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Distribution and Sustainable Management of Roadside Trees in Bahawalpur, Pakistan

ADILA SHAFQAT[1]
Department of Geography
Baghdad ul jadeed campus, Faculty of Science
The Islamia University, Bahawalpur
Pakistan
SAJID NOOR
Department of Geography
Baghdad ul jadeed campus, Faculty of Science
The Islamia University, Bahawalpur
Pakistan

Abstract:

Greening the city is realized as universal appeal because the presence of green particularly trees act as lungs for the city environment. Due to the competition between different land uses within the city, green spaces in compact areas are being swallowed by residential and commercial areas. In such circumstances roadside amenity trees are in particular need to be protected against the most acute stress. The lanes of trees along the road not only produce soothing and cooling for the busy roads but also enhance their social and aesthetic significance. Bahawalpur City is situated on the margin of Cholistan desert, having hot and dry climate. To meet the needs of rapidly growing population new roads are being constructed and expansion of existing roads had taken place since last few years. This construction and expansion of roads has disturbed greenways, roadside trees and median belts. So proper management and planning is required to preserve and protect these roadside trees. Data has been collected through the field survey of roads; number of trees along the major regional roads were counted and mapped. Tree density and inter

[1] Corresponding author: adila.shafqat@iub.edu.pk

tree density was calculated to measure the environmental sustainability along different urban roads. Interviews were conducted with the local authorities regarding the management to enhance and increase the roadside beauty. Results show that Tree density along the major urban roads is low in some segments, especially those which are nearer to the city center. Road users appreciate the new tree plantation schemes by local authorities and they also stress to launch cost effective tree plantation and management in which institutions, organizations and community must be involved. Sustainable and viable management practices must be enhanced with the coordination of various institutions, departments, administration and community involvement.

Key words: Roadside trees, Tree density, Inter tree distance, Sustainable management, Green space, Bahawalpur

Introduction

The concept of city has been changed recently from the aggregate of people or the concrete jungle to more viable and sustainable places where the economic benefits are not obtained at the cost of social and ecological threats. According to the UN Habitat successful sustainable cities cannot segregate development and environment. There are countless services which natural environment provide to the cities (Douglass 1992). Hence preservation of natural elements is compulsory for sustainability of the cities.

Importance of green structures cannot be denied in today's urbanized world. Green spots form essential structural and functional elements of cities and make them more livable place for their citizens. In urban infrastructure trees and green spaces are considered as essential parts (Schmid 1975) due to their environmental and ecological importance. In origin urban green spaces can be natural, semi-natural and artificial habitats. City greening is a very old concept due to its ecological and aesthetic value but in today's world greening the cities more important to reduce the small scale effects and impacts of

many human activities. There is always a strong competition between different land uses to occupy space within urban areas. The higher the launce pay, may occupy the space. As a consequence green structures can compete only for a small area as compared to the other land uses like commercial and residential. In these circumstances roadside trees must be planted and protected to lessen the problem. These lanes of trees not only produce soothing and cooling effect for the busy roads but also create their social and aesthetic significance. With ever increasing use of roads for transportation in modern life, the roadside vegetation has become one of the major elements of the roadside environment which people experience on a frequent basis (Akbar, Hale, and Headley 2003). In city landscape and urbanization process, transportation routers and roads are considered as important element of development (Bennett 1991; Abatena 1995). Roadside vegetation not only provide scenic beauty and visual comfort for the users but also perk up the artistic quality of road by preventing attrition of nearby areas (Hayasaka et al. 2012). Roads are a human legacy on the landscape (Lugo and Gucinski 2000). though all types of green spaces within cities suffer disturbance and mistreatment due to the growth of infrastructure, increasing land values, high population burdens and sometimes poor management, roadside vegetation bears acute stress and continual exploitation (Buckley, Singh, and Kalarickal 2007; TOOL) which not only effect microclimate but also disturb the hydrology and soil conditions. These instabilities are the reasons that roadside vegetation cannot maintain its uniformity of composition (Bennett 1991).

Healthy plantation of roadside trees is a challenge for municipality, urban forestry department, highway authorities and other civic bodies (Programme 2003; Spodek 1983) hence maintaining the landscape beauty of the roads. There is no need for an evident strategy of greening, or clear cut plan which can be followed to encourage the growth of trees (Daniere,

Takahashi, and NaRanong 2002) because local climate and local environment of every city differ from other. Understanding of user preferences, local soil and water conditions, and climatic conditions are very important in this regard. Mostly the tree sites are exploited due to the expansion of roads or encroachment of nearby infrastructure (Jantunen et al. 2006; Rentch et al. 2004). That is why municipality and tree management programmes face double edge problems; on one hand they has to compete the pace of development and on the other has to maintain ecological significance of city. Similarly sometimes this continual degradation of tree sites is the most troublesome problem for tree management. (Herbert-Cheshire 2000; Douglass 1992). Understanding of these types of frequent damages is very important not only for the authorities but for the community itself. Unless and until community do not realize the importance and benefits of a healthy stand up tree this situation will not improve. They fight against the local heat islands produced on roads due to busy traffic and vehicular emissions. Trees can perform many utilities other than their esthetic appeal. Linear parks along roads can play significant role (Dunnett, Swanwick, and Woolley 2002), even in the compactness of cities small sites here and there can be used for tree plantation (Jim 1999) . In an article published by Landscape and Urban Planning (Jim and Chen 2003) explain the riparian linkages, pedestrian routes, street and street side system and planting schemes in urban areas along roads. Keeping that in view following types of sites can be identified for tree growth along roads;

(1) Sidewalk or footpaths

(2) Planting corridors, that can be placed between roads and public property as tree lines or tree lawns

(3) Central divider or central greenbelt

(4) Roundabouts or Chowks

All these small sites along roads have their significance. Green along the roads not only has positive effect of environment and

local climate but they also have many positive psychological impressions on the road users (Attorre et al. 2000) .

Study Area and Methods

Bahawalpur (29.9833° N, 73.2667° E) is the twelfth largest city of Pakistan. West of Bahawalpur is a fertile alluvial tract in the Sutlej River valley that is irrigated by floodwaters, planted with groves of date palm trees, and thickly populated forests. East of Bahawalpur is the Pat, or Bar, a tract of land considerably higher than the adjoining valley. It is chiefly desert irrigated by the Sutlej inundation canals and yields crops of wheat, cotton, and sugarcane. Farther east, the Cholistan, is a barren desert tract, bounded on the north and west by the Hakra depression with mound ruins of old settlements along its high banks; it is still inhabited by nomads. According to 1998 census report, TMA Bahawalpur city comprised of 2,372 sq. kilometer and had a total population of 377467 persons. The average household size was 7.35 persons. During the inter-census period of 1981-1998 it has recorded an urban growth rate of 5.2 per anum, second fastest growing city after the capital city (Islamabad) of Pakistan (Population Census Organisation 1998). Climate is hot and dry, in summer season temperature reaches high forties degrees Celsius during the day while nights are little cooler. People of Bahawalpur experience extreme temperatures in both winter and summer season. Rainfall is very low and scarce. Average rainfall is 20 to 25 cm annually.

The importance of trees along the road in the city of Bahawalpur needs to be well understood keeping in view the fact that the city is situated on the margin of Cholistan desert with hot and prolonged hot and dry weather condition prevailing throughout the year. On one hand it is need of time to grow more and more trees along the urban road side to meet the challenges of harsh climate, exploding urban population

and urban development and to enhance the ecological benefits. But on the other hand it has been observed that most of the trees from the roadside has been cut and removed in the name of urban road expansion. Hence dire need of attention must be given to plant more trees along the newly constructed or expanded roads.

A city wide field survey was conducted in 2011 along four major regional roads within the city municipality boundary, beyond this main built up area was not included. Survey study was conducted with a view to describe the distribution of trees along busy regional roads and to identify potential planting sites at these roadsides. For this purpose four major regional roads were surveyed and for the sake of study, were given the name Road 1 to 4, namely

Road 1 (Yazman Road),
Road 2 (University road),
Road 3 (Circular and Ahmadpur Road)
and Road 4 (Multan Road).

The origin point for the present study is the most renowned Farid Gate (one of the major gates of old walled city of Bahawalpur). These are major regional roads heading towards other urban center from Bahawalpur City. Land use along these roads is commercial and residential in most parts. Within the city boundary these roads are considered as busiest roads according to vehicular use. Hence microclimate around these roads can be experienced as warmer than surroundings. Due to the recent expansions and presence of commercial sectors, these regional roads tend to be more significant than other local roads. Numbers of trees were counted on both sides of roads, linear tree density and average inter-tree distance was calculated and map was prepared with the help of ArcGIS 9.2. Tree density can be used as a tool to understand the distribution of trees on all roads. While inter tree distance is calculated as average distance (in meters) between two trees. This value is significant in finding the potential sites for

growing more trees along busy urban roads.

Results and Discussion

Study conducted shows following results for number of trees as shown in table 1. There is an evident difference in number of trees on left and right side of road this difference is due to the multiple land use on both sides. Out of the total 26 km along all the four major urban roads the average tree density was found to be 26 trees/km. The tree density along the left and right side of the roads was calculated as 15 trees/km and 11 trees/km respectively. A clear difference lies in 0-1000 meters of Road 1 where left and right sides of road respectively show 23 and 3 trees. This difference is due to the newly constructed roadside buildings near cantonment area on right side and some government offices on the left side. Boundary walls of government offices are mostly ornamented by the green covers and trees. Similar type of difference can be seen in segment of road from 0-1000 and 3000-4000 meters of Road 2, segment at 0-1000 meters of Road 3 and 1000-6000 meters on road 4. Over all data shows deficiency of trees in many patches along roads. Clear picture can be seen in fig 1.

Table 1: Number of trees along selected regional roads

Roads	Distance (meters)	Number of Trees		
		Total	Right	Left
Road 1	0-1000	26	3	23
	1000-2000	12	6	6
	2000-3000	3	3	0
	3000-4000	42	36	6
	4000-5000	51	14	37
	5000-6000	93	34	59
Road 2	0-1000	8	0	8
	1000-2000	27	18	9
	2000-3000	86	61	25
	3000-4000	60	19	41
	4000-5000	58	41	17
	5000-6000	4	3	1
	6000-7000	3	3	0

	7000-8000	40	26	14
Road 3	0-1000	10	0	10
	1000-2000	20	5	15
	2000-3000	12	7	5
	3000-4000	46	34	10
	4000-5000	42	40	2
	5000-6000	30	24	6
Road 4	0-1000	22	15	7
	1000-2000	12	2	10
	2000-3000	1	0	1
	3000-4000	0	0	0
	4000-5000	0	0	0
	5000-6000	0	0	0

Tree deficit areas can be identified with the help of map shown in figure 1. Between 2000-3000 meters on Road 1 catch the glimpse at once showing only 3 trees throughout the road. This small number is due to the recent expansion and widening of road. Not only existing trees were cut during the process of road widening but consideration has also not been given to new roadside plantation of trees. Due to the expansion of one way road this patch has grown as new commercial area and shop owners are reluctant to grow trees in front of their shops because they prefer economic consideration more than environment.

It can be seen that all the selected regional roads are deprived of trees near the central point, as no trees on any side of roads were seen. The reason behind this is the development of concrete commercial areas and shops, no vacant land is present for tree growth; owing to the reason of high commercial land values and lack of open space. Shops end near pedestrian paths, hence minimizing the grounds for tree growth. Roads are metalled, footpaths are paved and encroachment of shops and parking areas doesn't support tree plantation as a barrier in between. This Central node is one of the busiest node of city; roads and footpaths are always busy with traffic and pedestrians. Due to the lesser number of trees and heavy traffic emission temperature is relatively higher than the neighboring

areas during day times, developing a small "urban heat island".

Figure 1: Distribution of trees along selected regional roads in Bahawalpur City

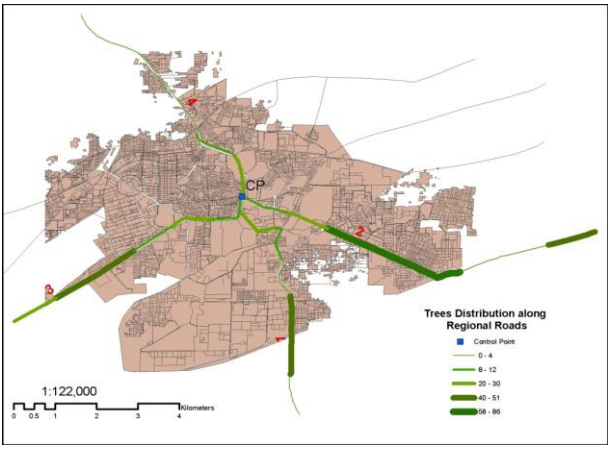


Figure 1 illustrates that with the increasing distance from the central point (Farid Gate) distribution of trees seems better on Road 1, 2 and 3. Numbers of trees on both sides of roads are almost equal as seen in table 1; this is because land use is kind of residential, here the numbers of trees are 40 to 86 per 1000 meters. Empty grounds between main regional road and service road provide enough space for tree growth. Most bad condition can be seen on road 4, where in last 3000 to 6000 meters no trees are present. The reason behind this is again the recent road widening and the consequences are not yet restored. Due to no trees along the road environment around is very sunny and warm during day time. Main Bus Stop of the city is situated on this road due to which it is full of activity by regular heavy traffic, busses, vans, cars, rickshaws. Due to this significant vehicular activity smoke and emissions surrounds whole area creating local heat island. There is a dire need of proper plantation and tree management along this road. Figure 1 may provide the help to easily trace out the areas where there is acute shortage of trees and these patches and segments need to be planted urgently and properly.

Table 2: Tree Density along selected roads (No. of trees per 1000 meters)

Roads	Cumulative	Right side	Left side
Road 1	37.83	12	21.8
Road 2	35.75	21.37	14.37
Road 3	26.6	8.3	8
Road 4	5.8	2.8	3
All roads	26	15	11

If for an instance uniformity and size of trees is ignored and the main concern is whether or not the area is adequately stockpiled with trees. Table 2 shows the density of trees on both sides of roads and in cumulative. Road 4 with lowest density of trees is in an environmentally deteriorating condition. Taking a closer look on the land use of along these road shows that except few segments this road is surrounded by commercial areas, shops, small industrial area and a flyover bridge. Such land use does not allow trees growth in their frontline because they are considered as barrier. Potential sites are present that can be used for future tree plantation. Though road 1 carries highest density it doesn't mean that potential sites are not present. There are few empty roadsides where refilling is necessary and these are identified in map (fig 1) above with 0-4 category.

Figure 2: Tree Density (Number of trees per 1000 meters) on selected roads

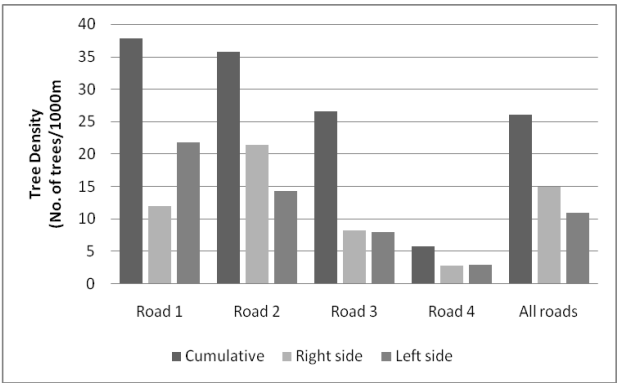


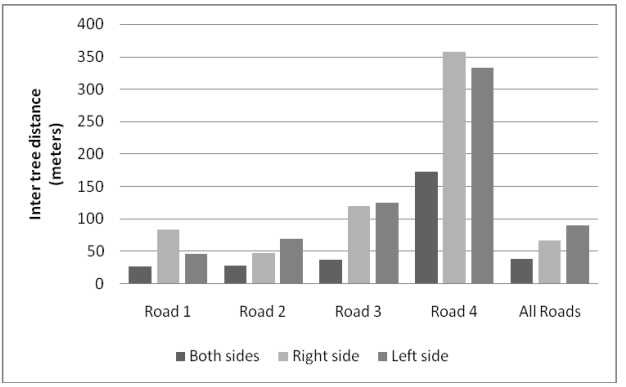
Fig 2 shows a clearer picture of the of tree density of all roads. Road 1 and 2 are above the mean value (15 trees/km on right, 11 trees/km on left). Road 3 lying below average is considered as major commercial activity zones, comprising of shops, plazas, hospital, medical and nursing colleges, fuel filling station and many other commercial land uses. This road has fewer number of trees until it runs around these commercial nodes but near the city margins due to the change in land use; from commercial to residential, number of trees are more that before (fig 1). As already discusses above Road 4 due to its newer construction has lowest density and can be planted at many segments.

However, Inter tree distance can be used as a technique for the proper spacing and managing the distribution of roadside trees. Inter tree distance is used as a technique to find out the degree of closeness between trees. If the value of inter tree distance is high it will show that road has less trees and having high risk to ecological threats and vice versa. Table 3 depicts the average inter tree distance as 38.46 meters, while 66.66 meters on right and 90.9 meters on left side of the road. Greater inter tree distance shows that spaces are present which can be used for the future plantation.

Table 3: Average Inter tree distance of selected roads (in meters)

	Both sides	Right side	Left side
Road 1	27.02	83.3	45.87
Road 2	27.97	47.6	69.58
Road 3	37.59	120.48	125
Road 4	172.4	357.14	333.3
All Roads	38.46	66.66	90.9

Figure 3: Average Inter tree distance (in meters) of selected roads



Lesser inter tree distance means higher number of trees along roads. As fig 3 shows Road 1 and 2 has lesser inter tree distance, though number of trees is not sufficient because many public and private owned trees can be grown in many potential sites. Road 4 with highest inter tree distances is most deprived of trees. Due to the recent road widening, and flyover construction, high vegetation loss was observed. Land use along this road is mostly commercial type and an industrial area is also located there, but many segments along road have soil patches which can be used to green the road. As map (figure 1) shows that between 3000 to 5000 meters of road, there is a long vacant space on right side of the road which needs to be planted. So basically different patches of empty roadsides can be used to plant trees and monitor as well.

However, central green belts along all roads are planted and managed in a good manner. Recent step taken by Municipality for the plantation of Date trees is appreciated by the city dwellers. These plantations were experimented on selective sites of Road 1 and Road 2 on central greenbelts. Local climates support the growth of date trees, as they need less water and can survive in extreme high temperatures.

The results of survey imply that over all the management and distribution of roadside amenity trees is not very good. Plantation of more trees on vacant roadsides must be

grown to reduce the effects of vehicular emissions and noise. Map in figure 1 may provide help to easily trace out the areas of acute shortage of trees, these deprived segments need to be planted urgently and properly. A policy can be adopted to support the setback of commercial buildings from roads; it will help many sites near the commercial nodes to improve the environmental conditions. Similarly open soil sites are scarce; hence authorities can encourage the replacement of paved covers with some porous units (Jim 1999) to make sure proper aeration to the soil. This will also help in lowering the water demand for trees. Broader footpaths or pedestrian tracks can be used as plantation sites. There should be coordination among the different institute and department responsible for the different services in city i.e. Tehsil Municipal Administration, Urban Forestry Department, Highway authorities, NGOs (Non Governmental Organization) and CBOs (Community Based Organization) and Environmental Protection Agency. This will help in improving effective management practices, and reduce severe threat to the environment. It is also a cost effective way to consume resources and funds.

A combine effort by the management authorities and road users can improve the condition of roadside tree distribution. People residing around roads can make possible street-tree management by planting and nurturing their front door trees by themselves. Perception and preference of community and road users play a vital role in tree management programmes because they are the real targets (Akbar, Hale, and Headley 2003).

Conclusion

Importance of roadside vegetation particularly trees cannot be ignored in terms of their benefits for atmospheric conditions, pleasant environment, aesthetic beauty and ecological benefits.

Modern world livable cities where vehicular pressure and road usage is very high, it is essential to maintain the regularity of tree growth and composition. Expansion of roads and road widening are the main reasons behind loss of trees. Study identifies some sites along roads which are deprived of trees and need urgent attention. Tree density is very low; alarming worse conditions in future if steps are not taken significantly. Urban infrastructure development should be sustainable and compatible with the environmental development.

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