

Evaluation of Cd, Pb, and Ni as Toxic EQS Elements in the Ishëm River Basin (Albania)

Vjola Bakillari^{1*}, Fatos Huqi¹, Xhuljo Sema¹, Vjola Saliaga¹, Irena Duka¹, Eugen Skura¹, Ilir Kristo¹, Fatbardh Sallaku¹, Ferdi Brahushi¹, Alexander Pressl², Thomas Ertl², Stephan Fuchs³, Klajdi Sotiri^{3;4}, Seit Shallari¹

¹Department of Environment and Natural Resources, Faculty of Agriculture and Environment, Agricultural University of Tirana, Tirana, Albania

²Department of Water, Atmosphere and Environment, Institute of Sanitary Engineering and Water Pollution Control, Vienna, Austria

³Department of Aquatic Environmental Engineering, Institute for Water and Environment – Water Quality Management, Karlsruhe Institute of Technology, Karlsruhe, Germany

⁴Limknow GmbH & Co KG, Karlsruhe, Germany

River Basin Conference 2026
Karlsruhe, Germany





Introduction



Why this study?

- ✓ WFD implementation in Albania
- ✓ Reliable data needed for RBMPs
- ✓ Limited heavy metal data
- ✓ Need for monitoring & modelling approaches

Albania Water Resources

- Rich water resources
- Sustainable development needs

EU Integration

- EU candidate country
- WFD implementation
- RBMP development

Data Gaps

- Limited pollutant data
- Limited pathway understanding

Study Focus

- Ishëm River Basin
- Heavy metal monitoring (Cd, Pb, Ni)
- Pollution pathway assessment
- Support for MoRE modelling

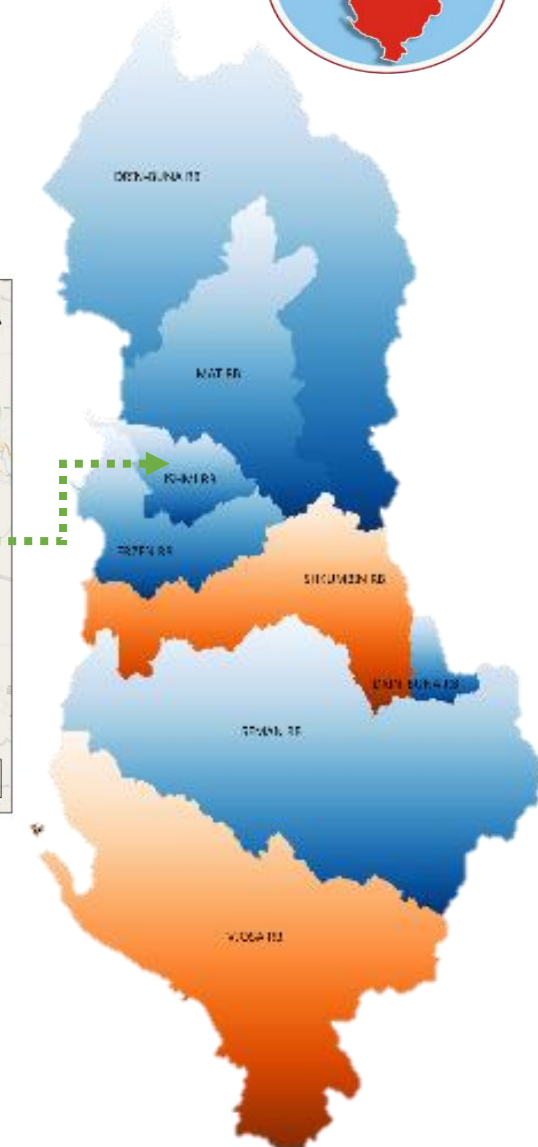
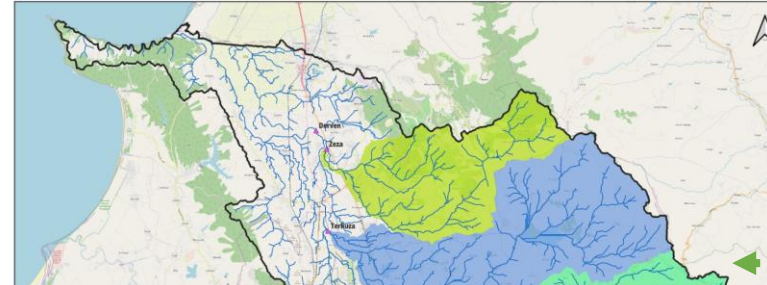
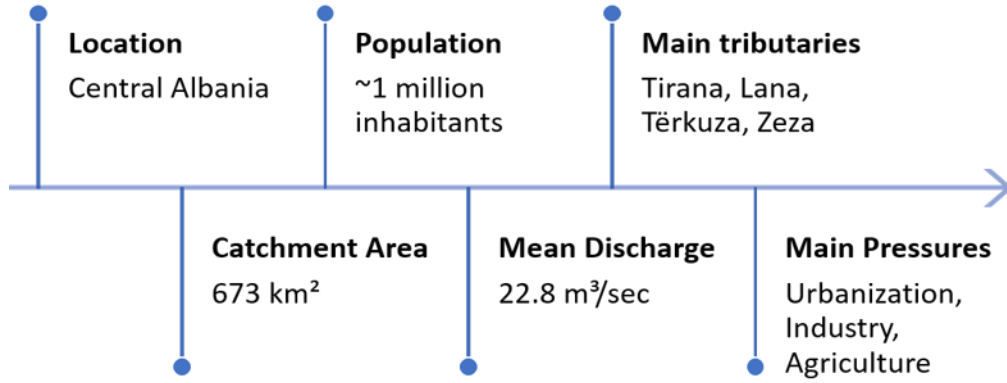
Support for WFD Implementation



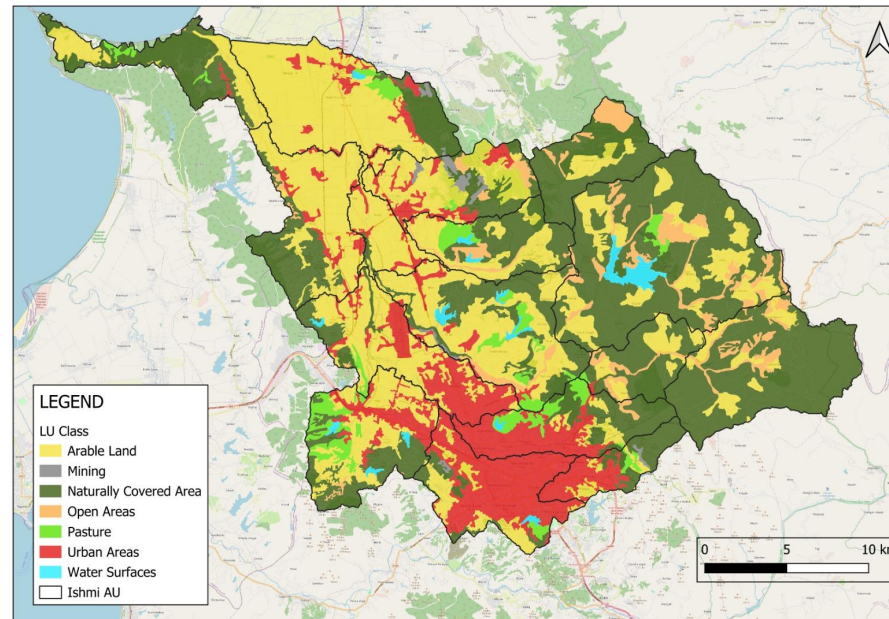
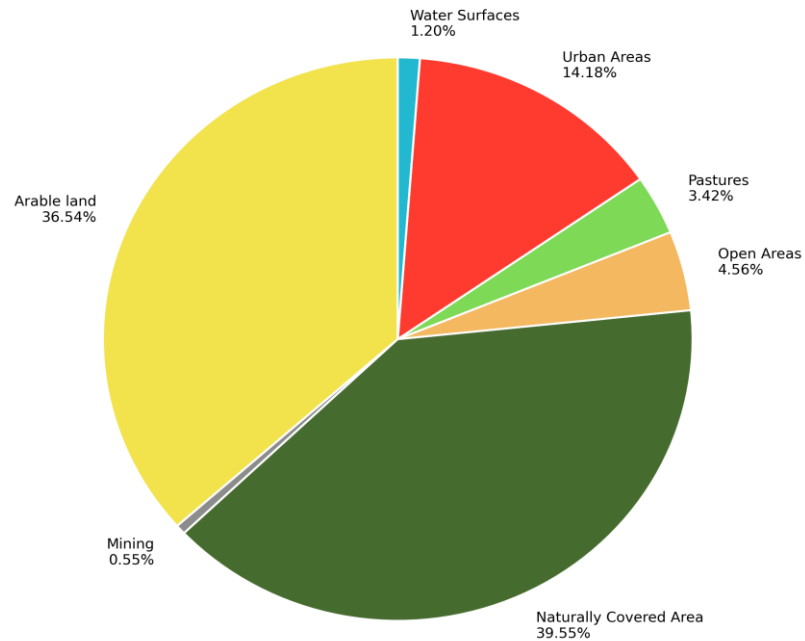
Study supported by the AMORE-AL project (2024–2027) - monitoring and modelling framework supporting WFD implementation in Albania



Ishëm River Basin Profile



Land Use/Land Cover Distribution (%)



To assess the occurrence and status of Cd, Pb and Ni in the Ishëm River Basin using a monitoring-based framework

I

Assess the spatial variability of Cd, Pb and Ni concentrations

II

Compare measured concentrations with EU Environmental Quality Standards (EQS)

III

Provide monitoring data to support future MoRE model development and validation

Monitoring Activities and Sampling Strategy



Supporting Status Assessment

River water quality monitoring

❖ 9 monitoring sites

(every three months)

4 upstream reference sites

5 downstream impacted sites

(monthly sampling)

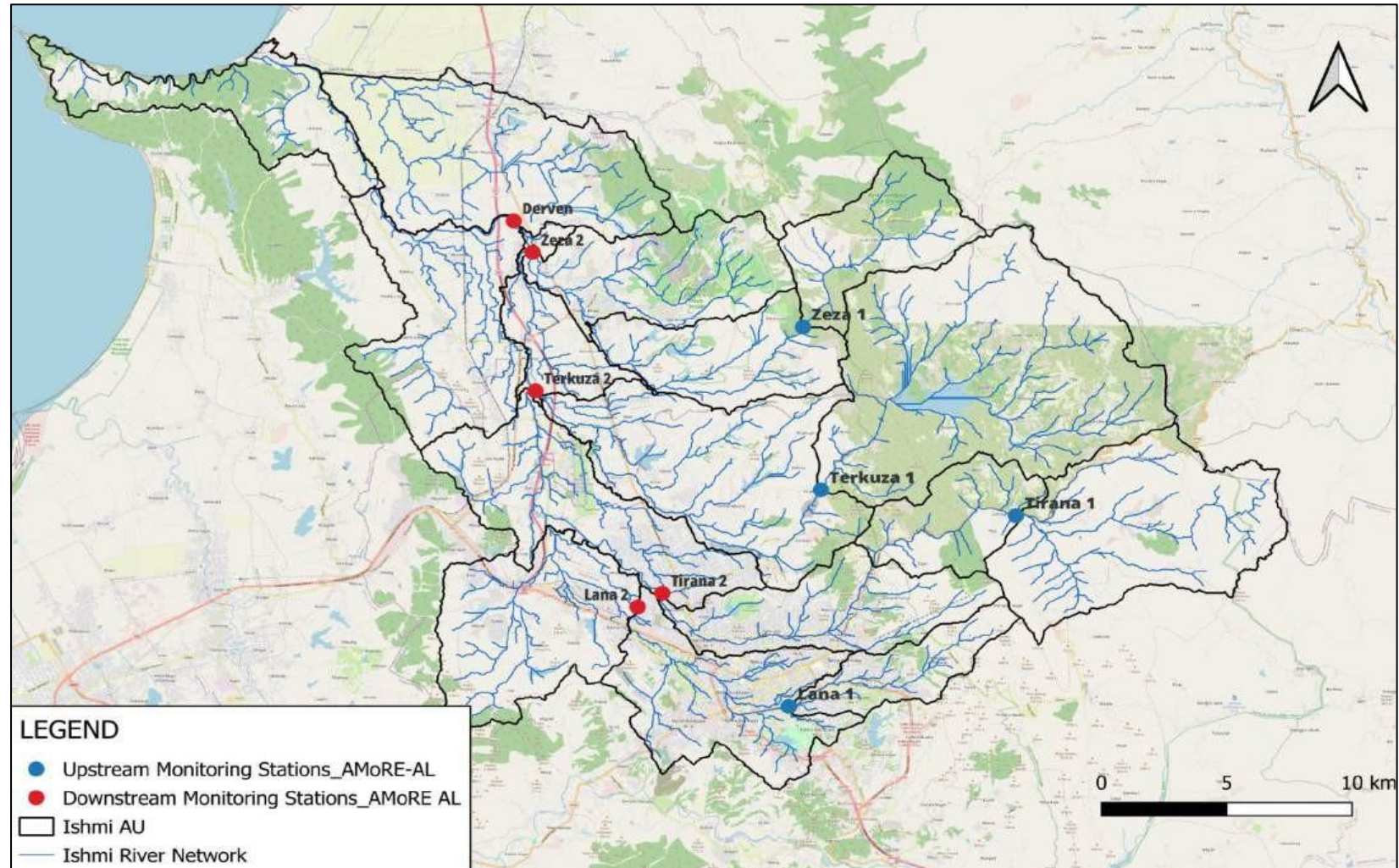
❖ Duration

April 2024 – September
2025

In-situ measurements and
Laboratory analysis (AUT)

*Characterisation of river water
quality*

**Cd, Pb and Ni analysis - Spatial
assessment - Data for MoRE
modelling**



Monitoring stations – Ishëm River Basin

Zeza river upstream



Tirana river upstream



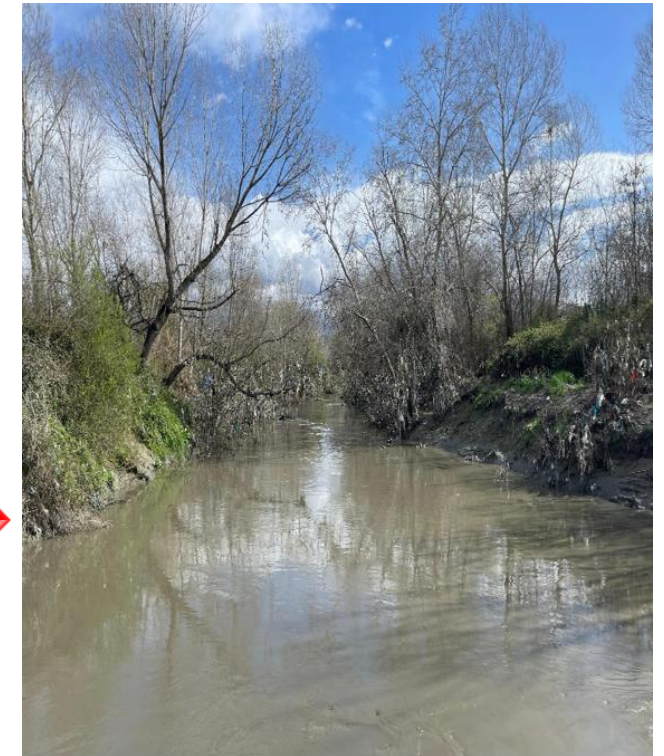
From Upstream to Downstream
Increasing Anthropogenic Pressure



Zeza river downstream

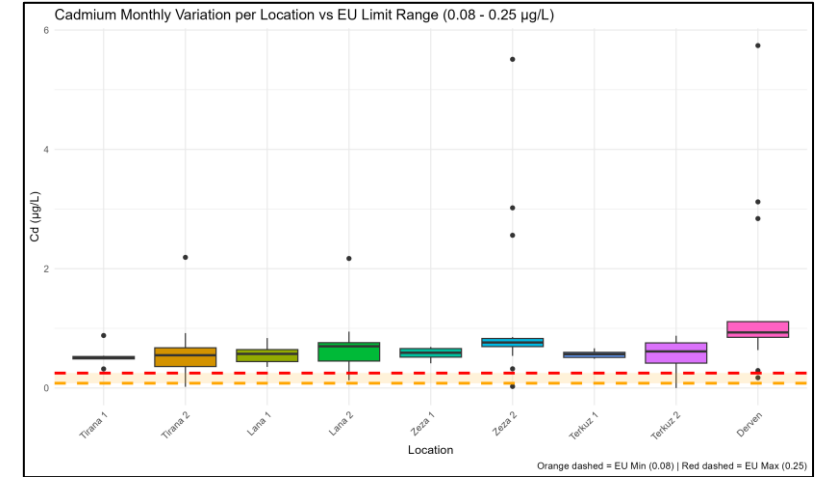
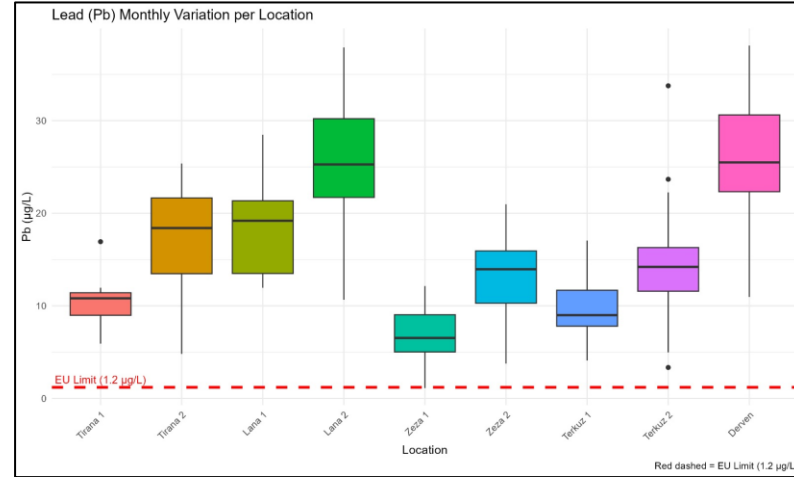
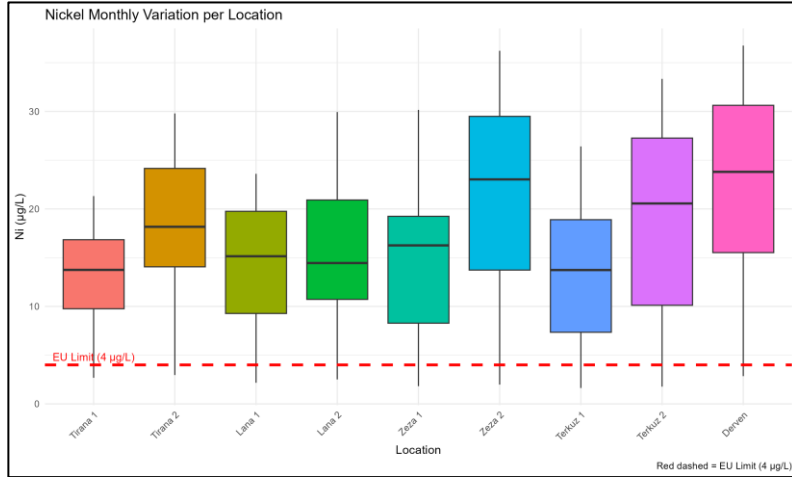


Tirana river downstream



Ishmi river basin

Monitoring results



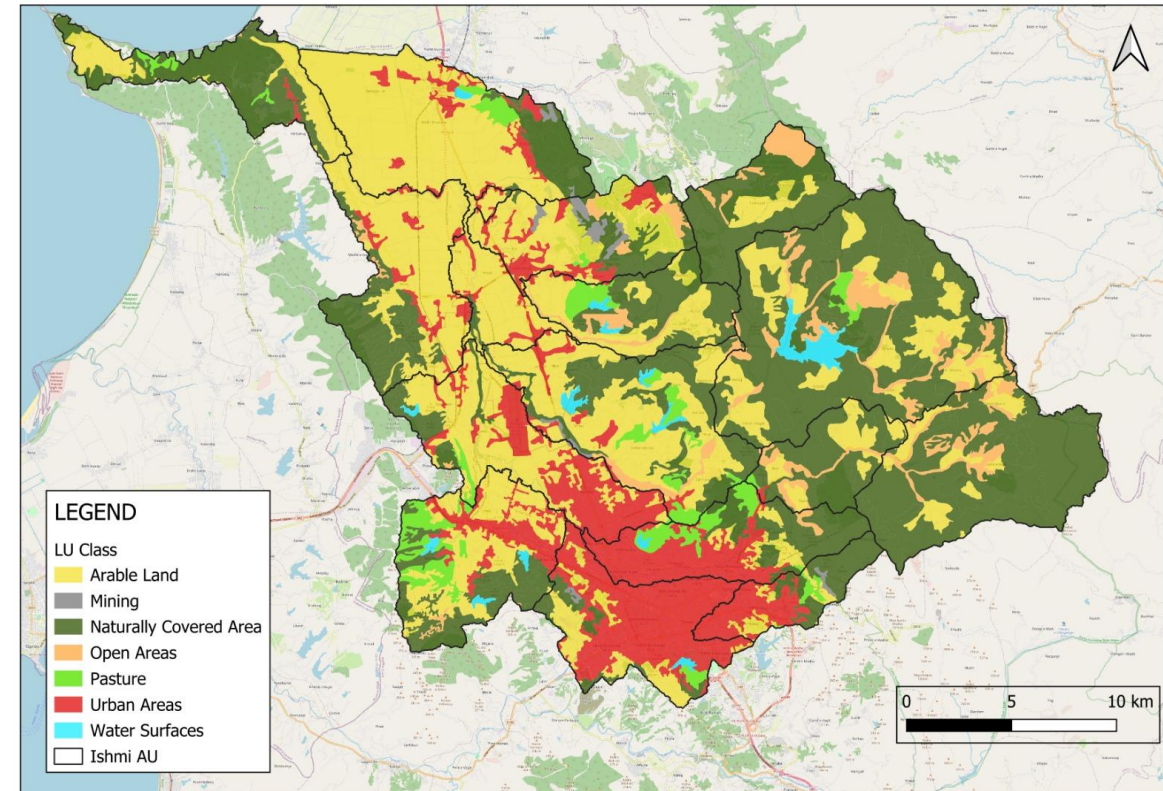
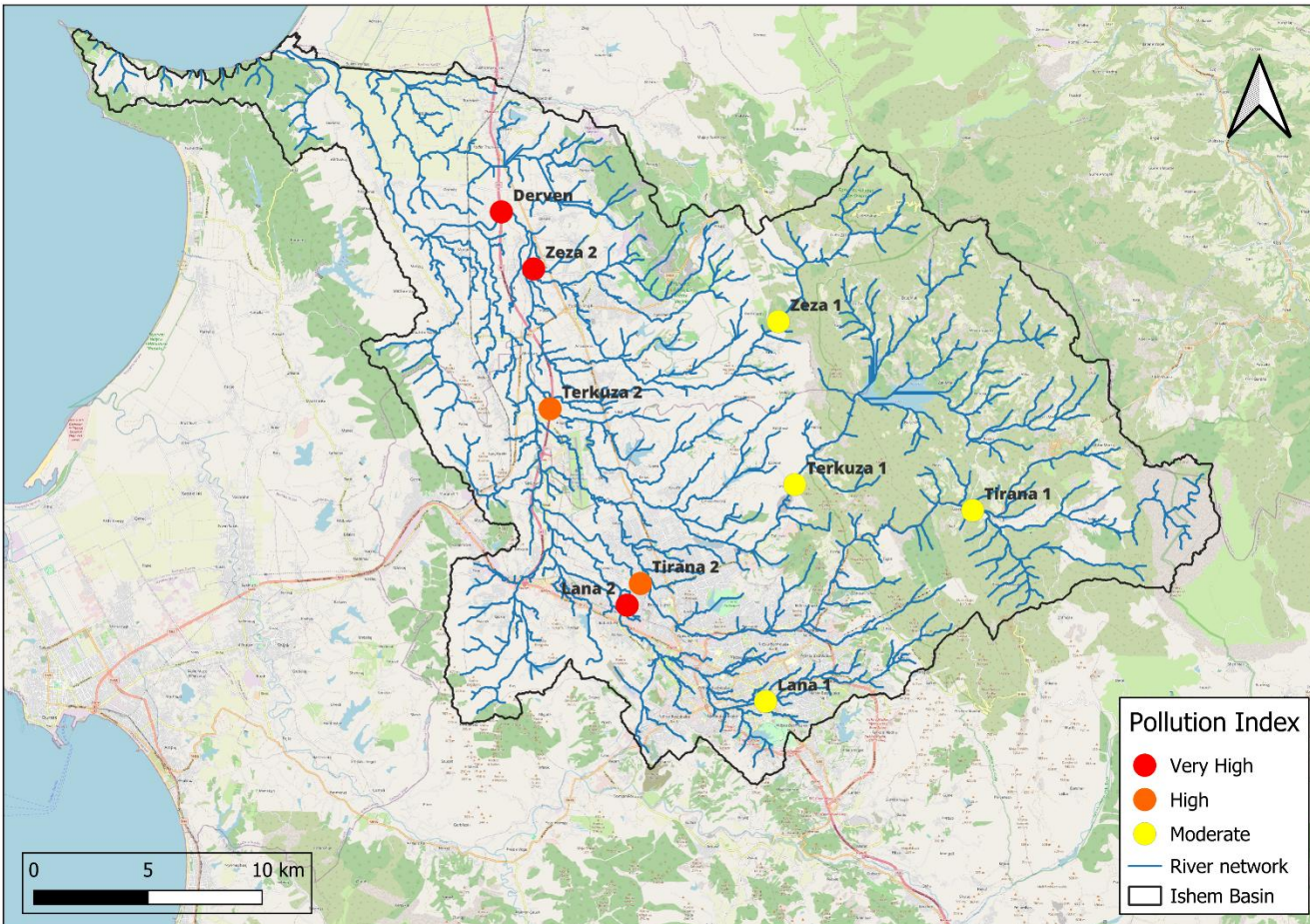
- ❖ All stations exceeded EQS
- ❖ Highest concentrations at Derven, Zeza 2 and Tërkuza 2
- ❖ Persistent exceedance during the monitoring period
- ❖ Potential influence of urban and industrial sources

- ❖ Pb exceeded EQS at all stations
- ❖ Highest values at Derven and Lana 2
- ❖ Spatial variability indicates localized sources
- ❖ Elevated concentrations near urbanized areas

- ❖ Cd exceeded EQS at all stations
- ❖ Highest concentrations at Derven and Zeza 2
- ❖ Strong temporal variability

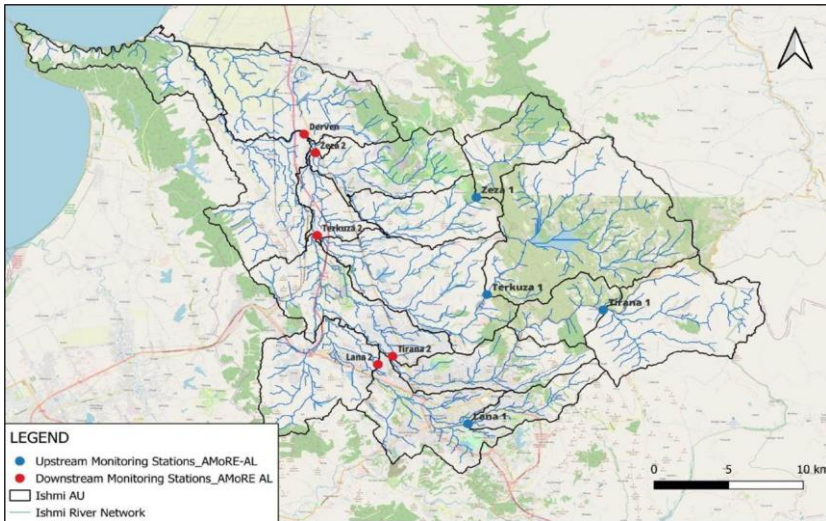
Monitoring results

Spatial distribution of heavy metal pollution hotspots



Monitoring results

Chemical Status Assessment of monitoring stations in the Ishëm River Basin



| Substance | AA-EQS (µg/L) |
|--------------|---------------|
| Cadmium (Cd) | 0.08–0.25* |
| Nickel (Ni) | 4 |
| Lead (Pb) | 1.2 |

*Cd EQS depends on water hardness according to WFD.

| Monitoring Station | Cd | Ni | Pb | Chemical Status |
|--------------------|----------|----------|----------|-----------------|
| Tirana 1 | Not Good | Not Good | Not Good | Not Good |
| Tirana 2 | Not Good | Not Good | No Good | Not Good |
| Lana 1 | Not Good | Not Good | Not Good | Not Good |
| Lana 2 | Not Good | Not Good | Not Good | Not Good |
| Zeza 1 | Not Good | Not Good | Not Good | Not Good |
| Zeza 2 | Not Good | Not Good | Not Good | Not Good |
| Terkuz 1 | Not Good | Not Good | Not Good | Not Good |
| Terkuz 2 | Not Good | Not Good | Not Good | Not Good |
| Derven | Not Good | Not Good | Not Good | Not Good |

Chemical status assessment → WFD “one-out-all-out”

Good chemical status, when all EQS are met

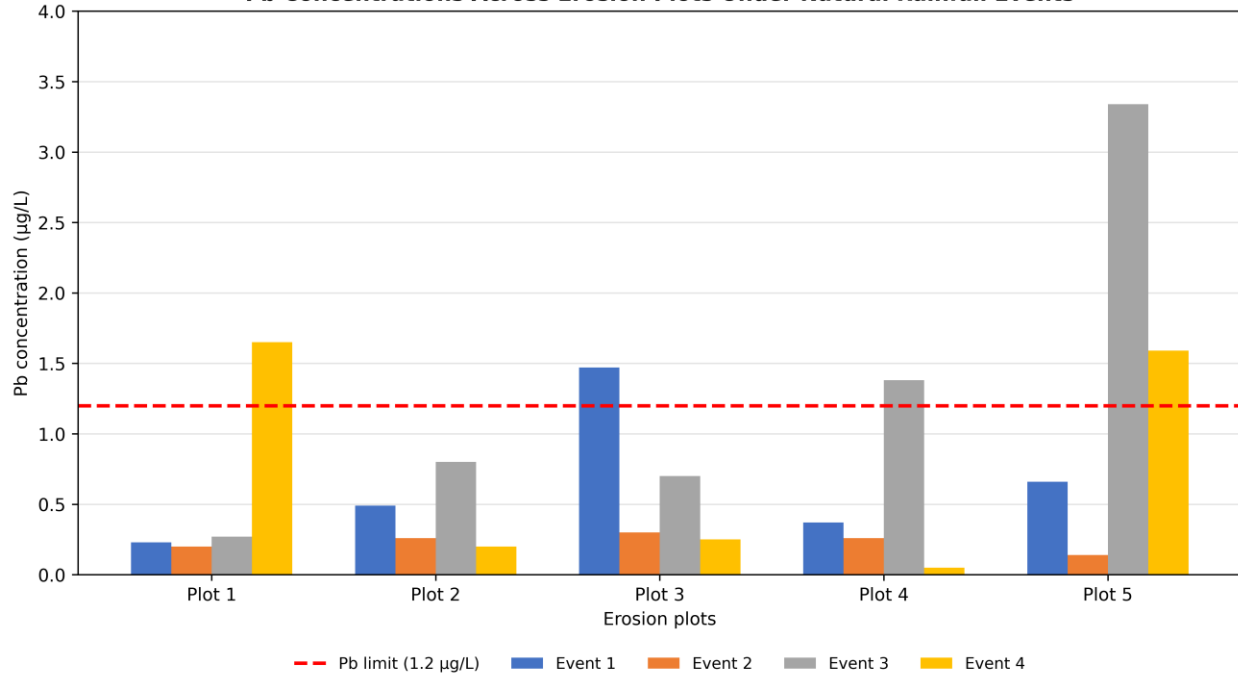
All monitoring stations exceeded the EQS for Cd, Ni and Pb → **“Not Good” Chemical Status**

Monitoring input from agricultural areas

Agricultural Input
 Soil and runoff sampling during rainfall event
Characterisation and assessment of agricultural runoff pollution
 Cd, Pb and Ni analysis – Diffuse load assessment – Input data for MoRE modelling

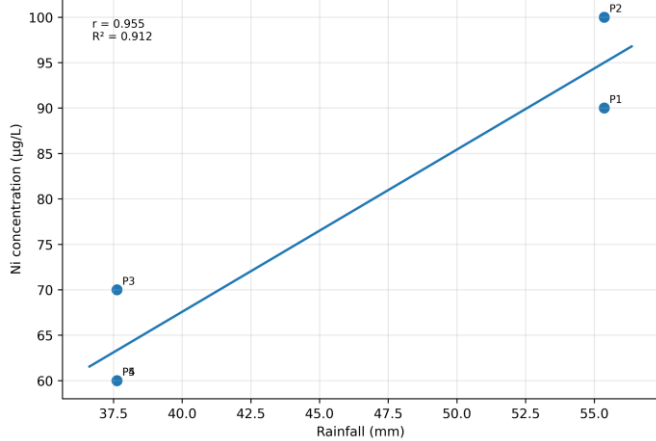


Pb Concentrations Across Erosion Plots Under Natural Rainfall Events



Monitoring of inputs from urban surface runoff

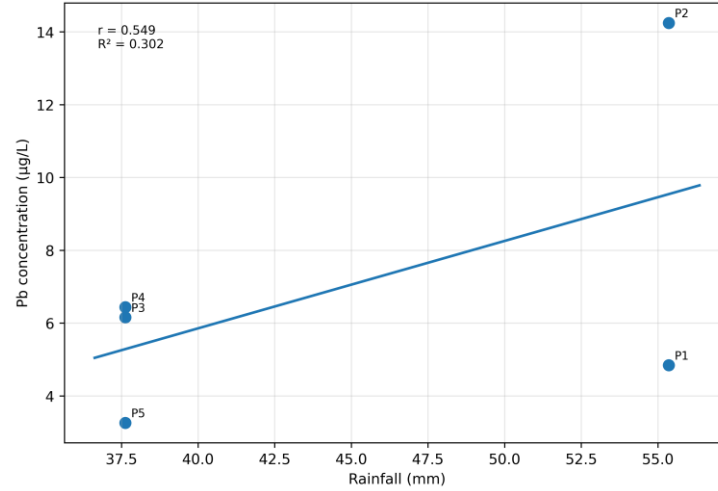
Relationship Between Rainfall and Ni Concentration



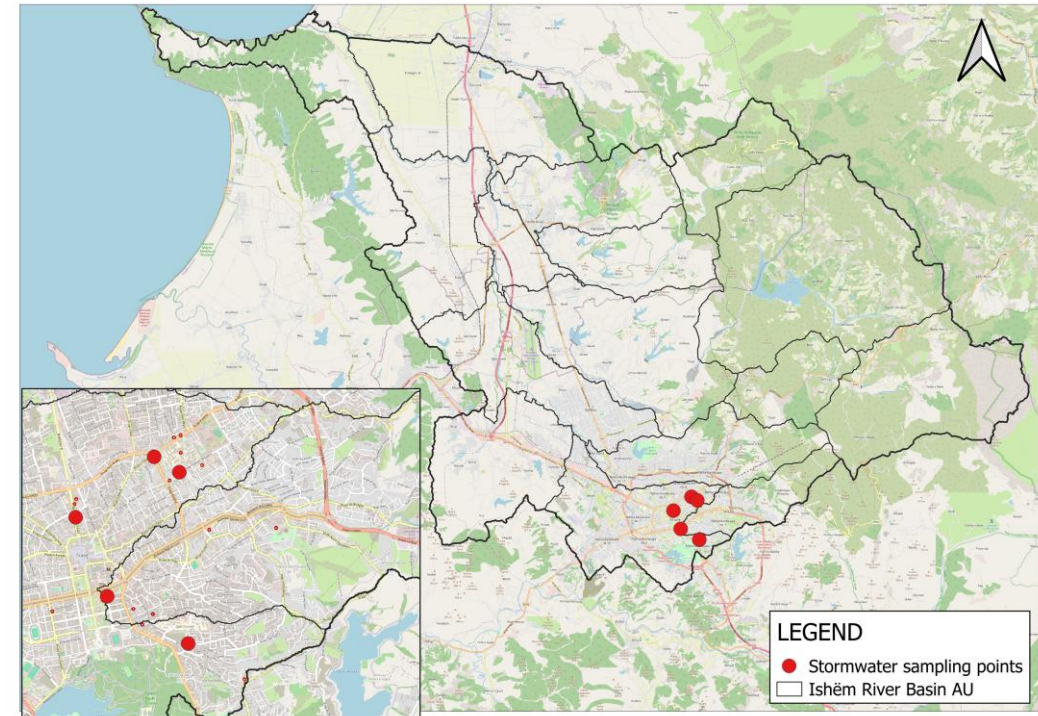
Strong rainfall–Ni correlation

Weak to Moderate rainfall–Pb relationship

Relationship Between Rainfall and Pb Concentration

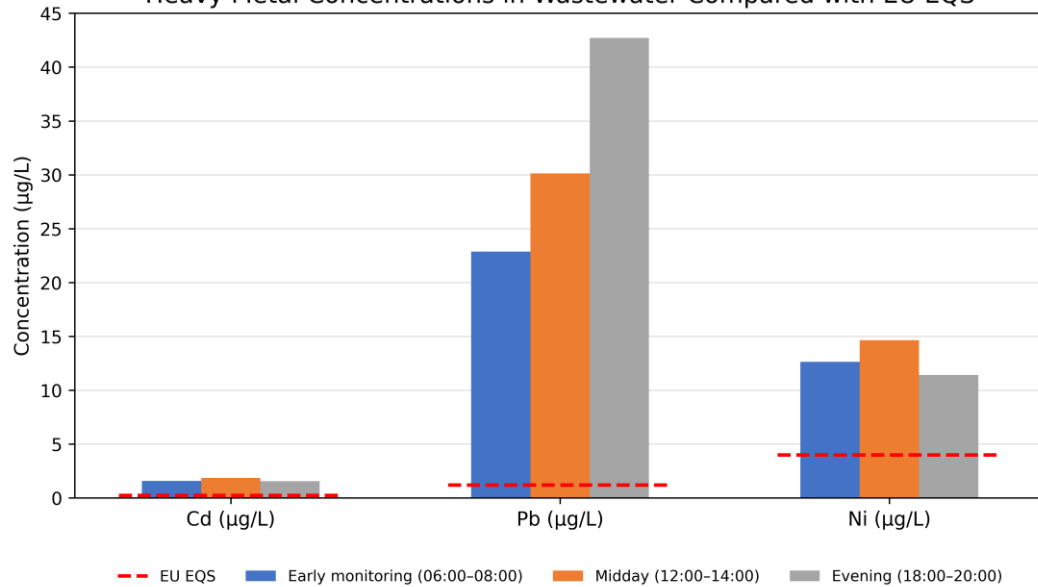


Urban Runoff
 Collection of runoff samples during rainfall events with ISCO automatic sampler
Characterisation and assessment of urban runoff pollution
Cd, Pb and Ni analysis - Urban load estimation –Data for MoRE modelling



Monitoring of wastewater

Heavy Metal Concentrations in Wastewater Compared with EU EQS

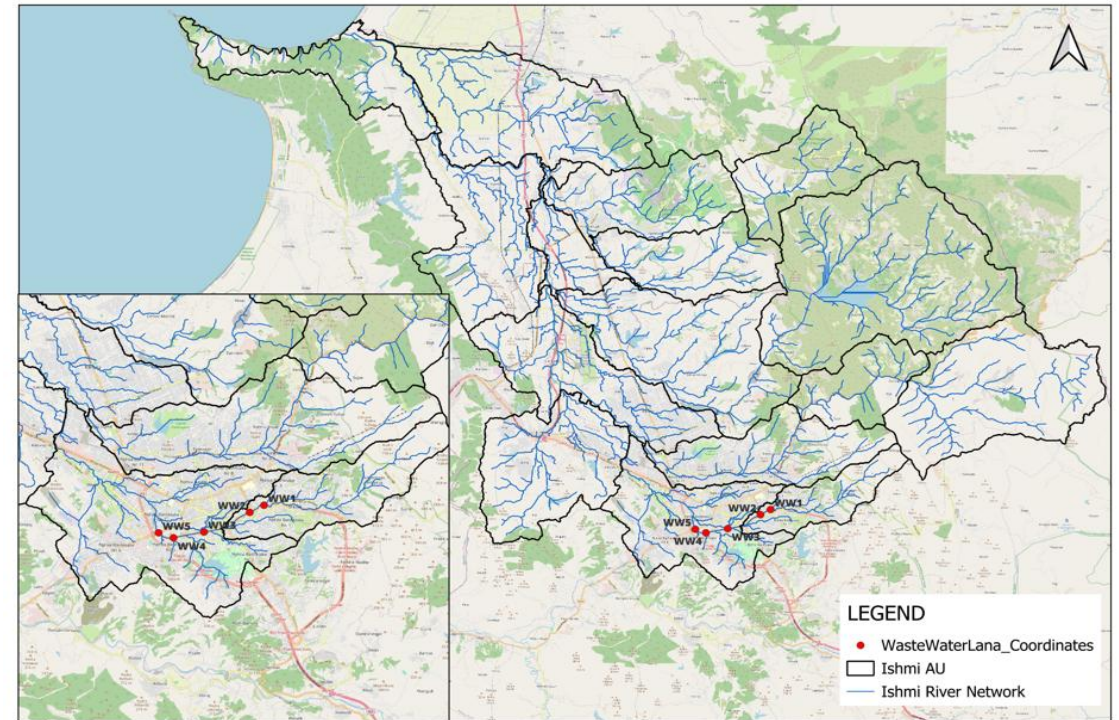


Wastewater Monitoring

- ❖ 5 monitoring locations along the Lana River
- ❖ Municipal wastewater discharges monitoring
- ❖ Three daily sampling intervals

Characterisation and assessment of wastewater pollution

Cd, Pb and Ni analysis – Wastewater load estimation - Data for MoRE modelling



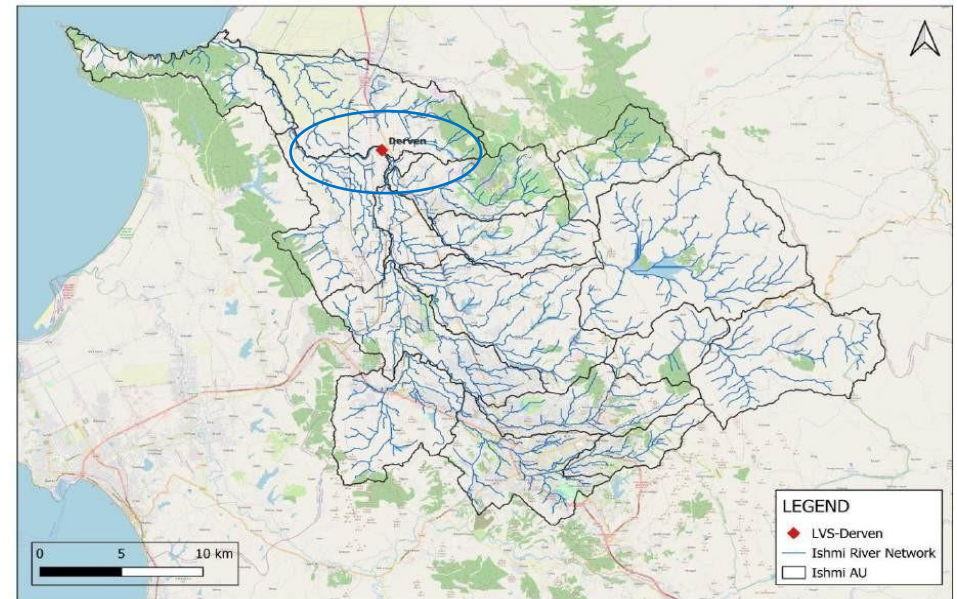
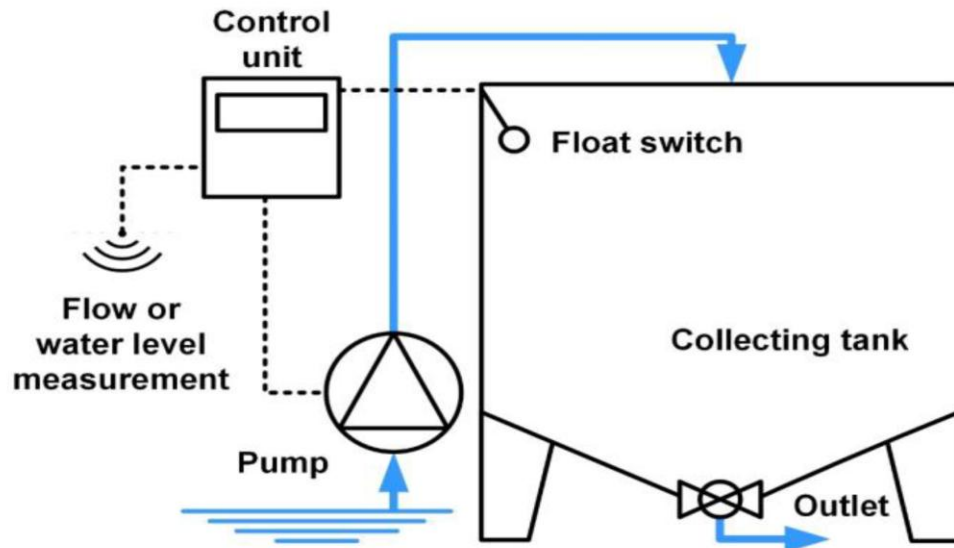
Monitoring and quantification of emission's load at the catchment's outlet

Outlet Load Monitoring

The first automatic setup for continuous river water quality monitoring in Albania

Location: Derven outlet station (Ishëm River Basin)

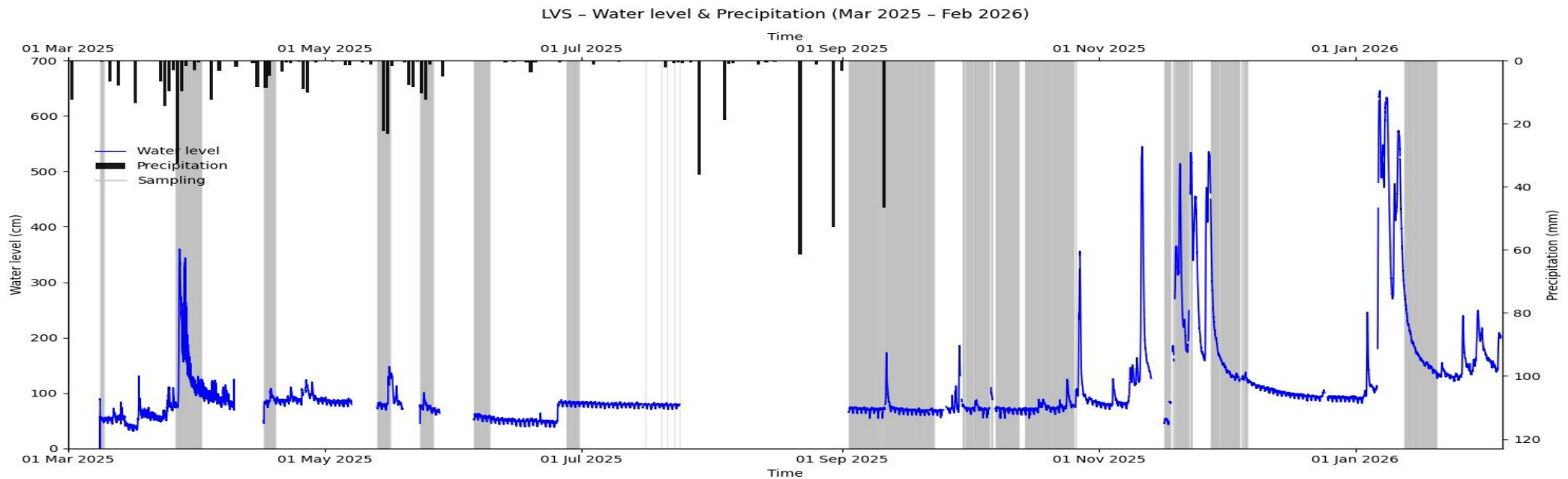
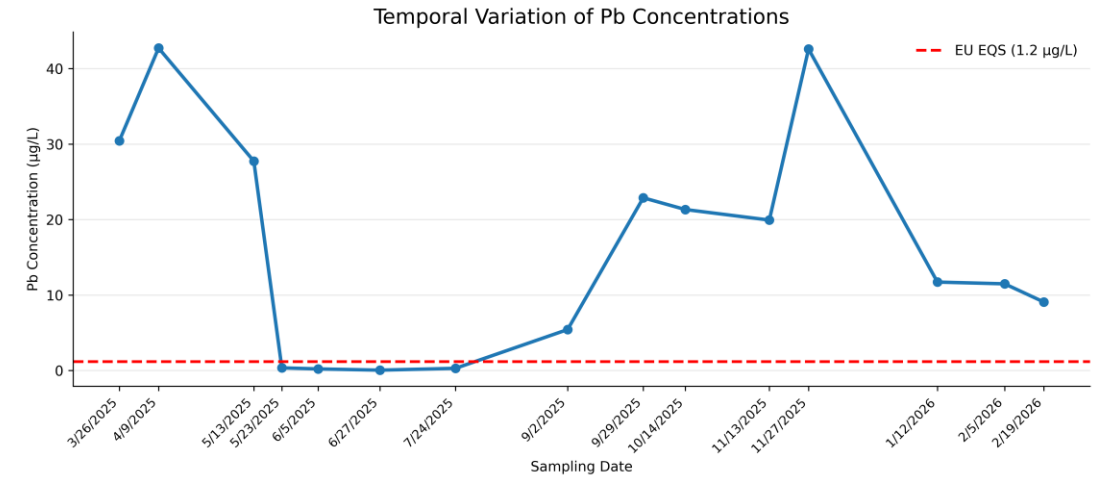
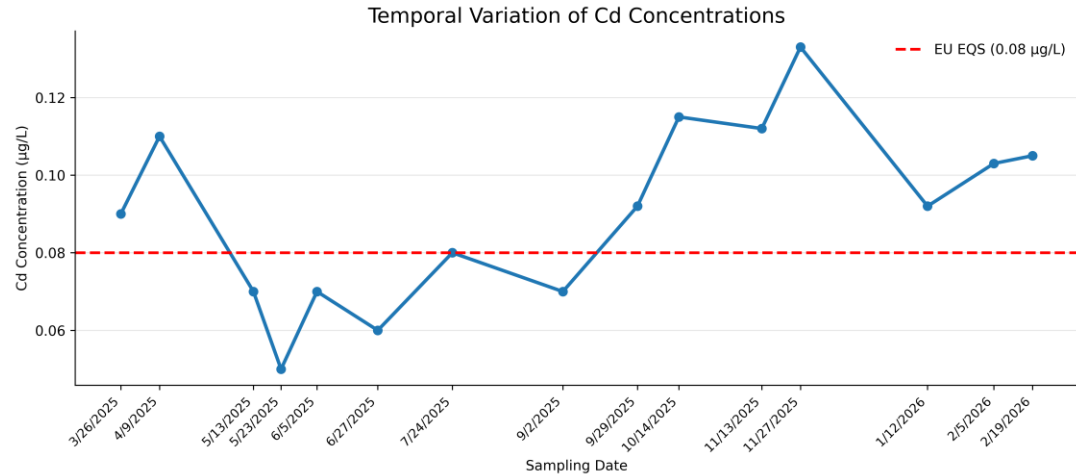
Cd, Pb and Ni analysis • Basin scale load quantification • Emission model calibration and validation



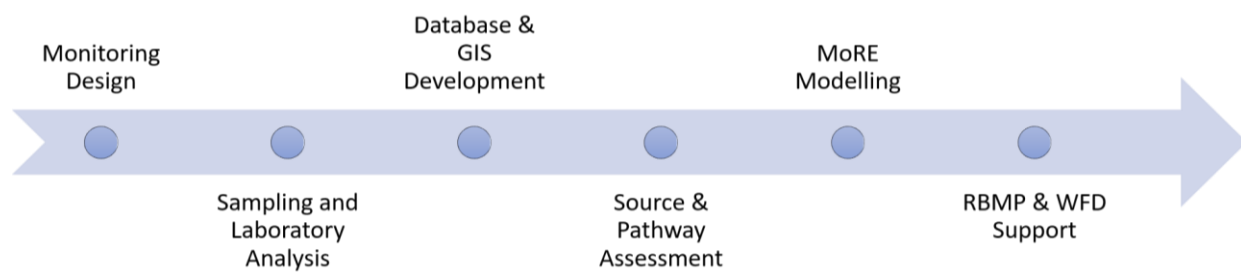
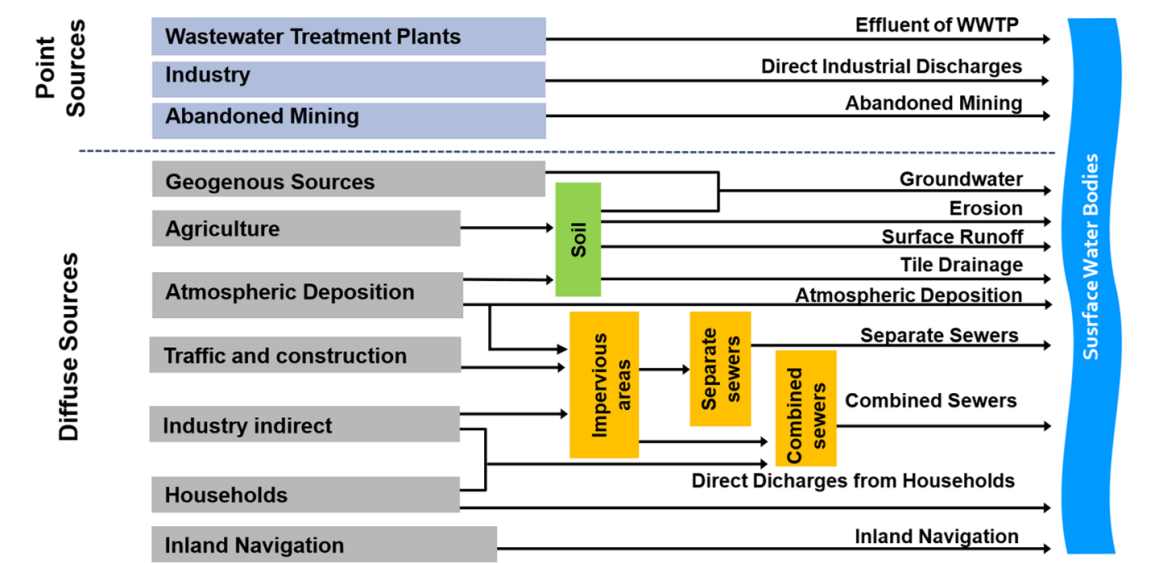
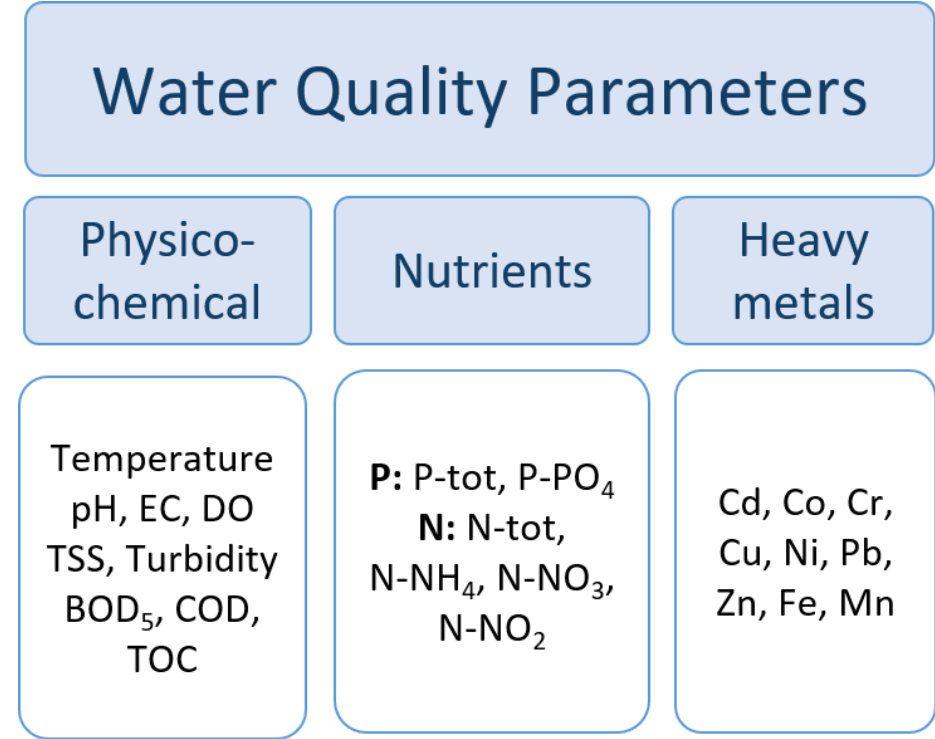
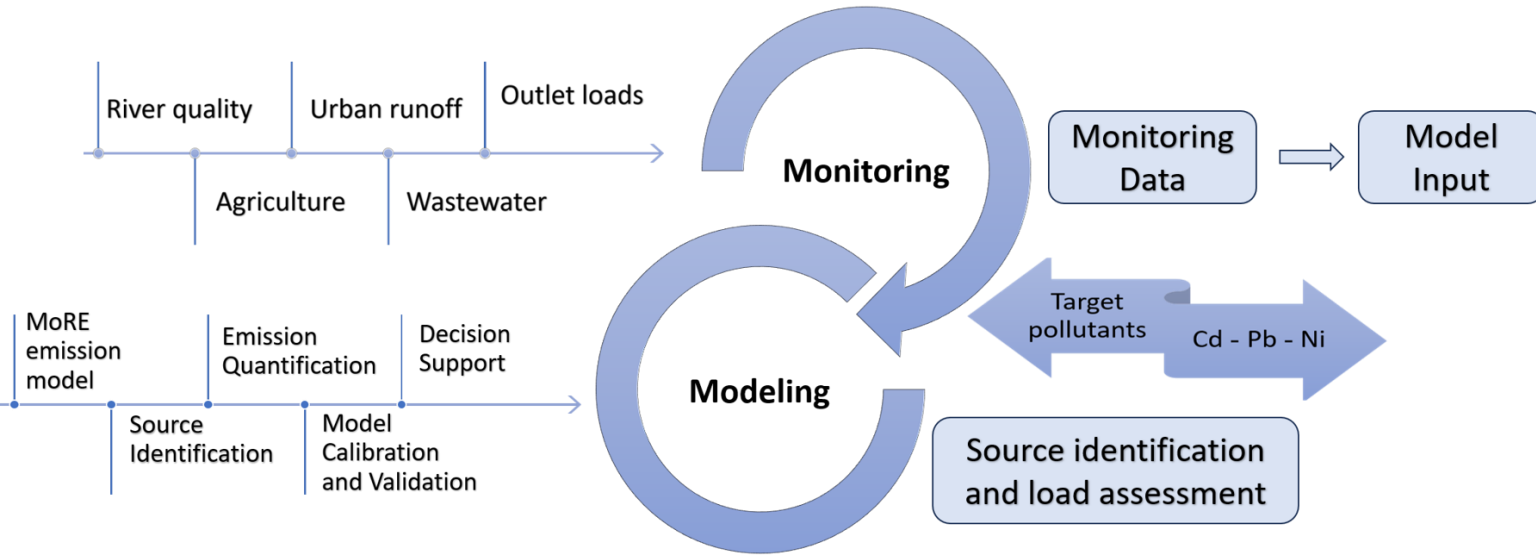
Large volume sampler scheme. Source: Adapted from Fuchs et al. (2007)



Monitoring and quantification of emission's load at the catchment's outlet



From Monitoring to Data Modelling



Conclusion and future work

◆ Heavy metal contamination was widespread throughout the Ishëm River Basin, with all monitored stations failing to achieve Good Chemical Status under WFD.

◆ Spatial patterns revealed pollution hotspots associated with highly urbanized and anthropogenically impacted areas.

◆ Urban runoff, wastewater discharges and rainfall-driven transport were identified as key pathways controlling Cd, Pb and Ni emissions to surface waters.

◆ The monitoring programme provides the first comprehensive dataset on heavy metal occurrence and transport pathways in the basin.

◆ This work establishes the first monitoring-based framework for future emission modelling and source apportionment using the MoRE approach.

Integrated monitoring transformed concentration data into an understanding of sources, pathways and pressures, providing the scientific basis for future MoRE implementation in Albania.



Acknowledgements



This study was supported by the APPEAR Project No. 320 AMoRE-AL and the Austrian Development Agency (ADA). We gratefully acknowledge the contributions of all project partners and collaborators.



River Basin Conference
11-12 June 2026





Thank you for your attention!

Vjola Bakillari

Agricultural University of Tirana

vbakillari@ubt.edu.al



River Basin Conference
11-12 June 2026

