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# Analysis of socio-environmental impacts of the loss of urban trees and vegetation in Lahore, Pakistan: a review of public perception

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## Abstract

**Introduction:** This paper focused on the process of urbanization in Lahore and its correlation with the loss of urban vegetation and perceived environmental impacts based on local population's perception through administration of a questionnaire survey. Lahore is known as a city of gardens and green spaces in Pakistan and always possessed rich green character in its long history. For the past few decades due to rapid urbanization, the city has lost its aesthetically important urban vegetation, tress, and greenery. The field studies and remote sensing data revealed that the loss of vegetation has been experienced at an astonishing rate in many union councils of the city.

**Methods:** This study was conceived to probe importance and value of the urban tress and vegetation of Lahore in an environmental context and its general importance for the residents of the city. The objectives were to analyze the role of vegetation in the life of citizens; the specific objective was to reveal the attitudes and responses of city dwellers about loss of urban trees/vegetation and its role in the overall environment, process of urbanization, and maintenance strategies. In the present paper, perception of local people ( $n = 2080$ ) regarding the socio-environmental impacts due to the ongoing process of urbanization and detriments of vegetation loss has been probed through administration of a household questionnaire. The collected data has been tested with respondent's age, gender, marital status, education, monthly income, and occupation.

**Results:** This study was an attempt to document and explore the change in historical transformation in vegetation and perception of the sample population of Lahore. This perception survey has revealed that urbanization is the major cause of loss of vegetation and has caused a number of perceived environmental problems in the city.

**Conclusions:** The study underlined an analysis of people's perceptions regarding the loss of trees and vegetation. The perceived socio-environmental findings revealed that the urbanization and population growth are the fundamental reasons for trees/vegetation loss in the city.

**Keywords:** Anthropogenic, Union council, Socio-environmental, Perception, Vegetation, Urban trees

## Introduction

Urbanization is taking place in the world with much faster rates than ever before. Today, more than 54 % of the world's total population is living in cities, and an estimated 66 % of it will occupy urban areas by the year 2025 (UN 2014). In comparison to the rest of the world, 46 % of the total population of Asia is living in urban areas. Pakistan is not far behind in urban population with 35 % of its

population living in the cities and towns. The urban proportion of the population in Pakistan is the highest among South Asian Association for Regional Cooperation (SAARC) countries. At present, the urban population of Lahore is more than 80 % and is at par with the urbanization level of the developed countries, that is, 80 % of the total population. Natural increase, rural to urban migration, and foreign and local investment in various sectors are the major impetus for growth of cities as well as urbanization in Lahore-Pakistan. With this pace of population rise, Lahore will be among the top 30 cities of the world in terms of urban proportion of population by

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2025. Lahore ranked 56th in the world in 1975 and 38th in 2007 while it will be 24th in 2025 (UN 2007). During the last few decades, rapid urbanization has played a pivotal role in socioeconomic prosperity of cities of the developing countries and therefore remained an area of prime concern among scientists, policy makers, and city managers (Zhang and Song 2003; Siciliano 2012). As urbanization is increasing all over the world, many cities experience high population growth rates, causing degradation to the local environment like noise and carbon pollution, soil erosion, and habitat and species loss (Zipperer et al. 1997; Vesely 2007; Young 2010). This rapid urbanization has caused a number of ecological and environmental problems and has also degraded the quality of environment of many cities of the world (Folke et al. 1997; Gregg et al. 2003; Alberti and Marzluff 2004; Kim and Baik 2005; Zhao et al. 2006; Matteucci and Morello 2009).

Urban vegetation is one of the determining factors in increasing the market values of vicinity properties (Lindsey et al. 2004; Saphores 2012), thereby having a considerable commercial importance. Urban green spaces provide employment opportunities and help attract businesses and tourists to an area (Swanwick et al. 2003). The city's vegetation effectively plays its role in moderating urban heat island impacts and urban hydrology and air quality and in reducing noise pollution as well as the energy demands (Pauleit and Duhme 2000; Fang 2005; González et al. 2005; Konijnendijk et al. 2005). What is not known is how resilient urban vegetation is and will it change over time. This is particularly relevant in the context of predictions for climate change and changing social and personal values related to open space (Wu 2008). Urban trees and vegetation have profound effects on biodiversity and also on provision of aesthetic, psychological, and socioeconomic ecosystem services to the dwellers (Schoeder and Cannon 1983; Ulrich 1986; Kaplan and Kaplan 1989; Huang et al. 1992; Kaplan 1992; McPherson et al. 1994; Sullivan and Kuo 1996; Wolf 1999; Nowak 2001). Therefore, the study of environmental-related issues and consequent impacts due to urbanization has now become an area of prime importance (Chen 2007; Li and Yao 2009; Martínez-Zarzoso and Maruotti 2011).

Lahore always possessed a rich green character among the cities of the sub-continent during different phases of its history. The canal irrigation system in the district was started in 1859 when the Bari Doab Canal was opened. During that period, indigenous trees were grown along the roadside and canals. Most of the trees were Peepal, Mulberry, Banyan, Jamun, etc., which gave rise to a new vegetation structure to the city and suburbs. Soon after Independence in 1947, due to urbanization (new settlements, construction of roads, bridges, and other infrastructural landmarks), most of

the old and indigenous trees had been cut, thus leaving behind a small proportion of indigenous trees in the city (Masood 2004). It is evident from the field and discussions with the native and old personalities of Lahore that the trees and vegetation of the city have been greatly modified by anthropogenic activities. In most cases, the urbanization and city development is often a compromise of agricultural or forested lands, and the city of Lahore is no exception.

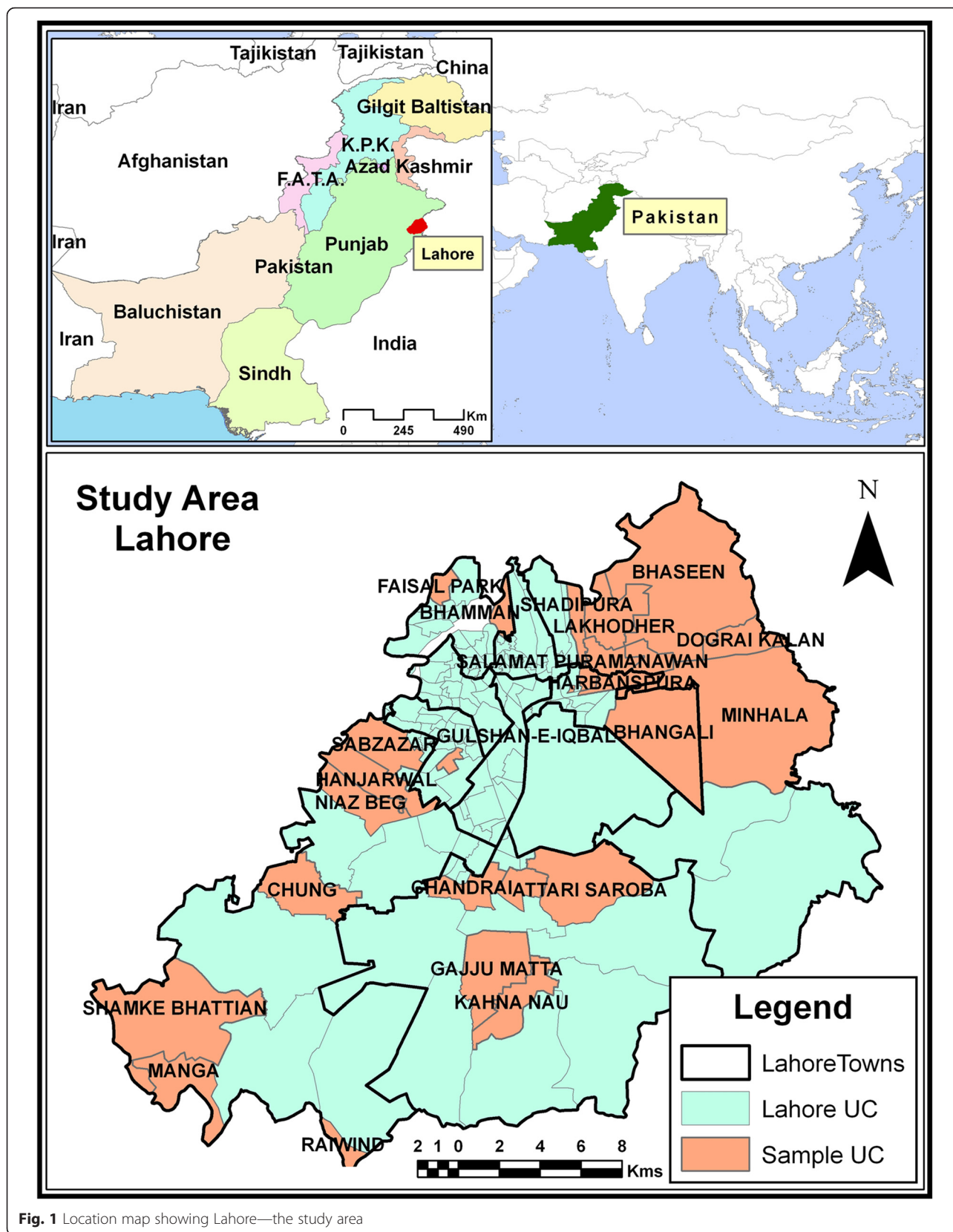
The role of urban vegetation in provision of numerous ecosystem services vis-a-vis the ongoing rapid-paced urbanization in many parts of the world has extensively been documented in literature (cf. Tzoulas et al. 2007; Niemelä et al. 2010; Colding 2011; Bastian et al. 2012; Haase 2013). The monitoring of vegetation in Lahore-Pakistan which is famous for its greenery is important and relevant in the context of city development and human health. It would further investigate how the people perceived about the vegetation change and why preservation of trees is important for city dwellers. The rapid development in cities and resultant land use and land cover (LULC) changes always left imprints on their terrestrial, biological, physical, and climatological processes, leading to numerous environmental and ecological problems (Latifovic et al. 2005; Fisher et al. 2006). Therefore, quantity, quality, and distribution of urban vegetation/trees in cities across the world reveal the history of urbanization and related ecological changes (Jim 2004; Jim and Zhang 2013) in due course of time.

In this research, we hypothesized that quantity of urban vegetation in Lahore has reduced because of urbanization during the last two decades and has had numerous impacts on the overall environment and people of Lahore. Further, the socio-environmental impacts that have been perceived by the residents were different in different socioeconomic backgrounds of the people.

## Methods

### Study area and selected sites

Lahore (Fig. 1) lies between 31° 15' and 31° 43' N latitude and 74° 10' and 74° 39' E longitude with an area of 1772 km<sup>2</sup> (GoP 2000a,b). The city is the provincial capital of Punjab-Pakistan and the second most populous city in the country. It is located on the bank of River Ravi—one of the five rivers of the Indus River system with an altitude range between 150 and 200 m above mean sea level. The climate of Lahore is extreme continental in nature and experienced three well-marked seasons, viz, winter, summer, and rainy monsoon. The monsoon rainfall is quite supportive of vegetation which is further augmented by canals and rivers flowing in Lahore. It is hot in summer and usually cold in winter. The maximum rainfall occurs in summers from inflowing monsoon; winter is characterized by partial or



complete drought; the length of dry season varies due to local factors (Kazi 1951). Being a metropolis, it is accessible from all parts of Punjab-Pakistan via rail, road, and air facility. It is a bordered city and linked to Amritsar-India by both rail and road from Wagah.

Table 1 reveals that the population of the city has grown more than 40 times since the beginning of the twentieth century from a population of 202,964 persons in 1901 to 8,462,000 in 2009. From 1901 to 1921, the annual average growth rates were slow which may be ascribed as under enumeration of the population mainly because of the difficulty in area coverage. Since then onwards, the rate of population growth remained steady, and after Independence in 1947, it picked up at a faster rate, i.e., 2.38 and 4.32 % during the intercensal periods 1951–1961 and 1961–1972, respectively. This had registered a corresponding increase in population of 52.65 and 67.36 %. This increase can be attributed to substantial rural to urban migration, which took place during that period (Government of Pakistan 2000a, 2000b). The drop in average annual growth rate to 3.71 % during 1972–1981 and a further decrease to 3.32 % for 1981–1998, however, seem to be because of intra-urban residential motilities from the inner city of Lahore towards suburbs of the city which was not included in the city limits at that time. A glance at Table 2 shows that the overall increase in population of Lahore has been about six times during 47 years of its census history, i.e., 1951–1998. The population of the city grew at an average rate of 3.32 % during the intercensal period 1981–1998

**Table 1** Population, intercensal increase, and growth rates of Lahore-Pakistan, 1901–2009

Census year	Population Lahore	Intercensal increase (%)	Avg. annual growth rate (%)
1901	202,964	–	–
1911	228,687	12.67	1.20
1921	281,781	23.22	2.11
1931	429,747	52.51	4.31
1941	671,659	56.29	4.57
1951	849,476	26.47	2.38
1961	1,296,477	52.62	4.32
1972	2,169,742	67.36	4.79
1981	2,952,689	36.08	3.48
1998	5,143,495	74.20	3.32
2009 <sup>a</sup>	8,462,000	23.51	2.37

Source: District Census Report of Lahore 1961 and Pakistan Statistical Year Book 1977 (Karachi: Statistics Division, Govt. of Pakistan, 1978) and City Report Lahore Population and Housing Census 1998 (GoP 2004). Government of Pakistan, Statistics Division, Population Census Organization 2004

<sup>a</sup>Estimated population: Statistical Year Book of Pakistan 2009, p. 309. Punjab Development Statistics 2009. Computed from 1951, 1961, 1972, 1981, and 1998 censuses

(17 years) and registered an increase of 74.20 % over 1981 when the population was 3,544,942. The total population of Lahore was 6,318,745 as per the 1998 census. This large-scale increase in population and resultant development in residential/infrastructural sectors has since long caused increased pressure on urban vegetation (Table 1). This has resulted in loss of the city's green character (Shirazi 2012); therefore, the urban vegetation has been significantly removed or reduced (Almas et al. 2005) and thus had a significant socio-environmental impact on the residents of Lahore. The process of urbanization and global impacts on climate change in Lahore have also adversely affected the climate of the city (Sajjad et al. 2009). It was therefore imperative to appraise the perception of the public regarding the loss of city's greenery/vegetation due to urbanization in Lahore by highlighting its causes and consequences as per people's opinion through firsthand information. The main objective of this study was so see the impact of urbanization on vegetation and resultant environmental degradation in the city of Lahore. This objective was achieved through people's perception gathered with the help of fieldwork and questionnaire survey. It was also necessary to assess the socio-environmental awareness related to the tree/vegetation loss and urbanization of the socioeconomic characteristics of the sample population of Lahore. It was also the aim to gauge the concerns of the local residents about environmental problems arose by the urbanization and vegetation loss in the city of Lahore.

The figures presented in Table 2 represent the LULC changes in each category since 1992. Built-up area in 1992 occupied more than 51.42 % of the total area, followed by vegetative cover (36.40 %). The major category of the built-up area has shown consistent increase since 1992, i.e., from 51.42 to 57.12 % in 2001 and 71.61 % in 2009. This was mainly because of the fact that Lahore remained the major recipient of the migrants from all over the Punjab province as well as from many other areas of Pakistan. In order to cater the needs of growing number, the residential colonies sprung up on vacant lands covered with natural vegetation. On the contrary, there has been gradual and persistent decline in the vegetative cover in Lahore (Table 2). This continuous decrease in vegetative/green cover in the city was mainly because of rapid population growth (Table 1) and consequent urbanization which had taken place over green areas and agriculture lands of Lahore City.

Since the study area was Lahore, which is too large, in terms of both population and area, therefore, a sample of 25 union councils (a small administrative unit of City District Government, Lahore) was selected to collect the wholesome data from the residents. In order to make it rational, the basic criterion for choosing these union councils (UCs) was the proportion of vegetative cover in



**Table 2** Change in LULC of various categories in Lahore District: 1992, 2001, and 2009

LULC categories <sup>a</sup>	1992	2001	2009	% change 1992–2001	% change 2001–2009	% change 1992–2009	% annual change
Built-up <sup>a</sup>	911.14 (51.42 %)	1012.11 (57.12 %)	1268.85 (71.61 %)	100.97	256.74	357.71	21.04
Vegetative cover	645.06 (36.40 %)	417.51 (23.56 %)	249.7 (14.09 %)	−227.54	−167.81	−395.36	−23.26
Open areas	174.69 (9.86 %)	288.1 (16.26 %)	179.26 (10.12 %)	113.41	−108.84	4.57	0.27
Water bodies	15.95 (0.90 %)	25.31 (1.43 %)	34.95 (1.97 %)	9.36	9.63	19	1.12
Mixed	25.16 (1.42 %)	28.96 (1.63 %)	39.25 (2.21 %)	3.8	10.28	14.08	0.83
Total	1772	1772	1772				

Source: Shirazi S.A (2012), "Temporal Analysis of Land Use and Land Cover Changes in Lahore-Pakistan." "Pakistan Vision" Vol. 13 No. 1 June, 2012, pp. 188–207, *Journal of Pakistan Study Center, University of the Punjab, Lahore*

<sup>a</sup>In square kilometers

1992 (all the 25 UCs were selected because of the vegetative cover of more than 65 % of their total area in 1992). For this purpose, 1992 Landsat TM images of Lahore were classified and interpreted into LULC data set categories which revealed that out of 150 UCs, 29 UCs were having a vegetative cover of more than 60 % of their respective geographical area. Out of these 29 UCs, top 25 UCs were selected for data collection and household survey to be conducted. The vegetative area ranges from UC no. 125 Manga (65.50 %) to UC no. 108 Gulshan-e-Iqbal (85.71 %)—the UCs have now been the most affected by urbanization. In Lahore, the perception/awareness about the trees and vegetation loss viz-a-viz perceived environmental concerns due to urbanization, among the people, was different in different UCs and at different level groups. In order to achieve our targeted questions, we evaluated four themes of the study:

- The perceived causes of urbanization and loss of vegetation in Lahore
- Residents' perceived concerns about urban vegetation and its importance
- The perceived environmental effects due to loss of vegetation
- The value of tress/urban vegetation as perceived by the residents

Therefore, the understanding of the geographical localities was necessary before conducting the household survey in the sample areas of Lahore, in order to include every tier of the population. The categorization of the vegetation percentage helped to understand the impact of urbanization on vegetation loss scenario and in understanding the urbanization phenomenon. First of all, the UC level map of Lahore was acquired and the sample UCs of Lahore were identified as per criteria set forth for the purpose. It was decided to cover all the 25 UCs of Lahore keeping in view their geographical location and orientation, so as to cover all directions of the city of Lahore (Fig. 1). Based on this pre-survey rational,

as well as understanding, the sample localities/the survey sites were selected.

#### Questionnaire design, sampling, and fieldwork

In order to find the perception, attitude, and comprehension of the people of Lahore regarding loss of vegetation due to urbanization and its perceived impacts, we designed a semi-structured questionnaire with mainly close-ended questions for the common residents of Lahore (hereinafter called the perception survey). The first part of the questionnaire was about the socioeconomic traits of a sample population followed by questions related to the importance and environmental significance of vegetation, amenity value of vegetation, and benefits of vegetation. The survey was conducted in the sample UCs of the study area to explore the facets of citizen the perception towards the impact of vegetation loss as per people's opinion through firsthand information. It was also to assess the socioeconomic and environmental awareness related to the vegetation loss and urbanization of the sample population of Lahore and to understand the concern of the people about perceived environmental problems arose by the urbanization and vegetation loss in the city of Lahore. The questionnaire was designed after numerous meetings with the officials of Lahore Development Authorities (LDA), experts in the field of urban planning and environment, and my colleagues at the University of the Punjab, Lahore. After designing the questionnaire, a pilot test was run at five UCs which were part of the 25 selected sites for data collection. The filled questionnaires were scrutinized carefully, and few questions were excluded from the survey instrument while wordings of few questions were rephrased to make it easier to understand. The questionnaire was prepared in English, but the enumerators were instructed to translate each question for the respondents if someone does not understand the question.

There were 2150 sets of questionnaires circulated among the 25 UCs/sampling areas. A minimum of 50 questionnaires and a maximum of 70 questionnaires were filled in from each sample area. A total of 70 questionnaires were found improper, incorrect, and incomplete;

therefore, they were excluded from the final analysis, while the rest of the 2080 questionnaires were used for statistical analysis. The methods used for the research were qualitative and quantitative in nature. Since the primary data collected for this research was to assess the knowledge of the people of Lahore, relating to urbanization and tree/vegetation loss, therefore, as the sampling technique, household units were randomly sampled and were used while an interview was conducted to fill the questionnaire. Before the start of the interview, the purpose of the survey was explained to each respondent and their consent was sought for the purpose.

A fieldwork was conducted since 01-09-2009 and ended on 31-12-2009 under the supervision of the researcher from the *ZindaDilan-e- Lahore* (people of Lahore). About 20 volunteer post-graduate students of the Geography Department of Punjab University, Lahore, were entrusted to work as enumerators. For the present study, the idiom “urban vegetation” is used for all those plants found in the district of Lahore, hence referring to the ground cover provided by the plants, trees and forests, weed patches, crop fields, roadside vegetation (natural and planted), privately owned gardens and lawns, parks, aquatic and marshy vegetation, and green spaces maintained by public and private enterprise; all are encompassed by the term vegetation (Borgström et al. 2006; Breuste 2008; James et al. 2009; Qureshi et al. 2010) which might be called as “urban green space” in a broader urban ecological perspective.

Prior to this survey, enumerators were briefed about the purpose of study, the questionnaire, and data collection strategy. Most of them were the present students while there were few old students of the investigators who were engaged in the fieldwork. In addition to the volunteers, the researcher himself collected the data from the field, particularly from the far flung sample UCs of Lahore. It is customary in Pakistani society that females do not respond to unknown people while male members were out of home. Therefore, in most cases, the data collection was done in the afternoon between 3 and 6 pm, but not limited within this time frame so as to have male members at home. That is why the major proportion of respondents was males (Table 3).

The questionnaire used for the perception survey comprised of a variety of aspects related to various socioeconomic conditions, knowledge about vegetation loss, concerns of the people about the past and the present vegetation of Lahore, importance of vegetation in the daily affairs of life, maintenance of vegetation, knowledge about the importance of vegetation, environmental importance of vegetation, sentimental attachment to city's vegetation, standard and status of vegetation in Lahore, and perception of vegetation quality among different strata of the residents of Lahore. A number of questions were particularly

designed to target the importance and problems related to the vegetation of Lahore. Investigations of people's perception about urbanization and vegetation loss were also carried out by asking questions about the type, value, and importance. However, results of only ten questions (tested variables) from the household survey have been documented and depicted in figures.

The questions included in the questionnaire primarily about the perception of people regarding socio-environmental conditions, benefits, adverse impacts, economic values due to loss of trees/vegetation, and urbanization of Lahore were coded as variables. Similarly, data of all the 2080 filled questionnaires were then key-punched to infer analysis. For the analysis, SPSS 17.0 has been used as a statistical software program to test cross tabulation, chi-square test, and Pearson's product moment correlation for responses and later presented in tabular and graphical forms to have better comparative review of the results.

#### **Socioeconomic profile of the respondents**

The gender composition of the total sample of 2080 respondents has been given in Table 3 in the summary statistics of the household survey. From the total, 62.7 % were male while the remaining 37.3 % were female respondents. More or less, the same proportion exists in all the 25 surveyed UCs of Lahore. Table 3 indicates the marital status of the respondents in the entire sample UCs collectively. It reveals that, out of the total 2080 respondents, 79.4 % were married while 19.6 and 1.0 % were single and divorced/widowed, respectively. As far as the age of the respondents in the area is concerned, majority of them falls in the age group of 41–50 years followed by 31–40 years and 21–30 years age groups. Since the surveyors mostly interviewed the heads of the households, or the elder persons, therefore, the percentage is higher for the age group of 41–50 years. The same is true for the entire sample of the 25 UCs of Lahore. There were 15.8 % of the respondents who fall into the age group of 50 years and above.

Educational characteristics are of fundamental importance in any in-depth study of present nature. As far as educational characteristics of the sample population is concerned, it was found that most of the respondents were bachelors (34.6 %) followed by the masters, engineers, and doctors, etc., with a percentage of 28.5. There were only 1.5 % of the respondents who were uneducated. The proportion of “others category” was 6.2 %. The data pertaining to occupation of the respondents reveals that most of the respondents belong to the category designated as the businessmen (27.1 %) followed by the government employees (15.2 %), private employees (14.8 %), pensioners/retired personnel (11.9 %), and self-employed (9.2 %). Only 10.8 % of the

**Table 3** Socioeconomic characteristics of the respondents

Characteristics	Participants	No. and % age of respondents N = 2080 (100 %)
Gender	Male	1304 (62.7)
	Female	776 (37.3)
Age	<20	32 (1.5)
	21–30	412 (19.8)
	31–40	589 (27.9)
	41–50	728 (35.0)
	>50	324 (15.8)
Marital status	Single	408 (19.6)
	Married	1652 (79.4)
	Divorced/widow	20 (1.0)
Educational level	Uneducated	32 (1.5)
	Below matriculation	96 (4.6)
	Matriculation	176 (8.5)
	Intermediate	336 (16.2)
	Bachelor	720 (34.6)
	Post-graduate/Dr./engineers	592 (28.5)
	Others	128 (6.2)
Occupation	Govt. employee	315 (15.2)
	Pvt. employee	308 (14.8)
	Self-employee	148 (7.1)
	Businessman	564 (27.1)
	House wife	192 (9.2)
	Student	56 (2.7)
	Retired/pensioner	248 (11.9)
	Unemployed	224 (10.8)
	Others	25 (1.2)
Monthly household income (Rs.) 1 US\$ = Pak.Rs.80 at the time of survey—2009	<15,000	568 (27.3)
	15,000–30,000	828 (39.8)
	30,001–45,000	500 (24.0)
	45,001–60,000	136 (6.5)
	>60,000	48 (2.3)

respondents were unemployed. Table 3 indicates the distribution of the respondents according to their occupation.

As far as the data is concerned, it was explored that majority of the respondents were government employees followed by the private employees. Their detailed UC level break-up indicates that the ratios of these two major sectors are more or less the same with those in the entire sample UCs. For example, in Green Town (a sample UC), government employees were 29.6 % as compared to 18.4 % of private employees. The question relating to the income of the respondents was very important in order to assess the economic conditions of

the respondents as well as that of the sample area. Table 3 revealed that most of the respondents of all the UCs of the selected are fall in the income category ranging from Rs. 15,001–30,000 (39.8 % of the total sample) per month, while the remaining falls within the categories of Rs. 30,001–45,000 (24.0 %); Rs. 45,001–60,000 (6.5 %); and Rs. >60,000 (2.3 %) while a substantial proportion of the residents (27.3 %) fall in the income category of monthly income of Rs. <15,000.

### Results and discussion

The results of the chi-square test revealed that the vegetation loss and its perceived causes have highly significant association with each other,  $\chi^2 (8, N = 2080) = 90.25$ ,  $p = .00$  (Table 4). This means the residents were aware of this fact that the vegetation in Lahore was less as compared to the last 15–20 years, and they identified the causes of this degradation in the order of population increase (16.98 %), urbanization (15.38 %), development by City District Government of Lahore (11.34 %), traffic congestion (9.42 %), and climate change (6.15 %). It clearly revealed that the residents believe that during the past 15–20 years, the urban vegetation of Lahore has definitely reduced and the perceived causes of this phenomenon were similar to many other studies of similar nature.

Population increase is one of the major reasons of urbanization in Lahore as elsewhere in the world; therefore, results of chi-square reveal that population increase in the city of Lahore in the past two decades was the major reason of vegetation loss and that both have been significantly associated with each other,  $\chi^2 (2, N = 2080) = 5.77$ ,  $p = .05$  (Table 5). This can also be seen in Table 2 as to how the population has increased over the period of time in Lahore. The study further probed it to the people's perceptions with the help of ten tested variables related to the main objectives of this research.

#### 1. *Urban trees/vegetation is an important part of Lahore City*

The results presented in Table 3 showed that the marital status of the individuals as well as their income has no effect on their perception about the test statement that “Urban trees/vegetation is an important part of Lahore City,” as both the  $p$  values for the chi-square test of these two tested variables are greater than the significance level of 0.05, showing an insignificant value. However, the gender, age, education, and occupation of the individuals do have an effect on the respondent's perception about this statement. The  $p$  values of these four variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these four variables at a 0.05 significance level. Another way to put this may be that the respondents'

**Table 4** Cross tabulation and chi-square test for responses on questions related to vegetation loss (N = 2080)

	Causes of vegetation loss					$\chi^2$	p
	Climate change	Development by CDGL <sup>a</sup>	Urbanization	Traffic congestion	Population increase		
Vegetation is less today as compared to the last 15–20 years	128 (6.15)	236 (11.34)	320 (15.38)	196 (9.42)	352 (16.98)	90.25	.00

Note:  $\chi^2$  chi-square

p < .05; p < .00

<sup>a</sup>City District Government, Lahore

perception about the statement “Urban trees/vegetation is an important part of Lahore City” is dependent on the individual’s gender, age, education, and occupation.

2. *Trees/vegetation protects us from adverse environmental effects such as pollution and dust storms, reduces noise, blocks unsightly views, etc.* Table 6 shows that the marital status of the individuals has no effect on their perception about the test statement “Trees/vegetation protects us from adverse environmental effects such as pollution and dust storms, reduces noise, blocks unsightly views, etc.,” as the p value for the chi-square test is greater than the significance level of 0.05, showing an insignificant value. However, the gender, age, education, income, and occupation of the individuals do have an effect on the respondent’s perception about this statement. The p values of these five variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these five variables at a 0.05 significance level. This can also be inferred that the respondents’ perception about the statement “Trees/vegetation protects us from adverse environmental effects such as pollution and dust storms, reduces noise, blocks unsightly views, etc.” is dependent on the individual’s gender, age, education, income, and occupation.
3. *Trees/vegetation in your area is less today as compared to 15–20 years ago* All the socioeconomic variables of gender, age, marital status, education, income, and occupation of the individuals have an effect on the respondent’s perception about the test statement “Trees/vegetation in your area is less today as compared to 15–20 years ago,” as the p values of all these six variables are less than 0.05, hence pointing towards a significant relationship between the test variable

and each of these six socioeconomic variables at a 0.05 significance level. Another way to put this may be that the respondents’ perception about the statement “Trees/vegetation in your area is less today as compared to 15–20 years ago” is dependent on the individual’s gender, age, marital status, education, income, and occupation.

4. *Population growth and urbanization in Lahore are the two major causes of vegetation loss* All the socioeconomic variables of gender, age, marital status, education, income, and occupation of the individuals have an effect on the respondent’s perception about the test statement “Population growth and urbanization in Lahore are the two major causes of vegetation loss,” as the p values of all these six variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these six socioeconomic variables at a 0.05 significance level. Another way to put this may be that the respondents’ perception about the statement “Population growth and urbanization in Lahore are the two major causes of vegetation loss” is dependent on the individual’s gender, age, marital status, education, income, and occupation.
5. *Observed/felt change in the climate of Lahore* The results displayed in Table 6 showed that the gender of the individuals has no effect on their perception about the test statement “Observed/felt change in the climate of Lahore,” as the p value for the chi-square test is greater than the significance level of 0.05, showing an insignificant value. However, the age, marital status, education, income, and occupation of the individuals do have an effect on the respondent’s perception about this statement. The p values of these five variables are less than 0.05, hence pointing towards a significant relationship

**Table 5** Cross tabulation and chi-square test for responses on questions related to vegetation loss (N = 2080)

	Population increase is the major cause of vegetation loss			$\chi^2$	P
	Yes	No	don’t know		
Vegetation Loss	1232 (59.23)	452 (21.73)	396 (19.03)	5.77	.05

Note:  $\chi^2$  = Chi-square. = p < .05. = p < .00



**Table 6** Chi2 test results for respondent's socioeconomic traits for 10 tested variables in some selected localities of Lahore, Pakistan

Tested variables	Chi2 test <i>p</i> value for respondent's socioeconomic traits					
	Gender	Age	Marital Status	Education	Income	Occupation
Urban trees/vegetation is an important part of Lahore City	.057	.024	.101	.000	.354	.000
Trees/vegetation protects us from adverse environmental effects such as pollution and dust storms, reduces noise, blocks unsightly views, etc.	.053	.000	.825	.000	.000	.000
Trees/vegetation in your area is less today as compared to 15–20 years ago	.018	.000	.000	.000	.000	.000
Population growth and urbanization in Lahore are the two major causes of vegetation loss	.028	.000	.000	.000	.000	.000
Observed/felt change in the climate of Lahore	.082	.001	.000	.057	.003	.000
Loss of vegetation cover is one possible cause of climatic change in Lahore	.235	.253	.000	.087	.000	.000
Trees in business districts and residential neighborhoods attract more business and residents	.856	.029	.000	.000	.000	.000
Trees are important because they increase property values	.917	.067	.001	.002	.101	.000
Willing to pay some tax/"Tree Tax" to the city's administration to be spent to protect the vegetation/trees of Lahore	.248	.000	.007	.000	.000	.000
Will halt the Government agency if it intends to remove the trees without any genuine reason/need from our vicinity	.000	.000	.006	.000	.000	.000

Note: Significant *p* values for Chi2 (X2) test (based on frequency of response) ( $p < 0.05$ )

between the test variable and each of these five variables at a 0.05 significance level. Further, the respondents' perception about the statement "Observed/felt change in the climate of Lahore" is dependent on the individual's age, marital status, education, income, and occupation.

6. *Loss of vegetation cover is one possible cause of climatic change in Lahore*

The results depicted in Table 6 showed that the gender, age, and education of the individuals have no effect on their perception about the test statement "Loss of vegetation cover is one possible cause of climatic change in Lahore," as the *p* value for the chi-square test for each of these three variables is greater than the significance level of 0.05, showing an insignificant value. However, the marital status, income, and occupation of the individuals do have an effect on the respondent's perception about this statement. The *p* values of these three variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these three variables at a 0.05 significance level. In another way, the respondents' perception about the statement "Loss of vegetation cover is one possible cause of climatic change in Lahore" is dependent on the individual's marital status, income, and occupation.

7. *Trees in business districts and residential neighborhoods attract more business and residents*

Table 6 shows that the gender of the individuals has no effect on their perception about the test statement "Trees in business districts and residential

neighborhoods attract more business and residents," as the *p* value for the chi-square test is greater than the significance level of 0.05, showing an insignificant value. However, the age, marital status, education, income, and occupation of the individuals do have an effect on the respondent's perception about this statement. The *p* values of these five variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these five variables at a 0.05 significance level. However the respondents' perception about the statement "Trees in business districts and residential neighborhoods attract more business and residents" is dependent on the individual's age, marital status, education, income, and occupation.

8. *Trees are important because they increase property values*

The results displayed in Table 6 show that the gender, age, and income of the individuals have no effect on their perception about the test statement "Trees are important because they increase property values," as the *p* value for the chi-square test for each of these three variables is greater than the significance level of 0.05, showing an insignificant value. However, the marital status, education, and occupation of the individuals do have an effect on the respondent's perception about this statement. The *p* values of these three variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these three variables at a 0.05 significance level. Another way to put this may be that the respondents' perception

about the statement “Trees are important because they increase property values” is dependent on the individual’s marital status, education, and occupation.

9. *Willing to pay some tax/“Tree Tax” to the city’s administration to be spent to protect the vegetation/trees of Lahore*

The results portrayed in Table 6 revealed that the gender of the individuals has no effect on their perception about the test statement “Willing to pay some tax/‘Tree Tax’ to the city’s administration to be spent to protect the vegetation/trees of Lahore,” as the  $p$  value for the chi-square test is greater than the significance level of 0.05, showing an insignificant value. However, the age, marital status, education, income, and occupation of the individuals do have an effect on the respondent’s perception about this statement. The  $p$  values of these five variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these five variables at a 0.05 significance level. Another way to put this may be that the respondents’ perception about the statement “Willing to pay some tax/‘Tree Tax’ to the city’s administration to be spent to protect the vegetation/trees of Lahore” is dependent on the individual’s age, marital status, education, income, and occupation.

10. *Will halt the Government agency if it intends to remove the trees without any genuine reason/need from our vicinity*

All the socioeconomic variables of gender, age, marital status, education, income, and occupation of the individuals have an effect on the respondent’s perception about the test statement “Will halt the Government agency if it intends to remove the trees without any genuine reason/need from our vicinity,” as the  $p$  values of all these six variables are less than 0.05, hence pointing towards a significant relationship between the test variable and each of these six socioeconomic variables at a 0.05 significance level. Therefore, the respondents’ perception about the statement “Will halt the Government agency if it intends to remove the trees without any genuine reason/need from our vicinity” is dependent on the individual’s gender, age, marital status, education, income, and occupation.

The results show a highly significant positive relationship between age and attitude/perception towards vegetation such as trees have rights as human beings which means that as age increases the attitude improves. It also reflects that as age increases, the sense that trees increase property value also improved. The table demonstrated that as age increases, the personal concerns towards vegetation decrease. A positive highly significant

relationship was found between education and value of vegetation. It means that as education increases, the value of vegetation, such as trees decrease noise, provide shade, and protect from adverse environmental effects, increases. A highly significant inverse relationship was found among income, attitude towards vegetation, and knowledge of vegetation loss. It means that as income increases, the attitude towards vegetation and knowledge of vegetation decrease. The table also reflects that as income increases, the value of vegetation (it attracts more business and it improves quality of life) also increases. The table also shows a positive highly significant relationship between attitudes towards vegetation and value of vegetation. It means that as positive perception towards vegetation improves, the value of vegetation also enhances. A highly significant positive relationship is found between the role of vegetation and value of vegetation (it provides shade and cool, reduces noise, and improves quality of life). A negative correlation is found between the role of vegetation and the belief that it protects from adverse environmental effects.

### Conclusions

The study underlined a simple methodology to study and analyze people’s perceptions regarding the loss of vegetation due to urbanization in the second largest city according to the population in Pakistan. Urbanization has not only resulted in loss of vegetation but also caused environmental problems in Lahore, including numerous ecological effects. The perceived socio-environmental findings revealed that the urbanization and population growth are the fundamental reasons for vegetation loss in the city. A number of socio-environmental consequences of the vegetation loss, particularly at the UCs’ level in Lahore and on the overall environ of the city, have been quite evident in view of the perception of the city residents. The continuous vegetation loss was also attributed to the degradation of environment of the city which ultimately has reflected in people’s perception. Therefore, it could be a model city to carry research of present nature.

Urban trees and vegetation of a city are one of the most important aspects in a resident’s life. The plantation of trees in an urban area is primarily related to its aesthetic and ecological values. However, because of urbanization, the loss of trees/vegetation is the major concern for city dwellers of Lahore as well as in many other parts of the world. The residents of Lahore are also concerned about this issue and regard it as to be taken up by the government on war footing. The issue received attention by the vast majority of the respondents, and they showed their concerns in this regard.

### Abbreviations

LULC: land use and land cover; SAARC: South Asian Association for Regional Cooperation; UC: union council.

**Competing interests**

The authors declare that they have no competing interests.

**Authors' contributions**

Both the authors have contributed equally, read the manuscript, and have approved the final version for submission to *Ecological Processes*. Furthermore, both the authors accept the responsibility for its content.

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