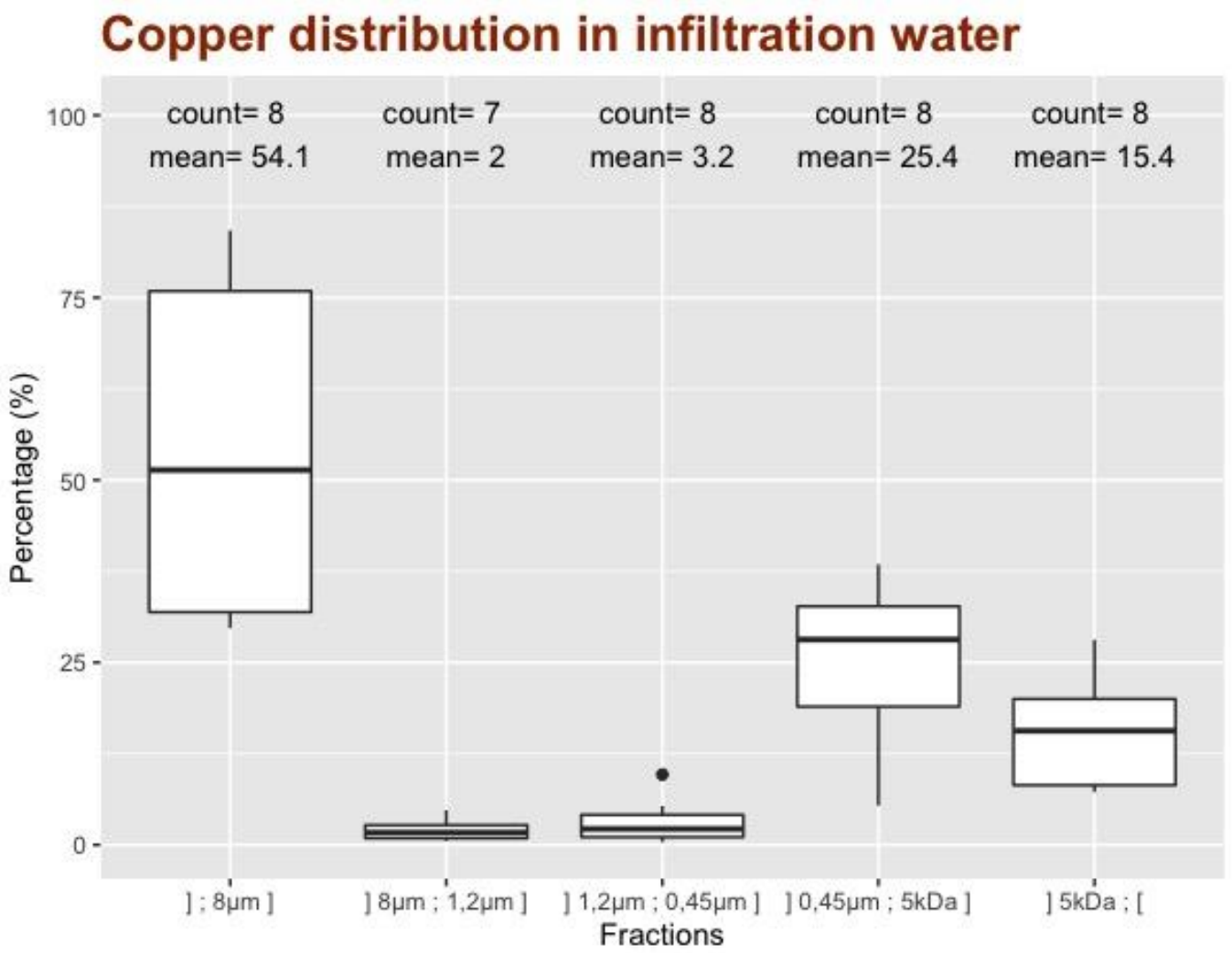


About 5% of total copper in surface water is in particulate form] ; 8µm] (against 60% in runoff water, by decantation in basin).

~90% of total copper in surface water in basin is in mobile forms which is 70% colloidal and 20% dissolved.

Université Gustave Eiffel

Results:
Size fractionation of copper in infiltration water



About 55% of total copper in infiltration water is in particulate form] ; 8µm] (porous water in river alluvium, sampled through geotextile)

Colloidal copper in infiltration water takes 30% of the total.

Dissolved copper is around 15% of total copper in porous water.

=> ~45% of total copper in the infiltration water is mobile.

Université Gustave Eiffel

Conclusions

- Copper in runoff water is mostly founded in particulate form.
- By decantation in the basin, particulate copper in surface water is only 5% of the total concentration.

  However, most of copper in surface water is mobile (~90% of total Cu = colloidal Cu 70% + dissolved Cu 20%). In case of overflowing to the river, copper may then interact with living microorganisms in the waterways.
- Around 45% of the total copper concentration in infiltration water is mobile and potentially transfered to the alluvial groundwater .

- To assess the environmental impact, copper bioavailability is to be studied through characterization of chemical speciation (by DGT for example).

Du Phuc Tho Dang, Béatrice Béchet, Liliane Jean-Soro

du-phuc-tho.dang@univ-eiffel.fr
beatrice.bechet@univ-eiffel.fr
liliane.jean-soro@univ-eiffel.fr

Université Gustave Eiffel

iRSTV

OSUNA planètes et environnement

EGU