

STUDYING SOME FOREST CHARACTERISTICS USING A DRONE

Kerimov I.A., Elzhaev A.S.

Grozny State Oil Technological University named after Academician M.D. Millionshchikov, Grozny, Chechen Republic
ibragim_kerimov@mail.ru

Abstract. The article presents some results of the study of the Roshni-Chu forest area using the Geoscan 401 unmanned aerial vehicle. The research methods include multispectral and lidar imaging. The equipment used includes a digital camera, a multispectral camera, and a laser scanner.

Key words: research area, multispectral survey, lidar survey, NDVI, height of trees, crown volume.

Introduction

There is a steady trend towards the development of the unmanned aerial systems market and the active use of unmanned technologies in the economy for solving various tasks (geological exploration and mining, construction, agriculture, forestry, etc.). As part of this area, we are conducting work using aerial photogrammetry, multispectral, and laser data collection tools to further process the obtained data, create thematic maps, and conduct analysis.

In the current year, in order to obtain information about the heights of trees and the volumes of their crowns, we conducted multispectral and lidar surveys using the *Geoscan 401* unmanned aerial vehicle.

The surveys were conducted in the forest area in the village of Roshni-Chu in the Chechen Republic [2, 6].

Methods and techniques

We conducted remote measurements (multispectral and lidar surveys) on the study site using the Geoscan 401 drone, which was equipped with a high-performance *Geoscan Pollux* multispectral camera, an *AGM MS 1.2* laser scanner, and a *Sony ZV-e10* digital camera [5].

The Geoscan Pollux multispectral camera allows you to capture images simultaneously in five narrow (12-40 nm) bands. In addition to the main visible spectrum channels (blue, red, and green), the camera captures far-red and infrared wavelengths, enabling the calculation of various vegetation indices.

A laser scanner (lidar) provides rapid acquisition of accurate and detailed digital terrain models for subsequent mapping of vegetation cover and measurement of tree height, biomass volume, and other measurements.

Using an aerial camera simultaneously with a laser scanner allows you to create the most accurate orthophotos. Thanks to the camera's swivel mechanism, all details of objects are recorded, and a detailed three-dimensional model can be created based on the obtained materials.

Aerial, multispectral and lidar data were processed using *Agisoft Metashape* and *LiDAR 360* software.

Multispectral survey. The survey was conducted at an altitude of 250 m. at a speed of 10 m/s. The coverage area was 3.43 km². To avoid gaps in the terrain, the survey was conducted with a 60% overlap. A total of 12210 images were captured. After uploading the images to the Agisoft Metashape software and aligning them, a dense point cloud was created for better terrain detail and model construction.

Different indices are used for visualization and practical application of multispectral imaging materials. The vegetation condition is determined using vegetation indices, the most common of which is the Normalized Difference Vegetation Index (NDVI) [1, 3, 4].

Lidar survey. The survey was conducted in order to obtain accurate and detailed digital models of the studied area and to construct cartograms of tree heights and crown volumes for the subsequent determination of quantitative values of these parameters. The survey was performed at a height of 110 m with the relief

skirting. The density of points on the studied surface at the specified height was about 300 points/m². The total area of the scanned forest area is 240 ha. The data obtained allowed us to obtain the desired taxation indicators (tree height and crown volume) and construct the corresponding cartograms.

Results and conclusions

Based on the multispectral data we calculated the NDVI index and created maps to assess the vegetation activity of the plants (Fig. 1). Figure 1 (a) shows the NDVI map based on the multispectral data collected in May 2023. Fig. 1 (b) shows the NDVI map based on the multispectral data collected in October 2023 on the same site.

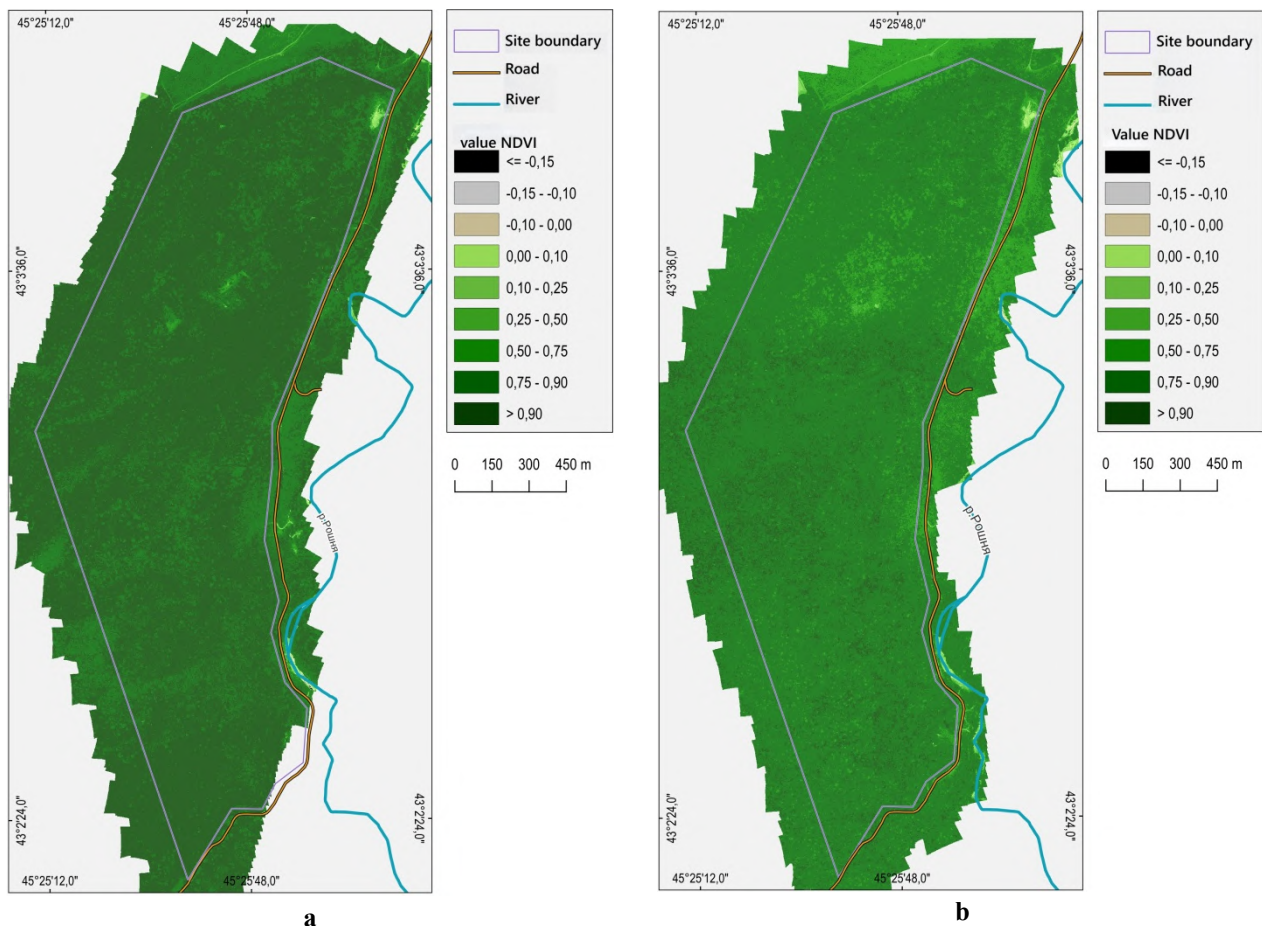


Fig. 1. NDVI maps constructed during the period of maximum vegetation (a) and during the period of reduced vegetation activity (b)

From fig. 1 (a) it can be seen that the "Roshni-chu" site is dominated by high values of the NDVI index, which are characteristic of physiologically healthy green foliage and fall within the range of 0.75-0.90. These values were obtained at the beginning of the maximum vegetation period.

Fig. 1 (b) shows a decrease in the NDVI index values, which is consistent with the autumn decline in plant vegetation activity. The values are predominantly within the range of 0.25-0.50.

Processing of lidar survey data allowed to obtain a three-dimensional point model (point cloud), consisting of an array of laser reflection points (LRPs) with a density of up to several hundred points per 1 m² and an accuracy of determining their coordinates of up to 5 cm. in plan and in height. Further processing included automatic classification of LRPs using such modules of the LiDAR360 program as *Forestry* and *Terrain*. Three-dimensional digital elevation models were obtained. Fig. 2 (a) shows a 3D terrain model processed in the *Forestry* module, and figure 2 (b) shows a 3D terrain model processed in the *Terrain* module.

The heights of the trees and the volume of their crowns were calculated. The maps of the heights of the trees and the volumes of their crowns were created using the *QGIS* GIS system. To create these maps, the original data was converted to the *GPKG* format and represented as a vector point layer, where each point

was interpreted as a single tree. The file containing the data on the trees contained 119,000 objects. The study area was divided into 50x50 m cells, and the maximum and average values for «tree height» and «crown volume» were recorded for each cell. As an example, the average values of crown height and volume are shown in Fig. 3.

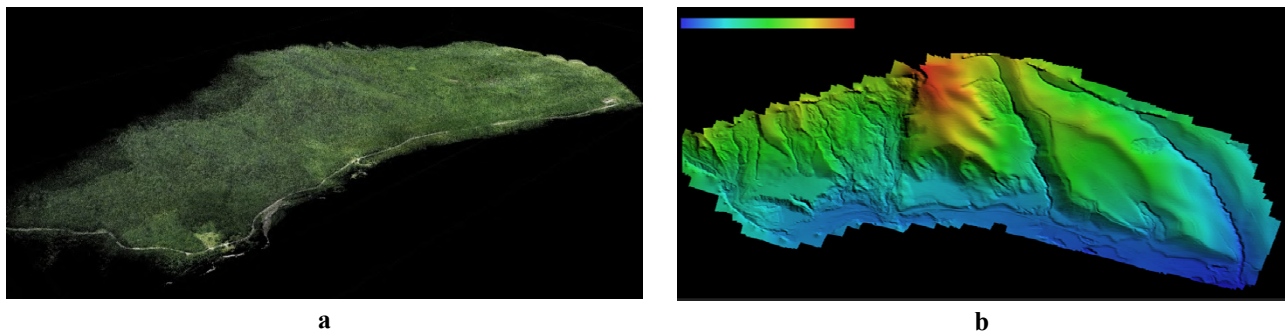


Fig. 2. Digital elevation model built in modules Forestry (a) и Terrain (b)

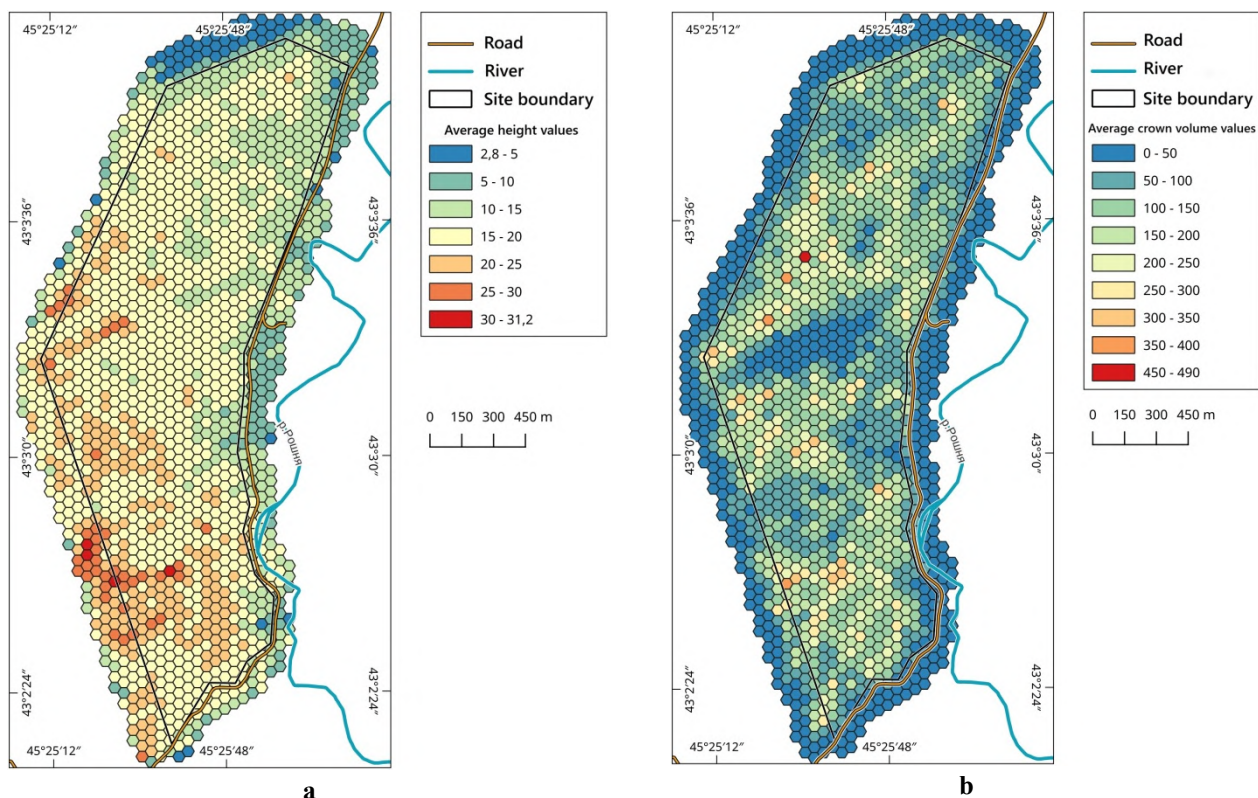


Fig. 3. Maps of average tree height (a) and crown volume (b)

The analysis of the results obtained allowed us to draw the following conclusions:

1. The materials obtained from multispectral and lidar surveys are of high quality and can be used to solve a wide range of problems in various fields of human activity.
2. The NDVI map constructed from the multispectral survey data confirms the conclusion that the forest area under study consists of healthy trees.
3. Detailed topographic models were constructed based on the results of the lidar survey, and quantitative indicators of tree heights and crown volumes were calculated. The data on tree heights and crown volumes are representative. The area is dominated by trees with heights of 20-30 m.

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