COMPREHENSIVE ASSESSMENT OF THE ECOLOGICAL CONDITION OF SOME CONTINENTAL WATER BODIES AND ADJACENT TERRESTRIAL ECOSYSTEMS OF WESTERN GEORGIA

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***Abstract**. This study provides a comprehensive ecological assessment of selected freshwater bodies (the Pichora, Abasha, and Enguri rivers, and Lakes Paliastomi and Tsivi) and their adjacent terrestrial ecosystems in the lowland zone of Western Georgia. The findings indicate varying degrees of anthropogenic pressure across the study sites, reflected in both water quality and the structural and functional integrity of surrounding terrestrial habitats. In Lake Tsivi, organoleptic indicators were deteriorated relative to reference norms due to nearby construction activities; concentrations of phosphate (PO_4^{3-}) and nitrite (NO_2^-) exceeded regulatory limits for surface waters, while E.coli levels surpassed acceptable thresholds. In the Enguri River, maximum allowable concentrations were exceeded for Al, Fe, Si, Li, Ti, V, and Ba; in the Abasha River, for V; and in Lake Tsivi, for Al, Cu, V, As, Li, and Ba. Based on the examined parameters, the Pichora River and Lake Paliastomi exhibited the highest water quality. Terrestrial ecosystems in the study area were also subject to anthropogenic impacts of varying intensity, contributing to habitat fragmentation and a decline in biodiversity.*

***Key words:** river, lake, ecological assessment, water quality, anthropogenic impact.*

Introduction

***Relevance**.* The lowland rivers of Western Georgia represent ecologically significant systems, as their associated terrestrial habitats are distinguished by high biodiversity and unique microclimatic conditions. However, in recent decades, the intensification of anthropogenic pressures has led to the degradation of river ecosystems, soil erosion, the spread of invasive species, and a decline in local biodiversity [3, 4, 9]. In the Pichora River basin, increasing urbanization and unsustainable agricultural practices have resulted in habitat fragmentation. Around the Abasha River, land-use changes have had severe impacts on the stability of adjacent terrestrial ecosystems. In the vicinity of the Enguri Dam, hydrotechnical infrastructure has altered the structural characteristics of the surrounding landscape [5, 7]. Lakes Paliastomi and Tsivi form integral components of the unique wetland ecosystems of the Colchic Lowland, providing essential ecosystem services for the region. Their surrounding floodplain meadows, reed beds, and alluvial forests play a crucial role in maintaining habitat connectivity and landscape integrity [2, 17]. Yet, these ecosystems are increasingly affected by land-use changes, ecotone degradation, habitat fragmentation, and biodiversity loss. Under these circumstances, a comprehensive ecological assessment of local ecosystems becomes highly relevant and necessary [1, 6, 8].

Methods

The study employed a combination of field measurements [10, 11], titrimetric analyses [20], and inductively coupled plasma atomic emission spectrometry (ICP-AES) [15, 16, 19] to evaluate physicochemical parameters of surface waters. Microbiological analyses were performed to determine the presence and abundance of indicator organisms [12, 13]. In parallel, baseline surveys of terrestrial habitats adjacent to the studied rivers and lakes were conducted to document vegetation structure, land-use patterns, and habitat conditions [14, 18-23].

Results

1. Field Measurements. The pH values indicated slightly acidic conditions in the Pichora River (pH 6.0), neutral conditions in the Enguri River (pH 6.9), and slightly alkaline conditions in the Abasha River (pH 7.9). Among the studied lakes, Lake Paliastomi was slightly alkaline (pH 7.4), whereas Lake Tsivi was moderately acidic (pH 6.3). Electrical conductivity was highest in the Pichora River and lowest in the Enguri River, reflecting differences in dissolved ion content. Lake Paliastomi exhibited a conductivity of 4251 μS/cm, confirming the influence of Black Sea saline water intrusion on the lake's increasing salinity. Temperature measurements showed that the Pichora River had the lowest water temperature, while the Abasha River had the highest. Dissolved oxygen levels were greatest in the Pichora River (4.52 mg/L), whereas the Enguri River (2.01 mg/L) and Abasha River (3.65 mg/L) exhibited relatively oxygen-poor waters. Lake Tsivi also showed oxygen depletion compared to Lake Paliastomi. Transparency assessments revealed that Pichora River waters were clear, while the Abasha and Enguri rivers exhibited moderate turbidity. Floating particulate matter was abundant in the Enguri River, particularly at the surface, largely due to the accumulation of woody debris near the Enguri Dam. In contrast, Lake Paliastomi appeared transparent, while floating particles were observed on the surface of Lake Tsivi. Organoleptic analysis of odour intensity indicated no perceptible odor in the Pichora River and Lake Paliastomi (0 points), weak odor in the Enguri River (1 point), and moderate odor in the Abasha River and Lake Tsivi (2 points).

II. Assessment of Water Pollution Levels

The chemical analyses revealed detectable concentrations of phosphate (PO_4^{3-}), nitrate (NO_3^-), and nitrite (NO_2^-) in the waters of the Enguri and Abasha rivers (Table 1). In Lake Tsivi, however, the concentrations of PO_4^{3-} and NO_2^- exceeded the established regulatory standards for surface waters. The elevated phosphate levels in Lake Tsivi indicate the onset of eutrophication processes, which were also visually apparent in the form of increased algal growth and decreased water transparency.

Table 1. Concentrations of Chemical Pollutants in the Studied Waters

№	Location	pH	PO_4^{3-} (mg/L)	NO_3^-(mg/L)	NO_2^-(mg/L)
1	Pichora River (Water Transport Last Stop)	6.9	–	–	–
2	Abasha River (near Martvili township)	7.9	1.43	1.85	0.123
3	Enguri River (near Enguri Dam)	6.0	2.43	4.15	0.6
4	Lake Paliastomi (Colchic National Park)	7.4	0.95	0,14	0.08
5	Lake Tsivi (Tskaltubo Park location)	6.3	3.8	0.85	1.68
	MPC	***6.5-8.5***	***3.5***	***45***	***0.2***

Counts of total Saprotrophic bacteria and lactose-positive *Escherichia coli* (E. coli) were recorded in the waters of the Enguri and Abasha rivers. Based on these indicators, the Pichora River exhibited the highest microbiological water quality (Table 2). In Lake Tsivi, however, the *E. coli* concentration was 7.6 times higher than the established regulatory limit, indicating contamination with fecal matter and a high degree of water pollution.

Table 2. Results of Saprotrophic Bacteria and *E. coli* Determination

Parameter, Unit	**Location**					
	Pichora River	***Abasha River***	***Enguri River***	***Lake Paliastomi***	***Lake Tsivi***	***Standard***
Total number of Saprotrophic bacteria, Pieces/1mL	3	25	34	70	90	Not more than 100/1mL
E.coli, Piece/1L	<300	82	96	290	2300	Not more than 300/1L

III. Multi-Element Water Analysis

In the Enguri River, the concentrations of Al, Fe, Si, Li, V, and Ba exceeded the regulatory limits (MPC – Maximum Permissible Concentration) for surface waters, while in the Abasha River, elevated levels of Al and V were detected (Table 3). No detectable levels of Cr, Cu, Ni, Zn, Se, Hg, Pb, Cd, Sn, Ti, or Be were found in the waters of any of the rivers. Concentrations below the MPC were recorded as follows: B and Ba in the Pichora River; Mn, Sb, and Ba in the Abasha River; and B, Co, Mo, Sb, Be, and As in the Enguri River. In Lake Paliastomi, sodium (Na) concentration exceeded the standard by four times, and potassium (K) by three times. In Lake Tsivi, concentrations of P, Al, Cu, V, As, Li, and Ba exceeded the MPC. No Zn, Co, Be, Cd, Cr, Hg, Se, or Ti were detected in the lakes. Concentrations of Si, B, Mn, Mo, Ni, Sb, and Pb remained within Maximum Permissible Concentrations in both lakes.

Table 3. Concentrations of Micro- and Ultra-Trace Elements in Water (mg/L)

Location	Fe	Si	B	Al	Cu	Mn	Ni	V	As	Li	Ba	Sb	Mo
Pichora	-	4.62	0.005	0.437	-	-	-	-	-	-	0.003	-	-
Abasha	0.032	1.96	-	15.9	-	0.0009	-	0.002	-	-	0.005	0.002	-
Enguri	2.78	14.1	0.011	4.47	-	0.0638	-	0.001	0.01	0.04	0.268	0.001	0.004
Paliastomi	-	0.121	0.18	0.163	-	0.0017	0.008	-	-	-	0.002	0.002	0.002
Tsivi	0.054	0.230	0.218	0.546	1.24	0.0074	0.008	0.003	0.11	0.04	0.215	0.003	0.008
MPC	***0.3***	***10***	***0.5***	***0.5***	***1.0***	***0.05-0.1***	***0.01***	***0.001***	***0.05***	***<0.03***	***0.1***	***0.005***	***0.25***

IV. Assessment of the Ecological Status of Terrestrial Ecosystems Surrounding the Studied Water Bodies.

Fichora Valley represents a typical subtropical landscape characterized by Colchic forests interspersed with subtropical shrubs and riparian wild habitats. These ecosystems are partially fragmented due to anthropogenic pressures. Locally, the dominance of invasive species impedes natural ecosystem renewal processes. *Ecological risks:* habitat fragmentation and increasing tourist pressure. ***Abasha Valley*** is dominated by alluvial forests, shrubs, and cultivated agricultural plots. The river basin landscapes have been significantly transformed by human economic activities. Forest cover is fragmented due to human land use. Terrestrial ecosystems show a trend of invasive species encroachment, replacing native biocenoses. Agricultural expansion intensifies soil erosion, while widespread solid waste accumulation along riverbanks reduces the ecosystems' self-regeneration capacity. *Ecological risks:* Intensification of agricultural exploitation and deterioration of water resource quality. The ***Enguri River Basin*** and its surrounding areas are rich in Colchic-type forests, meadows, and semi-natural biodiverse zones. The expansion of the water surface upstream of the Enguri Dam and the reduced downstream flow have affected the structure of riparian habitats and reduced forested areas along the river. Changes in floristic composition have led to a decline in forest biodiversity. *Ecological risks:* Altered hydrological regimes disrupting landscape dynamics and biodiversity loss.

Conclusion

The analysis of baseline studies indicates that the landscapes of the river basins in the Colchic zone of Western Georgia are subject to both natural dynamics and strong anthropogenic pressures, resulting in habitat fragmentation, intensified soil erosion, reduction of natural vegetation, and deterioration of water quality. Elevated concentrations of PO_4^{3-}, NO_3^-, and NO_2^- were recorded in the Enguri and Abasha rivers, while in Lake Tsivi, PO_4^{3-} and NO_2^- exceeded permissible limits. The *E. coli* level in Lake Tsivi was 7.6 times above the regulatory standard. Based on elemental composition, the cleanest waters were observed in the Pichora River and Lake Paliastomi, whereas the most polluted were found in the Enguri River and Lake Tsivi.

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