Topography-based Modelling of Soil Moisture

Using LiDAR-derived High-Resolution Digital Elevation Models

Objectives & Methods

Recently, terrain-based indices have been increasingly used for soil wetness estimation, but a comprehensive comparison is missing for assessments in floodplain ecosystems and on small scale. This study therefore assessed the suitability of three terrain-based indices for small-scale soil moisture modelling in the Salzach River floodplains in Austria. The following research questions were addressed:

To what extent are the observed indices suitable for small-scale high-resolution soil moisture modelling in floodplain ecosystems and what differences can be observed between them?

What is the spatiotemporal variability of soil moisture as depicted by the indices in the Salzach River floodplains?

Indices

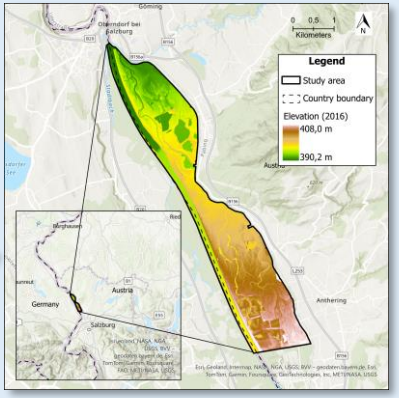
Index	Definition	Reference
Depth-to-Water (DTW)	Simulated vertical difference between a landscape cell and the nearest surface water cell along the least-cost slope path	Murphy et al. (2007)
Height-Above-the-Nearest-Drainage (HAND)	Elevation difference between a cell and the nearest stream along the local drainage direction	Rennó et al. (2008)
SAGA Wetness Index (SWI)	The likelihood of a site being saturated to the surface based on its contributing area and local slope characteristics	Boehner et al. (2002)

Data sources

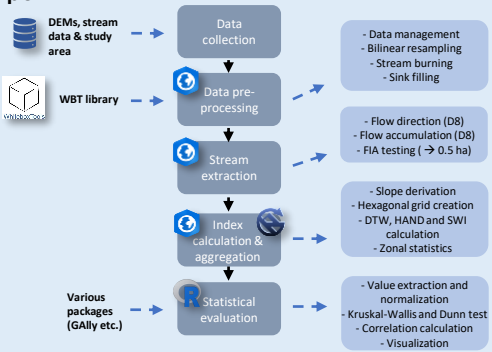
High-resoultion (0,5m) LiDAR-derived Digital Elevation Models were obtained from the Federal State of Salzburg © SAGIS for the years 2016 and 2022

Vector stream data for stream burning was obtained from the Austrian Federal Office for Metrology and Surveying (BEV)

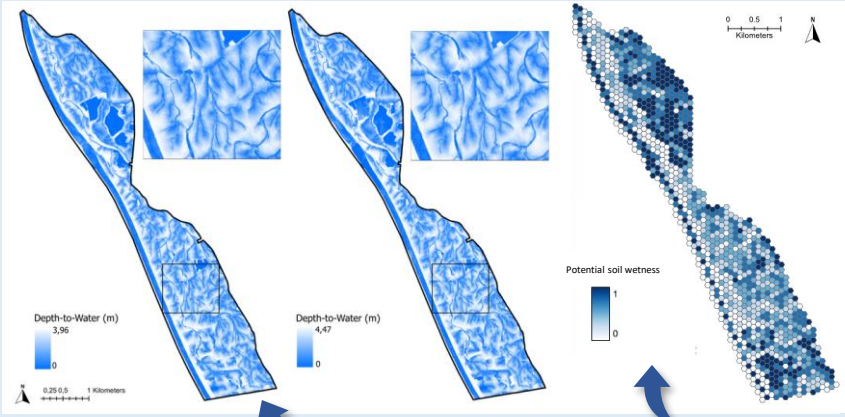
Study area



Cooking recipe



Findings & Conclusion



Index maps for 2016 (left) and 2022 (right)

Normalized and aggregated soil wetness map

- **While statistically significant differences exist between the indices, there are no statistically significant changes and consistently high correlations over the six-year period, indicating stable patterns and high internal consistency and robustness of the index calculations.**
- **While the values between DTW and HAND show a strong positive correlation, the SWI differs the most, displaying a moderate negative correlation with the others.**
- **For the selected parameters and the FIA, the SWI calculates the test area as overall drier compared to the other indices, which estimate higher soil wetness.**
- **The northeastern and southern parts of the test area are the wettest locations, while areas to the right of the Salzach River are classified as drier, likely due to bank reinforcement or natural elevations.**

The observed topographic indices are suitable for small-scale high-resolution soil moisture mapping in floodplain ecosystems. However, since the SWI differs most from the other indices and literature indicates its unreliability for high-resolution DEMs, the DTW and HAND indices are more suitable for such mapping in the Salzach River floodplains. In the future, incorporating in-situ measurements and observing the influence of the flow initiation threshold on DTW and HAND could enhance the assessment's accuracy and the applicability of the indices.

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Use the QR-Code to access the paper and the project's GitLab repository!

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