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PAPER

THE FLORA OF THE ARNASOY STATE NATURE RESERVE AND ITS FUNCTIONAL IMPORTANCE IN SUPPORTING THE STABILITY OF DESERT ECOSYSTEMS

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Abstract

This study analyzed the floristic composition of the Arnasoy State Nature Reserve, with a particular focus on its role in maintaining ecological stability and the distribution characteristics of polymorphic plant families. To quantitatively assess floristic richness, a new mathematical model entitled the "Floristic Stability Coefficient (FSC)" is proposed by the author. Using this model, the relative contribution of each polymorphic family to ecosystem stability was determined based on the species abundance and ecological dispersion.

Key words: Arnasoy Reserve, flora, polymorphic families, ecological stability, floristic richness, ecological dispersion, FSC model, mathematical modeling, desert ecosystem

Introduction

In the current era, global environmental changes, climate warming, water scarcity, and the decline in biodiversity pose serious threats to the stability of natural ecosystems. In particular, the preservation and scientific monitoring of ecological functions in desert and semi-desert ecosystems, such as those found in arid regions, such as Uzbekistan, has become a pressing issue. In this context, the study of natural areas with hydrological and ecological significance, such as the Arnasoy State Nature Reserve, holds great scientific and practical value [7].

The flora of this reserve is ecologically unique, encompassing a variety of landscape types including desert, saline soils, reed beds, marshes, and open water bodies. Landscape diversity has contributed to the formation of plant families with high ecological dispersion. Polymorphic families such as Asteraceae, Poaceae, Amaranthaceae, and Brassicaceae are the dominant components of the local flora [8].

This study focused on ten polymorphic families within the Arnasoy flora and analyzed their distribution across different ecological habitats. To provide a quantitative assessment of floristic richness, the author introduces, for the first time, a mathematical model called the "Floristic Stability Coefficient (FSC)."This model is based on the following formula:

$$\mathrm{FSC}_i = \frac{T_i}{T_{\text{total}}} \cdot \frac{1}{D_i}$$

Where:

FSC_i - is the stability coefficient of the i-th family,

$T - i$ - is the number of species in the i-th family,

T_{total} - is the total number of species in the dataset,

D_i - is the ecological dispersion of the ith family, defined as the number of distinct habitat types in which the species occurs.

This integrative approach served as a methodological foundation for understanding the functional role of floristic structures in maintaining ecological stability. It also has potential applications in ecological monitoring and the development of digital assessment tools [9:6].

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Materials and Methods

***Study area description**

The Arnasoy State Nature Reserve is a unique protected area in Uzbekistan, characterized by a distinct hydro-ecological system. It is located in the Arnasoy district of the Jizzakh Region, and encompasses Lake Arnasoy and adjacent marshland ecosystems (Figure 1). This protected area plays a critical role in the conservation of natural hydrobiocenoses and supports stable development of wetlands and aquatic ecosystems. The total area of the reserve is approximately 35,000 ha, with the majority consisting of water bodies, reed beds, and saline soils [3].

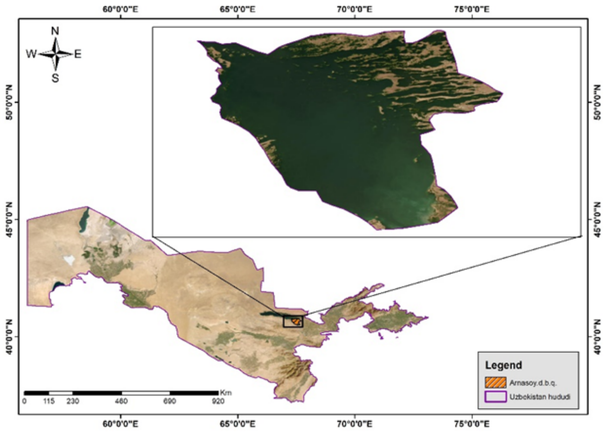

Figure 1. Geographic location and hydro-ecological landscape of the Arnasoy State Nature Reserve.

In recent years, intensive scientific efforts have been made to investigate the flora of the Arnasoy Reserve. Field expeditions, floristic surveys, and herbarium-based studies have provided valuable data on the ecological and geobotanical distribution of plant species, their life forms, and phytocenotic roles [2]. These studies are conducted within the framework of a national scientific project implemented by the Laboratory of Plant Conservation and Ecology at the Institute of Botany, Academy of Sciences of Uzbekistan:

"Development of a multi-scale classification system for the natural ecosystems of Central Uzbekistan and creation of a cadastral and monitoring database for rare plant species."

According to these studies, the flora of the reserve comprises 45 plant families, 122 genera, and 179 native species. These species primarily belong to ecological groups associated with semi-desert and wetland landscapes and are well-adapted to the hydrological conditions of the area. The floristic richness of the Arnasoy Reserve is not only a valuable natural resource, but also a key indicator of ecosystem stability in desert environments.

Among the plant families represented in the reserve, ten polymorphic families had the highest species richness and ecological importance (Figure 2). These families play a dominant role in the composition of local phytocenoses owing to their ecological flexibility and adaptive capacity.

***Floristic stability coefficient model**

To assess the contribution of dominant plant families to ecosystem stability, a new quantitative model, termed the Floristic Stability Coefficient (FSC), was developed. This model evaluates floristic resilience based on species richness and ecological dispersion of polymorphic plant families. The FSC was calculated using the following formula:

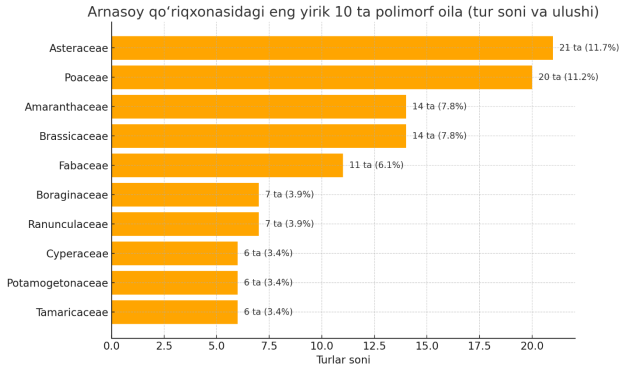

Figure 2. Top 10 polymorphic plant families in the Arnasoy flora based on species richness.

$$FSC_i = \frac{T_i}{T_{\text{total}}} \cdot \frac{1}{D_i}$$

Where:

FSC_i - Floristic Stability Coefficient of the i-th family

$T - i$ - Number of species in the i-th family

T_{total} - Total number of species across all families

D_i - Ecological dispersion of the ith family, expressed as the number of different ecological habitats in which the species are found.

This approach integrates two key ecological indicators, species richness and environmental adaptability, and provides a robust metric for evaluating the structural and functional importance of floristic groups within desert ecosystems.

Results

Using the FSC model, ten polymorphic families within the Arnasoy flora were assessed based on their species count, habitat dispersion, and proportional representation within the total flora. Table 1 presents the key values for each family, including the species number (T_i), ecological dispersion (D_i), calculated FSC, and normalized FSC values (scaled between 0 and 1).

Table 1. Floristic Stability Coefficients (FSC) of Dominant Polymorphic Families in the Arnasoy Reserve

Family	Species Count (T_i)	Habitats (D_i)	FSC	Normalized FSC
Asteraceae	21	4	0.0293	1
Poaceae	20	5	0.0223	0.761
Amaranthaceae	14	3	0.0261	0.890
Brassicaceae	14	3	0.0261	0.890
Fabaceae	11	3	0.0205	0.699
Boraginaceae	7	2	0.0195	0.666
Ranunculaceae	7	3	0.0130	0.044
Cyperaceae	6	3	0.0112	0.382
Potamogetonaceae	6	2	0.0168	0.573
Tamaricaceae	6	3	0.0112	0.382

To enable a comparison of the ecological contributions, the FSC values were normalized using min–max scaling:

$$FSC_{norm} = \frac{FSC_i}{FSC_{max}}$$

This standardization places all values on a scale from 0 to 1, allowing for an easy interpretation of ecological dominance. The Asteraceae family exhibited the highest FSC (0.0293), indicating its critical role in maintaining floristic stability owing to both high species richness and broad habitat adaptability.

Amaranthaceae and Brassicaceae, each with 14 species and ecological dispersion across the three habitats, demonstrated high normalized FSC values (0.890), highlighting their ecological prominence despite more limited habitat specialization compared to Asteraceae [1]. Families such as Fabaceae, Boraginaceae, and Potamogetonaceae showed moderate contributions, while Ranunculaceae, Cyperaceae, and Tamaricaceae had the lowest normalized FSC values, likely due to narrower ecological niches or specialization in specific habitat types (e.g., hydrophytic or halophytic zones).

Discussion

This study highlighted the crucial role of polymorphic plant families in maintaining the ecological stability of the Arnasoy State Nature Reserve. The proposed Floristic Stability Coefficient (FSC) model enables the functional evaluation of plant families by integrating both species richness and ecological dispersion into a single quantitative metric.

The results demonstrated that families such as Asteraceae, Amaranthaceae, and Poaceae had the highest FSC values, reflecting their broad ecological adaptability and significant contribution to ecosystem resilience across diverse habitat types. These families serve as key structural elements within desert and wetland plant communities in the reserve.

The FSC model is a useful tool for floristic monitoring, comparative assessment across regions, and development of data-driven ecosystem evaluation frameworks. It offers a novel methodological basis for identifying ecologically dominant taxa and for enhancing long-term conservation strategies in arid and semiarid landscapes.

Acknowledgments

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