Vegetation Mapping in Tisza-lake Using Airborne Hyperspectral and LiDAR Data

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1. Introduction

Tisza-lake, the second largest lake in Hungary, is situated between Kisköre and Tiszalök and its total surface is 127 sq kilometres. Therefore it significantly influences the water-regime of the Tiszántúl Region and the Hungarian Great Plain. It is an artificial reservoir that was set up for economic purposes (water supply, flood protection, energy development and tourism), even though a unique and valuable habitat network has formed there.

Tisza-lake belongs to Hortobágy National Park, thus it is also Ramsar site. It is part of the Natural Ecological Network and the Natura 2000 Network (Birds Directive Site and Habitat Directive Site). The two third of the whole reservoir is protected from 2008.

There is a numerous variety of plant communities (forest, aquatic and marshland) developed on the area of the lake, from which wetland plant communities have occupied more and more parts of the reservoir. Since the proportion and the spatial pattern of each plant community continue to change year after year, it is difficult to show them. In many cases it is also difficult to assess plant communities (forest, aquatic and marshland) hence they cannot be evaluated by traditional field work.

Images derived from different remote sensing tools can offer an opportunity for solving this problem, and by targeting processing of them plant communities, vegetation types and individual plant species can be mapped. The remote sensing is often regarded as a useful technique for monitoring and mapping natural areas and habitats. Using airborne and spaceborn images based on (semi) automated spectral pattern recognition algorithms, changes can be detected in near real time (Stone 2010). The remote sensing technologies offer a great potential for monitoring large areas rapidly. Because of large volume of spectral information hyperspectral imagery is capable of separating plant species, which plays important role in mapping invasive plant species (Clark et al. 2005, Underwood et al. 2007).

There are a number of studies focusing on mapping vegetation from remote sensed images at species level (DiPietro et al. 2002, Kokaly et al. 2003, Underwood et al. 2003, Burai et al 2010).

Complementing hyperspectral images (with high spatial and spectral resolution) with elevation data from the Airborne Laser Scanning (ALS) the quantitative attributes can be mapped besides the qualitative ones, furthermore identification and distinction of individual plant species can become more reliable (Narumalani et al. 2009).

2. Study area and data

Our studies were made at a 15.6 sq kilometres study area between the Valki-basin and the Tiszafüred-basin at Tisza-lake (Figure 1). The LIDAR data were acquired using an Airborne Laser Scanner (RIEGL-Q680) with an average point density of 4 per m^2. During data acquisition multiple-returns were detected from the discret returns. The hyperspectral data were collected using an AISA Eagle II push-broom sensor covering the visible (VIS) and near infra-red (NIR) region from 400-1000 nm with a spectral resolution of 4.5 nm and a spatial resolution of 1m. The pre-processing of the hyperspectral data (atmospheric and geometric correction) was performed using CaligeoPro-software.

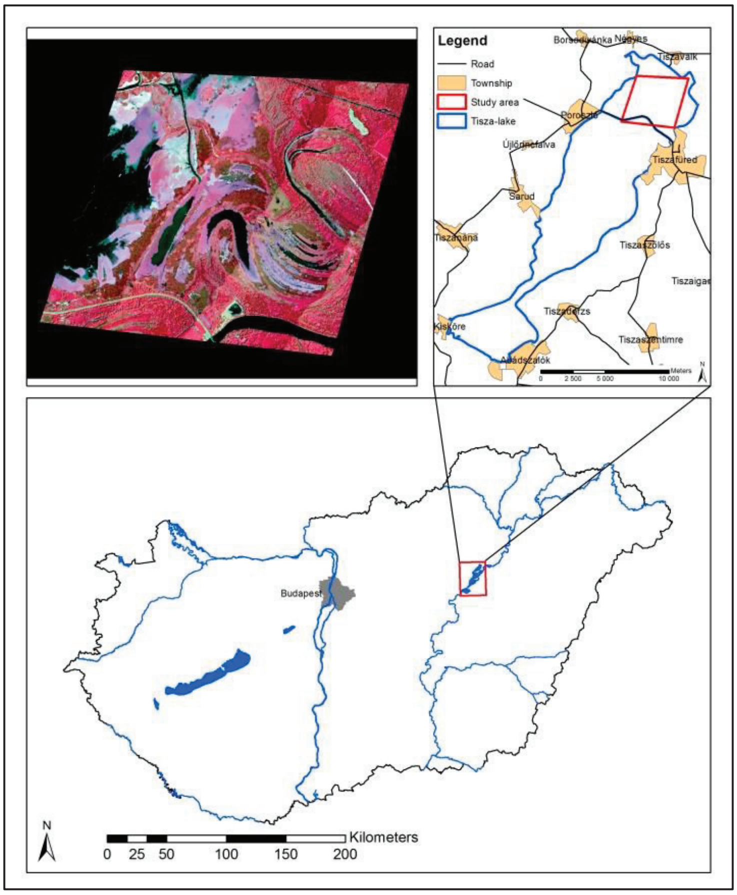

Figure 1: The study area of Tisza-lake

3. The aims of this work

The aim of this research was to elaborate a map showing the marshland and aquatic vegetation of the study area of Tisza-lake by using high-resolution remote sensing images and field datasets. The atmospherical corrected hyperspectral data was also radiometrically calibrated, and the open-water pixels were removed.

This study aimed to compare the pixel and Object Based Image Analysis (OBIA) classification methods, in addition to survey the potential of the joint classification of the hyperspectral data combined with ALS data for aquatic vegetation.

We applied a pixel-based supervised classification on the datasets. The training and the ground truth classes of the typical vegetation types were identified using a DGPS during the field survey. We perform the Spectral Angle Mapper (SAM) classification on the original hyperspectral images, extracted features using Minimum Noise Fraction (MNF). On the MNF bands the following classification methods were performed: Maximum Likelihood Classification (MLC), Support Vector Machine (SVM), and Random Forest (RF).

In our research the Normalized Differential Surface Model - nDSM from LiDAR datasets was taken into hierarchical image processing chain for the object-based (OBIA) classification. The calculated digital elevation model includes the elevation data of the field objects from the surface, which can provide the potential to distinguish and morphologically filter the vegetation types at different high level.

Besides these, an object-based (OBIA) classification was applied on the hyperspectral images, for which we used pre-defined spectral bands and transformated layers (e.g. narrow band NDVI). A hierarchical image processing chain was developed using raster based image classification and object-based (OBIA) classification method.

Finally we examined and compared the accuracy of the classification result derived different classification methods.

The integration of hyperspectral images and ALS data can improve the classification accuracy for individual plant species. Hyperspectral and ALS dataset can improve the effective mapping of specific vegetation types across a range of environments, such as floodplain, aquatic and marshland, in addition they are suitable for investigating and monitoring environmental elements.

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