Assessing the impacting factors responsible for the variation in the throughfall rate of black pine trees in diverse urban climates.

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1. Introduction

The contribution of trees in altering the hydrological cycle necessitates evaluating the effects of meteorological conditions, leaf cover, seasonal variations, and rainfall magnitude on throughfall beneath pine tree canopy across different climates. Understanding trees' rainfall interception characteristics is essential for effective urban greenery planning and stormwater management.

2. Motivation

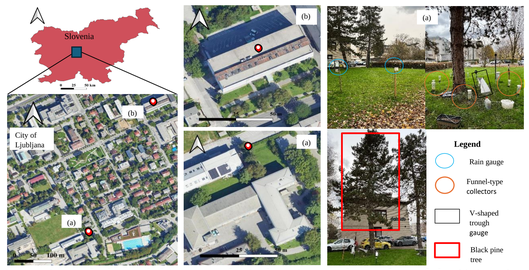
- Examining rainfall interception by the same tree species across different climates is crucial to developing region-specific nature-based solutions and supplementing transnational flood mitigation strategies aligned with the EU's climate resilience frameworks.

3. Research objectives

- To measure and compare the canopy throughfall of black pine trees (*Pinus nigra*) located in diverse urban climates, specifically in Slovenia and Hungary.
- To investigate the factors influencing the differences in the throughfall rate of the trees between these two regions.

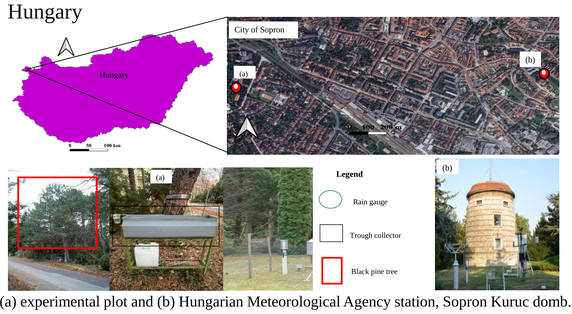
4. Study site and data collection

- Slovenia



(a) experimental plot and (b) meteorological station on the rooftop of the University of Ljubljana, Faculty of Civil and Geodetic Engineering

- Hungary



(a) experimental plot and (b) Hungarian Meteorological Agency station, Sopron Kuruc domb.

5. Data summary

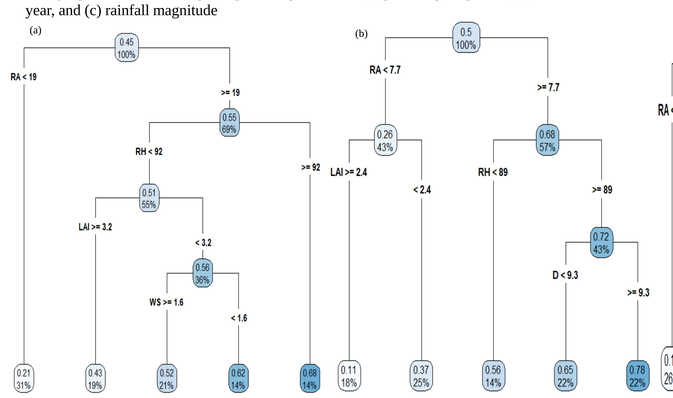
- Number of rainfall events: 42 and 51 in Slovenia and Hungary, respectively.
- Study period: September 2023 - September 2024
- Predictor variables: rainfall amount (RA), intensity (I), duration (D), relative humidity (RH), wind speed (WS), air temperature at the start of the rainfall events (Ts), average air temperature (Ta), and leaf area index (LAI).

Statistics	Slovenia Mean (± Std. Dev.)	Median	Mini-mum	Maxi-mum	Hungary Mean (± Std. Dev.)	Median	Mini-mum	Maxi-mum
RA [mm]	37.9 (±28.9)	31.4	4.2	124.8	15 (±15.1)	12.5	2.1	71.8
D [h]	22.5 (±18.9)	15.9	1.25	98.2	9.8 (±7.8)	7.8	0.2	35
I [mm/h]	2.02 (±1.2)	1.6	0.7	6.8	1.9 (±2.1)	1.6	0.2	12.6
Ts [°C]	14.6 (±5.4)	15.2	1.2	23.6	14.2 (±7)	14.8	0.3	26.5
Ta [°C]	13.8 (±5.1)	14.5	3.2	21.7	12.3 (±6.3)	13.0	0.4	22.8
RH [%]	87 (±5.4)	88.5	65.4	94.7	91.1 (±5)	92.1	76.6	98.9
WS [m/s]	1.4 (±0.6)	1.5	0.0	2.9	3.5 (±1.7)	3.2	0.7	8.8
LAI	3.2 (±0.7)	2.9	2.1	4.4	2.5 (±0.4)	2.4	1.4	3.2

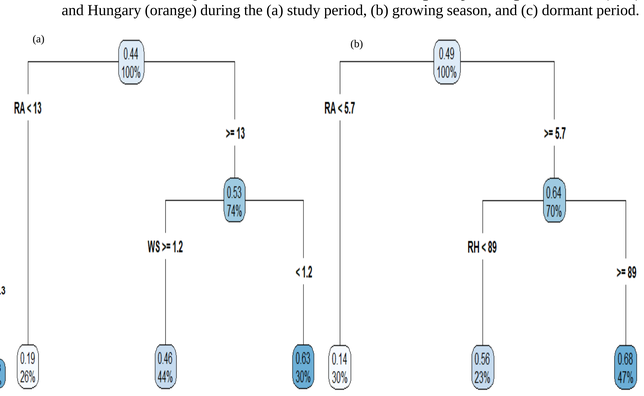
6. Results

Grouping of the event throughfall percentage based on (a) phenological period, (b) calendar season of the year, and (c) rainfall magnitude

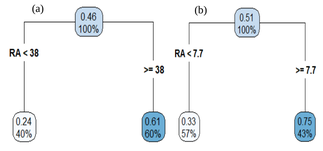
Relative influence of predictor variables on the event throughfall percentage in Slovenia (blue) and Hungary (orange) during the (a) study period, (b) growing season, and (c) dormant period.



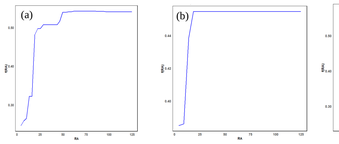
Regression tree (RT) model results for the whole study period in (a) Slovenia and (b) Hungary.



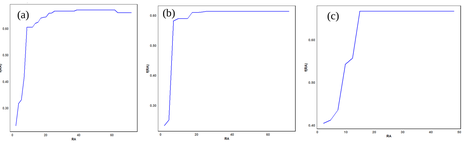
RT model results for the growing period in (a) Slovenia and (b) Hungary.



RT model results for the dormant period in (a) Slovenia and (b) Hungary.



Partial dependence plots (PDPs) showing the relative influence (RI) of rainfall amount (RA) on the event throughfall percentage in Slovenia during the (a) whole study (b) growing and (b) dormant period.



PDPs showing the RI of rainfall amount (RA) on the event throughfall percentage in Hungary during the (a) whole study, (b) growing, and (b) dormant period.

7. Main findings

- The mean event throughfall percentage over the measurement period was 45% in Slovenia and 50% in Hungary
- The difference between the growing and dormant periods was 2.0% in Slovenia and 1.9% in Hungary, with higher throughfall recorded during the dormant period at both sites.
- RA primarily influenced the event throughfall percentage, but secondary factors varied according to site and phenological period.
- The 5% difference in the average event throughfall percentage observed between the two locations underscores the effect of microclimatic conditions, notably, RA and RH, and canopy attributes (LAI) on the interception of rainfall by a pine tree canopy.

QRcode to Abstract

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