Building Monumental Tree Inventory Using Geographic Information System

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Key words: GIS, Forest, Monumental tree, Monumental tree inventory

SUMMARY

Forests are the significant integral part of the sustainable natural resources all around the world. They cover approximately 30% of the Earth's land surface. Besides they provide critical services including food, water and shelter for human and animals and wide array of benefits such as raw materials for industry needs but most of them poorly recognized. Monumental trees mean that trees which have much larger sizes than the common sizes of their species in terms of age, diameter and height, have a special place in the history, culture and folklore of the local and is naturally old enough to provide communication between past to present and also present to future are recognized as "monumental trees". Numerous monumental trees identified and conserved all around the world until today.

In the last three decades, information technologies have giant effects on research techniques specific to geography. Geographical Information System technology offers giant capabilities for more informed management decision making, rendering competent decisions still depends on having reliable data. Geographical Information System (GIS) as an integrated, spatial, data handling technological program that collect, store and retrieve data, transform and display them from the real world for a specific set of aims. Besides, GIS is a multipronged system which all different types of geographical data is efficiently used, stored, updated and analyzed. In geographic information system software, hardware, data methods, and users which all components can manage and support the analysis of standardized geographic data. Data collection is an important aspect in order to get the coordinates of the trees accurately. GPS technology is the accurate equipment for tree location mapping. In this research, the study area is located in Marmara Region of Turkey, the border of Bogazici University Kandilli Campus in Istanbul. The coordinates of the study area is 41º 03' 39'' – 41º 03' 53'' North Latitute and 29º 03' 26'' – 29º 03' 42'' East Longitude. The aim of the study is to detect, manipulate and register the database for the monumental trees located in Bogazici University Kandilli Campus. For this purpose, first reconnaissance performed, then all available, information collected and registered using ArcGIS software. In this paper, monumental tree inventory for the campus area which are based on GIS will be introduced.

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1. INTRODUCTION

A forest can be defined as an area that incorporates all living and non-living things and is dominated by trees that can grow to at least 2 meters high, with a canopy that covers 20% or more of the ground data [1]. All around the world, forest areas are diminished and destroyed due to the improper use. The forest is roughly 30% of the entire world however deforestation rates is 13 million hectares per year [2]. In Turkey, forest and forestland cover 27,2% of total country which corresponds to 27 million hectares. The protected area is approximately 1,6% which corresponds to the total country area (Fig1).

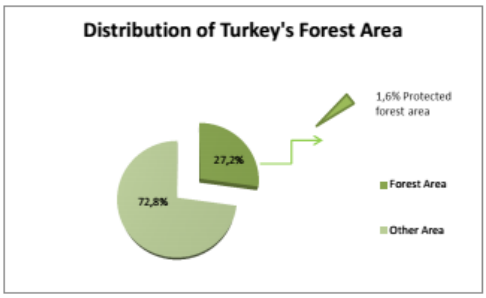

Figure1: The Distribution of Turkey's Forest Area

Turkey is one of the most prosperous countries in the world in terms of different plant species. The estimated number is more than 10000 species of vascular plants which is roughly 34 % are endemic in Turkey [3,4,5]. In 1999, World Wide Foundation (WWF) identified 100 Forest Hot Spots which should be protected in Europe. In Turkey, there are nine important forest areas among these hot spots. These hot spots are, Istanbul Forests, Küre Mountains, Yenice Forests, Karcal Mountains, Fırtına Valley, Amanos Forests, Ibradi- Akseki Forests, Datça and Bozburun Peninsulas, Fethiye Babadag [6]. These hot spots are displayed in figure 2. Due to their importance to the nature conservation and to protect our forests, some significant precautions should be taken. In this study, Kandilli campus forest area is located in Istanbul Forests.

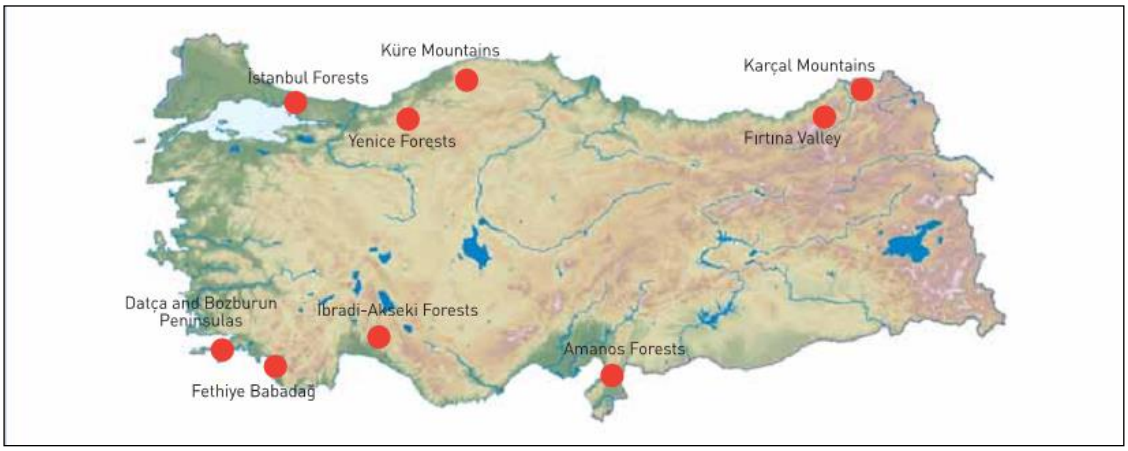

Figure 2: The Hotspots in Turkey

Benefits of the trees and forests are overlooked to become urbanized and make the environment urbanization improperly in the last century. Forests and trees are significant part of carbon storage and they also provide critical services including food, water and shelter for human and animals. Besides, forests provide wide array of benefits such as raw materials for industry needs but most of them poorly recognized. However, forests are exploited for different purposes such as wood for construction and fuel also food supply for grazing for a long time.

2. MATERIAL & METHOD

2.1 Study Area

The study area is located in Marmara Region of Turkey, the border of Bogazici University Kandilli Campus in Istanbul. The coordinates of the study area is 41º 03’ 39’’ – 41º 03’ 53’’ North Latitute and 29º 03’ 26’’ – 29º 03’ 42’’ East Longitude. The Kandilli campus covers 306 acre area.

2.2 Monumental Tree

Monumental trees mean that trees which have much larger sizes than the common sizes of their species in terms of age, diameter and height, have a special place in the history, culture and folklore of the local and is naturally old enough to provide communication between past and present and also present and future are recognized as “monumental trees” [7,8]. Additionally monumental trees are old age trees with some strange-shaped and exceptional diameters, spectacular height, peculiar foliages and gifted with an unrepeatable genetic code. Monumental trees are classified into four main groups in terms of their characteristics. These

are historical, mystic, folkloric and dimensionally monumental tree. All types of monumental trees have different features [9]. In this study, we classified trees in terms of their dimensions. Forest inventory commonly means the measurements of many important parameters of forests, trees and shrubs to the analysis of abundance, distribution, state, change and trend of forest resources. Besides, forest inventory is significant as a basis for sustainable forest management. The forest inventory process consists of the documents that evaluate and characterize the forest and tree attributes which is a core set of attributes that consists of the type of trees, size, tree height, diameter at the breast height (dbh), condition and also location of the forests, trees and shrubs in the community.

2.3 Method

In the last three decades, information technologies have giant effects on research techniques specific to geography. Geographical Information System (GIS) as an integrated, spatial, data handling technological programme that collect, store and retrieve data, transform and display them from the real world for a specific set of aims. GIS fundamental components are hardware, software, people, data and methods. Location of tree and tree attributes are significant elements for enhancing tree management system. Creating tree database in a GIS, users are able to access other type of digital data.

Data collection is an important aspect of any type of research study. Besides, there are numerous techniques available tree map locations efficient, precise and accurate form including aerial photo interpretation, GPS, surveying techniques and using existing maps for tree placement. Nowadays, surveyors use a great variety of equipment to measure the trees. These equipments can range from a magnetic compass, steel tape, clinometer, increment borer, to a laser distance equipment or to the most precise and accurate one GPS. GPS technology is the accurate one for tree location mapping. In this study, we prefer GPS method depending upon the accuracy of the GPS equipment in order to get the coordinates of the tree. The applied method in this study is essentially based on expert knowledge modelling and GIS, which enable the production of an inventory importance map for any forestland.

2.4 Tree Species in the Study Area

In the study area, the inventory identified 37 monumental trees, belonging to 8 different species. The species are, Cypress, Cedar, Linden tree, Horse chestnut tree, Plane tree, Oak, Celtis and Stone pine. Table 1 displays all monumental trees type, height, crown spread, diameter and trunk circumference.

No	Latitude	Longitude	Type	Height	Crown Spread	Diameter (m)	Trunk Circumference (m)
1	41,06313	29,06117	Linden tree	185	10	1,21	3,80
2	41,06273	29,06109	Celtis	175	15	0,67	2,10
3	41,06284	29,06088	Stone Pine	160	10	0,83	2,60
4	41,06248	29,06118	Oak	186	15	0,67	2,10
5	41,06343	29,05982	Stone Pine	160	20	0,86	2,70
6	41,06343	29,05992	Stone Pine	160	18	0,78	2,45
7	41,06373	29,05996	Stone Pine	160	15	0,70	2,20
8	41,06371	29,05987	Cypress	185	7	0,57	1,80
9	41,06371	29,06005	Stone Pine	160	15	0,72	2,25
10	41,06369	29,06015	Stone Pine	160	16	0,67	2,10
11	41,06356	29,06064	Stone Pine	160	16	0,89	2,80
12	41,06353	29,06063	Stone Pine	160	17	0,83	2,60
13	41,06337	29,06056	Stone Pine	160	14	0,76	2,40
14	41,06325	29,06052	Stone Pine	160	15	0,89	2,80
15	41,06331	29,06048	Stone Pine	160	10	0,62	1,95
16	41,06330	29,06042	Stone Pine	160	12	0,76	2,40
17	41,06338	29,06011	Stone Pine	160	15	0,89	2,80
18	41,06338	29,05970	Cypress	185	7	0,57	1,80
19	41,06297	29,05879	Cypress	185	8	0,95	3,00
20	41,06296	29,05889	Cypress	185	8	0,78	2,45
21	41,06293	29,05858	Stone Pine	160	20	0,70	2,20
22	41,06276	29,05850	Horse Chestnut Tree	165	20	0,70	2,20
23	41,06271	29,05847	Cypress	185	12	0,84	2,65
24	41,06271	29,05880	Cypress	185	12	0,67	2,10
25	41,06247	29,05856	Plane Tree	180	25	0,70	2,20
26	41,06243	29,05855	Plane Tree	180	25	0,99	3,10
27	41,06222	29,05824	Plane Tree	180	30	0,95	3,00
28	41,06214	29,05793	Cypress	185	8	0,80	2,50
29	41,06208	29,05783	Cypress	185	6	0,54	1,70
30	41,06223	29,05777	Cypress	185	4	0,67	2,10
31	41,06236	29,05777	Cypress	185	6	0,80	2,50
32	41,06239	29,05787	Cypress	185	6	0,89	2,80
33	41,06238	29,05779	Cedar	190	12	0,64	2,00
34	41,06251	29,05788	Cedar	190	10	0,73	2,30
35	41,06258	29,05789	Cedar	190	12	0,70	2,20
36	41,06265	29,05792	Cedar	190	15	0,76	2,40
37	41,06270	29,05794	Cedar	190	12	0,62	1,95

Table 1: Monumental tree Specification

During the study, monumental forest inventory geodatabase is created using ArcGIS software. In the database, monumental tree genus, latin names, ages, height, crown spread, diameter, trunk circumference, latitude and longitude data are written. Besides, all monumental trees photos are taken and verbal information with photos also are embedded into the database. Different type of queries are possible with ArcGIS software.

3. STUDY STEPS

In this section, basic premises and assumptions of how to measure a tree will be discussed. There are four different types of steps that measure the tree which are tree height, diameter at a breast measurement, crown spread measurement and finally tree age estimation.

3.1.Tree Height Measurement: There are two different ways to measure the height of tree. First method, we need clinometer which is an equipment that is a vertical angle gauge measuring the slope from the eyes to both top and bottom of the tree. The second method is to determine the height by trigonometric method. By using basic trigonometry and laws of similar triangles and right angles, the true height of a tree can be easily obtained. Figure 3 illustrated the principles involved in measuring tree height by geometric method.

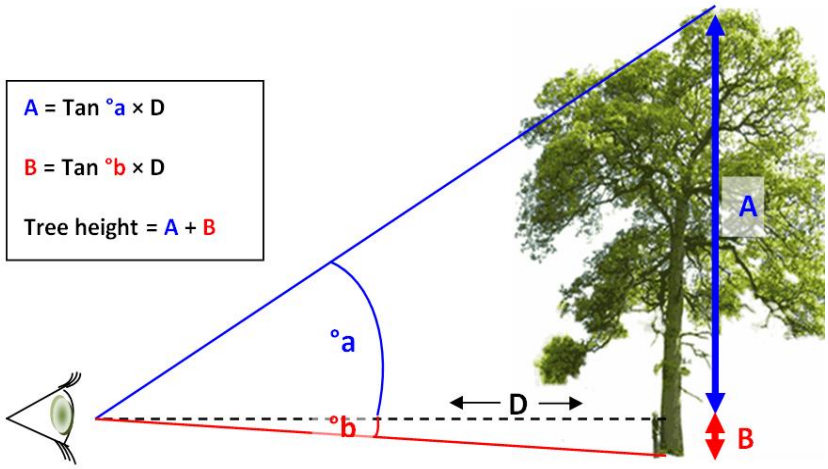

Figure 3: Tree height basic trigonometry

3.2.Diameter at a Breast Measurement: The diameter of tree should be measured in centimeters accuracy at 1.3 m above the ground. Then the result is divided by Pi number (3,14). The diameter is achieved (Fig 4). During the measurement, using a stick is the convenient way in order to get the precise result. Besides the most accurate method is to measure the diameter is using diameter tape. Since the diameter tape is calibrated which the circumference measurements are converted precisely and accurately pi number.

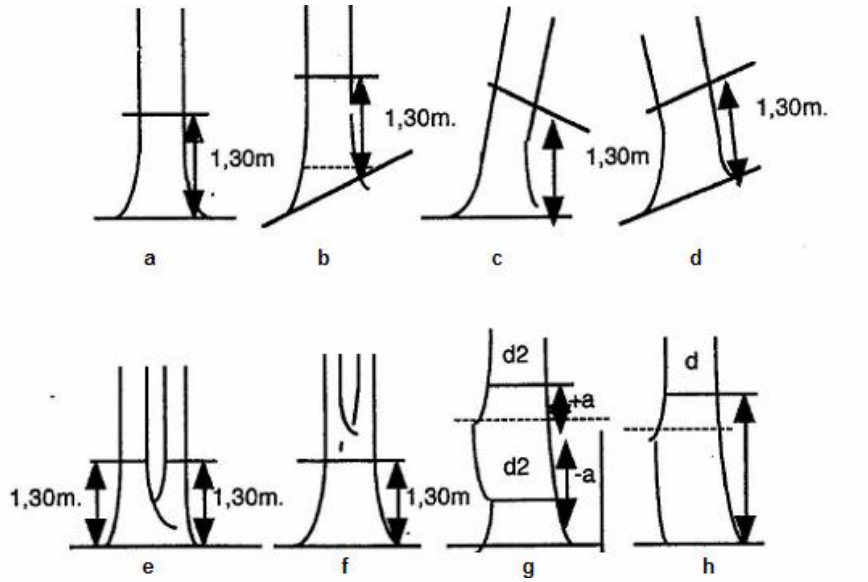

Figure 4: Diameter measurement ways

3.3. Measure the Crown Spread: Average crown spread is obtained by measuring the longest and shortest extent of the crown and averaging the figures. Crown spread is taken independent of trunk position. Start with your back to the trunk of the tree and measure to the point directly below the end of the furthest limb. All four measurements (A,B,C,D) are made the same way. Measure "A" & "B" and find the average. Measure "C" and "D" and find the average. Your final answer will be the average of the two averages already calculated (fig 5) [10]

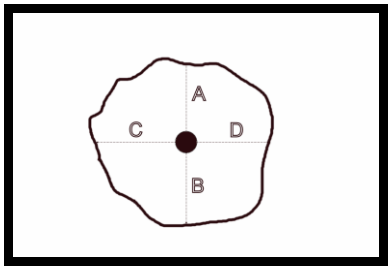

Figure 5: Measure the crown spread method

3.4. Age estimation: In order to estimate the trees age, increment borer are used.To get an accurate age of any tree, the rings must be counted near the base (ground) of the tree. Tree stumps can be used but only just after the tree is harvested. All trees have increment every year. We calculate the tree age with 5-year accuracy. For instance; between 450-454 the age is 450, between 455-459 the age is 455 [11]

4. CONCLUSION & DISCUSSION

Forests and forest areas are the most dominant vegetation in the forest ecosystem, however forest areas are diminished and destroyed due to the improper use. Monumental trees are the trees which have much larger sizes than the common sizes of their species in terms of age, diameter and height that have distinctive role and significant position in our culture and history to provide communication between past to present and also present to future. The value of monumental tree awareness is dramatically increased in the last two decades in the world. However, further studies and efforts are necessary to make local authorities aware of importance of careful inventories.

In this study, monumental trees that are situated in Bogazici University Kandilli Campus, are determined their location by GPS, assigned the genres, measured trunk circumferences, diameter and crown spread and finally calculated the age of all trees. All data are registered in ArcGIS. Besides, the inventory identified 37 trees, belonging to 8 different species. Most represented species are Stone pine (Pinus Pinea, 14 trees), Cypress (Cupressus, 11 trees), Cedar (Cedrus, 5 trees), Plane tree (Platanus, 3 trees) and rest of them Oak (Quercus, 1 tree), Linden tree (Tilia, 1 tree), Celtis (Celtis 1 tree) and Horse chestnut tree (Aesculus, 1 tree).

An effective and convenient tree inventory database can be created by good base map, a team of trained people, handheld GPS and GIS technology. In our country, monumental tree inventory studies has started in the beginning of 1970s however, these studies was conducted on a small scale and therefore was insufficient. GIS technology can be provided numerous opportunity in this area.

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BIOGRAPHICAL NOTES

Res. Assist. **Aslı SABUNCU** was born in 1980. She graduated from Yildiz Technical University in 2005 as Geodesy and Photogrammetry Engineer. She obtained M.Sc. degree from Bogazici University KOERI Geodesy Department. She is a research assisstant in the Geodesy Department in Bogazici University, Kandilli Observatory and Earthquake Research Institute and PhD student in Istanbul Technical University Geomatics Engineering. Her main interests are GIS applications, developing 3D GIS applications, database management systems,remote sensing and its applications, ENVI, GPS applications and crustal deformation studies with precise geodetic instruments and precise levelling.

Assist.Prof.Dr. **Asli DOGRU** was born in 1976. She received the B.S. degree in 1999, and the M.Sc. (2002) in Geodesy and Photogrammetry Engineering both from Istanbul Technical University and Ph.D. (2008) degree in Geomatic Engineering from the same university. She is currently working at the Geodesy Department of Kandilli Observatory and Earthquake Research Institute, University of Bogazici. She has ten years experience in earthquake studies on North Anatolian Fault Zone and

carried out more than 15 scientific research as a researcher. Her main interests are application of information technologies to the solution of problems in geoscience, geodesy, InSAR applications in geoscience research, GPS and crustal deformation using precise geodetic techniques. She has authored or co-authored over 50 scientific papers. She is a member of the Turkish Chamber of Surveying Engineers and the American Geophysical Society.

Prof. Dr**. Haluk OZENER** was born in 1967. He graduated from Istanbul Technical University in 1988 as Geodesy and Photogrammetry Engineer. He obtained M.Sc. and Ph.D. degrees. He is currently is the Vice Director of Kandilli Observatory and Earthquake Research Institute of Bogazici University and is also chairing the Geodesy Department. His primary field of research is Tectonic Geodesy. He is member and director of over 20 research projects and the author/co-author of over 100 publications related to Active Tectonics of North Anatolian Fault Zone/East Anatolian Fault and Aegean Extensional Regime, geodetic monitoring of deformation, establishment of geodetic networks, GPS applications to Earth Science, earthquake hazards, bathymetric surveying, Geoinformation Systems/GIS applications. He also serves as the chair of sub-commission 3.2 (Tectonics and Earthquake Geodesy) of IAG (International Association of Geodesy).

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