CARBON SEQUESTRATION BY URBAN TREES ON ROADSIDES OF VADODARA CITY

G Sandhya Kiran*

Dept. of Botany, Faculty of Science, The M. S. University of Baroda, Vadodara-390002

Shah Kinnary

Dept. of Botany, Faculty of Science, The M. S. University of Baroda, Vadodara-390002

Abstract

A potential enhancement of the Earth's greenhouse effect is a critical environmental problem. Carbon Dioxide (CO_2) is the most significant contributor to the human influence on the greenhouse effect. Because CO_2 emissions are directly linked to many economically prosperous activities, it is difficult for the society to quickly accomplish large reductions in its production. As trees grow, they remove CO_2 from the atmosphere during the process of photosynthesis. The CO_2 is fixed as organic carbon accumulating in the form of biomass. Our own findings suggest that 73.59 tones of CO_2 is removed by trees planted on road sides of Vadodara city which represents 22% of the City's estimated total CO_2 production. Total CO_2 Emission at major roads was found around 159.47 tones because of more number of automobiles as it is the third most-populated city in the Indian state of Gujarat. Results are restricted to the CO_2 that is sequestered by trees planted only on road sides excluding other carbon sinks. It is therefore evident that tree planting on roadside are an effective method of offsetting CO_2 from human sources.

Key Words: Carbon Dioxide (CO_2), Carbon Emission, Carbon Sequestration, Biomass.

INTRODUCTION

Carbon is the major component of all cellular life forms; trees utilize carbon as a building material with which to form trunks, roots, stems, branches, and leaves. Trees remove (sequester) carbon from the atmosphere through photosynthesis (Francesco Ferrini *et al.*,2011), extracting carbon dioxide from the air, separating the carbon atom from the oxygen atoms, and returning oxygen to the atmosphere. In doing so, trees store a tremendous amount of carbon in their structures, and annual growth increases the carbon stored within the structure.

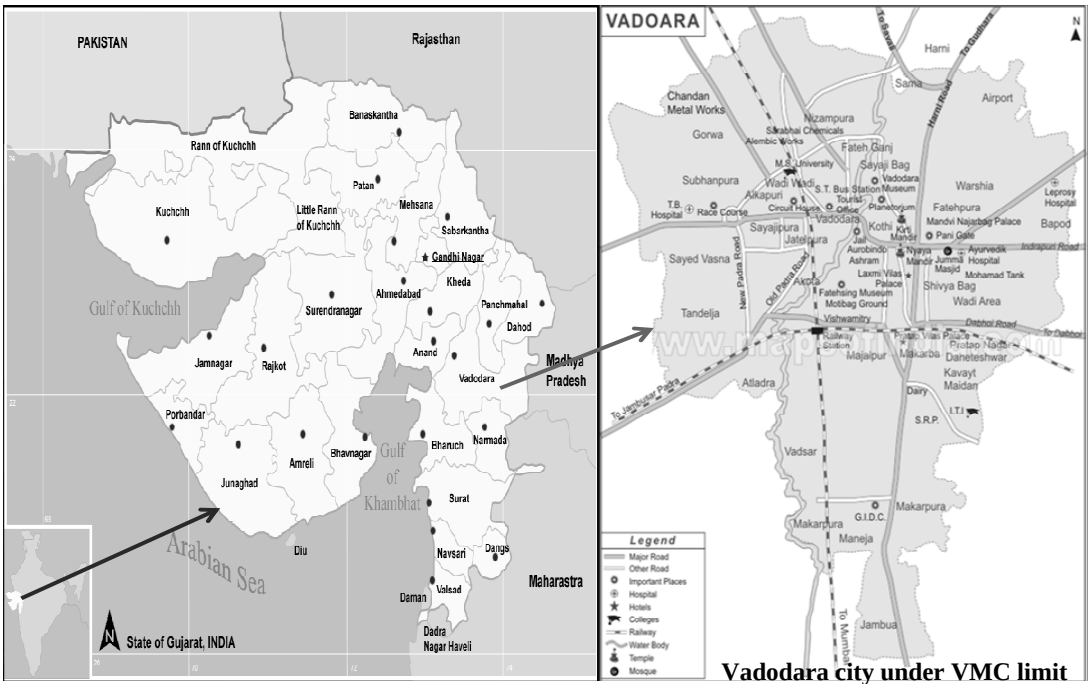
Urban trees perform important ecological function in cities by sequestering carbon and reducing automobile pollution. The net save in carbon emissions that can be achieved by urban planting can be up to 18 kg CO2/year per tree and this benefit corresponds to that provided by 3 to 5 forest trees of similar size and health (Francesco Ferrini ***et al***., 2011). Tree canopies provide a cooling effect on microclimate directly by shading the ground surface and indirectly through transpiration (Scott ***et. al***., 1999). Roadside trees, because of their proximity to the generation of vehicle emissions, are important in reducing pollution. For example, Beckett ***et. al***., (2000) found that roadside trees capture more large-size particulate matter than trees not near the road. These effects have implications for air quality standards. Roadside trees additionally have high emotional and aesthetic value to residents and high ecological value to urban areas as part of our green infrastructure. However, in urban environments trees face an array of man-made and natural stresses that may lead to degradation of urban forest and reduce their life spans compared to trees in rural areas or natural stands. Although estimates vary, life spans of trees in downtown areas are often less than years. One of the important stressors of urban trees include air pollution, it has a negative impact on tree health. Air pollution reduces plant growth and the extent of growth reduction depends on the plant species, concentration and distribution of pollutants and a number of environmental factors.

The urban forest therefore is a unique ecosystem experiencing different combinations of stressors than many other ecosystems. It therefore requires site- specific research in addition to special strategies and policies to govern its management and design.

Increasing our understanding of the relation of urban site factors to tree stress and health is critical for urban tree management, tree selection, and success of urban tree planting programs.

The above relevant fact has brought the need of evaluating the assessment of green cover in an urban ecosystem. In this context the present study was undertaken in Vadodara city wherein major roads within the Vadodara Municipal Cooperation (VMC) limit were considered (fig.1). The city lies between 22°18′00″N and 73°12′01″E. The total road length within the VMC limits is about 1000 km. approximately covering 11.47 sq. km. which is 10.59% of the total city area.

Figure: 1 Map showing study area



MATERIALS AND METHOD

In this study, the aspect of the measurement of the amount of carbon has been carried out and this was based on the amount of standing woody biomass of trees on the road sides of Vadodara City. Initially the trees were sampled by quadrate method. Quadrates of size 20m x 20m were taken at different roadsides and at the same time measurements of GBH (cm) and Basal Area (m^2) for different trees were taken (Yadava and Supriya, 2006). Based on these values standing woody biomass (T/ha) (Abraham *et al.*, 2005) and Carbon sequestration rate of trees (T/ha) (Negi et *al.*, 2003) were calculated. These values were then converted into ton/km as per unit conversion and then values were find out for CO_2 from C and then the comparison were done of Total Carbon emitted and sequestered from all the road sites.

Different equation used were

Basal Area (m^2) = $(GBH/2\pi)^2 * \pi$ (1)

Standing Woody Biomass (ton/ha) = -1.689+8.32*BA (2)

Carbon Sequestration= 0.46*SWB (3)

RESULTS AND DISSCUSSION

There is an increasing tendency among the environmentalists to view holistically the ever decreasing tree cover and subsequent fall in carbon sinks. This decline in carbon sinks has resulted in concomitant increase in carbon emission and a subsequent rise in global temperatures (A. Waran and A. Patwardhan, 2001). Thus increase in CO_2 is amongst the most dreaded problems among the urban tree cover because of the vehicular pollution. In the urban areas the roadside trees are in the close proximity to the source of vehicular emissions. They serve as an important component in reducing such emissions. In this city the urban tree cover provides benefits such as carbon storage and sequestration along with the reduction in the air pollutant. Keeping in mind the above relevant facts the need for evaluating and assessing the roadside tree cover in an urban ecosystem becomes imperative. This green cover in the form of urban forest has a significant potential in carbon sequestration (Nowak *et.al.* 1994). Nowak, 2002 has brought out that Carbon sequestration is not only related to the increased tree cover but also very much related to the increased proportion of large and healthy trees in population. In the present study this point is very clearly brought out as certain roads of Vadodara city with similar number of species exhibited variation in the values of the carbon sequestered (*Table 1*). The amount of carbon sequestered by these road side trees has amounted to 73.59 tons (*Table 1*) of carbon dioxide per year. The source of carbon sequestered by these trees can be attributed to the different categories of vehicles passing by these trees.

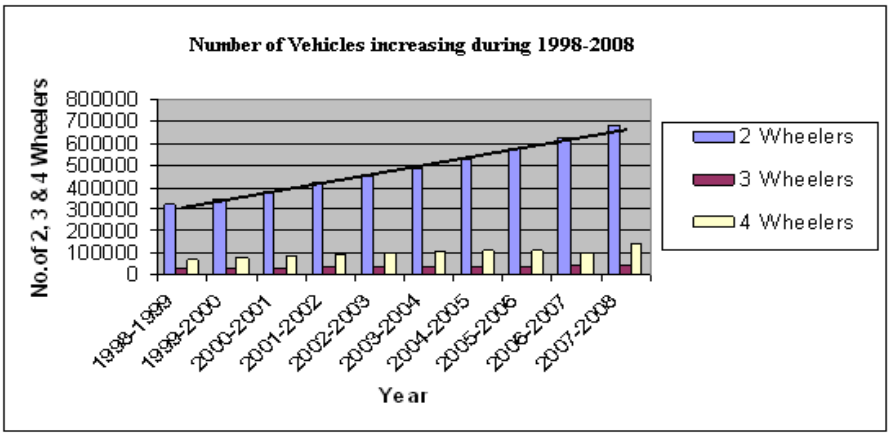
Table 1: Total CO_2 sequestered from all Roadsides of Vadodara City

Sr No.	Name of road	Total Number of Trees on each Roadsides	Total CO_2 sequestered (ton/km)
1	Ajwa road	100	3.48
2	Raopura	113	1.40
3	M G Road	59	1.07
4	Station road	242	11.61
5	RC Dutt road	144	3.79
6	Indrapuri road	159	3.83
7	Navapura	66	3.00
8	Channi	78	7.00
9	Nizampura	170	3.19
10	Fategunj	128	3.43
11	Karelibaug	163	4.79
12	Muktanand	88	1.59
13	Pani tanki road	108	1.83
14	Varasiya Ring Road	83	1.07
15	VUDA Circle	68	1.97
16	VIP Road	100	1.18
17	New VIP Road	67	0.91
18	Harni Road	11	0.33
19	Sangam to Fatehpura	49	0.72
20	Fatehpura	44	0.52
21	Vadi	34	0.47
22	Market	61	1.16
23	Gotri Road	167	2.12
24	Makarpura	40	0.63
25	Sarabhai Road	189	2.23
26	IPCL Road	45	3.52
27	Samta	98	1.99
28	Refinery Road	71	1.56
29	Tandalja road	16	0.19
30	New IPCL road	15	0.24
31	Old Padra Road	112	2.77
	Total		**73.59**

In recent years the increase in carbon dioxide level in urban cities is considered not only due to rapidly increasing population but also due to the vehicular traffic (Wallace, J., ***et.al***. 2009). All the types of vehicles were considered during measurement of carbon emissions. All the 3 types of vehicles i.e. 2 wheelers, 3

wheelers and 4 wheelers were observed. Vehicular population showed increasing trend during last ten years. It showed increasing strength of 2 wheelers when compared to 3 or 4 wheelers (figure 2). The contribution of carbon dioxide by each type when taken into consideration, each contributed 75.47, 45.15, 48.85 tones of carbon respectively amounting to 159.47 tones of carbon dioxide

Figure: 2 Numbers of Vehicles increasing during 1998-2008 in Vadodara City



The existing tree population contributes only 22% in reducing carbon pollution which needs to be increased to maintain the carbon cycle balance.This can be achieved by increasing the tree cover by carrying out tree plantation activities in the space available. The selection of tree species in such cases if done precisely i.e specifically looking at their development of girth size and capacity to resist pollution, additional environmental and economic benefits can be accrued.. For the present study area the species recommended to be planted on road side were like Neem *(Azadirchta indic*a), Indian laburnum *(Cassia fistula and C. siamea), Gulmohar (Delonix regi*a), Pipal *(Ficus religios*a), Java plum *(Syzygium cumin*i), Jacaranda *(Jacaranda mimosifoli*a), Indian lilac *(Lagerstroemia indic*a), and Temple or Pagoda tree *(Plumeria rubra* and *P. alb*a) have also been recommended as they have been shown to have a higher carbon sequesteration rates and are more suitable in urban environment (Chakre. 2006).

CONCLUSIONS

Cities are a major source of carbon dioxide emissions. As demonstrated by this research paper urban trees planted on roadsides can help in sequestering CO_2 and mitigate the effects of carbon emitted from the automobiles. It is important to reduce fossil fuel emissions and planting large and healthy trees to maximize the amount of CO_2 sequestered by urban trees on roadsides. In Vadodara city there is need to increase roadside plantation to retrieve the 88% effect of emitted carbon.

REFERENCES:

[1] A. Waran and A. Patwardhan (2001). Urban carbon burden of Pune City: A case study from India. Masters thesis submitted to Univ. of Pune.
[2] Abraham, L., G. Sandhya Kiran. (2005), Role of Planning strategies in success/failure of Joint Forest Management. *Current Science.* 88(2):288-292.
[3] Beckett, K.P., P. Freer-Smith, and G. Taylor. 2000. Effective tree species for local air-quality management. J. Arboric. 26:12–19.
[4] Chakre, O.(2006) Choice of Eco-friendly Trees in Urban Environment to Mitigate Airborne Particulate Pollution. J. Hum. Ecol., **20**(2): 135-138.
[5] Francesco Ferrini *et al.* (2011) Sustainable management techniques for trees in the urban areas. *Journal of Biodiversity and Ecological Sciences JBES.* **1** (1):1-20.
[6] INFRASTRUCTURE ASSESSMENT OF VADODARA CITY.
[7] http://www.vadodaracity.com/cdp_report.htm
[8] Negi, J.D.S., Manhas, R.K., Chauhan, P.S. (2003), Carbon allocation in different components of some tree species of India: A New Approach for Carbon Estimation. *Current Science.* **85** (11):1528-1531.
[9] Nowak, D.J., E.G. McPherson, and R.A. Rowntree. (1994), Executive Summary, pp. iii–vi. In McPherson, E.G., D.J. Nowak, and R.A. Rowntree (Eds). Chicago's Urban Forest Ecosystem: Results of the Chicago Urban Forest Climate Project, General Technical Report NE-186. USDA Forest Service, Northeastern Forest Experiment Station, Radnor, PA.
[10] Nowak. D., Crane. N. (2002), Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution*. **116**:381–389.
[11] Scott, K.I., J.R. Simpson, and E.G. McPherson. 1999. Effects of tree cover on parking lot microclimate and vehicle emissions. *J. Arboric.* 25:129–142.

[12] Wallace, J., *et.al.* (2009) Mobile monitoring of air pollution in cities: the case of Hamilton, Ontario,Canada. *Journal of Environmental Monitoring*. **11**: 998–1003.
[13] Yadava, P.S. and Supriya Devi, L. (2006), In Floristic diversity assessment and vegetation analysis of tropical semi evergreen forest of Manipur, north east India. *Tropical Ecology.* **47**(1):89-95.