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Study on Stored Carbon in Dominant Tree Species in Two Major Cities of India: An Approach for a Carbon Free Urban Zone

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Abstract

Global warming is considered as one of the most challenging environmental issues in the present era. Emission of carbon dioxide is the strongest causal factor for global warming. Therefore there is an urgency to develop low cost strategies to reduce atmospheric carbon dioxide. Carbon sequestration through producer community seems to be a cheap and viable option. Trees, herbs and shrubs are the natural store houses for carbon. In the present investigation the stored carbon in the Above Ground Biomass (AGB) of dominant trees in two major cities of India (namely Kolkata and Bhubaneshwar were studied during 2014. The present study may serve as a roadmap to reduce the atmospheric carbon dioxide rise at local level by using-species wise carbon dioxide - equivalent as proxy, through which the potential of the floral species in off setting carbon dioxide can be identified.

Keywords: *Carbon dioxide; Above Ground Biomass (AGB); Above Ground Carbon (AGC); Carbon dioxide -equivalent*

Background Information

Current models of global climate predict a gradual increase in the atmospheric concentrations of green house gases over the next century and associated increases in global temperature. The rise of global temperature has several negative implications like adverse impact on human health, spreading of parasitic diseases, forest fire, heat stroke, rise in salinity, recession of glaciers *etc*. It is therefore important to stabilize/control the rise of temperature by regulating the carbon dioxide level in the atmosphere. Terrestrial carbon sequestration through producer communities is an effective avenue to reduce atmospheric carbon dioxide, which relies on stored carbon in all biomass in living vegetation, both woody and herbaceous above the soil including stems, branches, bark, seeds and foliage and the dead organic matter as well as Soil Organic Carbon (SOC). In terms of atmospheric carbon reduction, trees in urban areas offer the double benefit of direct carbon storage and stabilty of natural ecosystem with increased recycling of nutrients along with maintainence of climatic conditions by biogeochemical processes.

In this programme (under taken during 2014-115), estimations have been carried out on the biomass and stored carbon for the dominant tree species in two major cities (Kolkata and Bhubaneswar) located in the maritime states of India (West Bengal and Odisha) by using four vital parameters namely Diameter at Breast Height (DBH), height of the tree (h), wood density (WD) and form factor (ratio of the square of radius at breast height to the radius of the tree at base). Carbon percentage (for each species) was detected through CHN analyzer.

Ground Reality and Interpretation

In the city of Kolkata (in the state of West Bengal), the AGB ranged from 12.92 tonnes ha^{-1} (in *Tamarindus indica* during premonsoon) to 4974.93 tonnes ha^{-1} (in *Ficus bengalensis* during postmonsoon). The AGC ranged from 6.149 tonnes ha^{-1} (in *Tamarindus indica* during premonsoon) to 2198.919 tonnes ha^{-1} (in *Ficus bengalensis* during postmonsoon).

In the Bhubaneswar city of Odisha, the value of AGB ranged from 3.24 tonnes ha-1 (in *Lagerstroemia speciosa* during premonsoon) to 2376.29 tonnes ha^{-1} (in *Delonix regia* during postmonsoon). The AGC ranged from 1.51 tonnes ha^{-1} (in *Lagerstroemia speciosa* during premonsoon) to 1128.74 tonnes ha-1 (in *Delonix regia* during monsoon).

The low values of stored carbon on account of relatively low above ground biomass of the tree species in the city of Bhubaneswar may be related to edaphic factors. The laterite soil with low pH (~3.00) may be a possible reason behind the low biomass of trees in the city of Bhubaneswar.

Our first order analysis shows that the trees in the city of Kolkata are comparatively better sink of carbon dioxide than the city of Bhubaneswar in Odisha. In Kolkata *Ficus bengalensis* is the most potential sink of carbon dioxide (CO_2 equivalent = 6705.89 tonnes ha^{-1}) followed by *Neolamarckia cadamba* (CO_2 equivalent = 1015.34 tonnes ha^{-1}), *Mangifera indica* (CO_2 equivalent = 979.36 tonnes ha^{-1}), *Delonix regia* (CO_2 equivalent = 900.53 tonnes ha^{-1}), *Mimusops elengi* (CO_2 equivalent = 330.59 tonnes ha^{-1}), *Ficus religiosa* (CO_2 equivalent = 184.58 tonnes ha^{-1}), *Azadirachta indica* (CO_2 equivalent = 148.38 tonnes ha^{-1}) and *Tamarindus indica* (CO_2 equivalent = 22.95 tonnes ha^{-1}). All the eight species together generate a CO_2 equivalent of 10287.62 tonnes ha^{-1} (mean of 3 seasons) in the area under investigation. On contrary, in the city of Bhubaneswar the dominant tree species exhibited a CO_2 equivalent of 6714.93 tonnes ha^{-1} (mean of 3 seasons). This may be the probable cause of low CO_2 level in the atmosphere of Kolkata (349 ppm) compared to the city of Bhubaneswar (399 ppm).

Figure 1: *CO_2 level in the atmosphere of Bhubaneswar.*

Figure 2: *CO2 level in the atmosphere of Kolkata.*

Global Picture

We compared our results with the carbon storage values by trees in major cities of the world and observed the present results mostly above the range of the world figures (Table 1). This may be attributed to the location of the present study area in the tropical belt (unlike the city/state stated in table 1, which are mostly in the temperate belt) that receives the considerable solar radiation, water and CO_2 – major raw materials for organic carbon synthesis. The overall results thus speak in favour of mitigating the CO_2 level in the atmosphere through green vegetation in the urban areas. A better understanding of this ecosystem service can be used to develop management plans and national policies to combat and reduce carbon dioxide emissions considering urban trees in the loop.

City/State	Storage	
	Kg Cm^{-2}	SE
Arlington, TX	6.37	0.73
Atlanta, GA	6.63	0.54
Baltimore, MD	8.76	1.09
Boston, MA	7.02	0.96
Casper, WY	6.97	1.50
Chicago, IL	6.03	0.64
Freehold, NJ	11.50	1.78
Gainesville, FL	6.33	0.99
Golden, CO	5.88	1.33
Hartford, CT	10.89	1.62
Jersey City, NJ	4.37	0.88
Lincoln, NE	10.64	1.74
Los Angeles, CA	4.59	0.51
Milwaukee, WI	7.26	1.18
Minneapolis, MN	4.41	0.74
Moorestown, NJ	9.95	0.93
Morgantown, WV	9.52	1.16
New York, NY	7.33	1.01
Oakland, CA	5.24	0.19
Omaha, NE	14.14	2.29
Philadelphia, PA	6.77	0.90
Roanoke, VA	9.20	1.33
Sacramento, CA	7.82	1.57
San Francisco, CA	9.18	2.25
Scranton, PA	9.24	1.28
Syracuse, NY	8.59	1.04
Washingto DC	8.52	1.04
Woodbridge, NJ	8.19	0.82
Indiana	8.80	2.68
Kansas	7.42	1.30
Nebraska	6.67	1.86

North Dakota	7.78	2.47
South Dakota	3.14	0.66
Tennessee	6.47	0.50

Table 1: *Carbon storage (in Kg Cm^{-2}) by trees in different cities of the World.*

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