ASSESSMENT OF CARBON STORAGE AND SEQUESTRATION BY USING I- TREE PROGRAM FOR ATRUSH FOREST/NORTH OF IRAQ

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ABSTRACT
This study was aimed to assess the data collected from the Iraqi North forests of Atrush, for reporting the urban forests and their status in many locations with different scales and ranges. This process was carried out by using a up-to-date technology. Such technology included the economic scopes of evaluation ecosystem, by i-Tree Eco evaluation, and the US Forest Service which help out in such a program. The evaluation included the total carbon storage of 41 species of trees, and it was found that 27.78 t of those trees which the value of $ 4743608.35 had an amount of gross carbon sequestration rate of 0.63 t /year and a value of $107.576.431.These results indicated that carbon storage within those trees of different species investigated by program were not the same and the Oriental plane trees are different and distinguish from other trees in term of their storage of carbon amount and only seven trees had the storage of 20.51 t of carbon with carbon sequestration of 0.32 t. Other species in the sample had less amount of carbon sequestration.

تقييم خزن وعزل الكاربون باستخدام برنامج i .tree لغابات اتروش/ شمال العراق

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المستخلص

هدفت الدراسة تقييم البيانات التي تم جمعها من منطقة اتروش في مواقع غابات من شمال العراق، لذا تم تحقيق هذا الإجراء من خلال دراسة خدمات النظام البيئي التي يمكن أن توفرها له هذه الأشجار. وقد تم تنفيذ هذه العملية باستخدام التكنولوجيا الحديثة. وشملت هذه التكنولوجيا النطاقات الاقتصادية لتقييم النظام البيئي، والتقييم كان باستخدام برنامج i-Tree Eco ، الذي يقوم بتقييم بنية الغابات الحضرية. لذا إرسلت البيانات إلى مصلحة الغابات الأمريكية للمساعدة في إجراء التحليل باستخدام هذا البرنامج، وبالفعل فقد تم الحصول على نتائج التقييم التي تضمنت تقييم إجمالي تخزين الكربون لـ 41 نوعًا من الأشجار، وتبين أنه بلغ 27.78 طن كاربون من هذه الأشجار بقيمة بلغت 4743608.35 دولارًا، أما معدل عزل الكربون الإجمالي فقد بلغ 0.63 طن / سنة وبقيمة بلغت 107.576.431 دولار. وقد أشارت النتائج إلى أن تخزين الكربون داخل تلك الأشجار من أنواع الاشجار المختلفة لم تكن متساوية وأن أشجار الجنار الشرقي أظهرت اختلافًا عن الأشجار الأخرى، فقد كان خزين سبعة أشجار فقط بحدود 20.51 طن من الكربون مع كميات من عزل الكربون بمقدار 0.32 طن، لذا يمكن لنتائج هذه الدراسة أن تساعد في تقدير الدور الفعلي للغابات الحضرية في تقليل كمية ثاني أكسيد الكربون في الغلاف الجوي.

INTRODUCTION

Generally, urban forests mean as complete trees located within the urban tuft (12). Urban forests provide variety of benefits and services, especially the major and substantial connotation of the ecosystem. The ecosystem and benefits include more than a constituent such as:-the decrease of urban temperature, the importance of water and air quality by in purifying and also absorbing pollutants. So ecosystems have many examples such as, forests, a pond, a grassland, an estuary (19), and ecosystem have many means, Temperate Forest which exist in some areas of Europe and eastern United State of America, Tropical Rain Forests, desert ranges, The Taiga, Grasslands, Chaparral, Tundra, and The Ocean.(15). So environmental systems provide material and experiential benefits (5).In addition, trees store and isolate the carbon by absorbing it into their tissues, therefore; forests in ecology are known for their ability to remain revived have long been considered in climate research for their amplitude to replace revival by rerouting carbon dioxide to biomass (7). Forest ecosystems are classified according to their climate type as tropical, temperate or boreal (9). Forests are part of the carbon cycle due to their ability to isolated and store carbon. Carbon sequestration means the process in which the carbon dioxide is stored as biomass as it changed to uncooked materials through the operation of photosynthetic (17).Thus, this research concentrates on carbon storage and sequestration due to need of all the benefits. Everything that trees offer to the ecosystem with a value can reduce the cost of cities has to be sustained. The worldwide climate variation is considered as an important issue. The importance of trees however, is not the limitation of carbon dioxide through photosynthesis in their tissues and help counteract climate change, but also to transform energy exhaustion by reducing carbon dioxide emissions from the fossil fuels burned by plants (1). The aboveground biomass thickness of forests must be weighted and affined symmetrically to the meaning of carbon elements (13). So trees can reduce other kinds of gasses such as **carbon monoxide (CO) which contamination represents a major global concern (3).**

The agricultural sector is one of the essential economic sectors in Iraq (16), and in Kurdistan Region. So forests' in Kurdistan Region of Iraqi are economically futile since they had no revenues, despite the fact that the regional government had assigned a lot of money deducted from its budget to support and finance those forests and other projects in forests sector. The economic development of the Iraqi Kurdistan Region is no associated by an increasing demand for ecosystem services. Forests are of central concern to ecosystem in many cases the value of non-wood forest products – which are non-marketed - may increase faster than the values of wood and as secondary products. Ecosystem services are defined as the benefits that humans obtain from ecosystems; in spite of the relationship between these services, human welfare and the monetarism of ecosystem services is a new concept in Iraqi Kurdistan Region, one result is that certain forest areas are increasingly valued more than timber product for the environmental uses. Hence, the rich areas of forest will be for wildlife protection and the increasing attention of public authority to managing forests is for aesthetic values, recreational, which has become an important product of forests in developed countries, and is increasing in Iraqi Kurdistan Region where income and urban population are growing rapidly, through the last decade a pioneer economic evolution in the region was observed, but it was not on the basis of scientific researches and facts, as these researches ignored all sectors except the oil sector. Forests are considered the green gold and they have an essential role in reversion of capital to the region, but unfortunately, it has only a weak role and only recently the government has realized its important role in forest sector. In addition, until now there is not any interest in the quantitative assessment of the carbon sequestration, storage and other ecosystem services provided by the urban forest in all Iraq cities which has not conducted to date. This research focuses on the benefits of trees in the ecosystem, although trees have many benefits such as reduces air pollutant emissions from the power plants

(10). Here we consternate on storing carbon and carbon sequestration, and evaluating these benefits by adopting i- tree Eco program for the urban forest of Atrush area. The objective of this research is to update and estimate the urban carbon storage and sequestration depending on field data of Atrush forest and to study the different species of trees for more than one level. (14). The assessment of ecosystem services provided by urban trees was used and it include the following:-The public lands within the urban growth outlines of Corvallis.-A computer paradigms advanced to measure the ecosystem benefits in both physical and economic terms. The annual benefits include, sequestration storage of carbon dioxide, the principal atmospheric greenhouse gases result that the total amount of carbon dioxide stored was valued at $1.45 million and the total replacement value of the trees was estimated to $450 million. In study of Nowak et.al. (13) about carbon storage and sequestration by trees in urban and social areas of the United States, those assess the size as well as function of urban forests in link to climate change, using data from 28 cities and 6 states to determine the average carbon density per unit of tree cover, they found that the whole tree carbon storage spending average 7.69 kg- cm of tree cover and sequestration spending average 0.28 kg- cm of tree cover per year, and they are equal to the results with whole carbon storage and sequestration and their values in the U.S.A. Seifert (17) assessing the urban forest structure, ecosystem services, and economic benefits on vacant land which includes carbon storage and sequestration, some results show the change of the rising tree size, and the health of trees ability to backing annual carbon sequestration. The trees growing on vacant land in Roanoke sequester an estimated 2091 t of gross carbon per year with a potentiality 2016, 8, 679 10 of 18 economic value of $163,000.The net carbon sequestration from vacant land in the city reached was approximately 1959 tons annually, which is more valuable in comparison with other land uses. The aim of Woldegerima et.al. (20) research is to assess selected ecosystem services such as carbon storage potential, habitat support and other services supplied by various classes of the urban forest of Addis Ababa, results showed that carbon intensity rate in the study area was different from the forest denomination that is. 293tons/ha, 142tons/ha and 132tons/ha in the heavy, medium, and open the forest types respectively. The Shannon-Wiener diversity index is 3.24 for Junipers dominated forest, 2.98 for mixed forest and 2.76 for Eucalyptus dominated forest.

MATERIALS AND METHODS
Study area
This study is based on a survey conducted at (Atrush Forests)which has clear ecological and forest features. The site has various tree intensities and forest features. Forests at the areas contain many species of trees, which are characterized by varying qualities form different vegetation coverings. The natural and artificial forest site is one of the formations of the mountainous region of Iraq. Fig1 shows Atrush forest located at the northern part of the Kali-Qayamat mountain range and the eastern part of the heights of the Kane Mazi, it is bordered by the western part of the center of Sub-District Atrush and the southern part is bordered by the Shekhan District AinSufni, indicated within latitude 36:49,36:53 south and longitude 43:17,43:27 north, and at a height ranging from 669-1017 MSL. Which is Found there trees of: (*Pinusbrutia*), (*Pinuspinea*),(*Quercusajelops*),(*Quercusinfectoria*)(*Platanusorientalis*),(*Ficuscarica*) as well as shrubs *(Crataegusazarolus)*, *(Junipoursaxycedrus)*,(*Salix babylonica*),(*Prunusamygdalus*), (*Rhuscoriaria*) others are characterized by heavy clay soils.
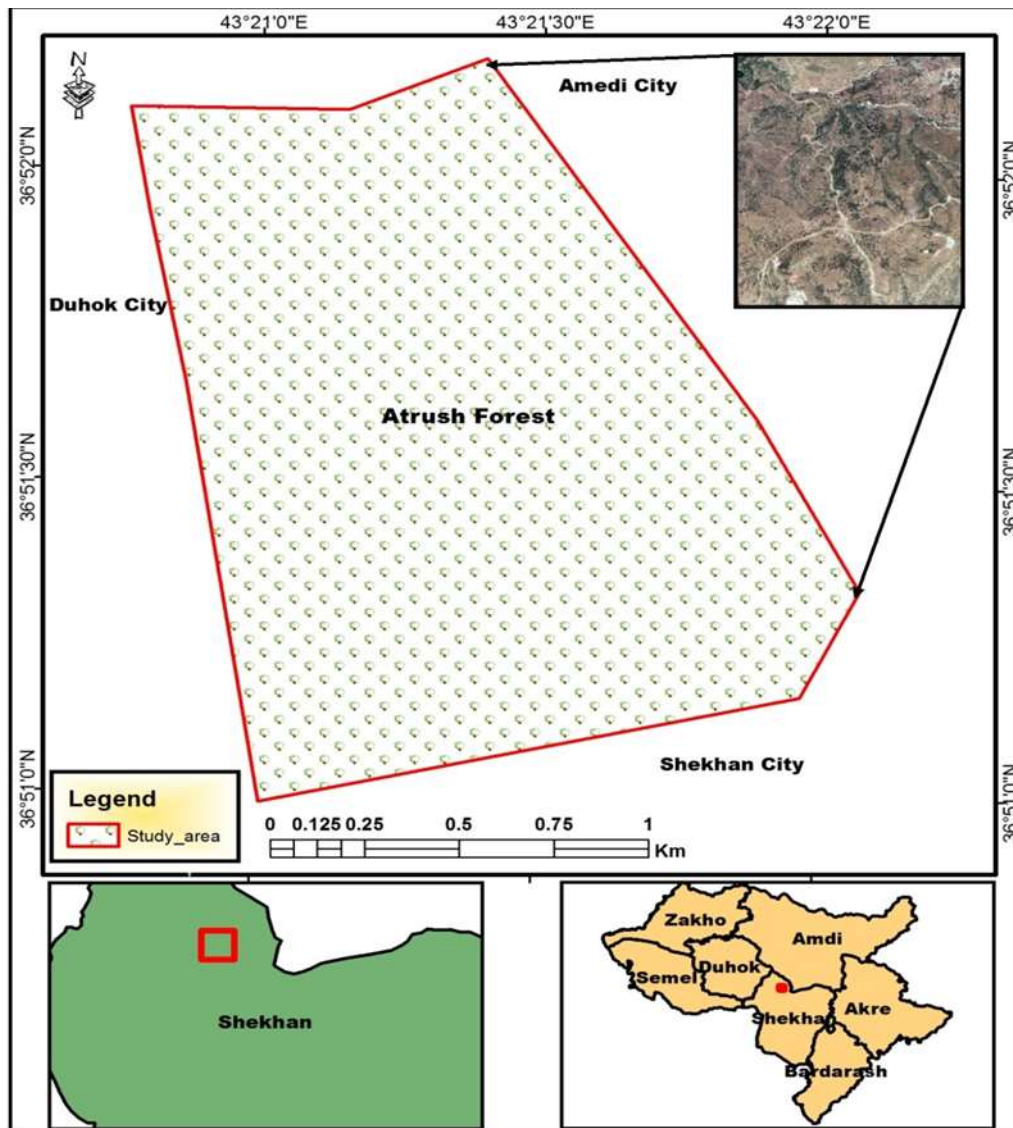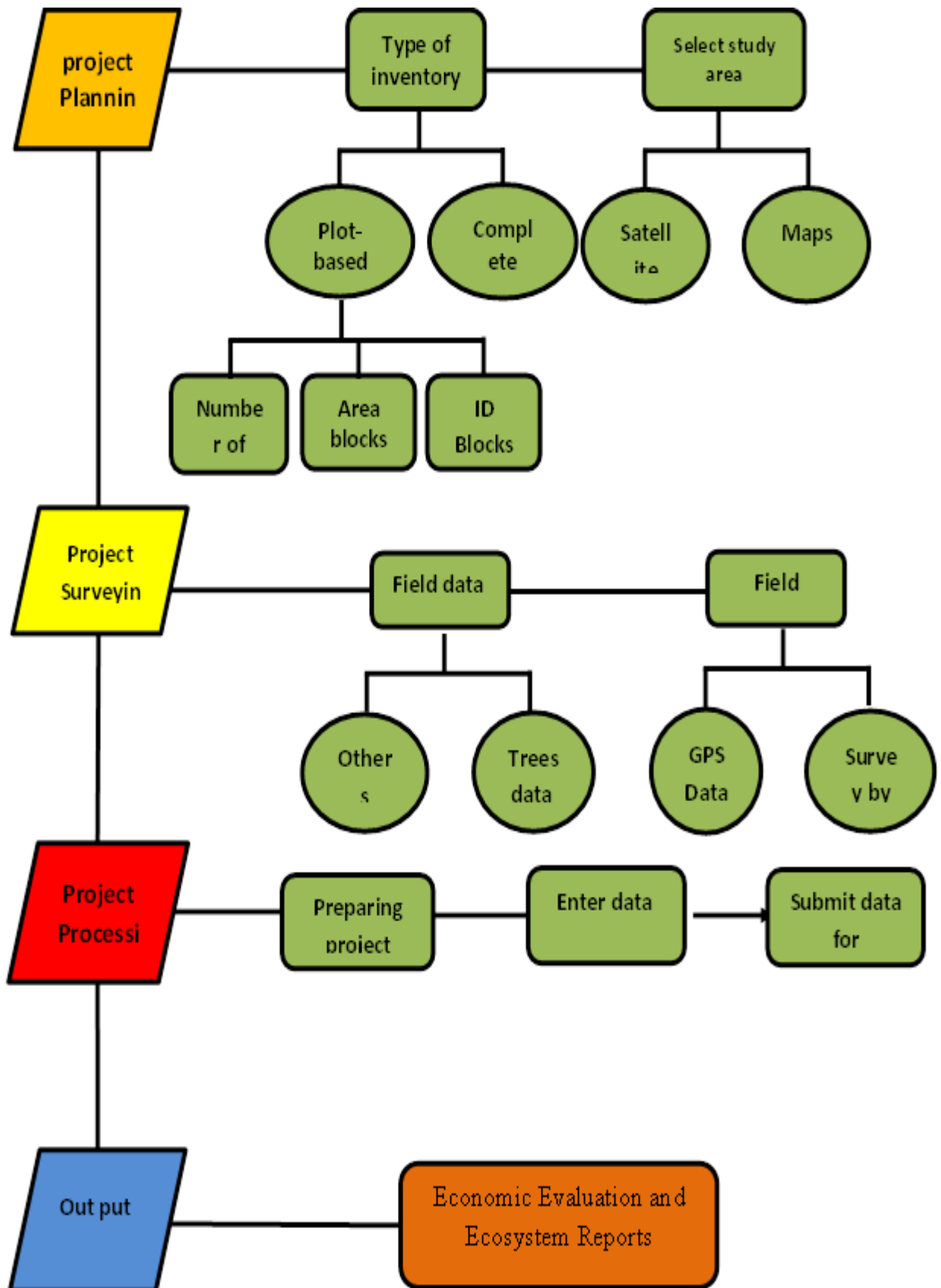
Fig. 1.Atrush Forest Location

Field work and inventory This study was based on the down-mentioned structure down Fig.2. which aims to explain and review in the data treatment as well as and the analysis of the subject of study. Follow a specific work structure by the researchers which include the Figure 2.

Source: by the researchers
Fig.2. Work Structure for Economic Evaluation and Ecosystem Report
Fig.2. illustrate work main structure on three
stages

Firstly: Project planning

The forest inventory characterizes the quantity and the quality of forest arbor and also the characteristics of the land area on which trees are plant. With the rising importance of forest areas in the code of non-timber values, such as tourism and hiking, river basin management, wildlife, the idea behind forest inventory should be explained . When non-wood values are important, other characteristics of the forest and the soil in which it is situated will need to be observed, measured whenever possible, and the resulting data should be analyzed (2).

Trees have two types of inventory

Inventory Process

The complete inventory

The complete inventory includes the inventory of whole trees for the studied areas and that is achieved by saving the tryout analyst to embrace the area covered by the forest which includes: the property reaching the small unconnected area such as the residential and accommodation areas and the property ownership within the inventory area.

The planned inventory

The planned inventory means collecting information for all the trees within the study areas to equal the variation between them anyway, the resolution may be influenced by what the researchers prepared for the menstruation of all tree for every layer during the sample to reach the sample inventory by dividing the area into smaller units in order to illustrate and includes the planned inventory, because it is impossible to continue an overall and joined inventory because of the shortage of technical resources expert cadres. Since the integrated method is done by employing teams of survey and specialized consisting of several people, so the researchers went to the second method, which can be divided by the area studied number of the circumstantial locations with known distances, so the process of inventory Knowing and collection and menstruation is simple and does not require several people, and the inventory process was based on a large number of people is based on prepared before the start of the field survey of the inventory for the trees located within the divisions of the study area the procedures included the following:

1-Numbering block

2 - Area or size blocks

The study area was divided to a number of Plots amounted to (0.25) ha

3-Plots Numbers

Depending on the last procedures, the map was developed, that shows the distribution of the area chosen for the study on a number of plots where the selection of the plots which included the density of trees more than others, especially those that included large-sized trees because those have more impact on the natural environment, this Fig. 3. indicates the numbering of plot, and their locations within Atrush forests contained 21 plots and 8 trees type: 1-*Ficuscarica, 2-Platanus orientalis.3-Quercus spp.4-Quercus ajelops.5- Salix babylonica.6-Pinus brutia.7-Pinus pinea.8-Crataegoussaligna*
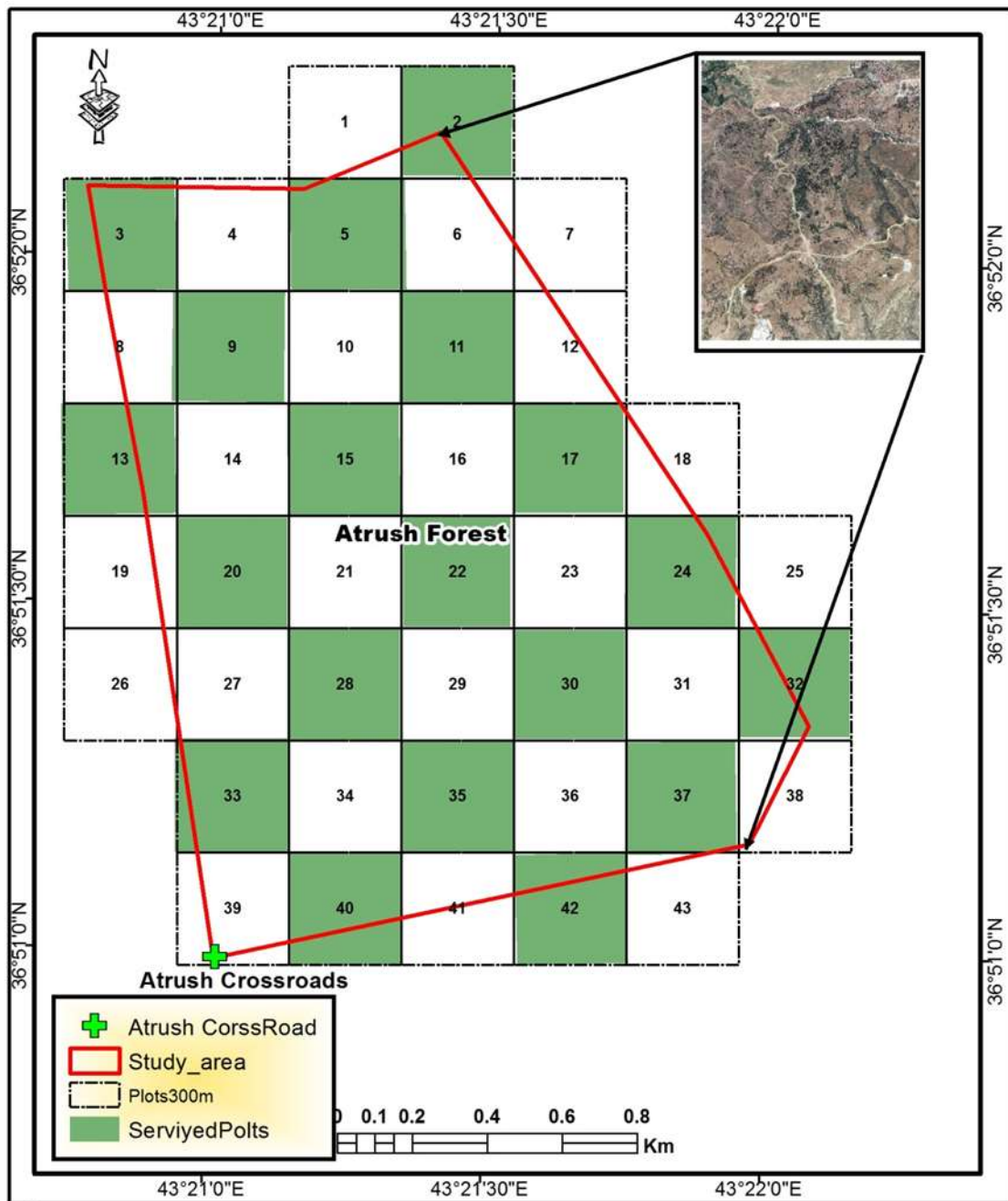
Fig. 3. Divided and numbered plots in the area of Atrush

Secondly: Survey operations

The survey allows the transfer of most important field data to the information collection unit in the United States and entered into the electronic calculator in a scientific and logical sequence for the implementation of the program I-Tree Eco. Version 6.0 for 2017.

Field data identification

To record the field survey data is required a form was technically designed so as to reach the study objective and includes:

1 - Location number

2 - Location Status (Rural, City)

3. Block address

4-Date of survey

5- Area (ha)

6-Number of plots 21

7 - Ratio of soil cover (rocks, soil, grass, herbs, and water)%

8- Type of land use (agriculture, water, and other).

9- Trees and their species (Oak trees are naturally developing species. *Quercus aegilops*).

10- Measure the Diameter at Breast Height (DBH).

11- Tree height

12- The height of the crowns of the upper summit

13-Width of crowns

14- Percentage of missing space for crowns

15 - Information about the shrubs located in(the type of shrubs, height, the proportion of rumors Lost).

Field survey procedures

Shape the Global Positioning System(GPS)assortment using the Trimble GPS device: is a globally used system to identify and monitor objects or moving vehicles very accurately through the method of a network of satellites ranging from 18 to 24 satellites covering the space of the globe, use of GPS was limited to the old military institutions, which was used to know the movements of troops and military equipment in war zones, struggle, monitoring the positions of these forces on a continuous basis, GPS operates in any weather and throughout the day at no cost. At the path of this work, we employed the assortment of the study project blocks using Trimble GPS, depending on the previous map. The larger trees were selected during the single lot to be a point (X, Y, Z) and to use these on-site values as input to the I-Tree Eco application. These values were well used in mapping the component obtained from the application of the above (18).

Plots survey

In this portion the survey in a plots method were employed, a geometric method to divide a segment an area into an equal number and segment with known dimensions, and there are several ways of doing such (Random-Fixed Grid-Randomized Grid),In this project, we used the "Fixed Grid" method, which is one of the three preferred methods used in a wide range of economic assessment projects for forests as the beneath Photos show:
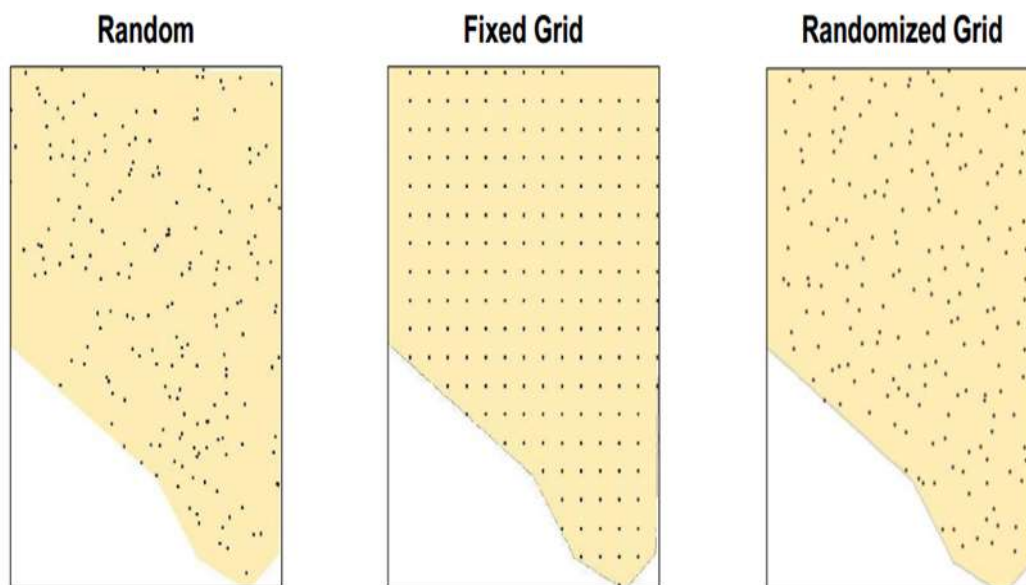
Source: I-Tree Eco User's Manual,(2017).

Thirdly: Processing: The I-Tree Eco application giving a consecutive technique to know the ingredient of the study subject and to input the desired datum through figure tabs, procedures can be performed to make the application of I-Tree Eco a function of giving ecological and economic conclusion for a group of trees and shrubs within the area and when working with the application, it is substantial to think about the requirement to depend on the direction drawn shown on the support schedule shown on the application screen aforesaid above, wherever these directive command the user step by step how to use the features of this application and its procedural buttons automatically, relying on the type of survey or inventory that will be taken by the user whether the inventory of the type of Plots, or the type of Complete. Thus, delete several functions or stay inactive depending on the types the survey procedure of the project approved. It must be indicated that the I-Tree Eco application supply's ready-to-read, ready-to-view form before starting our project. These programs supply a clear concept of how to work with the application and provide more features about what the application offers I-Tree Eco.

This application consists of several components:
Configure the project
Project definition
Because define data and information about the study area by the project definition function, the researchers insert a new project, which is a requisite procedure for differentiate I-Tree Eco for a certain type of inventory method according to the methodology Which was applied by the researcher, was selected Plot sample in order to define the basic data of the project and through 3 components (11).
Data entry procedures
The data login was scheduled for trees and shrubs in the study area is divided into four base department of the demands in order to be formally identified when making a project using the I-Tree Eco application. These sections include:Inventory plots, Field management, Inventory of tree data, Data collection of shrubs, and Check Data.

Processing: This stage included
Data entered
The application I-Tree Eco version VI divided into two functions can be clarified in the following points:
1-Sending data for processing.
2-Trace and retrieve results.

RESULTS AND DISCUSSION
Urban forests help to mitigate climate change by carbon sequestering from the atmosphere and storing it in the trees' tissue. The annual carbon storage and sequestered are annually increasing depending on the health and size of the trees. In Atrush forest as mentioned in Table 1 the gross sequestration of carbon by total selected trees approximately by strata was 0.63 t of carbon per year with a predicted CO_2equivalent of 2.33 t /Y.

Table 1. Annual Carbon Sequestration of Trees by Strata in Atrush Forest :

Strata	Gross Carbon Sequestration t/y	CO_2 Equivalent t/y
Urban	0.63	2.33

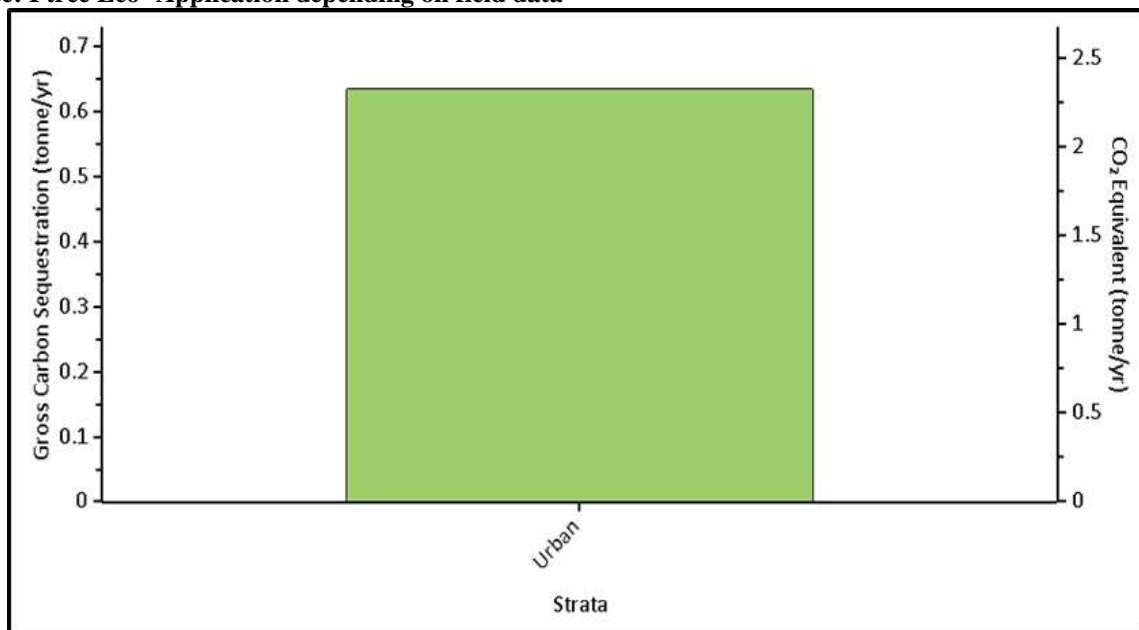Source: I tree Eco- Application depending on field data

Fig. 4. Annual Carbon Sequestration of Trees by Strata in Atrush Forest
Source: I tree Eco- Application depending on field data

While we notice that the annual carbon sequestration of trees by strata per unit area in Atrush forest was 117.50 kg year ha this amount is equivalent to CO2 of 403.86 kg year ha (Table 2)

Table 2. Annual Carbon Sequestration of Trees by Strata per Unit Area in Atrush Forest :

Strata	Gross Carbon Sequestration Density kg yr ha	CO_2 Equivalent kg yr ha
Urban	117.50	430.86

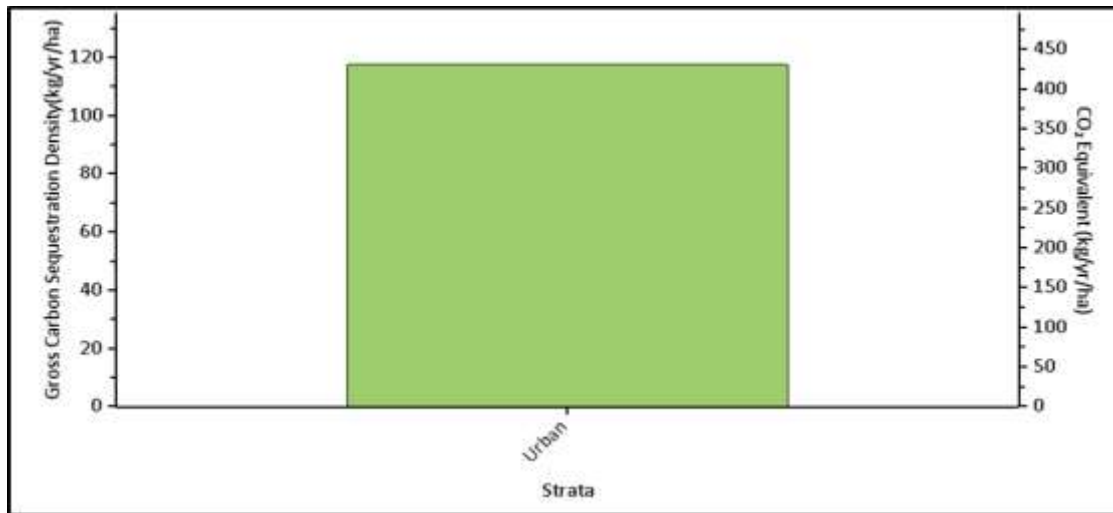Source: I tree Eco- Application depending on field data.

Fig. 5. Annual Carbon Sequestration of Trees by Strata per Unit Area in Atrush Forest
Source: I tree Eco- Application depending on field data

So the gross carbon sequestration for each trees species shown in Table 3.

Table 3. Annual Carbon Sequestration of Trees by Species in Atrush Forest.

Scientific name	Gross Carbon Sequestration t y	CO_2 Equivalent t y
Ficuscarica	0.02	0.06
Pinusbrutia	0.13	0.48
Pinuspinea	0.01	0.02
Platanusorientalis	0.32	1.16
Quercusspp	0.04	0.14
Quercusajelops	0.09	0.33
Salix babylonica	0.02	0.07
Crataegoussaligna	0.01	0.05
Total	0.63	2.33

Source: I tree Eco- Application depending on field data.

From Table 3. we find that species of oriental plane trees had the higher gross carbon sequestration comparing with other trees species, and this sequestration of carbon equivalent 1.16 t Year of CO2. The application of I- tree approach gave us the net annual carbon sequestration of trees by strata in Atrush forest which show that equal to 0.55 t year with CO2 equivalent of 2.00 t year, and per unit area which is equal to 101.09 kg year ha for study area. (Tables 4,5).

Table 4. Annual Net Carbon Sequestration of Trees By Strata in Atrush Forest :

Strata	Net Carbon Sequestration t yr	CO_2 Equivalent t yr
Urban	0.55	2.00

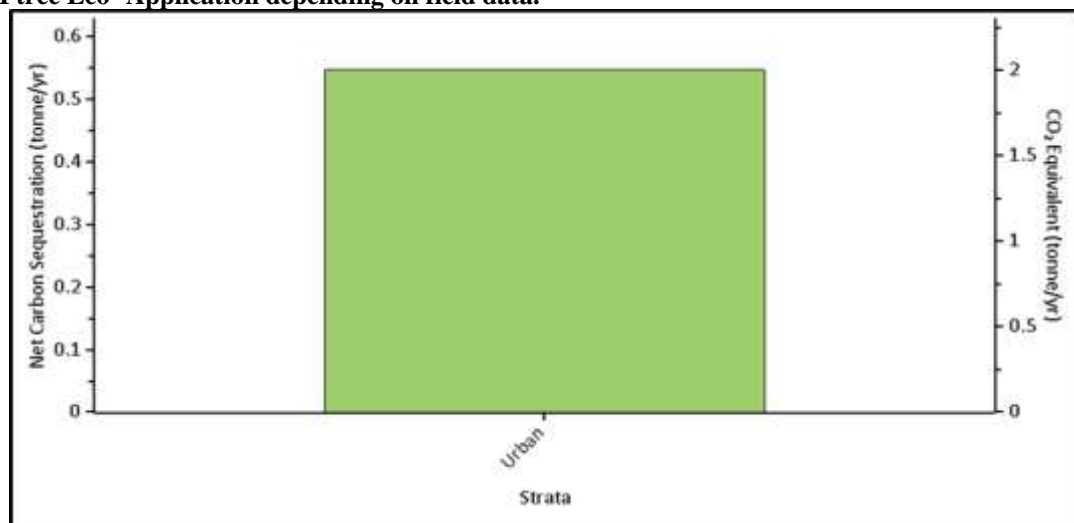**Source: I tree Eco- Application depending on field data.**

Fig. 6. Annual Net Carbon Sequestration of Trees By Strata in Atrush Forest
Source: I tree Eco- Application depending on field data

Table 5. Annual Net carbon Sequestration of Trees By Strata per Unit Area in Atrush Forest :

Strata	Net Carbon Sequestration Density kg y ha	CO$_2$ Equivalent kg y ha
Study Area	101.09	370.70

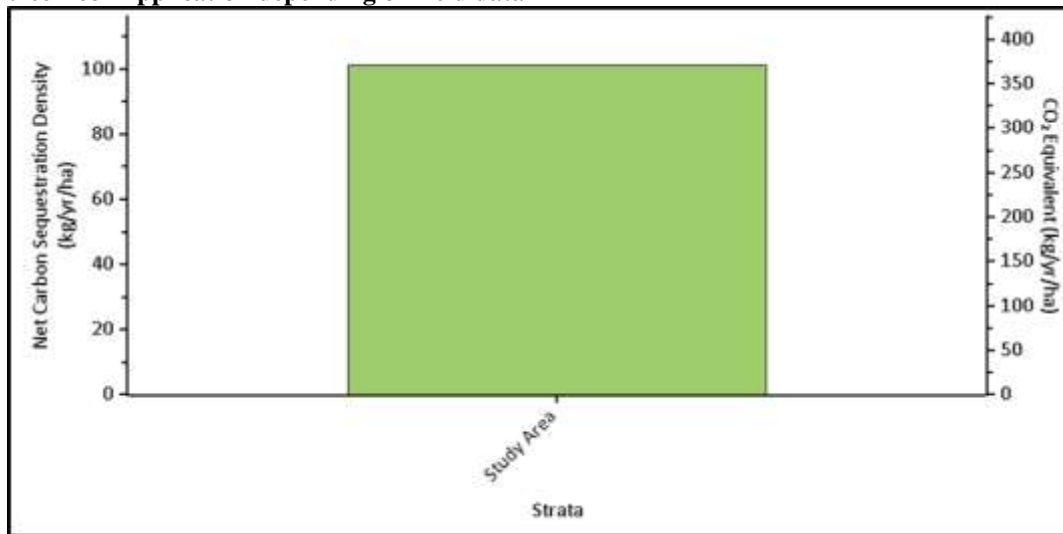**Source: I tree Eco- Application depending on field data**

Fig.7. Annual Net carbon Sequestration of Trees By Strata per Unit Area in Atrush Forest
Source: I tree Eco- Application depending on field data.

Additionally, the I-tree program also present the detailed analysis of annual net carbon sequestration of trees by species which indicated that oriental plane trees have the higher net carbon sequestration in comparison with other trees species reached to 0.27 t y with CO2 equivalent of 0.99 t y, and which equivalent approximately to the half of total net carbon sequestration of all trees species in the selected sample, that means the enrichment of CO2 led to increase the percentage of carbohydrate in the trees leaves (4).The trees in Atrush forest also stored an additional 27.80 t of carbon equivalent to 101.90 t, and the carbon storage of trees by strata per unit area was 5143.60 kg ha, that equivalent 18861.70 kg ha, which indicate to a large amount of carbon storage, and its equivalent to CO2. (Tables 6,7).

Table 6. Carbon Storage of Trees by Strata in Atrush Forest

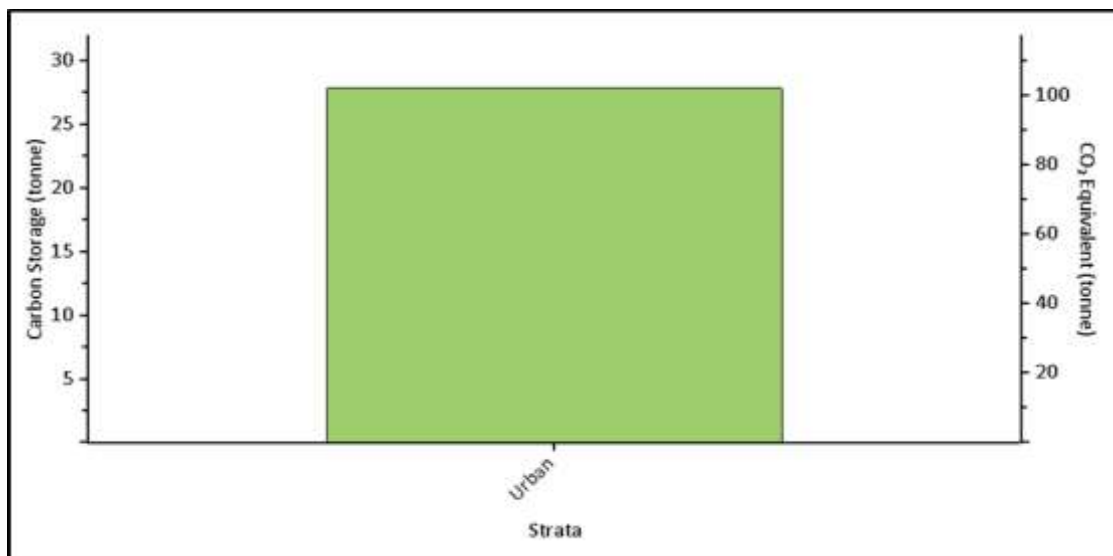| Strata	Carbon Storage t	Carbon Storage (%)	CO$_2$ Equivalent t
Urban	27.80	100.0 %	101.90

Fig. 8. Carbon Storage of Trees by Strata in Atrush Forest
Source: I tree Eco- Application depending on field data

Table 7. Carbon Storage of Trees by Strata per Unit Area in Atrush Forest

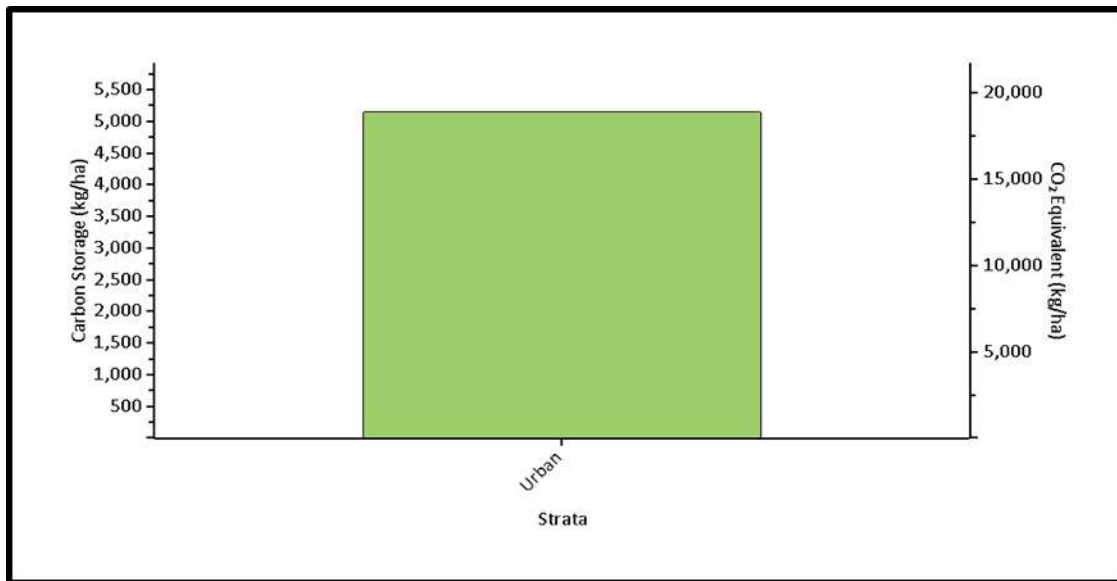| Strata	Carbon Storage kg ha	CO_2 Equivalent kg ha
Urban	5143.60	18861.70

Fig.9. Carbon Storage of Trees by Strata per Unit Area in Atrush Forest

Source: I tree Eco- Application depending on field data

The different species of trees store differ amount of carbon, Table 8. shows that varied peaking with oriental plane trees storage 20.50 t of carbon formed about 73.9% of the total trees species in the sample, and it is equivalent to 75.20 t of CO2. The direct trees impact on CO2 appear firstly to be unimportant. So, the urban forest potential to reduce CO2 emissions through the reduction energy, and its role in lowering urban temperatures, climate adaptation through evaporative cooling and soil carbon protection, we must note overlooked. While, the carbon storage quantities of other species were much lower than oriental plane trees this stimulates the cultivation of this species in this area. Table 8. shows the different amount of carbon storage of trees by species in Atrush forest.

Table 8. Carbon Storage of Trees by Species in Atrush Forest

Scientific name	Carbon Storage (ton)	Carbon Storage (%)	CO_2 Equivalent (tone)
Ficuscarica	0.20	0.6 %	0.60
Pinusbrutia	3.70	13.2 %	13.40
Pinuspinea	0.10	0.3 %	0.30
Platanusorientalis	20.50	73.9 %	75.20
Quercusspp	1.10	4.1 %	4.20
Quercusajelops	1.80	6.6 %	6.70
Salix babylonica	0.30	0.9 %	0.90
Crataegoussaligna	0.10	0.5 %	0.50
Total	27.80	100%	101.90

The differences between various trees species in carbon sequestration and storage is due to the suitability of conditions in the area with the conditions and requirements of trees growth. When discussing the benefit aspect of carbon and the impact of various types of trees in the current study sample on ecosystem, we find that there is a fixed gathering of carbon within the trees that enter the internal structure of the parts of a tree the amount of carbon storage varies from one tree into another, and the values of this storage alter as a result of variation in the quantity in the tree as well as the species of trees. The i- tree program gave us the benefits of carbon storage and sequestration in Atrush forest by species.

Table 9. Benefit Summary By Species in Atrush Forest

Scientific name	Trees		Carbon Storage			Gross Sequestration		Carbon
	Number	SE	Tone	SE	$	Tone/Yr	SE	$/yr
Ficuscarica	2	±0	0.17	±0.02	29.028.56	0.02	±0.00	3.415.1248
Pinusbrutia	19	±1	3.66	±0.20	624.967.838	0.13	±0.01	22.198.3112
Pinuspinea	2	±0	0.07	±0.01	11.952.936	0.01	±0.00	1.707.5624
Platanusorientalis	7	±0	20.51	±1.56	3.502.210.48	0.32	±0.02	54.641.9968
Quercusspp	1	±0	1.15	±0.19	196.3693676	0.04	±0.01	6.830.2496
Quercusajelops	6	±0	1.83	±0.17	312.483.919	0.09	±0.01	15.368.0616
Salix babylonica	2	±0	0.26	±0.03	44.396.622	0.02	±0.00	3.415.1248
Crataegoussaligna	2	±0	0.13	±0.02	22.198.311	0.01	±0.00	1.707.5624
Total	41	±0	27.78	±1.49	4.743.608.35	0.63	±0.02	107.576.431

Source: I- Tree Program application.

The results in Table 9. indicates that oriental plane trees were distinguished from the rest of the trees in the amount of their carbon storage, as only seven trees contained 20.51 tons of carbon at an estimated value according to the analysis of the "I-Tree" program, to 3502210.48 dollars. This is the result of the reflection of the species of trees characterized by rapid growth, which increases the size of the tree and thus increases the carbon storage in it and increases the estimated value of this carbon storage. While other types of trees have different values, they were less than the value given by the oriental plane trees, although the number of Turkish pine trees were distinct in the sample and formed 19 trees, the amount of carbon stored in them was less storage carbon and less valuable than oriental plane trees. It should be noted here that the amount of carbon stored by the only 14 sample trees was 27.78 t, which is a large amount of carbon storage. The value 4743608.35 dollars of this storage is significant, which means that the storage of carbon through the trees in the Atrush area is high and has a positive impact on the Ecosystem. When turning to carbon sequestration we find that the amount of the increases in the annual carbon storage was the largest in the oriental plane trees and formed 0.32 t for the seven trees worth 54.641.9968 dollars and this result is logically based on the qualities and size of this type of tree. As for the annual increase in the total carbon sequestration of 41 trees amounted to 0.63 t with a value worth of 107.576.431 dollars, which is also an indicator of the positive impact of carbon on ecosystem, especially if it is calculated in a total manner for all trees in the Atrush region It be concluded that urban forests have significant impacts on the ecosystem and its services by reducing the levels of atmospheric carbon dioxide, this study aimed to investigate the various species of trees in the urban forests and in Atrush forests as a selected area, storing different amounts of carbon as stated by some trees characterizes such as tree species, size of the trees, growth rates, conditions, and trees age. Urban trees may play a function in dictating the maximum storage and sequestration possible in a location. The important indicators of services provided are a high ratio of large-diameter trees and trees height. The I- Tree Program is very suitable application and good method to estimate, evaluate, and product most benefits of urban forests, and this model can explain the effective function of trees on the ecosystem thus, through this model carbon storage and sequestration were estimated for every person tree of a selected area. This study previous that the suitable tree species in this area forest was oriental plane, it has the higher carbon storage and sequestration comparing with other species in the location, therefore the important recommendations are to increase the numbers of these tree species in this area, and to depend on the current study results to provide baseline of future assessments for other urban forest areas in Iraq, and can be useful in comparing these results with other future studies in the farm of urban woodland evaluation. The differentiation between the current study results some of previous studies

display that a high value of carbon storage and sequestration comparing with the results of Phillips et.al., but it is less than the results of other three previous studies which are in the introduction of our study (13, 17, 19). These facts mean that the conditions and the maintenance for trees in Atrush urban forest were not at the advanced levels.

REFERENCES

1. Abdollahi, K., Z. Ning, and A. Appeaning, 2000. Gulf Coast Regional Climate Change Council. In Global Climate Change & the Urban Forest; Franklin Press: Baton Rouge, LA, USA. pp:21

2. Ffolliott, P. and D. Worly, 1965. An inventory system for multiple use evaluation, U.S. Forest Serv. Res. Paper, RM- 17, pp:15

3. Hassoon, H., 2019. Measurement of carbon monoxide emissions from vehicles exhaust pipe using portable gas detector, Iraqi Journal of Agricultural Sciences, 50 (3) :936-942

4. Hgemi, S. and M. Khafaji, 2016. Effect of co_2 enrichment and foliar spray agroleaf and kelpak on lraves content of N, P, K, protein and carbohydrate of smooth peach transplants, The Iraqi Journal of Agricultural Sciences – 47: (Special Issue): 106-111

5. Howarth, R. and S.Farber, 2002. Accounting for the value of ecosystem services, Ecological Economics, 2002, vol. 41, issue 3, 421-429

6. KRG,Ministry of Planning, Data and Maps General Director-Duhok,2010

7. Kurz, W., and M. Apps, 1999. A 70-year retrospective analysis of carbon fluxes in the Canadian forest sector. Ecological Applications, 9:526-547

8. Lambert, M. C., C. Ung, , and F. Raulier, 2005. Canadian national tree aboveground biomass equations. Canadian Journal of Forest Research, 35, 1996-2018

9. Mace G. , K. Norris , and A. Fitter, 2011. Biodiversity and ecosystem services: a multilayered relationship. Trends in Ecology & Evolution 27(1):19-26

10. Nowak, D. and J. Dwyer, 2000. Understanding the Benefits and Costs of Urban Forest Ecosystems, Urban and Community Forestry in the Northeast pp 25-46.

11. Nowak, D. J., and D. Crane, 2002. Carbon storage and sequestration by urban trees in the USA. Environmental Pollution, 116(3): 381-389

12. Nowak, D. J., E. Greenfield, R. Hoehn, and E. Lapoint, 2013. Carbon storage and sequestration by trees in urban and community areas of the United States. Environmental Pollution, 178, 229-236

13. Nowak ,D., Eric J., Robert E., and Elizabeth L. 2013. Carbon storage and sequestration by trees in urban and community, Environmental Pollution, 178: 229-236

14. Phillips, D., C. Burdick, B. Merja, and N. Brown, 2010. Assessment of Ecosystem Services Provided by Urban Trees: Public Lands Within the Urban Growth Boundary of Corvallis, Oregon, U.S. Environmental Protection Agency. pp 61

15. Philander S. 2008. Encyclopedia of global warming and climate change, Sage publications, Volume 1.

16. Salim, Y. and A. Ahmed, 2019. Impact of monetary policy on agricultural domestic product in iraq for the period (1990-2014), Iraqi Journal of Agricultural Sciences, 50(2):557-566

17. Seifert, T. 2016. Assessing Urban Forest Structure, Ecosystem Services, and Economic Benefits on Vacant Land, Sustainability MDPI , p. 18

18. USDA Forest Service. 2016. I-Tree applications. I-Tree Tools for Assessing and Managing Forests & Community Trees. Retrieved October 17, 2016 from http://www.itreetools.org/ applications.php

19. Whitman, W. , 2017. The Ecosystem and how it relates to Sustainability, the Regents of the University of Michigan unless noted otherwise.p.2

20. Woldegerima, T., Y. Kumelachew , and L. Sarah 2017. Ecosystem services assessment of the urban forests of Addis Ababa, Ethiopia, Urban Ecosystems 20(3): 683- 699 ·