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Carbon Storage and Sequestration by Trees in some Urban Public Parks of Jalalabad Afghanistan

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ABSTRACT
Urban areas, characterized by rapid development and increasing carbon emissions, have become focal points for climate change mitigation strategies. This research investigates the role of urban trees as crucial components in carbon storage and sequestration, exploring their potential impact on mitigating climate change. The objectives include assessing the efficacy of urban trees in sequestering atmospheric carbon, examining variations in carbon storage across different urban settings, and elucidating the factors influencing the sequestration potential of various tree species. Additionally, the research investigates the indirect impacts of urban tree cover on local climate dynamics, including temperature regulation, air quality improvement, and overall environmental resilience. The anticipated outcomes encompass comprehensive data on the carbon storage and sequestration potential of urban trees, providing insights into the variation of these capacities within different urban contexts. By understanding the relationships between urban trees, carbon sequestration, and climate change, the research aims to inform urban planning, policy formulation, and sustainable development practices. The carbon sequestration of 512 trees belonging to 45 species was estimated. The average carbon content of these trees was 50.391t/tree. The total carbon sequestered by these trees was 120.757t/year. Highest (23709 kg/year) sequestration was observed in *Ficus relegiosa* and the lowest (50.59 kg/year) in *Morus alba*. *Ficus relegiosa* showed the highest average DBH and more carbon sequestration potential, whereas *Morus alba* showed the minimum carbon sequestration potential. The regression analyses indicated that both DBH and number of trees have a positive relation with carbon sequestration rate of tree species.

Keywords: Climate Change, Resilience, Urban Parks, Forestry, Carbon Sequestration, Urban Greenery

INTRODUCTION

According to UN, (2015) more than half of the world's population lives in urban areas, and this figure will contanuesly increase at about 4% every decade by 2050. Summer heat stress is commonly amplified by the urban-specific heat loads in some cities of Afghanistan. Outdoor heat pressure forces peoples into air-conditioned buildings, creating comfortable indoor microclimates as the cost of an ever increasing outdoor ambient temperature (Matsumoto *et al.*, 2008). Fast urbanization imposes magnificent social and environmental challenges such as compromised human health (Gong *et al.*, 2012), modification of local and regional climate (Chrysanthou *et al.*, 2014).

It is Believed that forest patches in urban areas deliver many ecological and social benefits, which partially moderate urbanization-caused decline of the Environemnt (Nowak *et al.*, 2014). Thus, more studies are required to accurately assess each ecosystem service provided by urban forests and clearly communicate the scientific findings. Cities are responsible for ~75% of worldwide anthropogenic carbon dioxide(CO_2) emissions (Seto *et al.*, 2014). In recent decades, there has been much research conducted to quantify the C sequestration of urban forests Abdollahietal (Zhao *et al.*., 2013).

A few studies also propose that vegetation carbon density And carbon accumulation rate in urban forests can be larger Than that of adjacent natural forests (Daviesetal *et al.*, 2011). Therefore, accurate quantification of the C storage in various urban forests is critical to improve our understanding of the role of urban green space in the urban carbon balance. In addition, cities experience elevated temperature (i.e., urban "heatisland"warming), CO_2 and nitrogen deposition, and are Usually intensively managed relative to rural settings (Churkina *et al.*, 2015). These drastic differences between urban and natural systems suggest that characterizing C dynamics of urban forests is an important component of the Carbon cycle discipline since the

1990s, fine-resolution remote sensing, combined with ground thought data and modeling, has provided a useful way to quantify C storage and sequestration by urban forests (Rao *et al.*, 2013). To illustrate, using field data and photo-interpretation of tree cover (Nowak *et al.*, 2013) assessed that annual sequestration in U.S. urban areas is 25.6 T g C (1Tg=1012 g) which is equal to $2.0 billion in acare bonmarket. Similar work has also been conducted in some Chinese cities like Xiamenand Shenyang (Liuand Li, 2012).

MATERIALS AND METHODS

Study Area

Jalalabad is located in the east of Afghanistan between the coordinates of 34°26′03″N 70°26′52″E. It has a typical warm sub-tropical dry climate with four distinct seasons. The average annual precipitation is 152-203mm, and the temperature can reach a maximum of 120 °F (49 °C). The Jalalabad municipal government administers the total area of Jalalabad city into 9 zones. Amir Shaheed, Siraj ul amarat and Eidgah Mosque park, Farm e Hada park are located in the center of Jalalabad city, some of them (Amir Shaheed and Siraj ul amarat) are highly protected from development because of their significant historical and cultural values. 1^{st} to 4^{th} zones of the city are designated as rapid growing districts to support important economic and cultural functions of the city. Urban park system that currently contains some large and small urban parks (Siraj ul amarat, Amir Shaheed Bagh, Farm hada park, Eidgah park and some other small parks located in central Jalalabad) is an important symbol of Jalalabad green places in this famous heavily populated city in eastern Afghanistan. Data on the DBH of 512 trees were documented using measuring tapes, the height of the trees were estimated by the Automatic height measurement instrument (Nikon Forestry pro 2 laser range finder) and their age was documented from the data provided by the farmers or by some age measurement methods. The trees were selected randomly. The Above Ground Biomass (AGB) was calculated using the equation developed by (Udaya kumar *et al.*, 2016) for the tropical dry forests: AGB dry = Above ground dry biomass of tree (kg); DBH = diameter at breast height at 1.37 cm constant. Below Ground Biomass (BGB) was calculated using the following formula (Hangarge et al 2012): BGB (Kg/tree) = AGB (Kg/tree) x 0.26 Total Biomass (TB) is the sum of the AGB and BGB (Sheikh et al 2011): TB = AGB+ BGB (kg/tree) Generally, 50% of biomass of any plant species is considered as carbon (Pearson et al 2005). Therefore, the weight of carbon in the tree was estimated by multiplying the biomass of the tree by 50% (Birdsey 1992). Carbon Storage = Biomass x 50% or Biomass/2 (kg/tree). To determine the weight of CO_2 sequestered in the tree, multiply the weight of carbon in the tree by 3.6663 (Vishnu and Patil, 2016). The weight of CO_2 sequestered in the tree per year was determined by dividing the weight of carbon dioxide sequestered in the tree by its age.

Samples Collection

The data were collected from the direct measurement of the available trees in the urban parks of Jalalabad city. In this study all of the trees which are available in the parks are estimated with professional forest measuring instruments available in the market.

Statistical Analysis

Statistical analyses were made following SPSS Statistics software. The relationship between CO_2 sequestration, DBH and the number of individuals of tree species were investigated using the curve estimation procedure. The rate of CO_2 sequestration and the distribution of tree species were log transformed as they were not distributed uniformly.

RESULTS AND DISCUSSION

The present study estimated the carbon sequestration in randomly selected 512 trees belonging to 20 species. The estimated total AGB of the trees was 59.732 t and the total BGB was 16.796 t. The total biomass was 80.781 and total carbon storage by the trees was 40.391 t. The annual total carbon sequestration of the trees under study was 128.763 t /year. Among the trees studied, *Ficus relegiosa*, the most prevalent species in the study area, sequestered 23709 kg CO_2 /year which was the tallest among the species studied. In the present study the annual CO_2 sequestration of *Ficus relegiosa* was 3168.25 kg/year which had the highest average DBH (280 cm) among the trees. *F. relegiosa* had the highest AGB (25433.51 kg/tree) and total biomass (24566.23 kg/tree). The rate of CO_2 sequestration was also high (53365.05 kg/tree) in *F. relegiosa*. In this study *Bombax cieba* was sequester 7215.08 kg/tree and had shown the second highest average DBH as well as average total biomass. Higher level of biomass storage in *Bombax cieba* may be attributed to its maximum energy conversion potential and photosynthetic rate as described by (Srivastava and Ram 2009). *B. cieba* has the highest average age (60.75) and its annual CO_2 sequestration was 9083.86 kg/year. The carbon content of *Morus alba* in the present study was 69.32 kg/tree. This species had the lowest average DBH and sequestered 135.41 kg/year, this may be due to its smaller DBH and low height.

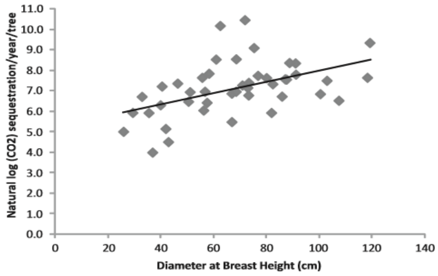

Fig. 1. Relation between the tree DBH and CO_2 sequestration

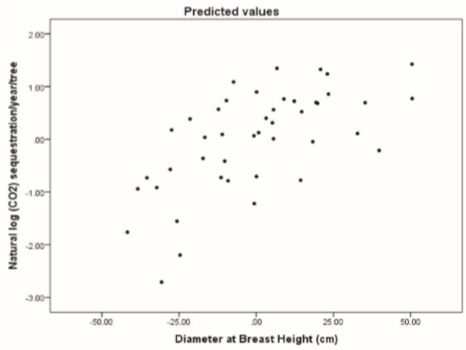

Fig. 2. Linear relation between DBH and CO_2 sequestration

CONCLUSION

The trees with higher biomass have more sequestration potential and the rate of CO_2 sequestration was high in *Ficus relegiosa* which had the highest average DBH, AGB and as total biomass. The woody plants have more carbon sequestration potential than others as they store more carbon in their woody biomass. There was a significant positive relation between the tree DBH and CO_2 sequestration. The DBH has linear relationship with the sequestration rate and the CO_2 sequestration logarithmically increased with number of trees.

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