TREE INVENTORY REGISTRATION SYSTEM

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ABSTRACT:

As human life develops in all aspects, nature is damaged and faced with the threat of extinction. With the increasing population, cities are expanding. The importance given to greenery and the ecological system is very low in these cities and they look like a concrete forest. However, urban trees are the most important and dominant vegetation materials that make important contributions to the city and the city people in terms of ecology, social, cultural, economic and aesthetics. A tree inventory system that will be created using GIS technologies will be very helpful in terms of both protecting the trees and tracking the forestation. In Nicosia, the capital of Northern Cyprus, the importance of the trees in the city has started to reflect on public awareness. In this study, with the GIS study carried out on the pilot region selected in Nicosia, trees were registered by using a tree registration form and ArcMap and shown on the system according to their types. The tree information stored in the database together with the data collected in 9 categories will make it easier to track trees and prevent them from being cut down. In addition, in the study, it was explained how the system should be converted into a smart city application with use of mobile technology.

1. INTRODUCTION

The period we live in our world, which has undergone a great change with the introduction of the computer into our lives, is called the "Information Age" (Dekkers, 2019). In this age, societies that can actively use information technologies are improving and developing because these societies could understand the value of information in different fields and improved themselves to use information systems correctly (Miller, 2020). With all these improvements, significant advances are being made all over the world in Geographical Information Systems (GIS) applications. GIS, which is used in many different areas such as the protection of nature from city planning, have a very important usage all over the world (Burrough et al., 2015). Especially, making use of GIS tools in spatial planning studies can make it possible to implement future decisions after evaluating them in a wider perspective (Simao et al., 2009).

Increasing air pollution every day with crowded cities has confronted our world with two disasters such as climate change and global warming (Rosenzweig et al., 2011). While high greenhouse gases released from cities cause global warming, they also cause many dangerous diseases such as cancer and cardiovascular diseases (Haines et al., 2006). Especially carbon monoxide released from car exhausts is very dangerous because it causes lung cancer. Also, the reason of being constantly tense and tired in the cities where there is heavy traffic is carbon monoxide. On the other hand, residential buildings are responsible for 18% of the carbon monoxide emission in the atmosphere (World Health Organization, 2011).
At this point, the importance of trees, which are the most effective air cleaning tool of the earth, should be emphasized. An adult pine tree converts the carbon dioxide released by 40 people into the air in one hour into oxygen in 1 hour. 1 hectare pine forest filters 36.4 tons of dust in the air and produces 30 tons of oxygen per year (Dwyer et al., 1992). All tree species contribute to nature. An adult beech tree produces 1.5 kilograms of oxygen per hour. One hectare spruce forest cleans 32 tons of dust per year, and one hectare beech forest cleans 68 tons of dust per year (Thomas, 2014).

Wildlife is necessary even for highly modified areas such as cities because it can positively influence the quality of human life. Trees are very important for wildlife as they support the living of many organisms. Many animals' uses trees for food, shelter, resting and nesting. Forestation in cities will also contribute to the development of wildlife (Leedy et al., 1978).
Trees in the cities are very important in terms of ecological balance (Dieleman, 2017). In cities insufficient forestation, the quality of life decreases with the effect of concreting and the air pollution that occurs has negative effects on human health (Greene et al.., 2018). Greenhouse gases emitted especially in cities where there is heavy traffic can only be reduced with sufficient forestation (Cai et al., 2019). For this reason, it is important to record tress in the GIS and accept them as the main inventory of the city. Thus, while contributing to forestation, concreting can also be prevented (Corbett and Mellouli, 2017).

2. THE PROBLEM AND PURPOSE OF THE STUDY

According to the "Strasbourg European Urban Charter" included in the "International Environment Agreement", it is necessary to establish nature conservation areas and to improve the use of plants, and to plan open and green areas (Yıldız, 2013). On the other hand, according to the report of the World Health Organization; the green area per person should be 9m2 in cities (World Health Organization, 2016).

Nicosia is the capital of Northern Cyprus with a population of 82,539 and in this city, there are concrete structures built side by side. Open green areas and forestation in the city are very few. The city developed unplanned in parallel with population growth and open green spaces were not sufficiently covered in this plan. The total woodland areas in Nicosia Central Region, where the concrete structures are the most, are shown in Figure 1 as acres.

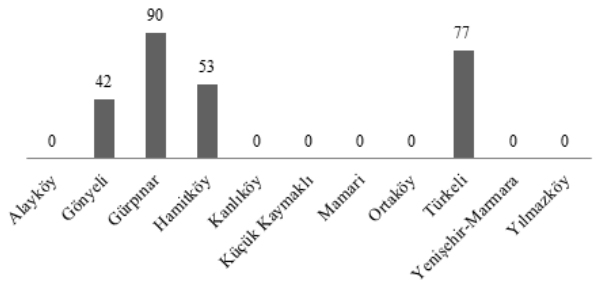


Figure 1. Total Woodland Areas in Nicosia Central Region (TRNC State Planning Organization, 2017)

As can be seen in Figure 1, while the total woodland area is more in regions such as Gönyeli, Gürpınar, Hamitköy and Türkeli, which are close to the border of the region designated as the city center, the total woodland area is 0 acres in other regions located in the center of the city.

Another important point in Nicosia is; municipality-controlled trees are very few and many of the existing trees are within the private property of individuals. In Northern Cyprus, it is forbidden to cut pine, cypress, juniper, eucalyptus, plane tree, oak and poplar trees, which are defined as forest trees in the law, even they are planted in private properties. These trees can only be cut with permission from the Forestry Department if they are infected or dead. Also, permission must be received from the district governorships for the cutting or trimming of fruit or decoration trees in the houses (Forest Protection and Utilization Regulation, 1983). However, since the trees are not registered in any inventory, these actions cannot be controlled. People can cut these trees in their private property without permission to make room in their gardens or to use the land for other purposes like construction. Because these trees are not registered in any inventory system, following or proving illegal actions is very hard. The purpose of this study is to make a tree inventory system for trees of Nicosia with the help of GIS.

3. METHODOLOGY

It is important to record each tree as an inventory in Nicosia, to protect existing trees and contribute to forestation. In the GIS environment used for this purpose, the tree inventory approach was tested by applying it to trees located on the 16th, 17th and 18th streets of Taşkınköy. There is no municipal tree in these streets and all trees are in private properties.

As in previous studies, at the beginning of the process, the base sheet was created. This step is important to determine the location information of the trees that fall within the boundaries of the determined pilot region. The data thus obtained can be used in the creation of an information system for trees. In this process, the zoning plan was used. In order to benefit from the zoning plan in GIS environment, some transformations were made in the coordinate system and the images were converted to raster data format. It is also possible to check whether the data fits correctly in their coordinates by this converted layout (Gül et al., 2012).

ArcMap 10.7 was used to determine the location of city trees. The World Imagery layer, which was updated on 22 July 2020, was implemented on base map. A Tree Registration Form was then designed to identify trees in the pilot area.

Tree Registration Form

Date: ____/_____/_____

Tree No	Tree Code	Tree Name	Area	Street Name	Latitude	Longitude	Situation	Type	Health
1									
2									
3									
4									
5									
6									
7									
8									
9									
10									
11									
12									
13									
14									

Figure 2. Tree Registration Form

The tree registration form contains data in 9 different categories as shown in Figure 2. These data will be entered as follows.

Tree Code: This code will contain abbreviation information about the region where the tree is located, registration order, street name and the type of tree. For example, the fruit tree on the 18th street of Taşkınköy region which has registered in the first row will be coded as TAS18-01FR. The abbreviation FR was used for fruit trees, the abbreviation FO was used for forest trees, and the abbreviation DE was used for decoration trees.

Tree Name: This part will contain the scientific name of the tree.

Area: The name of the region where the tree is located.

Street Name: The name of the street where the tree is located.

Latitude and Longitude: The net coordinates of the tree will be recorded in the form as latitude and longitude. In order to determine the net position of the tree both on the created substrate and on ArcMap, the registrar will find the exact location of the tree using Google Map.

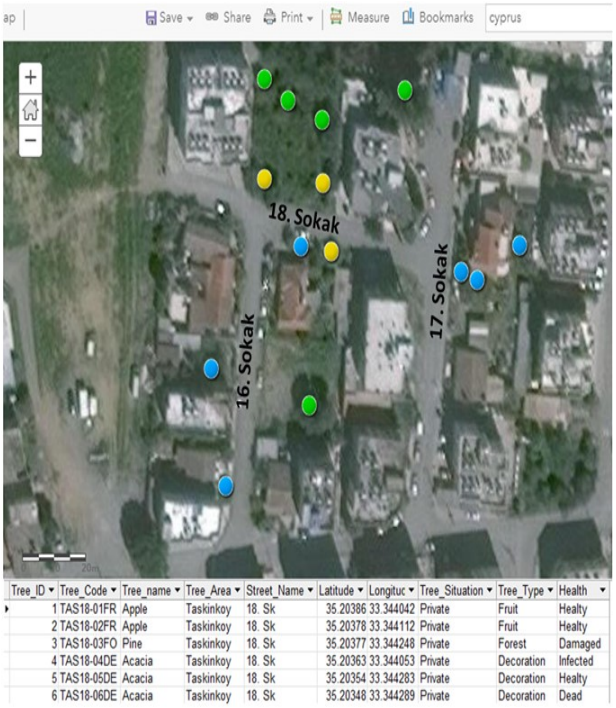
Situation: In this area, it will be written whether the tree belongs to the municipality or it is in a private property.

Type: In this field, the type of the tree will be written. Tree type will be written in 3 different categories as fruit, forest and decoration trees.

Health Condition: Health information of the tree will be entered in this field. Health status will be written in 4 different categories as healthy, infected, damaged and dead.

A database has been created for the tree to process the data in the tree information forms obtained in the ArcMap. The database chart has been clarified in ArcMap program to include tree information form information.

Figure 3 shows representation of trees in the pilot area by ArcMap. The green colour used for marking represents forest trees, the yellow colour represents fruit trees and the blue colour represents decorative trees. The location of the trees, color codes and all the data in the database were created in line with the tree registration form. The disadvantage here is the loss of data that will occur if the paper is lost or worn. In addition, while the purpose is protecting trees, causing extra paper usage also contrasts with the purpose of the study.



Tree_ID	Tree_Code	Tree_name	Tree_Area	Street_Name	Latitude	Longitud	Tree_Situation	Tree_Type	Health
1	TAS18-01FR	Apple	Taskinkoy	18. Sk	35.20386	33.344042	Private	Fruit	Healty
2	TAS18-02FR	Apple	Taskinkoy	18. Sk	35.20378	33.344112	Private	Fruit	Healty
3	TAS18-03FO	Pine	Taskinkoy	18. Sk	35.20377	33.344248	Private	Forest	Damaged
4	TAS18-04DE	Acacia	Taskinkoy	18. Sk	35.20363	33.344053	Private	Decoration	Infected
5	TAS18-05DE	Acacia	Taskinkoy	18. Sk	35.20354	33.344283	Private	Decoration	Healty
6	TAS18-06DE	Acacia	Taskinkoy	18. Sk	35.20348	33.344289	Private	Decoration	Dead

Figure 3. Representation of Trees with ArcMap.

If the project is successfully implemented with a traditional way, an update should be applied on this traditional information collection system with use of mobile application. Figure 4 shows an android application interface proposal which is designed to collect data for tree information system. The proposed mobile application interface is designed with Android Studio and it is compatible with the SqLite database. There are multiple advantages of digitizing paper-based systems. First of all, digital/computerized systems such as mobile applications are time and cost-effective. Using mobile application for tree registration system will bring advantages such as follows:

- Paper waste will be prevented. Besides it is cost-effective, preventing paper waste is very important to protect trees. In United States, approximately 1 billion trees worth of paper are thrown away annually. This amount is enough to heat 50 million houses for 20 years.
- Because system allows officers to record directly in the database, both the employee who records the trees outside and the person who transfers these records to the GIS environment in the office can work simultaneously. Therefore, lots of time will be saved.
- Report producing will be much faster and cheaper because data is stored safely and available when it is needed.
- Classic troubles such as duplication of data entry, miskeying, paper loss or paper damage will be prevented.

Coordinate information can be drawn using Google Map, just as in the traditional way, or it can be obtained by using the location feature of the phone with a code to be added to the software. In this case, the only thing to be done is to go to next or under the tree to be registered with the mobile device and enter the data of the tree with the location data into the database. Those working in the office part of the same project will be able to access this information instantly and start the necessary work on ArcMap without waiting.

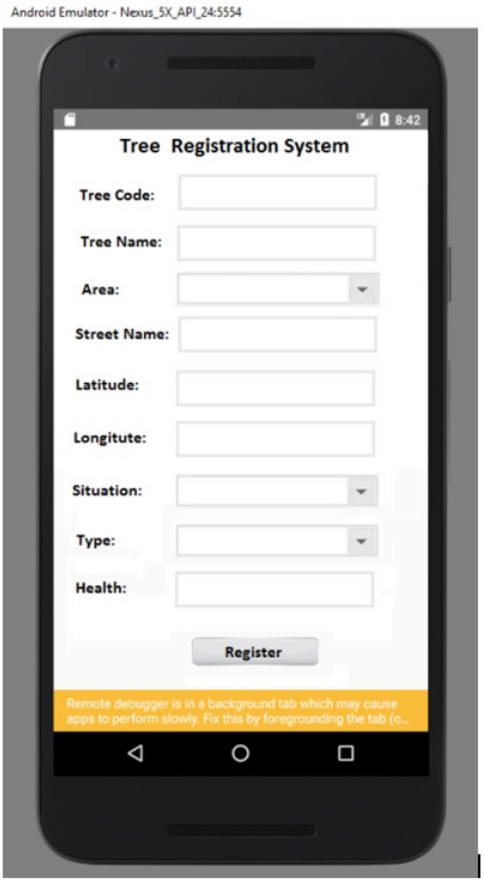


Figure 4. Android Application Interface for Tree Inventory Registration System

Figure 5 is an illustration of the sample database designed for the proposed mobile application. All tables and fields in the database have been designed in accordance with the tree registration form. Just like in the form; the type table will contain three categories: forest, fruit and decoration. Situation table will determine whether the tree is in the municipality or private land. Finally, the condition of the tree in the health table will be determined as one of 4 different categories as healthy, infected, damaged or dead.

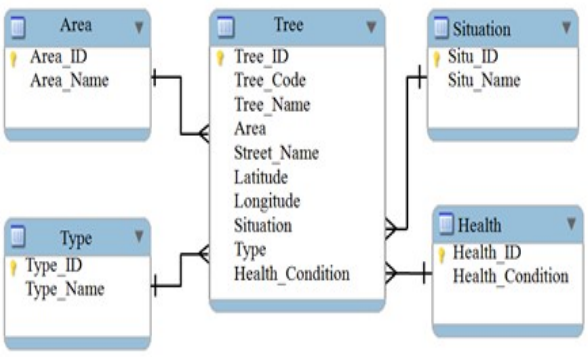


Figure 5. Sample database designed for the proposed mobile application

4. CONCLUSION AND RECOMMENDATIONS

Trees in cities are an important component of urban life worldwide and provide numerous benefits to people. Many cities have a poor understanding of the value of trees for wildlife. Therefore, it creates a gap in our knowledge of conservation in urban ecosystems (Wood and Esaian, 2020). It is important to determine the current status of the trees with an inventory study, to monitor their changes over time and to be able to respond to these changes in a timely manner (Vaughan et al., 2001). Developed countries control trees by using GIS technology because they consider trees as one of the most important parts of natural resources. However, there is no such a practice in Northern Cyprus.

In 2012, Gül et al., conducted a study to offer a registration model for Isparta city's trees by using a GIS. Data collection phase of the study is completely paper based. In 2020, Oguz et al., designed a web based tree registration system for Kahramanmaraş city. This web application can be accessed with personal computers, tablets or smart phones. Data about trees were also collected manually and paper based. The most important difference of this study with similar studies is that after applying the system once, it will be continued immediately through the mobile application.

With the inventory recording system presented in this study, trees in Nicosia will also be protected. People who will be deprived of the freedom given by being uncontrolled will feel obliged to follow the rules and will be aware that if they do not, they can be fined at any time. For this reason, coordination work and agreements should be done with Nicosia Municipality and Directorate of Forestry Department. Thus, it is ensured that other trees are planted instead of the trees that have to be cut and the forestation works in the city can be tracked more efficiently. Following the successful implementation of this system in the capital city, the system can be implemented in all cities of the whole island. On the other hand, the database will turn into big data storage and may lead to many scientific studies on forestation and wildlife in Northern Cyprus, also will be a resource for machine learning studies.

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