QUALITY ASSESSMENT OF LIDAR BASED DSM MODEL IN THE FRAME OF CHANGEHABITATS2 PROJECT

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Abstract

During the last few years different airborne remote sensing technologies became an effective tool to monitor the environment. The airborne data, such as airborne laser scanned (ALS) data may help the researchers to evaluate the quality and quantity of different habitats and changes. The accuracy of the ALS data depends on several conditions, such as cloud coverage, wind speed and direction, vegetation coverage. The aim of this paper is to evaluate the accuracy of ALS data during habitat monitoring by the comparison of traditional survey data.

Key words: airborne laser scanning, habitat monitoring, survey, remote sensing.

INTRODUCTION

The survey of general conditions, the determination of the changes, the investigation of artificial and natural direct and indirect effects of forest's wildlife and biocoenosis are very important factors in ecological point of view (Tamás et al., 2011).

The environment of the aforementioned protected sites is continuously changing, unfortunately typically deteriorating. In order to be able to counteract to the negative effects of industrialization, urbanization, growing traffic networks and similar processes, the Natura 2000 sites have to be regularly observed whether the habitats and species to be protected are affected by changes. This tedious work is typically based on observations in the field and, of course, it is a very costly activity (Székely B. et al., 2012a; Zlinszky A. et al., 2012).

With advanced high-resolution remote sensing technologies the technical possibility of observation of some features and habitats is available but it needs accurate data and has to be complemented with on field measurements (Onojeghuo, Blackburn, 2011; Hollaus et al., 2012).

The goal of our project (ChangeHabitats2) is the development of cost- and time-efficient habitat assessment strategies by employing effective field work techniques supported by modern airborne remote sensing methods, i.e. hyperspectral imagery and laser scanning (LiDAR) (Székely et al., 2012b).

In frame of Change Habitat2 project was selected 5 reference site where collected real field measured data by different expert groups. Our task was to develop or/and compare different new and traditional field surveying methods to evaluate the practice of habitat site mapping. We used equally non connecting primary and secondary field data to validate different methods. Based on prepared data sources, we evaluate different error resources and calculate accuracy assessment. Next section we introduce the results of Uckermark, Germany site.

MATERIAL AND METHOD

The selected area is Uckermark – Boltzenburgland which is situated 87 km from Berlin, Germany. The selection criteria of test site were follows:

- Well explored by ecological experts of consortia,
- Forested areas with relatively homogeneous species (birch),
- Canopy structure of forest vertically and horizontally complex but can be well isolate in space,
- The site involved both closed and gap vegetation,
- The site were LIDAR scanned at two important biological phases - leaf off (2012) and leaf on (2011) periods by REIGL with LMS-Q560 FWF laser scanner (2-50 echos/m^2).

The area was 50 X 50 m, that size is also widely used by field ecologist to evaluate the habitat type.

On the field we applied combined methods to realize better field accuracy. Differential GPS point was the reference landmark on the flat asphalt covered road. This road was scanned by LIDAR with high spatial density as horizontal reference line (Figure 1).

Habitat site surveying typically includes the gathering of information, interpretation of information, figures of landscape, 3-D details of the surface and exact measurements for distinguishing the particular landforms. First part we identified the corners of test site. We used traditional optical techniques because the GPS signal highly scattered in forest where dense vegetation results significant multipath error. At important geodetic reference landmark stones were measured DGPS but static measuring time was minimum 2 hours at one point which is time consuming method.

Next steps were to measure every points at geodetic network where mesh size was 1x1 m (Figure 2).

Fig. 1. Position of horizontal reference objects close to test field

Fig. 2. Measured geodetic grid

Parallel with geodetic data collection we measured every trees position and diameter. To simulate canopy density we take photo orthographical position to sky direction (Figure 3).

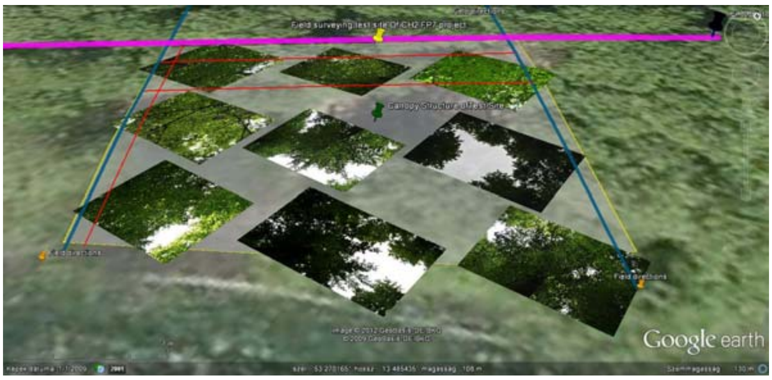

Fig. 3. Photomosaic of Canopy

For the evaluation of the surveyed data we used ArcGIS software kit.

RESULTS AND DISCUSSION

In classical statistics, observations are assumed as independents, there is no correlation between observations. In geostatistics, the information on spatial locations allows you to compute distances between observations and to model autocorrelation as a function of distance. The mean center is a point constructed from the average x and y values for the input feature centroids. The median center uses an iterative algorithm to find the point that minimizes Euclidean distance to all features in the dataset. The Standard Distance tool creates a new feature class containing a circle polygon centered on the mean for each case. Each circle polygon is drawn with a radius equal to the standard distance. The attribute value for each circle polygon is its standard distance value (Figure 4).

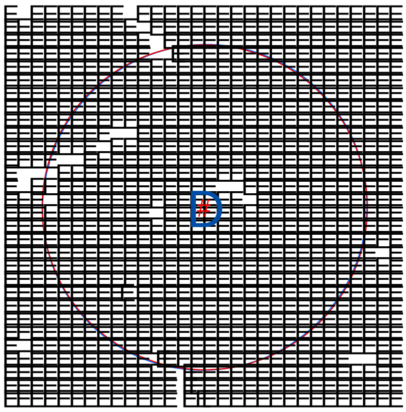

Fig. 4. The "Standard distance" result of the surveyed area

Figure 4 shows the grid that was built by the traditional survey at the selected test area. The missing values are results of the different object of the surface, such as high roots and lying dead wood. On the right top of the surface – where the canopy had a gap - the grid is complete, no other object affected the survey. To determine the effects of the objects we made a histogram of the elevation values (Figure 5).

The histogram of z (elevation) values (Figure 5) indicates two sample populations (marked with red). When there is a local outlier, the value will not be out of the range of the entire distribution but will be unusual relative to the surrounding values. We can see that there is no single value that is unusual. The location in question is highlighted in the lower tail of the histogram (see the highlighted points in Figure 6). The Box-Cox statistics help us to find geographical positions of the highest and lowest outsiders. A cumulative distribution graph was produced by plotting the ordered data versus the cumulative distribution values.

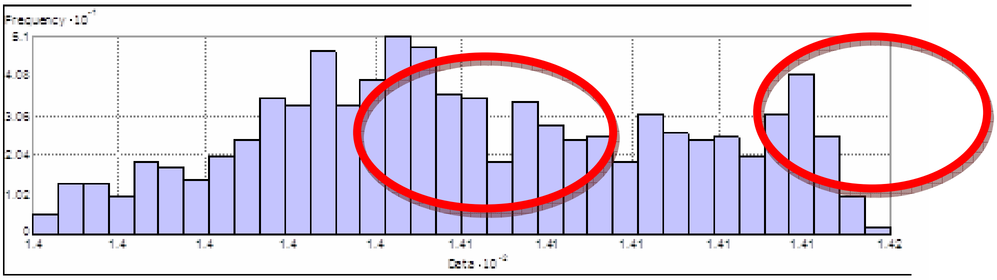

Fig. 5. The histogram of z (elevation) values of the surveyed area

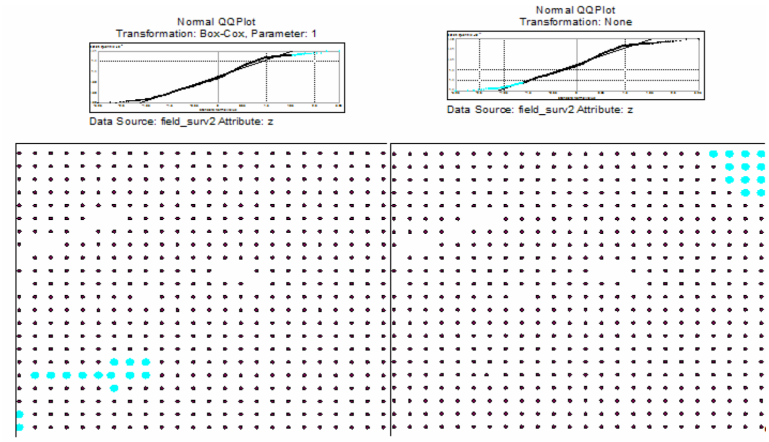

Fig. 6. Results of Box-Cox statistics – highest and lowest outliers

The highlighted (blue) areas may be local outliers. Further investigation should be made before deciding if the value at that point is erroneous or in fact reflects a true characteristic of the relief and should be included as part of the digital elevation model. A global outlier is a measured sample point that has a very high or a very low value relative to all the values in a dataset. It is important to identify outliers because of two reasons: they may be real abnormalities in the phenomenon, or the value might have been measured or recorded incorrectly.

The on-field measurements and the comparison with the ALS data satisfied that the highest and lowest values are resulted by the elevation differences of the surface.

To compare the field survey with the ALS data we made surface models from both data sets. For ALS based surface model we used the leaf off dataset to be more accurate. We examined the two surfaces with pixel based correlation.

During the comparison a shift in the coordinate system appeared so the GPS data had to be corrected and refined. After the correction the regression analysis was made and resulted medium correlation between the two datasets with a 0,56 r value. The correlation was effected by the accuracy of GPS data, the stems that were in front of the view of the theodolite and the number of points per m^2 which was averagely 6 in the case of ALS data and 1 during traditional survey.

CONCLUSIONS

The traditional habitat mapping needs time and human resource. Remote sensing methods can be applied during the evaluation of habitat quality and to examine the changes of habitats. The airborne remote sensing methods, such as ALS, need on field data. In our research we examined difficulties of traditional surveying and compared the surveyed data with ALS datasets. From our results we can conclude the traditional survey is accurate but the points have to be collected in large frequency grids that need human resources. The quality of traditional surveying depends on the amount of the objects on the surface (roots, stems, lying deadwood, etc.). The ALS data can be used for digital elevation modelling especially if the data is collected during leaf off period and the GPS positioning is correct. The collected ALS data can be used for further data evaluation (habitat monitoring, species determination, etc.) as well.

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