Modeling the effects of forest stand characteristics on the water dynamics of mountain forests

Franciele de Bastos and Hubert Hasenauer
Institute of Silviculture, University of Natural Resources and Life Sciences, Vienna, Peter-Jordan-Strasse 82, A-1190 Vienna, Austria

Introduction

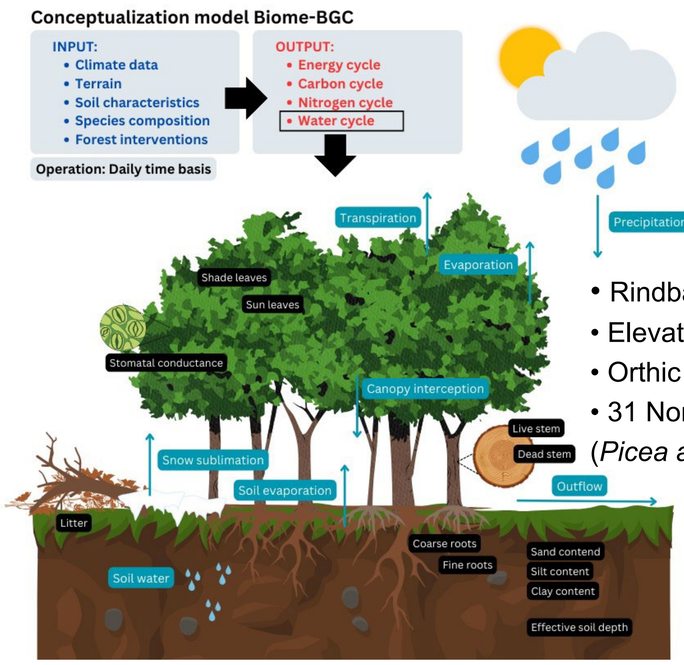
Mountain Forests → Protection function → Runoff → Sediment transport → Natural hazards reduction

Research Goals

Address the protection function of mountain forests by assessing the interactions among the forest structure and the water dynamics.

We are specifically interested in the forest's ability to reduce the outflow during a 10-day rainfall period according to the leaf area index (LAI) of the forested areas.

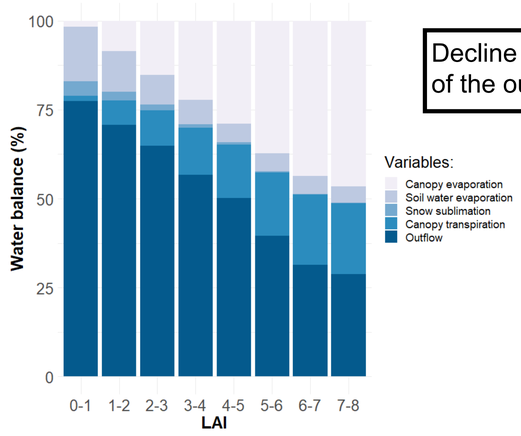
Methods



- Rindbach watershed, Austria
- Elevation: 446 to 1379 m
- Orthic Redzina
- 31 Norway spruce (*Picea abies*) forest stands

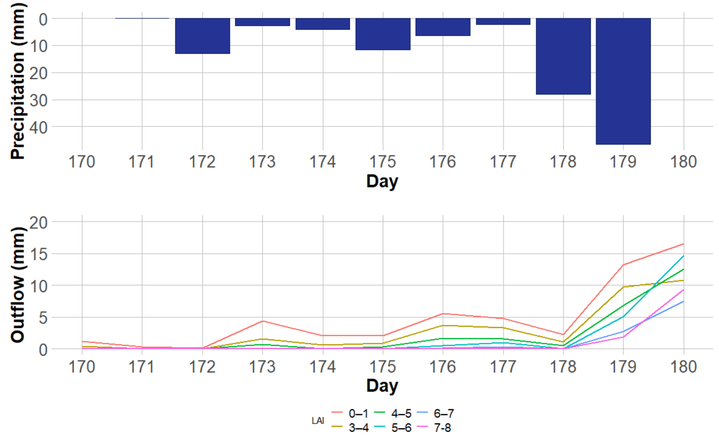
Operation scheme of the species-specific version of the biogeochemical mechanistic ecosystem model Biome-BGC. Black boxes represent the variables considered in the model, while blue boxes represent the input and outputs from the water cycle.

Results and Conclusions



Decline of ~ 49% of the outflow

Relative proportion of the average annual water balance parameters simulated for the forest stands in Rindbach covering the period of 1960 to 2022 (de Bastos and Hasenauer, 2024).



Daily rainfall and outflow during the 10-day rainfall event grouped according to the leaf area index (LAI)

Norway spruce forests with an LAI ≥ 7 m^2/m^{-2} resulted in 4 to 5 times lower outflow compared to forest stands with an LAI < 1 m^2/m^{-2} (e.g. 51.3 versus 11.1 mm, within 10 days).

This emphasizes the importance of forest vegetation coverage in reducing runoff, avoiding flooding, mudslides, and sediment transport, and improving the protection function of mountain forests.

References:
de Bastos, F., & Hasenauer, H. (2024). The Water Dynamics of Norway Spruce Stands Growing in Two Alpine Catchments in Austria. Forests, 15(1). https://doi.org/10.3390/f15010035
Pietsch, S. A., Hasenauer, H., & Thornton, P. E. (2005). BGC-model parameters for tree species growing in central European forests. Forest Ecology and Management, 211(3), 264–295. https://doi.org/10.1016/j.foreco.2005.02.046

Acknowledgments: Waldfonds Republik Österreich
Eine Initiative des Bundesministeriums für Land- und Forstwirtschaft, Regionen und Wasserwirtschaft