



Evaluating the ecological status and distribution of grasses in the city and suburbs of Lahore in the wake of urbanization

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Abstract

The present work was carried out to find the distribution and ecological status of grasses in Lahore as an aid to determine the impact of urbanization. Six sites (Urban Riverian, Suburban, Rural Wasteland, Natural Suburban, Agricultural Area, and Urban) were selected for analysis. The data was collected during spring, winter, summer, and rainy season for two consecutive years. For the ecological study, percentage frequency, density, and cover were used to drive the importance of the value index, and finally, the Shannon diversity index was used to evaluate the diversity of each site. Results indicated that grasses were abundant in the natural suburban site, having the highest richness index, and the urban site has least richness index. On comparing the results with past literature, it appears that the decline in the diversity of grass was due to urbanization, industrialization, pollution, and the invasion by exotics.

Keywords: Ecology Studies, Grasses, Species Richness, Taxonomy, Urbanization

Abbreviations: NA

1. Introduction

The rich growth of the herbage grasses in the Punjab plains gives the impression that it is ideally suited for grasses. This is because the climate is most favorable for the production of this luscious green growth during a large part of the year. Ecologically, the association of grasses in the Punjab plains is almost entirely successional in nature as natural selection gradually reverts to scrub and from scrub to thorn forest (Chaudary, 1952; Rutter and Sheikh, 1962; Khan, 1994). Generally, the grasses are tolerant of adverse conditions; some are less tolerant, and some have lost

favorable habitat to crops, whereas other have been reduced in number. The majority have been inherited in natural and semi-natural communities (Husain et al., 2009; Hubbard, 1967).

The information on grasses in Pakistan is well documented. In Pakistan, 150 genera and 492 species are found with about 26 grass tribes (Cope, 1982; Hameed et al., 2008). In Lahore district, Ahmad (1954) reported 59 grass genera having 114 species distributed among 16 different tribes. He mentioned the distribution of grasses and their habitats in Lahore, along with their complete taxonomic descriptions. The objective of the present work was to estimate the diversity and



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richness of grasses in response to the fast pace of urbanization in Lahore. It is designed in such a manner that an estimation of present ecological values can be made by comparing it with the record. It will help in evaluating the impact of urbanization on the grasses of the study area. Since the ecological analysis is based on urban and suburban habitats, the results can help in appreciating the impact in the two situations.

2. Materials and Methods

The current study is based on the survey of grasses in the Lahore district of Punjab, Pakistan. The study was carried out on a subjective basis during the years 2006-2008 at regular intervals throughout the year. The grass was collected in both flowering and fruiting stages.

2.1 Selection of Site

The area under investigation is located in the Lahore District of the Punjab Province. It lies between $31^{\circ} 13'$ to $31^{\circ} 43'$ N latitudes and $74^{\circ} 00'$ to $74^{\circ} 39'$ E longitude, with the elevation ranging from 211 to 213 meters. It covers about 1772 square kilometers. The climate of Lahore is classified as Sub-humid Subtropical Continental. The maximum mean daily temperature during summer is 39.7°C in the month of July, while it is 19.5°C in January, the coldest month. The mean annual rainfall is 693 mm (PMD, 2020).

The two surveys were conducted initially to select sites in the following areas: urban, suburban, natural, urban Riverian, suburban Riverian, rural wasteland, and agricultural lands. Since sites selected were to be monitored throughout the seasons, those sites were selected having sufficient area so that replicates representing the area are available in case of disturbances in the selected sites. The study area was divided into six different sites according to habitat type (Figure 1; Table 1).

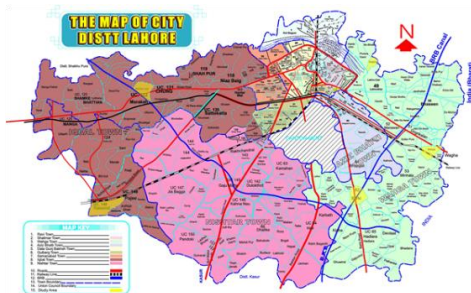


Figure 1. Map showing the study area (Modified from City District Government Lahore)

2.2 Seasonal Monitoring

The complete inventory of grasses of the study area was prepared as the first step for the quantitative characteristics of grasses. The quadrat method was used ($1\text{m} \times 1\text{m}$), grass species occurring in each quadrat were listed along with associates, and their numbers were counted. The grasses were collected throughout the study period at an interval of about 15 days. The collected plants were to be preserved and identified with the help of available literature (Ahmed, 1954; Chaudhry, 1969; Cope, 1982; Akhter, 2003; Soreng et al., 2017), and the voucher specimens were submitted to the Dr. Sultan Ahamad herbarium, Botany Department, GC University, Lahore. For nomenclature, the flora of Pakistan (grasses) was followed (Cope, 1982). The study was conducted in September.

2.3 Data analysis

The following methods were used to record the data to find the diversity of grasses. Percentage frequency, density, cover, importance value, importance value index (Risser and Rice, 1971), and Shannon diversity index (Magurran, 1988) were calculated.

3. Results

3.1 General Description

The results based on year-round data revealed that the family Poaceae had 55 species belonging to 39 genera. In Urban Riverian (S1) 39 grass species were found, along with 10 associated species (herbs) belonging to 6 families. In Suburban Riverian (S2) 35 grasses were found having 10 associated species belonging to 7 families. Rural Waste lands (S3) had 41 grasses with 11 associated species belonging to 7 families. In the Suburban Natural area (S4), 51 grass species, along with grasses, and 17 associated species belonging to 13 families were recorded. The agricultural area (S5) had 43 grass species, which were associated with 14 species belonging to 10 families. Urban site (S6): 18 grasses were recorded along with 10 associated species belonging to 8 families (Table 2).

3.2 Ecological indices

Importance value index (IVI) and Shannon diversity index were used to evaluate the diversity of grasses

Table 1. Habitat-wise division of the Lahore district into six different sub-sites

S.No	Name of the Site	Habitat Type	Site Symbol
01	Saghian around Ravi Bridge, Kamran Bara Dari, and adjacent areas	Urban Riverian	S1
02	Mohlan waal and riverbed	Suburban Riverian	S2
03	Raiwind	Rural Waste Lands	S3
04	Burki, Defense and around Allama Iqbal International Airport	Suburban Natural Area	S4
05	Wahga Boarder, Jallo Park and surroundings	Agricultural, area	S5
06	Sewage Channel (between Jail Road and Mall Road) is loaded with waste pollution and organic matter	Urban	S6

and sedges in six different sites of Lahore according to their habitat-wise distribution.

3.2.1 Importance value index (IVI)

In six different sites of Lahore district, the family Poaceae was distributed among three subfamilies, i.e., Pooideae, Panicoideae and Chloridoideae. The total number of grass species was 55, among which 22 grass species were distributed in subfamily Pooideae, 32 in Panicoideae, and 1 in Chloridoideae.

• IVI of Sub Family Pooideae

Sub Family Pooideae showed maximum IVI in site S5 (Agricultural area), which was 16.87, while site S3 (Rural wastelands), having IVI 13.84, was in second place. The remaining four sites, S4 (Suburban Natural area), S2 (Suburban Riverian), S1 (Urban Riverian), and S6 (Urban) were on the 3rd, 4th, 5th, and 6th numbers, having IVI values 11.23, 8.95, 7.75, and 6.80, respectively (Figure 2).



Figure 2. IVI of grasses (subfamily-wise) in different sites of Lahore district.

• IVI of Sub Family Panicoideae

The second subfamily Panicoideae showed a maximum IVI value of 28.79 in S3 (Rural wastelands), while S2 (Suburban Riverian) had an IVI value of 24.76. The sites S1 (Urban Riverian), S4 (Suburban Natural area), S5 (Agricultural area), and S6 (Urban) had IVI values of 23.25, 22.21, 19.78, and 4.63, respectively. (Figure 2)

• IVI of Sub Family Chloridoideae

The third subfamily Chloridoideae is found only in the S3 (Rural waste lands) site, with only one member, *Aeluropus lagopoides*, which showed an IVI value of 11.33. It is present only on this site and not in other sites, because it forms dense patches on sandy saline soil, as some areas of this site are saline, therefore it flourishes here (Figure 2).

Regarding IVI, the grasses were dominant in the site S3 (Rural wastelands), having an IVI 53.96; site S5 (Agricultural area), having an IVI value of 36.65, was in second place. Site S2 (Suburban Riverian), site S4 (Suburban Natural area), site S1 (Urban Riverian), and site S6 (Urban) had IVI values of 33.71, 33.44, 31.00, and 11.43, respectively (Figure 3).

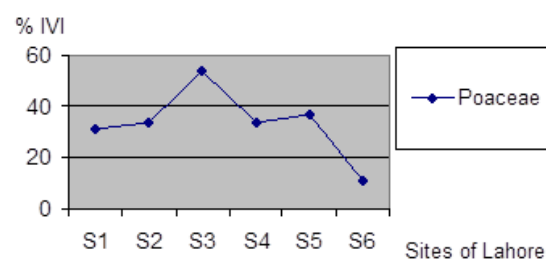


Figure 3. IVI of grasses in different sites of Lahore district

3.2.2 Shannon diversity index

- Diversity of Subfamily Pooideae

Subfamily Pooideae contained 19 grass species in the site S4 (Suburban Natural area), having a maximum diversity value of 0.1478, while the site S1 (Urban Riverian) had 17 grass species with a diversity value of 0.0985. The remaining four sites, S2 (Suburban Riverian), S3 (Rural wastelands), S5 (Agricultural area), and S6 (Urban) possessed 13, 16, 15, and 5 grass species having diversity value of 0.0692, 0.0185, 0.0783, and 0.0198, respectively. The highest number of grass species is in the site S4, which means richness is maximum, which shows that the diversity of grass species was high compared to the other sites. (Figure 4).

- Diversity of Subfamily Panicoideae

The second subfamily, Panicoideae contained 25 grass species in the S3 (Rural wastelands) site, having a maximum diversity value of 0.1052, while S5 (Agricultural area) contained 28 grasses, having a diversity value of 0.0928. The remaining four sites, S1 (Urban Riverian), S2 (Suburban Riverian), S4 (Suburban Natural area) and S6 (Urban) contain 22, 22, 32, and 13 grass species, having diversity 0.0783, 0.0440, 0.0641, and 0.0210, respectively. Although the number of grass species is greater in the S4 (Suburban Natural Area) site, it possesses less diversity. It shows that the species diversity was found in the S4 site, but grass species were less dense in distribution as compared to the other sites. On the other hand, the site S3 (Rural wastelands) contains only 26 grass species, but it has maximum diversity because the grass species were densely distributed in the respective site (Figure 4).

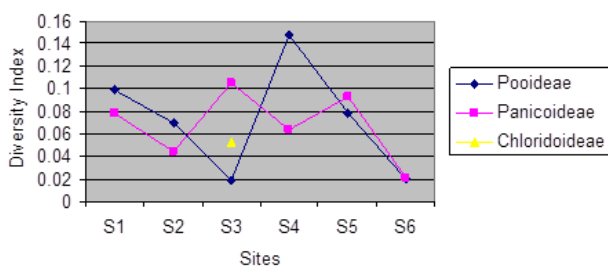


Figure 4. Diversity of grasses in different sites of Lahore district.

- Diversity of Subfamily Chloridoideae

The third subfamily Chloridoideae was found only in the S3 (Rural wastelands) site, having a diversity value of 0.0531 (Figure 4).

It contains 51 grass species, with a diversity of 0.2119. The site S2 (Suburban Riverian) contained 35, and S3 (Rural wastelands) contained 41 grass species; both sites had an equal share of diversity, i.e., 0.1768 each. While the site S1 (Urban Riverian) had 39 grass species, having a diversity of 0.1718, and S5 (Agricultural area) contained 43 grass species, having a diversity of 0.1711, respectively. The minimum diversity index was found in site S6 (Urban), which is 0.0408. The above-mentioned data showed that the richness of the grass species was maximum in site S4 (Suburban Natural area) with the maximum diversity index, which indicates the richness of grass species (Figure 5). It is because the distribution of the grasses is not being much affected by urbanization, as this site is categorized as natural suburban. It comprises mostly agricultural land and natural suburban. The species richness in this area is due to proximity to the irrigation canal, which passes through this site; in addition, the area is used for agricultural purposes, and the escape of nutrients from surrounding habitation. In sites S2 (Suburban Riverian) and S3 (Rural wastelands), a minor difference was found with respect to the number of grasses having the same diversity index. Site S1 (Urban Riverian) covers an urban-riverian area along the riverbed; it is the active flood plane area, due to which grass species are not as stabilized as compared to other sites. While the site S3 (Rural waste lands) comprises rural waste lands areas and agricultural patches, in which mostly the distribution of the grasses was found in the small patches or confined to certain areas forming small communities of grasses. The site S5 (Agricultural) which constituted the agricultural areas, is somehow protected from factors like grazing and urbanization (Figure 4).

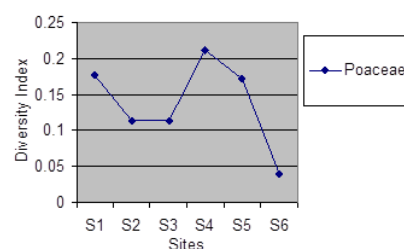


Figure 5. Diversity of grasses in different sites of Lahore district.

Discussion

The results revealed that the suburban natural area site (S4) is the most diverse, followed by urban riverian (S1), agricultural area (S5), suburban riverian (S2), rural wasteland (S3), and urban (S6) is the least diverse site. It appears that the high diversity of grass in S4 is due to favorable conditions, as it is a semi-natural site. The poor diversity of grasses at site S6 is due to its presence in the urban area, where the presence of structures discourages the dispersal of seed, and secondly, not much habitat is available for the establishment of grasses, because most of the green areas are intensively managed, and road verges are polluted.

Ahmad (1954) reported 114 grass species in the Lahore district. *Aeluropus lagopoides* was absent in the study of Ahmad (1954). *A. lagopoides* (Linn.) Trin. Ex Thw. is a salt-secreting rhizomatous perennial grass distributed from North Africa (Morocco to Somalia), Sicily and Cyprus, through the Middle East to Central Asia, Pakistan and India (Cope, 1982). The population of Lahore was 849,000 in 1954 and increased to 51,43,000 in 2008, resulting 505% increase in population. The urbanized area increased 146.58 % from 163.84 km² to 404 km², which decreases the habitat for the grasses (Mazhar & Jamal, 2009).

The decrease in diversity of grasses is mainly due to habitat destruction, pollution, and the introduction of exotic plant species into the habitat. There are also many other significant reasons for the depletion of biodiversity. Prominent among them are expansion of agriculture, industries, urbanization, road construction, and large-scale developmental projects (Sattar et al., 2025). The factors responsible for the decrease in grass diversity in Lahore district may be natural or artificial (Khalid Et al., 2025). The major factors are:

- (a) Decrease in the amount of water in the Ravi River after the construction of a dam by India, and an increase in the amount of sewage sludge from the city of Lahore, and encroachment on the flood plains of the river. (Momen, 2006).
- (b) The development of the infrastructure road network led to the fragmentation of the area.
- (c) Invasion of *Parthenium hysterophorus* (Ejaz, 2002) led to both quantitative and qualitative loss of biodiversity of grasses in the Lahore district.

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Author(s) contribution Conceptualization, RM; methodology, AK; software, MUH; validation, RM; formal analysis and investigation, RM; data curation, AK; writing—original draft preparation, AK; writing—review and editing, ZS, MI; supervision, RM. All authors have reviewed and approved the manuscript.

Conflict of interest The authors declare no conflict of interest.

Data availability All data supporting the findings of this study are available within the paper. We do not have any research data outside the submitted manuscript file.

Declarations

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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