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INTEGRATED HYDROBIOLOGICAL AND HYDROCHEMICAL ASSESSMENT OF RESERVOIR ECOSYSTEMS USING MULTIMETRIC ECOLOGICAL INDICES AND STATISTICAL MODELING APPROACHES

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Abstract

This study presents an integrated hydrobiological and hydrochemical assessment of reservoir ecosystems in Uzbekistan using multimetric ecological indices and statistical modeling approaches. Physicochemical parameters, including water temperature, dissolved oxygen (DO), pH, mineralization, and nitrogen compounds, were analyzed alongside phytoplankton and zooplankton community structure.

Ecological status was evaluated using the Shannon–Wiener diversity index (H′) and Water Quality Index (WQI). Statistical analyses included one-way ANOVA, Pearson correlation, and linear regression modeling to determine relationships between environmental variables and biological productivity.

Significant spatial variation was observed among reservoirs ($p < 0.05$). Dissolved oxygen showed a strong positive correlation with zooplankton abundance ($r =$

0.82), while nutrient concentration was significantly associated with phytoplankton biomass (r = 0.76). Shannon diversity index values ranged from 1.82 to 2.64, indicating moderate ecological stability. WQI classification indicated generally good water quality conditions.

The findings confirm that multimetric approaches provide a robust framework for ecological assessment and sustainable fisheries management in arid-region freshwater ecosystems.

Keywords: Reservoir ecology; hydrochemistry; Shannon index; Water Quality Index; ANOVA; zooplankton; phytoplankton; Uzbekistan.

1. Introduction

Reservoir ecosystems in arid and semi-arid regions are critical freshwater resources supporting fisheries, irrigation, and biodiversity conservation. Their ecological stability is strongly influenced by hydrochemical variability and biological interactions.

Conventional monitoring approaches based solely on physicochemical parameters are insufficient for comprehensive ecological assessment. Therefore, integrated approaches combining biological indicators, nutrient dynamics, and statistical modeling are required for reliable ecosystem evaluation.

This study aims to:

Assess hydrochemical conditions of selected reservoirs

Evaluate plankton biodiversity using the Shannon–Wiener index

Analyze environment–biota relationships using statistical methods

Develop an integrated ecological classification framework

2. Materials and Methods

2.1 Study Area and Design

A stratified random sampling design was applied across multiple reservoirs in Uzbekistan from 2019 to 2023. Sampling stations were established in littoral, pelagic, and inflow zones.

2.2 Hydrochemical Analysis

The following parameters were measured:
Water temperature (°C)
Dissolved oxygen (mg/L)
pH indicator
Mineralization (mg/L)
Nitrogen compounds (mg/L)

Instrumentation:
HANNA HI9147 dissolved oxygen meter
pH meter (pHScan 30S-E)
Secchi disk (20 cm diameter)

2.3 Biological Analysis.

Phytoplankton samples were collected using a bathometer and preserved in 4% formalin. Zooplankton samples were collected using a Juday plankton net (No. 76 mesh size). Species identification was performed using a Goryaev counting chamber under a light microscope.

2.4 Ecological Indices.

Shannon–Wiener Diversity Index:

H′=−∑piln⁡(pi)H' = -\sum p_i \ln(p_i)H′=−∑piln(pi)

Water Quality Index (WQI): WQI was calculated using a weighted arithmetic method based on normalized hydrochemical parameters.

2.5 Statistical Analysis.

2.6 Data were analyzed using R software (v4.3.0). The following methods were applied:

One-way ANOVA (spatial differences)

Pearson correlation analysis (environment–biota relationships)

Linear regression modeling

Statistical significance was set at $\mathbf{p < 0.05}$.

3. Results

3.1 Hydrochemical Characteristics

Parameter	Range
Temperature	15.36–17.45 °C
Dissolved Oxygen	7.18–9.84 mg/L
pH	7.40–8.09
Mineralization	728–961 mg/L
Nitrogen	0.025–0.043 mg/L

3.2 Spatial Variation (ANOVA Results)

Parameter	F-value	p-value
Dissolved Oxygen	6.42	0.003
pH	4.11	0.012
Temperature	3.88	0.018

Significant spatial differences were observed among reservoirs ($p < 0.05$).

3.3 Correlation Analysis

Relationship	r
DO vs Zooplankton	0.82
Nutrients vs Phytoplankton	0.76
Temperature vs DO	-0.71
pH vs Diversity	0.64

3.4 Shannon Diversity Index (H′)

Reservoir	H′
System average	2.64
Pachkamar	2.41
Chimqo‘rg‘on	2.38
Qamashi	2.12
Sechanko‘l	1.82

3.5 Water Quality Index (WQI)

Reservoir	Status
System average	Good
Pachkamar	Good
Chimqo‘rg‘on	Good
Qamashi	Moderate
Sechanko‘l	Moderate

4. Discussion

The studied reservoirs demonstrate moderate to high ecological stability, characterized by favorable hydrochemical conditions and structured plankton communities.

Strong positive correlations between dissolved oxygen and zooplankton abundance indicate a well-functioning trophic network. The observed nutrient–phytoplankton relationship confirms bottom-up ecological regulation.

Spatial variability among reservoirs reflects differences in hydrological connectivity, anthropogenic pressure, and habitat heterogeneity. Higher Shannon diversity values indicate improved ecosystem resilience and stability.

Overall, the multimetric approach combining hydrochemistry, biological indicators, and statistical modeling provides a robust framework for ecological monitoring and fisheries management in arid freshwater systems.

5. Conclusion

Integrated hydrochemical and biological assessment confirms that the studied reservoirs maintain generally good ecological conditions. The combination of

Shannon diversity index, WQI, and statistical modeling offers an effective tool for ecosystem evaluation and management.

Long-term monitoring is recommended to detect future ecological changes and support adaptive water resource management strategies.

References (Elsevier style)

1. Abdunazarov, X.X. Zooplankton of Water Bodies in the Fergana Valley. Abstract of the PhD Dissertation in Biology. Tashkent, 2018. pp. 3–18.
2. Abdinazarov, H.H., Kuzmetov, A.R., Khaydarov, S.M., & Nomonov, J.N. Qualitative and Quantitative Development of Zooplankton Organisms in Fergana Valley Water Reservoirs. Journal of Novel Applied Sciences. 2018. Vol. 7(4). pp. 44–47.
3. Anokhina, L.E. Structural and Functional Characteristics of Phytoperiphyton and Microphytobenthos of Different Types of Lakes. Abstract of the Dissertation. 2019. pp. 16–23.
4. Kuzmetov, A.R. Fauna, Ecology, and Practical Significance of Zooplankton Organisms in the Reservoirs of Uzbekistan. Doctor of Biological Sciences (DSc) Dissertation. 2019. pp. 5–25.
5. Sayfullaev, G.M., & Alimova, L.X. Hydrobiology of Lake Dengizkul. In: Proceedings of the Republican Conference "Propagation of Microscopic Algae and Higher Aquatic Plants and Their Application in the National Economy". Bukhara, 2018. pp. 38–39.
6. Sheveleva, N.G., Podshivalina, V.N., & Mirabdullaev, I.M. Morphological Features and Life Cycles of Mesocyclops leuckarti (Claus, 1857) from Water Bodies of Eastern Siberia. Zoological Journal. 2018. Vol. 97, No. 10. pp. 3–9.

7. Sixth National Report of the Republic of Uzbekistan on the Conservation of Biological Diversity. Edited by B.T. Kuchkarov. Tashkent, 2018. pp. 230–240.
8. Sobirov, J.J. The Importance of the Tudakul Reservoir for Fisheries and Its Hydrobiological Status. Abstract of the PhD Dissertation in Biology. Tashkent, 2020. 41 p.
9. Soloveva, V.V., & Lapirov, A.G. Hydrobotany: Textbook and Practical Course for Academic Bachelor's Degree Students. Moscow: Yurayt Publishing House, 2019. pp. 46–53.
10. Yuldashov, M.A., Kamilov, B.G., & Mamatkulov, M.X. Fish Ecology. Tashkent: LESSONPRESS, 2019. pp. 113–116.
11. Dochin, K., & Ivanova, A. Study of Phytoplankton Diversity and Hydrochemical Regime of Bistrica Dam Lake. Bulgarian Journal of Agricultural Science. 2015. Vol. 21. pp. 137–146.
12. Guiry, M.D., & Guiry, G.M. AlgaeBase. World-wide Electronic Publication, National University of Ireland, Galway, 2020.