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Need of Urban Forestry for Ecological Development in Varanasi City

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Abstract:
The role of urban forest in the improvement of urban habitats and quality of life is significant. Trees in urban system provide a variety of ecosystem services including biodiversity conservation, removal of atmospheric pollutants, oxygen generation, noise reduction, mitigation of urban heat island effect, microclimate regulation, stabilization of soil, groundwater recharge, prevention of soil erosion and carbon sequestration. The important roles played by green spaces are social, economic, cultural and environmental aspects of sustainable development. Urban green spaces can be a comprehensive tool for long term protection of environmental sustainability through improving the quality of life and air quality, increasing property value due to their amenity and aesthetic characteristics, and reducing the energy costs of cooling buildings.Varanasi city is the centre of Indian tradition religion, culture practices and rituals, rich in heritage and colours of India, a city having a sense of its own, breathing and living in daily homage paid to the god and goddesses. The city as old as the culture of the country itself, built centuries ago is now wanting more space to breath and grow to come out of the old maze like narrow streets which has become its identity, with crumbling buildings which still hold the mark of its beauty, buried under dust of lack of maintenance it is asking for attention. Varanasi is a city in mess, with uneven development, and unplanned expansion of unapproved colonies. The city which is very significant as a religious and tourist centre, at present is in need of urban forestry which is only about less than 5 % and which actually should be 20% for urban areas. The question that arises is that in spite of its significant as one of the important cities in the north why have the care or initiative not been taken by the State or central government. The paper highlights on the present condition of green covers in the city, various plantation work done by the forest division to create green belts and plant them by social forestry schemes to make the city ecologically balanced and awareness of peoples about urban greening on the basis of pilot survey, which was conducted within the city.

Keywords: *biodiversity conservation, atmospheric pollutants, sustainability, ecosystem etc.*

Introduction

Urban forestry is the management of trees for their contribution to the physiological, sociological and economic well being of the urban society. Urban forestry deals with woodlands, group of trees and individual trees where people live With only 2% of the world population urbanized in 1800, global urban population reached 15% mark in 1900 and today almost 1,80,000 people are added to the world's urban population every day (Pitale, 2011). Hence, making urbanization an inevitable and yet favoured phenomenon for development of any nation on this planet. In the context of rapid urbanization and growing environment problems, there is a need of social awareness campaign for the governance of urban systems that counters the menace of defacement of patches of tree cover and sensitizes the issues of environment – green space, hygiene, sanitation and solid waste management (Chaudhry et.al,

2011). Such governance is now essential in the cities and towns in developing countries such as India where urbanization is at an unprecedented rate.

Trees in city forests and woodlands, parks and gardens, schools, hospitals, institutional compounds or on the streets in the urban landscape improve air and water quality; reduce pollution and suspended particulate matter; bring cooling effect and save energy; provide biodiversity richness and recreational and educational benefits and bring positive impact on human health and social life (Rowantree, 1991). In other words, trees are major environment capital assets and infrastructure in cities that require care and maintenance. The Green India Mission (GIM), one of the missions under India's National Action Plan on Climate Change (NAPCC), has recognized these roles of urban trees and has aimed to enhance tree cover in the urban and peri-urban areas in over 200,000 ha in a decade (Anon, 2011).

Immense environmental, ecological and economic benefits from urban forest have been documented in some countries. Urban land in USA currently occupies about 28 million hectare (m ha) which stores approximately 704 million tonnes (mt) of carbon in trees with an estimated annual net carbon sequestration of around 22.8 mt. Besides directly storing carbon, urban trees also reduce carbon dioxide emissions by cooling ambient air and allowing residents to minimize annual heating and cooling and remove particulate matter and other pollutants4. Similar assessment has been done for some cities in Asia, such as those in China and Japan to strengthen urban forestry activities. Carbon sequestration and release of oxygen, important functions of the trees, are related to the tree species, their dimension and age (Chaudhary, Tewari, 2011). For example, the large healthy trees remove more air pollution and carbon annually than small trees.

Strategic urban planning using a green infrastructure approach focuses on how to identify the lands to grow trees and the rest of lands to accommodate development, in order to help communities balance environmental and urban growth. The sustainable urban development concept with adequate tree cover addresses the need of planners to adopt a green infrastructure approach and presents the technical means to incorporate trees into planning (Singh, 2013). This also guides communities to develop urban forestry programmes to capture the social and environmental benefits of trees. In this approach, the urban forestry professionals learn the interface with the urban planning process to maximize green infrastructure and reduce grey infrastructure costs. The condition of Varanasi is degrading with a rapid pace, with the increasing population, and the pressure on the city to provide urban amenities to the growing population and also the additional pressure of floating population of tourists who visit the city in large numbers. The city is not able to take in any more, its deteriorating environmental condition is calling for attention.

Statement of the Problems

The green belts in urban area are considered to be an integral part of the urban landscape lending beauty to the concrete of which the city is made. It gives fresh environment and release of mental stress caused by the hectic life. Varanasi is a city in mess. With uneven development, and unplanned expansion of the city. Where no heed is being paid to the environmental aspect of the city, which is in a poor state. The city which is very significant as

a religious and tourist centre, at present is in need of urban forestry which is less than 5 % and which actually should be 20% (recommended for plain area).The question that arises is that in spite of its significant as one of the important cities in the north why care or initiative is not been taken by the State or central government.

Objectives

The objectives of the study are as follows:-

- To examine the open/ green spaces in the city.
- To assess the level of air/noise pollution in the city.
- To study Public awareness about urban forestry in city.

Methodology

The data were collected using primary as well as secondary sources. The data of the plantation work and proposed plantation work is of secondary nature. It collected from the Office of Forest Division, Varanasi, and land use data collected from the office of Town and Country planning, the data of pollution from Dept. of Environmental Science (B.H.U.), the evaluation or the public perception about the urban forestry and the work done by different government bodies has been done with the help of random sample survey method and the evolution of result was done with the help of Statistical Cartographic method and using MapInfo (8.5) and Arc GIS (9.1) for map making.

Study Area

The city of Varanasi is located in the middle Ganga valley of North India, in the Eastern part of the state of Uttar Pradesh, along the left crescent-shaped bank of the GangaRiver. The Varanasi City is the district headquarters of the Varanasi District and the major part of the urban area, delimited by the Census as 'Varanasi Urban Agglomeration' (VUA; 82º 56'E - 83º 03'E and 25º 14'N - 25º 23.5'N, covering an area of 112.26 sq. km) and consisting of 7 urban sub-units (Fig.1). These urban units are: (a) Varanasi, (b) Ramanagar MB, (c) Maruadih Railway Settlement, (d) Varanasi Cantt, (e) Banaras Hindu University NA, (f) Phulwaria CT, and (g) Sheodaspur CT. The average height of the city from mean sea level is 77m., i.e.: around 72 m in the south along the Assi stream, and 83m at the high ground near the confluence of the Varana to the Ganga River in the north (known as Rajghat plateau). The nature and the character of the banks of the Ganga River has made the position of Varanasi so stable and enviable that it is among the few cities of the world which show little shifting in its site. The city proper is built on a high ridge of kankar (lime concretion) that forms the left bank of the Ganga for a distance of 5km, being quite above normal flood level. The maximum temperature of summer season is 45 and the minimum temperature is 32; and the average rainfall is 600–1,000 mm.Due to floods caused every year the Quaternary Sedimentary layer is covered with two layers of soil, the new Alluvium and the Old Alluvium. Old Alluvium is formed as the mixture of Khad and Sand and is still found in the riverbeds of Ganga River and its tributaries.

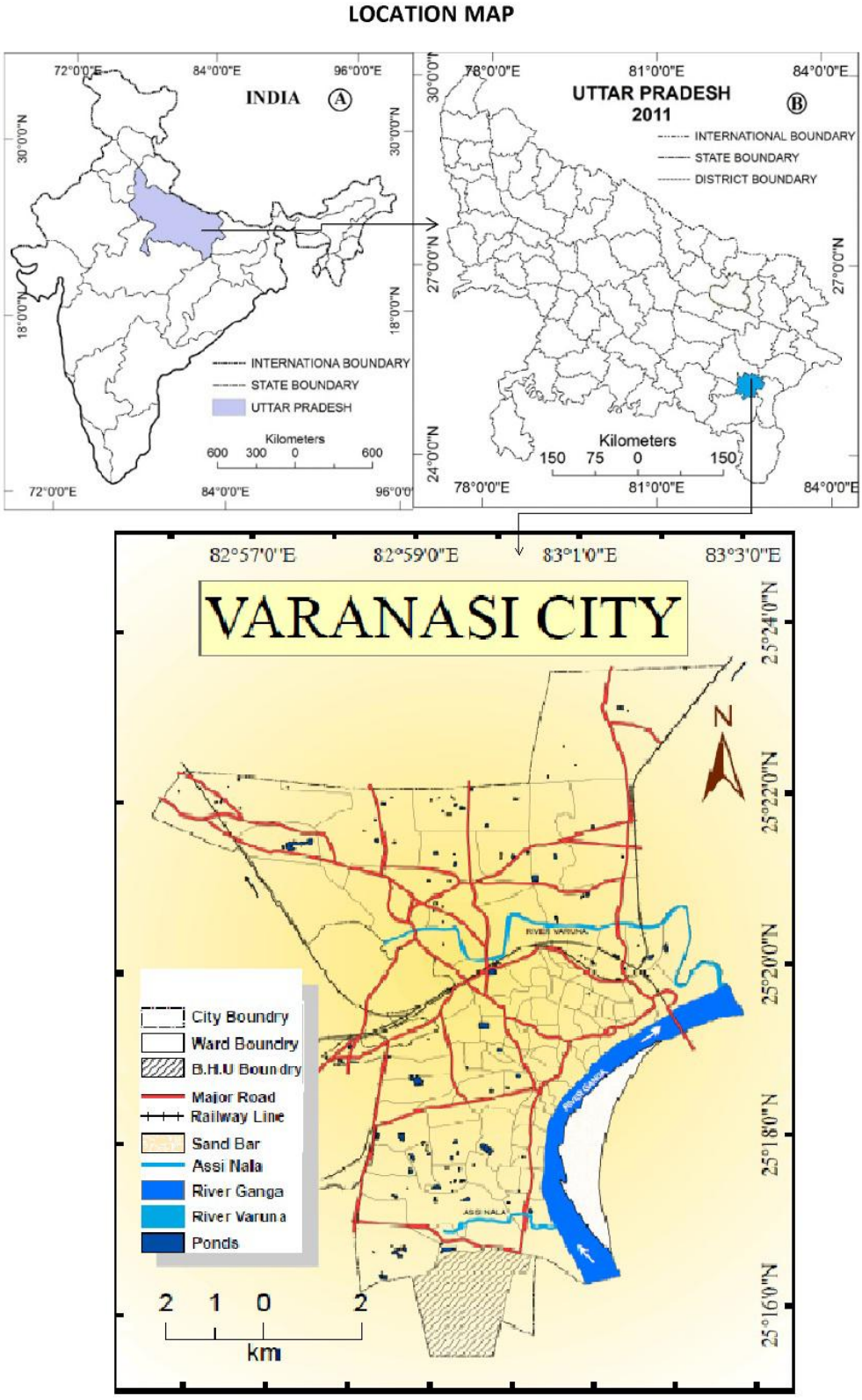

LOCATION MAP
INDIA
A
72°0'0"E
84°0'0"E
96°0'0"E
30°0'0"N
18°0'0"N
INTERNATIONA BOUNDARY
STATE BOUNDARY
UTTAR PRADESH
Kilometers
600 300 0 600
UTTAR PRADESH
2011
B
78°0'0"E
81°0'0"E
84°0'0"E
27°0'0"N
24°0'0"N
INTERNATIONAL BOUNDARY
STATE BOUNDARY
DISTRICT BOUNDARY
Kilometers
150 75 0 150
VARANASI CITY
82°57'0"E
82°59'0"E
83°1'0"E
83°3'0"E
25°24'0"N
25°22'0"N
25°20'0"N
25°18'0"N
25°16'0"N
N
City Boundry
Ward Boundry
B.H.U Boundry
Major Road
Railway Line
Sand Bar
Assi Nala
River Ganga
River Varuna
Ponds
2 1 0 2
km

Fig. 1

NEED OF URBAN FORESTRY IN VARANASI

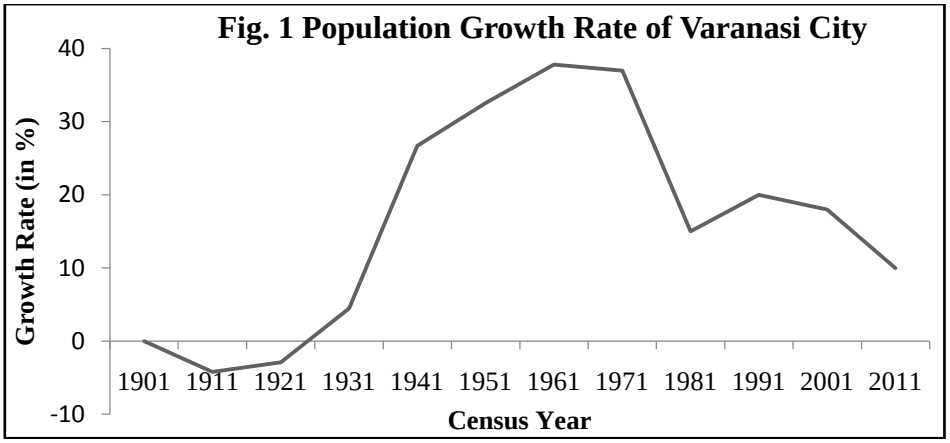
Population Pressure

According to the Census of 2011, the present area under Municipal Corporation of Varanasi (MCV) jurisdiction is 79.79 sq. km. with a population of 1.2 million. Owing to its rich tourism potential, the estimated daily flow of tourists and pilgrims to the city is 25,000. Varanasi town shows a constant increase in the population with varying rate of increase from decade to decade. In last seven decades the population has grown almost six folds, with increase in population from 207,650 in 1931 to 1198491 in year 2011.It can be observed that there is a sharp drop in the growth rate of the town in the last decade although the trend is not unusual and can also be seen in the past. VMC population accounted for 2% of the total state's population and 33% of the Varanasi district population. The riverfront and old city is densely populated (above 500 persons/ per ha), and it is here that development pressures are altering irreversibly the socio-cultural fabric of the city. Shrinking spaces, with population growth, is increasing the demand for utilising every inch of free space, including gardens. This is creating pressures for substituting existing spacious architectural forms with optimal space utilisation plans. Parks are becoming smaller and giving way to concrete residential or commercial structures Modifying urban spaces. The modification of urban spaces in the old city centre of Varanasi could also negatively alter the religious and cultural life increasing traffic. Increasing population is leading to traffic congestion, not only at peak hours but at most hours of the day. This leads to noise pollution and smog.

Table: 1 Population Growth of Varanasi City (1901-2011)

Year	Population	Growth Rate
1901	226105	-
1911	217012	-4.20
1921	210145	-2.89
1931	220745	4.46
1941	278955	26.72
1951	369799	32.57
1961	505952	37.82
1971	6,71,934	37
1981	7,73,865	15
1991	9,29,270	20
2001	10,91,918	18
2011	11,98,492	10

Source: Census of India, 2011



Source: Census of India, 2011

Tourism and Pilgrimage Pressure

Like most urban areas in India, Varanasi too has to affront intense development pressures. The impact of these pressures is harder in the old city centre where every inch is constructed, where population density is extremely high (400 to 500 persons/ per ha) and where the city is bursting at its seams. The development pressures can be classified into the following ways.

Every year around a million pilgrims come to this city, and all of them bathe in the Ganga River, followed by worshipping in various temple. Tourism and related activities are major source of city's economy. However, it is more important to maintain a sustainable tourism development that is in harmony with the existing cultural and religious atmosphere of the city.

Environmental Pressure

The rich abundance of clay has kept the eco-system of the river still intact but increasing urban and industrial pressure and pollutant agricultural run-offs have started stretching the sustainable limits of the river system to the maximum. The river eco-system is facing pressures in the river front zone and also from other parts of the city whose sewage flows directly into the river. It is also facing pressure from the pollutant agricultural run-offs from villages around the city. However, approximately 80% of the pollution in the River Ganga in Varanasi is urban waste, and of its 60% is concentrated in the Riverfront.

Air Pollution

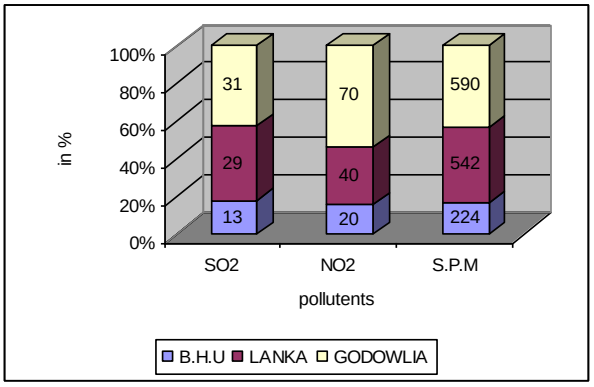
The air pollution in the city is increasing with the increase in the number of vehicles running on diesel and petrol. The numbers of factories are increasing which are located in the city or in areas very close to the city. These include not only large factories but also small scale and cottage industries , specially the traditional sari industry and handicraft industry, although their contribution is less but they do form an important contributor .domestic sources which has increased its contribution due to increase in the population and number of houses. The data acquired from the Department of Environmental Science, BHU shows the comparison of air pollution recorded in three places in Varanasi city at BHU, Lanka and Godowlia, showing contrasting difference between these three places in the amount of SO_2,

NO_2 and S.P.M. (suspended particulate matter). BHU considered to be the most green area located on the Southernmost tip with abundant trees has SO_2 concentration of 13 micro gram/meter^3, 20 micro gram/meter^3 and S.P.M. of 224, the pollution level recorded at Lanka just outside BHU So_2 concentration of 29 micro gram/meter^3, 40 micro gram/meter^3 and S.P.M. of 542 and the level of pollution in Godowlia the busiest place in the city is SO_2 concentration of 31 micro gram/meter^3, 70 micro gram/meter^3 and S.P.M. of 590.

Table: 2

Level of Pollution at Different Monitoring Stations in Varanasi City 2011

MONITORING STATION	SO_2	NO_2	S.P.M
B.H.U	13	20	224
LANKA	29	40	542
GODOWLIA	31	70	590



Source: Deptt. Of Environmental science, 2011

Noise Pollution

The level of noise pollution in the city although has not crossed the danger line but still it is significantly high than the nominal level.

Table: 3 Noise Level Recorded at Various Stations in Varanasi (in dB)

MONITORING STATION	TIME	AVERAGE NOISE LEVEL	MINIMUM	MAXIMUM
DURGAKUND	MORNING	48	42	60
	AFTERNOON	53	48	64
	EVENING	51	43	66
	NIGHT	39	36	50
ASSI	MORNING	50	44	59
	AFTERNOON	50	49	65
	EVENING	48	45	63
	NIGHT	40	37	50
CANTT.RAILWAY STATION	MORNING	62	55	75
	AFTERNOON	71	59	82
	EVENING	68	53	78
	NIGHT	58	49	67
GODAULIA	MORNING	61	46	76
	AFTERNOON	69	62	79
	EVENING	70	68	80
	NIGHT	-	-	-
B.H.U.	MORNING	54	49	62
	AFTERNOON	67	44	58
	EVENING	48	39	56
	NIGHT	39	34	49

Source: Department of Environmental Science, B.H.U

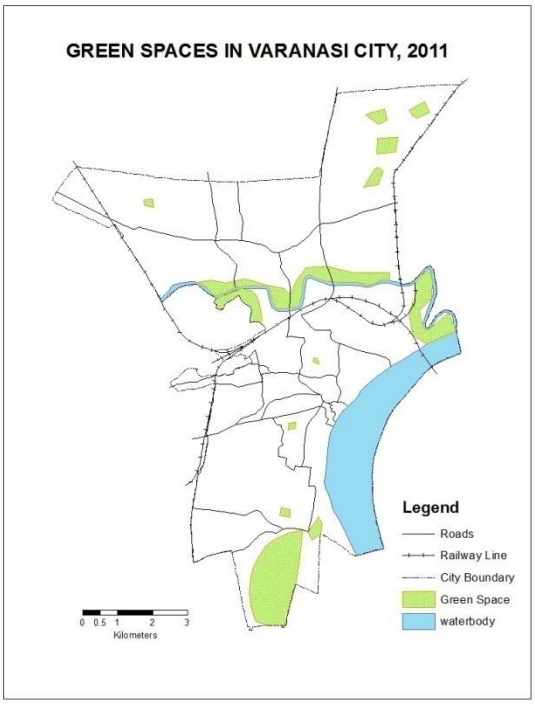
The level of noise pollution recorded at Gowdulia (Commercial area) by the department of Environment Science shows the recordings at 69 dB during the day while the Standard given by the Gov. stands at 65 dB during the day and 55 dB at night for commercial area.

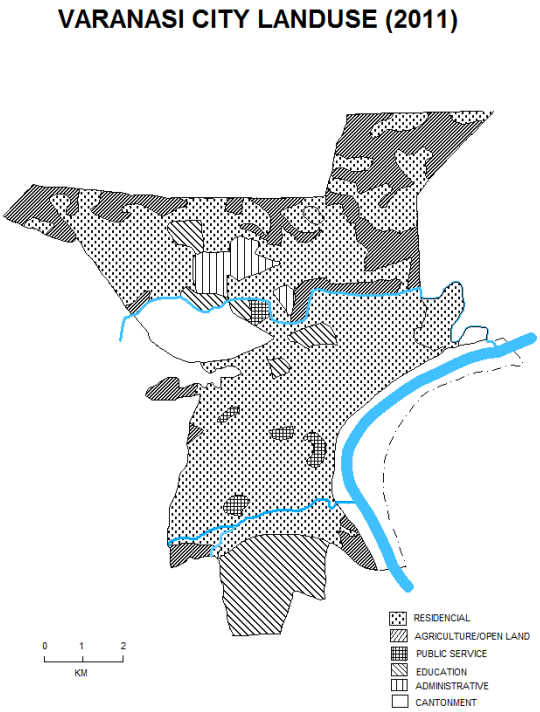
Open and Green Spaces in Varanasi City

National forest policy (1986) recommended that there should be 33 percent forest cover of the total geographical area of the country in all, 60 percent land in the hilly region 20 percent in the plain.The study area has only 5.49 percent green cover of its total geographical area. There is a negative change of -64.95% in green cover of the city during 1991 to 2011. In 1991 2,705.75 hectare land has green covers but in 2011 it shrinked very much and now only 948.47 hectare land has greenery in the city, which shows its poor condition in city sustainability.

Table: 4 Changes Land use in Varanasi City, 2011

S. No.	Land use category	Area 1988,ha	I:MP as in 1991		I:MP as in 2011		Change
1	Residential	2615.64	5,457.24	37.65	9,254.61	51.62	+69.58
2	Commercial	176.08	475.10	3.28	618.23	3.45	+30.13
3	Industrial	195.31	981.37	6.77	656.19	3.66	-33.13
4	Public and Community facility	261.05	450.42	3.11	1,309.07	7.30	+190.63
5	Recreational (Parks/Open grounds)	53.04	2705.76	18.67	984.47	5.49	-64.95
6	Services and utilities	-	-	-	103.97	0.58	-
7	Government and Semi government	56.69	292.18	2.01	1433.15	7.99	+390.50
8	Tourism	-	-	-	423.73	2.37	-
9	Transport and communication	914.30	1300.27	8.97	1460.35	8.15	+12.31
10	Others(Agriculture and Open space)	1393.79	28,32.06	19.54	1,683.45	9.39	-40.56
	Total	5,665.90	14,494.40	100.00	17,127.22	100.00	+23.68





Source: City Development Plan, 2011, Varanasi

Public Perception and Sample Survey

The public or the people play a very important role in solving or aggravating various problems and are responsible for success or failure of programs and plans implemented for the betterment of the city. Thus they form an integral part of the study undertaken on urban greenery in Varanasi.

The assessment is based on the public opinion taken along the roads, Residential colonies, crossings etc. where the work of plantation has already been carried out. The area selected for the survey was Ashok Vihar colony, BHU to Durgakund road, Ashapur Sarnath Road, BHU, Lahurabir Crossing, Police Line Parisar, Naatiimli Park., Maidagin Crossing island. From the area mentioned above 100 samples were taken, which includes the age group from 20 and more. The conclusions derived from the survey are given as follows:

Public Awareness (2015)

The people of this city are aware of the need for more trees, and 95 % agree that the amount of trees cover is far less than required which according to the forest department should cover at least 20% of the city, but which is only about less than 5 %. In addition, 84% people agree that more trees would improve the present condition of the city. Moreover 16 % of the people think that there are other issues in the city which are more important. More than 82% of the people were never informed about the methods of tree plantation that can be done

in their backyards. While 18 % of the people agree that they were informed about the benefits by means of mass communications as radio and television.

100% of people say that they were never involved in any kind of foresting programs carried out by the forest department municipality. 43% people agreed to lend helping hand to protect the planted trees by guarding them or giving them water daily and the rest 67% said that they had no adequate time. 37% people were ready to give their land if asked for foresting and the rest said that there is not enough land in Varanasi. 100% of the surveyed people agreed to planting trees and plants in whatever land they possessed in their backyard or their front yard or in flower pot, which did not have enough open space.

Work done by the Forest Department

The questions put to assess the work done by the forest department showed the result that:62% of people say that Plants where never planted in the area around them (pilot survey) the rest 38%who agree that plants where planted but were unable to survive because of the domestic Animals who would eat them before they could grow 20%, and cut down by the local people before they could grow and remove the iron fencings or brick guards put to protect the plant in order to be used for their own personal use21%, and 48% agree that the planted trees are damaged by both local people and by Domestic animals, and the rest 1%say that the degraded environmental condition of the city does not allow the plants to survive.

Ranger guards have to be appointed according to the forest department to look after the trees already planted which according to the survey where never seen or posted. Only 27%people agree that the work done by the forest department is appreciable and the rest think that it is not adequate and more work should be done and in a better manner. The main problems that the people thought where cause by the lack of green belts in the city are Air pollution ,Noise pollution, inadequate rainfall and health problems which includes mainly respiratory problems likes Bronchitis Asthma etc.

On the whole the people of Varanasi are aware of the need for plantation and protections of saplings already planted, but are not very enthusiastic to participate. A very common phenomenon that is seen in the people in this city are that , they tend to cement all the land which is around their houses, the plants that is grown by them is only in the flower pots ,which are not very helpful in providing compensation of the lacking green belts. Although the people think that the work carried out by the forest division is not very significant, but even the little work that has been done is rendered useless because the planted saplings are not able to survive, that may be due to domestic animals who eat them, or by humans who destroy them for their own purpose or may be due to both reasons.

DIFFICULTIES, PROBLEMS AND SOLUTION OF URBAN FORESTRY BY THE FOREST DIVISION VARANASI

Difficulties

I. The area where tree plantation is possible in the city is under the municipal corporation, educational institutions or government offices. Generally cooperation for the work of foresting is not got from these institutions.

II. Adequate monetary help in not provided by the government for undertaking the work of plantation, therefore the forest department has to depend on other organizations, who not well informed about the technique of plantation therefore, the work of urban foresting is not always successful.

III. Since the needs of forested plants are different therefore the plantation done under the prevalent techniques are not successful, they are not even useful in the beautification of the city.

IV. The plants suitable for plantation in the urban areas are not grown in the nurseries of the forest department, because it's very difficult to grow them and to look after them and this also becomes very costly and surpasses the budget.

V. The trees planted in the urban areas need a lot of care, because these trees are badly affected by the pollution and population pressure, but due to lack of funds proper care can't be given.

VI. Apart from the forest department the work of plantation done by other government and non-government organizations are not given proper attention or care.

Management for Urban Forestry

The conservation of natural processes in an urban landscape supports the prevention and mitigation of potential environmental problems and enhancement of the quality of life (Barrico *et al*, 2012). Therefore, we must have efficient and effective management plans for conservation and enhancement of urban green spaces. A planned, systematic and integrated approach is the key to skilful management of urban greenery (Johnston, 2014). The ecological and environmental awareness of the citizens also plays a crucial role in determining the health, structure, conservation, management and demand for urban greenery. The greenery in an urban ecosystem often decreases with increasing density of built-up. Therefore, it is critical to have effective management plans to safeguard the green spaces in urban spaces. Varanasi city has only 5.49% vegetation cover of the total geographical area. To maintain the standard level (33%) of vegetation cover, there is considerable built-up area in the core of the Varanasi city. The semi-urban areas around the Varanasi city showed an increase in tree cover—these areas are the planned setups around Varanasi. Although a substantial disparity exists in the tree cover of the planned setups. The tree cover increased in the order of cantonment > DLW > BHU. Interestingly, the greater amount of tree cover in the cantonment area can be attributed to the restricted movement of the humans in this planned set up. However, the tree cover in BHU was significantly lower as compared to cantonment and DLW; this was due to the restricted tree plantations only along the roads (manoj *et al*, 2009). There is need to plant trees that provide multiple benefits, particularly in house compounds for providing edible pods, flowers, fruits, leaves etc like *Mangifera indica, Murraya koenigii, Moringa oleifera, Tamarindus indica, Artocarpus integrifolia, Phyllanthus embelica* and *Syzygium cumini*

Conclusion

Urban forests are fundamentally a human dominated ecosystem i.e. the role played by human beings in the urban forestry environment is critical. The educational level and

environmental awareness of urban residents play a crucial role in determining species composition, management and overall demand for urban forests. Urban greenery development relies not only on investment and technology, but largely on the attitude and involvement of urban residents. The need of the hour in India is to educate people and policy makers about the utility of urban green spaces, because public knowledge of the connection between human wellbeing and ecosystem services is limited (chaudhry,2010). Urban greenery plays a significant role in developing countries towards development of tourism sector, thereby contributing in city's economy (Tewari, 2010).

Urban green belts are very important for the city, the present environmental state of the study area, The city has very few pockets, at present only 948.47 hectare land covers green belts due to irregular financial support, plantation work is not regularly done likewise in 2010-2011 no plantation work has been done in the city because fund was not provided by the government. Some of the suggestions to reduce the problems due to low tree cover, specifically in the urban areas of Varanasi: constructing buildings in such a way where roof top plantation can be done properly, schools and educational institutes should take more initiation towards this loss and can plant more within their boundaries, offices and other institutions which are not needed within the urban city can be shifted to peri-urban area so that vacant areas in the heart of the city can be planted. In a case study of Varanasi, sandy areas can be planted with sand loving plants across the river Ganga. Sensitize awareness among people for conservation and management to have a trickle down efforts at an individual level. Reforestation with plantations provides substantial environmental, social, and economic benefits. Targeted plantations can help control erosion, reduce salinity and improve water quality and can ameliorate urban space.

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