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Green roof aging or Isolatic Technosol's pedogenesis? Impact on hydrologic performances

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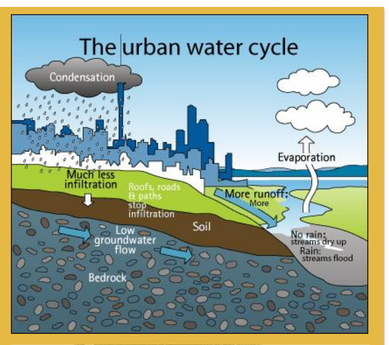
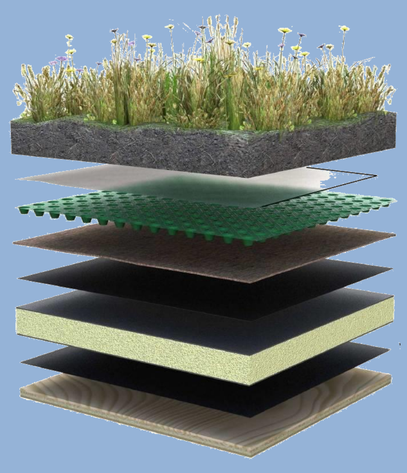
INTRODUCTION

Urbanization = sealed surfaces poorly covered by vegetation → **amount of water that can infiltrate soils** ↘ which can lead to **flooding** during major rain events. **Green roofs** (GR) = part of the **solution for urban water management** because they can **store and release water with a delay**. Storage capacity = 40 to 80% of the total annual rainfall volume depending on the substrates properties (*i.e.* thickness, characteristics and proportion of its organic and mineral components).

But GR are also **living systems** that are submitted to a significant **evolution with time of the poral architecture of the substrates**. The **influence of GR aging on their hydrologic performances was yet poorly addressed**.



ISOLATIC TECHNOSOL



ISOLATIC TECHNOSOLS (ANDIC, DRAINIC, FOLIC, TRANSPORTIC) (IUSS, 2014)
soil material containing fine earth without any contact to other soil, above technic hard material or above a geomembrane (*e.g.* soils on roofs).

IN SITU EXPERIMENTAL GR

300 M² OF EXPERIMENTAL PLOTS
Located in Tomblaine (N-E France)
Oceanic to continental climate
Implemented in Sept. 2011

SAMPLING + CHARACTERIZATION

Comparison of initial substrate (S_0) and evolved substrate (S_{4yrs}) under three land covers: i) bare soil, ii) sedums, iii) moss.
Physical properties (porosity, water retention curve, particles size distribution) + chemical composition (C_{org} and N_{tot})

EVALUATION OF GR HYDROLOGIC PERFORMANCES

LABORATORY SET-UP FOR WATER FLUXES MONITORING

Experimental device (500 × 400 × 400 - H×h×l, in [mm]) that reproduces and monitor vertical water flow through a sampled GR during rain events

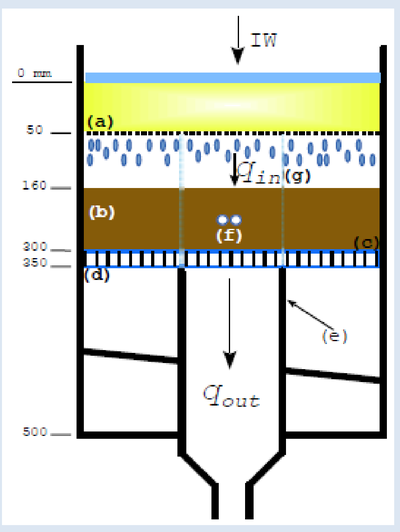
WATER BALANCE

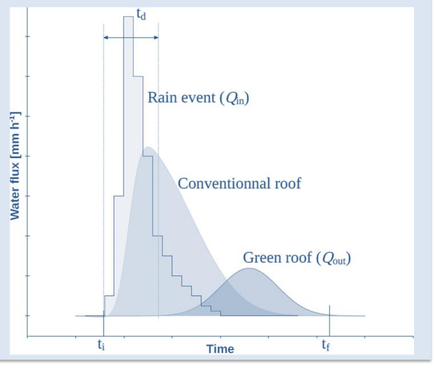
$Q_{out} = Q_{in} + \Delta S$
Q_{in}: incoming rainwater,
Q_{out} : drainage water,
ΔS: evapotranspiration + stored water [mm h^{-1}]

RETENTION CAPACITY (RC)

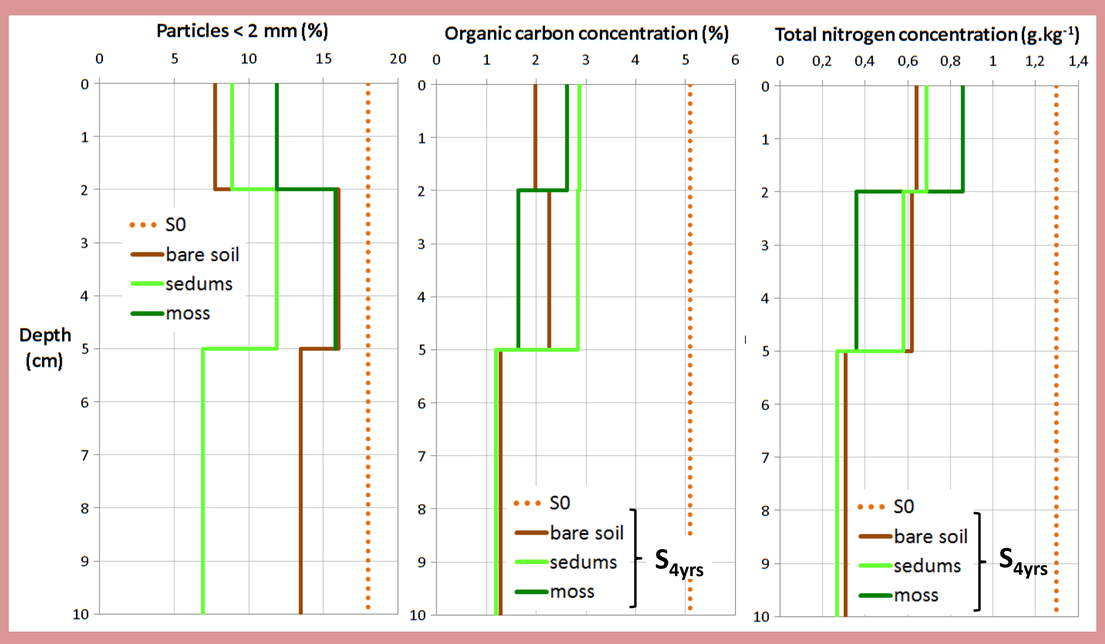
$$RC = \int_{t0}^{tf} \left(1 - \frac{Q_{out}}{Q_{in}}\right)$$

RC is the amount of water which is not evacuated to the storm water collection network during a period under the action of gravity





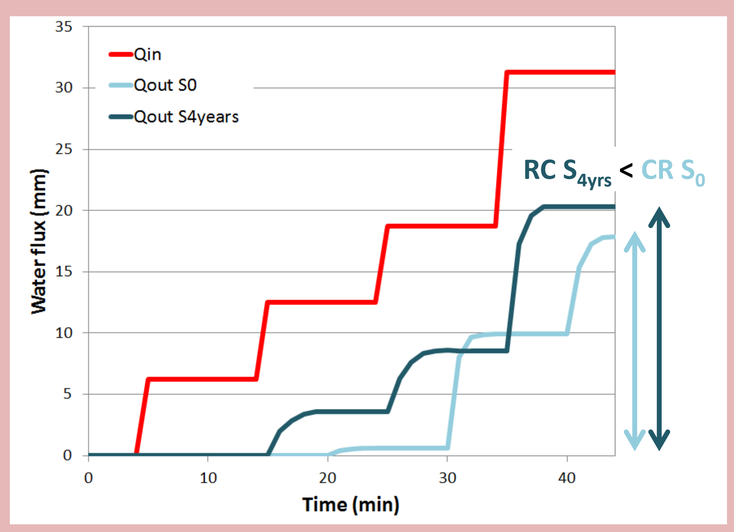
EVOLUTION OF PHYSIC-CHEMICAL PROPERTIES

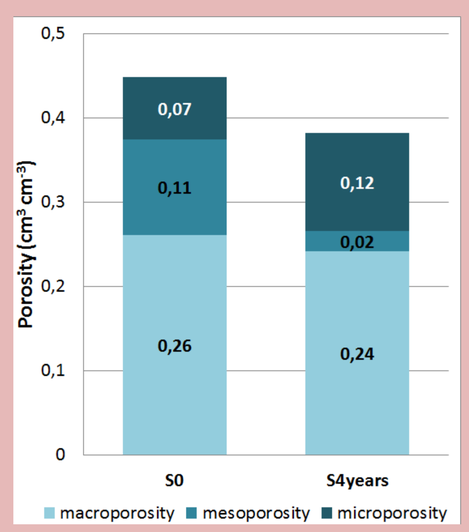


DEVELOPMENT OF SUB-HORIZONS + INFLUENCE OF LAND COVER

There were significant loss in fine particles (< 2 mm), organic carbon and nitrogen with time.
A distinct « epi-argic » sub-horizon between 2 and 5 cm deep which is enriched in fine particles (that are associated with or composed of organic matter)
Different results were observed depending on the land cover

HYDRODYNAMIC BEHAVIOR OF GREEN ROOF





DECREASE OF HYDROLOGIC PERFORMANCES

The experimental simulation of rainfall was conducted on S_0 and S_{4years} with the same rainfall sequence (Q_{in}).
Q_{out} was bigger for S_{4yrs}, => the retention capacity was smaller.
The outflow began earlier for S_{4yrs} => its delayed effect is shorter.
Significant decrease of substrate total porosity has been observed (especially mesoporosity) with time. This result can be positively correlated with the decrease of GR hydrologic performances.

CONCLUSION

Green roofs are Isolatic Technosols that are submitted to an **early pedogenesis**. Their substrates result in an anthropic association of **different parent materials that evolve with time under the influence of vegetation and climate**. Aged green roofs exhibited a **loss of fine particles** including organic matter and nitrogen; an **epi-argic sub-horizon appears**. Consequently, a **significant decrease of their hydrologic performances** is expected that could be anticipated.

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