Hungarian University of Agriculture and Life Science

Szent István Campus

Agricultural Water Management Engineering

Modeling and Analysis of Soil Erosion in Hungary

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Summary

Soil erosion by water remains to be a major concern on a global scale, and is associated with a range of environmental, ecological, and economic problems. This is particularly worrisome when it occurs on land used for agriculture, as it can seriously impact productivity. While soil erosion is a natural part of landscape formation, human activities have greatly accelerated the rate at which it occurs. Factors such as deforestation, overgrazing, forest fires, construction activities, and unsustainable farming practices all contribute to this acceleration.

Soil erosion is not simply a farming problem, but is a significant issue at both the local and global levels. At a global level, soil erosion has been identified as one of the most severe forms of soil degradation. For example, according to the Global Soil Partnership led by the UN Food and Agriculture Organization (FAO) in 2017, around 75 billion tonnes of soil are eroded annually from arable lands worldwide, resulting in an estimated financial loss of US $400 billion per year. The average rate of soil erosion is estimated at 2.8 Mg/ha/y (Borrelli et al. 2017).

The research focuses on the regression analysis of soil erosion rates in the Hungary, using random forest model in R Studio. This study utilizes data on soil erosion obtained from the latest soil erosion risk maps of Hungary (Waltner et al. 2020). The data was collected based on the combined results of the PESERA and USLE models.

The overall objective of this MS thesis is to identify the outlier values (extreme values) that are far away from the central mass of observations, which are considered extreme and not typical under Hungarian conditions. To achieve this, a random forest model has been developed to effectively eliminate these outliers from the observations at a reasonable value and an appropriate threshold. It must be noted that this work will complement recent soil loss assessment of Hungary, conducted and published by (Waltner et al. 2018).

This research has the following specific objectives:

• Identification of the optimum threshold value of soil erosion rates at national scale.

• Identification of the critical threshold value over lowland areas.

• Identification of the critical threshold value over mountain areas.

• Recommendations for land users and decision makers on erosion control measures, especially with regard to prevent erosion impacts.

Model results showed that the country was characterized by an overall optimum threshold value of 82 t/ha/y, 84 % of the optimum threshold values ranged from 80 t/ha/y to 84 t/ha/y, while the remaining 16% show predicted values outside the range of 82 ±2 t/ha/y. The maximum optimum threshold value was 82 t/ha/y in 2000 and 2006, whereas the minimum value was 75 t/ha/y in 2012. A significant spacial variability of the optimum threshold value of soil erosion rates is observed. The overall optimum threshold value over lowland areas for the year 2006 was found to be 10 t/ha/y, whereas, the overall optimum threshold value over mountain areas was found to be 120 t/ha/y.

The utilization of the model aided in predicting the most suitable threshold values, which in turn facilitated the identification of areas where water and soil conservation efforts should be concentrated. Nevertheless, these regions with elevated rates of erosion necessitate meticulous supervision and sustainable land management approaches, particularly in areas with steep slopes that may significantly worsen the generation of erosion and sediment due to the future impacts of land use and climate changes.

The outcomes of this study can be valuable for the stakeholders in Hungary who aim to preserve a lasting soil cover through the use of rapidly growing or perennial vegetation that provides temporary or permanent stability in open areas. Altering land management practices and modifying certain human activities that contribute to soil erosion can also help regulate erosion. In hilly regions, hillside terracing is a practical measure to diminish runoff rates and consequently lower erosion rates. Lastly, sustainable agricultural methods such as conservation of agriculture, minimal tillage, and cultivation of cover crops should be adopted in all farming regions.