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Assessing Contamination Risks in Sultanköy and Altınyazı Reservoirs (Türkiye) Using Modified Organic Pollution Indices

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Abstract

Due to their lentic and enclosed nature, lakes are more susceptible to organic pollution and eutrophication. Sultanköy and Altınyazı reservoirs are located in the Edirne Province of Türkiye, where is classified as "Agricultural Land" because of its abundant freshwater resources and fertile soils. The reservoirs are exposed to organic pollution from surrounding agricultural activities and domestic wastewater. This study evaluated and compared the contamination threats for the Sultanköy and Altınyazı dam lakes by means of some modified organic contamination indices using Turkish Standards. For this purpose, nutrient pollution index (NPI) and water quality index (WQI) were selected as the organic pollution risk assessment indicators. Water samples were collected in the autumn season of 2024 and measured for 5 limnological parameters (SO_4, NO_3-N, NO_2-N, NH_4-N and PO_4-P) that are used to calculate the indices. The results revealed that although the Altınyazı Reservoir exhibits a lower potential eutrophication risk compared to Sultanköy Reservoir, the waters of both dam lakes were highly polluted.

Keywords: *Sultanköy Reservoir, Altınyazı Reservoir, Organic pollution indicators*

Introduction

Organic contaminants, particularly nutrients derived from agricultural runoff and wastewater, are critical drivers of algal bloom formation in lacustrine ecosystems (Atıcı et al., 2018; Haq et al., 2023; Din et al., 2023; Muhammad et al., 2025). These blooms, characterized by excessive algal proliferation, disrupt aquatic ecosystems by depleting dissolved oxygen, obstructing light penetration, and altering trophic dynamics. Furthermore, organic contamination contributes to the development of hypoxic zones, where oxygen concentrations decline to critically low levels (Howarth et al., 2011; Borrell et al., 2019; Mia et al., 2023). The assessment of organic contaminants is crucial for understanding their cumulative effects on aquatic biodiversity, water quality, and overall ecosystem integrity (Çiçek et al., 2014; Köse et al., 2020; Varol et al., 2022; Ustaoğlu et al., 2022; Yüksel et al., 2024). A comprehensive approach is required to effectively evaluate aquatic ecosystem health and formulate sustainable management strategies. Notably, key indicators such as the Nutrient Pollution Index (NPI) and the Water Quality Index (WQI) are widely utilized to assess the synergistic impacts of organic contamination (Tokatlı and Varol, 2021; Varol et al., 2022; Muhammad et al., 2024; Tokatlı et al., 2025).

Sultanköy and Altınyazı Dam Lakes are among the most significant reservoirs in Edirne Province, Türkiye, serving as essential water sources for both irrigation and drinking water supply. Constructed by the General Directorate of State Hydraulic Works (DSİ) to enhance agricultural productivity and fulfil the water demands of local communities, these reservoirs play a crucial role in maintaining both economic stability and ecological balance (http://www2.dsi.gov.tr/). However, similar to many freshwater ecosystems, they are increasingly subjected to anthropogenic pressures, particularly from agricultural runoff and domestic wastewater discharge. These activities introduce excessive nutrients, pesticides, suspended solids, and organic pollutants into the water bodies, posing significant risks to water quality and aquatic ecosystem health (Tokatlı et al., 2017; Tokatlı, 2019; 2020a; 2020b). This study aims to assess and compare the contamination threats affecting Sultanköy and Altınyazı Dam Lakes by employing a set of modified organic contamination indices. The evaluation is conducted in accordance with Turkish Standards, providing a comprehensive framework for analysing the extent and impact of organic pollution in these freshwater ecosystems. By utilizing standardized assessment methods, the study seeks to offer valuable insights into water quality dynamics and potential environmental risks, thereby contributing to the development of effective management and conservation strategies.

Materials and Methods

Research area and sample collection

Sultanköy and Altınyazı Dam Lakes, along with the selected sampling stations on these reservoirs, are presented in Figure 1, providing a visual representation of the study area. To evaluate the current water quality status, water

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samples were systematically collected from the designated stations during the autumn season of 2024, ensuring that potential pollutant influxes were accurately represented in the analysis.
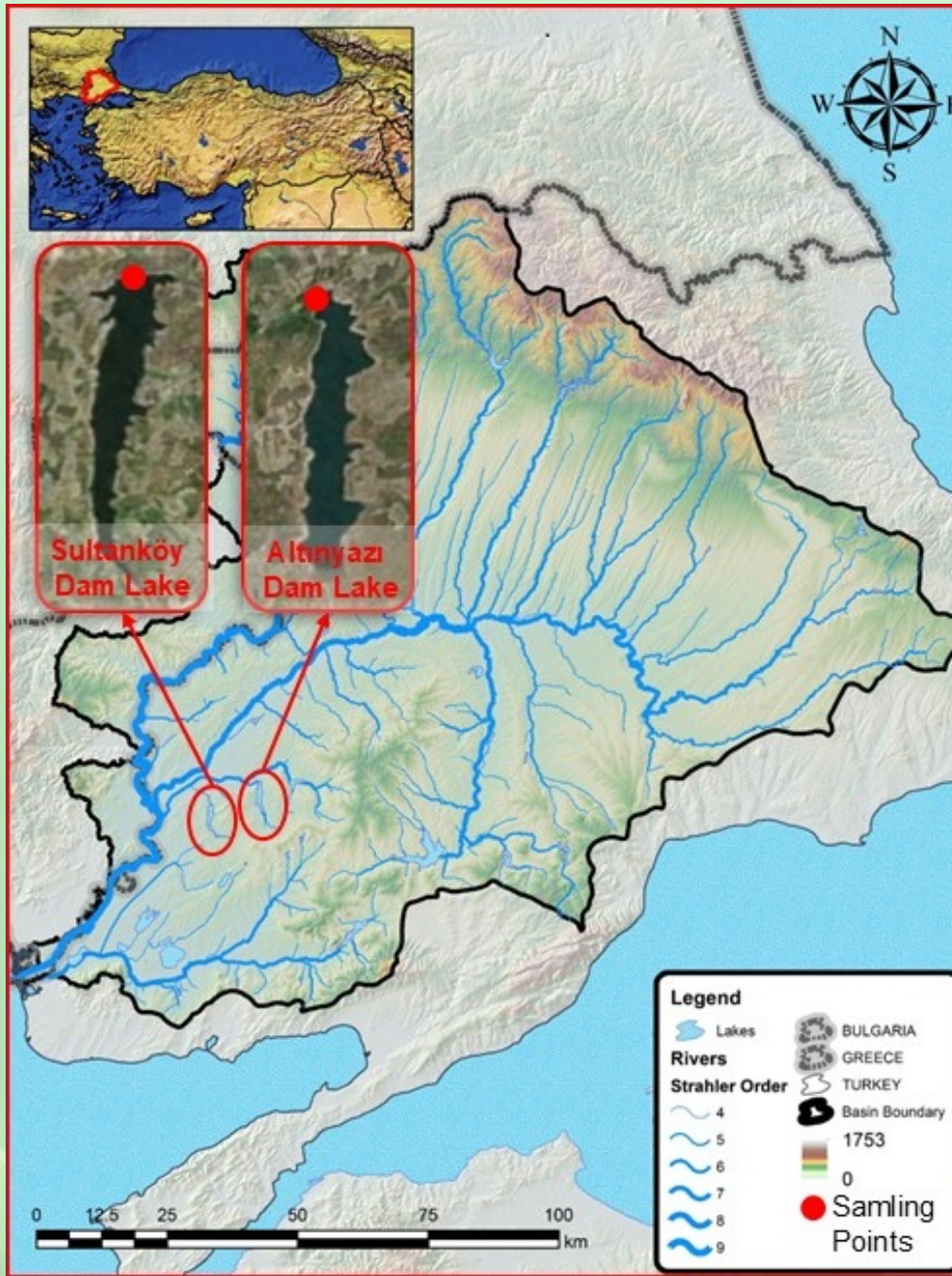

Figure 1. Meriç – Ergene Basin, investigated reservoirs and selected sampling stations

Physicochemical analysis and ecological indices

The concentrations of phosphate-phosphorus, nitrite-nitrogen, nitrate-nitrogen, ammonium-nitrogen and sulphate were analysed in the laboratory following APHA protocols (1998, 2017) using a Hach spectrophotometer and a Hach colorimeter.

The details of the formulas and computation techniques for the modified organic contamination indices applied in this study, based on the Turkish Standards (TSWQR, 2021), are provided in Table 1 (Tokatlı et al., 2025). These indices were carefully selected to assess the level of contamination and biodegradability in the water samples, ensuring an accurate representation of the environmental conditions.

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Table 1. Methods of applied modified organic pollution risk assessment indices

Index	Calculation	Formula Explanations	Rating of Water Quality
NPI	$NPI = (C_N/MAC_N) + (C_P/MAC_P)$	C_N: The levels of NO_2-N in water sample C_P: The levels of PO_4-P in water sample MAC_N: The maximum limit of NO_2-N MAC_P: The maximum limit of PO_4-P	<1: No polluted 1-3: Moderate polluted 3-6: Considerable polluted >6: Very high polluted
WQI	$$WQI = \sum_{i=1}^{n} Wı \; x \left(\frac{Ci}{Si}\right) x \; 100$$ $$Wı = \frac{W_i}{\sum_{i=1}^{n} W_i}$$	WI: The relative weight Wi: The values assigned to i (1-5) Ci: The values of measured parameters Si: The standard values	<50: Excellent water quality 50–100: Good water quality 100–200: Poor water quality 200–300: Very poor water quality >300: Unsuitable

Results and Discussion

The data for the calculated modified organic contamination indices for the waters of the Sultanköy and Altınyazı reservoirs are presented in Figure 2. The results indicate that although the Altınyazı Reservoir exhibits a lower potential eutrophication risk compared to Sultanköy Reservoir, the waters of both dam lakes were highly polluted. According to the applied ecological indices, it was determined that the water qualities of both reservoirs are considerably degraded, exhibiting high levels of pollution. Specifically, the Nutrient Pollution Index (NPI) were recorded as 8.10 for Sultanköy Reservoir and 6.50 for Altnyazı Reservoir, both falling into the "very high pollution" category. Similarly, the Water Quality Index (WQI) values were recorded as 284 for for Sultanköy Reservoir and 198 for Altnyazı Reservoir, classifying as "very poor water quality" and " poor water quality", respectively.

The application of chemical fertilizers, which contain considerable amounts of nitrogenous and phosphorus compounds, is a prevalent agricultural practice in the areas surrounding the reservoirs. These fertilizers, along with organic pollutants from agricultural runoff, can be transported into adjacent water bodies through multiple pathways, including irrigation, precipitation, and soil erosion (Mutlu et al., 2021a; 2021b; Jannat et al., 2022; Tokatlı et al., 2023; 2024). The accumulation of these pollutants within the reservoirs leads to excessive nutrient enrichment, thereby exacerbating the risk of eutrophication. Furthermore, domestic wastewater discharges from nearby settlements are considered a major contributing factor to the elevated ecological risk index values identified in this study, highlighting the significant anthropogenic pressures impacting these freshwater ecosystems.
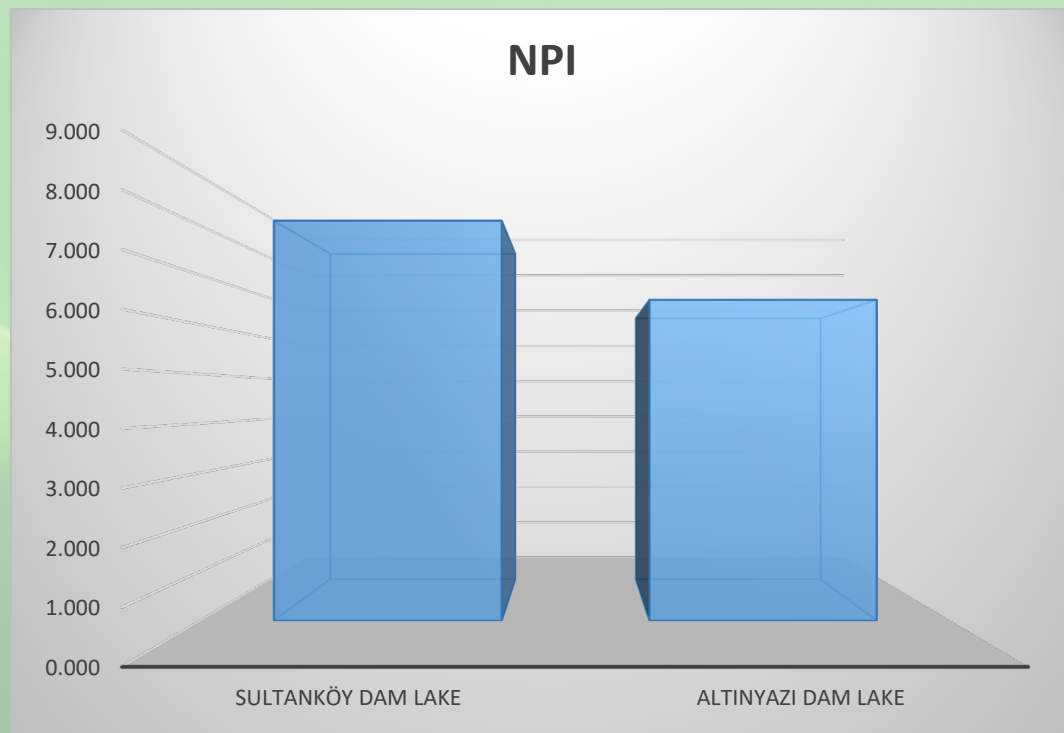

Figure 2. Results of applied NPI (up) and WQI (down) in waters of investigated dam lakes
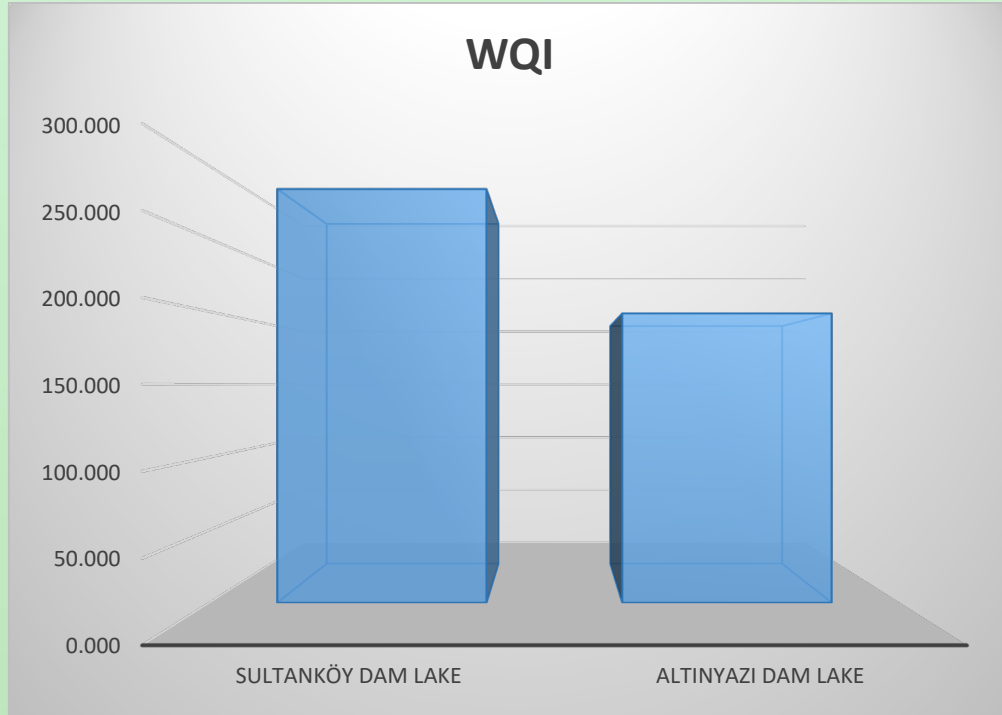
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Figure 2. Results of applied NPI (up) and WQI (down) in waters of investigated dam lakes (continued)

Conclusions

The findings of this study reveal significant organic contamination in both Sultanköy and Altınyazı Reservoirs, highlighting severe water quality degradation. Although Altınyazı Reservoir exhibited a relatively lower risk of eutrophication compared to Sultanköy Reservoir, the overall pollution levels in both water bodies were alarmingly high. The calculated Nutrient Pollution Index (NPI) values of 8.10 for Sultanköy Reservoir and 6.50 for Altınyazı Reservoir indicate that both reservoirs fall within the "very high pollution" category. Similarly, the Water Quality Index (WQI) values of 284 for Sultanköy Reservoir and 198 for Altınyazı Reservoir classify the water quality as "very poor" and "poor," respectively. These results underscore the urgent need for comprehensive water management strategies to mitigate further degradation and restore ecological balance in these critical freshwater ecosystems.

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