ASSESSMENT OF HYDRAULIC PROPERTIES OF TECHNOSOILS CONSTRUCTED WITH WASTE MATERIALS USING BEERKAN INFILTRATION EXPERIMENTS

D. Yılmaz, P.-E. Peyneau, L. Vidal-Beaudet, P. Cannavo, G. Séré

SSS7.6/HS8.3.11
Soil water Infiltration. Measurements, assessment and modeling (co-organized)
CONTEXT

- Construction of Technosoiils using waste materials for greening applications such as parks, gardens, trees lines

- Sustainable Urban Approach:
  - Instead of using excavated soils from arable land for building soils for urban greening
  - Using urban waste materials such as demolition waste: excavated soil waste, brick manufacturing waste, track ballast waste, sludge waste and green waste

- SITERRE Project
  - Funded by the French Environment and Energy Management Agency (ADEME)
OBJECTIVES

- Construction of Technosoils at lysimeter scale
- Study of different mixtures of waste material as Technosol
- Study of the feasibility of the project by:
  - Hydraulic properties characterization
  - Plant development monitoring
  - Soil composition, water and nutrient monitoring
METHODOLOGY

- Construction of two types of Technosols
  - Growing Material
  - Skeleton Materials

- Study of different mixtures of waste materials in two sites in France:
  - Angers
  - Homécourt
METHODOLOGY

Growing Material GM:
- 58 % wt. brick waste
- 42 % wt. sewage sludge and green waste

Skeleton Materials SM:
- CG: concrete, green and excavated soils waste (Homécourt)
- RG: demolition rubble, green and excavated soils waste
- BS: track ballast, sewage sludge
- Reference soil (arable soil + chaceldony) used by the city of Angers
**METHODOLOGY**

- Homécourt site: 2 lysimeters

Beerkan infiltration experiments performed:
- GM: 1 + 1
- SM: 2 + 0
**METHODOLOGY**

- Angers Site: 9 lysimeters

- Beerkan infiltration experiments performed:
  - GM: 2
  - Reference: 2; BS: 2; RG: 3
METHODOLOGY

BEERKAN INFILTRATION:

BEST METHOD (Lassabatere et al., 2006) :
- Inversion of particle size distribution
- Cumulative infiltration curve
- $K_s$: saturated hydraulic conductivity
- $h_g$: capillarity length
RESULTS AND DISCUSSIONS

GROWING MATERIAL

| GM | BEERKAN INFILTRATION INVERSION | θs (-) | n (-) | |hg| (cm) | Ks (cm/h) |
|---|---|---|---|---|---|---|
| Homécourt - Mean | 0,692 | 2,24 | 1,85 | 19,7 |
| Angers - Mean | 0,771 | 2,22 | 5,9 | 9,9 |

STRUCTURAL MATERIALS

| SM | BEERKAN INFILTRATION INVERSION | θs (-) | n (-) | |hg| (cm) | Ks (cm/h) |
|---|---|---|---|---|---|---|
| Referans - Mean | 0,312 | 2,36 | 5,10 | 18,25 |
| BS : Ballast + Sludge | 0,358 | 2,25 | 7,20 | 14,40 |
| RG : Rubble Demoliton Excavated soil + Green waste | 0,417 | 2,25 | 3,63 | 3,40 |
| CG: Concrete Waste Excavated Soil + Green Waste | 0,484 | 2,31 | 10,23 | 6,57 |
RESULTS AND DISCUSSIONS

- Growing material
  - Evaporation experiment in laboratory (Yilmaz, 2015):
    - $\theta_s = 0.63$; $hg = 12.8$ cm; $K_s = 29.0$ cm/h
  
- Disk infiltrometer experiments in situ (Yilmaz, 2016):

| GM | DISK INFILTROMETER INFILTRATION INVERSION (2016) | $\theta_s$ (-) | $|hg|$ (cm) | $K_s$ (cm/h) |
|----|--------------------------------------------------|----------------|------------|-------------|
|    | Homécourt - Mean                                | 0.692          | 6.13       | 21.95       |
|    | Angers - Mean                                   | 0.771          | 2.95       | 26.35       |

| GM | BEERKAN INFILTRATION INVERSION                  | $\theta_s$ (-) | $|hg|$ (cm) | $K_s$ (cm/h) |
|----|-------------------------------------------------|----------------|------------|-------------|
|    | Homécourt - Mean                                | 0.692          | 1.85       | 19.70       |
|    | Angers - Mean                                   | 0.771          | 5.90       | 9.85        |
CONCLUSION

- Technosoils built from waste materials
  - High macroporosity $\rightarrow$ soil aeration
  - Hydraulic properties $\rightarrow$ between sand and loam
  - Yilmaz et al., 2016; chemical analysis + root distribution of trees
  - Possible to use such technosoils for greening applications
CONCLUSION

- Beerkan infiltration method is well suited to characterize hydraulics properties of Technosools built with coarse materials
  - Easy to set-up

- Results are consistent with those obtained by the disk infiltrometer method
  - Difficulty when soil surface has coarse material
  - Long duration of experiments
THANK YOU FOR YOUR ATTENTION!