SPATIAL ANALYSIS OF VEGETATION STRUCTURE USING UNMANNED AERIAL SYSTEMS

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INTRODUCTION

Applied ecologists always appreciate fine-scale data about vegetation structure. LiDAR provides an important source of accurate elevation data, however, data gathering is costly for the common user. Image matching approach offers an affordable alternative, especially for a local scale. Comparison and application of airborne and terrestrial LiDAR and UAV-borne data for the horizontal and vertical structure of vegetation in the man affected as well as close-to-nature environments are the main aims of this research.

STUDY AREA I

An arboretum founded in 2007 on site of the university campus, north-west Prague. The study area takes up 2.4 ha and includes approximately 900 plant species, divided into 22 thematic units. The relief of the area is topographically homogeneous (elevation ranges 280–289 amsl). The study site represents a man affected locality.

DATA

Terrestrial laser scanning (TLS) was performed on 20th July 2017 using FARO Focus 3D X130 at 42 stations resulting in 160 million points. UAV imagery was acquired on the 20th of June 2017. A miniature fixed-wing vehicle with a maximum take-off weight of approximately 0.8 kg and the wingspan of 0.96 m, with consumer grade digital compact camera DSC-WX220 was used. Both data were acquired during the full vegetation period.

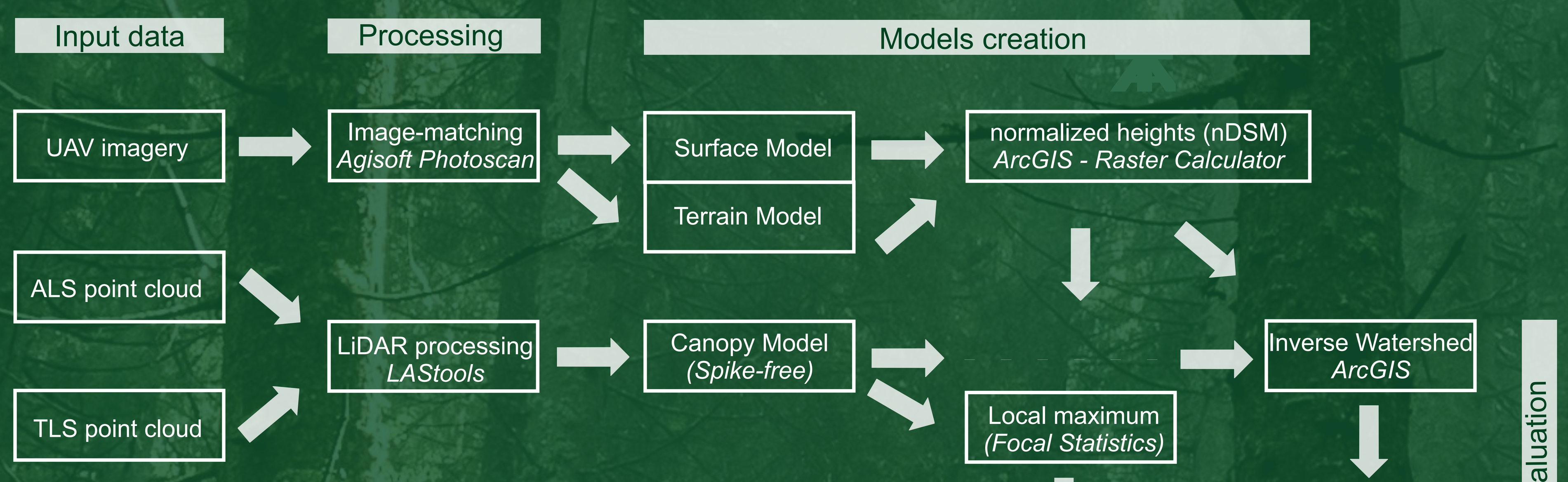
STUDY AREA II

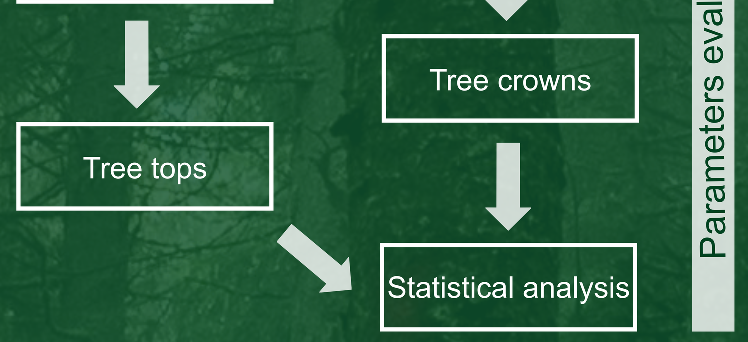
Military area used for NATO exercises takes place in mountains of Doupov, West Bohemia. The area is typical by landscape mosaic consists of forest with ordinary management and large no-forested area covered mainly by herbaceous and shrub vegetation affected only by military activities. The relief is predominantly hilly and topologically very ranked (elevation ranges 364–933 amsl). The study site (with approx. 144 ha) represents a close-to-nature area.

DATA

Airborne laser scanning (ALS) data was acquired on the 10th September 2016 by ALS70 Leica Geosystems. Whole scanned point cloud occupies an area of approximately 216 km^2 and contains almost 486 million points with mean density 20.61 pts/m^2 (last return density 15.54 pts/m^2). UAV imagery was acquired on the 20th June 2016 by the eBee aerial platform with Sony DSC-WX220 camera. Both data were acquired during the full vegetation period.

METHODOLOGY

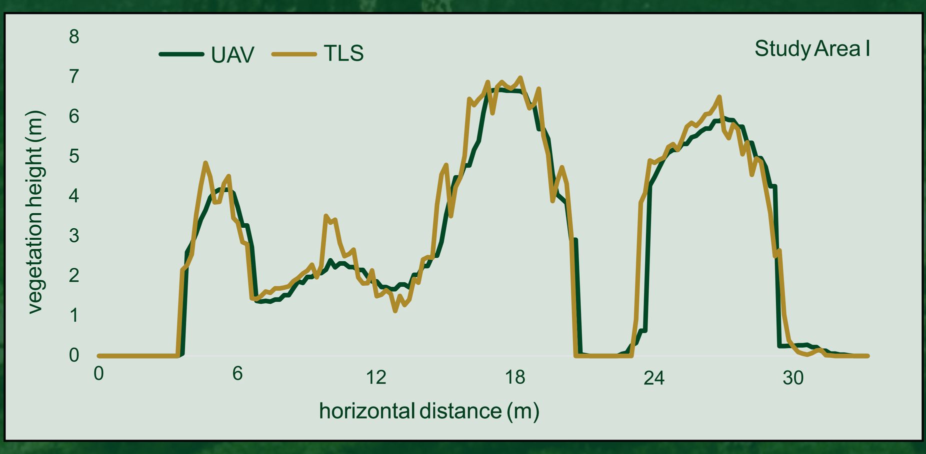


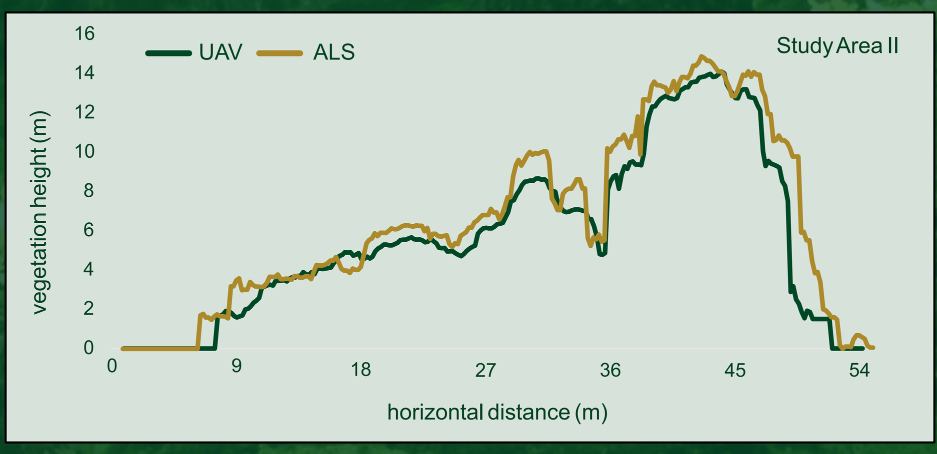


LiDAR data (ALS and TLS) was processed using LAStools. The processing workflow covers noise removing, points cloud classification (ground vs. vegetation), its normalization and building of Canopy Height Model using the Spike-free algorithm.

The UAV imagery was processed using Structure from Motion (SfM) approach in Agisoft PhotoScan. Digital Surface Model and Digital Terrain Model were subtracted in ArcGIS software in order to acquire normalized heights. Treetops (Local maximum approach) and crowns delineation (Inverse Watershed algorithm approach) were created at the level of individual trees in ArcGIS software. LiDAR and UAV data differences were visually compared for the case of crowns delineation and vertical profiles (trace indicated above the details of study sites).

Laser scanning ordinary tend to afford accurate results, in our case, both image matching and laser scanning gave similar results. That means UAVs provide a valuable solution for a fine-scale local analysis and image matching offers an alternative to still expensive high-tech solutions like a LiDAR. As the figures show, results are close to each other for both man affected and nature close areas.





RESULTS

An automated process of the tree crowns delineation for both environments are shown below. Man affected site is expressed using a terrestrial laser scanning (A) and image matching approach (B).

Nature close landscape is expressed below by an airborne laser scanning (C) and UAV-borne data (D).

APPLICATION

The knowledge of accurate delineation of tree crowns is important for detection of bark beetle infestation at the level of individual trees, especially in a point of view of an applied ecologist. Spectral images should be supported by object heights to make an automatic determination of tree position possible due to shadows. Therefore, UAVs represent a fine-scale flexible solution for local extents. In the case of using LiDAR technology, it's necessary to add another optical sensor (multispectral, hyperspectral, etc) to achive proper results.

Learn more about using UAVs not only for bark beetle attack detection at ***http://kurovec.czu.cz*** and at author's ***ResearchGate*** profiles!

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