EVALUATION OF STATE OF VINEYARDS AND CHARACTERIZATION OF VINEYARD SITES OF THE INTEGRATED AREA OF TOKAJ KERESKEDŐHÁZ LTD. IN TOKAJ REGION

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Abstract

The Tokaj Kereskedőház Ltd. is the only state owned winery in Hungary. The company is integrating grapes for wine production from 1100 hectares of vineyard, which consist of 3500 parcels with average size of 0,3 hectares, owned by about 500 families of the region. The vineyards are unevenly spread in total 27 village of Tokaj region. The aim of our study was to determine the state of vineyards of each single parcel of the integrated area, and the characterization of the ecology of the vineyard sites. Based on the information collected a site-specific vineyard design and cultural practice could be achieved on the given territory.
The state of vineyards, concerning variety, training system, trellis system, row and vine spacing, row orientation, and production characteristic was determined by visual inspection of every single parcel. Airborne hyperspectral imagery was taken, covering the whole Tokaj Wine Region. High-resolution spectral-spatial geodata were captured and analyzed to focus on variety determination, evaluate biophysical properties (NDVI, LAI, Red Edge Position), canopy continuity, structure and identify row anomalies.
The characterization of vineyards sites was accomplished based on large-scale determination of topography, soil and meso- and macroclimate variables covering the total 11000 hectares planted and potential vineyard land area of Tokaj Region. According to soil survey Digital Optimalized Soil Related Maps and Information Method was taken to produce the proper thematic data layers in 25 m spatial resolution. Results of surveys are analyzed and managed in a geographical information system designed for the project.
The methods applied during the data collection and analysis will be detailed, while the preliminary results of the state of vineyard and the characterization of vineyard sites will be demonstrated.

Keywords: Tokaj, vineyard survey, characterization of vineyard site, digital soil mapping, LIDAR survey, hyperspectral imaging

1 INTRODUCTION

Tokaj is a historical region for botritized dessert wine making in North East of Hungary. Tokaj region consists of 27 villages, which are guided by 8 wine communities (syndicates). The total producing vineyard surface area of Tokaj is 5500 hectares, and the total vineyard land exceeds 11000 hectares.
The Tokaj Kereskedőház Ltd. is the only state owned winery in Hungary, which is located in Tolcsva, in the center of the region. The company is integrating grapes for wine production from 1100 hectares of vineyard, which consist of 3500 parcels with average size of 0.3 hectares. The majority of the plantations were established in the late 70's and early 80's. Due to that fact the structure of the vineyards were designed for the mass production of the state owned cooperatives. The Tokaj Kerskedőház Ltd. is farming on 70 hectares of own vineyard land, which is located on famous terroirs, like Szarvas, Kővágó and Szentvér of the region.
In the year of 2013 the Hungarian Government has decided to improve a sustainable quality wine production of the Tokaj Kereskedőház Ltd, which is all together the biggest wine producer in the Tokaj region. To achieve the target it is indispensable to reconsider the vineyard structure and winery facilities, and to launch a technological improvement and necessary reconstruction in the vineyard and the winery. In the part of the vineyard the state of the plantations and the viticultural potential of the land had been decided to survey, to create a data base to have a precise view about the actual situation before making company scale decisions. Based on the fact that the Tokaj Kereskedőház Ltd. incorporates the $1/5^{th}$ of the total territory of the region the Council of Wine Communities of Tokaj Region has decided to widen the survey for the whole wine region in the year 2014.

The characterization of vineyard sites hasstarted in the 16th century (Boros 1996), but one of the most comprehensive work was done by Szabó and Török (1867) creating the "Album of Tokaj-Hegyalja". A new phase of characterization of vineyard lands of Hungary was started in 1979 (Bényei et al. 1999), evaluating over 400000 hectares in the country and just about 12000 hectares in Tokaj Region. The evaluation of the vineyard land was accomplished by the survey of topography, climate and soil characteristics, furthermore with the definition obtainable size of the parcels, and the quality of the roads. All together 18 indices were evaluated and then scored and vineyards were ranked on a 400 score scale. The qualification of vineyard lands is still exists, and utilized in the regulation of the viticultural sector (Bényei et al. 1999).
In 1998 a national vineyard registration has started, and a database has been created considering majorly structural factors of the vineyards. In 2001 a national GIS system were established, called VINGIS which supports data for grape and wine sector.
The majority of the existing information about the land and the vineyards need reconsideration based on the scale of the base map that has been utilized previously and about the factors which can change dynamically, like missing vines in the plantation.
The aim of our study was to recollect data on the ecology of the viticulture of Tokaj Region and the state of vineyards. In the current paper the methods of data collection and some preliminary results will be presented.

2 MATERIALS AND METHODS

The studied area

The characterisation of viticultural land and the survey of state of the vineyards of the Tokaj Kereskedőház Ltd. has started in 2013. The evaluated area was extended to the whole Tokaj wine region in 2014. The region is located in Borsod Abaúj Zemplén county in northeast of Hungary (Figure 1.).

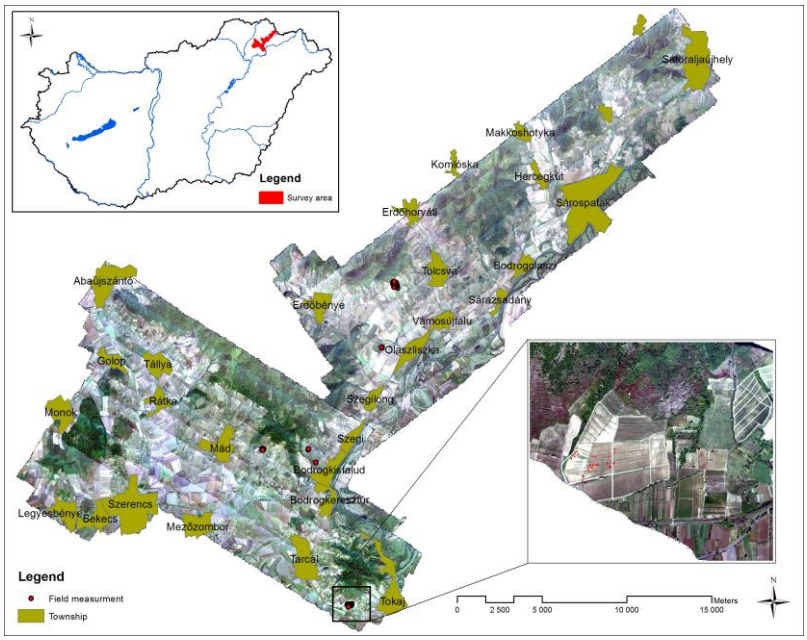

Figure 1 : The evaluated area and points of field mesuarements of hyperspectral analysis

Soil mapping

In the frame of the project we executed the spatial and thematic data mining of significant amount of soil related information available in the form of legacy soil data as well as digital databases and spatial soil information systems following the method of Pásztor et al. (2012). In the course of the analyses we leaned on auxiliary, spatial data (DTM of LIDAR survey, and short-wave-infrared (SWIR) hyperspectral imagine between wavebands of 1000 nm and 2450 nm) themes related to soil forming factors as well as to indicative environmental elements. Based on the established relationships we started to convert and integrate the specific data sets for the regionalization of the various derived soil parameters. For further data set, soil description and analysis was carried out on geostastistically determined locations (Figure 2-3). Soil sampling was carried out by drilling (M1-0507e Soil Column Cylinder Auger, Eijkelkamp, Netherland) to 2 m depth, and soil excavation was done in case of the major soil types. By the aid of selected and optimized geostatistical, data mining and GIS tools we multi-mapped and optimized some basic soil properties. We also carried out the spatial extension of

certain more sophisticated pedological variables featuring the state, processes, functions and services of soils (Pásztor et al. 2012, Pásztor et al. 2013a). We compiled digital soil related maps with 25 m of spatial resolution.

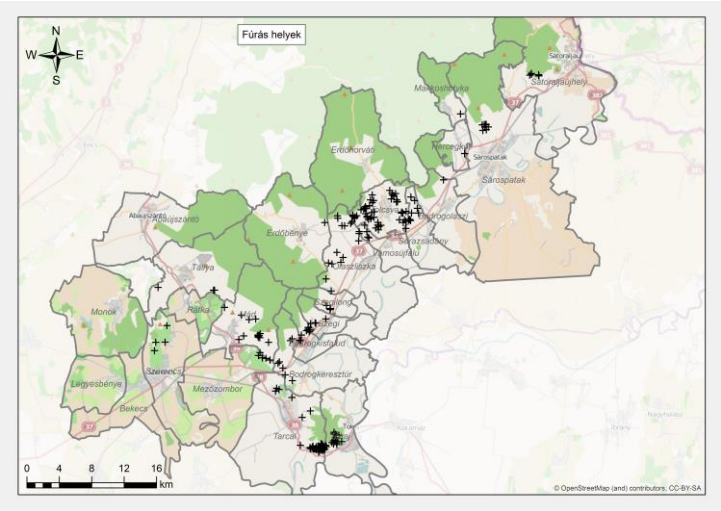

Figure 2: Points of soil sampling in Tokaj Region optimized to the integrated area of Tokaj Kereskedőház Ltd.

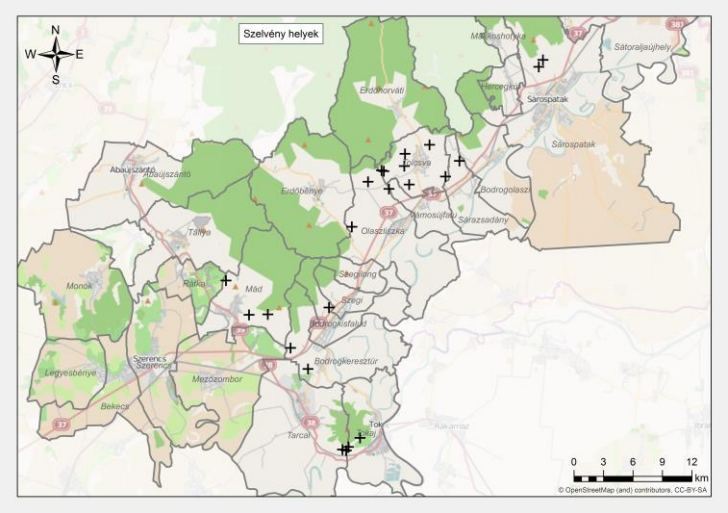

Figure 3: Points of excavation for the major soil types in Tokaj Region optimized to the integrated area of Tokaj Kereskedőház Ltd.

Topographical mapping

Digital Terrain Modell and Digital Surface Modell were created by LIDAR (Light Detection and Ranging) method. The LIDAR data were acquired using an Airborne Laser Scanner (LEICA ALS70HP) mounted on in Cessna TU-206E (285 HP) aircraft (Figure 4-5). An average point density of 4 per m^2 was obtained (RMSE=15 cm). During data acquisition multiple-returns were detected from the discrete returns. The LIDAR measurement was simultaneously carried out with the digital camera survey in 15 cm geometric resolution in RGB and NIR colour composition. The result of the airborne laser scanning was an accurate DTM and DSM based on LIDAR cloud point.

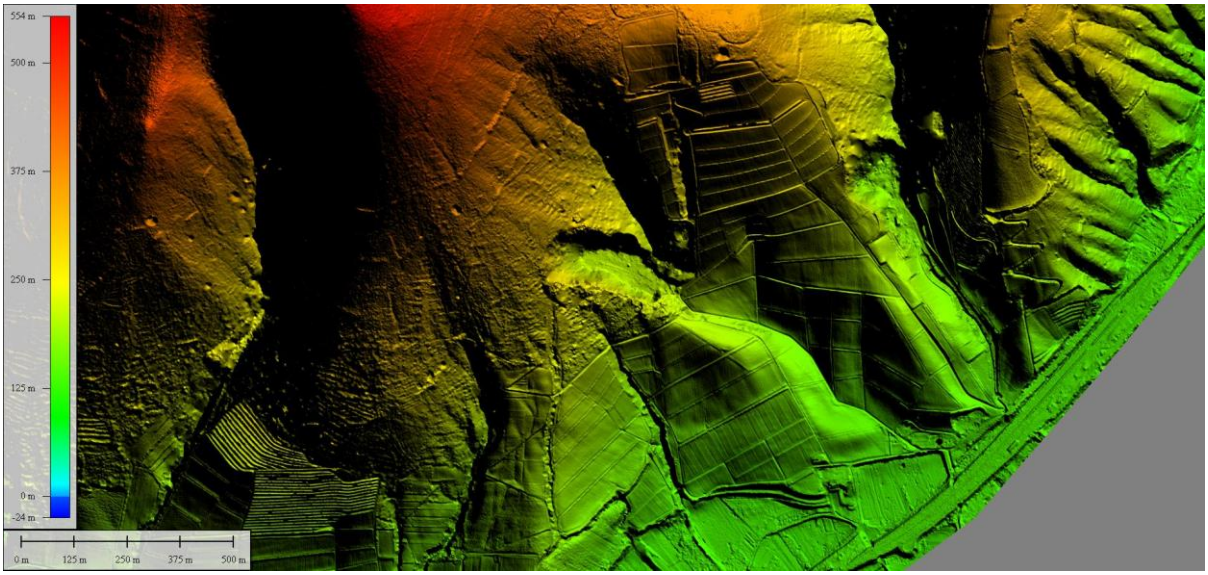

Figure 4: The 3D DTM of the southern part of Tokaj hill

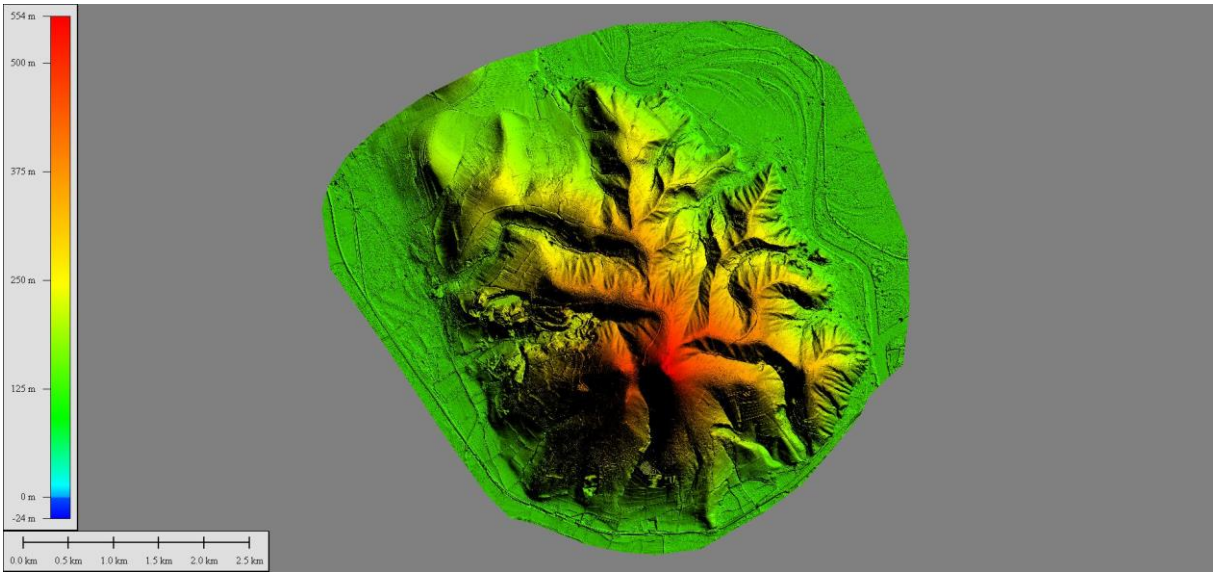

Figure 5: The 3D DTM of Tokaj hill, upper view

Climate

The main climatic indices (mean annual temperature, mean July temperature, GDD etc.) were determined by the National Meteorological Service utilizing Meteorological Interpolation based on Surface Homogenized data basis. 30 years averages of over 100 meteorogical stations were interpolated and presented on 600 m x 800 m grids (Figure 6).

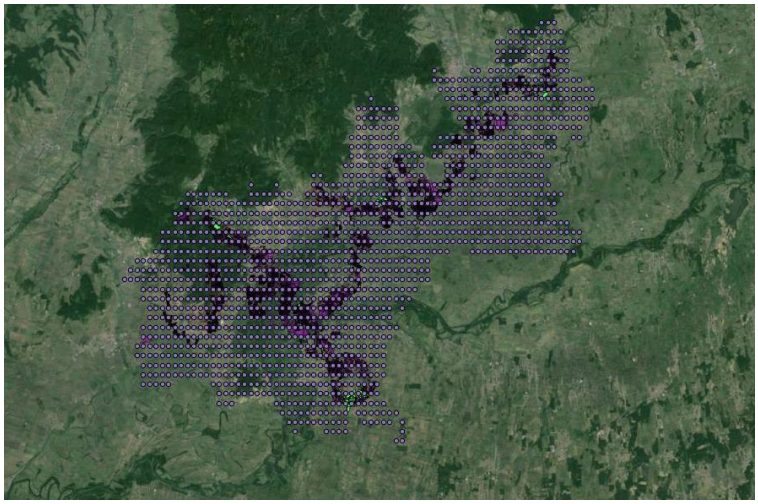

Figure 6: Climatic indices were collected in 600m x 800m grids

The land surface temperature in 100 m spatial resolution will be determined based on the measurements of thermal infrared sensor of LANDSAT 8 satellite by utilizing the method of Sobrino et al. (2008).

Vineyard survey

The professionals of the company individually visited 3500 parcels of the integrated vineyard area of the Tokaj Kereskedőház Ltd. During the survey a standard form was completed. The structure of the vineyard (row orientation, row and vine spacing, training system, trellis system, scion variety), the state of the vineyard (material and state of trellis, appearance of trunk diseases, appearance of nutritional deficiencies, percentage of missing vines, vine vigor) and the quality of viticutural practices (soil management, canopy management, phytosanitary management, awaited yield) were recorded. The evaluation and sampling methods were standardized, and two teaching sessions were applied to the evaluating professionals. The collected data were digitalized for further analysis. The vineyard survey will be extended to the whole region in September 2014.

Hyperspectral imaginary

Airborne hyperspectral imagery was taken to evaluate vineyard condition of Tokaj Wine Region focusing vine variety classification, evaluating of biophysical properties and measuring canopy cover, structure and row identification (Figure 7). The survey area of hyperspectral acquisition was 312 km^2. Digital images were taken by a push-broom typed Aisa Eagle II hyperspectral camera at the whole sample area, which is capable of imaging in the visible and near-infrared range (VNIR). The first acquisition was on 4th October, 2013. During the surveying, recording was set up with 4.5 nm sampling in the full spectrum (400-1000 nm), so each pixel contains 128 spectral channels. Average geometric resolution of images were 1 m. High-accuracy OxTS RT 3003 GPS/INS system was used for recording of the navigation data. The hyperspectral camera was mounted on the Piper Aztec-type airplane. During the recording, 28 hyperspectral images were made together, from which a mosaic was made after the preprocessing, so a coherent image file is available for the entire sample area.
Several biophysical indices were calculated from atmospherically corrected hyperspectral images. Field measurements were applied for validation of biophysical indexes (NDVI, LAI, Red Edge Position) with DGPS. Furthermore, field samples of dominating grape types were recorded by DGPS system in order to collate training area for image classification methods.

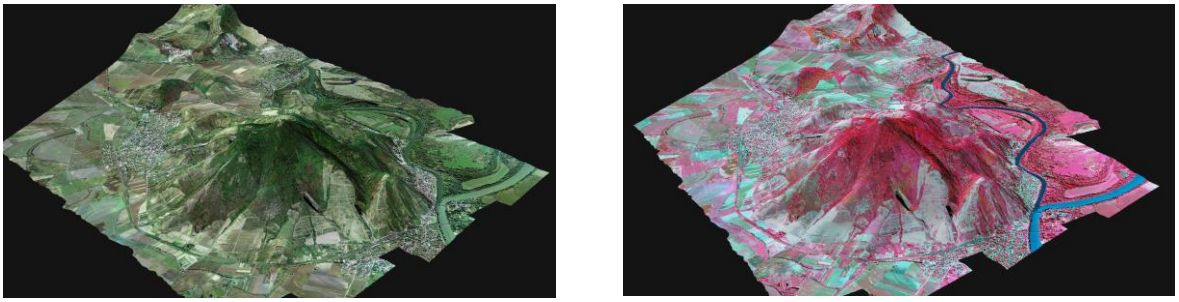

Figure 7: RGB and NIR image of the Tokaj hill in Tokaj wine region

GIS system

All data layers were collected in a geographical information system designed for the Tokaj Kereskedőház Ltd. (Figure 8). The customized GIS system will be connecting georeferenced data with backoffice databases, displaying georeferenced data on new map layers, executing frequent queries, spatial analysis and supporting special queries.

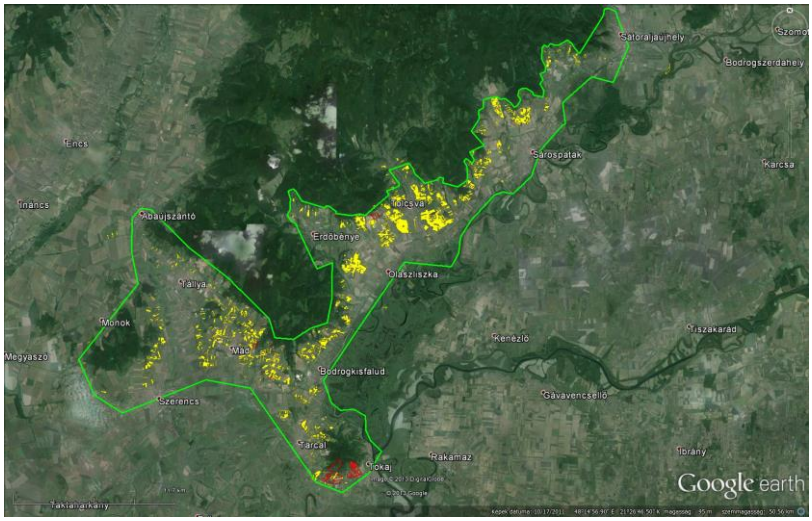

Figure 8: Integrated vineyard parcels of Tokaj Kereskedőház Ltd.

3 AWITED RESULTS

The awaited result of the comprehensive vineyard and land survey is to enable precise information about the possible potential of the vineyard land and the state of plantations. Based on the collected dataset the Natural Terroir Units are planed to circle around. Each unit the optimal target of production, scion and rootstock usage, vineyard design and applied viticultural practices will be defined. For the precise description of the vineyard land potential and for the valorization of our results, historical datasets will be evaluated and the growers experiences, following Morlat (2001) will be scanned. By examining the results of state of vineyards, the possible locations of the vineyard reconstruction could be pointed out.

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