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An object-based approach for flood mapping in vegetated areas based on Sentinel-1 and Sentinel-2 imagery

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Flooding is one of the most severe natural hazards with respect to both economic and human losses. Therefore, it is of prime importance to provide timely and accurate information about these events, both for emergency management and flood risk assessment. Synthetic Aperture Radar (SAR) sensors are particularly suited to provide flood observations given their all weather, day/night sensing capability and the distinctive backscatter characteristics of smooth water surfaces. Over the past years, a considerable number of SAR-based flood mapping approaches has been developed. However, most of these focus on the retrieval of open water surfaces only. Flood mapping in vegetated and urban areas remains challenging due to the more complex backscatter mechanisms occurring in these areas. Yet, accurate delineation of floods in these areas is all the more important given their economical and societal relevance.

This study focuses on the retrieval of flood extent information in complex, vegetated landscapes by means of freely available data. The considered imagery includes a pair of Sentinel-1 images, one acquired before and one acquired during the flood, as well as a cloud free Sentinel-2 image or mosaic acquired under non-flooded but representative vegetative conditions. An object-based change detection approach is used. Grouping pixels into segments prior to further analysis allows the integration of contextual and morphological information as well as the combination of different information sources. Segmentation is achieved by means of the quickshift algorithm, considering both polarization bands of the SAR image pair. Next, object properties with respect to SAR backscatter, surface reflectance and elevation are calculated and objects are grouped using spectral clustering. By including optical imagery, vegetation cover is considered and the flooded vegetation class can be better discriminated. The resulting clusters are then assessed, analysed and classified. Post-processing is done by means of contextual and topographical information. The use of fuzzy logic allows to assign an uncertainty measure to the obtained classification. For full scene processing, a thresholding-based preliminary flood extent is first derived in order to speed up the classification process and correct for class imbalance. The approach is presented based on multiple study cases, amongst which the 2019 floods along the Sava River, Croatia.