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High resolution mapping of evapotranspiration in wetlands by a joint use of hydrological models and remote sensing data

Joanna Suliga (1), Solomon Seyoum (1), Tadesse Abitew (2), José Miguel Barros (3), Boud Verbeiren (1), Jarosław Chormański (4), Ann van Griensven (1), and Hans van der Kwast (2)

(1) Vrije Universiteit Brussel, Hydrology and Hydraulic Engineering, Brussels, Belgium, (2) IHE-Delft, Institute of r Water Education, Delft, The Netherlands, (3) Royal Meteorological Institute, Brussels, Belgium, (4) Warsaw University of Life Sciences, Hydraulic Engineering, Warsaw, Poland

Wetlands though provide numerous vital ecosystem services, their quality and health are deteriorating globally. Anthropogenic pressure especially in northern hemisphere peatlands is disturbing the natural balance and causes irreversible changes in peat composition leading to the degradation of the whole ecosystem. Monitoring of highly vulnerable wetlands is hence needed and strongly encouraged by the EU birds and habitats directives, Ramsar guidelines and UN sustainable development goal number 6.6.1. Remote sensing techniques, with its limitations, produce an abundance of freely available data that can support the development of new monitoring techniques for wetlands by providing continuous observation of spatial and temporal changes in vegetation cover. Evapotranspiration (ET) is a dominant component of the water balance in wetlands and a potential indicator for detecting anomalies in vegetation cover. The water balance approach utilized in traditional distributed hydrological models provides continuous ET estimations at reasonable spatial or temporal resolution, however, assumptions and parameterizations employed in such models often lead to aggregated representation of the spatial and temporal variability of the vegetation dynamics. On the other hand, energy balance modelling approaches based on spaceborne imagery can provide more realistic estimations though at low temporal resolution and with image quality often affected by cloud cover. To overcome the limitations of both approaches, both methods were combined in the process of data merging and assimilation.
In this study, we present the coupled use of remote sensing, hydrological and energy balance models to provide high spatial and temporal evapotranspiration simulation for the Biebrza wetland located in north eastern part of Poland within the borders of Biebrza National Park, that is enlisted on the Ramsar list of wetlands of international importance. Within the research the wetland area was subdivided into various vegetation classes to better represent the natural biodiversity of Biebrza wetlands. The paper presents and explores results for wetlands monitoring based on the comparison of ET estimations derived from four sources: 1. classical hydrological model - WetSpa, 2. modified hydrological model WetSpa, that uses LAI maps derived from ProbaV satellite as an input, 3. energy balance model - RMI, 4. Assimilated energy balance models with Wetspa using Ensemble Kalman Filter technique of data assimilation. The results are evaluated using ET data derived from Eddy Covariance Tower that is located within the study area. The results indicate that better ET estimates can be obtained when remote sensing data are incorporated in the hydrological model (results 3 and 4).