ECOLOGICAL VULNERABILITY OF THE VILUNI LAGOON SYSTEM IN ALBANIA USING COPERNICUS SENTINEL-2 IMAGERY

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Background: The Viluni Lagoon, a critical coastal ecotone in northern Albania, is shaped by hydrological interactions between the Shkodra Lake system, the Buna River, and the Adriatic Sea. This dynamic interface between freshwater and marine environments supports diverse migratory bird populations and specialized species adapted to transitional conditions, making it highly sensitive to environmental change. Anthropogenic pressures, including tourism, sand extraction, and altered river discharge, disrupt the lagoon's natural balance and contribute to habitat degradation. At the same time, climate-driven processes such as coastal erosion, floodplain shifts, and intensified storm surges increasingly influence shoreline dynamics, water levels, and salinity patterns.
The aim of this study was to asses the ecological vulnerability of the Viluni Lagoon system (Albania), based on Copernicus Sentinel-2 Imagery .
Materials and methods: To define the study area, a Digital Elevation Model (DEM) was used to delineate the lagoon's catchment, limited to elevations below 10 m above sea level and within a 10 km buffer. A multi-temporal analysis was conducted using Sentinel-2 (MSI) imagery from 2017 to 2025, with one representative June image selected annually to ensure phenological consistency. Shorelines were digitized manually from True Color Composites (TCCs), with supervised classification used to improve boundary accuracy. Biophysical conditions were assessed using spectral indices (NDVI, NDMI, NDWI, and MNDWI). Binary rasters were converted to vector format to quantify total lagoon area and the proportion of open water. A rule-based classification identified five vegetation and habitat classes.
Results indicate that fluctuations in lagoon extent and water coverage reflect interactions between sea-level rise and sediment inputs from the Buna River. The observed expansion of the lagoon, peaking in 2021, suggests habitat loss in salt marshes and wet meadows, likely replaced by shallow water and mudflats. The western shoreline emerges as a critical zone of ecological vulnerability and a potential tipping point for habitat loss, underscoring conservation priorities.
Conclusion: The results demonstrate that the Viluni Lagoon system is highly vulnerable to the combined effects of sea-level rise and river sediment dynamics, leading to shoreline instability and progressive habitat transformation, particularly along the western sector, which should be considered a priority area for conservation and management.

Keywords: vulnerability; coastal wetlands; Sentinel-2; Copernicus; Adriatic lagoon; Albania

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