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GEOMATIC TECHNIQUES FOR THE ENVIRONMENT

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ABSTRACT:

The main goal of this paper is to implement modern, up to date, geomatics techniques and technologies in the environment. The entire database is made in GIS software, a GNSS device is used to record detailed points on the field and for recording and preparing a new orthophoto was used a modernly sophisticated drone (UAV) DJI Mavic Pro. QGIS (Quantum Geographic Information System), as main software, was used for data processing and implement measurements taken from the field, and other utility programs were used to perform the tasks. The subject of the paper is the Promenade riverside Kumanovo, Macedonia, which is a convenient place to try and implement this data processing method. First of all, it is a small area with a pretty large scale which makes it easier to recognize and practically examine the details on the field. Also this method can be applied in the forestry, agriculture, water management, geodesy, spatial planning, sustainable development and environmental protection.

Keywords: QGIS, GNSS, UAV, inventory, geomatics techniques, remote sensing.

1. INTRODUCTION

The good appearance and preservation of nature is a wealth that needs to be passed on from generation to generation. The care for the environment and the overall natural environment becomes a moral responsibility of the whole community [3]. With the great advances in the technologies in all spheres, as well as in forestry and urban areas, new transparent databases are created that will make it easier, more effective and safer to manage the environment. In recent decades, remote sensing techniques applied in forestry has been given an increased attention, which leads to the ability of extracting important information for forest planning and sustainable management such as the forest structure, composition, volume or growth [11]. In Finland, the City of Helsinki's Street and Park Division maintains a digital tree register (approximately 40,000 trees) that includes trees that are situated at road sides and some of the trees in the parks. The tree-register data includes information on the species, height, diameter-at-breast height (DBH), and geolocation.

The tree-register data are used in urban and environmental planning, in locating old trees that are hazardous (for citizens), and in biodiversity monitoring [21]. In the last decade, drones of different sizes, shapes and capabilities have grown rapidly and have acquired a growing interest in civilian applications, as well as precision agriculture, forestry, biodiversity, meteorology, emergency preparedness, so the drone revolution is already here [11]. It represents a powerful technology that surely enters into everyday life. The progress of UAV is growing with the progress of other technologies such as computing power, which is no longer an obstacle, and the process of collecting and processing huge amounts of data is now much easier [1]. A GNSS (GPS) or global navigation satellite systems is a very precise way to display the desired location. The accuracy dependents on the device itself, or data available on the base station, and of course the number of available satellites in the sky when the data is collected [2]. There is also a method of collecting data on the exact location of the trees with the so-called Total Station. After the collecting of data is completed with this device they can be directly downloaded into a computer and entered into GIS.

GIS or geographic information system gradually but surely becomes a valuable tool for demonstrating how natural and human-produced components communicate with one another. In many countries, GIS software is used as the main tool in many departments and sectors.

2. MATERIALS AND METHODS

2.1. Study Area Description

It is located 840 meters from the city center of Kumanovo and represents one of the newest built urban green areas occupying 45,200 square meters. On the north, this area is located at the crossroads that connect the boulevard Oktomvriska Revolucija and boulevard Gjorche Petrov ; 42.13573, 21.72777 and 42.13579, 21.72853. On the south the coordinates are on the intersection that connects boulevard Oktomvriska Revolucija and boulevard Makedonska Udarna Brigada; 42.12597, 21.73119 and 42.12616, 21.73225.

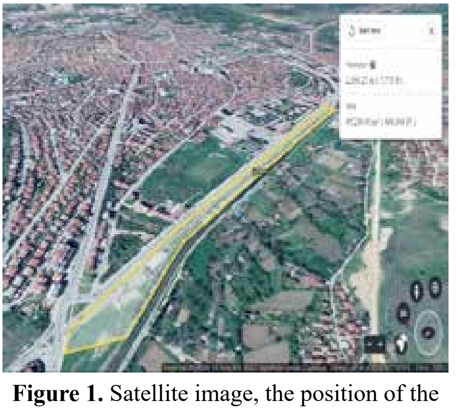

Figure 1. Satellite image, the position of the river bank Kumanovo (Google.Earth.2018)

Figure 2. 3D projection aplication dronedeploy

2.2. Data Acquisition and Processing

This study started on August 1, 2018, and the entire database was developed in GIS software, a GPS device was used to record detailed points on the ground, as well as for recording and for making a new orthophoto recording with a modern sophisticated drone, DJI Mavic Pro, was used. GIS will make it efficient, effective, executable and exemplary in designing, decision making, action taking and evaluating park and recreation management services. Besides offering better alternative for tree management system of Public Parks, it also can enhance the quality of the parks by a proper maintenance where the standard system provides a framework for periodically inspecting and evaluating the condition of the trees in the park. This park's standard maintenance system represents the attempt to clearly outline quality standards for all public parks [23]. Positions of marked trees were individually recorded as waypoints using a Garmin GPS receiver. The GPS receiver is small, handy, and easy to use; these features are suitable for forest inventory [22]. In this case the details of the terrain are recorded with the Garmin Dakota 20 GPS device, which is a sport model with good features. All the details of the terrain were recorded i.e. the location of all trees was recorded, in this case, 647. At the same time, a collection of attributes of the trees in this area has been carried out simultaneously. GIS software was also used in this paper, Geographic Information Systems (GIS) use georeferenced (location based) data to visually represent the dataset, which allows users to better understand and solve problems. GIS can be defined as "A system for capturing, storing, checking, integrating, manipulating, analyzing, and displaying data which are spatially referenced to the earth"[7].Similarly, the drone is useful. As previously mentioned, Drone is an unmanned aircraft that is driven by ground. The very control and management of the drone can be manual, that is, without a pre-made flight plan by which the drone will be moving, or with the help of various applications that give the opportunity to create a map or route for the drone to move.

The current use of drones in forestry applications is still at an experimental stage, but with great potential in the near future [11]. The first step for using this new application is to install it into a device (mobile phone/smartphone) that will be connected later with the drone controller.

Aplication is dronedeploy www.dronedeploy.com. It creates a profile of it and gives the opportunity at any time to plan and edit new or old maps and flight plans. Flight Path Planning and Data Acquisition After finalising and testing the components of the selected UAV, the next stage of the training comes with planning the flight path and capturing the images. A flight-planning tool is used to minimize the manual effort needed in flight planning processes such as overlapping of photo imagery to guarantee appropriate overlapping coverage. The pilot from the ground control unit then decides the region of interest on an interactive map, photo size and resolution, flight altitude above the ground, flight speed, and longitudinal and traverse coverage of each photo for maximum survey area coverage. The operator than finally defines the start and end points of the flight path to be formulated [24]. In this case, it was recorded with a height of 100 meters with a pixel size of 3 cm, overlap of shots of 70% and a maximum flight speed of 54.7 kilometers per hour. Recording of the site lasted 21 minutes and 241 photos were taken. Lizarazo uses RGB photos to create 3D geometry first because the spatial resolution tends to be more optimized than the infrared photos. In addition, they developed algorithms and applied Wallis filters to successfully improve the accuracy of the final product [19]. In addition to the orthophoto, the application also offers a 3D projection of the marked space as well as photographs from the altitude, and pictures showing the state of the trees.

Figure 3. Dronedeploy aplication, create flight plan

2.3. Processing the collected field data

The processing of data collected from the field is carried out in the QGIS (Quantum Geographic Information System) platform version 2.18.25. Geo-referencing of footage, processing of collected GPS points (Waypoints), processing of excel tables, moving of GPS points was performed. Georeferencing involves image alignment in a coordinate system. Is the stage at which the image becomes a form of spatial data, since they are characterized by reference to a coordinate system defined by parameters such as projection and point of origin (datum). For georeferencing a map we need at least two pieces of information: a series of points easily identifiable on the map whose location (latitude and longitude, rectangular coordinates) are precise (here the principle is: "the more, the better") and the projection system where the original map on paper was made. When processing the collected GPS points (Waypoints), a database of information on individual trees is created. This information includes tree location, diameter, height, canopy width, condition [25]. As indicated in the GPS chapter and the GPS points collection, each recording makes a certain "error" depending on the characteristics of the device itself.

The GPS device that it is used for this work has approximate accuracy of 3-10 m. With the processing of the points, i.e. their input, as well as the input of the drone photos into the GIS software it has come to an incomplete match of these two important elements. Specifically, the GPS device for each point, in this case, the tree deviates for a certain distance. In order to complete this operation and processing, the GIS software offers us the opportunity to move these points to the desired position.

3. RESULTS

3.1. Overview of the dendroflora on the river bank Kumanovo

With the inventory carried out in this area, a total of 647 trees were identified, a total of 27 species of trees were recorded. In addition, a table from the entire dendroflora of the river bank Kumanovo is presented. The complete tree inventory of public lands in river bank Kumanovo showed a very diverse mixture of tree species. There were 27 species of trees present (Table 1). Of these, five species represented the majority of the trees: Catalpa bignonioides (79 trees), Fraxinus Americana (170 trees), Thuja orientalis (78), Cupresuss arizonica (53), and Salix matsudana (53 trees) [20].

Table 1. Dendroflora of the river bank Kumanovo shown in tabular form

Taxa	Tree mark
Catalpa bignonioides	79
Acer platanoides	7
Celtis australis	5
Cupressocyparis x leylandi	22
Fraxinus americana	170
Juglans regia	1
Morus alba	6
Picea pungens	11
Thuja occidentalis ‘Smaragd	7
Tilia tomentosa	6
Prunus cerassifera ‘nigra	7
Koelreuteria paniculate	3
Thuja orientalis	78
Cupressus arizonica	53
Picea abies	37
Cedrus deodara	10
Quercus frainetto	2
Thuja occidentalis	19
Thuja plicata	3
Cupressus sempervirens	1
Pinus wallichiana	5
Cedrus atlantica	11
Juniperus sabina	1
Acer negundo	1
Salix babylonica	32
Salix matsudana	53
Acer dasycarpum	7
Total:	647

3.2. Mapping Attributes in the GIS Platform

For the purpose of detailed and transparent presentation of the dendroflora and collected attributes from the river bank, the GIS platform offers us various possibilities and benefits in terms of mapping or creating maps. For this purpose, 5 maps were prepared:

- Map of species
- Map of diameters
- Map „Width of the canopy"
- Map of heights
- Map of damages

In the window Categorized we have an opportunity the previously arranged layer to be divided by the input attributes. In this case, data are provided from which the maps themselves are made, ie the type, diameter, canopy, height, damage. By opening one of the offered attributes and clicking Classify, all of them are classified in different colors for different data. This operation completes the first stage in making a thematic map. For example, a map of species will be presented (Figure 4).

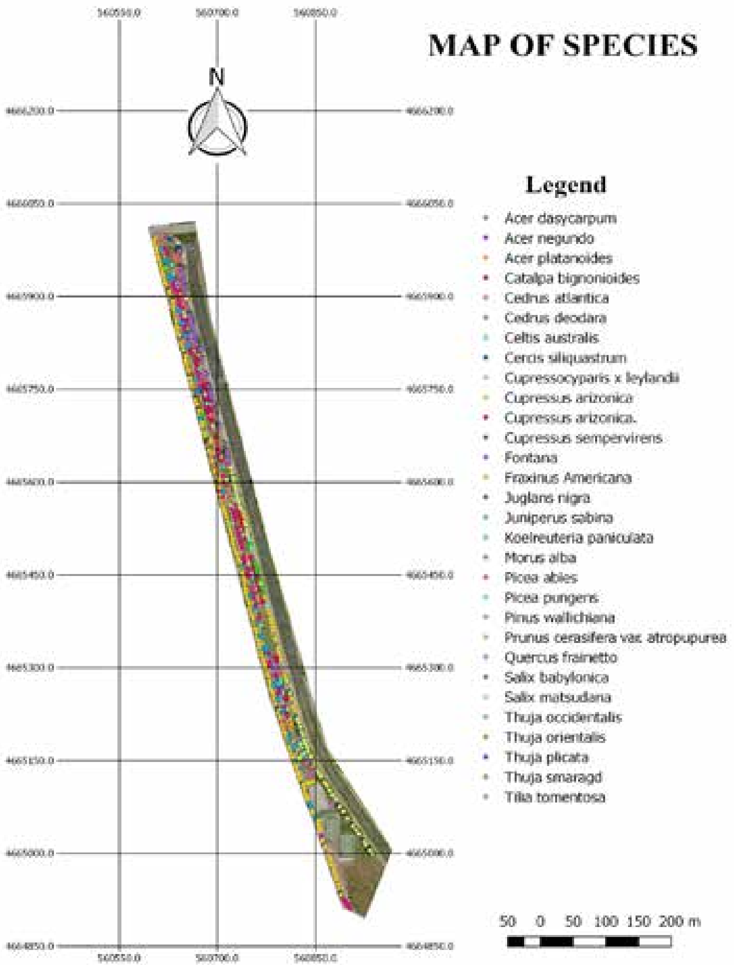

Figure 4. Map of species river bank Kumanovo

3.3. Publishing thematic maps on a GIS platform

Once a GIS database is created composed of GPS points collected from the field and their processing as well as the input of attributes, a DRON photo processed (geo-referenced) creates a digital map i.e. a web page that provides forestry and horticultural data for the points that are the subject of this paper. In this complete database GIS software gives us the opportunity through the QGIS Cloud plug-in to create a web-based digital map of all trees on the river bank, which would be accessible to all citizens. All citizens, visiting the river bank may have an overview of the trees species, their condition, height and diameter for each tree separately [6].

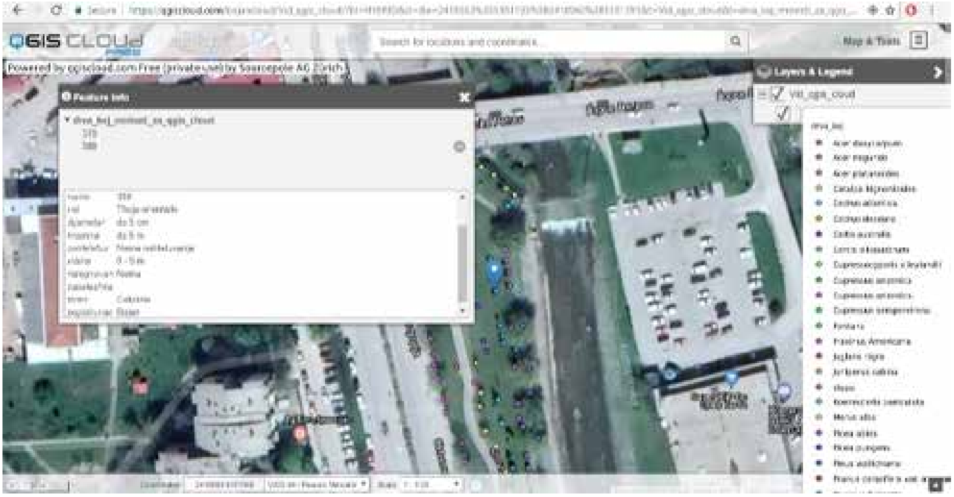

Figure 5. Web-based digital map of all trees on the river bank Kumanovo

4. CONCLUSION

The need of our society for such devices and drones is necessary but there have always been obstacles in the introduction of new technologies, primarily because of the funds, lack of development strategy, lack of educated staff that will implement the reforms, but most of the cases are from ignorance or insufficient information about the advantages of this technology. The use of drone and the technology of drones besides that can and has a great application for a variety of purposes has its advantages and disadvantages. As an advantage can be cited surveillance and security. His ability to give an overview of the environment is one major advantage of survival. You can easily identify what is happening in your area or if there are some riots nearby. In addition, having airborne drones can help you investigate the damage caused by storms or any natural disaster. The ability to control a drone from a distance allows you to detect problems before reaching you without having to expose you to potential threats. To identify and avoid objects in the flight path, you can add proximity sensors. When the battery is low or the controller loses connectivity, the “return-to-base” function is a great asset. One of the main advantages of the drone is that it is available to all users, that is, the prices are pretty small for this kind of technology. A shortcoming is the short life of the battery, although drones are suitable for use, they have short battery life. On average, the battery with a single charge gives you the opportunity to use the drone 20-25 minutes depending on the drone itself and its specifications. The drone used for this study can fly 27 minutes with one battery. One of the drawbacks of drones is that they can be shot down, trapped. Although the drone is considered a technology that helps society to develop, in some cases this type of drone is used for terrorist attacks or attacks that endanger the lives of the civilian population, ie it is a fairly cheap and effective weapon. This paper presents how with the aid of modern geomatic techniques and technologies we can greatly improve the environment. The inventory carried out on the green area of the Kumanovo riverbank is a detailed overview of the urban dendroflora under the jurisdiction of "JP Chistota i Zelenilo", and as such it will be of great benefit to the same company. In fact, that information or the census itself gives us the knowledge of what we actually have and what we have on our disposal. What is significant is the result that 674 trees have been recorded and 27 different types were encountered on such small space in an urban environment. The prepared maps presented in the previous chapter are an example of many large cities in Europe and the world about how a public company actually organizes managing green areas. All 5 cards are 3 pixels high resolution and high-quality recordings shot by DRON. The ultimate goal of this paper is to digitize the data collected from the field and to make them available to the general public. By publishing the thematic maps in Gis Software, a complete transparent digital map data has been obtained, with which each visitor on the page has an overview of the overall dendroflora the processed area with all the attributes and information gathered from the field.

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