Original Research

Urban Sprawl and its Impact on Soil and Plant Species in Peshawar, Pakistan

**Kashif Ali[1, 2], Muhammad Shuaib[3]*, Tamoor Malik[4], Syed Sadaqat Shah[1],
Sajjad Ali[5], Naseer Ali Shah[6]**, Fida Hussain[7], Ikramullah Khan[8],
Naveed Akhtar[2], Zhijian Li[1]*****

[1]School of Life Sciences, Northeast Normal University, Changchun 130024, China.
[2]Department of Botany, Islamia college Peshawar, Pakistan
[3]School of Ecology and Environmental Science, Yunnan University, Kunming, Yunnan, P.R. China
[4]Department of Statistics, Yunnan University, Kunming, China
[5]Department of Botany, Bacha Khan University Charsadda, Pakistan
[6]Department of Biosciences, COMSATS University Islamabad, Pakistan
[7]Department of Botany, Qurtuba University of Science and Information Technology, Peshawar, Pakistan
[8]Department of Botany, Abdul Wali Khan University Mardan, Pakistan

Abstract

The current paper aims to highlight: 1) Major problems due to urbanization, including land cutting, erosion, overgrazing, biodiversity loss, and climate change. 2) The impact of grazing on plant community structure and ecosystem functioning. 3) Management and conservation of natural ecosystems in Sheikh Muhammdi Peshawar.

For the current work, three different sites (Zones 1, 11, 111) were selected in the local area. The populations of the local area have increased very rapidly in the last 40 to 50 years. Anthropogenic activities associated with population and industrialization in the district, with vegetation clear for developing of towns and roads, has resulted in the substitution of vegetations with the dark color surface, the temperature of the environments much higher than before, leading to the phenomenon of the urban heat island effect. This urbanization and construction work at Amman plots Sheikh Muhammadi Peshawar is causing the extinction of vegetation and there would be no more wild vegetation in the near future in that particular area.

Keywords: urbanization, grazing, soil erosion, vegetation cover, Sheikh Muhammadi, Pakistan

*e-mail: zeyadz44@yahoo.com
**e-mail: drnaseeralishah@gmail.com
*** e-mail: khankhanafridi10@yahoo.com

Introduction

Large areas of vegetation will have to be destroyed in order to develop more towns. Naturally, vegetated surfaces will be replaced by buildings and paved streets. Peshawar has increased from 0.5 million to 4.2 million. But most importantly, the additions of vegetation are usually lagging behind urban development. Human-induced disruption also has a reflective impact on vegetation and soil. The major anthropogenic activity is urbanization, which completely reduces the cover of vegetation [1]. Environmental and vegetation protection is a huge issue globally [2]. Related to other variables like industrial construction, it is one of the main sources of pollution – including air and water pollution [3]. Construction of buildings has a direct and indirect effect on humans and vegetation [4]. One of the big problems of the environment is the rapidly increasing human population. The formation of agricultural land is the most important way because in the future arable land is not increasing, and in fact is probably decreasing, due to erosion and land deterioration. The huge population creates extra pressure on the environment. The success of plants is due to the interaction between soil and other major abiotic factors like soil, water, and light, which change in the water contents. The major consequence of this change is the amelioration of soil [5], which results in the alteration of the hydrologic characteristics of the site [6]. Below the vegetation cover, the addition of organic matter and the moderation of soil microclimate provide a significant zone for microbial activity and the creation of water-stable soil aggregates [7]. The branch of science in which we study a plant relationship with its environment – including soil texture, structure, and their composition – also is developing [8].

The objectives of our paper are to highlight the major problems due to urbanization, including land cutting, erosion, overgrazing, biodiversity loss, and climate changes, the impact of grazing on plant community structure and ecosystem functioning, and managing and conserving natural ecosystems in Sheikh Muhammdi Peshawar. The outcome of this survey can help the government prepare proper sustainability plans and also increase knowledge through training and awareness programs. Further research needs to investigate the on-site sustainable performance measurements using identified environmental impacts in advance. A large area of vegetation is being replaced with buildings, roads, and another hard surface, and this survey determines the impact of construction on vegetation and on the soil of the area.

Materials and Methods

Four study sites were selected in the Sheikh Mohammadi area of the Peshawar District for phytosociological investigations. The sites were selected on the basis of physiognomy, to get an accurate image of the vegetation of the whole area. Expeditions were conducted to five sites in spring 2016 following standard locality procedures [9]. Sampling was carried out systematically using the quadrat method and a quadrat size of 4 x 4 m throughout the study. Sampling was started at the initial margins of each zone and quadrats were laid onward after every 100 m. Species data, including cover, frequency, and density was recorded from the sites following [10, 11]. The collected specimens were pressed, dried, and mounted on standard herbarium sheets. The specimens were then identified with the help of Flora of Pakistan [12]. The Voucher specimens were deposited into the herbarium at the Department of Botany, Islamia College University Peshawar, and Khyber Pakhtunkhwa, Pakistan. Composite soil samples were taken from all Quadrats of each study site and physicochemical analyses were conducted at the Agricultural Research Institute in Tarnab, Peshawar. These soil parameters analyzed organic matter, pH, saturation, texture, phosphorus (ppm), and potassium (ppm). The above-mentioned parameters were calculated with the following formulae:

Density

$$\text{Density/m}^2 = \frac{\text{Total number of plants species present in all quadrates}}{\text{Area sampled}}$$

Relative density (%)

Relative density will be computed by the following formulae:

$$\text{Relative density} = \frac{\text{Density of individual species}}{\text{Total density of all species}} \text{ X } 100$$

Frequency (%)

$$\text{Frequency} = \frac{\text{Number of quadrates in which the species present}}{\text{Total number of quadrates}} \text{ X } 100$$

Relative Frequency (%)

$$\text{Relative frequency} = \frac{\text{Frequency value of a single species}}{\text{Total frequency}} \text{ X } 100$$

Importance Value

$$\text{Importance value} = \text{Relative density} + \text{Relative frequency} + \text{Relative cover}$$

Canopy Cover

Cover is the vertical projection of foliage shoots/crown of a species to the ground surface expressed as a fraction or percentage of surface area.

$$\text{Cover} = \frac{\%\ \text{Cover of a species}}{\text{Total cover of all species}}$$

$$\text{Relative Cover} = \frac{\text{Cover of a species} \times 100}{\text{Cover of all species}}$$

Soil Analysis

Soil samples were collected from 3 sites (1 kg dry soil) of Sheikh Muhammadi District in Peshawar and sent to the Agriculture Research Institute (ARI) in Tarnab, Peshawar, for physico-chemical analysis. Soil samples were taken from all quadrats of each study site and physico-chemical analyses were conducted at ARI. The soil parameters investigated included soil organic matter, pH, saturation, texture, phosphorus (ppm), and potassium (ppm), and calculated using the following formulae:

Statistical Methods

For data analysis we used Amos Graphic and SPSS 21 to analyze the data.

Results and Discussion

The current results are a focus to finding the urbanization issue and vegetation cover in the Amman plots of Sheikh Muhammadi in Peshawar, Pakistan. The area is divided into 3 zones: Khyber Fields (Zone 1), grid stations (Zone 11), and Amman Plots (Zone 111). Urbanization exerts a substantial effect on biodiversity, resulting in the loss of native species and the introduction of non-native species. The present research emphasizes the impact of urbanization, which refers to the shifting of population from the nearby area to Sheikhmuhammadi. The accumulated amount of adverse effect on the vegetation occurs and also produce waste, noise, and dust, and is hazardous for the same impact on construction [13, 14]. Soil erosion is a major naturally occurring process on all land and many agents of soil erosion are responsible for water and wind. In grid satiation the soil erosion was done by water, and this erosion causes a significant amount of soil loss each year in grid satiation.

Soil Analysis

Soil is one of the important abiotic components of the environment because it is the ultimate source of minerals nutrients. Best soil management ensures that

Table 1. Phsico-chemical analysis of soils (fertility evaluation).

Sample	Textural Class	Percent		Major Elements (PPm)			pH	EC×10⁻³	TSS %	Clay %	Silt %	Sand %
		CaCO$_3$	Organic matter	N (%)	P (%)	K (%)						
1	2	3	4	5	6	7	8	9	10	11	12	13
Khyber Field (Zone 1)	Silty clay loam	11.21	0.84	0.02	6.2	110	8.3	0.71	0.067	28	64	19
Grid station (Zone 11)	Loamy Sand	13.08	0.14	0.09	4.9	132	8.1	0.76	0.060	22	17	54
Amman plots (Zone 111)	Silty clay loam	11.09	0.70	0.04	11.0	119	8.1	0.89	0.067	28	53	11

the mineral element does not become deficient and toxic for plants. The physicochemical analysis of soil showed two different kinds of texture of soil, including silty clay loam and loamy sand (Table 1).

Physicochemical Analysis of Khyber Field Soil (Zone 1)

The texture of this zone is silty clay loam, the amount of nitrogen is 0.02 (%), potassium is 6.2 %, Potassium 110%, and pH of the soil is 8.3. On the basis of size, particle silt and clay particles are respectively prominent by 64% and 28%. Khyber field area soil shows the best texture for the agriculture field [15].

Physicochemical Analysis of Grid Station Soil (Zone 2)

The texture of this zone is loamy sand, the amount of nitrogen is 0.04 (%), potassium is 11.0%, potassium 119%, and pH of the soil is 8.1. On the basis of size, particle sand and clay particles are respectively prominent at 54% and 22%. In recent year agriculture was also done by the local people, but due to the formation of grid station, the soil becomes eroded due to lack of vegetation and agricultural practice [16].

Physicochemical Analysis of Amman Plot Soil (Zone 3)

The texture of this zone is Silty clay loam, the amount of nitrogen is 0.09%, potassium is 4.9%, Potassium 132%, and pH is 8.1. On the basis of particle

sizes, silt and clay particles are the most prominent at, respectively, 53% and 28%. The soil texture of this zone is best for the agriculture but due to starting construction work it is no more in agricultural use. The management of soil is also important for the productivity of crops, environmental sustainability, and human health. Because of the projected increase in world population and the consequent necessity for the increase of food production, the management of soils will become increasingly important in coming years. This is the first attempt to analyze the impact of urbanization and grazing of Sheikh Muhammadi in District Peshawar.

ZONE 1. Khyber Field

Phytosociological Study

On the basis of the physicochemical analysis of soils, Khyber Field is one of the fertile sites of the research area. Physicochemical analysis of soils showed that it had silty clay loamy soil, which is the best for agriculture and plant growth. Major elements N, P, and K are present in sufficient amounts (0.02%, 6.2%, 110% – Table 1), and due to fertile soil this site showed a huge amount of the flora which is the most prominent among the other sites of the research. The present survey reported 28 plant species that were reported during phytosociological studies. The *Parthenium hysterophorus* community dominated, showing the important value of 13.665, followed by *Setaria viridis* at 11.796, *Eclipta alba* at the least important value of 1.730, followed by *Calotropis procera* at 1.908 (Fig. 1).
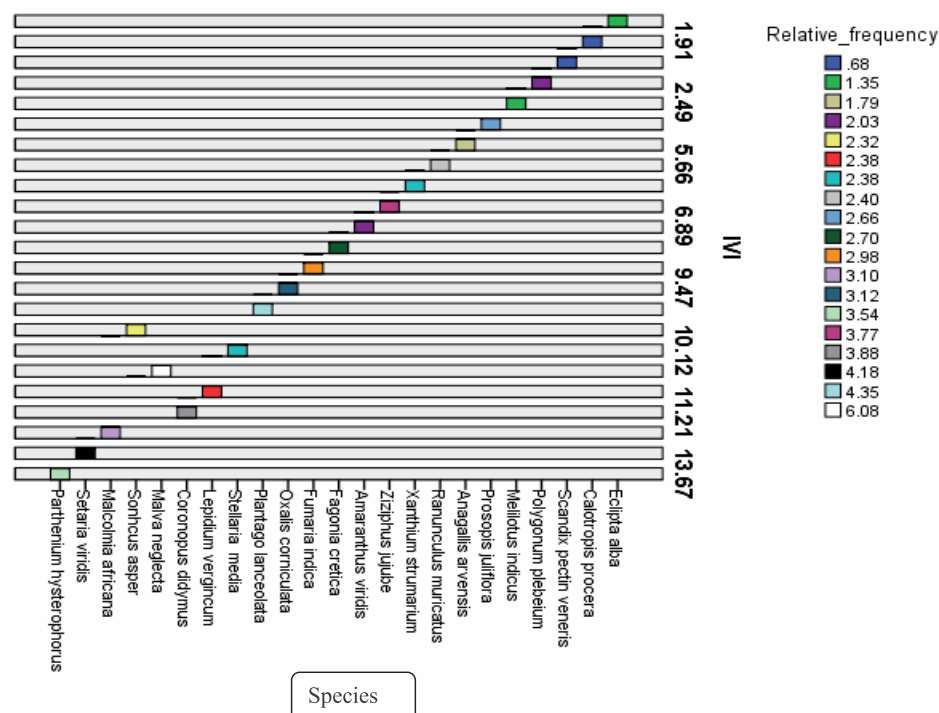

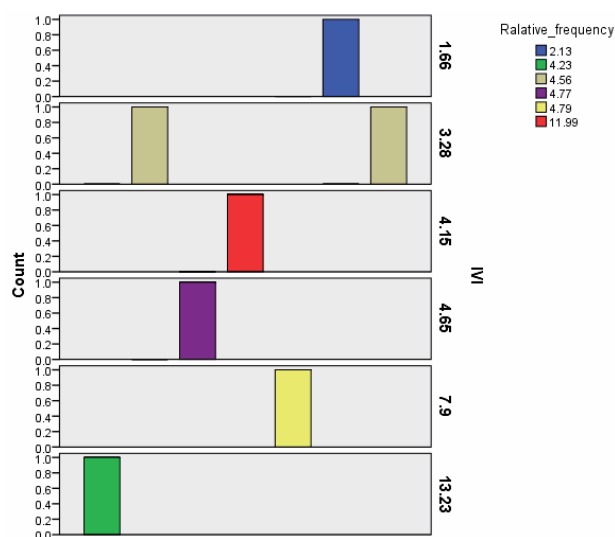Fig. 1. Importance value index and relative frequency of Khyber Field (Zone 1).

Fig. 2. Importance value index and relative frequency of grid station (Zone 2).

Khyber Field and its Impact

Overgrazing and cutting of plant species also showed a great impact on the native flora and soil in the Khyber field area [17]. A total of 23 plant species were reported in Khyber Field. Excessive grazing animals like cow, goat, and buffalo, and the misuse of these herbaceous species, reduced the native flora at a great rate (Fig. 4). In this study, the low values in total vegetation cover and aboveground biomass in under-grazing grassland can

be attributed to grazing sheep and goats that affected vegetation growth directly through consumption and trampling, or due to the nature of plant species that grow under grazing (prostrate species, dwarf species, species with medium-specific leaf area, etc.) [18, 19]. Hence, the present results are consistent with observations from other studies that have attempted to relate changes in vegetation to rainfall and grazing intensity [20, 21].

ZONE 11. Grid Station

This report covers the technical audit of Sheikh Muhammadi (Peshawar) 500 kV Grid Station (GS) located near Indus highway about 13 km from Peshawar, KPK. The GS was commissioned on December 8, 1995. It has 900 MVA transformation capacity connected to the grid out of the installed capacity of 1350 MVA feeding a major portion of KPK. There are three (03) 450 MVA-500/220 kV autotransformer banks, three (03) 160 MVA - 220/132 kV, one (01) 250 MVA-220/132 kV autotransformers, and two (02) 10/13 MVA-132/11 kV power transformers at this GS that are owned and maintained by NTDC. One (01) 500 kV, four (04) 220 kV, and eight (08) 132 kV transmission circuits link this station to others (Figs 4-5). The GS is connected to Tarbela Hydropower Station through 500 kV single circuit four bundled transmission lines and to Ghazi Barotha Hydropower Station, Shahibagh 220 kV, and Daud Khel 220 kV GS. 500 kV and 220 kV switchyards use a 1.5 breaker scheme, whereas a 132 kV switchyard uses a double-bus single-breaker scheme. A single line diagram is attached [22]. It covers
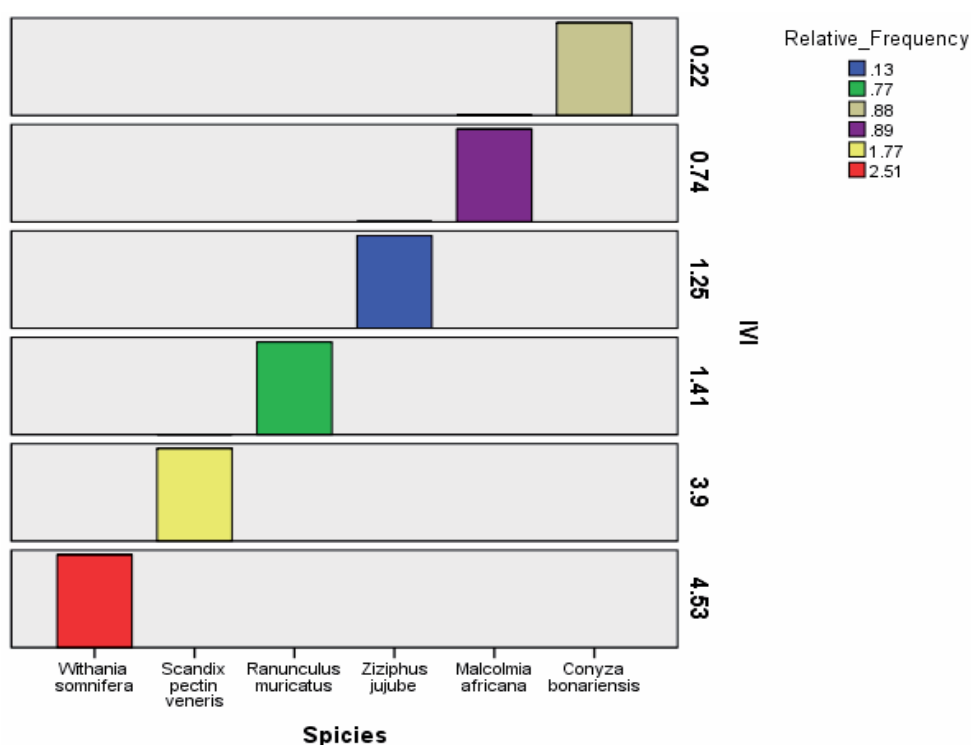

Fig. 3. Importance value index and relative frequency of Amman Plots Sheikh Muhammadi (Zone 3).

a huge area of the Sheikh Mohammadi, which covers a large agriculture area.

Phytosociological Study

Grid stations are the 2nd area of the research site according to the phytosociological study *Amaranthus viridis* dominating the community showing the highest IVI 22.67, *Lepidium vergincum* 18.13, and *Setaria viridis* 18.132 (Fig. 2). The soil fertility analysis showed loamy sandy texture for major elements like N, P, K 0.09, 4.9, and 132 shown in Table 1.

Main Issue of the Grid Station

The soil texture of the grid station showed loamy sand texture, which is best for the agriculture also, but the area is completely filled by a huge electricity pole, for which serious damage to the soil texture as well and also the gate causes soil erosion [23]. Due to excessive rain and lack of vegetation the soil is gradually eroded and will be completely removed in the future [24].

Soil Erosion

In many areas of the grid station the loss of topsoil through removal of the entire vegetation also causes mineral imbalance and erosion. This is one of the main and large threats to agricultural productivity. The topsoil sustains most living organisms, being the ultimate source of their mineral nutrients, the mentioned effects like soil erosion affects the community of plants if the texture and structure of the soil is changed with the mentioned issue, and the mentioned issue was also reported for various parts of the world [25, 26]. The land of grid station is known as completely eroded and loses its capability and top soil layer (Fig. 4). In this zone, soil erosion is one the causes of soil degradation. Soil erosion is one form of soil degradation along with soil compaction, low organic matter, and loss of soil structure. These other forms of soil degradation, serious in themselves, usually contribute to accelerated soil erosion. Soil erosion potential is increased if the soil has no or very little vegetative cover of plants and/or crop residues. Plant and residue cover protects the soil from raindrop impact and splash, tends to slow down the movement of surface runoff, and allows excess surface water to infiltrate.

Zone 111. Amman Plots Sheikh Muhammadi

Phytosociological Studies

The vegetation of the Amman plots Sheikh Muhammadi is very low at just 6 species because of construction and cutting the dominating communities of *Withania somnifera* IVI 4.53, *Scandix pectin veneris* 3.897, and *Ranunculus muricatus* 1.410 **(**Fig. 3). Nearby tree species are removed because of the mentioned activity, and the growth of cities may cause biodiversity to decline in a large area of natural habitat on which many plant species depend.

The Main Issue in Zone 111

Impact of Construction

The constructions are responsible for using a large volume of natural resources and generate a great amount of pollution in present days as well in the future. The same issue was also reported by [27, 28]. Although there are many causes of habitat loss, urbanization has been shown to be one of the most damaging in terms of a number of plant species loss or threats to them (Figs 3, 5). Construction work will cause the extinction of the vegetation [29-32]. The land that is conducive and fertile for agriculture will be no more in the upcoming year. The other major problems like urban heat and increases in temperature will be more prominent in the near future due to heavy traffic and industries, and the same result was also reported by [33, 34]. Huge land of vegetation will have to be finished because of new cities and towns. This agricultural area will be replaced by roads and streets [35].

Fig. 4. a), b), c), and d) represent soil erosion in Zone 11 grid station of Sheikh Mhammadi, Peshawar .

Fig. 5. a), b), and c), represent the construction in Zone 111 Amman Plots and d) represents the wastelands of Sheikh Muhammadi in Peshawar, Pakistan.

Novelty and Conclusion

In Peshawar District the populations are increasing with high ratio and people are shifting from the main city to the allied areas of the district. A lot of issues have arisen with the increase of population. The local area Sheikh Muhammadi has seen so many issues in recent years, including urbanization, grazing, loss of vegetation, and soil erosion. These problems are raised because of the majority of people involved in the destructive cutting of vegetation and extreme grazing. A few species are affected in the local area and have become endangered (*peganum harmella* is extinct, for example). The new town is developed through which the agriculture land is nearly covered by homes and road, and vegetation is fully disturbed. Overthe last 10 years the land has become continually eroded due to vegetation removal, and it is totally disturbed by rain, as shown in Fig. 4.

Conflict of Interest

All the authors declare no conflict of interest.

Acknowledgements

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