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Physical Properties of Some Urban Trees for Carbon Dioxide Sequestration: a case Case Study of a Residential Complex

Al-Zahraa A. Mohsen*, Asraa Khtan Abdulkareema

Department of Atmospheric Sciences, College of Science, Mustansiriyah University, Baghdad, Iraq

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Abstract

In recent years, there has been a significant urbanization of the world, including in Iraq, particularly in Baghdad. This has led to an increase in pollutants and greenhouse gas (GHG) emissions, particularly carbon dioxide (CO_2). Therefore, it was necessary to find sustainable environmental solutions to reduce these gases, one of which is the biological sequestration of CO_2 using trees. Therefore, this study aimed to calculate CO_2 sequestration from trees using field data and biological methods for the Yamama City residential complex in Baghdad. The results showed that the complex's trees, numbering 3788, contributed to sequestering 197039.2 kg/year. This amount varies between four types (*Conocarpus, Acacia, Albizia,* and *Palm*), the largest contribution being *Conocarpus* trees, amounting to 18662.7 kg/year, which represents 95% of the total number of trees, and the least contribution being *Acacia* trees, amounting to 135.6 kg/year, which represents 2%. Since the sequestration quantities were calculated by field data for all trees and due to the difficulty of this method in measurement, the sequestration quantity was calculated using a modified method, and its accuracy was proven by calculating the correlation coefficient between the modified method values and the actual values, which recorded r = 0.98. To know the effect of the physical properties of trees on the amounts of carbon dioxide sequestration, the effect of tree height and diameter was compared with the sequestration quantities, where it was found that the diameter has a greater effect, in addition to the fact that age has a direct relationship with the sequestration quantities. Finally, this study confirms the role of urban trees in reducing CO_2 emissions and provides practical methods for sustainable urban planning in fast-growing cities such as Baghdad.

Keywords: Climate change, CO_2 Mitigation, Trees physical parameters, Urban tree species, Sustainability.

الخصائص الفيزيائية لبعض الاشجار الحضرية لعزل ثاني اوكسيد الكربون: دراسة حالة في مجمع سكني

الزهراء عادل محسن*, اسراء قحطان عبدالكريم

قسم علوم الجو, كلية العلوم, الجامعة المستنصرية, بغداد, العراق

* Email:alzahraa.adel@uomustansiriyah.edu.iq

الخلاصة

شهد العالم توسعًا حضريًا كبيرًا في السنوات الاخيرة ومن ضمنه العراق خصوصا العاصمة بغداد حيث نتج عن هذا التوسع زيادة في الملوثات وارتفاع معدلات انبعاث الغازات الدفيئة، ومن أبرزها غاز ثاني أكسيد الكربون . لذلك كان لا بد من ايجاد حلول بيئية مستدامة لتقليل تلك الغازات واحدها العزل البيولوجي لثاني أكسيد الكربون باستخدام الأشجار. لذلك هدفت هذه الدراسة الى حساب عزل ثاني اوكسيد الكربون حقليا من الاشجار باستخدام الطريقة البايلوجية لمجمع مدينة اليمامة السكني في بغداد واظهرت النتائج ان اشجار المجمع البالغ عددها 3788 شجرة ساهمت بعزل 197039.2 كغم/ السنة. تباينت هذه الكمية بين اربع انواع (كونوكاربس , اكاسيا , البيزيا , نخيل) اكثرها مساهمة هي اشجار الكونوكاربس بمقدار 18662.7 كغم/ سنة والبالغ نسبة عددها 95% من الاشجار الكلية, واقلها مساهمة اشجار الاكاسيا بمقدار 135.6 كغم/ سنة والبالغ نسبة عددها 2%. بما ان كميات العزل تم حسابها حقليا لكل الاشجار ولصعوبة تلك الطريقة في القياس تم حساب كمية العزل بطريقة معدلة واثبتت دقتها من خلال حساب معامل الارتباط بين قيم الطريقة المعدلة والقيم الفعلية والذي سجل r = 0.98. و لمعرفة تاثير الخصائص الفيزيائية للاشجار على كميات عزل ثاني اوكسيد الكربون تم مقارنة تاثير ارتفاع الاشجار واقطارها مع كميات العزل حيث تبين ان القطر له تاثير اكبر بالاضافة الى ان العمر له علاقة طردية مع كميات العزل. تؤكد هذه الدراسة على دور الأشجار الحضرية في خفض انبعاثات ثاني أكسيد الكربون وتوفر أساليب عملية للتخطيط الحضري المستدام في المدن سريعة النمو مثل بغداد.

1. Introduction

Rapid urbanization is becoming a key driver of climate change, causing land use change, a reduction in biodiversity, and pollution both inside and outside the city. A significant portion of this pollution is caused by rising levels of greenhouse gas (GHG) and carbon dioxide (CO_2), which is one of the sources of greenhouse gases and is responsible for the greenhouse effect [1, 2]. The overall global amount of GHG grew by 80% in 2019 compared to 1990 and will continue to rise until 2050, owing primarily to anthropogenic activities that enhance climate change risk [3, 4]. Disruptions in the global carbon cycle led to greater levels of CO_2 and global temperatures [5]. The future climate change tends to include a rise in global mean temperature (more than 2°C - 4°C), significant drying in some regions, and an increase in the severity and frequency of extreme droughts, and heat waves, hot extremes, according to the Intergovernmental Panel on Climate Change (IPCC) in 2007 [6,7]. The Kyoto Protocol, approved in 1997 by the United Nations Framework Convention on Climate Change (UNFCCC), is the first international agreement requiring countries to set enforceable goals for lowering emissions by law. One of the Kyoto Protocol's key goals was to reduce carbon dioxide levels while supporting sustainable development [8]. CO_2 is eliminated through an extensive biological cycle called "carbon sequestration" [9]. Carbon sequestration is the occurrence of removing carbon in the form of CO_2 from the atmosphere and storing it in the trees' tissue through a natural or mechanical process to help mitigate climate change. The distinction between geological and biological sequestration lies in the location of carbon storage. Trees, along with carbonate minerals, oceans, and geologic formations, function as carbon sinks, which play a crucial role in moderating the impact of GHG on the environment and contribute to the establishment of an eco-friendly and sustainable ecosystem in urban green zones [5, 10]. The promotion of urban plants is considered an effective mitigation tool for climate change in terms of its ability to capture CO_2 for the growth of plants, resulting in decarbonization and the utilization of CO_2 for photosynthesis [10]. Urban plants are all types of plants that grow within urban areas, including trees, shrubs, grasses, and green spaces spread along streets, public parks, gardens, and green roofs of buildings [11]. It is regarded as a solution based on nature in various national and international policies [12]. When there are trees in urban areas, they help decrease noise and soil erosion, mitigate the urban heat island, and enhance soil fertility and air quality [13, 14]. Therefore, they play an important role in determining the city's carbon footprint [15]. Despite CO_2 being an essential part of photosynthesis for plant food production, but an excessive amount of it can have detrimental environmental effects, as it contributes to 61% of global warming and climate change [16]. Given the problem at hand, it is important to identify effective management strategies to mitigate the impacts of GHG emissions, particularly CO_2, which is an essential worldwide concern. In this context, several solutions have been suggested, including reducing the use of non-renewable fossil fuels, altering land use, and finally, the matter of carbon sequestration [5, 17]. For example, in 2022, Tamanna *et al.*, used a non-destructive method and allometric equation to quantify the carbon sequestration capacity of trees at the GITAM University campus in Visakhapatnam, India. The study discovered that the total carbon sequestration capacity of the trees on campus was 475,921.5 kg/year, with greater diameter trees accounting for much more carbon sequester. This emphasizes the importance of larger trees in increasing the efficacy of vegetation in lowering emissions and improving the local climate [5]. Another study, conducted in 2023 by Pragya *et al*., discovered that the total carbon sequestered by 849 trees on the Janki Devi Bajaj Government Girls College campus in Kota, Rajasthan, India, was 788.38 tons per year, illustrating the role of urban greenery in reducing CO_2 emissions and addressing climate change [1]. Furthermore, in a study focusing on urban forests, Roberto *et al.,* did a study in Lima, Peru, in 2024 to analyze the impact of urban trees on carbon sequestration and air pollution reduction. The study used I-Tree Eco software to estimate that Lima's urban trees store a total of 2,859 tons of carbon and a yearly sequestration rate of 238.68 tons [18]. These results collectively show that maintaining trees and increasing urban green cover are effective techniques for fighting climate change and lowering emissions, emphasizing the importance of sustainable urban green space management in achieving global goals for the environment. For that there is a growing need to comprehend the significance of carbon sequestration in urban areas particularly in densely populated cities [12]. As in Baghdad, the urban expansion on land used for agriculture has continued in all years, leading to the reduction of vegetation due to degradation of the land. The building area rose from approximately 863 km^2 in 2001 to 1469 km^2 in 2020. This has had a deleterious impact on the climate, with the highest temperature rates observed in urban expansion regions and places with no vegetation [19].

Nevertheless, no research has yet estimated and examined the potential for carbon sequestration in urban areas of Baghdad. The current study aims to cover a substantial research gap by determining the potential of tree species in reducing CO_2 emissions from residential complexes. This will be achieved by calculating the potential sequestration by existing trees.

2. Material and Methods

2.1 Study Area

The study area chosen for this work is a residential complex called Yamama City, located west of Baghdad, Iraq, at coordinates 33.3321° north and 44.3348° east. The climate of the city is defined as semi-arid, subtropical, and continental [20]. Winters are cold, springs are brief, and summers are hot and dry [21]. Temperature extremes, frequently occurring on the same day, between day and night, and between summer and winter, are among its most notable features, and this strong contradiction is evident [22]. Over the previous 30 years, the average maximum temperature was 31.95 °C, while the average lowest temperature was 18.05 °C. In the winter, daily maximum temperatures can reach 16 °C, with night minimum temperatures as low as 2°. In the summer, night minimum temperatures in July and August can reach 26 °C or exceed 43 °C [23]. There tends to be 140 mm of annual average rainfall; summer sees no rain [24]. The residential complex has a total area of 80,000 m^2 and is divided into four sections, A, B, C, and D, as shown in Figure 1. Each section contains different species and numbers of trees, and the complex is surrounded by a fence of 2,930 *Conocarpus* trees on most sides. The number of trees was provided by complex management and verified through field counting. Table 1 describes each section in terms of area, trees number, and species. The residential complex was chosen due to the large amount of vehicle traffic inside it and the fact that it contains a green space of at least 70% of its area, which is abundant with trees, thus evaluating the amount of CO_2 sequestration emitted from human activities inside it. In addition, the increasing construction of residential complexes in Baghdad makes it necessary to highlight the allocation of green spaces within the area of these complexes to contribute to reducing emissions, also increasing the sustainability of human society and enhancing urban area well-being.

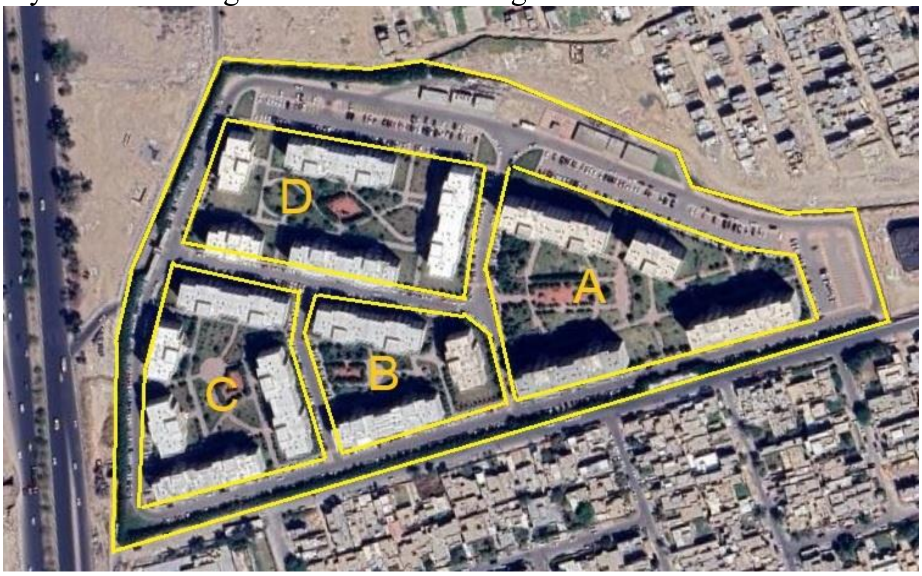


Figure 1: Study area, Yamama City Residential Complex

Table 1: Description of sections

Section	Area (m^2)	Tree Species	Number of trees
A	17812	*Conocarpuse*	196
		Acacia	33
		Albizia	29
		Palms	23
B	8763	*Conocarpuse*	139
		Acacia	16
		Albizia	5
		Palms	9
C	13075	*Conocarpuse*	183
		Acacia	16
		Albizia	10
D	15457	*Conocarpuse*	131
		Acacia	26
		Albizia	42

2.2 Data and Methodology

One method used to lower CO_2 levels is biological carbon sequestration, which estimates how much CO_2 is stored in vegetation like grasslands and forests [25]. According to the nature of environmental research, the non-destructive biophysical procedure estimates a tree's biomass without destroying it to calculate characteristics of trees like height, diameter, and age [26]. Field data were recorded for tree species and numbers in the residential complex, where the circumference was measured using a measuring tape (that was subsequently converted to diameter) and height using a Laser Range finder device for each tree. The age of the trees was determined through management and the agricultural engineers responsible for planting and caring for them. Based on these parameters, the carbon sequestration of each tree was calculated individually. The growth features of the tree species, the growing conditions where the tree is planted, and the wood density of the tree all affect the rate of carbon sequestration [27].

The following five sequential processes were used to calculate the annual amount of CO_2 sequestered in a tree [27], namely: (I) The height and diameter of the tree's trunk, which was measured, should be used to calculate the weight of the tree. (II) The amount of organic matter that is transformed into dry weight should account for 72.5% on average of the total weight. (III) When estimating carbon, 50% of dry weight is taken into consideration.(IV) Since each carbon molecule contains two additional oxygen molecules, the total amount of carbon will multiply 3.6663 to get the net amount of CO_2 sequestered. (V) To get the annual amount of sequestration, the total carbon sequestration was divided by tree age. The Equations (1) and (2) for the measurement of CO_2 sequestered in a tree per year are summarized as follows [27]:

$$W = \frac{D^2 \times H \times 0.15 \times 1.2 \times 0.5 \times 3.6663 \times 0.725}{Tree\ Age} \quad \text{(When D >= 11 inches)} \quad (1)$$

$$W = \frac{D^2 \times H \times 0.25 \times 1.2 \times 0.5 \times 3.6663 \times 0.725}{Tree\ Age} \quad \text{(When D < 11 inches)} \quad (2)$$

where W is the weight in pounds of CO_2 that the tree sequesters annually, D is a tree's diameter in inches, and H is a tree's height in feet [27].

The research stages are shown in the flowchart below.

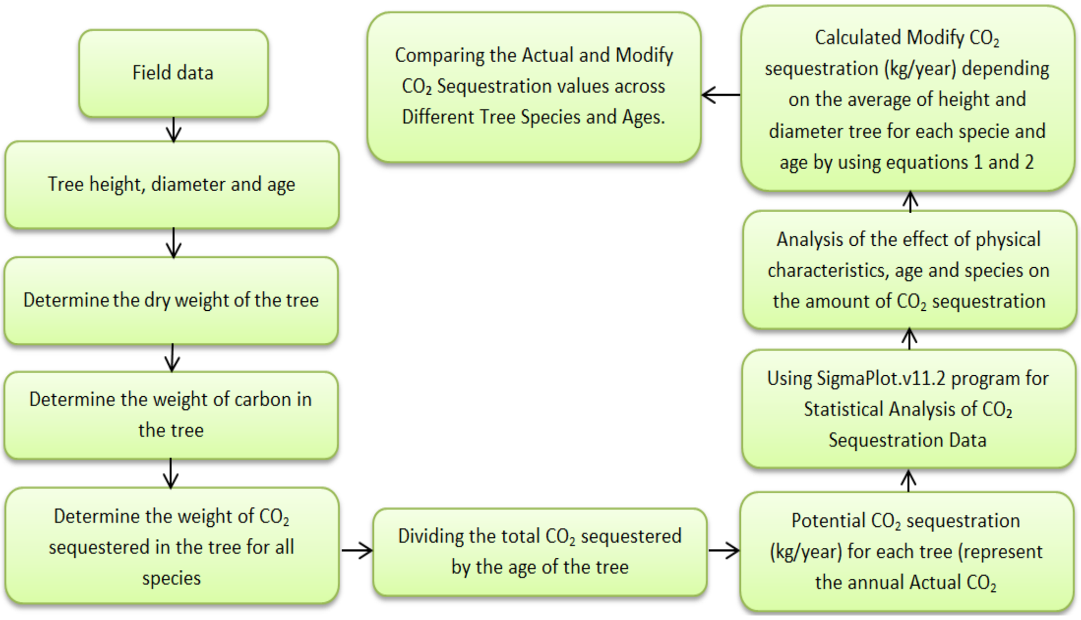


Figure 2: The research methodology

3. Results and Discussion

A total of 3788 trees belonging to 4 diverse species were counted, and field data for the physical characteristics (diameter and height) of each tree were recorded. The selected trees were a height of >= 100 cm and a diameter of >= 2.4 cm. Figure 3 shows the percentages for each type. It is clear that the most dominant species was *Conocarpus*, which covered most of the total number of trees (94%), with 3,579 trees. The lowest percentage of trees planted is the palm, at 1 %, with 32 trees.

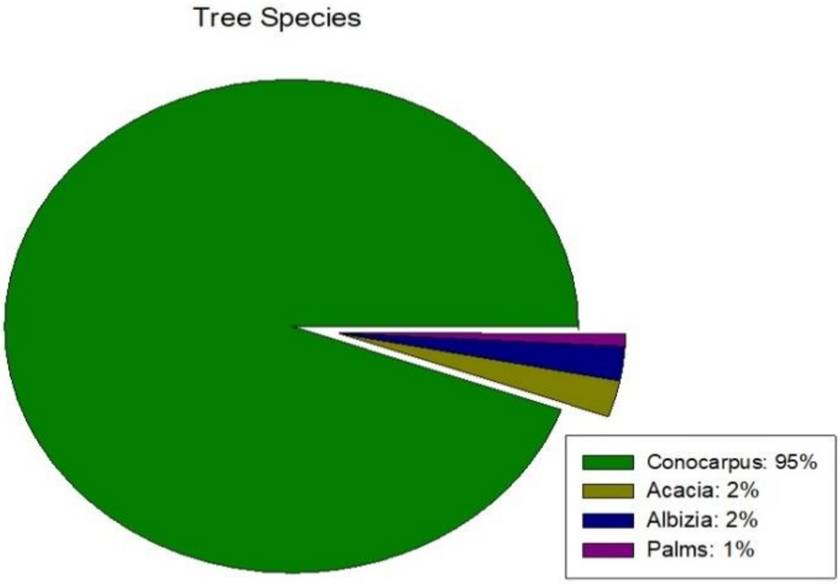


Figure 3: Percentage of tree species

3.1 The physical parameters of trees

The physical characteristics of the selected trees were measured from field data, differing in their height, diameter, and age, as shown in Table 2. In general, the ages of the trees ranged between 2 and 7 years. Trees of *Conocarpus* and *Albizia* were found to be the highest height, with 720 cm and (630 cm), respectively. The trees of *Palm* and *Acacia* were found to be the lowest height with (320 cm) and (350 cm), respectively. While the diameter did not record the same sequence with height, as it was found to be the highest diameter with (56 cm) for the *Palm* and (35 cm) for *Conocarpus*. This is due to the differences in types.

Table 2: The CO_2 sequestration of various tree species in the study area

Species	Age (year)	Height (cm)	Diameter (cm)	Tree Count	Total CO_2 Sequestered per year (kg)
Conocarpus	2,4,7	140-720	2.4-35	3579	18662.7
Acacia	2,4,7	100-350	2.4-14	91	135.6
Albizia	2,4,7	150-680	2.4-20	85	303.56
Palms	2,4,7	50-320	12.9-55.7	32	601.34
Total				3788	197039.2

3.2 Behaviour of Calculated CO_2 sequestration by trees

Using Eq. (1 and 2) and based on field data of physical parameters, the annual sequestration of each tree was calculated individually. As shown in (Table 2), the maximum sum of CO_2 sequestrated per year in the complex has been observed in *Conocarpus* trees (18662.7 kg/ year) due to their large numbers in the study area and the height values of heights and diameters. It is also noted that, despite the numbers of *Acacia* and *Albizia* trees being close, the sum annual sequestration value of the latter (303.56 kg/year) was greater than that of *Acacia* (135.6 kg/ year), as *Albizia* has higher values of heights and diameters than *Acacia*. The same is true for *palm*, despite their very small number of trees, but they sequestrated greater amounts of sum CO_2 annually (601.34 kg/year) from *Albizia* and *Acacia*, due to the large diameter of these trees. Thus, the physical properties have a significant impact on sequestration. As Waring *et al.,* indicate, several variables, including species, soil structure, temperature, water, and nutrient availability, as well as additional logistical and financial difficulties, affect tree growth and, thus, carbon sequestration [28].

Figure 4 illustrates the yearly CO_2 sequestration (kg/year) over three age periods (2, 4, and 7 years) for the four tree species in the study area. The results show a significant relationship between age, species, and carbon sequestration capacity, which is an important finding for reforestation plans. In general, for all species, the older the tree, the more CO_2 it sequesters due to the increase in its height and trunk circumference, and it varies according to the species of tree and its growth. *Palms* showed the highest amount of CO_2 sequestration, which increased significantly with age due to a significant increase in diameter, reaching (12.9 cm) at 1 year old and (55.7 cm) at 7 years old with more than 50 kg/year sequestration, making them very efficient at sequestering carbon, as shown in Table 2. *Albizia* and *Conocarpus* change well, as demonstrated by the clear difference in the amount of CO_2 sequestered in these trees at the age of 1 year compared to 7 years in the same trees, reaching about 10 kg/year and 8 kg/year, respectively at the age of 7 years. While the sequestration rate of *Acacia* trees is the lowest, changing little with age and reaching less than 4 kg/year at 7 years old. However, these trees help sequester carbon, albeit with less success than *palms*, especially in mixed species plantations that support biodiversity. This is consistent with confirmation of previous studies, as the trees store different amounts of CO_2 depending on their age. In trees younger than 15 years old, the weight of CO_2 sequestered increases smoothly. Between the ages of 15 and 45, CO_2 sequestration increases dramatically [27].

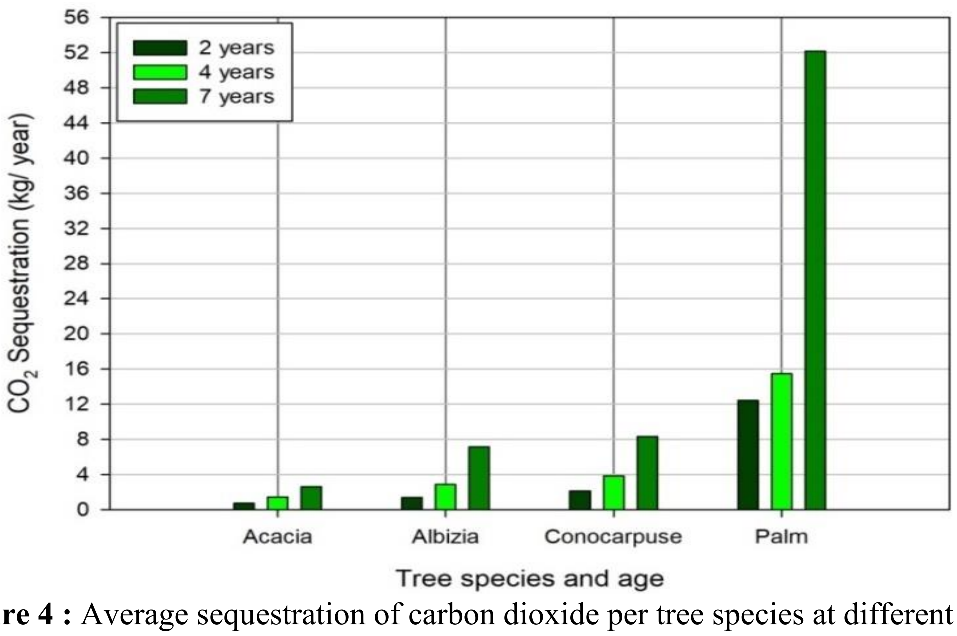


Figure 4 : Average sequestration of carbon dioxide per tree species at different ages

3.3 Carbon sequestration in trees by each section

Since the complex is divided into four sections, A, B, C, and D, most of the trees are located near buildings or along roadways. Figure 5 shows the total weight of CO_2 sequestered in the trees by section. Note that the trees in section A have sequestered an amount of CO_2 equivalent to what was sequestrated in all other sections of the complex with (2016.5 kg/year). The major reason for the highest CO_2 sequestration in this section is that it contains the largest number of trees. Moreover, the majority of trees in section A are 7 years old and have larger diameters and heights than in the other sections, which have mostly 2 and 4 year old trees. The trees in the other sections have only sequestrated about (687 kg/year) of CO_2 per section.

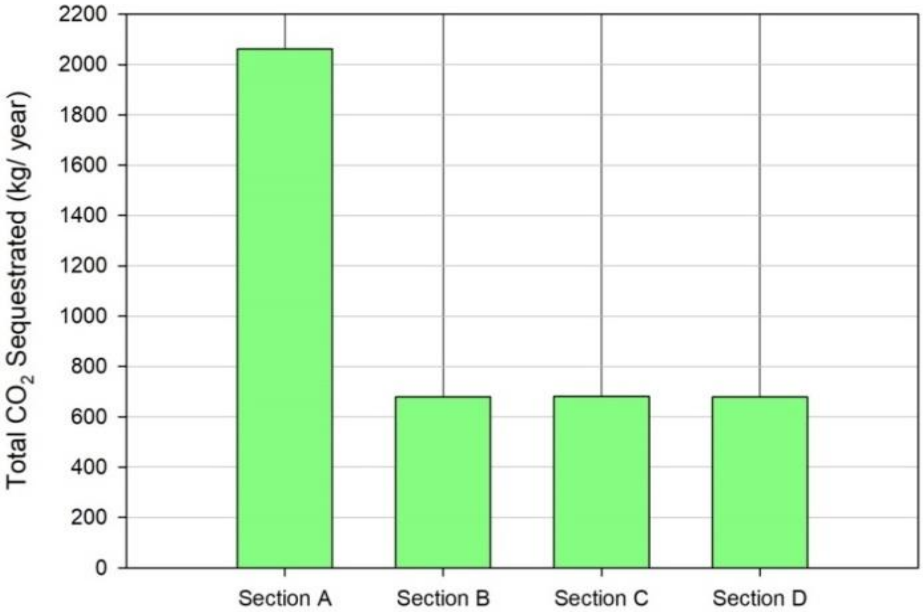


Figure 5: Current total weight of CO_2 sequestration in trees of complex, by sections

3.4 Effect of diameter and height on CO_2 sequestration

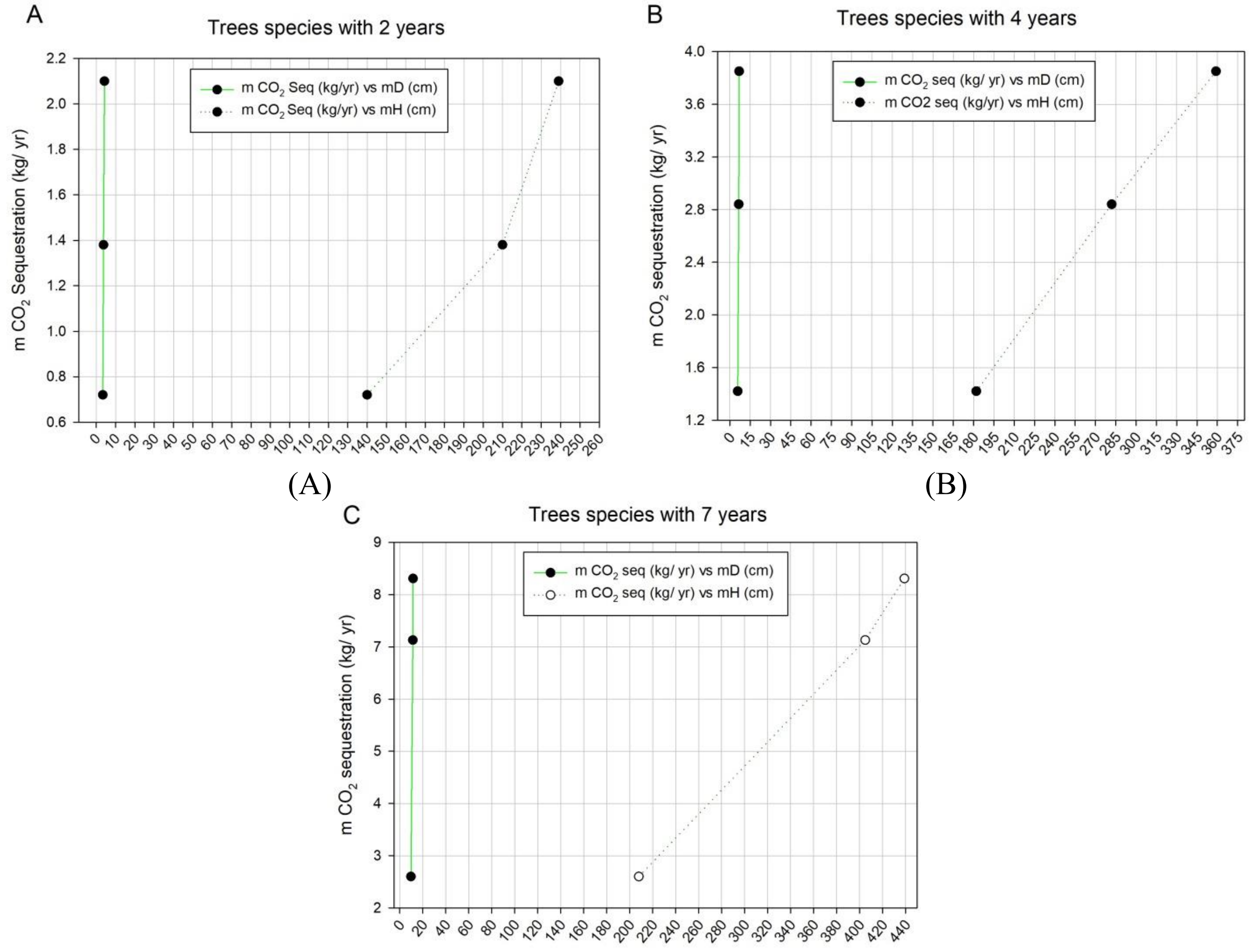
The study showed that the ages and types are different, in addition to a large number of study area trees, which caused a large overlap in heights and diameters, so it was difficult to build a clear relationship between diameters, heights, and the amount of CO_2 sequestrated by trees. Therefore, a processor was created to clarify this relationship, where the age was fixed (according to the ages of the trees in study 2, 4, and 7 years) for each type of tree (regardless of palm trees, as they differ from other types in terms of their large diameter, which exceeds the diameters of the rest of the types and the type of their leaves), then the average diameter and average height were taken for each type according to its age and called the modified diameter (D m) and modified height (H m) respectively. After classifying the trees according to age and using Eq. (1 and 2), the CO_2 sequestration was calculated based on D m and H m, then divided by its age to obtain the CO_2 sequestration per year. Which is called modify CO_2 sequestrated (modify CO_2 sequestration), as shown in Table 3. Finally, the effect of diameter and height on the amount of CO_2 sequestrated for each type and its age is compared.

Table 3: The diameter and height modified with CO_2 sequestrated modified per year of tree species

Tree Species	Age	D m (cm)	H m (cm)	m CO_2 Sequestered per year (kg)
Acacia	2	3.40	140	0.72
Albizia		3.78	210	1.38
Conocarpus		4.28	239	2.10
Acacia	4	5.80	182	1.42
Albizia		6.59	282	2.84
Conocarpus		6.92	359	3.85
Acacia	7	9.70	208	2.60
Albizia		11.34	405	7.13
Conocarpus		11.50	439	8.31

Figures 6 (A, B, and C) show a significant relationship between tree diameter (D m) and height (H m) and CO_2 sequestration at different growth stages (2, 4, and 7 years). This

relationship demonstrated that, at the age of 2 years, as shown in Figure 6 (A), even slight increases in diameter (ranging from 3.4 to 4.2 cm) lead to a significant increase in CO_2 sequestration, ranging from (0.7 to 2.1 kg per year). Height also contributes to sequestration, but its impact is more gradual. At the age of 4 years, as shown in Figure 6 (B), both diameters ranging from (5.8 to 6.92 cm) and height (up to 359 cm) continue to enhance sequestration, resulting in a sequestration rate of approximately (1.42 to 3.85 kg) per year. The diameter continues to be the primary factor; however, the significance of height is increasing. At the age of 7 years, as shown in Figure 6 (C), the process of CO_2 sequestration reaches its highest point, with tree diameters ranging from (9.7 to 11.5 cm) and heights reaching (up to 439 cm). This leads to a about (8.0 kg/year) sequestration rate. The diameter continues to be the most influential factor.



(A) (B)

(C)

Figure 6: The relationship between m CO_2 sequestration (kg/year) and diameter m D (cm) and height m H (cm) for tree species, (A) Across 2 years growth stage, (B) Across 4 years growth stage (C)Across 7 years growth stage

The findings demonstrate that both the diameter and height of a tree play a critical role in CO_2 sequestration. The data suggests that even small increments in diameter result in substantial increases in CO_2 sequestration, thus establishing diameter as a more important factor, particularly during the initial stage of a tree's development. In contrast, the relationship between height and CO_2 sequestration is more gradual and consistent. Moreover, there were noticeable variations in the rates at which different species were sequestered. *Conocarpus* consistently had the best capacity for CO_2 sequestration at all stages, with

Albizia and *Acacia* following, indicating the differing influence of diameter and height on CO_2 sequestration among various tree species.

3.5 Actual vs. Modified CO_2 Sequestration

To enhance accuracy, efforts were made to minimize assumptions by collecting field data to measure the physical characteristics of all trees. The actual annual amount of CO_2 sequestration for each tree was then calculated based on this data. These individual sequestration values were combined to determine the total sequestration values, categorized by species and age. The resulting amounts, representing the actual CO_2 sequestration per year, are presented in Table 4.

Table 4: Annual CO_2 sequestration comparison between modified and actual values across various tree species and ages

Tree species and age	Tree count	Modify CO_2 sequestered per year (kg)	Actual CO_2 sequestered per year (kg)
Conocarpus 2	183	384.3	434.76
Conocarpus 4	380	1463	1534.9
Conocarpus 7	86	713.8	1089.9
Albizia 2	28	38.6	38.5
Albizia 4	41	116.44	128.1
Albizia 7	16	114	136.9
Acacia 2	35	25.2	27.8
Acacia 4	40	56.8	63
Acacia 7	16	41.6	44.15
Palm 2	24	298.56	292.29
Palm 4	3	46.35	46.85
Palm 7	5	260.9	262.22
Total	857	3559.55	4099.37

The comparison between actual and modified CO_2 sequestration in Figure 7 and Table 3, reveals minimal differences, suggesting that applying this method has little effect on the total sequestration potential; therefore, it can be used instead of calculating the sequestered CO_2 per tree. Moreover, the correlation coefficient ($r = 0.98$) between the actual and modified values reflects a high level of agreement, confirming the accuracy and reliability of this methodology in quantitative estimates of carbon sequestration.

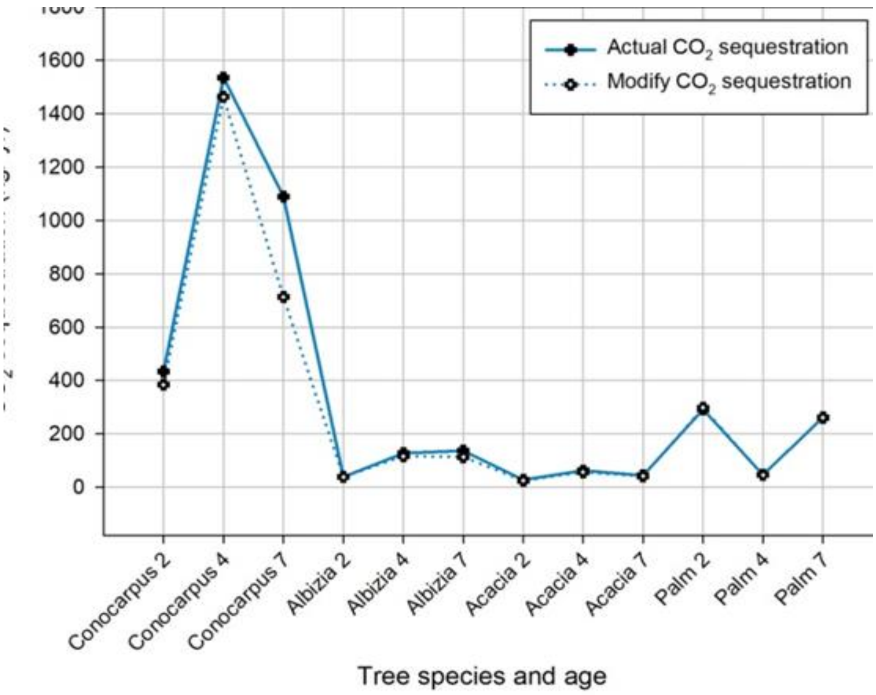


Figure 7: Comparison of actual and modified CO_2 sequestration across different tree species and ages

4. Conclusion

Using field measurements (non-destructive biophysical procedure) and Eq. (1 and 2), this study offers a thorough evaluation of the urban tree species' capacity to sequester carbon within a residential complex in Baghdad, Iraq. The following main conclusions are attained. (I) The findings indicate that the most effective species for sequestering CO_2 is *Conocarpus* trees, which account for 94% of all trees and contribute about (18,662.7 kg/year). This is mostly because of their abundance and favorable biophysical characteristics like diameter and height; in contrast, *Acacia* was the least productive species, contributing just about (135 kg/year) due to its small height, diameter, and numbers. (II) The entire residential complex's overall carbon sequestration capacity was determined to be (197,039.2 kg/year), indicating the vital role that urban trees play in reducing greenhouse gas emissions worldwide. Additionally, it demonstrated how species diversity enhances the overall resilience and efficacy of carbon sequestration strategies, even while *Conocarpus* trees predominate in terms of numbers. The benefits are not limited to carbon sequestering and storage; the trees around the complex give shade, which eventually filters heat and decreases radiation, cooling the surrounding area. (III) Tree age is an important component of estimating sequestration potential; older trees generally sequester more CO_2 due to their bigger size and biomass, which varies by species. (VI) Tree diameter was discovered to be a more important determinant than height in affecting CO_2 sequestration capacity, particularly in the early growth phases. (V) Comparisons between the actual and modify CO_2 sequestration estimations show that there are minimal differences in sequestration amounts, indicating the validity and use of the method for extensive evaluations and giving trustworthy resources to evaluate and improve metropolitan areas' capacity to sequester carbon.

The study highlights how crucial it is to include a variety of mature tree species in urban planning to optimize carbon sequestration and mitigate climate change. In order to improve environmental sustainability, future research should examine the long-term effects. It can also be repeated study in the same location after (2-5) years to see how the physical properties of the trees affected the amount of insulation with age and the advantages of expanding green spaces in metropolitan areas and diversifying species.

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Ethical responsibilities of authors

The authors confirm that this article has not been previously published or submitted to another journal and that all authors have contributed adequately to the scientific work and bear joint responsibility for the results while complying with all ethical principles followed, including avoiding plagiarism and data manipulation.

Statements on compliance with ethical standards and standards of research involving Animals

This article does not contain any studies involving animals performed by any of the authors.

Disclosure and conflict of interest

The authors declare that they have no conflicts of interest.

References

The full name of the journal, not the abbreviation in the references, must be written and in italics.
All authors must be mentioned in the references without using et al.

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