Forecasting Water Pollution Indicators Using the STL-ARIMA Model: A Case Study of the Dniester River

Marusic Galina
Technical Univerisity of Moldova

Branişte Rodica
Technical Univerisity of Moldova

Kulev Mihail
Technical Univerisity of Moldova

Istrati Daniela
Technical Univerisity of Moldova

Şevcenco Nina
N. Testemitanu State University of Medicine and Pharmacy, Republic of Moldova

Abstract:

The continuous monitoring and forecasting of water quality indicators are essential for the sustainable management of aquatic ecosystems and the protection of public health. This study investigates the temporal dynamics of two important water pollution indicators, namely nitrite nitrogen (NO_2-N) and nitrate nitrogen (NO_3-N), in the Dniester River at the Olăneşti monitoring station, Republic of Moldova. Monthly observations collected during the period 2019–2024 were analyzed using a hybrid statistical approach based on Seasonal-Trend Decomposition using Loess (STL) and the AutoRegressive Integrated Moving Average (ARIMA) model.

The STL procedure was employed to decompose the time series into trend, seasonal, and residual components, providing a better understanding of the temporal behavior of each pollutant. Subsequently, ARIMA models were fitted to the deseasonalized series to generate forecasts of future pollutant concentrations for the period 2025–2027. Model performance was assessed through residual diagnostics and forecasting accuracy measures.

The results reveal persistent seasonal patterns and different levels of variability in the analyzed indicators, with nitrate nitrogen exhibiting greater fluctuations than nitrite nitrogen. The STL-ARIMA framework successfully captured the temporal structure of both time series and produced stable forecasts without evidence of pronounced long-term increasing trends. The proposed methodology represents an effective decision-support tool for environmental monitoring and water resource management, facilitating the early detection of potential water quality risks and supporting data-driven strategies for river ecosystem protection.

Keywords:

water pollution, Dniester River, ARIMA model, time series forecasting.