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Assessing the impact of soil erosion on plant vigor (NDVI) and the spatial patterns of soil-bound Cu, Zn and B micro- and N, P macronutrients in a sloping vineyard (Tokaj, Hungary)

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Soil erosion in sloping vineyards greatly influence the spatial distribution of soil nutrient contents and can affect plant nutrition and vigor. The study aimed to evaluate possible links between the grapevine (Vitis Vinifera) vigor and the erosion-impacted macro- and micronutrient contents in the topsoil. Our study combined field observations, laboratory measurements and remote sensing data.

The field experiment was performed in a 1.8 ha vineyard plot in Tokaj (NE Hungary) with a mean slope of 8° and a slope length of 270 m. The main soil type in the vineyard is Regosol developed on loess. The stock unearthing method was applied for estimating soil loss/sedimentation in the vineyard. The study plot is separated by pathways perpendicular to the south-facing main slope into four equal areas with decreasing slope steepness. A total of 42 soil samples (0-10 cm) were collected (10-12 in each area) to measure organic matter content, plant-available nitrite+nitrate-N, P_2O_5-P, and total contents of Cu, Zn and B micronutrients. Additionally, five subsoil samples were taken at 2 m depth for determining micronutrient accumulation in the topsoil due to vine treatments. The spatial variability of topsoil nutrient contents was assessed by interpolating the measured parameters using the inverse distance weighting method. The effects of soil erosion and spatial distribution of the nutrient contents on plant vigor were analyzed using the Normalized Difference Vegetation Index (NDVI). Sentinel-2 images with 10 m resolution were acquired on three dates in June and July 2020. In the study area, a median Cu enrichment factor (EF=topsoil/subsoil) of 2.7 can be attributed to a prevailing anthropogenic origin of the topsoil-bound Cu content. The vineyard is an organic farm, therefore Cu use (in a dose of 4 kg/ha/year) is an obvious way to protect grapevines against fungal infections. We also observed a moderate degree of Zn and B enrichment in the topsoil (EF_{Zn}: 1.2, EF_B: 1.4) due to vine treatments with foliar fertilizers. The element distribution maps show a fairly similar spatial pattern of Cu, available P_2O_5-P, and organic matter contents. Their accumulation in the footslope area with the lowest steepness can be seen. Compared with the soil loss/sedimentation map based on stock unearthing data, the Cu, P_2O_5-P and organic matter contents of the topsoil are lower in areas subject to more intense erosion, which may even affect the development of vines. The latter is to

be examined in the light of vegetation indices (NDVI). Changes in vegetation indices along the main slope can be observed with clearly increasing NDVI values in the footslope area. Spatial changes in B, Zn and nitrite-nitrate-N contents do not show a clear relationship with the topographic patterns of the area and the resulting soil erosion losses. Besides the nutrient contents, the presumably higher soil moisture content in the footslope area may also explain the higher NDVI values.

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