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# GEOTIZIMLAR VA ULARNING KOMPONENTLARI O‘RTASIDAGI O‘ZARO BOG‘LIQLIK (BUXORO VILOYATI MISOLIDA)

***Annotatsiya.*** *Ushbu maqolada geosistemalarning nazariy asoslari, ularning tarkibiy qismlari hamda qismlararo o‘zaro bog‘liqlikning tabiiy jarayonlar barqarorligidagi roli yoritilgan. Buxoro viloyati misolida landshaft - urochishe - fatsiya kabi tabiiy mayda tarkibiy birliklar tuzilishi tahlil qilingan. Mintaqaning iqlim, tuproq, suv va o‘simlik resurslari o‘rtasidagi o‘zaro ta’sirlar hamda “suv - tuproq - o‘simlik” tizimida yuz berayotgan degradatsiya va cho‘llanish jarayonlari ilmiy asosda ko‘rib chiqilgan. Tadqiqot natijalari Buxoro viloyati geosistemalarini barqaror boshqarish uchun tabiiy komponentlar o‘rtasidagi muvozanatni saqlash zarurligini ko‘rsatadi.*

***Kalit so‘zlar:*** *geosistema, landshaft, urochishe, fatsiya, Buxoro, cho‘llanish, ekologik muvozanat.*

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# ГЕОСИСТЕМЫ И ВЗАИМОСВЯЗЬ ИХ КОМПОНЕНТОВ (НА ПРИМЕРЕ БУХАРСКОЙ ОБЛАСТИ)

***Аннотация***. *В данной статье рассмотрены теоретические основы геосистем, их структурные компоненты и роль взаимосвязей между ними в обеспечении экологической устойчивости природных процессов. На примере Бухарской области проанализирована ландшафтная структура геосистемы, включающая уровни ландшафт - урочище - фация. Проанализировано взаимодействие климата, почвы, водных ресурсов и растительного покрова, а также процессы деградации и опустынивания, происходящие в системе «вода - почва - растительность». Результаты исследования подчеркивают необходимость сохранения природного баланса компонентов для устойчивого управления геосистемами региона.*

***Ключевые слова:*** *геосистема, ландшафт, урочище, фация, Бухара, опустынивание, экологическое равновесие.*

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## GEOSYSTEMS AND THE INTERRELATION OF THEIR COMPONENTS (BASED ON THE EXAMPL OF BUKHARA REGION)

***Annotation.*** *This article examines the theoretical foundations of geosystems, their structural components, and the significance of intercomponent relationships in maintaining ecological stability. Using the Bukhara Region as an example, the study analyzes the landscape structure of geosystems, including the levels of landscape - urochishche - facia. The interactions between climate, soil, water resources, and vegetation, as well as degradation and desertification processes within the "water - soil - vegetation" system, are discussed. The research*

*highlights the importance of maintaining balance among natural components for the sustainable management of regional geosystems.*
***Keywords:*** *geosystem, landscape, urochishche, ecological balance, Bukhara facia, desertification.*

**Introduction**. Geosystems are complex territorial natural complexes in which climate, relief, soil, water, vegetation, and wildlife are interrelated and function as a single ecological and functional unit. The stability and sustainability of geosystems depend on the dynamic interaction between these components. Any change in one element may trigger a cascade of effects that alter the structure and functioning of the entire system.

Bukhara Region, located in the central part of Uzbekistan, is characterized by an arid and continental climate, low annual precipitation, and limited water resources. These factors, combined with anthropogenic pressures such as agriculture, urban expansion, and industrial activities, have resulted in significant transformations of local geosystems. Therefore, understanding the interactions between geosystem components is crucial for the development of sustainable land and water management strategies.

The aim of this study is to analyze the structure of geosystems at various hierarchical levels and to examine the interrelationships between componentsusing the Bukhara Region as a case study.

**Theoretical Foundations of Geosystems**

The concept of a “geosystem” was introduced by V.B.Sochava and refers to a natural territorial complex characterized by the exchange of matter and energy between its components. A geosystem is an open system where all components -

climate, relief, soil, water, vegetation, wildlife, and human activity - interact dynamically. Geosystems are hierarchical, consisting of:

- Landscape: The largest structural unit characterized by common climatic and geomorphological features.
- Urochishche (local natural complex): A medium-sized homogeneous natural area within a landscape.
- Facia (smallest homogenous unit): The smallest unit, uniform in soil, vegetation, microclimate, and hydrological conditions.

**Components of Geosystems**.

The main components of geosystems include:

1.Climate determines temperature, precipitation, and humidity, influencing vegetation and soil formation.
2.Relief affects drainage, soil erosion, distribution of vegetation.
3.Soil provides nutrients, supports plant growth, and regulates water retention.
4.Water resources control the availability of moisture, influence irrigation potential, and shape ecosystems.
5.Vegetation and wildlife participate in energy and nutrient cycles, stabilize soil, and maintain biodiversity.
6.Human activity alters natural processes, converts landscapes into agricultural, urban, and industrial areas.

**Dynamic Relationships**

Components of geosystems interact reciprocally. Changes in climate influence vegetation patterns, which then impact soil composition and water retention. Similarly, anthropogenic activities such as irrigation or deforestation

affect soil quality, water availability and biodiversity.

This triad forms the foundation of ecosystem stability:

-Vegetation reduces soil erosion, maintains microclimate, and retains soil moisture.

-Soil supplies essential nutrients and water to vegetation.

-Climate sets the limits for vegetation growth and soil processes.

**Geosystems of Bukhara Region**

Landscape Structure: Landscape – Urochishche – Facia Bukhara Region exhibits two main landscape types:

Kyzylkum desert landscapes

- Characterized by arid conditions, sandy and saline soils.
- Vegetation: saxaul and other xerophytes.
- Environmental problems: vegetation degradation, sand and dust storms, wind erosion.

Irrigated agro-landscapes of the Zarafshan valley

- Fertile soils due to irrigation; main crops include cotton, alfalfa, vineyards, and melons.
- Environmental problems: secondary soil salinization, groundwater depletion.

Within each landscape:

- Urochishche: Medium-scale homogeneous natural areas, such as sandy plains or irrigated fields.
- Facia: Smallest units, homogenous in soil type, vegetation, microclimate.

Transformation of the “Water - Soil - Vegetation” system.

Current environmental challenges in Bukhara include:

1. Reduced water flow in the Zarafshan river.
2. Secondary salinization of irrigated soils.

3. Decline of saxaul forests.

4. Increased frequency of dust and sand storms.

**Soil humus and nitrogen levels in Bukhara region:** According to a recent study, the soils in the Bukhara region show extremely low humus content (around 0.5% in sandy desert soils) and nitrogen content between 0.04–0.05% in those soils. Grey-brown soils on the periphery of irrigation zones have humus of 0.6–0.9%, and in intensively irrigated areas up to 1.2–1.8%. Nitrogen content in those soils is 0.05–0.16%. These poor soil fertility metrics underline the high vulnerability of the geosystem to degradation and desertification.

**Water salinization downstream of the Zarafshan River:** In the Zarafshan Valley irrigated system, the salinity levels of surface waters increase significantly downstream: near Bukhara the values reach 1,600–1,800 mg/L compared to 250–300 mg/L upstream. Groundwater salinity also mirrors this trend, making irrigation water poorer in quality and raising salt loads in eluvia ted soils.

**Climatic extremes and aridity:** Studies show that the region has extremely high evapotranspiration (around 2,000 mm/year) compared to very low annual precipitation (120–140 mm/year) in parts of Bukhara region. Such a disparity makes the system heavily reliant on irrigation and vulnerable to water-table rise, salinization and soil saturation.

**Vegetation and biodiversity pressures:** In the region, for example in the Romitan District area of Bukhara Province, halophilic vegetation communities (such as Aeluropus littoralis, Salicornia europaea, Halostachys caspica) occupy saline depressions caused by subsidence of salt-bearing rocks

and high groundwater levels. Also, some 25 plant species in Bukhara Province are listed in the national Red Book, 14 of which are endemic. These facts highlight that beyond land degradation, biodiversity loss and habitat fragmentation are major concerns.

**Recommendations for sustainability:**

- Introduce water-saving irrigation technologies (drip and sprinkler systems).
- Reforest degraded desert areas with native species like saxaul.
- Cultivate low-water-demand crops to reduce pressure on groundwater.
- Monitor and manage industrial and agricultural waste.

**Recent desertification mitigation efforts:** Local media reported that in 2025, over 1,800 trees were transplanted along a 20 km stretch of road in the Bukhara region (A-380 highway) to make way for road expansion. While intended as mitigation, concerns were raised about survival of the transplanted trees and exacerbation of desertification due to removal of roadside vegetation. This underscores the social and ecological interface: infrastructure development may inadvertently weaken geosystem components (vegetation) and reduce resilience.

**Conclusion**. The geosystems of Bukhara Region are complex and highly sensitive to both natural and anthropogenic influences. Maintaining ecological stability requires the careful management of water, soil, and vegetation, alongside sustainable agricultural practices. By preserving the balance among geosystem components, it is possible to mitigate land degradation, prevent desertification, and ensure sustainable development of the region.

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