A model-based case study for wetland restoration effects on the hydrological conditions at a Hungarian lowland catchment

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1. Introduction: Background, motivation and objective

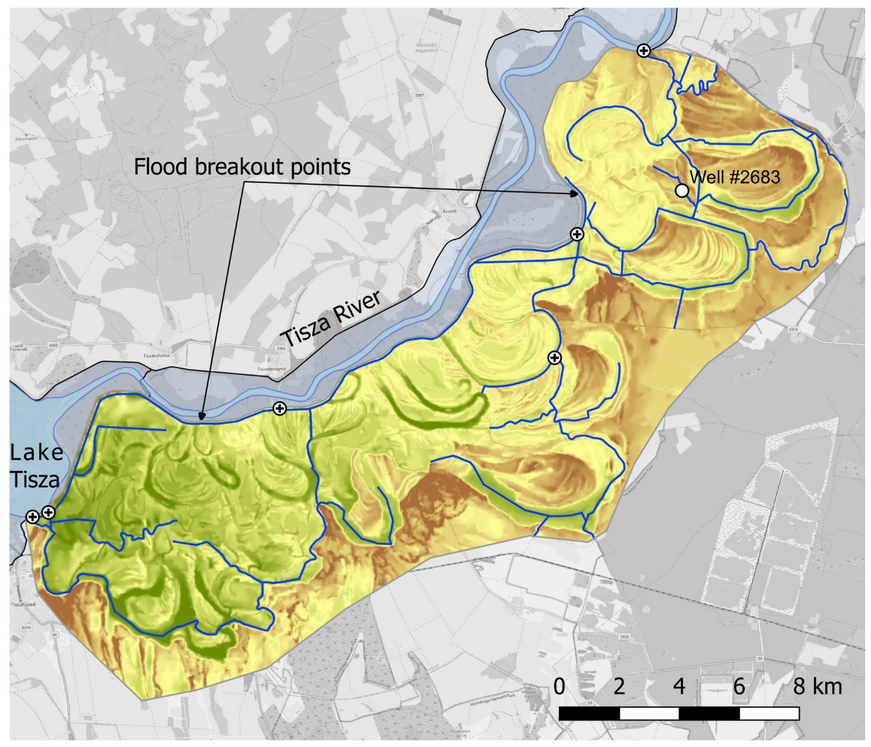
- The alluvial character of the Great Hungarian Plain has long determined its land use
- Major wetland and river regulations between the 18th and 20th centuries led to a trajectory of constrains
- Agricultural production is influenced by floods, excess waters and droughts
- Contemporal Hungarian landscape management is facing a major crisis, worsened by climate change
- Combination of large scale water retention and adaptive land use seems to be the most feasible alternative scenario
- We examined a Nature Based Solutions approach with hydrological simulations at a deep floodplain along the Tisza River

2. Materials and methods

- Time period: 2000-2010 (incl. flood, droughts and excess water)
- Area: 243 km^2, cell size: 50 m, ~20 m deep unconfined aquifer
- Looped channel network + pumps
- Fully coupled hydrological model: MIKE SHE + MIKE RIVER

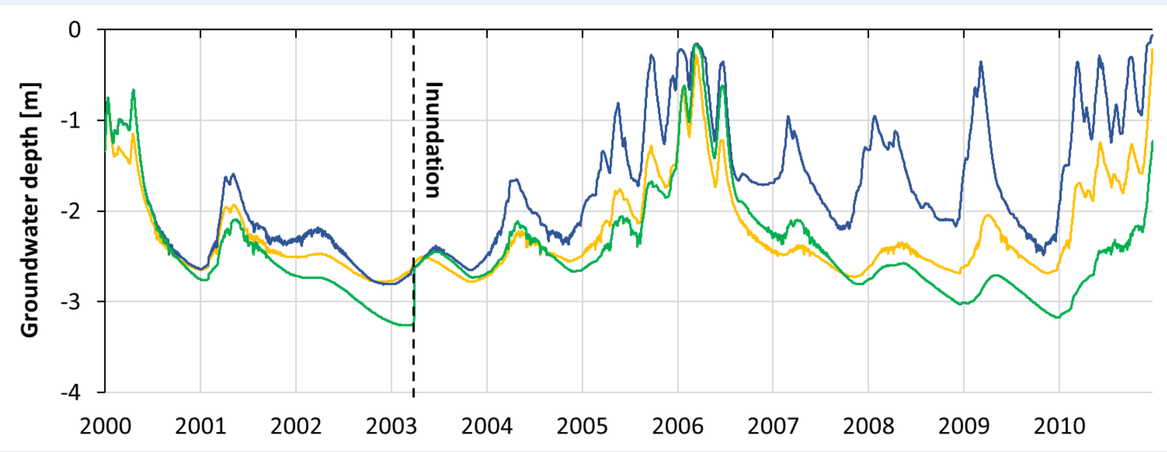
Six scenarios

- 3 water management * 2 land use variations
- Present land use and water management scenario (*CLC_REF*) was used for model calibraion: https://doi.org/10.3390/su151511700
- Excess water retention (*EWR*) = no drainage and no pumping of water surplus
- Riverine inundation (*FLOOD*) = *EWR* + a single release of ~33 million m^3 water from the flooding Tisza River into the area in 2003
- Alternative land use (*ALT*) follows the prevailing Hungarian landscape planning logic and is based on the *CLC_FLOOD* water coverage duration results
- *ALT*: Half of the croplands were converted into wetlands (15% increase) or soft/hardwood forests (20% increase)



3. Results and conclusions

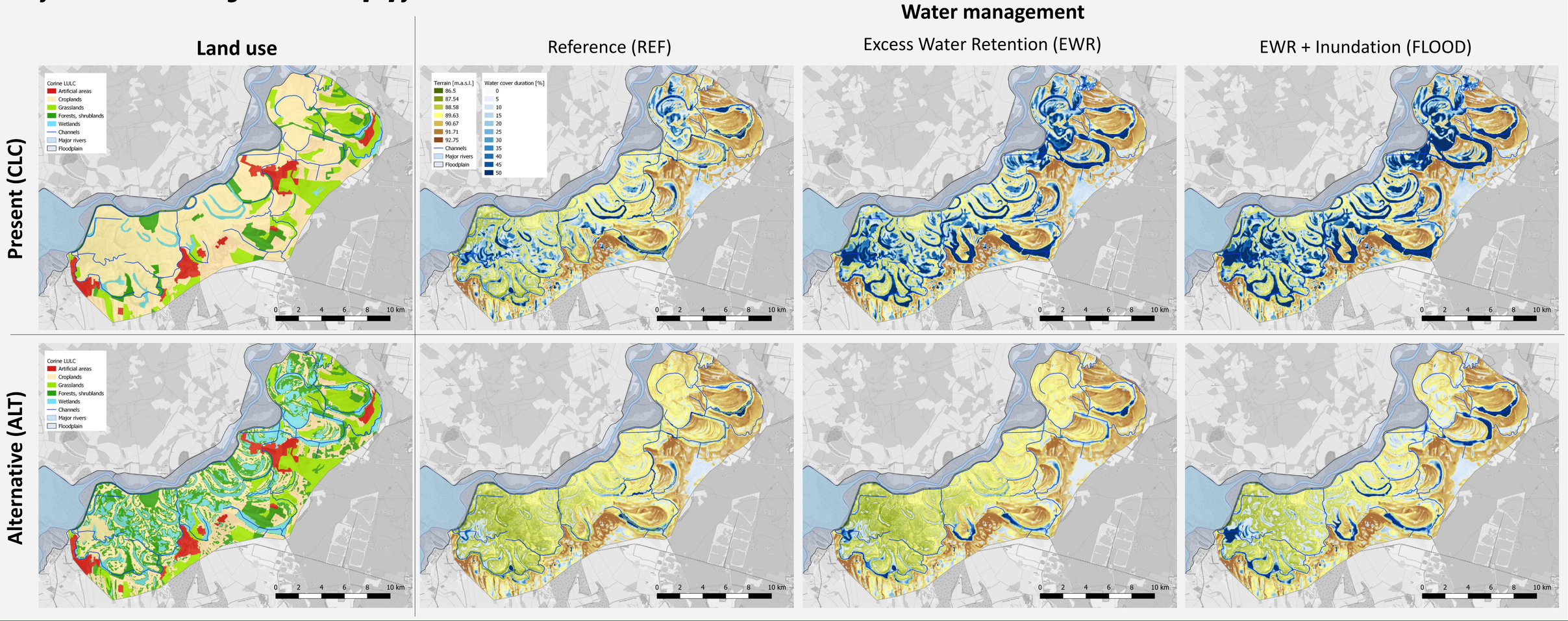
- For present conditions, the drainage network effectively reduces water coverage duration (*CLC_EWR* vs *CLC_REF*), but cannot completely eliminate the excess water (*CLC_REF*)
- The extent and duration of water coverage can be controlled with stepwise water retention (Step 1: *EWR;* Step 2: *FLOOD*)
- Only water retention (*CLC_EWR* or *CLC_FLOOD*) would inhibit agricultural crop production in the low parts by water surplus
- Only aforestation (*ALT_REF*) without water retention would dry out the deep floodplain, also causing agricultural drought damage
- Finding the optimal proportion of afforestation and water retention could be facilitated with iterative modelling of various water management-land use scenarios in the fashion introduced here
- As part of our research, these hydrological results are being assessed with crop yield modelling and tree growth estimates to compare the provisioning ecosystem service performance of different scenarios



Ground-water depth at well #2683

Land use	CLC	CLC	ALT
Water management	REF	FLOOD	FLOOD

Surface water coverage durations [%] for the six scenarios



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