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Grid System Analysis of Urban Flora of Bukhara City (Uzbekistan)

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Abstract

This article presents information on the study of the flora of Uzbekistan based on grid system mapping. The urban flora of the city of Bukhara was researched in it. As a result of research, the territory of Bukhara city was divided into 85 indexes based on 1 × 1 km^2 grid mapping system. The diversity and density of species in the indexes are determined. The influence of anthropogenic factors on the diversity of species in the indexes is determined.

Keywords

Bukhara City, Urban Flora, Index, Grid Map System, Herbarium, Geoinformation

1. Introduction

Advances in information technology have also led to improved research in botanical geography, particularly mapping plant species distributions. The increase in the amount of georeferenced data makes it possible to widely use the geoinformation system (GIS) [1]. In this regard, the first steps taken in Uzbekistan were aimed at mapping the distribution of certain species in the cross-section of natural-geographic regions [2], and in recent year's grid mapping has been taking a central place [3]. This method of biodocumentation of biological diversity, which is widely used in Western European countries, was first used in Central Asia, when studying the flora of mountainous regions of Uzbekistan [3]. In it, a grid mapping system of each species was created. As well, currently, for the first time, studies devoted to the implementation of a large-scale analysis of the composition of the flora of urbanized areas on the basis of grid mapping system are being carried out. As a result of the grid mapping system of the flora, accurate information on the diversity of plants in the designated research areas is collected.

Therefore, it is of theoretical and practical importance to study the composition of the urban flora of Uzbekistan and the laws of its modern formation based on grid mapping system. As a result, the composition of the urban flora is analyzed separately in each index, its current state is determined, and the areas of distribution of species are predicted in the future. According to A.P. Seryogin [4], grid mapping system allows for a high-level study of the flora in a short period. Therefore, the study of urban flora based on this method allows to fully and precisely study its composition. Another advantage of the grid mapping system is that the currently existing plant species of the area are included in the map and filled in based on new information. The information included in the map provides detailed information about the previously existing and later introduced plant species, and the location of the plants on the map is estimated. According to the main criteria of the grid mapping system method, it is required that the areas selected for research have sufficient information on the composition of the flora [4]. According to A.I. Tolmachev [5], grid mapping system can be done only in well-studied floristic regions. It is this criterion that shows that this method of research is still not used in many regions outside of Europe. As a result, the possibility of using methods with high accuracy is delayed [4]. In particular, grid mapping system of natural flora has been popular in Russia since the 2000s [6], in Central Asia, including Uzbekistan, since 2015 [3]. Currently, the urban flora of large cities of Uzbekistan is being studied using the method of grid mapping system. In particular, the urban flora of the city of Bukhara meets the criteria mentioned above, and it is being researched using the grid mapping system method.

2. Literature Review

There is not much information about the plants of Bukhara city and its surroundings. Some plant specimens collected from Bukhara city (*Ceratophyllum demersum* L., *Phalaris minor* Retz., *Clematis orientalis* L., *Ranunculus sceleratus* L., *Lotus krylovii* Schischk., *Melilotus officinalis* (L.) Pall.) can be seen in the National Herbarium of Uzbekistan. In the last years, H.K. Esanov [7], while studying the flora of Southwest Kyzylkum, also gave a lot of information about the plants of Bukhara city. Information about the natural flora of the city of Bukhara is given in his research. Currently, it is noted that the flora of Bukhara city has an increasing number of foreign species and a high level of adventivation. Also, several new species to the flora of Uzbekistan were identified in the urban flora of Bukhara [8]-[13]. The conducted studies provide information on the composition of the flora of the area, but grid mapping system has not been done.

3. Research Methodology

Individual studies were conducted in each index and herbariums were collected in a routed [14] method. Collected herbarium specimens were identified using data from "Conspectus Florae Asiae Mediae" [15] "Analysis of Flora of Bukhara

Oasis" [10] and "Flora of South-West Kyzylkum" [7]. The grid map system of the Bukhara city area was created in ArcGIS version 10.6.1 based on the WGS 1984 (World Geodetic System 1984) projection. Systematic mapping of 1 × 1 km^2 grid was carried out for this area. When conducting field research in the section of indexes and determining the georeferences of the species included in the records, the mobile application "Tracklia" was used.

4. Research Results

Collecting data on indexes, of course, as the fastest result of the work, allows to determine the number of species in each investigated area [4]. As a result of research carried out in the years 2021-2023 in the territory of the city of Bukhara, it was found that there are 255 species of higher plants belonging to 170 genera, 42 families. Data on species diversity within each urban flora index were collected and herbarium specimens (notes in field diaries) of species were collected. On the basis of these collected data, a grid mapping system and analysis of the urban flora of Bukhara was executed. Grid map system and analyzes were conducted on species diversity and assemblage density. In consequence, grid maps system of the urban flora of Bukhara city was created in the geoinformation system (Figure 1 & Figure 2).

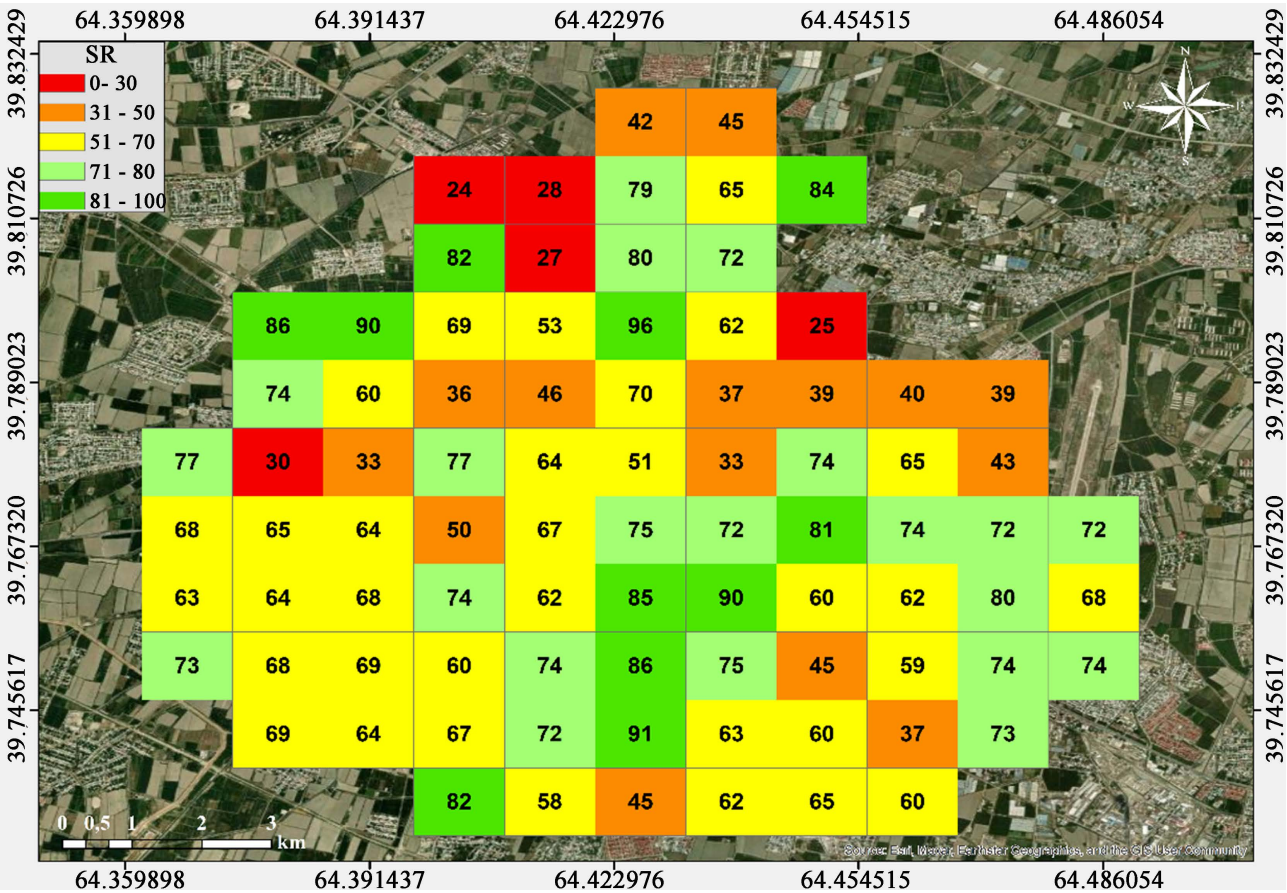

Figure 1. Index of species diversity (SR) in the urban flora of Bukhara city.

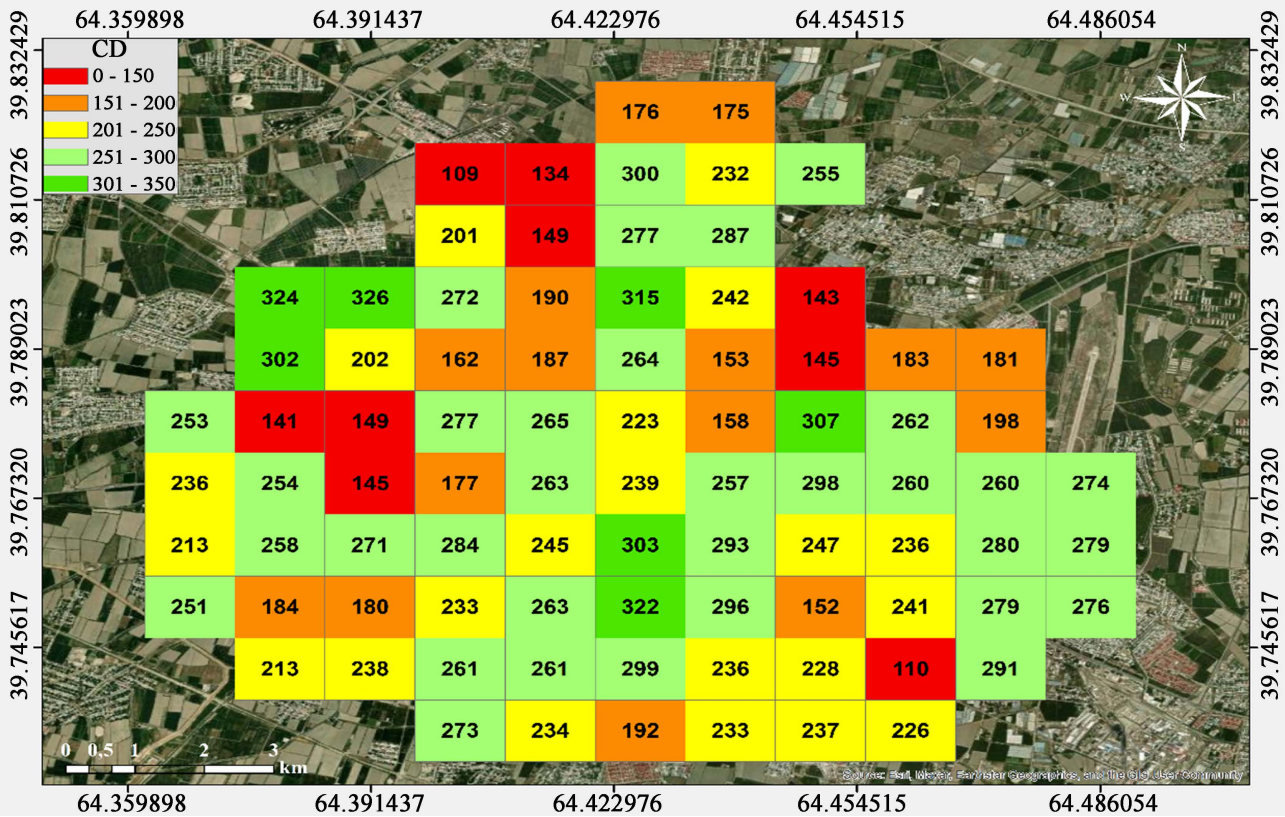

Figure 2. Herbarium collections of the urban flora of Bukhara Density (CD)-based grid map system.

Previously, the classical method, that is, route method, was used to study the structure of urban flora. In it, plants are studied according to the specified direction. But today, the development of information technology has made it possible to study the distribution of plants on the basis of grid mapping system. As a result, flora research is being carried out by this method.

The outcome of the research, the species diversity of all indexes of the grid map system of Bukhara city was determined and data was collected. 81 - 96 species participated in 11 indexes, 72 - 80 species in 21 indexes, 51 - 70 species in 33 indexes, 33 - 50 species in 15 indexes, 24 - 30 species in 5 indexes. In terms of species diversity of urban flora, D6 showed a high index. 96 species were registered in it. This index covers the area of the amusement park established in 2010. It is possible to see the presence of alien plants in this area due to several species introduced from foreign countries. The lowest indicator was observed in B4, B5, C5, D8 indexes. The main structure of the urban flora was made up of 33 indexes consisting of 51 - 70 species, and each of these indexes corresponded to an average of 63 species. They make up 38.82% of the flora of the region. SR indicators of the urban flora of Bukhara on a total of 85 indexes made an average of 63 species. The number of species was low in densely populated areas, such as the old city and areas with multi-story buildings. The main factor was the lack of plant-growing zones in these areas. In densely populated areas of the city, biodiversity can be increased by expanding green areas and planting more

ornamental plants.

The high level of the CD indicator in the index section of the urban flora of Bukhara was 302 - 326, and they were recorded in seven indexes (Figure 2). The maximum figure was 326 samples in the D3 index. The average indicator of the density of collections in the section of indexes was 234. The results of the general analysis of indices SR and CD indicators are presented in the table below (Table 1).

Table 1. Distribution of SR and CD indicators in the cross-section of indexes.

SR (species number)	Number of indexes	CD (collections number)	Number of indexes
0 - 30	5	0 - 150	9
31 - 50	15	151 - 200	15
51 - 70	33	201 - 250	21
71 - 80	21	251 - 300	33
81 - 100	11	300 - 350	7

251 - 300 samples were recorded in 33 indexes with average density in terms of density of collections. They accounted for 38.82% of the urban area and corresponded to the average species diversity. 0 - 150 samples were detected in 9 indexes with the lowest index, and 300 - 350 samples were identified in 7 indexes with the largest index.

In conclusion, grid mapping system of flora is a long-term and at the same time the most reliable research method. During the reporting period, new research on the example of the Bukhara city area should be taken as the first step in this regard and showed that it can be successfully conducted in the urbanized areas of Central Asia, especially Uzbekistan. Based on the needs of the user, the created database provides the opportunity to create thematic maps of various types, to obtain graphic images for analysis. In particular, it will have information such as polymorphic families and genus, rare and endemic species in the flora, adventive (invasive) species, taxonomic units, biomorphological groups, and their distribution across the territory. In addition, this method and the database created based on it provide the opportunity to conduct retrospective analyzes of flora configuration.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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