Journal of University of Duhok., Vol. 22, No.1 (Agri. and Vet. Sciences), Pp 107-121, 2019
https://doi.org/10.26682/avuod.2019.22.1.11

TOWARDS THE ESTABLISHMENT OF A SITE-SPECIES-SPECIFIC TABLE FOR CARBON SEQUESTRATION OF *Morus nigra* And *Salix alba* IN DUHOK PROVINCE, KURDISTAN REGION

AREE ABDULKHALEQ, HISHIAR SAEED[*], HONAR SAFAR MAHDI[**] and SAMI YOUSSEF[***]
[*]Dept. of Forestry, College of Agriculture, University of Duhok, Kurdistan Region - Iraq
[**]Dept. of Recreation and Ecotourism,College of Agriculture, University of Duhok,Kurdistan Region - Iraq
[***]AMAP (botany and Modelling of Plant Architecture and vegetation), University of Montpellier -France.

(Received: August 14, 2018; Accepted for Publication: October 30. 2018)

ABSTRACT

From the past decades, carbon dioxide emissions have been dramatically increased and concentrate in atmosphere mainly due to human activities. This disastrous situation was a huge concern on the increasing the atmospheric carbon dioxide emissions inside urban areas and it became a challenge to the public health worldwide, as well as, its main cause of rising climate changes. Hence, the present project study tempted to address the important role of the urban vegetation for air quality. Here, we report the carbon dioxide capture by two urban tree species frequently planted (*Morus nigra* L.) and/or naturally occurred (*Salix alba* L.)in Duhok governorate areas and almost in all towns and cities of the Kurdistan Region.The results of this study showed a variation between *Salix alba* and *M. nigra* trees species in term of ratio dry/wet biomass, the carbon sequestration net and the annual CO_2 sequestration capacity. The main findings of this research were the annual carbon content quantification for common tree species grown in Duhok city: for white willow was (23 kg) and for black mulberry was (15 kg). Compare with, for some other trees that been done in previous studies for *Pinus brutia, Eucalyptus camaldulesnsis, Quercus aegilops,* and *Cupressuss empervirens* were 44.95, 38, 33.93 and 17.2 respectively. These results can be considered as an initial step to decrease the level of carbon dioxide emissions by planting the native treespecies. For the first time, a site-species-specific allometric equation has been developed based on the relationship between tree volume-wood biomass extracted from true values "destructive method" of biomass quantification. Consequently, thanks to this new volume-weight equation, we can assess the important roles of urban trees in the carbon sequestration process in urban areas of the Kurdistan Region without cutting the trees can be assessed.

KEYWORDS: Carbon quantification, tree biomass, Morus, Salix, urban forest, Agroecology**.**

1. INTRODUCTION

Over the past century, there has been a dramatic increase of carbon dioxide emissions in atmospheric concentrations mainly due to anthropogenic activities (Solomon et al., 2009; Schellnhuber, 2008; Davies et al., 2011). In urban areas, the increasing concentration of atmospheric carbon dioxide is increasingly recognized asserious challenges, worldwide public health concern, besides of its fundamental role in starting off climate change (Hansen et al., 2007; Schellnhuber, 2008). In this dramatic context, the principal preoccupation of the United Nations Framework Convention on Climate Change (UNFCCC) is to achieve stabilization of Carbon emissions in the atmosphere at a low enough level to prevent the dangerous anthropogenic interference with the climate system (Hansen et al., 2007; Schellnhuber, 2008; Solomon et al., 2009) as well as make human society more sustainable and improve the wellbeing of urbanities (Davies et al., 2011; Strohbach et al., 2012). Therefore, there is widely concern about climate change which leads to understanding the emissions of CO_2 reduction, in addition, carbon fixing in the vegetation and soils is a part of reducing the emission of CO_2(Ross, 2007). Increasing in urbanization is destroying the environment and degradation of the natural ecosystem. Balancing the carbon (C) inside urban green spaces is a new challenge for major studies and concerning principal policy in efforts to address climate change, as urban areas are both major roles in the search for good strategies to create more sustainable society and urban improvement and also concentration on carbon dioxide in atmosphere (greenhouses gases) (Pataki et al., 2006; Romero Lankao, 2007; Rosenzweiget., 2010; Escobedo et al., 2010; Davies, 2011; Feliciano & .Prosperi, 2011; Strohbach et al., 2012; Neirottiet et al., 2014). Urban area infrastructure transformation not just limited to buildings and transportation, however, it is also including all the implementation of green area infrastructures as a Carbon store (Gill et al., 2007; McPherson et al., 2013). The infrastructure of green area including a large number of natural components in urban green areas for example gardens, parks, woodlands, waterways, greenways, wilderness areas, forests, community farms and green roofs are able to help as an active strategy for mesoscale, macroscale and microscale climate change adaptation and mitigation because green cover can store and capture carbon by biotic sequestration (Rowntree & Nowak, 1991; Nowak & Crane, 2002; Pataki et al., 2006; Vidrih & Medved, 2013).To diminish some of these issuessome provincial governments globally conducted large projects on tree planting (afforestation) and also covering all infrastructure, particularly implementing green infrastructure as a carbon sink to support ecosystem services and habitats for example reducing air and noise pollution, carbon fixing, attenuate water storm and regulating microclimate (Escobedo et al., 2010; Gaffin et al., 2012; Auckland Council 2012; Oldfield et al., 2013). A forest has a significant role in the ecosystem estimation estimated and regulating global warming diversity, furthermore, helps to make a balance between carbon dioxide and oxygen and forests are considered as a part of the global carbon sequestration (Ross, 2007). As well as, there are some other values and functions come from the trees that planting in cities (such as local climate mitigation, ornamental purposes etc..) that area significantly influence on the quality of the environment and human health (Gomez-Baggethun et al., 2013). The importance of Carbon fixing or carbon sequestration through plant has been highly reported nowadays as a result of developing the role of plant determinations within the ecosystem (Schroter et al., 2005). Carbon dioxide is fixed from the atmosphere naturally throughout physical, chemical and biological processes (Saeed et al., 2016). Unfortunately, in the Kurdistan region, little information is known about carbon sequestration or removal of pollution, by tree species in urban (Mizori, 2010). The results of Saeed et al. (2016) which was carried out on *Cupressus sempervirens* var. *horizontalis* and *Eucalyptus camaldulensis* are accounted as a initial step toward carbon offsetting potential quantification and later the approaches of developing specific region that Kurdistan cities can be utilized to assess carbon dioxide fixing using specific allometric models and the framework availability of tree species inventories at local scale (Duhok governorate). These frameworks are for future carbon fixing measurement should effortlessly be integrated into future urban planning, management and urban green space area policies. Thus, the main aim of this research is carbon captured determination from two tree species occur commonly (*Salix alba* L.) and frequently planted (*Morus nigra* L.*)* in urban areas of Duhok governorate and almost all cities and towns of the Kurdistan Region. They are and both tree species are native and widely occurring in natural and urban areas of Kurdistan Region. This approach can be used to support assessing the role of urban tree species in diminish the $CO_2$and help Kurdistan region carbon sequestration planning in the future.They will drove scientists working through tests to quantify the perfect trees species, which provide a good suggestion and recommendation in developing green space areas, Robert. (2005) recommended in increasing carbon sequestration practices in urban forestry areas.

2. MATERIALS AND METHODS

2.1. Study area:

The present research project was carried out after the course of the full growing period in June and July 2018 in Duhok city. The Duhok city is located on the north of Kurdistan Region of Iraq (N 36˚ 52′ 03″ E 42˚ 59′ 34″). It makes up the urban area administrated by Duhok governorate and it covers about 10715 km². From a landscape standpoint, Duhok city is encircled by two chains of hills eastward west ward direction. Which are Bekhair and Zawa hills situated in northern and southern of Duhok City. These mountains confer the city an elongated landscape shape but with high air pollution risk. On other hands, there are two rivers passing through the city (Duhok River and Heshkarow). These two small rivers constitute an important riparian urban forest with the dominance of some native tree species e.g. *Morus sp*., *Salix sp*., *Platanus sp.*, *Populus sp.*, etc (Shahbaz, 2010). Consequently, this riparian urban forest with the semi-natural vegetation cover on the hills encircled the city green belt form the green belts and thus play a primordial role on the environmental quality of the urban areas in Duhok city i.e. carbon sequestration, phytoremedation of air pollution, help control sediment and reduce the damaging effects of flooding. The climate is continental Mediterranean with mild, wet winters and warm dry summers (Youssef et al., in press). The precipitation mainly falls in late winter to late spring i.e. from December to marsh (Youssef et al. 2015; Youssef et al., in press). According to bioclimatic data from Malta nursery-Duhok, the city belongs to the Mesopotamian region and having some Mediterranean climate features. The mean annual temperature for 2016-2017 was 26.7 C°; the average annual precipitation in Malta nursery was (386 mm), while the precipitation started on 28 October 2016 and ended on May 20 of 2017. According to the classification of Köppen-Geiger climate system (Peel et al., 2007), the area is classified it as a semi-aridregion.

2.2. Study species:

In this research project, two nativetree species were selected over the urban area in Duhokcity. It widely growing tree (for *S. alba)* in natural habitats and/or frequently planting (for *M. nigra)* in urban areas almost cities and towns of the Kurdistan Region have been selected. These two tree species are an important element in terms of urban greening process and vegetative cover, which in turn play an essential role for carbon sequestration and decreasing the Carbon emission in urban and semi-urban areas which absorb the CO_2 from atmosphere and stored in the soil and plant leaves.

2.2.1. *Morusnigra* L. (Moraceae family):

Morus nigra is one of the two native mulberries in Kurdistan Region of Iraq (Townsend and Guest, 1966). It is a deciduous tree growing to 12 m with a dense spreading leafy crown. It is cultivated and naturalized in moist situations in the mountains, foothills and in orchards. In added, it founds quite common in the almost mountain-forest region up to altitude 1650 m a.s.l. of Kurdistan Region (N Iraq), but occasionally in foothills and pseudo-steppic plains (Shahbaz, 2010). This lack mulberry is thought to have originated in the mountainous areas of W. Asia (Mesopotamia, Zagros, and Persia) and are now wide spread and has long been cultivated for its edible fruit and is planted and often naturalized across the Europe C. Asia and N. Africa (Townsend and Guest, 1966). Its fruits can be eaten for dessert or made into jam, syrup etc. The black mulberry has a long history with medicinal uses: its delicious nutritive edible fruits have a rich amount of anthocyanin, phytochemical and antioxidant properties (Özgen et al., 2009); while its leaf hasanti-inflammatory effects by reduced paw edema (Padilha et al., 2010) and its potential in improving cognitive deficits, mainly due to its high antioxidant capacity (Turgut et al., 2016).From an urban greening standpoint, it is widely cultivated in urban areas “family garden” for edible purposes and/or often in a public garden and in roadside plantations for ornamental purposes. Furthermore, it is widely used in urban areas as a biological indicator o their suitability for air quality biomonitoring (Daud et al., 2011).

2.2.2. *Salix alba* L. (Salicaceae family):

It is a tree up to 30 m. high with a narrow or spreading crown which occurs naturally in the Kurdistan Region of Iraq.It is a species of willow native to Europeand w. & C. Asia and N. Africa (Townsend and Guest, 1980). In theKurdistan Region, it founds occasionally over stream sides in the mountains, also near water (along with channels, etc.) on the plains. It occurs naturally in riverine habitats with others riparian tree species such as others Willow (*Salix sp*.), Oriental plane (*Platanus orientalus* L.) and Poplar (*Populus sp*.). They often constitute together natural riparian forests in Kurdistan Region. White Willow is well known for its longevity, spreading crown and their survival and success in dry soils and in most temperate latitudes once it is established. In spite of its important role as greening belts surrounding the urban areas, it is rarely used for greening purposes in urban areas. The white Willow genus has a considerable economic importance wherever it is found:it provides timber, fuel, and wood for carpentry as well as material for basket-making; the bark tannin was used in the past for tanning leather (Rushforth, 1999); It has an important biomass productivity and phytoremediation potential (Mleczeket al., 2010); It plays prominent roles in the therapeutic actions due to its anti-inflammatory and antipyretic efficacy (Shara&Stohs, 2015).

2.3. Field Procedure and Sample preparation:

To date various methods have been developed and introduced to measure the carbon sequestrated in tree species (Pastor et al., 1984; Birdsey, 1992; Nowak, 1994; Pertram et al., 2003; Wang, 2006; Nowak et al., 2008; Basuki et al., 2009; Rutishauser et al., 2013). Previous studies have based their criteria for selection on the allometric equations to estimate/calculate the percentage of carbon in the tree in terms of extracting the total dry weight of a tree and the percentage of carbon sequestration in terms of local measurements (e.g. Nowak, 1994; Nowak et al., 2008). Our previous study based on allometric equation was conducted within Duhok governorate on two different treespecies from open forest formation to estimate the susceptibility of carbon sequestration (Mizori, 2010). This allometric equation was based on the diameter at the breast height (dbh) and height of the tree to calculate the wet weight of the whole tree (Total wet weight = 0.25 D^2H) (according to Clark et al., 1986). However, these calculations do not give the true values of the ratio of carbon sequestrated by the tree, but taken as approximate rates in terms of reality based on the tree species found's in the United States depending on the environmental conditions of the growth of the tree and the area which trees grow. In his study, Mizori (2010) had shown that the estimated annual mean carbon content based onthe allometric equation was smaller than the real content. He reported that the difference between species and may be within the same species is mainly due to the moisture content of wood that varies with location in standing trees (Mizori, 2010). In this study, two parallel approaches have been used: the first one is based on the calculation of the real carbon sequestration content via cutting the trees; while the second one is based on the relationship between the volume according to Smilian equationand the real total dry biomass of the trees. This alternative method "volume-weight relationship" will have a greatvalue to quantify the significance of Kurdish urban/natural forests in regional carbon budgets. Therefore, the method is based on the field data of two urban tree species with potential fast growing that frequently found in urban/natural habitats in the Kurdistan Region. The field process started as follows: two individual trees had been randomly selected for both tree species (*Salix alba* and *Morus nigra*) according to a good specification in term of volume, growth, and age.The limited number of selected individuals was due to the legal instructions of the governorate of Duhok Province. The trees were felled down by a chainsaw and then the twigs, branches and leaves of the trees were separated (Figure 2). In addition to bucking the main logs of a tree into lengths of meters and measuring the lower and upper diameters of each pole.According to these diameters, the volume of the whole log with the volume of each section of a tree was calculated.

The Smalian's formula (equation 1) could be used to calculate volume If the stem is subdivided into sectionsit is known that theTree volume determination is always based on measurements of diameter and length. When calculating a section-wise volume (Figure 1).

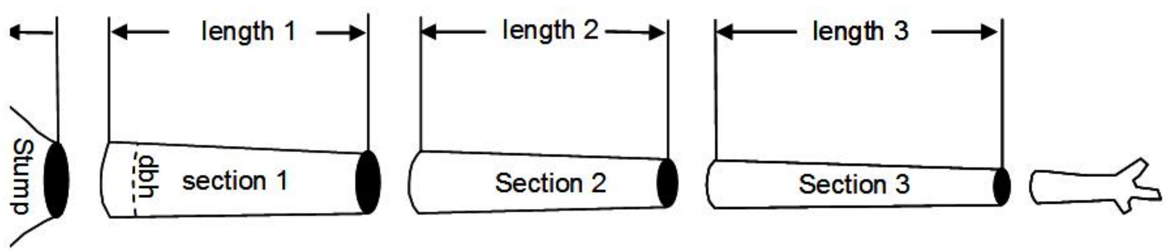

Fig. (1): Subdivision of a stem into sections.

Smalian's formula (S.F.) = 0.00007854*(h)*[d12 /2+ d22 + d32 + d42 + d52 + d62 + d72/2]……….(1)

Knowing that extracting mechanically root from the ground is often not an option to derive tree carbon stocks, particularly in urban areas (Figure 2). Therefore, to calculate the total green weight of the tree, multiply the aboveground weight of the tree by 1.2 according to the method developed by Clark et al. (1986). Then, the total wet weight of a tree was calculated via the weight of the whole of (logs, branches, leaves, and twigs) by electronic scales (with a precision of 0.01 g and a capacity of 300 kg) directly from the field. However, three random samples were taken for each of the branches, leaves, and twigs in suitable sacks for avoiding loss of moisture. As well as one sample of each section of logs which bucked to lengths of meters had been taken; and then took five other trees randomly for each type and measurement of heights and diameters for each one and determine the bottom and upper diameters according to the length of the tree, the volume of each tree calculated depending on smalian's formula, and taking the sample for each tree by using increment borerand pick up in

Journal of University of Duhok., Vol. 22, No.1 (Agri. and Vet. Sciences), Pp 107-121, 2019
https://doi.org/10.26682/avuod.2019.22.1.11

appropriate sacks. While the weight of all samples was calculated before (green weight) and after (dry weight) drying in the oven at 105°C for 48 hours in the laboratory of the department of forestry, college of Agriculture, University of Duhok. After then, all green weight of all parts and dry weight (multiply the green weight on percentage of dry weight in samples of all parts oftrees) (Figure2).

Fig. (2): field procedure and sample paration Stages. (a) Tree selection. (b) The chainsaw has been used to felling. (c) Height, diameter, and age Measurement for each tree of Willow and Mulberry. (d) Cuttingthetree to standard pieces. (e) BranchesWeighting. (f) Limbs Removing(branches, leaves and twigs). (g) Taking Samples. (h) Measuring wet weight. (i) Dry weight measuring.

which indicates the half of the total dry biomass is considered the average of carbon content. Thus, the carbon sequestration weight of the tree was estimated by multiplying each individual total dry weight of trees by 0.5. Moreover, to calculate the carbon CO_2 sequestrated weight of the tree, we multiplied the carbon weight by 3.6663 (atomic weight of C is 12.001115 and for CO_2 is 43.999915) Wicaksono et al, (2011). In order to achieve annual CO2 sequestrated weight, we divide the CO_2 sequestrated weight of trees by the tree age. For value of carbon sequestration and storage estimation, C values are multiplied by $78.5 per ton of C depending on social costs of carbon estimation with a 3 % percentagerate of discount (Interagency Working Group, 2010).

Journal of University of Duhok., Vol. 22, No.1 (Agri. and Vet. Sciences), Pp 107-121, 2019
https://doi.org/10.26682/avuod.2019.22.1.11

3. RESULTS AND DISCUSSION

Planting trees and maintenance the urban green spaces have increasingly become a major research challenge and a principal urban policy concern in efforts to improve the life-quality of urban residents related to theatmospheric carbon emission (Nowak et al, 2006; Chen, 2015; Kiss et al., 2016; Boukili et al., 2017). This balance between life-environment quality is one of the most important issuesto make human society more sustainable and thus improving the wellbeing of urbanites (Elmqvist et al., 2015; Kuittinen et al., 2016).In this circumstance, the urban forests play an important role in improving the environmental quality and it is an effective green-technological solution for carbon sequestration in urban areas. Therefore, the results of this study are inset in the continuity towards estimating the rate of carbon storage by urban trees at local and/or regional scale in Kurdistan Region. In this context, an accurate estimation of biomass in urban trees is crucial for future urban land use planning and policy strategies. Our results showed a variation between *M. nigra* and *Salix alba* trees species in term ofratio dry/green biomass, the net carbon sequestration and the annual CO_2 sequestration capacity.

3.1. Carbon sequestration capacity of *M. nigra* versus *S. alba*:

Black mulberry (*Morus nigra*) is a deciduous tree founds commonly in natural habitats (mountain-forest, foothills and often plains regions). It is widely cultivated in both private and public parks and gardens for ornamental purposes and for its edible fruits (Townsend and Guest, 1966; Shahbaz, 2010). In terms of biomass, our results, as shown in table 1, 2 and figure 3a, indicate that the ration of total dry (195.11 Kg) to green (344 Kg) biomass is 56.72 with 43.28 % of moisture. This relatively high percentage of water may be due to its occurrence in private garden with regular irrigation by the urban residents. In more details, the highpercentage of both dry and green biomass is found in the stem (about 60 %) and the roots (17 %). In contrast, less than a third (about 24 % in total) of the dry or green biomass was found in the crown without the stem parts (branches, twigs, and leaves). These findings enhance our understanding of the biomass allocation strategy of black mulberry tree species. The balance of the biomass allocation reflects the influences of evolutionary and ecological processes as a trade-off of multiple bio-functions (Bazzaz& Grace, 1997; Pons et al., 1998; Youssef, 2011). In added, the total carbon dioxide sequestrated for the black mulberry was 357.67 kg with an annually rateabout 14.9. This annually carbon storage is equal to a price of approximately 1.17 $ per year per each individual tree (Table 2).

Table (1): Illustration of wet and dry weight of both Mulberry and Willow samples in Duhok Provence.

Sample	H	D	Stems		Leaves		Twigs		Branches		Roots		Total Wet	Total Dry
			Wet	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**	**Wet**	**Dry**		
Morus	12	19.4	204.4	120.36	19.22	10.57	13.39	7.9	49.66	23.77	57.33	32.5	344	195.111892
Salix	11	41	263.28	160.07	28.6	14.01	18.54	10.2	71.47	45.03	76.38	45.86	458.268	275.164053

Table (2): Total carbon sequestered and moisture content of both Morus nigra and Salix alba.

Tree species	H (m)	D (cm)	Annual rings	Total Wet	Total Dry	Dry/Wet %	MC %	Carbon	CO_2 Sequestration	Price ($)	Annually CO2	Annually Price ($)
Morus	11.50	19.40	24	344.00	195.11	56.72	43.28	97.56	357.67	28.08	14.90	1.17
Salix	11	41	22	458.27	275.16	60.04	39.96	137.58	504.42	39.60	22.93	1.80

Journal of University of Duhok., Vol. 22, No.1 (Agri. and Vet. Sciences), Pp 107-121, 2019
https://doi.org/10.26682/avuod.2019.22.1.11

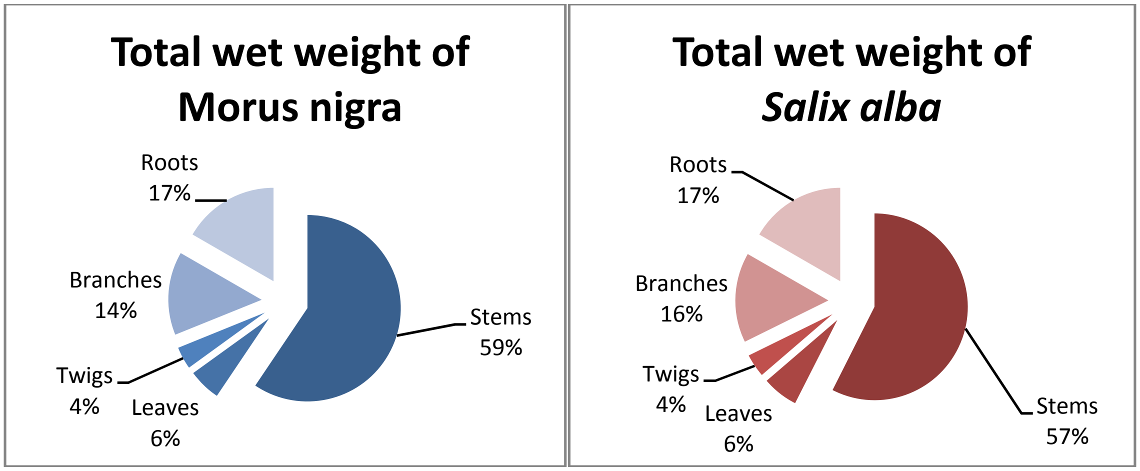

Fig. (3a): Total wet weight of all part of both tree *Morus nigra* and *Salix alba*

Concerning White Willow (*Salix alba*), it is a native riparian tree species with a wide ecological range over streamsides and rivers in Kurdistan Region (Townsend and Guest, 1966; Shahbaz, 2010). It constitutes with other tree species an important natural riparian forest, even if in urban and semi-urban areas, where it plays a primordial role in the environmental quality like its role in carbon sequestration and phytoremediation. It is apparent from tables 1,2 and figure 3b that it has a similar pattern of the biomass allocation partitioning between the above and below-ground parts. In fact, the white Willow sequestrated about 275.16 kg of total dry biomass and 458.26 Kg of total wet biomass with a 60.04 dry to wet biomass ratio. The total percentage of the water was approximatively 40%. This high rate of moisture may be explained by the fact that it grows principally in wet habitats over streamsides and rivers. In addition, white Willow, as like black Mulberry, has a relatively high ratio of total biomassin the stem (about 58 for both dry and wet weight)compared to the crown without the stem (about only 25 %) and the roots (about 17 %). As can be seen in the details from the figure 3b, the percentage of the biomass approximatively were 58 %, 17 %, 16 %, 5 %, 4 % in stem, roots, branches, leaves and twigs respectively. The most striking result to emerge from the biomass data is that both the tree species have a similar allocation strategy for their parts (Table 1, Figure 3a, b). This also accords with earlier research results for *Eucalyptus* species, which showed a similar biomass allocation biomass strategy (Saeed et al., 2016). Therefore, results consolidate the idea that the evergreen tree species have a different biomass allocation strategy compared to deciduous ones with a higher carbon concentration in crown tissues compared with stem wood and roots (Bert & Danjon 2006; Mello et al., 2012; Saeed et al., 2016). Consequently, the carbon sequestration by the both urban species (*M. nigra* and *S. alba*) has important implications for developing an innovation greening strategy in urban areas in Kurdistan Region. These two native urban trees have an essential role in carbon storage and thus contribute significantly to the human health of the residents as well as the environmental quality.

https://doi.org/10.26682/avuod.2019.22.1.11

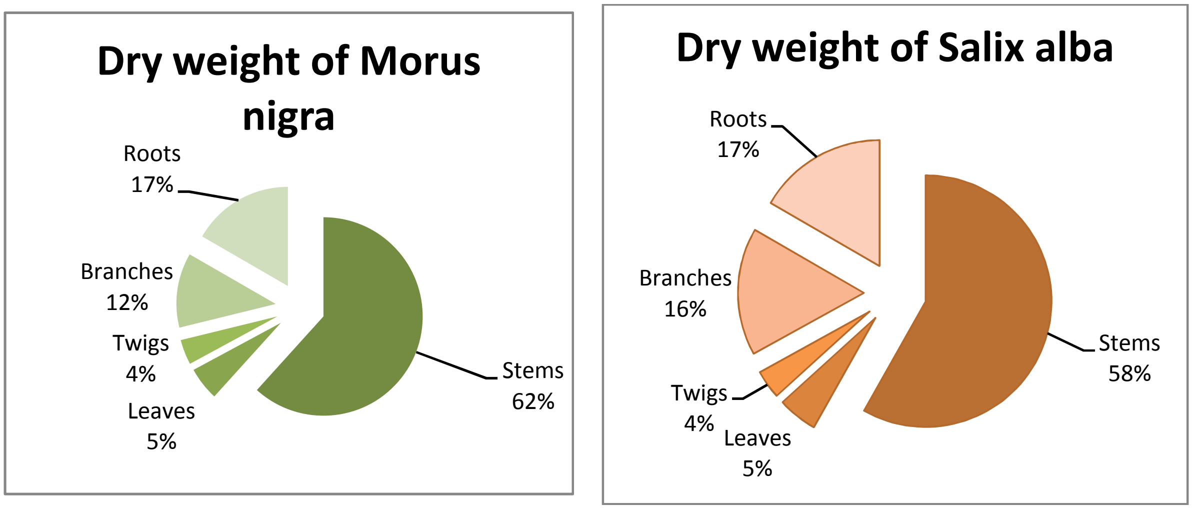

Fig. (3b): Strategy of carbon distribution between all parts of both *Morus nigra* and *Salix alba* trees

3.2. Towards a site-species-specific table establishment of CO2 sequestration for urban areas in Kurdistan Region:

Worldwide modern urbanisation generates with a wide range of environmental challenges adversely affecting human health and well-being such as urban catchment hydrology and stormwater runoff, emission of air pollutant particles, soil and water pollution and global warming (Calfapietra et al., 2015). In this environmental circumstance, it's important to understand the main role of urban vegetation and how to manage it. As urban areas expand the roles of trees in improving the quality of environment increase in importance (Nowak, 2006). Consequently, urban forests occurred inside and around the cities supply the areas with various ecosystem servicesfor improving the life-quality of urban residents (Salbitano et al., 2016).

This study set out with the aim of assessing the important roles of urban trees in the carbon sequestration process. Therefore, the combination of the current results with earlier studies (Mizori, 2010; Saeed et al., 2016), provides some support for the conceptual premise on the establishment of a site-specific table for carbon sequestration in Kurdistan's urban areas. As can be seen from the table 3 and figure 4, the quantity of carbon sequestration by the trees has differed considerably between species. What is interesting in this data is that the native Pine in the Kurdistan Region has been the tree species that most stock the carbon with an annual average of 44.95 kg. For the other trees species, the amount of the annual carbon sequestration, in descending order, were 38.3, 33.93, 22.93, 21.6, 14.958 %, 17 %, 16 %, 5 %, 4 % in *E. camaldulesnsis*, *Q. aegilops*, *S. alba*, *C. sempervirens* and *M. nigra* respectively. The carbon sequestration data of *E. camaldulesnsis* and *C. sempervirens* has been taken from *(*Saeed, et al., 2016) and for *Quercus aegilops* and *Pinus brutia* from Mizori H.S. (2010).

These differences of efficient capacity on carbon sequestration between tree species can be explained principally by evolutionary life history strategy, biological traits (i.e. physic-chemical characteristics, wood density, physiology, morphology, etc.) and environmental conditions (Bazzaz & Grace, 1997; Pons et al., 1998; Campioli et al. 2010; Russo et al. 2014; Youssef, 2011; Nowak et al. 2013; Yan et al., 2016). One of the issues that emerges from these findings is the developing a reasonable future urban green planning and policy management of the green spaces in urban areas. However, more research on the carbon sequestration topic needs to be undertaken to achieve a global overview of the urban greening innovation.

Table (3): Quantifying carbon sequestration of Six Tree species in Duhok Province

Samples	H (m)	D (cm)	Annual rings	CO2 Sequestration	Price ($)	Annual Carbon content (Kg)	Annually CO2	Annually Price ($)
Morus	11.50	19.40	24.0	357.67	28.07704507	4.064831073	14.90	1.17
Salix	11	41	22.0	504.42	39.59673328	6.253728485	22.93	1.80
Eucalyptus	13.50	23.15	13.5	517.10	40.59267324	10.44759259	38.30	3.01
Cupressus	7.31	21.75	21.5	464.38	36.45361211	5.891209302	21.60	1.70
Quercus	12	38	51.0	1730.445	135.8399325	9.254642042	33.93	2.66
Pinus	19	56.5	104.0	4674.715	366.9651275	12.26009402	44.95	3.53

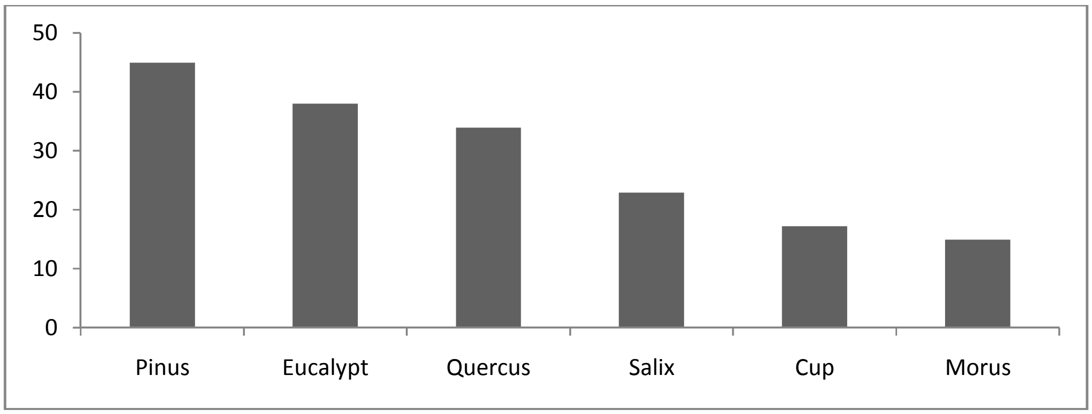

Figure (4): Quantifying carbon sequestration of Six Tree species in Duhok Province

3.3. Quantifying CO2 sequestration by volume–biomass relationship:

Recently, distinctivemodels have been used to assess carbon storage estimation by urban tree species to enhance the management, planning, and urban forest policies improvement (Pastor et al., 1984; Birdsey, 1992; Nowak, 1994; Pertram et al., 2003; Wang, 2006; Nowak et al., 2008; Basuki et al., 2009; Nowak et al. 2013; Rutishauser et al., 2013). The approximate carbon storage rate in trees is typically derived from above-ground biomass by assuming that 50% of the biomass is made up by carbon (e.g. Basuki et al., 2009). On the other hand, the most accurate model to quantify the biomass oftrees is through the cutting of all tree'sparts and weighting of their parts (Mizori, 2010; Saeed et al., 2016). In spite of the accuracy of this method, it is considered the most destructive model for the vegetation. Consequently, various non-destructive approaches had been developed like the allometric equations to estimate the carbon sequestrationon the basis of morphological/biophysical measurements like as DBH and height of the tree (e.g. Clark et al., 1986; Nowak, 1994; Nowak et al., 2008). Inaddition, the remote sensing technic also had been developed to directly or indirectly estimate the carbon storage on the forest over a large areas (Clark et al., 2001; Wang et al., 2003; Chiesi et al., 2005; Myeong et al., 2006; Tan et al., 2007). However, this estimation do not give the true values of the of carbon storage by the tree species, but taken as approximate rates that mainly depends on both environmental conditions bio-characteristic of the plants. Furthermore, the lack of a species-specific allometric equation for plants is evident in urban areas of the Kurdistan Region. Therefore, in this research, a site-species-specific allometric equation is developed by establishing the relationship between tree volume and wood biomass for some urban trees in Duhok city. This volume-biomass relationship is based on true values "destructive method" of biomass quantification (by the cutting of all tree's parts).The results obtained from the linear regression are presented in (figure 5a,b). Interestingly the correlation between tree volume (dependent variable) and wood dry biomass (predictor variable) is verystrong. In this context, the regression analysis can be used to get carbon sequestration estimation without cutting the trees. Based on the findings of the research analysis, it has

Journal of University of Duhok., Vol. 22, No.1 (Agri. and Vet. Sciences), Pp 107-121, 2019
https://doi.org/10.26682/avuod.2019.22.1.11

indicated astrength rate of relationship between *Morus nigra* volume and dry weight with R^2= 0.905 (Figure 5a). Moreover, a similar pattern of the volume-biomass relationship has been found for *Salix alba* with R^2= 0.946 (Figure 5b); hence, it has been found that the relationship between volume and dry weight of this tree species will increase carbon storage in the tree species.

Table (4): Row data of Relationship between volume and dry weight of *Morus nigra*

Samples	Volume	Dry weight (g)
1	0.04678	23.51390221
2	0.03018	22.90402576
3	0.02272	14.23899502
4	0.02013	12.77368664
5	0.01659	12.10076888
6	0.01235	8.356379822
7	0.00912	8.154175873
8	0.00746	6.903365659
9	0.00604	6.642733635
total	0.16533	120.3555429

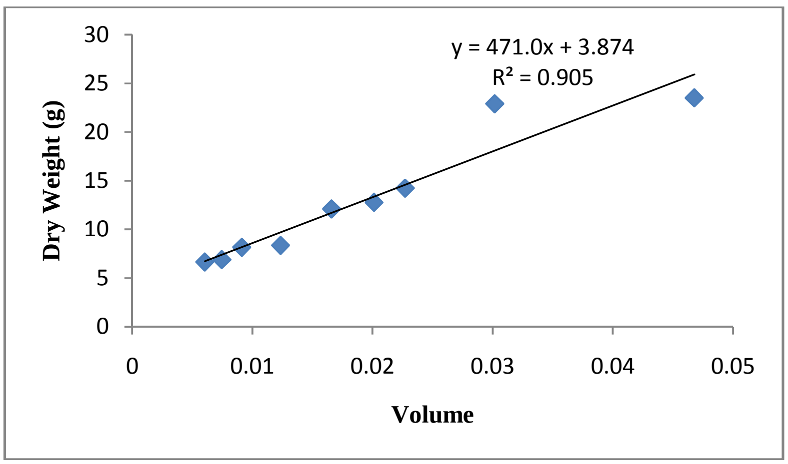

Fig. (5a): Illustration of relationship between volume and dry weight of *Morus nigra*

Samples	Volume	Dry weight (g)
1	0.1626	38.11885633
2	0.1393	37.98298491
3	0.1078	27.54192131
4	0.0646	16.40472884
5	0.0279	14.90546675
6	0.0204	11.7578177
7	0.0166	10.15044643
8	0.0131	3.204055543
Total	0.5226	160.0662778

Table (5): Row data of Relationship between volume and dry weight of *Salix alba*

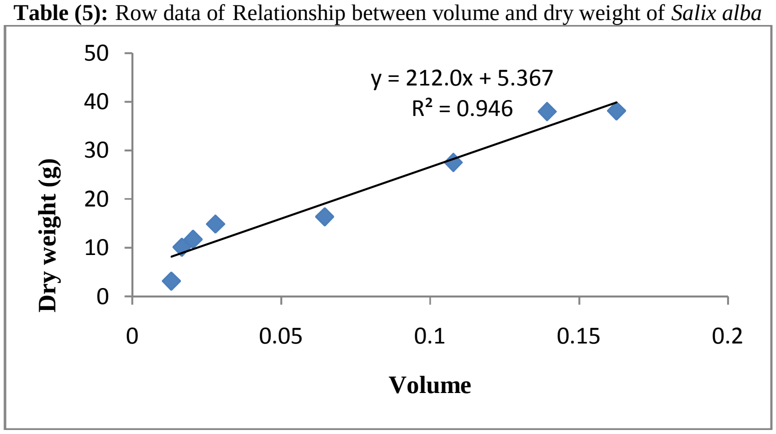

Figure (5b): Illustration of relationship between volume and dry weight of *Salix alba*

ACKNOWLEDGEMENTS.

Authors are highly grateful to the local people of Duhok city for their friendly cooperation during field works. Authors would like to express deepest gratitude and sincere thanks to the staff of the Faculty of Agriculture and the University of Duhok, for their supporting encouragements of Authors urban forest experiments. The authors wish especially to thank PAUSE program (National program for the urgent aid and reception of scientists in exile) for allowing to finalize this urban agroecological project.

4. REFERENCES:

Auckland Council (2012). The Auckland Plan. http://theplan. The Auckland plan.govt.nz/ (accessed 14 July 2018).

Basuki, T. M., Van Laake, P. E., Skidmore, A. K., &Hussin, Y. A. (2009). Allometric equations for estimating the above-ground biomass in tropical lowland Dipterocarp forests. Forest Ecology and Management, 257(8), 1684-1694.

Bazzaz, F. A., & Grace, J. (Eds.). (1997). Plant resource allocation. Elsevier.

Bert, D., & Danjon, F. (2006). Carbon concentration variations in the roots, stem and crown of mature Pinus pinaster (Ait.). Forest Ecology and Management, 222(1-3), 279-295.

Birdsey, R. A. (1992). Carbon storage and accumulation in United States forest ecosystems. Gen. Tech. Rep. WO-59. Washington DC: US Department of Agriculture, Forest Service, Washington Office. 51p., 59.

Boukili, V. K., Bebber, D. P., Mortimer, T., Venicx, G., Lefcourt, D., Chandler, M., & Eisenberg, C. (2017). Assessing the performance of urban forest carbon sequestration models using direct measurements of tree growth. Urban Forestry & Urban Greening, 24, 212-221.

Calfapietra, C., Peñuelas, J., &Niinemets, Ü. (2015). Urban plant physiology: adaptation-mitigation strategies under permanent stress. Trends in plant science, 20(2), 72-75.

Campioli, M., Gielen, B., Granier, A., Verstraeten, A., Neirynck, J., &Janssens, I. A. (2010). Carbon allocation to biomass production of leaves, fruits and woody organs at seasonal and annual scale in a deciduous-and evergreen temperate forest.Biogeosciences Discussions, 7(5).

Chen, W. Y. (2015). The role of urban green infrastructure in offsetting carbon emissions in 35 major Chinese cities: a nationwide estimate. Cities, 44, 112-120.

Chiesi, M., Maselli, F., Bindi, M., Fibbi, L., Cherubini, P., Arlotta, E., ... &Seufert, G. (2005). Modelling carbon budget of Mediterranean forests using ground and remote sensing measurements. Agricultural and Forest Meteorology, 135(1-4), 22-34.

Clark III, A., Saucier, J. R., &McNab, W. H. (1986). Total-tree weight, stem weight, and volume tables for hardwood species in the southeast. Georgia Forest Research Paper, (60).

Clark, D. A., Brown, S., Kicklighter, D. W., Chambers, J. Q., Thomlinson, J. R., Ni, J., & Holland, E. A. (2001). Netprimary production in tropical forests: an evaluation and synthesis of existing field data. Ecological applications, 11(2), 371-384.

Daud, M., Khalid, N., Waheed, S., Wasim, M., Arif, M., & Zaidi, J. H. (2011). Morusnigra plant leaves as biomonitor for elemental air pollution monitoring. RadiochimicaActa International journal for chemical aspects of nuclear science and technology, 99(4), 243-252.

Davies, Z. G., Edmondson, J. L., Heinemeyer, A., Leake, J. R., & Gaston, K. J. (2011). Mapping an urban ecosystem service: quantifying above-ground carbon storage at a city-wide scale. Journal of applied ecology, 48(5), 1125-1134.

Elmqvist, T., Setälä, H., Handel, S. N., Van Der Ploeg, S., Aronson, J., Blignaut, J. N.,& De Groot, R. (2015). Benefits of restoring ecosystem services in urban areas. Current Opinion in Environmental Sustainability, 14, 101-108.

Escobedo, F., Varela, S., Zhao, M., Wagner, J. E., &Zipperer, W. (2010). Analyzing the efficacy of subtropical urban forests in offsetting carbon emissions from cities. Environmental Science & Policy, 13(5), 362-372.

Feliciano, M., &Prosperi, D. C. (2011). Planning for low carbon cities: Reflection on the case of Broward County, Florida, USA. Cities, 28(6), 505-516.

Gaffin S. R, Rosenzweig C, Kong A. Y. Y (2012). [Correspondence] Adapting to climate change through urban green infrastructure. Nature Climate Change 2: 704.

Gill, S. E., Handley, J. F., Ennos, A. R., &Pauleit, S. (2007). Adapting cities for climate change: the role of the green infrastructure. Built environment, 33(1), 115-133.

Gomez-Baggethun E, Gren A, Barton D, Langemeyer J, McPhearson T, O'Farrell P, Andersson E, Hamstead Z, et al. et al. (2013). Urban ecosystem services. In: Elmqvist T, Fragkias M, Goodness J, Güneralp B, Marcotullio P, McDonald RI, et al.et al., editors. Urbanization. Challenges and Opportunities. Springer: Biodiversity and Ecosystem Services;. Pp. 175–251.

Hansen, J., Sato, M., Ruedy, R., Kharecha, P., Lacis, A., Miller, R., &Aleinov, I. (2007). Dangerous human-made interference with climate: a GISS modelE study. Atmospheric chemistry and physics, 7(9), 2287-2312.

Interagency Working Group on Social Cost of Carbon, United States Government, 2010. Technical Support Document: Social Cost of Carbon for Regulatory Impact Analysis Under Executive Order 12866. http://www.epa.gov/oms/climate/ regulations/scc-tsd.pdf (last accessed June 2012).

Kuittinen, M., Moinel, C., &Adalgeirsdottir, K. (2016). Carbon sequestration through urban ecosystem services: A case study from Finland. Science of the Total Environment, 563, 623-632.

McPherson, E. G., Xiao, Q., &Aguaron, E. (2013). A new approach to quantify and map carbon stored, sequestered and emissions avoided by urban forests. Landscape and Urban Planning, 120, 70-84.

Mizori H.S. (2010). Interaction between forest harvesting and some of environmental elements in Dihok Province. Thesis submitted at College of Agriculture, University of Duhok, Kurdistan Region of Iraq.

Mleczek, M., Rutkowski, P., Rissmann, I., Kaczmarek, Z., Golinski, P., Szentner, K., ... &Stachowiak, A. (2010). Biomass productivity and phytoremediation potential of Salix alba and Salix viminalis. Biomass and bioenergy, 34(9), 1410-1418.

Myeong, S., Nowak, D. J., &Duggin, M. J. (2006). A temporal analysis of urban forest carbon storage using remote sensing. Remote Sensing of Environment, 101(2), 277-282.

Neirotti, P., De Marco, A., Cagliano, A. C., Mangano, G., &Scorrano, F. (2014). Current trends in Smart City initiatives: Some stylised facts. Cities, 38, 25-36.

Nowak, D. J. (1994). Atmospheric carbon dioxide reduction by Chicago's urban forest. Chicago's urban forest ecosystem: results of the Chicago Urban Forest Climate Project. Gen. Tech. Rep. NE-186. Radnor, PA: US Department of Agriculture, Forest Service, Northeastern Forest Experiment Station, 83-94.

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

Nowak, D. J., Crane, D. E., Stevens, J. C., Hoehn, R. E., Walton, J. T., & Bond, J. (2008). A ground-based method of assessing urban forest structure and ecosystem services. Aboriculture& Urban Forestry. 34 (6): 347-358., 34(6).

Nowak, D. J., Robert III, E., Crane, D. E., Stevens, J. C., & Walton, J. T. (2006). Assessing urban forest effects and values, Casper's urban forest. Resour. Bull. NRS-4. Newtown Square, PA: US Department of Agriculture, Forest Service, Northern Research Station. 20 p., 4.

Nowak, D.J., Greenfield, E.J., Hoehn, R.E., Lapoint, E., (2013). Carbon storage and sequestrationby trees in urban and community areas of the United States.Environ.Pollut. 178, 229–236.

Oldfield E. E, Warren R. J, Felson A. J, Bradford M. A, (2013). Challenges and future directions in urban afforestation. Journal of Applied Ecology. 50: 1169–1177.

Özgen, M., Serçe, S., & Kaya, C. (2009). Phytochemical and antioxidant properties of anthocyanin-rich Morusnigra and Morusrubra fruits. ScientiaHorticulturae, 119(3), 275-279.

Padilha, M. M., Vilela, F. C., Rocha, C. Q., Dias, M. J., Soncini, R., dos Santos, M. H., ... &Giusti-Paiva, A. (2010). Antiinflammatory properties of Morusnigra leaves. Phytotherapy Research, 24(10), 1496-1500.

Pastor, J., Aber, J. D., &Melillo, J. M. (1984). Biomass prediction using generalized allometric regressions for some northeast tree species. Forest Ecology and Management, 7(4), 265-274.

Pataki, D. E., Alig, R. J., Fung, A. S., Golubiewski, N. E., Kennedy, C. A., McPherson, E. G., ... &Lankao, P. R. (2006). Urban ecosystems and the North American carbon cycle. Global Change Biology, 12(11), 2092-2102.

Pataki, D. E., Alig, R. J., Fung, A. S., Golubiewski, N. E., Kennedy, C. A., McPherson, E. G., ... &Lankao, P. R.

https://doi.org/10.26682/avuod.2019.22.1.11

(2006). Urban ecosystems and the North American carbon cycle. Global Change Biology, 12(11), 2092-2102.

Peel, M. C., Finlayson, B. L., & McMahon, T. A. (2007). Updated world map of the Köppen-Geiger climate classification. Hydrology and earth system sciences discussions, 4(2), 439-473.

Pons, T. L., Lambers, H., & Chapin III, F. S. (1998). Plant physiological ecology.

Richard A. 1992. Carbon Storage and Accumulation in United States Forest Ecosystems, General Technical Report.Birdsey, United States Department of Agriculture Forest Service, Northeastern ForestExperiment Station, Radnor, PA, August 1992.

Robert, N. (2005). The cost of U.S. forest-based Carbon sequestration.

Romero Lankao, P. (2007). How do local governments in Mexico City manage global warming?. Local Environment, 12(5), 519-535.

Rosenzweig, C., Solecki, W., Hammer, S. A., &Mehrotra, S. (2010). Cities lead the way in climate–change action. Nature, 467(7318), 909.

Ross, W.(2007). Carbon Sequestration in Forests,Order Code RL31432.

Rowntree, R. A., & Nowak, D. J. (1991). Quantifying the role of urban forests in removing atmospheric carbon dioxide. Journal of Arboriculture. 17 (10): 269-275., 17(10).

Rushforth, K. (1999). Trees of Britain and Europe.

Russo, A., Escobedo, F. J., Timilsina, N., Schmitt, A. O., Varela, S., &Zerbe, S. (2014). Assessing urban tree carbon storage and sequestration in Bolzano, Italy. International Journal of Biodiversity Science, Ecosystem Services & Management, 10(1), 54-70.

Rutishauser, E., Noor'an, F., Laumonier, Y., Halperin, J., Hergoualc'h, K., &Verchot, L. (2013). Generic allometric models including height best estimate forest biomass and carbon stocks in Indonesia. Forest Ecology and Management, 307, 219-225.

Saeed, H., Youssef, S., Abdulkhaleq, A., Younis, A., & Ibrahim, M. A. (2016).Quantifying carbon sequestration by two urban trees in Duhok province.In the 2nd Scientific Agricultural Conference (p. 302).

Salbitano, F., Borelli, S., Conigliaro, M., &Yujuan, C. (2016). Guidelines on urban and peri-urban forestry.FAO.

Schellnhuber, H. J. (2008). Global warming: Stop worrying, start panicking?. Proceedings of the National Academy of Sciences, 105(38), 14239-14240.

Schröter, D., Cramer, W., Leemans, R., Prentice, I. C., Araújo, M. B., Arnell, N. W., Bondeau, A., Bugmann, H., Carter, T. R., Gracia, C. A., De La Vega-Leinhart, A. C., Erhard, M., Ewart, F., Glendining, M., House, J. I., Kankaanpaa, S., Klein, R. J. T., Lavorel, S., Lindner, M., Metzger, M. J., Meyer, J., Mitchell, T. D., Reginster, I., Rounsevell, M., Sabate, S., Sitch, S., Smith, B., Smith, J., Smith, P., Sykes, M. T., Thonicke, K., Thuiller, W., Tuck, G., Zaehle, S., and Zierl, B. (2005) 'Ecosystem service supply and vulnerability to global change in Europe', Science 310 (5752), pp. 1333-1337.

Shahbaz S. (2010). Trees and Shrubs: A field guide of the trees and shrubs of Kurdistan Region of Iraq. Duhok University Press.

Shara, M., &Stohs, S. J. (2015). Efficacy and safety of white willow bark (Salix alba) extracts. Phytotherapy Research, 29(8), 1112-1116.

Solomon, S., Plattner, G. K., Knutti, R., &Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. Proceedings of the national academy of sciences, 106(6), 1704-1709.

Strohbach, M. W., Arnold, E., &Haase, D. (2012). The carbon footprint of urban green space—A life cycle approach. Landscape and Urban Planning, 104(2), 220-229.

Tan, K., Piao, S., Peng, C., & Fang, J. (2007). Satellite-based estimation of biomass carbon stocks for northeast China's forests between 1982 and 1999. Forest ecology and management, 240(1-3), 114-121.

Townsend, C. C. and Evan Guest.(1966). Flora of Iraq.Vol. two, Ministry of Agriculture and Agrarian Reform, Baghdad, Iraq.

Turgut, N. H., Mert, D. G., Kara, H., Egilmez, H. R., Arslanbas, E., Tepe, B., ... &Tuncel, N. B. (2016). Effect of black mulberry (Morusnigra) extract treatment on cognitive impairment and oxidative stress status of d-galactose-induced aging mice. Pharmaceutical biology, 54(6), 1052-1064.

Vidrih, B., &Medved, S. (2013). Multiparametric model of urban park cooling island. Urban Forestry & Urban Greening, 12(2), 220-229.

Wang, C. (2006). Biomass allometric equations for 10 co-occurring tree species in Chinese temperate forests. Forest Ecology and Management, 222(1-3), 9-16.

Wang, H., Hall, C. A., Scatena, F. N., Fetcher, N., & Wu, W. (2003). Modeling the spatial and temporal variability in climate and primary productivity across the Luquillo Mountains, Puerto Rico. Forest ecology and management, 179(1-3), 69-94.

Wicaksono, P., Danoedoro, P., Hartono, H., Nehren, U., & Ribbe, L. (2011). Preliminary work of mangrove ecosystem carbon stock mapping in small island using remote sensing: above and below ground carbon stock mapping on medium resolution satellite image. In Remote Sensing for Agriculture, Ecosystems, and Hydrology XIII (Vol. 8174, p. 81741B). International Society for Optics and Photonics.

Yan, Z., Li, P., Chen, Y., Han, W., & Fang, J. (2016). Nutrient allocation strategies of woody plants: an approach from the scaling of nitrogen and phosphorus between twig stems and leaves. Scientific reports, 6, 20099.

https://doi.org/10.26682/avuod.2019.22.1.11

Youssef, S. (2011). Ecologie d'une espèce endémique méditerranéenne: étude des adaptations et des facteurs déterminant sa persistance et sa distribution (Doctoral dissertation).

Youssef, S., Mahmood, A., Mahdi, A., & Vela, E. (2015). New contribution on orchids (Orchidaceae) of Duhok province in Kurdistan region (N-Iraq). Journal EuropäischerOrchideen, 47(2-4), 4.

Youssef, S., Véla, E., Galalaey, A., Mahmood & A., Mahdi H. Illustrated wild orchids as a scientific window on the unexpected nature of the Kurdistan Region areas (NW Zagros). In press.

پوختە

سالێت بوریدا, وکسید کاربون بشێوەکێ یکی بەرەف زێدەبونێ ڤەدچو, و بەلاڤ دبو دناڤ هەوایدا ژ ئەگەرێ کاروچالاکیێن مروڤان. ف بارودوخێ سی پەیوەندییەکا مەزن ب زێدەبونا دوانوکسید دناف کەشی دا د باژێران دا, ستەنگەك ل سەر ساخلەمیا گشتی ل سەرانسەری جیهانێ, هەروەسا یا بویە ئەگەرێ ەکی بو زێدەبونا کوهرینا گەش و هەوای. لەورا ئەف پروژە هەولددەت بو دەست انکرنا رولێ نگ یێ بونا کەسکایتێ باژێراندا و باشکرنا کەش و هەوایی. ڤێرێ ئەم ئاماژە ب رتنا دوانوکسید کاربون ژ لایێ وزرین دارا کو برێژەکا زور هاتینە چاندن (تیپا رەش) و بشێوەکێ سروشتی پەیدا دبن (Sal i x) رێزگەها دهوك دا و هەروەسا دناڤ هەمی باژێر و باژاروکێن هەرێما ردستانێ. امێن ڤی ڤەکولینێ جیاوازی دیارکریە دناڤبەرا ج ێن دارێ سەر ئاستێ ژا وەلگرتنا ربونێ د بارستا هشك و زیندو دا و قەبارا جوداکرنا CO2 یا سالانە. روەسا ڤەدیتنا سەرەکی یا ڤێ کولینێ جودابون چەنداتییا CO2 سالاتە بو گشت دارێن هەین دناڤا باژێرێ هوکێ دا, بو دارا سپی (23) و بو دارا تیپا رەش (15) بون. اری هندەك دارێن دیتر کو بەری نوکە د ڤەکولینێن دیدا هاتینە دیارکرن 44.95 و 38 و 33.93 و17.2 ك لدیف ئێکێ. ئەڤە هەمی د شیاندایە بیتە دەسنیشانکرن وەك پێنگاڤەکا دەستپێکی ژبو مکرنا ئاستێ ێدانا دوانوکسید کاربون برێکا چاندنا جورێن دارێن خومالی دسروشتی دا هەین. هەروەسا مە بشەکا ئالومیترك و بو جارا ئێکێ ل سەر بنەمایا پەیوەندیا دناڤبەرا قەبارا دارێ ئەوا هاتیە دیارکرن هایێن دروست (کا وێرانکەر) یا چەنداتیا بارستا چالاك. ەنجامدا سوپاسی بو ڤێ وکیشا قەبارە و کێش ەم دشێین بڤێ رێکێ لێ نگ یێ دناف باژێراندا د پروسێسا وەلگرتنا دوانوکسید کاربون دیارکەین بیی کو داران ببرین.

Journal of University of Duhok., Vol. 22, No.1 (Agri. and Vet. Sciences), Pp 107-121, 2019
https://doi.org/10.26682/avuod.2019.22.1.11

خلاصة

خلال العقود الماضية، ازدادت انبعاثات ثاني أكسيد الكربون بشكل كبير و تركزت في الغلاف الجوي و يرجع ذلك أساسا إلى الأنشطة البشرية. كانت هذه الحالة الكارثية مصدر قلق كبير بشأن زيادة انبعاثات ثاني أكسيد الكربون في الغلاف الجوي داخل المناطق الحضرية، و أصبحت تشكل تحديًا للصحة العامة في جميع أنحاء العالم، فضلاً عن السبب الرئيسي وراء تصاعد التغيرات المناخية. و من ثم فإن الدراسة الحالية للمشروع تهدف معالجة الدور الهام للنباتات الحضرية في نوعية الهواء. هنا، نقوم بالإبلاغ عن احتجاز ثاني أكسيد الكربون بواسطة نوعين من الأشجار الحضرية التي تزرع بشكل متكرر (*Morus nigra L*)، أو تنبت بشكل طبيعي (*Salix alba* L) في مناطق محافظة دهوك و تقريباً في جميع بلدات و مدن إقليم كردستان. أظهرت هذه الدراسة تبايئًا بين نوعي (M nigra , Salix alba) من حيث نسبة الكتلة الحيوية الجافة و الرطبة، و نسبة امتصاص الكربون، و القدرة السنوية لعزل ثاني أكسيد الكربون CO_2. النتائج الرئيسية لهذا البحث هي الكمية السنوية لمحتوى الكربون لأنواع الأشجار الشائعة التي تنمو في مدينة دهوك: وهي للصفصاف الأبيض (23 كغم) و للتوت الأسود (15 كغم). علاوة على ذلك، بالنسبة لبعض الأشجارالأخرى في دراسات سابقة لـ *Pinus brutia*، *Cupressus sempervirens* و *Quercus aegilops* و*Eucalyptus camaldulesnsis* كان 44.95 و 38 و 33.93 و 17.2 على التوالي. أكثر من ذلك يمكن اعتبار هذه النتائج كخطوة أولية لتقليل مستوى انبعاثات ثاني أكسيد الكربون عن طريق زرع انواع الأشجار الأصلية. من ناحيةأخرى، لأول مرة، قمنا بتطوير معادلة قياسية خاصة بكل نوع من الكائنات تعتمد على العلاقة بين الكتلة الحيوية لأشجار التي تم استخلاصها من القيم الحقيقية "الطريقة المدمرة" لتقدير الكتلة الحيوية. و بالتالي، و بفضل هذه المعادلة الجديدة حجم الوزن، يمكننا تقييم الأدوار المهمة للأشجار الحضرية في عملية عزل الكربون في المناطق الحضرية في إقليم كردستان دون قطع الأشجار.