Innovative Hydrological Modeling for Groundwater Level Projections in the Carpathian Basin

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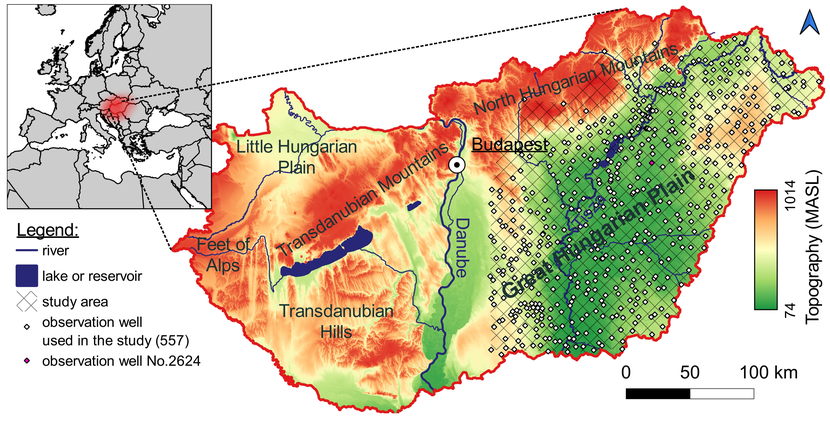
Background & Aims

- In Central-Eastern Europe, the Carpathian Basin plays an important role in the climate of the region, however, assessments at different scales indicate different exposures to climate change
- Contradictions between global and local scale forecasts must be resolved
- The analysis requires the ability to calculate large spatial extents over long periods quickly, therefore, a model has been developed that describes the physical processes simply, but well
- The change in groundwater levels is a good indicator of the effects of climate change, so the analysis is carried out from the perspective of modelling groundwater levels (GWLs)
- The aim is to assess the "no action" water management scenario for GWLs in 2050 and 2100 for the study area

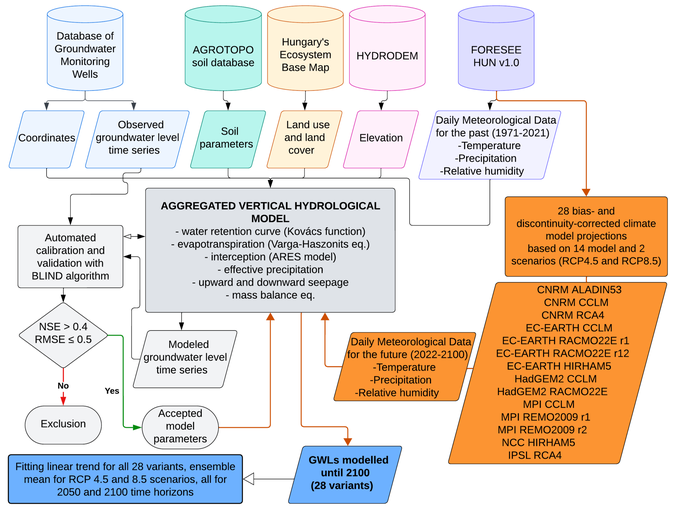
Study area

- The Great Hungarian Plain is situated in the central part of the Carpathian Basin
- Area: 40,473 km^2, here described with 557 GWL monitoring wells
- Most productive agricultural region of Hungary
- Although it is well known that this is a drought-prone region, the drought of 2022 made this obvious to the public, decision-makers, and stakeholders



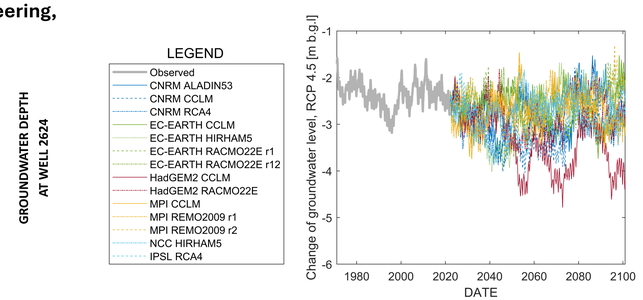
Methodology

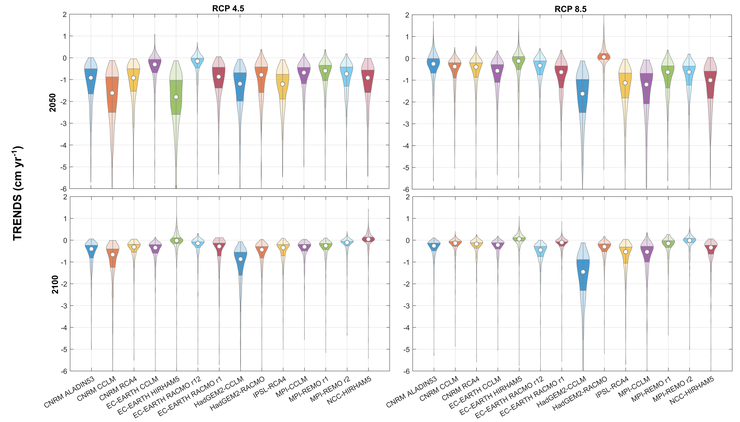
- Development of an aggregated vertical hydrological model; a modeling framework was established in which the datasets were linked on a 50 × 50 m resolution grid
- Model calibration and validation for the GWL monitoring stations
- Filtering of inadequately performing well models
- Estimation of climate change effects on GWLs

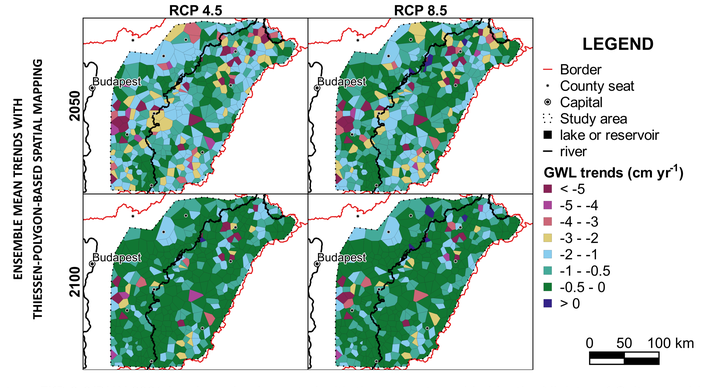


Results & Conclusions

- The NSE values of the validation of the accepted well models are 0.71 ± 0.09, and the RMSE is 0.31 m ± 0.07 m
- According to the calibration, the horizontal flow can be neglected, the GWL is more dependent on the vertical flux, the main driving force being meteorological factors
- The average value of soil moisture affecting evapotranspiration over 14-day time steps can be well described both at the soil surface and at the root zone height, based on the equilibrium retention curve defined by the GWL.
- In the vast majority of monitoring stations, the RCP 4.5 and 8.5 scenarios also show decreasing trends; however, the trend in GWLs shows a larger decline for the 2050 time horizon than for the 2100 time horizon
- Mean of the trends is –1.74 cm yr^{-1} for 2050-RCP4.5, which, for the area under study and assuming an average porosity of n = 0.4 indicates a water deficit of 281.7 million m^3 yr^{-1}







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ABSTRACT

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