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Spatial and temporal changes of major elements in surface water in Arieș River Catchment, Western România

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INTRODUCTION & AIM

The Arieș River, located in northwestern Romania, is a significant tributary within the Mureș–Tisza Basin, playing a key role in the hydrological and ecological balance of the region. The river crosses areas with intense anthropogenic influence, particularly a mining zone in its middle basin and an industrial area downstream. Historically, mining and related industrial operations have contributed to the input of various chemical contaminants into the aquatic system, potentially altering water quality and posing risks to ecosystems and health.

Understanding the hydrochemical dynamics of the Arieș River is essential for assessing the extent of anthropogenic impact and for developing effective water management and remediation strategies. The evaluation of major ion composition and its spatial and temporal variability offers insight into both natural geochemical processes and pollution sources affecting the river system.

The main objective of this study was to evaluate the spatial and seasonal variability of major hydrochemical parameters in the Arieș River, with a focus on identifying the influence of mining and industrial activities on water quality. To achieve this, twelve key water quality parameters were analyzed from ten sampling sites collected across four different seasons during 2017. The study further aimed to classify the water types using Piper and Durov diagrams and, to assess potential contamination patterns linked to anthropogenic sources.

STUDY AREA, SAMPLING AND ANALYIS

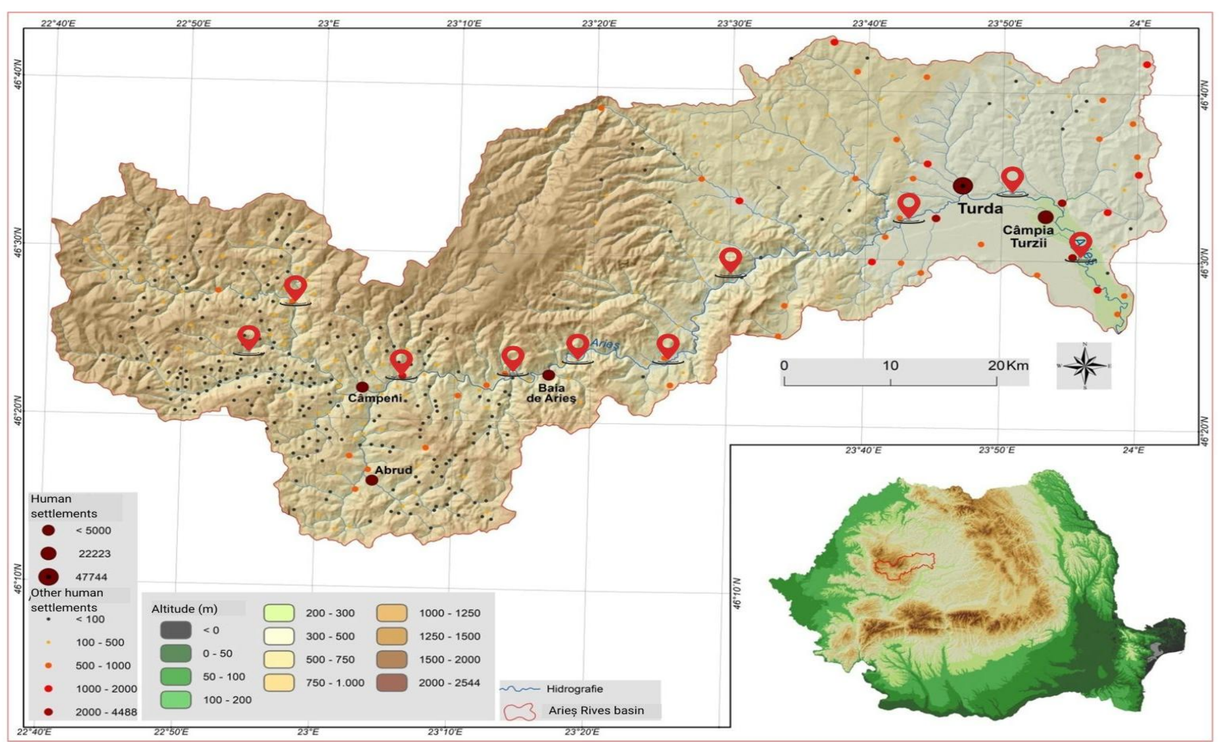

Figure 1. The Arieș River Basin.

- 4 sampling campaigns: January, May, August, November ;
- *12* surface water samples, in every campaign;
- For the Ca, Mg, Na, K, Fe determination, samples (filtered with 0.45 µm cellulose acetate membrane and acidified with 65% HNO_3) were analyzed by ICP-OES (Perkin Elmer, Waltham, MA, USA) and ELAN DRC II ICP-MS, Perkin Elmer, Waltham, MA, USA).
- Anions (F^-, Cl^-, NO_2^-, NO_3^-, SO_4^{2-}) were measured using a 761 IC compact ion chromatograph (Metrohm, Herisau, Switzerland).
- Bicarbonates (HCO_3^-) were determined by titration with 0.1 N HCl against bromocresol green.

RESULTS & DISCUSSION

- Water chemistry along the Arieș River showed clear spatial differences. Samples collected near the **mining area (SW4, SW5)** had the highest concentrations of **Na (21.4 mg/L), Mg (13.7 mg/L), and Ca (314 mg/L)**, indicating strong influence from mining activities. In contrast, samples near the **industrial area** showed lower overall ion levels.
- The concentrations of nitrate (NO_3^-), nitrite (NO_2^-), and phosphate (PO_4^{3-}) were generally low to moderate across all sites.
- No clear seasonal trend was observed, implying that anthropogenic rather than natural factors drive water quality variations.

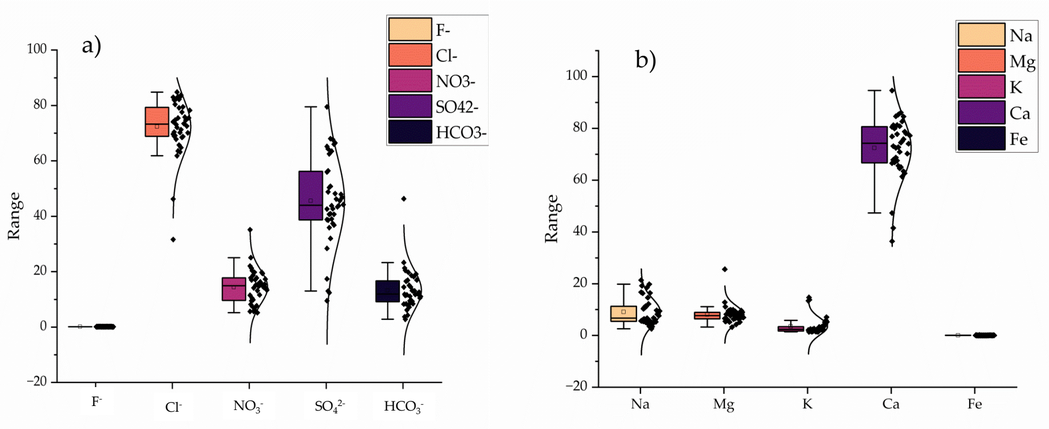

Figure 2. Temporal variations of the major elements in Arieș Rives Basin: (a) anions; (b) cations.

- According to **Piper** and **Durov diagrams**, waters were mainly of **Mg–HCO_3^-** and **Ca–Cl^-** types, reflecting both natural carbonate weathering and pollution from mining discharges.

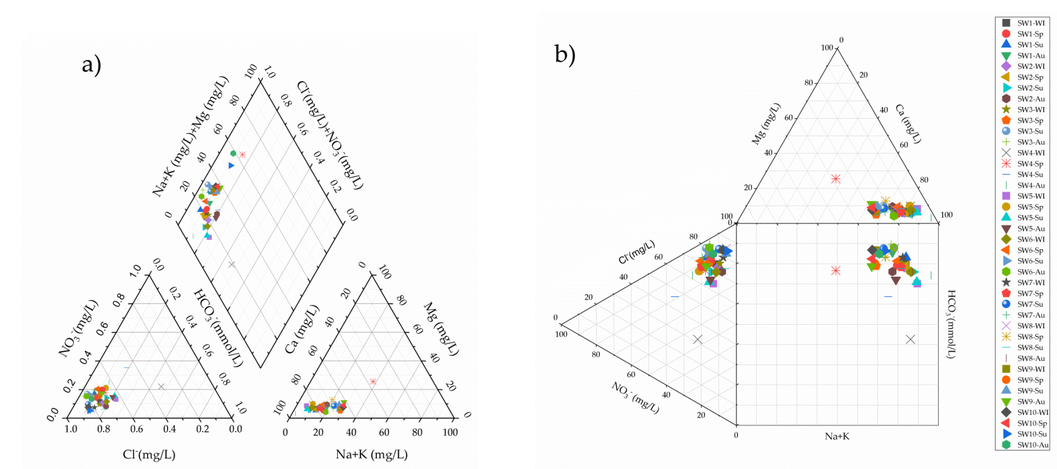

Figure 3. Water facies of Arieș Rives Basin: (a) Piper diagram; (b) Durov diagram.

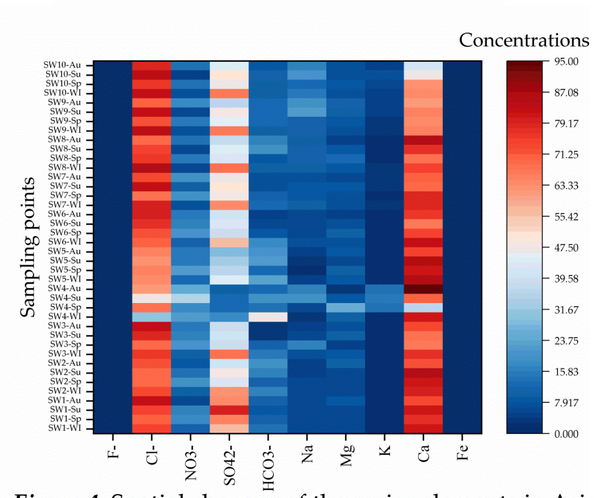

Figure 4. Spatial changes of the major elements in Arieș Rives Basin.

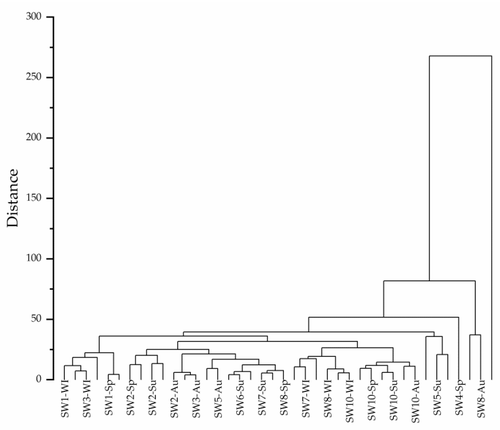

Figure 5. Hierarchical cluster analysis onto sampling points from Arieș River Basin.

CONCLUSION

Seasonal comparison of the datasets showed no consistent temporal trend in ion concentrations, implying that natural hydrological or climatic factors exerted minimal control over the water chemistry during the sampling year.

Overall, the results demonstrate that the **middle basin of the Arieș River** is more affected by mining-related contamination compared to the downstream industrial area. Although concentrations of major ions remain below acute toxicity levels, their elevated values, relative to background conditions, indicate ongoing anthropogenic pressure. These findings highlight the necessity for **continued monitoring**, **pollution mitigation**, and **water treatment measures** before the river water can be safely used for domestic or agricultural purposes.

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