



Sentinel-2 MSI for mapping Sahelian water bodies using a U-Net network

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Inland surface water, especially lakes and small water bodies, are essential resources and have impacts on biodiversity, greenhouse gases and health. This is particularly true in the semi-arid Sahelian region, where these resources remain largely unassessed, and little is known about their number, size and quality. Remote sensing monitoring methods remain a promising tool to address these issues at the large scale, especially in areas where field data are scarce. Thanks to technological advances, current remote sensing systems provide data for regular monitoring over time and offer a high spatial resolution, up to 10 metres.

Several water detection methods have been developed, many of them using spectral information to differentiate water surfaces from soil, through thresholding on water indices (MNDWI for example), or classifications by clustering. These methods are sensitive to optical reflectance variability and are not straight forwardly applicable to regions, such as the Sahel, where the lakes and their environment are very diverse. Particularly, the presence of aquatic vegetation is an important challenge and source of error for many of the existing algorithms and available databases.

Deep learning, a subset of machine learning methods for training deep neural networks, has emerged as the state-of-the-art approach for a large number of remote sensing tasks. In this study, we apply a deep learning model based on the U-Net architecture to detect water bodies in the Sahel using Sentinel-2 MSI data, and 86 manually defined lake polygons as training data. This framework was originally developed for tree mapping (Brandt et al., 2020, <https://doi.org/10.1038/s41586-020-2824-5>).

Our preliminary analysis indicate that our models achieve a good accuracy (98 %). The problems of aquatic vegetation do not appear anymore, and each lake is thus well delimited irrespective of water type and characteristics. Using the water delineations obtained, we then classify different optical water types and thereby highlight different type of waterbodies, that appear to be mostly turbid and eutrophic waters, allowing to better understand the eco-hydrological processes in this region.

This method demonstrates the effectiveness of deep learning in detecting water surfaces in the

study region. Deriving water masks that account for all kind of waterbodies offer a great opportunity to further characterize different water types. This method is easily reproducible due to the availability of the satellite data/algorithm and can be further applied to detect dams and other human-made features in relation to lake environments.