Theme 2 |Advances in soil mapping and monitoring

Integration of ground and remote sensing methods in soil water management in forest-steppe agriculture

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For the soils of the forest-steppe regions of Europe, unlike any other part of the world, there is an exceptionally high interannual variability in hydrothermal conditions. This is evident, for instance, in the pronounced lack of year-to-year stability in the timing of snowmelt or the annual precipitation totals.

Fig 1. European forest-steppe biome

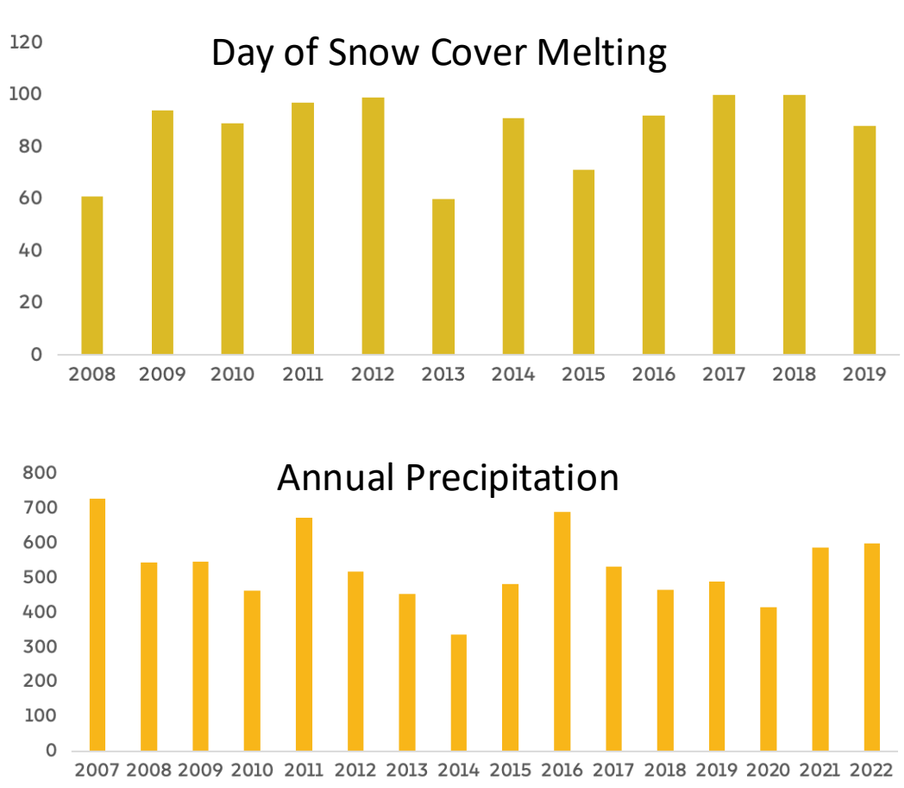


Fig 2. Hhigh interannual variability of weather

This high variability greatly complicates the task for agricultural producers to select optimal spatial and temporal strategies for crop cultivation technologies.

The challenging climatic conditions of the Oka-Don Lowland forest-steppe are further complicated by its distinctive flat terrain, characterized by numerous closed depressions. These depressions redirect surface water flow into the ground, leading to soil waterlogging even in the semi-arid climate conditions.

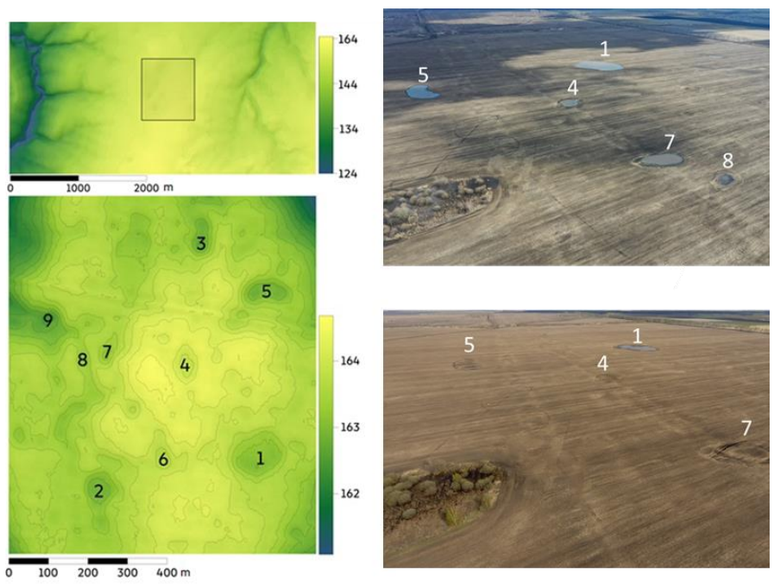
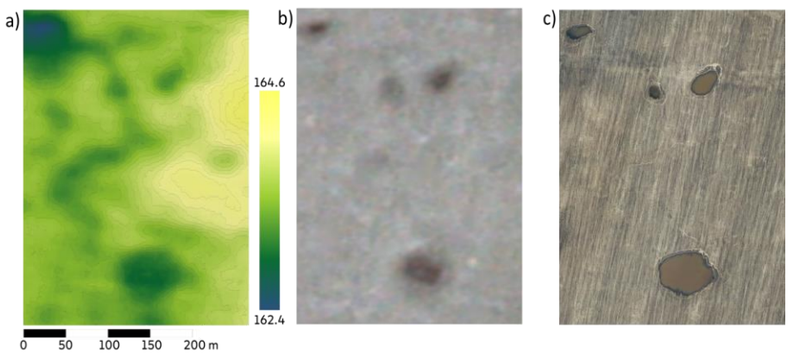


Fig 3. Key experimental site

For accurate spatiotemporal forecasting of soil moisture reserves, it is essential to have information about the volume of water entering the soil through closed depressions. This was demonstrated at a key site containing nine closed depressions.



UAV DEM CubeSat date UAV Ortho mosaic

Fig 4. Data use

To calculate the water volume and filtration rate from the closed depressions, we used a combination of UAV data, including a digital elevation model, orthophotos, and regular imagery from Planet Labs' CubeSat constellation. By employing an object-oriented classification method and high-resolution orthophotos, we were able to classify the water surface area for all available CubeSat scenes on cloud-free days.

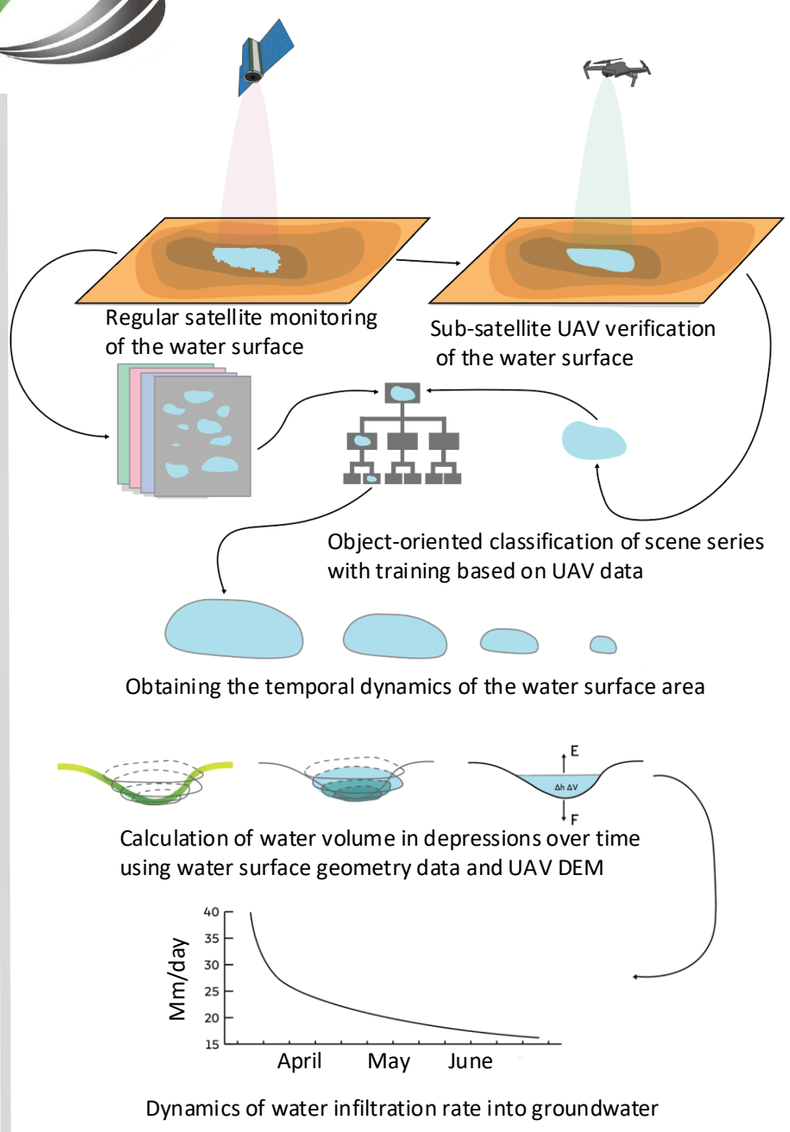


Fig 5. Methodology for calculating infiltration volumes through closed depressions

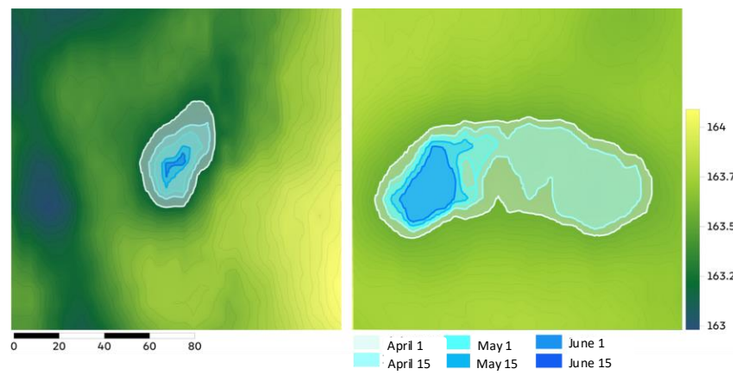


Fig 6. Water surface dynamics in closed depressions

We then use these materials as additional upper boundary conditions for hydrological modeling of the water regime

$$\frac{\partial \theta}{\partial t} = \frac{\partial}{\partial z}\left[K(\theta)\left(\frac{\partial \psi}{\partial z} + 1\right)\right]$$

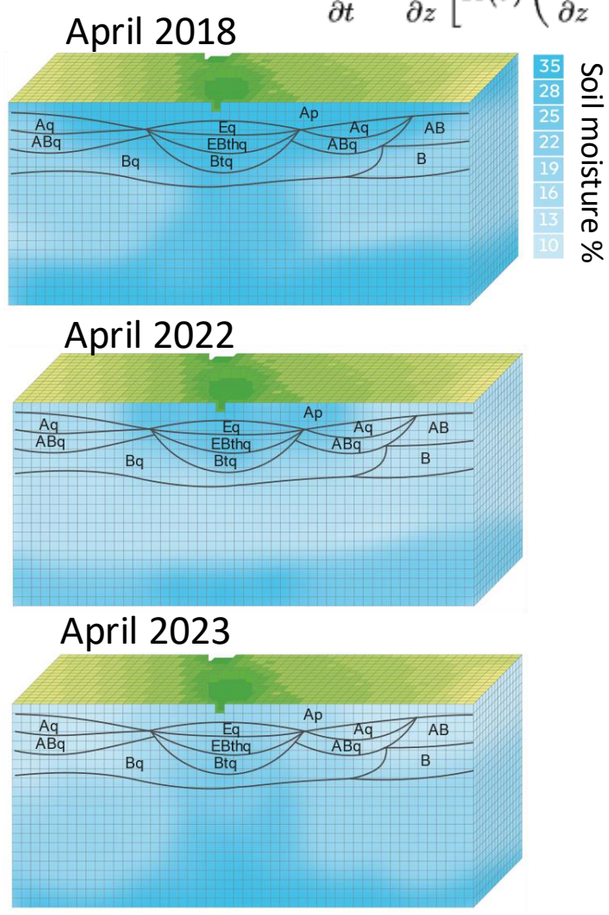


Fig 7. Modeling of soil water regime