Spatio-temporal variability in throughfall at the hillslope scale in a mountain beech stand

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Understanding the role of forests in modifying water inputs via rainfall interception is fundamental for a correct understanding and simulation of catchment scale runoff generation and changes therein as a result of land use or climate change. Despite many studies at the stand scale, still little is known about the role of hillslope topography and the associated tree stand characteristics on throughfall spatio-temporal variability. Therefore, this work aims at better understanding the dominant factors on throughfall variability and on the temporal persistence of throughfall spatial patterns along a transect on a steep hillslope characterized by differences in tree size and density.

The measurements were taken in an experimental hillslope near the outlet of the Lecciona catchment (0.3 km2), Tuscany Apennines, Central Italy. The study hillslope is roughly 110 m long and 60 m wide, has a mean slope of 25°, and is predominantly covered by beech trees and sparse oak trees. A grid of 126 throughfall collectors was installed in July 2020 across three subplots. In November 2021 a line of five automatic rain gauges connected to gutters was installed to increase the collection area on the hillslope. Throughfall from the grid collectors was manually measured approximately monthly. The rain gauges record data at a 5-min resolution.

The 27 manual measurements revealed a large temporal variability in interception (mean: 24%, standard deviation: ±31%), reflecting the seasonal precipitation pattern of Mediterranean areas and tree phenology. The spatial variability in interception was also high and reflected the spatial variability of the stand: interception was higher for the lower plot, characterized by a lower tree density and larger tree sizes than the upper plot (32±28% and 20±32%, respectively). Statistical analysis also showed that the spatial variability for each subplot was higher in the dormant season than in the growing season, suggesting an important role of branch morphology and stemflow.

The temporal stability analysis revealed that the most temporally-stable and representative measurement points were located on the extended transect that, overall, captured the different tree characteristics along the hillslope well.

Future forestry surveys will be conducted to measure tree characteristics (such as diameter height, and Leaf Area Index) to assess their effect on the spatial variability of throughfall. Moreover, the high-resolution data from the five automatic gauges will be used to assess their representativeness compared to the manual grid and to test and validate an interception model at the hillslope scale.

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