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Vegetation pattern in a natural wetland floodplain is predicted better using river-floodplain inundation extents than standard hydrological variables

Tomasz Berezowski¹ and Martin Wassen²

¹Gdansk University of Technology, Faculty of Electronics, Telecommunication and Informatics, Gdańsk, Poland
(tomberez@eti.pg.edu.pl)

²Utrecht University, Copernicus Institute of Sustainable Development, Utrecht, The Netherlands (m.j.wassen@uu.nl)

The extent of water from river and floodplain (groundwater, rainfall, and snowmelt) in an inundation is related to ecological processes such as vegetation development. A prominent example of this phenomenon is the Biebrza floodplain, which is a 220km² natural, temperate zone, fen wetland, with extensive river flooding. The lateral vegetation zonation in this area was related to the flooding frequency and water depth; however, more recent research showed that the extent of the river water zone within the inundation is a better predictor of the vegetation pattern. Despite its significance, the long-term sensitivity of vegetation zonation with respect to changing extent of water zones and climate was not investigated. In this study, we used the Hydraulic Mixing-Cell (HMC) method to simulate the extent of water from rainfall, snowmelt, groundwater discharge, and river flooding. The HMC is implemented in the HydroGeoSphere model, which was set up for the entire 7000 km² Biebrza catchment. The model was forced using the Twentieth Century Reanalysis data for the period 1881-2015 and using an ensemble of ten EURO-CORDEX simulations for RCP 2.6, 4.5, and 8.5 for the 2006-2099 period. The model output was used to establish vegetation models using three vegetation maps from 1960, 1980, and 2000 and the random forests algorithm. The results show that the vegetation pattern in Biebrza wetlands was predicted with higher accuracy with the water sources zonation predictors from the HMC, whereas the vegetation models using surface water depth and duration or soil moisture, groundwater discharge, and groundwater levels predictors had lower accuracy. Finally, the vegetation was predicted for the entire two centuries period to show that the vegetation change in Biebrza wetlands may occur due to change in water sources' zonation, which is driven by climate.