Earth Observation and Machine Learning for estimating the irrigation potential of municipalities in Vojvodina, Serbia

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ABSTRACT:

Irrigation agriculture has an indispensable role in global food production. In order to fulfill the rising demand for food and water perceived in reports issued by the United Nations and other organizations in the last couple of years, more attention needs to be given to cropland and water management. Knowing the spatial distribution of irrigated areas, amount of irrigation surface, size and number of canals and other water bodies are essential for planning irrigation development. To extract this knowledge for the main agricultural region in Serbia we utilized earth observation (EO) data, collected ground truth data needed to train machine learning (ML) and quantified irrigation potential from a network of canals.

Our research was split into two parts: 1) detection of irrigated fields and 2) estimating the utilization of resources based on detected irrigated areas and the density of canals that could potentially be used to irrigate arable land. Firstly, we used EO and an ML-based approach to map irrigation fields in Vojvodina Province, Serbia, in order to assess the current situation at the municipality level. As the most irrigated crops in Vojvodina are maize, soybean, and sugar beet, the ground truth data, considering if the parcel was irrigated or not, was collected. Sentinel-2 satellite imagery was acquired from the official Sentinel hub. Both ground truth data and satellite imagery covered four years (2017, 2020-2022) characterized by different weather conditions. This data was then used for training the Random Forest algorithms, separately for each crop type, and then the models were run for the whole territory of Vojvodina. The final products are 10 m resolution binary maps of irrigated maize, soya, and sugar beet. With the overall accuracy (2017: 0.86; 2020: 0.73; 2021: 0.72; 2022: 0.81) results showed that this method could be successfully used for detecting different irrigation fields: center pivot, linear systems as well as typhoons. Second part of the research focused on the utilization of the irrigation potential. To be precise, an indication of how much irrigation is practiced in a particular municipality, with respect to the distribution of canal network and current irrigation status, can be given. The final output is the ratio between the density of the canal network and the total irrigated area per municipality. Results showed that Bačka (southwestern part of Vojvodina) has the highest ratio between canal network density and irrigated agriculture where 14 municipalities have more than 100 km of canal network from which 9 municipalities irrigate more than 350 ha of these three crops. However, the other two regions, especially Banat with 35 municipalities with more than 100 km of canals, have a significant potential for irrigation development.

Generated maps indicate the potential for irrigation of agricultural land considering only the current situation with irrigation fields and an available canal network. Obtained results can serve as a valuable initial step for decision-makers in irrigation water management planning.