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MONITORING DIVICIORI FOREST IMPROVEMENT PERIMETERS USING AERIAL PHOTOS

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Abstract
Forestry research involves difficulties because it is largely on the field and less in the laboratory. Because of this, forest monitoring has been carried out quite hard, with a fairly low accuracy and their duration was rather high.
Along with the development of aeronautical, batteries and cameras technologies, unmanned aerial vehicles (UAVs) have emerged, which are used in agriculture and construction, and in recent years they have also been adopted in the forestry domain.
Today, the use of drones in forestry is reduced to forest surveillance, fire detection, identification of flora and fauna, but their potential is much higher.
Researches on the state of forest health have been carried out in an improvement area planted in the 1980s to stop soil erosion, using both modern techniques (drone overflight, GIS techniques) and traditional monitoring (soil level observations, sample shedding and laboratory determinations).
From the results obtained from the processing of data collected with the drone flight and validated using soil level observations and laboratory analyzes, it results that the forest in the improvement area is attacked by fungus Lophodermium pinastri.

Keywords: degradated lands, drone, forest health status.

1. INTRODUCTION

There are about 7 million hectares of forest in Romania (http://roifn.ro/site/rezultate-ifn-2/), of which about 2 million are inaccessible or very difficult to access. Because of this, the characterization of the forest fund in these areas is very difficult, sometimes even impossible, and their accessibility is not a priority. The access to new technologies, especially satellite technology, has helped forest specialists to characterize forest land in inaccessible areas with satisfactory precision.

Current research in Romanian forestry consists of two parts: field research and laboratory research. The correlation of the two parts implies the application of classical methods: harvesting of samples from live trees or downed trees, repeated monitoring in probing surfaces (Alexe, 1983; Moldovan, 2018) visual determinations in the field. The harvested samples are analyzed in the specialized laboratories (Tăut, 2018).

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With the development of aeronautical and space technologies and their use in the civilian area, various applications have been developed to facilitate research in the various fields where extensive land areas have to be covered in order to collect data such as agriculture, forestry, etc.

The most commonly used technologies for health monitoring are the satellites to obtain information on different forest areas, some accessible, others less accessible or even inaccessible.

With the development of batteries, diminishing their size and mass, autonomous flight systems (UAVs) have been developed for the civilian field and, implicitly, have been adopted in various fields of research. If the agricultural and construction sectors have been used for a few years with very good results, in the forestry domain this is at an early stage. As imagery and technologies associated are advancing and UAV's become financially more accessible, drones can be now used on a large scale in forestry, such as forest management, forest research, forest modeling or forest gaps mapping.

Today, the use of drones in the forest field is reduced to forest surveillance, fire detection, flora and fauna identification, but their potential to be used in various activities increases with camera refinement, LiDAR systems and infrared sensors. In the future, these new technologies will also facilitate other work, such as more accurate health monitoring.

2.MATERIALS AND METHODS

In order to achieve the proposed goals, to make effective use of drone technology in forest monitoring, bibliographic research has been carried out on diseases and pests that attack the foliar appliance, following attack patterns (Simionescu, 2000). Combining the models of attacks described in the literature with various models obtained from aerial photographs processing, biogrupes of attacking trees can be delineated, helping scientists with precise geographical landmarks in identifying infested areas in the forests.

The research was carried out in an area of land improvement with forest planted in the 1980s near Diviciorii Mari, Cluj Country, to stop soil erosion and improve environmental conditions. These have taken place in several stages, each having the role of better understanding each step taken to achieve the best possible results to continue this type of monitoring approach. This improvement area consists of two subcompartment 49a and 49b (Figure 1 and figure 2).

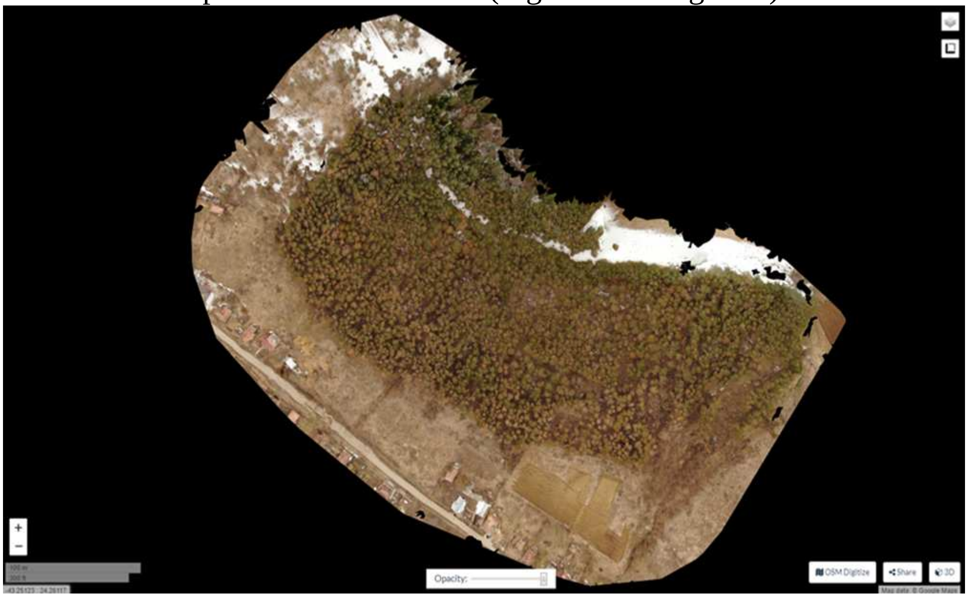

Figure 1. Subcompartment 49a

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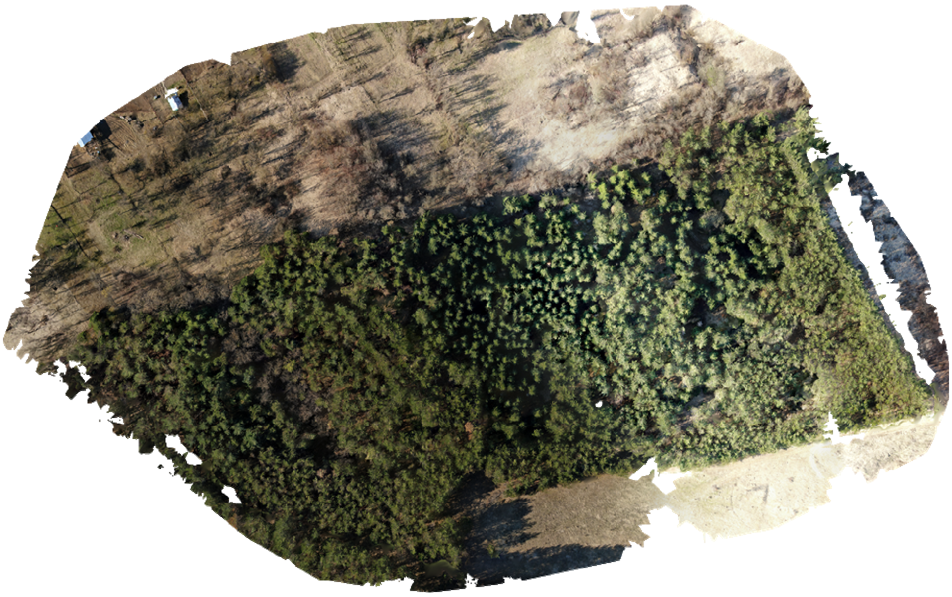

Figure 2. Subcompartment 49b

For collecting field data, the DJI Mavic 2 Pro Zoom drone (Figure 3) used to fly over the forests in the study area. It features a camera that can make high-quality photos that can be processed using specialized software to get orthophotomaps, which can later provide a variety of information, being the input data for further reprocessing (eg: VARI or TGI algorithms).

To achieve accurate results, multiple settings have to be taken into consideration, such as camera angle nadir direction (vertically downward - 90° angle), flying height (40 - 150 m AGL above ground level), front overlap (overlap in the flying way) 80%, side overlap 75%, Shutter Speed, ISO, White Balance, as well as the atmospheric conditions and light.
(https://blog.dronedeploy.com/seven-ways-to-improve-the-accuracy-of-your-drone-maps-9d3161f05956).

Figure 3. DJI Mavic 2 Pro Zoom drone

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3.RESULTS AND DISCUSSIONS

Photo processing resulted in orthophotomaps, the elevation pattern of the terrain and images in which vegetation is represented by pixels (LIN, 2015). They have a circular shape, in the case of trees, they are overlaid with colors depending on the natural environment to re-construct their shape, forming the 3D modeling of the forest (Figure 4 and 5).

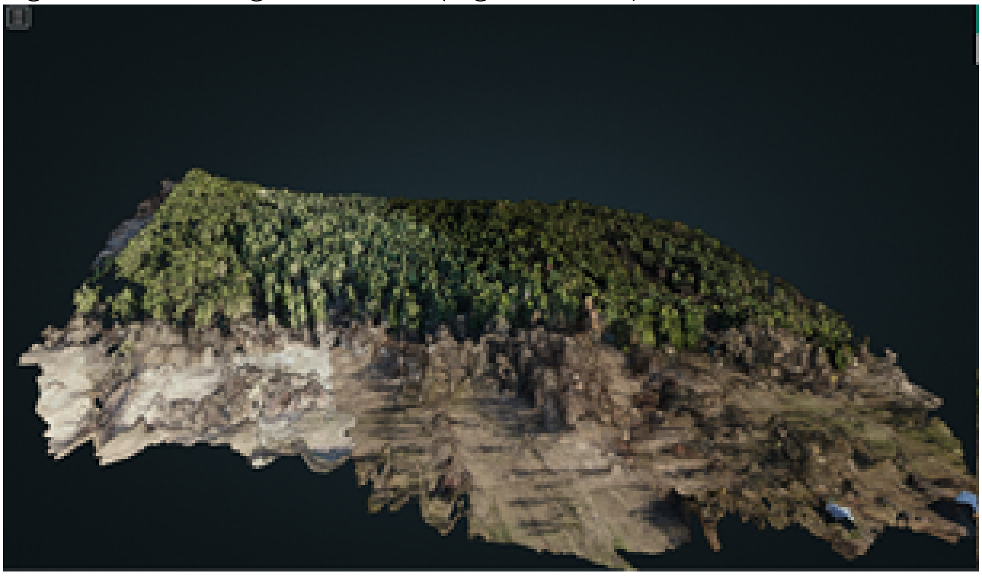

Figure 4. Subcompartment 49a 3D model

Figure 5. Subcompartment 49b 3D model

Analyzing stand level 3D modeling it was found that in subcompartment 49a, a large number of trees have reddish shades, which may mean that the trees are attacked. In subcompartment 49b, the number of attacked trees is smaller, due to the Northwest exposure, which means a lower sunstroke.

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Analyzing the 3D model at the individual level it was found that the arrangement of the reddish pixels is at the base of the tree, and as they climb to the top, they tend to a green hue (Figure 7, 8, 9). These analyzes are confirmed by ground observations (Figure 6).

Figure 6. Ground observations

Figure 7. Reconstruction of attacked trees in pixels, compared to those on the aerial photo

Figure 8. Reconstruction of attacked trees in pixels, compared to those on the aerial photo

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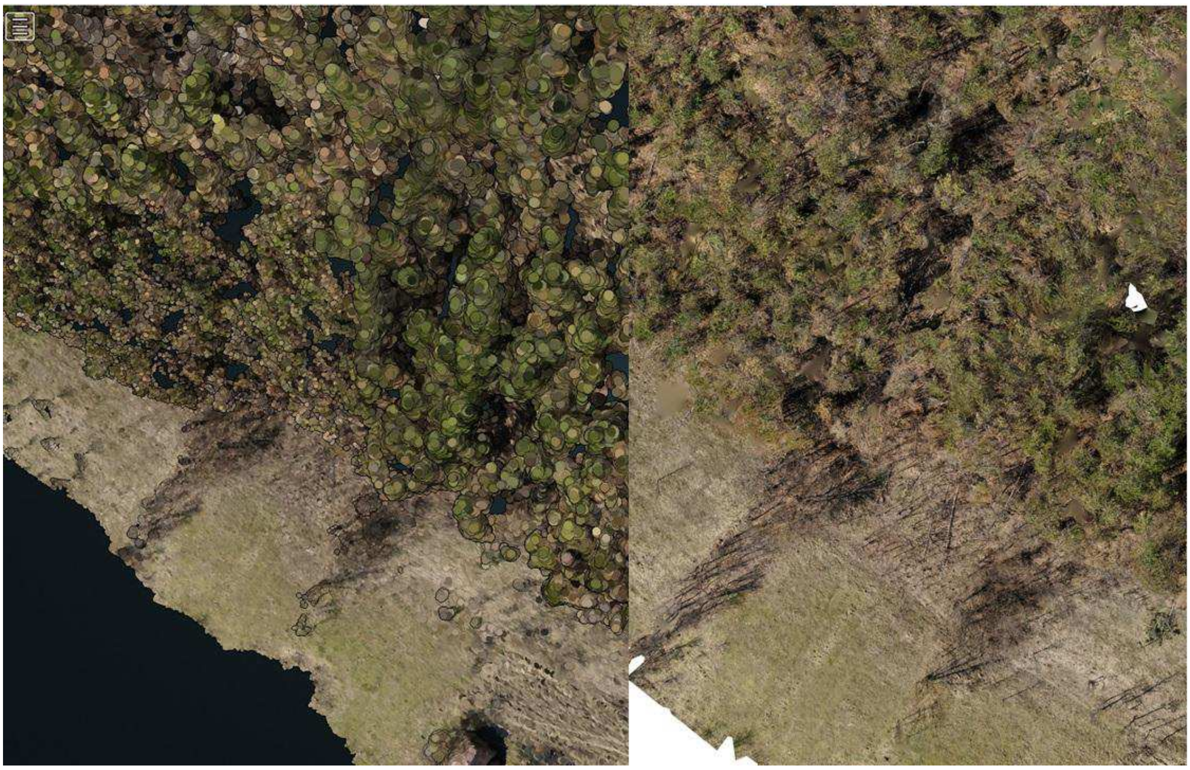

Figure 9. Reconstruction of attacked trees in pixels, compared to those on the aerial photo

According to the literature, this type of attack is caused by the pathogen *Lophodermium pinastri*, which causes the disease called flushing needles. In order to confirm the pathogen, shoots were harvested, both red and green, from both stands for laboratory analysis. Following their analysis, the disease-specific signs were found on needles (Figure 10, 11).

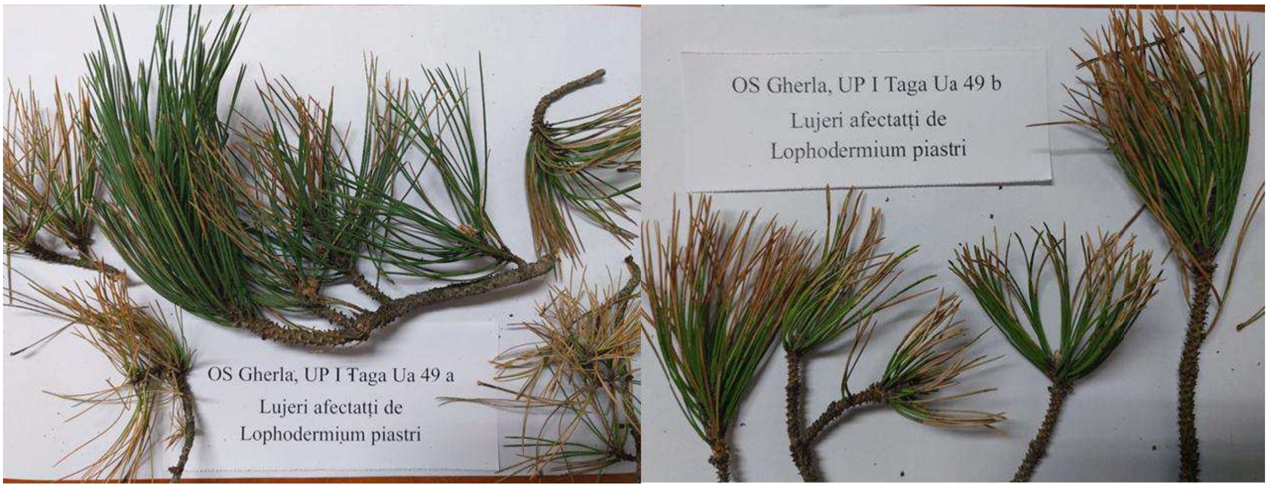

Figure 10. Attacked needles

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Figure 11 . Attacked needles-detail

4. CONCLUSIONS

Unlike the interpretation of satellite imagery, image processing with drones aims at establishing precise diagnostics on smaller surfaces. Thus, although satellite images have the advantage of scalability, the use of the drones brings a complementary solution for a more detailed analysis of research surfaces, even in areas of land that are normally accessible only by foot.

The stands within the perimeter were overflown and photographed, having the first image analyses layer processed with an open source platform (orthophoto maps and 3D models). Further development was made, in order to integrate algorithms, such as VARI and TGI, RGB-Based Vegetation Indices.

By correlating the 3D model at the individual level, which involves red base pixels and green tone pixels to the top, with the description of the literature attack, the redness of the needles from the base to the top of the crown, it can affirm that the pathogen present is *Lophodermium pinastri*.

The presence of the pathogen was detected by both field and laboratory analyzes.

The research described in the current paper is at an early stage. Further implementation will be conducted in order to automate measurements of forests canopies, such as density, cover and health, which can later be correlated to more accurate diagnosis.

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