

SATELLITE BASED ESTIMATION OF THE ARABLE TOPSOIL TEXTURE AT REGIONAL SCALE USING SENTINEL-2 DATA

Predrag Lugonja¹, Branko Brkljač², Vladimir Ćirić³, Pavel Benka³, Vladimir Crnojević¹

^aBioSense Institute, University of Novi Sad

^bFaculty of Technical Sciences, University of Novi Sad

^cFaculty of Agriculture, University of Novi Sad

*Corresponding author: lugonja@uns.ac.rs

INTRODUCTION and OBJECTIVES:

Although satellite imaging has been present as a source of valuable spatial data for a long time, it was not until very recently that high quality satellite imagery products produced by high resolution multispectral instruments became affordable and broadly available. On the other hand, information contained in such measurements proved to have significant impact on the overall improvement of the best practices in agricultural production and environmental monitoring. One of the applications that could benefit from the large scale satellite based measurements is characterization of topsoil properties of arable land. More exactly, bare soil spectra acquired by multispectral instruments can directly provide information about soil texture, represented by the content of clay, sand, or silt, over the observed vegetation free area. There have been a few attempts to investigate such possibilities in the context of the current and forthcoming multispectral and hyperspectral imagers. In a recently published study, a comprehensive evaluation of the capabilities of several imagers in the task of soil texture estimation was performed. However, those findings were based only on the simulated and resampled spectral responses derived from the soil spectral signature libraries acquired under controlled laboratory conditions using high precision hyperspectral instruments. Among the simulated imagers was also Sentinel-2 MSI. In line with these efforts, aim of this paper is to further investigate applicability of this instrument in the real working environment, characterized by the challenging factors introduced by the atmosphere, tillage and plant remains, missing data due to cloud coverage, variable soil moisture as a consequence of climate and volatile weather conditions, as well as natural soil spatial variability, due to the large spatial extent of the performed analysis.

MATERIAL and METHOD:

A study was carried out in Vojvodina (Northern Serbia), located in the southernmost part of the Pannonian Basin. This region covers an area of 21 506 km² characterized by semi-arid climate and lowlands with intensive agricultural production. Soil samples were taken from different soil types to assure the geographic representation of soil cover in the region. Content of sand, silt and clay fraction in soil samples was analyzed using pipette method. For the purpose of comparison with the results of the previous study, content of clay, silt and sand in the collected geo-referenced soil samples was estimated using the Partial Least Square Regression (PLSR) predictive model utilizing satellite based measurements. Ten Sentinel-2 multispectral bands representing surface reflectance values in the VNIR and SWIR region at spatial resolution of 10 m (4 bands) and 20 m (6 bands) were used as predictor variables. Snow free images with close acquisition dates from the winter period were selected as appropriate for bare soil sampling. As a preprocessing step, samples occluded with vegetation were discarded. In addition, in the similar fashion as in the mentioned laboratory study, skewed data (including satellite measurements) were transformed using the square root or power of the variable.

RESULTS and CONCLUSIONS:

Reported cross-validated results, expressed through coefficient of determination and root mean square error, are slightly worse than previously published laboratory-based estimates. However presented results confirm previous findings and encourage further investigation in the same direction using time series approach.

KEY WORDS: Sentinel-2, Satellite imaging, Topsoil texture, Estimation