Modelling of soil properties in a NATURA 2000 habitat site in the Carpathian Basin

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1. Introduction

The flat areas of Carpathian Basin holds the most extent naturally salt-affected soils in Europe. These areas are typically covered by alkali grasslands. Natural salt accumulation due to continental climate and the special local hydro-geological conditions (e.g. closed evaporative basins) is rare in Europe. Due to their good nature conservation status, alkali grasslands have an important role in the European Natura2000 network. In these sites, detection of soil properties is difficult because of the complex horizontal mosaic structure. This task is especially challenging in mapping temporarily water covered areas. There are two types of salinisation in the Carpathian Basin: (1) solonchak (saline soil) with high amount of water soluble salts and (2) solonetz (alkaline soil) high alkalinity and high exchangeable sodium percentage (ESP) in the B-horizon. In Hungary the dominant soil type is solonetz. High exchangeable sodium saturation of heavy-textured soil with large amount of expanding clay minerals results in unfavorable soil properties - alkaline pH in B-horizon, swelling/shrinking colloids**,** degradation of soil structure**,** limited infiltration and leaching conditions, low water and nutrient storage capacity of the shallow A-horizon, which limit their fertility, productivity and agricultural utility.

Due to macro relief (catena) properties, salt affected soils are located in the transition zone between the high-and low-lying areas (Máté 1955). The correlation of micro relief and salt accumulation in micro depression in case of a solonchak soil was published by Mile et al. 2001. Nevertheless, according to Tóth (1999) and Blaskó (2004) in case of solonetz soils salt accumulation is not typical in micro-depression. Soil salinisation process is highly correlated with surface water and ground water moving. The vertical salt profile changes were published by the authors (Sigmond E. 1923, Tóth 1999, Mile et. al. 2001, Tóth et. al. 2001, Blaskó 2004, Novák 2008), but less emphasis was put on the horizontal variations. Because of horizontal variation depending on the micro topography. Next to it need to take consider soil properties, vegetation types and runoff properties.

2. Scientific Approach and Results

The main reason of this study is improving the inaccurate spatial modeling of an extremely flat area. The high-density point cloud data from 3D LiDAR remote sensing provides good quality input data to detect the micro heterogeneity surface very effectively. Airborne LiDAR, - also referred to as Airborne Laser Scanning - is widely used for high-resolution topographic data acquisition, offering a planimetric (<50cm) and vertical accuracy

(<20cm) suited for many applications (e.g. in natural hazard management, forestry) (Höfle et al. 2009). However this technology is also applied in nature conservation and environmental protection. This technology was used by ChangeHabitats2 project, which first aim was to monitoring NATURA2000 habitat sites in Europe. Our study area is Ágota-puszta - one of the four Hungarian sample areas of ChangeHabitats2. This is part of Hortobágy National Park- mainly characterized by salt affected soils, alkali grasslands, micro heterogeneity surface and micro watershed isolated. The aim of this study to using data of LiDAR technology to evaluate correctly these properties in this area.
The survey was made with Riegl LMS-Q680i laser scanner. This use full waveform analysis and echo digitization. The system is suitable for distinguish different echo signals, while scanning parameters are stored. Full waveform analysis contribute to evaluate different levels in the investigated environment (e.g. high vegetation, medium vegetation, ground, etc.) more effectively. Emitted laser beam has a certain footprint, so the laser shots different objects. Echo digitization operates based on the return time. Figure 1 presents points which reflected from the ground, which derive from the last echo in our study area.

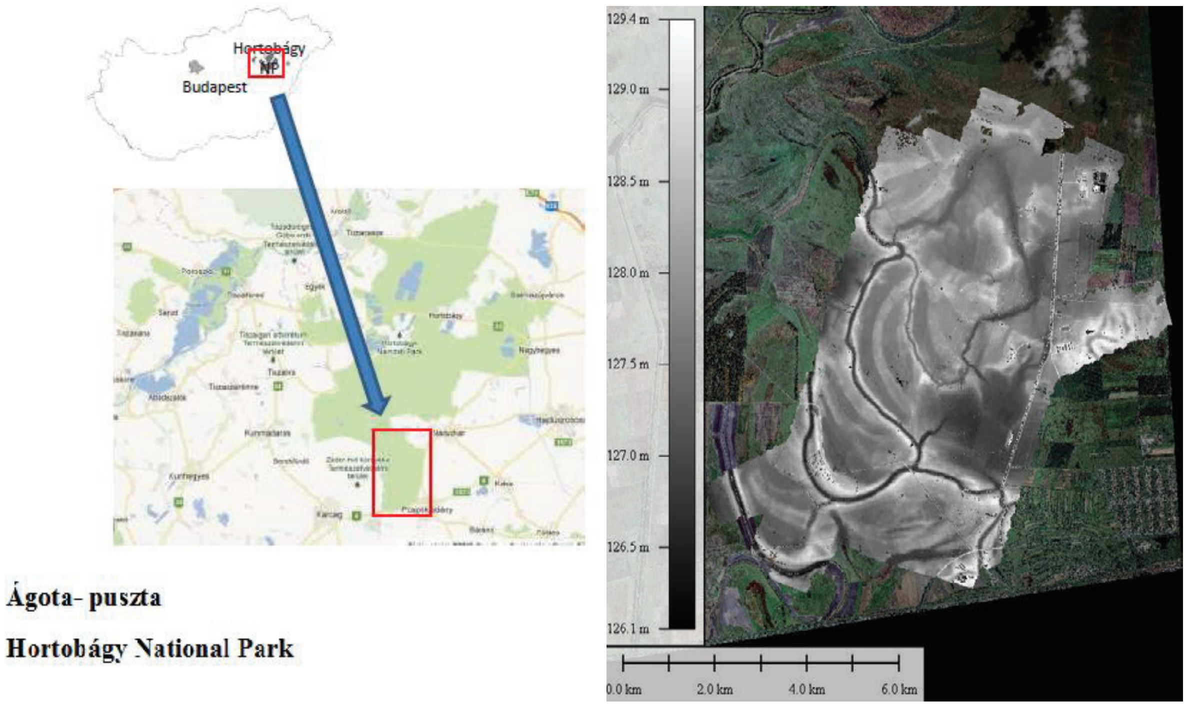

Figure 1: Ground points visualisation in our study area.

The purpose was to delineate impact of non permanent water pattern on salinisation. In the field survey mapping texture of different vegetation formations was performed by handheld GPS system unit. Measurement points were selected according to vegetation stratified sampling strategy and it was drilled depth of 0.6 m. In the 0.6 m range, the topsoil quality important from viewpoint of grasses could be characterized by soil texture. Furthermore soil laboratory tests have been conducted to determine the total salt content, pH value and texture of soils.
Furthermore DEM (Digital Elevation Model) was created in ENVI LiDAR 3.2 and the Global Mapper LiDAR module. Based on the DEM, the derived runoff model (which presents on Figure 2) of study area was created from the LIDAR point cloud by Tarboton algorithm

(Tarboton 1997) in ArcGIS 10.2 software environment. Whereas for determination of relationship between micro relief and soil characteristics statistics methods were used.

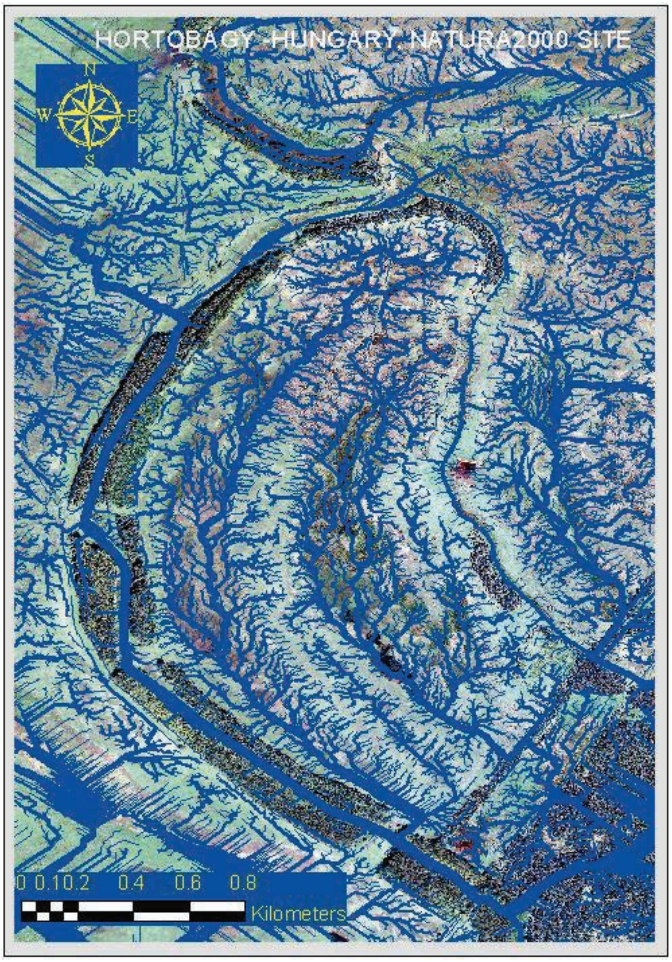

Figure 2: The runoff model of the study area.

The horizontal pattern of vegetation formation is largely depending on the movement of salt in soil profile, which is represented in the 3D DEM. In this way, it is possible to have a more accurate spatial analysis of correlation and understanding between movement of water and salt accumulation, micro-relief and vegetation. In the present study, we demonstrated monitoring Natura 2000 habitat site from LiDAR data processing to soil laboratory tests and field surveys.

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