NANGARHAR UNIVERSITY INTERNATIONAL JOURNAL OF BIOSCIENCES
e-ISSN: 2957-9988
ORIGINAL ARTICLE
NUIJB Special Issue, 2024

Received: 12 Dec 2023 Accepted After Revision: 24 Jan 2024 Published Online: 10 Feb 2024

Assessing the Trees and Shrubs Richness and Species Diversity in Malekyar and Farhang Parks of Herat City, Afghanistan

Rahmani Wahidullah [1*], Azizi Frahnaz[2], Pouyesh Ahmad Jawid[3], Sakandari Mohmmad Nazim[4], and Alias Mohamad Azani[5]

[1,2,4]Department of Forestry and Natural Resources, Faculty of Agriculture, Herat University, Herat, Afghanistan

[3]Department of Agranomy, Faculty of Agriculture, Herat University, Herat, Afghanistan

[5]Faculty of Forestry, Departement of Forestry Science and Biodiversity, Universiti Putra Malaysia, UPM Serdang 43400, Selangor, Malaysia

*Corresponding author: wahidrahmani72@gmail.com

ABSTRACT

Climate change and the industrialization of cities have led to excessive pollution, turning this matter into a significant issue in large urban areas. Consequently, the significance of green spaces is being scrutinized more than ever. This study aimed to assess the richness and biodiversity of the trees and shrubs of Malekyar and Farhang parks of Herat city as a representative of the green space of the city. For this purpose, the hundred percent data collection method was applied and the type, number, and breast height diameter of all the trees and shrubs in the two parks were recorded. For analysis, the Past and Ecological Methodology software was used, and the species richness and diversity indices were calculated. The results indicated that the species richness according to Margalef and Menhenic in Malekyar Park were 2.77 and 0.65, and in Farhang Park were 2.68 and 0.98 respectively, also for the species diversity the Simpson and Shannon- Weiner indices in Malekyar park were 0.90 and 2.40 and in Farhang park were 0.82 and 2.10 respectively. Finally, several tree and shrub species have been proposed to increase the species diversity and richness of the green area of Herat City.

Keywords: Herat City, Species Diversity, Richness, Park, Green Area

INTRODUCTION

An urban park adorned with diverse plant species offers a broad spectrum of ecosystem advantages, encompassing regulatory, supportive, and provisioning services (Pulighe et al., 2016). Regarding regulatory services, urban parks play a role in climate change mitigation by storing carbon (Zölch *et al.*, 2016). They enhance air quality by functioning as urban lungs that absorb carbon dioxide (CO_2) and release oxygen (Rózová et al., 2020) and contribute to lowering environmental temperatures (Bagheri et al., 2017). Urban parks also enhance water quality and diminish rainwater, aiding in the management of urban flooding. Concerning supporting services, these parks can enhance soil fertility and store soil organic carbon. Additionally, they serve as habitats for wildlife, notably birds and insects (Iskandar & Iskandar, 2016). Despite numerous studies contributing to improved knowledge about urban parks, certain challenges persist. Notably, issues such as insufficient infrastructure and vegetation quality, inadequate maintenance, limited space, and repurposing for urban infrastructure development pose ongoing problems in urban parks (Yan et al., 2016). Urban Park is sometimes dominated by infrastructure facilities rather than vegetation, implying that the area for and diversity of the vegetation are inadequately low. In this study, the diversity of trees and shrubs in Herat's green area (Malekyar and Farhang Parks) has been investigated to determine whether the expected performance can be obtained from the diversity of existing species or not.

MATERIALS AND METHODS

Study area: Herat city, spanning approximately 182.00 Km^2, is located in the western region of Afghanistan, positioned between 34° 20' 31" N latitudes, and 62° 12' 11" E longitudes, at an elevation of 920 meters above sea level (Abdullah, 2008). The area of Malekyar Park (MP) is approximately 131,685m^2, while the area of Farhang Park (FP) is about 11,268m^2.

Data collection: The data for this study were gathered through a comprehensive 100% data collection method, involving the enumeration of the total count and classification of trees and shrubs in MP and FP. Subsequently, using the software packages Past and Ecological Methodology, species richness and diversity were computed for each park based on Menhenic (1964) and Margalef (1958) richness indices, as well as Shannon-Wiener

(1949), Simpson (1949), Pielou's Evenness (Heip, 1974), and Berger-Parker (Magurran, 1988) abundance indices, which are widely utilized in this field.

RESULTS

According to the measurements conducted in urban MP and FP, as presented in Table 1, a total of 20 species were identified and measured in MP, as well as 16 species of trees and shrubs in FP (Table 2). According to the findings presented in Table 1, the plant community of MP exhibits varying frequencies, with Common ash trees at 0.17%, White willow at 0.16%, Pine at 0.12%, and White Mulberry at 0.11% having the highest frequencies. Conversely, Elm and Black popular exhibit the lowest frequency at 0.0% within the observed vegetation. Additionally, Table 2 reveals that in FP, the highest frequencies are attributed to Common ash0.36%, China berry 0.17%, and White Mulberry 0.9%, respectively. In contrast, Bird of Paradise and Arizona Cypress both show the lowest frequency 0.0%. According to the results obtained from MP (Table 1), the average dbh for Pine trees was 109.44cm, Weeping Willow 63.45cm, Walnut 57.5cm, and White Mulberry 56.34cm. Meanwhile, Japanese quince and European cranberry bush exhibit the lowest dbh, measuring 13.3cm and 13.5cm, respectively. Simultaneously, the results from FP (Table 2) indicate that the highest average dbh were recorded for Black popular at 82.50cm, White willow at 67cm, and White Mulberry at 61.20cm respectively. The species with the lowest dbh were Oriental Thuja at 35cm, and Bird of Paradise at 3.5cm, respectively.

Table 1: frequency and breast diameter of identified tree and shrub in the Malekyar Park area in Herat city.

Common Name	Scientific name	Abundance index (%)	Number of species	DBH (cm)
Common lilac	*Syringa vulgaris*	0.01	7	21.43
Japanese quince	*Chaenomeles japonica*	0.01	10	13.3
Common Ash	*Fraxinus excelcior* L	0.17	160	34.65
White Mulberry	*Morus alba L.*	0.11	109	56.34
Silk Tree	*Albizia julibrissin*	0.06	58	48.33
Black Locust	*Robinia pseudoacacia* L**.**	0.09	88	40.9
Northern white cedar	*Thuja occidentalis*	0.08	78	21.62
Oriental Thuja	*Thuja orientalis*	0.05	44	15.95
Italian cypress	*Cupressus sempervirens*	0.01	7	22.86
Pine	*Pinus spp*	0.12	115	109.44
Judas Tree	*Cercis spp*	0.05	44	25.89
White willow	*Salix alba* L.	0.16	150	55.95
Weeping Willow,	*Salix babylonica*	0.02	22	63.45
Tree of Heaven	*Ailanthus altissima* Mill.	0.01	5	17.4
China berry	*Melia azedarach*	0.02	23	33.17
Arizona Cypress	*Cupressus arizonica*	0.02	19	48.58
European cranberry bush	*Viburnum opulus*	0.00	4	13.5
Oriental plane	*Platanus orientalis Linn*	0.01	8	42.75
Elm	*Ulmus Montana*	0.00	4	27.75
Walnut	*Juglans regia*	0.01	6	57.5
	Total		961	

Table 2: frequency and breast diameter of identified tree and shrub in the Farhang park area in Herat city.

Common name	Scientific name	Abundance index (%)	Number of species	DBH (cm)
Common ash	*Fraxinus excelcior* L	0.36	97	54.28
White willow	*Salix alba* L.	0.07	20	67
Weeping Willow	*Salix babylonica*	0.06	15	60.40
Black Mulberry	*Morus nigra L.*	0.01	2	38.67
White Mulberry	*Morus alba L.*	0.09	25	61.20
Weeping Mulberry	*Morus nigra var pendula*	0.01	2	60.50
Black popular	*Populus nigra*	0.01	3	43.33
China berry	*Melia azedarach*	0.17	46	46.07
Northern white cedar	*Thuja occidentalis*	0.06	15	60.73
Catalpa	*Catalpa bignonioides*	0.04	11	43.82
Desert Poplar	*Populus euphratica*	0.04	10	82.50
Black Locust	*Robinia pseudoacacia* L.	0.03	9	39
Italian cypress	*Cupressus sempervirens*	0.03	8	46.25
Oriental Thuja	*Thuja orientalis*	0.01	3	35
Arizona Cypress	*Cupressus arizonica*	0.00	1	55.3
Bird of paradise	*Caesalpinia gilliesii*	0.00	1	3.5
	Total		268	

Diversity indices: Urban parks showcase a diverse array of plant life, fostering biodiversity, providing green spaces, and enhancing the well-being of city dwellers. According to Table 2, the highest species richness based on the Margalef is attributed to MP with a value of 2.77, and according to the Menhinick index, it is related to FP 0.98. The lowest species richness based on the Margalef index is associated with FP with a value of 2.68, and similarly, based on the Menhinick, it is related to MP 0.65. According to Table 3, the highest species diversity, as indicated by both the Simpson and Shannon-Wiener indices, is observed in MP with values of 0.90 and 2.40, respectively. The lowest diversity is found in FP 0.82 and 2.10, respectively. Additionally, based on the evenness index, MP has an evenness value of 0.35, while FP has an evenness value of 0.76.

Table 3: Species diversity and richness in Malekyar and Farhang Parks in Herat city.

Study area	Indices	Numerical value
Malekyar Park	Margalef Index	2.77
	Menhinick Index	0.65
	Shannon-Wiener Index	2.4
	Simpson Index	0.9
	Pielou's Evenness Index	0.35
Farhang Park	Margalef Index.	2.68
	Menhinick Index	0.98
	Shannon-Wiener Index.	2.1
	Simpson Index	0.82
	Pielou's Evenness Index	0.76

DISCUSSION AND CONCLUSION

In this study, the assessment of various biodiversity indices relies solely on the information obtained from woody species. Many other studies (Katebi et al., 2019; Ghomi Avili et al., 2007; Ghanbari et al., 2018) have also relied solely on the characteristics of woody species to examine biodiversity indices. According to the results the dominant species of trees and shrubs in MP and FP are different. *Fraxinus sp* is the dominant species,

account for 0.17% in MP and 0.36% in Farhang Park. Other trees and shrubs, including White willow at 0.16% and Pine at 0.12%, contribute to the vegetation composition in MP. Meanwhile, in FP, dominant species include China berry species 0.17% and White Mulberry 0.9%. On the other hand, as indicated in Table 2, species diversity in both MP and FP is relatively favorable. In other words, the existing species show a suitable distribution in both parks. This is because, under the current research conditions, even if species had a completely uniform distribution, the Simpson index would reach a maximum of 1, and the Shannon-Wiener index would approach 3.5. Currently, these two indices are close to these values with averages of 0.90 and 2.40 in MP and 0.82 and 2.10 in FP. However, in practice, the Shannon-Wiener index may not exceed 4.5 according to theoretical considerations (Bakhshi 2018). Furthermore, the maximum species richness is equal to 11, while the minimum value is 1 (Jafari, 2016). In this study, the numerical values obtained are 2.77 for Margalef 0.65 for Menhinick in MP, 2.67 for Margalef, and 0.98 for Menhinick in FP. These results indicate that the urban parks of MP and FP have good species richness. However, when species richness is considered alongside diversity, it can play a crucial role in interpreting the results. As observed in this context, diversity indices indicate favorable conditions, but when it comes to species richness, a definitive conclusion cannot be made. Influential factors in species richness and diversity include climatic conditions, the area of the region, and the scope of the study. Regarding the cultivated region (urban park) and the natural region, it is noteworthy that urban parks, being human-made areas, should ideally exhibit higher species richness and diversity compared to natural areas. The abundance of trees and shrub species such as Common ash, White Mulberry, Weeping Willow, Pine, Chinaberry, Black Locust, and Italian cypress can be indicative of the better adaptation of these species to the climate and conditions of the studied area. Similarly, the low abundance of species suggests a less attention to the importance of creating species diversity in green spaces. This highlights the need for planning in this regard. Tree species such as box elder (*Acer negund*o), Chinese date (*Ziziphus vulgaris)*, Hawthorn (*Crataegus monogyna*), Umbrella black locust (*Robinia pseudoacacia* var. Umbraculifera), Honey locust (*Gleditsia triacanthos*), Russian olive (*Elaeagnus angustifolia*), Silk tree (*Albizia julibrissin*), Common juniper (*Juniperus communis*), Common lilac (*Syringa vulgaris*), and various shrubs like European cranberry bush (*Viburnum opulus*), Black elder (*Sambucus nigra*), White saxaul (*Haloxylon persicum*), Dog rose (*Rosa canina*), Summer lilac (*Buddleia variabilis*), Spanish broom (*Spartium junceum*), Japanese quince (*Chaenomeles japonica*), Rose of Sharon (*Hibiscus syriacus*), are recommended.

Acknowledgment: We extend our appreciation to Associate Prof Dr. Abdulwasi Amiri for his unwavering encouragement and constructive feedback throughout the research process.

REFERENCES

Abdullah, S. H., Chmyriov, V. M., & Dronov, V. I. (2008). Geology and mineral resources of Afghanistan.

Bagheri, Z., Nadoushan, M. A., & Abari, M. F. (2017). Evaluation of the effect of green space on air pollution dispersion using satellite images and landscape metric: A case study of Isfahan City. Fresenius Environmental Bulletin, 26(12A), 8135-8145.

Bakhshi, Khaniki. (2018). Biodiversity. Payam Noor University Publications. 227 pages.

Erdianto, A., Irwan, S. N. R., & Kastono, D. (2019). Fungsi ekologis vegetasi taman denggung sleman sebagai pengendali iklim mikro dan peredam kebisingan. Vegetalika, 8(3), 139-152.

Ghanbari, S., & Sheidai Karkaj, E. (2018). Diversity of tree and shrub species in woodlands of Guijeh-bel region of Ahar. Iranian Journal of Forest and Poplar Research, 26(1), 118-128.

Ghomi Avili, A., Hosseini, S. M., Mataji, A., & Jalali, S. G. (2007). Studying regeneration and biological diversity of wood species in two managed societies in Kheyroud-Kenar Region. Journal of Environmental Studies, 33(2), 101-106.

Heip, C. (1974). A new index measuring evenness. Journal of the Marine Biological Association of the United Kingdom, 54(3), 555-557.

Hulbert S.H. (1971). The nonconcept of species diversity: a critique and alternative parameters. Ecology, 133, 125-133.

Iskandar, J., & Iskandar, B. S. (2016). Plant architectures: structure of village homegarden and urban green open space. Teknosain, Yogyakarta. [Indonesian].

Jacobs, M. J., Schloeder, C. A., & Tanimoto, P. D. (2015). Dryland agriculture and rangeland restoration priorities in Afghanistan. Journal of Arid Land, 7, 391-402.

Jafari (2016). Investigating the richness and diversity of tree species and shrubs in Aita Blvd... Kashani, Shahrekord. Environmental Research, 7(13), 77-84.
Katebi Far, S., Dyanat, M., & Oveisi, M. (2019). Weed Flora, Spatial Distribution and Diversity Indexes in Afforestation of Around of Karaj. Journal of Applied Research in Plant Protection, 8(1), 33-43.
Lloyd, M., & Ghelardi, R. J. (1964). A table for calculating the 'equitability' component of species diversity. The Journal of Animal Ecology, 217-225.
Magurran, A. E. (1988). Ecological diversity and its measurement.
Margalef, D.R. (1958). Information theory in ecology. General Systems, 3, 36-71.
Menhinick, E. F. (1964). A comparison of some species-individual's diversity indices applied to samples of field insects. Ecology, 45(4), 859-861.
Pielou, E. C. (1966). Species-diversity and pattern-diversity in the study of ecological succession. Journal of Theoretical Biology, 10(2), 370-383.
Pulighe, G., Fava, F., & Lupia, F. (2016). Insights and opportunities from mapping ecosystem services of urban green spaces and potentials in planning. Ecosystem Services, 22, 1-10.
Rózová, Z., Supuka, J., Klein, J., Jasenka, M., Tóth, A., & Štefl, L. (2020). Effect of vegetation structure on urban climate mitigation. Acta Horticulturae et Regiotecturae, 23(2), 60-65.
Shannon, C.E. (1949). The mathematical theory of communication. University of Illinois Press, Urbana.
Simpson, E.H., (1949). Measurement of diversity. Nature. 688 p.
Talal, M. L., & Santelmann, M. V. (2020). Vegetation management for urban park visitors: a mixed methods approach in Portland, Oregon. Ecological Applications, 30(4), e02079.
Yan, Y., Zhang, C., Hu, Y., & Kuang, W. (2015). Urban land-cover change and its impact on the ecosystem carbon storage in a dryland city. Remote Sensing, 8(1), 6.
Zölch, T., Maderspacher, J., Wamsler, C., & Pauleit, S. (2016). Using green infrastructure for urban climate-proofing: An evaluation of heat mitigation measures at the micro-scale. Urban Forestry & Urban Greening, 20, 305-316.