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Influence of functional traits of vegetation and substrate type on runoff from extensive green roofs

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Context

Rainwater retention is an important service provided by green roofs, however little is known about the influence of functional plant traits (=morphological characteristics of vegetation) on the runoff.

Objectives

→ How do the functional plant traits influence water runoff from green roofs?

→ How important are the meteorological conditions, the substrate humidity and the substrate type in that influence?

Methodology

2 substrates

- Commercial Zinco Substrate
- Recycled materials based home-made substrate

19 species with contrasted traits

40 single species green roofs of 1m²

Substrate X species Bare soil

Functional traits realised

vegetation height, length of the longest leaf, plant cover per month
SLA measured one time

Meteorological parameters

Rainfall quantity and temperature

Measures during 8 months over 2 years

May, June, Septembre, Octobre 2021
January, February, May, June 2022

Runoff

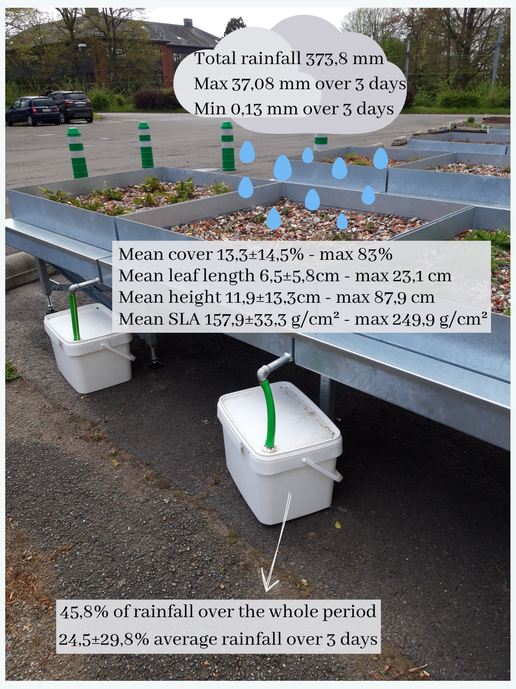
Quantity measured every three days during the studied period

Substrate humidity

Sensors TEROS 11 placed in 12 mini GR

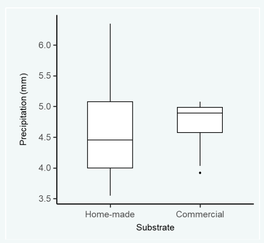
Results

Half of the rainfall captured by green roofs

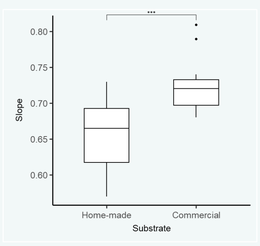


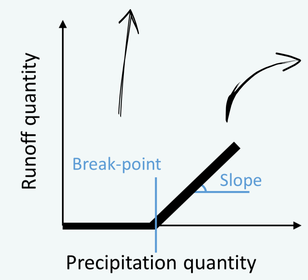
Substrate type influenced the dynamic of runoff

The mean precipitation threshold at which runoff occurred, "the break-point", was not influenced by the substrate type



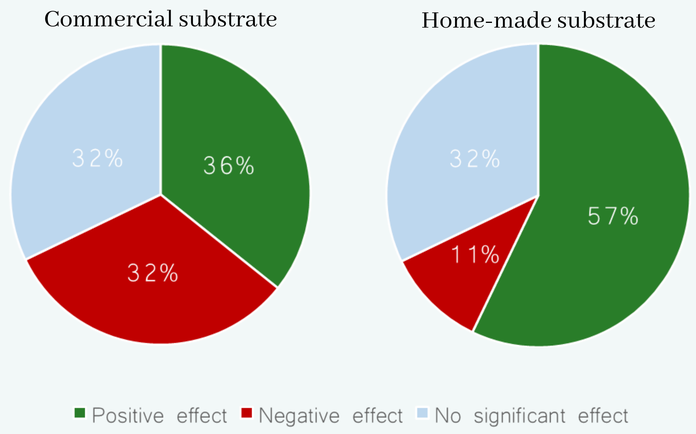
For the same amount of rainfall, commercial substrate induced more runoff than homemade substrate





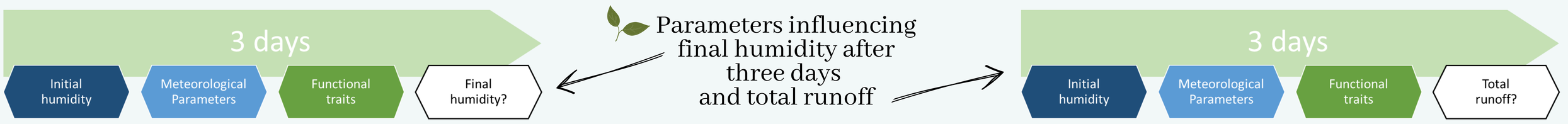
The effect of vegetation presence on runoff depended on substrate type

Comparison of runoff between vegetated and non-vegetated mini GR



Positive effect : runoff from vegetated GR is lower than from non-vegetated GR
Negative effect : runoff from vegetated GR is higher than from non-vegetated GR
No significant effect : runoff was not statistically different between vegetated and non-vegetated GR

Parameters influencing final humidity after three days and total runoff



Commercial substrate	Home-made substrate
Initial humidity R^2=0,95	Initial humidity R^2=0,98
Total precipitations R^2=0,43	Total precipitations R^2=0,38
Mean temperature R^2=0,59	
Aerial biomass proxy R^2=0,28	

Initial humidity — Substrate humidity at the beginning of the three-day period

Meteorological Parameters — Total precipitations and mean temperature over the three-day period

Functional traits — Height, leaf length, cover, SLA and aerial biomass proxy (cover*height)

Final humidity? — Substrate humidity at the end of the three-day period

Total runoff? — Total runoff over the three-day period

Commercial substrate	Home-made substrate
Initial humidity R^2=0,22	Initial humidity R^2=0,23
Total precipitations R^2=0,91	Total precipitations R^2=0,88
Mean temperature R^2=0,34	Mean temperature R^2=0,32
Aerial biomass proxy R^2=0,15	Aerial biomass proxy R^2=0,15
Height R^2=0,17	

Initial substrate humidity influenced the final susbtrate humidity more significantly

Aerial biomass proxy was the only plant trait influencing final substrate humidity

Total precipitation influenced the total runoff more significantly

Plant traits like aerial biomass proxy and vegetation height influenced the total runroff

Take home message

→ Substrate type and meteorological conditions are important factors in regulating runoff

→ Aerial biomass is the functional plant trait that is important to consider for optimizing the water retention capacity of extensive green roofs.

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