Plant Archives Vol. 18 No. 2, 2018 pp. 2687-2692 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

TREE SPECIES DIVERSITY AND COMPOSITION IN URBAN GREEN SPACES OF ALLAHABAD CITY (U.P)

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Abstract

Existing plantation and gardens, as an important component of urban green infrastructure, could make significant contributions to urban biodiversity. This paper is an attempt to quantify the species composition, floristic diversity, amenity ecological characteristics, habitat condition, and performance of trees in urban areas of Allahabad, Central India. Assessments of green spaces in urban areas provide guidance for urban planners to maintain the adequate amount of greenery in cities for human wellbeing as well as to maintain the biodiversity. In this study a total of one hundred sixty five quadrates of dimension 20 m×20 m (6.6 ha) were laid to reveal tree diversity and richness of UGSs. Total 1464 stems belonging to 64 species of 60 genera and 28 families with $\geq$ 10 cm girths at breast height (gbh) were inventoried. Fabaceae is the largest family with 13 species followed by Moraceae (6), Malvaceae (5); Myrtaceae, Rutaceae, Meliaceae (4) each; and Sapotaceae, Arecaceae (3) each. Allahabad's urban forest has a fairly un-healthy diversity, about 13.25% of total tree density occupied by most abundant species *P. longifolia*. Other five top most species include *P. longifolia, P.guajava, M.indica, W. bifurcata and P. pterocarpum* contributed about 34.76% to total tree density.

Key words: Tree diversity, density, richness, urban green spaces, Allahabad city

Introduction

Rapid increase in human population created an environmental imbalance in urban as well as in rural areas in most part of the country. It is estimated that 50% people are now living in less than 3% of the earth's urbanized surface. In addition, on the face of climate change, adaptation and mitigation actions for cities in India are critically required where the urban population is likely to grow by around 500 million over the next 50 years. India's 41 % population expected to be concentrated in urban cities by the year 2030 (UNDP). In India, 8 lakh people killed annually due to air pollution (WHO) which is second largest after China in the world. About 96.3 % of pollution removal from trees occurred on rural land. However, as human populations are concentrated in urban areas, the health effects and values derived from pollution removal are concentrated in urban areas with 68.1 percent of the $6.8 billion value occurring with urban lands. Thus in terms of impacts on human health, trees in urban areas are substantially more important than rural trees due to their proximity to people. Outdoor air pollution is a serious environmental health risk linked to both chronic and acute health conditions, including stroke, lung cancer, asthma, chronic obstructive pulmonary disease, and respiratory infections. Tree play vital role in reducing air pollution as well as particulate matter. Trees remove air pollution primarily by uptake of pollutants via leaf stomata. Some gaseous pollutants are also removed via the plant surface.

Addressing multiple risks due to climate change temperature and precipitation variability, drought, flooding and extreme rainfall, cyclone and storm surge, sea-level rise, and associated environmental health risk is a serious public policy and adaptation management challenge for India. The species diversity and community structure of a region can be analyzed by the quantitative study of vegetation called phytosociology (Khesoh and Kumar 2017). Beside environmental services urban forests and trees have positive impacts on the physical and psychological healthiness of the human being, provide healthy environment for stressed residents of city (Schroeder and Anderson, 1984; Hunter, 2001). It

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influences effectively the recovery rate of sick persons (Ulrich, 1984; Samet *et al.*, 2000; Todorova *et al.,* 2004). In addition, urban forests and parks provide recreational opportunities (Heidt and Neef, 2008), and solitude, peace and quietness to city dwellers (Grahn and Stigsdotter, 2003).Without careful production of knowledge and large investments to link that knowledge to action, cities will be overwhelmed with environmental challenges. Foremost among these challenges is maintaining human well- being by provisioning for clean air and healthy living through conservation and restoration of urban green spaces and urban forests. Urban vegetation can sequester good amounts of carbon (Pickett *et al.*, 2008), reduce storm water runoff and functions as pollutant traps and noise filters (McPherson *et al.,* 1997). Many policy instruments and robust scientific evidence in last two decades have emphasized the critical necessity of green areas within urban social-ecological systems to ameliorate several problems of city-living. Recently, Udaya kumar *et al. (*2011) has qualitatively measured plant diversity in a century-old academic institution in Chennai city.

As this paper will demonstrate, benefits of urban green spaces are wide-ranging including physical and psychological health, social cohesion, climate change mitigation, pollution abatement, biodiversity conservation and provisioning of the ecosystem goods and service to urban inhabitants. The term "urban green spaces" is a comprehensive term, comprising all urban parks, Institutions, forests and related vegetation that add value to the inhabitants in an urban area. The term "urban trees" includes trees growing both within the built environment as well as road-side avenues and public places in urban systems.

Materials and methods

In this study we focus on tree diversity, phyto-sociology and community structure in human-impacted urban spaces of Allahabad, one of the south-eastern districts of Uttar Pradesh. It lies between the parallels of North latitudes 24°47′ and 25°47′ and East longitudes 81°09′ and 82°21′ longitudes, (98 m asl) and is surrounded by the districts Pratapgarh and Jaunpur in north, Varanasi in east, Kaushambi in west, Mirzapur and Rewa of Madhya Pradesh on the south. There can be three distinct physical parts of the city, quite like the district itself (1) Trans-Ganga or the Gangapar Plain, (2) the Ganga-

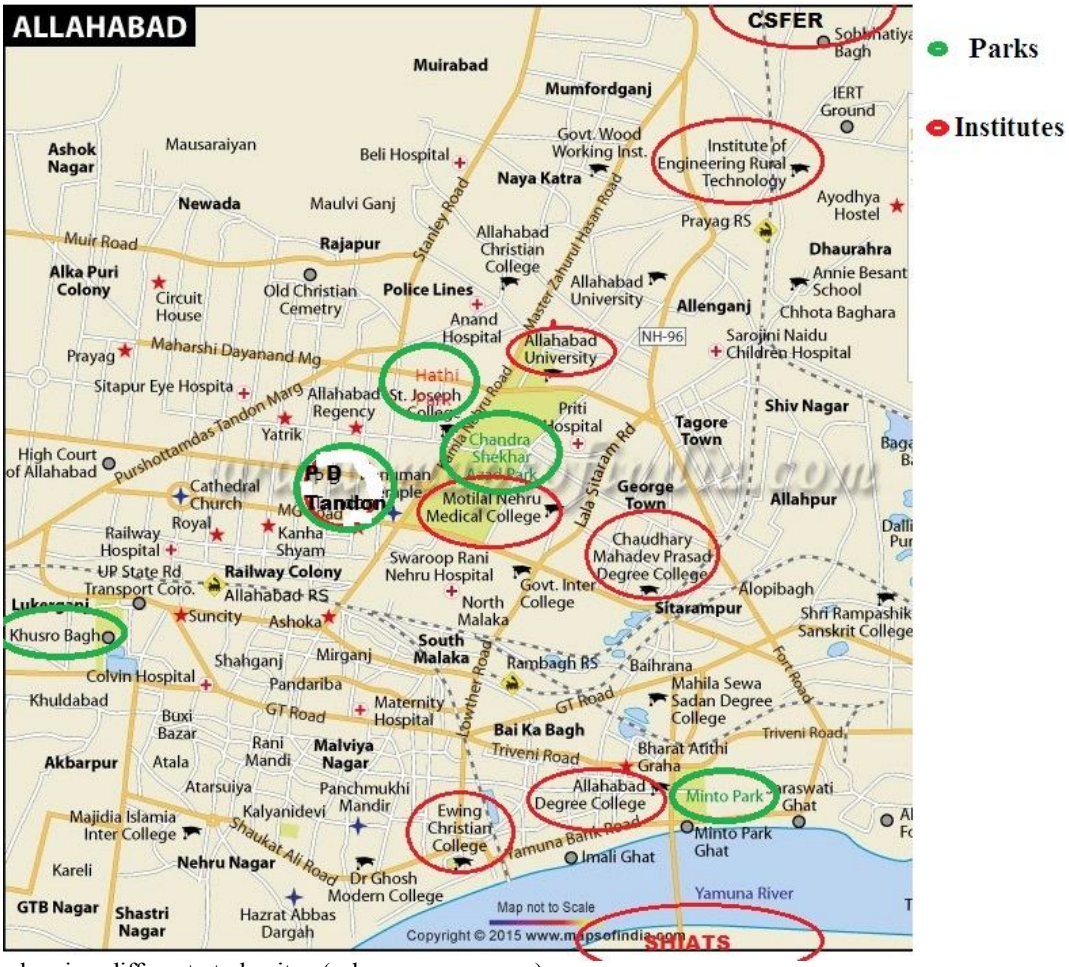

Fig.1: Map showing different study sites (urban green spaces)

Table 1: Name of the places and geographical coordination of urban green spaces where tree diversity assessment was carried out in Allahabad city, India.

Name of study areas	Geographical coordination	No. of plots (20 m×20 m) laid
Academic institution		
SHIATS	25.4131° N, 81.8479° E	20
ECC	25° 15' 10N, 81° 42' 58E	10
ADC	25.4341° N, 81.8521° E	10
IERT	25.4783° N, 81.8607° E	10
CSFER	21° 27' 30? N, 89° 02'E	10
CMPDC	25°26'45"N 81°51'32"E	13
MLNMC	25.4503° N, 81.8519° E	15
AU	25.4669° N, 81.8594° E	15
Urban park		
Minto park	25.4321^{0}N, 81.8627^{0}E	10
Hathi park	25.4579^{0}N, 81.8475^{0}E	8
Khusroo bagh	25.4395^{0}N, 81.8207^{0}E	15
Company garden	25.4541^{0}N, 81.8454^{0}E	20
PD Tandon park	25.449^{0}N, 81.8407^{0}E	9
Total		**165**

Yamuna doab (confluence), and (3) Trans-Yamuna or the Yamunapar tract, all three of which are formed by Ganga and its tributary Yamuna, the latter joining the former at Allahabad, the confluence being known as Sangam. General topography of the city is plain with moderate undulations. The climate of Allahabad is characterized by a long and hot summer, a fairly pleasant monsoon and the winters. The winter season usually extends from mid-November to February and is followed by the summer which continues till about the middle of June. The southwest monsoon then ushers in the rainy season which lasts till the end of September. October and the first half of November constitutes the post-monsoon season. All recorded trees were identified to species level in the field with the help of regional floras.

Field methods:

A total 13 selected sites the existing trees were identified and categorized as per their phyto-sociological parameter. The floristic diversity study was made by adopting random sampling approach, under which, quadrates were laid out with size of 20m × 20m in each site for the observation of trees. The vegetative structure of trees in each 13 sites was estimated for the following parameters by using expressions given by Curtis and McIntosh, 1950. Randomly one hundred sixty five Quadrat plot's area 400m² (20 m × 20 m) were used to collect data on tree species for urban green spaces of Allahabad city during the period of 2015-16. Thirteen green spaces (fig. 1 and table 1) were selected through an updated Google map (2010) and subsequently confirmed by field visits.

Parameters recorded:

The Phytosociological parameters analysis will be carried out after collecting the data of various species which include the value of Frequency, Density, abundance A/F(Abundance/Frequency), Relative Frequency ,Relative Density, Relative Dominance and Importance Value index (IVI) determined for each species of the community according to the formula given by Raunkiaer, 1934), Hason and Churchill,(1961)

Distribution Pattern: The distribution pattern of each tree species of selected urban area was analyzed by using the ratio of abundance to frequency. (Whit ford, 1949)

Distribution Pattern = Abundance/Frequency

Frequency percent: This term refers to the degree of dispersion of individual species in an area and usually expressed in terms of percentage occurrence. (Raunkiaer, 1934)

$$\text{Frequency \%} = \frac{\text{No. of sampling units in which the species occurred}}{\text{Total number of units studied}} \times 100$$

Density: It is an expression of the numerical strength of a species where the total no. of individual of each species in the quadrates is divided by the no. of the quadrates studies.

$$\text{Density} = \frac{\text{Total number of individual}}{\text{Total Number of quadrates studies}}$$

$$\text{Abundance} = \frac{\text{Total No. of individual of the species}}{\textit{Total} \text{ No. of quadrates in which the species has occurred}}$$

$$\text{Dominance} = \text{Density for a species x average basal area for species}$$

$$\text{Relative Dominance (RDO)} = \frac{\text{Dominance}}{\text{Total Dominance of all species}} \times 100$$

Relative Density: Relative density is the study of numerical strength of a species in relation to the total no. of individual of all the species & can be calculate as.

$$\text{Relative Density (RD)} = \frac{\text{No. of individuals of the species}}{\text{No. of individual of all species}} \times 100$$

Relative Frequency: The degree of dispersion of individual species in an area in relation to the no. of all the species occurred.

$$\text{Relative Frequency (RF)} = \frac{\text{No. of occurrence of the specie}}{\text{No. of Occurrence of all species}} \times 100$$

Importance value Index: This index is used to determine the overall importance of each species in the

common structure .In calculating this index, the percentage value of the relative, frequency, relative density & this value is designated as an or IVI of the species.

Importance Value Index (IVI) = Relative Dominance+ Relative density + Relative frequency.

Studies on biodiversity

Biodiversity is the totality of life form from where we directly draw ecological economic and aesthetic benefits. The flora and fauna of the area is the back bone of biodiversity studies. The plants species composition and diversity were studied by random sampling method. Shannon Weiner diversity index and Simpson's species richness index was implied to examine the biodiversity among the groves. The methods for various studies are as follows.

a) Shannon's Index

For studying the species richness and diversity Simpson's (1949) and Shannon-Wiener's (1963) indices were used.

Shannon's Index for diversity was calculated based on the abundance value of plant species.

Shannon's Index, $H' = -\Sigma Pi \log Pi$

Pi = the proportion of the important value of the i^{th} species

Pi = ni /N

ni = importance value of i^{th} speies.

N = importance value of all the species.

The maximum diversity which could possibly occur would be found in a situation where all species were equally abundant. Shannon -Wiener's index (H') depends on tree abundance and their distribution among the species. The index will be maximum when the species have same number of individuals and minimum when the individuals are maximally concentrated in one species.

b) Simpson's Index

Simpson's Index gives the probability of any two individuals drawn at random from and infinitely large community belongs to different species.

Simpson's index, $D = 1/ \Sigma Pi^2$

Population structure of important tree species will be studied based on girth class distribution and abundance of saplings and seedlings. Shannon-Wiener species diversity index (H') and Simpson index will be calculated to describe the species diversity and species richness respectively.

Statistical anatysis

To facilitate statistical analysis, all data were entered into a Microsoft Excel database. Basic data analysis was conducted with MS Excel 2000 (Microsoft, Redmond, USA).

Results and discussion

The study was undertaken in thirteen different green spaces of Allahabad to access the Phytosociological parameters. A total 1464 tree stems, belonging to 64 species, 60 genera and 28 families were recorded. Species richness (64 species in 60 genera and 28 families) as found in the present study is more when compared to urban forests of Bangalore metropolitan city (Nagendra and Gopal, 2010) and urban forests of Chennai metropolitan city (Udaya kumar Muthulingam, Sekar Thangavel, 2012). Forests of high species diversity are believed to be healthier than forests of poor species diversity (McPherson and Rowntree, 1989; Thaiutsa *et al.,* 2008). Allahabad's urban forests have a fairly un-healthy diversity, about 13.25% of total tree density occupied by a most abundant species *P. longifolia*. The five top most species *include P. longifolia, P. guajava, M. indica, W. bifurcata and P. pterocarpum* contributed about 34.76% to total tree density. The Shannon index of 1.07 identified in this study is less within the range compared with those of other urban areas in the USA (range 2.1–3.9; average 2.7) (McPherson and Rowntree, 1989); and Bangalore, India (2.68; Nagendra and Gopal, 2010). However, our study area holds larger Shannon's diversity (H) 1.07 value than Miami-Dade County of USA (H = 0.58; Zhao *et al.*, 2010). A large contribution (47.67%) of the top ten species to total tree density. *P. longifolia*, an introduced tree from Sri Lanka alone makes about 13.25% of the tree community in Allahabad UGSs. Government bodies and private building owners prefer this tree for its graceful drooping branches, cone shaped architecture and ever-greenness.

Polyalthia longifolia contributed a larger proportion (25.21 m^2 BA) with highest number of trees (194) than rest of the abundant species, so it holds the top most position in IVI. Tree density (221 individuals ha^{-1}) found is 3–5 times higher than for other urban forests. Urban forests of Bangalore, India have 45.6 (mean) trees in urban parks and 47.5 trees ha^{-1} (mean) in street tree population (Nagendra and Gopal, 2010, 2011). Nowak (1993) reported 111.9 trees ha^{-1} from Oakland, while Nowak and Crane (2002) estimated 147 trees ha^{-1} (mean, range = 36–276) from ten cities of USA. Zhao *et al.* (2010) quantified 235 trees ha^{-1} trees for Miami-Dade County; Birdsey and Heath (1995) reported 73 trees ha^{-1} for Sacramento city of USA; and from Beijing (China) Yang *et al.* (2005) reported 79 trees ha^{-1} for urban forests. On the other hand, we just enumerated a one hectare area of urban forest, researchers of other countries

Table 2: Species dominance and diversity of different urban green spaces of Allahabad City.

S.N.	Name of site	Total no. of species reported	Total no. of Families	Shannon Index (H)	Simpson Index (D)
1	SHIATS	25	16	1.23	11.73
2	ECC	20	9	0.92	5.74
3	ADC	20	10	0.99	5.50
4	IERT	21	9	1.08	7.87
5	CSFER	18	12	1.08	8.77
6	CMPDC	24	12	1.21	12.02
7	MLNMC	15	8	1.05	10.03
8	AU	36	21	1.29	11.11
9	Minto park	19	12	0.92	4.95
10	Hathi park	15	9	0.91	5.54
11	Khusroo bagh	21	8	0.92	5.30
12	Company garden	27	13	1.28	13.84
13	PD Tandon park	18	14	1.13	10.81
14	**Total**			**1.07**	

inventoried trees from entire region of their study area. Our results are in accordance with the findings of Nagendra and Gopal (2010, 2011) who reported the pre-dominance of *P. longifolia* in urban forests of Bangalore metropolitan city, India. Also, this two species represented well and hold important position in urban forests, of Bangkok, Thailand (Thaiutsa *et al.*, 2008).

The present study area is dominated by dry deciduous species. Geographically the study region is located in a Tropical dry deciduous zone; air temperature goes up to 46^{0}C during summer (April–June) hence existing environment favour dry deciduous species more than evergreen trees. Species recorded from Allahabad green spaces are also common in urban forests of India as well as other countries.

The predominant species of these green spaces are: *Polyalthia longifolia, Tamrindus indica, Holoptelea integrifolia, Wodyetia bifurcate, Bauhinia vriegata, Tectona grandis, Alstonia scholaris, Sterculia urens, Terminalia arjuna and Pongamia pinnata.* When all the study sites are pooled together the first 8 largest families having minimum 3 species. Fabaceae, is the largest representing family with 13 species. Moraceae occupies the

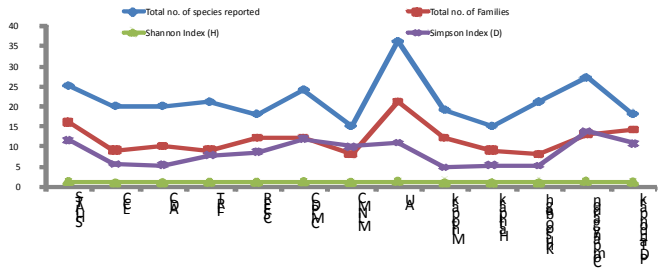

Fig. 2: Diagram showing the species dominance and diversity of different green spaces

second position with 6 species followed by Malvaceae (5); Myrtaceae, Rutaceae, Meliaceae (4) each; and Sapotaceae, Arecaceae (3) each.

Like the natural forests of Uttar Pradesh, urban forests are also dominated by the members of Fabaceae, Moraceae and Malvaceae. By carrying out similar studies, the role and value of urban green spaces of Allahabad city can be easily understood. Valuation studies on urban forests and trees are abundant in the Western world, but for the Indian sub-continent it is meagre. Thus, urban forests of India can be considered as a place for urban biodiversity and research has been carried in Allahabad urban green spaces.

Conclusion

The present study shows that native, abundant trees such as *Polyalthia longifolia, Tamarindus indica, Holoptelea integrifolia, Wodyetia bifurcate, Bauhinia vriegata, Tectona grandis, Alstonia scholaris, Sterculia urens, Terminalia arjuna and Pongamia pinnata* and conclude that Fabaceae is the largest family with 13 species followed by Moraceae (6), Malvaceae (5); Myrtaceae, Rutaceae, Meliaceae (4) each; and Sapotaceae, Arecaceae (3) each. Allahabad's urban forest has a fairly un-healthy diversity, about 13.25% of total tree density occupied by most abundant species *P. longifolia*. Other five top most species include *P. longifolia, P.guajava, M.indica, W. bifurcata and P. pterocarpum* contributed about 34.76% to total tree density. The information gathered during field work shows that most parts of the city are degraded area due to various ecological causes and human interference. Hence there require more attention towards maintenance of green space to enhance the quality of air, water and other ecosystem services provided by urban biodiversity.

References

Brack, C.L. (2002). Pollution mitigation and carbon sequestration by an urban forest. *Environmental Pollution*, **116**: 195–200.

Chavan, B.L. and G.B. Rasal (2010). Sequestered standing carbon stock in selective tree species grown in University campus at Aurangabad, Maharastra, India. *International Journal of Engineering Science and Technology,* **2**: 3003–3007.

Cilliers, S., S. Siebert, E. Davoren, and R. Lubbe (2012). Social aspects of urban ecology in developing countries, with an emphasis on urban domestic gardens. Pages 123-138 *in* M. Richter and U. Weiland, editors. *Applied urban ecology: a global framework*. Willey and Blackwell, Oxford, UK.

Cilliers, S.S., E. Van Wyk and G.J. Bredenkamp (1999). Urban

nature conservation: Vegetation of Natural areas in Thepotchefstroom Municipal Area, North West Province, South Africa. *Koedoe,* 42(1): 1–30.

Dearborn, D.C. and A.S. Kark (2009). Motivation for conserving urban biodiversity. *Conservation Biology,* **24**: 432–440.

DeFries, R. and D. Pandey (2010). Urbanization, the energy ladder and forest transitions in India's emerging economy. *Land Use Policy,* **27(2)**: 130-138.

Devadoss, M.D. and A. Lily-Rose (2009). Urban factors and the intensity of heat island in the city of Chennai. In: *The Proceedings of the Seventh International Conference on Urban Climate*, Yokohama.

Devadoss, M.D. and A. Lily-Rose (2009). Urban factors and the intensity of heat island in the city of Chennai. In: *The Proceedings of the Seventh International Conference on Urban Climate*, Yokohama.

Dorney, J.R., G.R. Guntensperger, J.R. Keough and F. Stearns (1984). Composition and structure of an urban woody plant community. *Urban Ecology,* **8**: 69–90.

Drayton, B. and R.B. Primack (1996). Plant species lost in an isolated conservation area in metropolitan Boston from 1984 to 1993. *Conservation Biology,* **10**,: 30–39.

Dunn, C.P. and L. Heneghan (2011). Section 2.4 Composition and diversity of urban vegetation. Pages 103-114 *in* J. Niemelä, editor. *Urban ecology: patterns, processes, and applications.* Oxford University Press, New York, USA.

Dunnett, N. and M. Qasim (2000). Perceived benefits to human well-being of urban gardens. *HortTechnology,* **10(1)**: 40-45.

Dwyer, J.F., E.G. McPherson, H.W. Schroeder and R.A. Rowntree (1992). Assessing the benefits and costs of the urban forests. *Journal of Arboriculture,* **18**: 227–234.

Gamble, J.S. and C.E.C. Fischer (1921–35). Flora of the Presidency of Madras. 3 Volumes. Adlard and Son Limited, London. German-Chiari, C., Seeland, K., 2004. Are urban green spaces optimally distributed to act as places for social integration? Results of geographical information system (GIS) approach for urban forestry research. *Forest Policy and Economics,* **6**: 3–13.

Gamble, J.S. and C.E.C. Fischer (1921–35). Flora of the Presidency of Madras. 3 Volumes. Adlard and Son Limited, London.

Goel, A., Singh, R.B., 2006. Sustainable forestry in mega-cities of India for mitigating carbon sequestration: case study of Delhi. *Advances in Earth Science* 21, 144–150.

Grahn, P. and U. Stigsdotter (2003). Landscape planning and stress. *Urban Forestry and Urban Greening,* **2**: 1–18.

Gupta, A.K. and S.S. Nair (2010). Flood risk and context of land-uses: Chennai city case. *Journal of Geography and Regional Planning,* **3**: 365–372.

Heidt, V. and M. Neef (2008). Benefits of urban green space for improving urban climate. In: Carreiro, M.M., Song, Y.C., Wu, J. (Eds.), Ecology, Planning and Management of Urban Forests, International Perspectives. *Springer, Amsterdam*, pp. 84–96.

Hunter, I.R. (2001). What do people want from urban forestry? The European experience. *Urban Ecosystems,* **5**: 277–284.

Khesoh, P. and H. Kumar (2017). Species diversity and community structure of trees and shrubs of Japfü mountain, Kohima: Nagaland, *International Journal of Forestry and Crop Improvement,* **8(2)**: 97-105.

McPherson, E.G., D. Nowak, G. Heisler, S. Grimmond, C. Souch, R. Grant and R. Rowntree (1997). Quantifying urban forest structure, function and value: the Chicago Urban Forest Climate Project. *Urban Ecosystems,* **1**: 49–61.

Montgomery, M.R. (2008). The urban transformation of the developing world. *Science,* **319**(5864): 761-764.

Müller, N., P. Werner and J.G. Kelcey (2010). *Urban biodiversity and design*. Conservation Science and Practice Series No. 7. Blackwell Publishing Ltd., Oxford, England.

Nagendra, H. and D. Gopal (2010). Street trees in Bangalore: density, diversity, composition and distribution. *Urban Forestry and Urban Greening* 9, 129–137.

Nagendra, H., Gopal, D., 2011. Tree diversity, distribution, history and change in urban parks: studies in Bangalore, India. *Urban Ecosystems* 14, 211–223.

Nowak, D.J., Crane, D.E., 2002. Carbon storage and sequestration by urban trees in the USA. *Environmental Pollution* 116, 381–389.

Pickett, S.T.A., Cadenasso, M.L., Grove, J.M., Groffman, P.M., Band, L.E., Boone, C.G., Burch JR., W.R., Grimmond, C.S.B., Hom, J., Jenkins, J.C., Law, N.L., Nilon, C.H., Pouyat, R.V., Szlavecz, K., Warren, P.S., Wilson, M.A., 2008. Beyond urban legends: an emerging frame work of urban ecology, as illustrated by the Baltimore Ecosystem Study. *Bioscience* 58, 139–150.

Raunkiaer, C. 1934. The Lifeforms of plants and Statistical Plant Geography. Oxford University Press, Oxford. pp 632.

Samet, J.M., Dominici, F., Curriero, C., Coursac, I., Zeger, S.L., 2000. Fine particulate air pollution and mortality in 20 US cities, 1987–1994. *New England Journal of Medicine* 343, 1742–1749.

Sanders, R. A. (1984). Some determinants of urban forest structure. *Urban Ecology*, 8, 13–27.

Sanders, R.A., 1983. Diversity and stability in a street tree population. *Urban Ecology* 7, 159–171.

Schroeder, H.W., Anderson, L.M., 1984. Perception of personal safety in urban recreation sites. Journal of Leisure Research 16, 178–194.

Shackleton, C. M., F. Paumgarten, and M. L. Cocks. 2008. Household attributes promote diversity of tree holdings in rural areas, South Africa. *Agroforestry System 72:221-230.*

Todorova, A., Asakawa, S., Aikoh, T., 2004. Preferences for and attitudes towards streets flowers and trees in Sapporo, Japan. *Landscape and Urban Planning* 69, 403–416.

Udayakumar, M., Ayyanar, M., Sekar, T., 2010. Herbal medicines used by the local traditional healers in Villupuram district of Tamil Nadu, Southern India. Medicinal Plants 2, 145–155.

Ulrich, R. S. (1984) View through a window may influence recovery from urgery, *Science,* 224, 420-421.