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RESEARCH ARTICLE

EVALUATING THE TREE SPECIES COMPOSITION AND CARBON SEQUESTRATION POTENTIAL OF A PARK IN BENGALURU

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ABSTRACT

Urban parks are significant in various ways. Apart from their recreational, health and fitness values, they contribute to the ecology of urban areas by maintaining the biological diversity of human interfered areas. They act as critical habitat spaces for urban wild life. Their role in sequestering carbon dioxide and acting as sinks for pollutants is well understood. The current paper is an effort to understand the species composition and carbon sequestering potential of a park in Bengaluru. The study reveals that the ratio of native and exotic species in the park is 51.82: 48.18 and its carbon sequestration potential was estimated to be 54,540.1 tonnes.

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INTRODUCTION

Most of us live and work in towns and cities. Though many people enjoy nature in the countryside as part of a day out, our most regular experience of wildlife and the natural environment comes from the gardens and public green spaces that we encounter as part of urban living (Scorrell and Doughty, 2006). Biological diversity of these areas is a parameter to be considered in urban planning as it can be used as an indicator of health of the green space, the required management inputs, habitat quality for the urban wildlife and therefore the sustainability of the managed green space. Managing for biodiversity in parks and green spaces means working to improve the ecological qualities of our towns and cities and to maximise the opportunities for people to experience nature close to hand (Scorrell and Doughty, 2006). The concept of biodiversity is a scientific basis for public demand and for protecting the natural ecosystems in reserves and parks and it is an obstacle for any change in the landuse pattern of the urban green space (Fard *et al.,* 2015). Irrespective of the tree species being native or exotic, it has a potential to assimilate and fix the atmospheric carbon by sequestering carbon resulting in the reduction of the effects of warming and regulating urban climate. Carbon sequestration refers to the process of capture and long-term storage of carbon in biomass, soils and in oceans resulting in decrease of carbon dioxide build up in the atmosphere. Biomass is the total amount of live and inert organic matter above and below ground expressed in tonnes of dry matter per unit area. Urban parks must focus on increasing the assimilation of atmospheric carbon dioxide and storing it over a long period of time (Nandini *et al.,* 2009). The current paper is an endeavour to identify the tree diversity characteristics and carbon sequestering potential of a park in the city of Bengaluru.

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Study Area

The present study was carried out in a park - (park located between 2nd and 4th main SFS – 208 in Yelahanka New Town) of the metropolitan area of Bengaluru situated at 13.100534 N, 77.572249 E. The area of the park situated in the northern part of the city is 1246.9 square meters (13422 square feet), with a unique design enclosed by houses all round with the rear doors of the houses providing access to the park. There are other entrances allowing the visitors. The periphery of the park and the walk ways are lined by trees of various species. There is play area for children, a part of it with play equipment and ample seating is provided in the park.

Map. Google map of SFS – 208 park in Yelahanka New Town, Bengaluru

MATERIALS AND METHODS

Biodiversity Analysis

For the enumeration of biodiversity characteristics, the direct count census method was followed. All the individual trees with a Girth at Breast Height (GBH) of 0.2metres (20 cms) were considered. Individuals with a GBH less than 0.2m were not included in the study. Each tree was measured for its GBH, height and the radius of the canopy, and recorded in metres (Ravindranath and Premnath, 1997).The statistical analysis of the collected data was subjected to the biodiversity calculator in order to arrive at Shannon diversity index and Simpson diversity index.

Carbon Sequestration

The collected data was classified and grouped into 5 classes with a class interval of 0.4 units. Using GBH values, basal area was estimated for each class and aggregated to be presented in m^2. The product of basal area and height of that class was used to calculate the volume of biomass. The volume of biomass was then converted into tonnes using the wood density values. The product of volume of biomass and wood density values resulted in above ground biomass (ABG). This was then converted to tones of carbon, by multiplying with a value of 0.5 (half of the biomass) as carbon content as per the IPCC (2006) guidelines. A default conversion factor of 0.26 was used to convert above ground biomass to below ground biomass (BGB) (IPCC, 2006).

The following formulae were used:

Basal area = $(GBH)^2 / 4\pi$
Biovolume = Basal area X Height
AGB = Biovolume X wood density
BGB = AGB X 0.26
AGC = AGB/2
Where,
GBH = Girth at Breast Height
AGB = Above Ground Biomass
BGB = Below Ground Biomass
AGC = Above Ground Carbon
For wood density of the tree species, the standard average of 0.45 gm/ cm^3 or 450 kg/ m^3 was taken.

Quantification of carbon dioxide

The quantum of carbon was then converted to the quantum of carbon dioxide using the following formula (Ajay Kumar and Singh, 2003).

$$\text{Quantum of } CO_2 = \frac{\text{Quantum of Carbon} \times 44}{12}$$

Where,

44 is the molecular weight of CO_2
12 is the atomic weight of the Carbon

RESULTS AND DISCUSSION

Biodiversity analysis

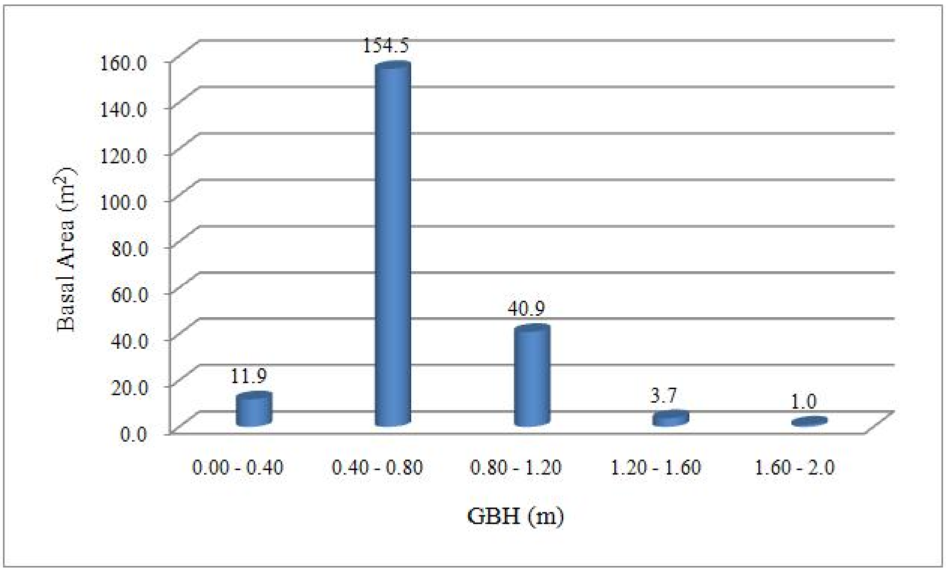
The park has a total of 137 trees across 26 species. Exotic trees account for 71 individuals from 11 species; whereas 66 individuals of native trees are found across 15 species with an average population size of 5.27. This indicates that the percentage share of the natives and exotics is 51.82 **:** 48.18. Nagendra and Gopal (2010) opined that urban parks constitute critical biodiversity hotspots in crowded, concrete dominated city environments. They found that the distribution was largely dominated by a few common species.

Carbon sequestration

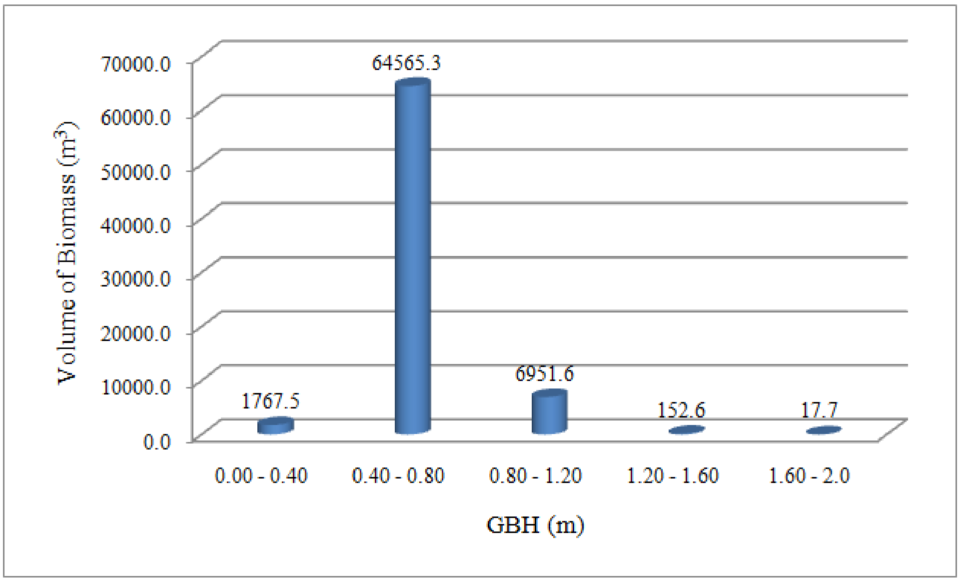
The proportion of exotic species was very high, with 77% of trees belonging to introduced species.

Table 1. Quantitative distribution of exotic and native tree species

Sl. No.	Origin	Species	No. of trees	Sl. No.	Origin	Species	No. of trees
01	Exotic	*Artocarpus altilis*	1	01	Native	*Artocarpus heterophyllus*	2
02	Exotic	*Araucaria sp.*	1	02	Native	*Azadirachta indica*	7
03	Exotic	*Carica papaya*	1	03	Native	*Emblica officinale*	1
04	Exotic	*Grevillea robusta*	11	04	Native	*Ficus religiosa*	1
05	Exotic	*Jacaranda mimosifolia*	4	05	Native	*Lagerstroemia speciosa*	4
06	Exotic	*Muntingia calabura*	1	06	Native	*Magnolia champaca*	1
07	Exotic	*Peltophorum pterocarpum*	3	07	Native	*Mangifera indica*	2
08	Exotic	*Spathodea campanulata*	1	08	Native	*Millettia pinnata*	8
09	Exotic	*Tabebuia impetiginosa*	13	09	Native	*Millingtonia hortensis*	3
10	Exotic	*Tabebuia pallid*	4	10	Native	*Swietenia macrophylla*	22
11	Exotic	*Tabebuia rosea*	31	11	Native	*Swietenia mahogany*	1
		TOTAL	71	12	Native	*Syzygium cumini*	2
				13	Native	*Tectona grandis*	10
				14	Native	*Terminalia catapa*	1
				15	Native	*Ziziphus jujube*	1
						TOTAL	66



Graph 1. Distribution of Basal Area in different GBH classes

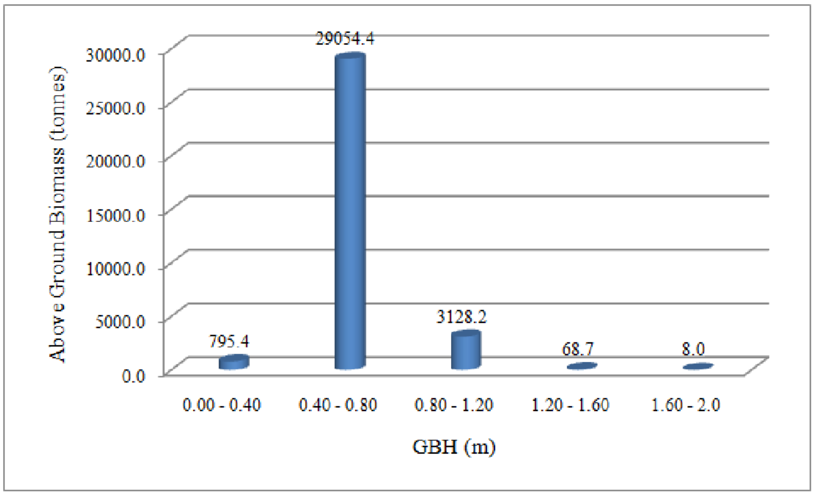


Graph 2. Distribution of Volume of Biomass in different GBH classes

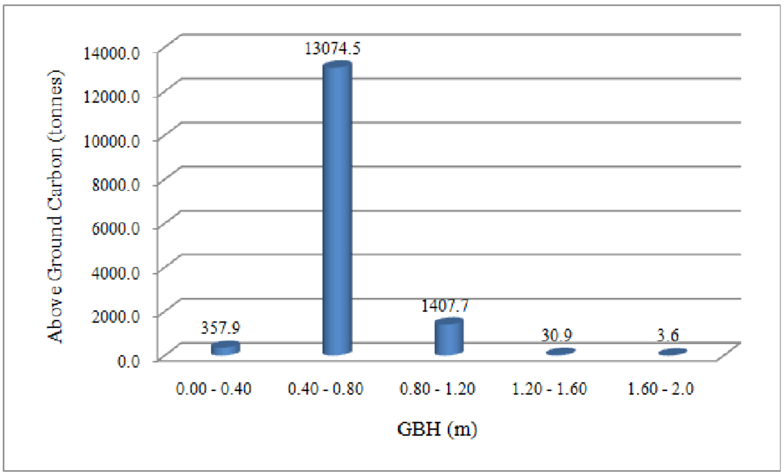
With reference to the species richness, *Tabebuia rosea* leads with 31 individuals followed by *Swietenia macrophylla* with 22 individuals. Interestingly there are 5 species from the exotics represented by 1 individual and 6 species from the natives are represented by 1 individual each. The Simpson's diversity index was found to be 0.102 and the Shannon diversity index was 2.622. In this study area, the GBH of the individual trees varied between 0.18 to 1.82 m.

The second class among the GBH classes i.e., 0.4 – 0.8 showed a maximum value (154.5) for the basal area and the data tapered towards the last class with a basal area of only 1.0.

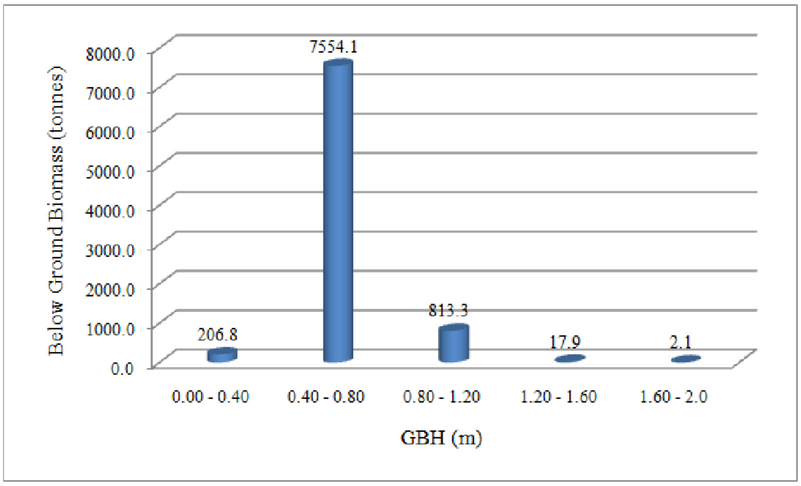
As further application of statistics depends on the basal area measurements, the volume of biomass, above ground biomass, above ground carbon, below ground biomass and below ground carbon follow the same pattern as Basal Area which is indicated by the graphs 2 – 6.



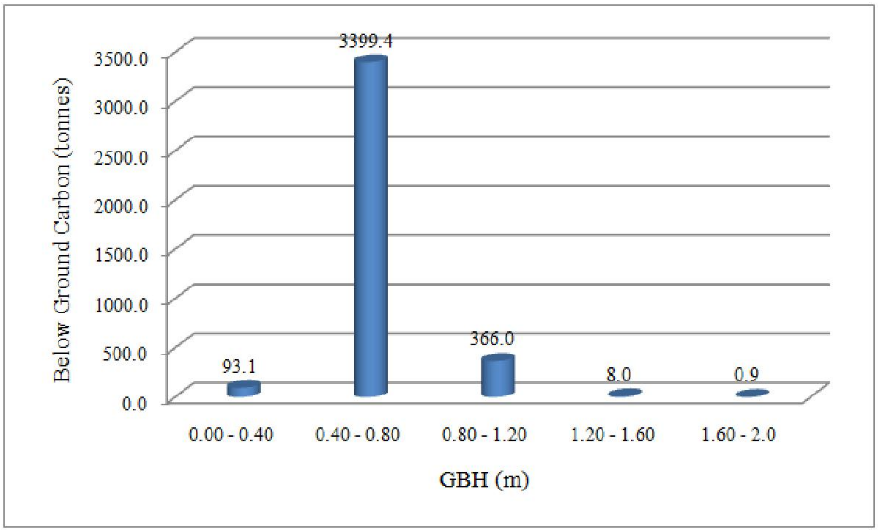
Graph 3. Distribution of Above Ground Biomass in different GBH classes



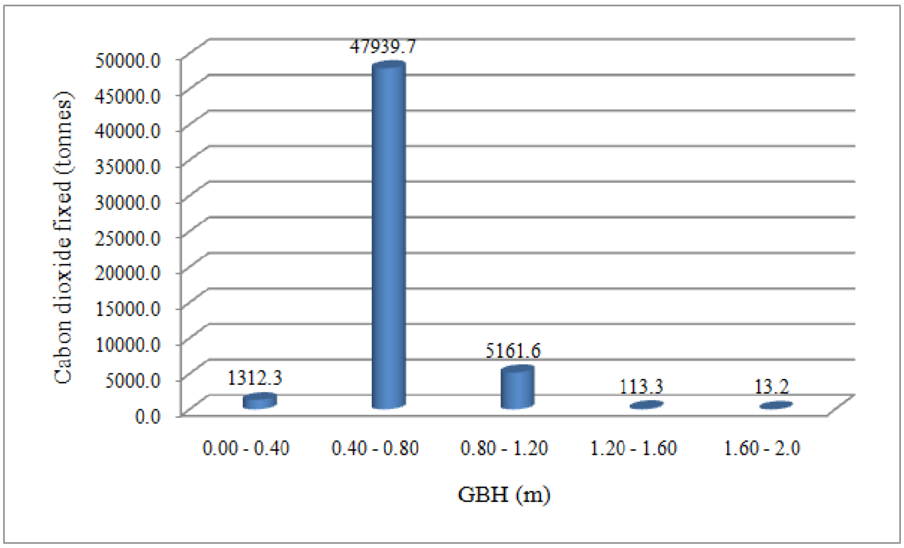
Graph 4. Distribution of Above Ground Carbon in different GBH classes



Graph 5. Distribution of Below Ground Biomass in different GBH classes



Graph 6. Distribution of Below Ground Carbon in different GBH classes



Graph 7. Distribution of Carbon dioxide sequestered in different GBH classes

The carbon sequestered due to the trees in the studied park amounted to a total of 54,540.1 tonnes, a significant quantity is attributed to the class 2 of the distribution i.e., 0.40 – 0.80 which indicates that most of the trees were planted in a specific period of time and have achieved girths between 0.40– 0.80 metres. The trees that were planted earlier and later did not comprise of sizeable numbers.

Conclusion

Biodiversity of a park in a city could mean different things to different people involved in the setting up of the park – for an urban planner, it would mean the space occupancy of a tree, the penetration of its roots and its longevity; the horticulturist may be interested in the beauty of the landscape, climatological requirements, dimensions of the tree, colour and the season of flowering and size of the fruit; a park manager would be looking at the leaf litter quantity, frequency of leaf fall, pruning, water demand and nutrient needs. For an ecologist, it would be an all encompassing idea including the representation of local species and cultures; habitat space for urban wildlife; carbon sequestration potential; pollution abatement; long term ecological stability and sustainability. The studied park is situated in a residential locality enclosed by houses, the residents have a direct access to the park from their houses and therefore the park has an increased interaction potential with the residents. The park showed an almost similar distribution of the exotic and native species though the number of individual trees was skewed towards the exotics. Most of the trees fall in the girth category of 0.40 – 0.80m indicating that most of them were planted in a specific time period and cared for equally. Apart from providing the facilities such as walking paths, seating and play equipment, the park plays a significant role in carbon sequestration by sequestering an estimated 54540.1 tonnes of carbon dioxide. This is a compelling reason to develop more woody patches in residential localities and areas of other utilities.

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