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The use of high temporal resolution Sentinel-1A/B SAR C-band imagery in hydrological connectivity of floodplain waterbodies

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Contemporary hydrological data collection requires deployment of technical infrastructure providing detailed information on water level changes, flooding extents, water stagnation time etc. These kinds of data will serve further as an input for hydrodynamic modeling and advanced eco-hydrological analyses. Recently, high resolution remote sensing techniques, used for water extent mapping, have gained an interest as an alternative to direct hydrometry. Especially SAR (Synthetic Aperture Radar) technology, demonstrating the capabilities to image the Earth's surface through the clouds and being sensible to surface roughness and dielectric properties of objects, has been frequently used for water extent mapping and monitoring. From hydrological point of view, the water residence time and its lateral extent is a crucial parameter of hydrological connectivity between floodplain waterbodies and river channels. Spatial and temporal changes in the connectivity influences water exchange dynamics and water quality parameters, what in turn modifies the habitat conditions for aquatic organisms and their diversity.

This study assesses advantages of using high temporal resolution SAR imagery from the Sentinel-1A/B satellite to monitor hydrological connectivity among waterbodies over 2-year survey (2015 - 2016) in the middle Biebrza River floodplain (Eastern Poland). Sentinel-1 satellite SAR operates in C-band (5cm wavelength) at VV/VH dual-polarization. Results reveal that generally at C-band open water surface represents very smooth surface characterized by specular reflection (backscattered signal is very weak) and in consequence by very dark, even black pixels on the image. Nevertheless the polarimetric configuration of Sentinel-1 is not optimal for water surface mapping based on amplitude (backscattering coefficient) only. Vertically polarized scattering component (VV) is strongly sensible to wind-induced water surface roughness and dramatically decreases the contrast between imaged land and water surface. In order to overcome this disadvantage the additional use of VH (cross-polarized) component, less sensitive to surface roughness, is sometimes proposed. As the advantage of Sentinel-1 A/B sensors it can be considered frequent revisiting time: 12 days for one satellite (A or B) or 6 days when using two satellites (A and B), permitting to avoid windy weather and misclassification of open water. Another advantage that has been used in presented paper is polarimetric decomposition of complex backscattered signal permitting to extract partially flooded vegetation. The adopted approach increased the accuracy of estimated period of hydrological connectivity of floodplain lakes with the main river channel. The trends in limno- and hydrophases derived from the hydrological regime of floods and droughts have been mapped and analyzed vs. abiotic changes (in-situ measurements) of aquatic habitats. We conclude that Sentinel-1 sensors show the great potential to monitor changes in the ecological status of waterbodies that undergo temporal changes of a degree of hydrological connectivity.