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Method for Using Meteorological Data Fusion to Model Crop Water Productivity

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Introduction

Crop water productivity modelling is becoming a more and more common tool for quick decision making in agriculture to improve water resource management. The purpose of this work was to model, predict and simulate crop water productivity (CWP) for wheat and maize grain yields. A variety of climate datasets were gathered, including maximum temperature minimum temperature, relative humidity, solar radiation, sunshine hours, wind speed and day length are all measured in degrees Celsius. Random forest, support vector regression, bagged trees, boosted trees and mother 5/2 gaussian process were the five ML techniques used. In addition, the CWP results for maize demonstrated that the BT model, comprised of SR, WS, H and T min data, outperformed other models with a correlation coefficient of 0.82. The findings revealed a number of high-performance ML-based alternative CWP estimation techniques that can be used in the absence of sufficient climate data to aid in water resource planners' and developers' decision-making. Increasing food production to meet the needs of a growing human population is one of society's major challenges. This is made harder by the limited and decreasing resources available for crop production. One of the most pressing environmental issues of the 21st century is sustainable water resource management because it is the foundation of food security. As a result of climate change, irrigation water use is expected to rise in the coming years.

Description

This could be a major source of conflict not only because of environmental concerns but also because of conflicts of interest between other sectors that use water. Therefore, optimal grain yield, water-use efficiency (WUE) and crop water productivity (CWP) are essential for sustainable wheat and maize production. The adoption of CWP as one of the Sustainable Development Goals (SDGs) helps ensure sustainable food production and performance-based evaluation of agricultural systems. Using crop yield and evapotranspiration (ET) data, the relationship between productivity and water consumed is frequently referred to as "water productivity" as an agronomic characteristic. The linear relationship between crop yield and water consumed has been extensively studied. To satisfy future food interest with restricted water supplies, farming should build the WP of harvests. However, there have been a number of criticisms from management regarding the goal of maximizing WP to address water shortages; for instance, more effective irrigation may even result in a rise in the amount of water used locally. Examined the issue of water productivity and the ways in which a unit of water use can produce more food, resulting in increased economic income and a reduction in ecosystem pressures from the environment. The authors make the observation that crop water productivity is already regarded as being high in many regions and that increases in yield do not always translate into increases in water productivity [1,2].

Their article emphasizes the significance of on-farm water recycling, which has the potential to cut down on water consumption. They add that improving water use requires not only the development of strategies that take into account intricate biophysical and socioeconomic processes but also the introduction of financial incentives and advancements in technology. In addition, they predict that plant breeding's significant progress in reducing water consumption will not be scaled up anytime soon. In areas where poverty is relatively common and water productivity is low, significant results in water productivity can be achieved; where there is a lot of competition for water and little water; in places where small-scale development of water resources can make a big difference (smaller amounts of water use lead to big improvements) also in instances of corruption of water-impacted environments [3].

Crop yield, on the other hand, is influenced by agronomic or other soil factors like soil fertility, disease control, agro technique and agricultural and cropping practices. Meanwhile, evapotranspiration is influenced by temporal and spatial patterns of precipitation, soil moisture, irrigation and drainage systems. As a result, on-farm practices are crucial to CWP improvement. In addition, meeting productivity goals, monitoring water use efficiency and comprehending the connection between water and food require knowledge of water resources. Therefore, WP estimation and mapping at the regional or even river basin level is necessary for determining the effectiveness of agricultural management strategies and locating areas with both good and bad agricultural management practices. The management of multi-factorial phenomena in the determination of prediction results has been significantly facilitated by machine learning-based prediction models. The majority of conventional crop modeling regression algorithms are unable to handle data with multiple predictor combinations because they are insensitive to the impact of outliers. Accordingly, procedures with slighter displaying suspicions are expected, as well as computerized methods for choosing instructive factors. A better estimation of the CWP at a regional level, taking into consideration the use of mathematical programming models, such as machine learning techniques, with even limited available weather data, is essential for improving decision support given the importance that governments place on increasing water productivity in agriculture. In addition, a new method for simulating CWP is remote sensing, which boasts a relatively high spatial resolution in addition to its extensive spatial coverage. Data processing algorithms, as a result, are able to quickly provide significant information and make it easier to perform additional monitoring tasks [4,5].

Conclusion

Predicting and simulating the crop water productivity (CWP) for grain yields of wheat and maize at the regional scale in support of designers, water managers, development planners and farmers was the primary objective of this project. Wheat and maize were chosen because they cover the most of the arable land in Hungary and at the study site. In addition, CWP estimation for wheat and maize in the research area is only briefly described in the literature, particularly in terms of its use of machine learning algorithms. Using some of the climatic data variables modelling CWP in a specific location, calculating the results of the performance of the machine learning model and selecting the best machine learning model for estimating CWP The performance of the machine learning model and observational data are compared when projecting CWP.

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