IDENTIFYING AND CLASSIFYING FORESTS AFFECTED BY THE ICE DAMAGE IN DECEMBER 2014, USING OBJECT-BASED IMAGE ANALYSIS

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Abstract

In December 2014 extreme weather conditions caused extensive ice damage in the forests of Börzsöny Mts. The extent and particularly the location of the damage was not very precisely recorded. Thus the objective of our work was to identify the damaged areas and also to classify them according to the extent of the damage using RS data. We used object-based image analysis on aerial images from 2013 and 2015 (before-after), forest inventory data, field data and reference based on visual interpretation. According to our first results, areas of major damage (many uprooted trees) can be identified correctly, however, locating areas where only partial crown damage occurred needs further methods to be developed.

Introduction

In December 2014 extreme weather conditions caused extensive ice damage in the forests of Börzsöny Mts. Similar weather-related events (windthrow and ice damage) have recently followed each other quite frequently in the area. Forest managers' first priority was safety and to salvage as much of the uprooted and broken wood as possible therefore the extent and particularly the location of the damage was recorded only haphazardly. However such information is important both from practical and scientific aspects; in order to find why certain stands were more affected, the factors influencing the extent of the damage need to be identified and analyzed. The first step is creating a precise map of the extent of the damage. The recent fast development of remote sensing data and methods provides useful tools in both the retrospective spatial analysis of such events, both near-real time damage assessment.

There are several databases and methods which allow such analysis, there has been similar damage assessment work done in Hungary using hyperspectral imagery, LIDAR and Landsat time series (see Kristóf et al. 2013, Tanács et al. 2017), however we needed very high spatial resolution data for a relatively big area, therefore we decided to use aerial imagery and OBIA methods.

Data and objectives

The objective of our work was to identify the damaged areas in the Börzsöny Mts area and also to classify them according to the extent of the damage (with special regard to damaged but not entirely broken crowns) using aerial images and OBIA methods.

Data:

UltraCam X digital CIR images from 2013 (40 cm) and 2015 (20 cm)

nDSM (2015)

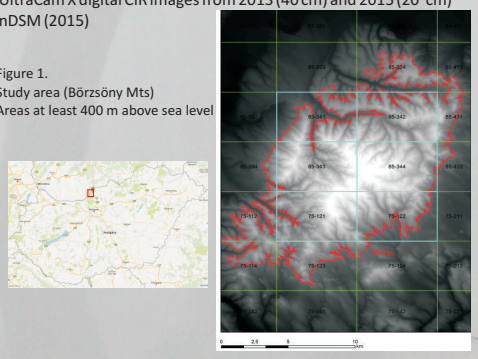


Figure 1.
Study area (Börzsöny Mts)
Areas at least 400 m above sea level

Methods

1. field sampling (stratified random sampling)
2. visual interpretation of aerial imagery from 2013 and 2015 (distinction between entirely broken and partly damaged tree crowns)
3. Object-based image analysis of the 2015 aerial images

Comparison of the results of the 3 methods (only the OBIA vs. visual intepretation presented here)

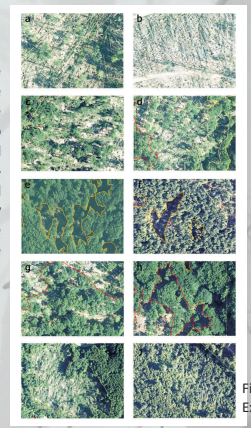


Figure 2.
Examples of different extent of damage

The classes of visual interpretation:

1) 50-100% fallen trees, in a patch over 100 m wide
Figure 2. a.) b.)
2) 25-50% fallen trees
Figure 2. e,) f)
3) 50-100% fallen trees, in a patch less than 100 m wide
Figure 2. c,) d)
4) Less than 25% fallen trees
Figure 2. g,) h)
5) Bended, but apparently still alive trees
Figure 2. i,) j)

Steps of the automated image analysis

1. contrast-split segmentation (sunny-shady crown parts)
2. multiresolution segmentation - generate a crown-level segmentation
3. classification by applying NDVI tresholds
4. generating a higher-level segmentation using tree height layer
5. classification of higher level based on tree height and standard deviation of tree height
6. refinement of the lower level classification based on the height classes
7. reclassification of higher level based on the relative area of sub-objects

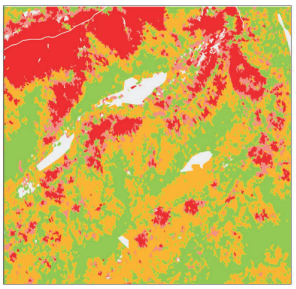
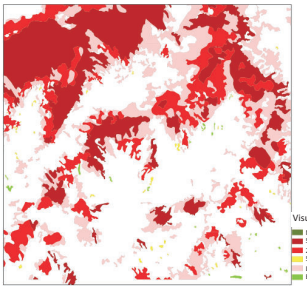


Figure 3.
Result maps



Results

Figure 3. shows the maps resulting from visual interpretation and the automated OBIA method. The two maps were intersected in ArcGIS and the differences analyzed. Figure 5. shows the error. The automatic classification recognised the areas of fallen trees quite well, the error is only 4% (a.). However 21% of the area where the automatic classification shows damage, was classified as 'No damage' by the visual interpreter (b.). However Figure 4. c.) shows that approx. 88% of that seeming misclassification is damaged crowns, which, at that stage, were not considered by the interpreter.

Figure 4.
Fish-eye photo of affected beech stand

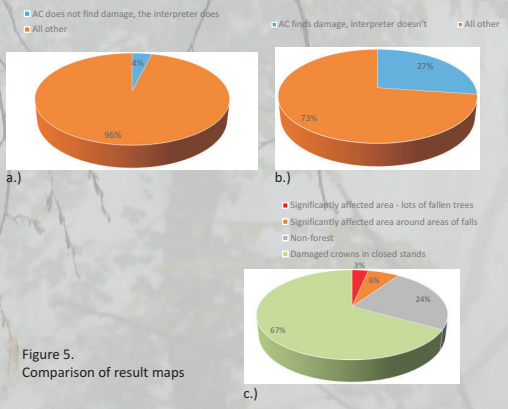


Figure 5.
Comparison of result maps

Discussion

When comparing the two maps, it is especially the areas with a high proportion of fallen trees which appear very similar on both. In the case of the less damaged stands the differences are probably caused by inherent differences in the two mapping approaches. While the visual interpreter considered the fallen trees (or in some cases the remaining root plates), in the course of the automatic analysis the characteristics of the remaining living trees were considered.

Conclusions

- NDVI is a useful summary of the general condition of thecrown layer, but it is affected by several factors, which need to be accounted for - threshold values should be customized for stands of different age and species composition
- Areas of major damage (i.e lots of fallen trees) can be identified correctly with most of the methods - however where a lot of trees remain standing crown damage and actual fall are hard to separate
- Crown damage is very hard to detect even in the field (also with visual interpretation) especially when the fallen trees and branches are removed

Major references

Kristóf, D., Belényesi, M., Burai, P., Czimber, K., Király, G. és Tanács, E. (2013a): Távérzékelési adatok és módszerek erdőtérképezési célú felhasználása. Esettanulmányok és ajánlások. – Kutatási jelentés. An Augur Kft

Tanács Eszter, Barton Iván, Belényesi Márta, Burai Péter, Czimber Kornél, Király Géza, Kristóf Dániel (2017): Távérzékelt adattípusok felhasználásának lehetőségei az erdőállapot-értékelésben. In: Standovár Tibor, Bán Miklós, Kézdy Pál (szerk.): Erdőállapot-értékelés középhegységi erdeinkben. 612 p. Budapest: Duna-Ipoly Nemzeti Park Igazgatóság, pp. 37-107.