

**Interreg
Danube Region**



Co-funded by
the European Union



Tethys

Monitoring and chemical analyses Main outcomes

Final conference

2 June 2026, Vienna (hybrid)

Presenters

Radmila Milačič Ščančar and Ottavia Zoboli

Introduction

Monitoring and chemical analyses were carried out under the Activity 1.1 Targeted cost-efficient transnational measurement of HS occurrence and concentration level in critical regions and in critical emission pathways

Partners involved:

JSI, TU Wien, BME, BWA, NARW, WRI, CETI, UHMI, HV, JUVS, UBA, JCWI

The driving objective of the monitoring

- To increase the number of data points in main rivers and tributaries for model validation
- To increase the data availability regarding specific emission pathways

Parameters measured:

SOP prepared jointly by all PPs

- SOP includes the criteria for selection of sampling sites and sampling protocols for chemical analyses planned within the Tethys project.
- SOP delivers instructions for sample identification, handling, preservation, transport and cleaning procedures for different type of the analysis.
- SOP provides parameters for chemical analysis for a particular sample matrix.

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Deliverable 1.1.1

Protocol for sampling, storage and transport
of samples

D1.1.1 Delivered by the end
of June 2024

Samplings across the countries of the TETHYS PPs



Urban storm runoff water, Liesingbach, AT



River Maros, HU



Yantra river, BG



Nelipyno, Vicha River, UA



Oborovo, Sava River, HR



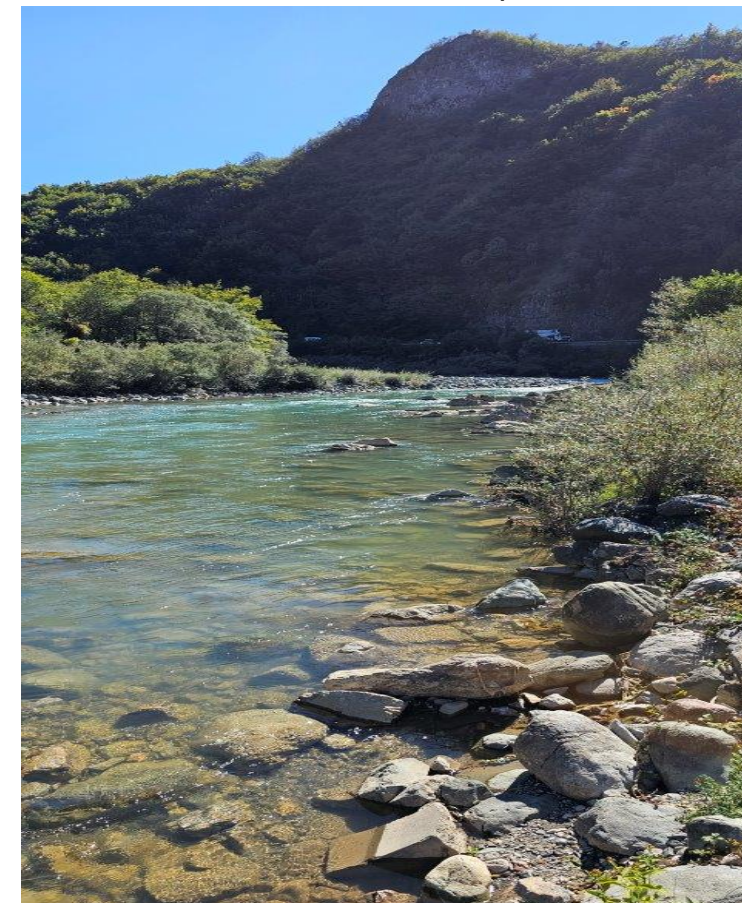
Razboj, River Vrbas, BA



WWTP Glina, Bucharest, RO



Groundwater sampling near international airport Nikola Tesla, Belgrade, highway, agricultural areas and releases of wastewaters from nearby settlements, RS



Landfill Mojkovac, Tara River, ME



Outlet of surface runoff from the Military Airport Sliac, SK



Sava Dolinka, background location, SI

Metal analysis: Cd, Pb, As, Zn, Cu, Cr, Ni

River water – Total and Dissolved

Wastewater – Total

Groundwater – Dissolved

Urban storm runoff water – Total

PPs regularly collected samples and store them frozen until delivery for metal analysis.

Analyses performed immediately upon sample receipt.

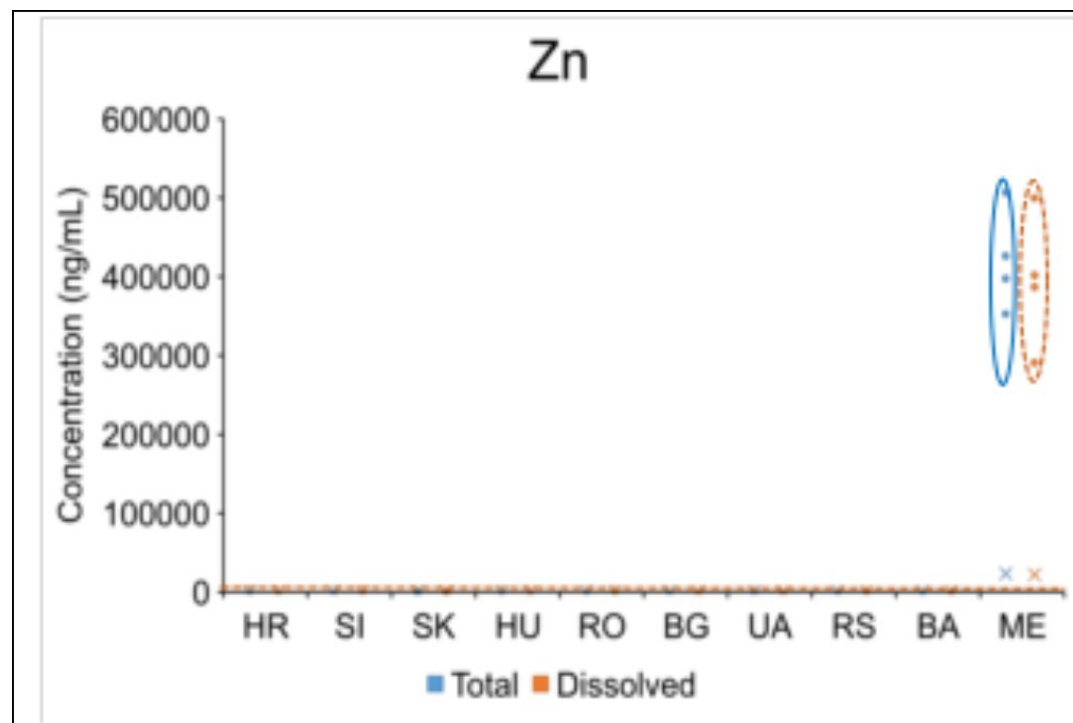
PPs followed the SOP for sampling protocols.

All planned samples collected and analyzed by the end of September 2025.

Excellent collaboration with PPs.

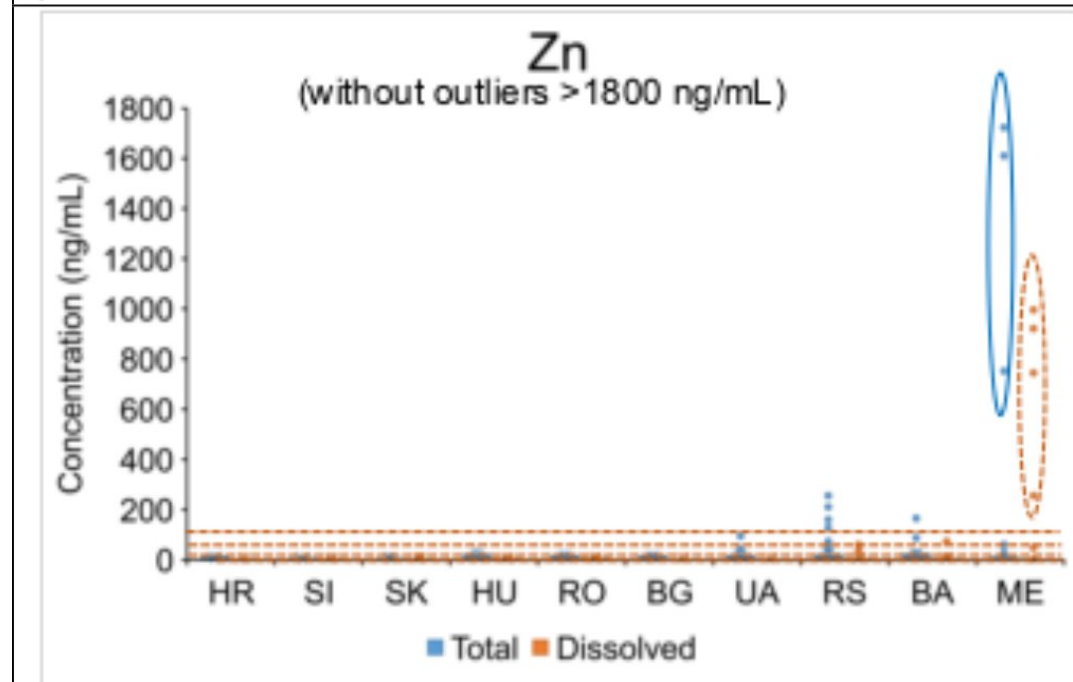
5992 data on metal concentrations provided to modelers

Zinc – River water



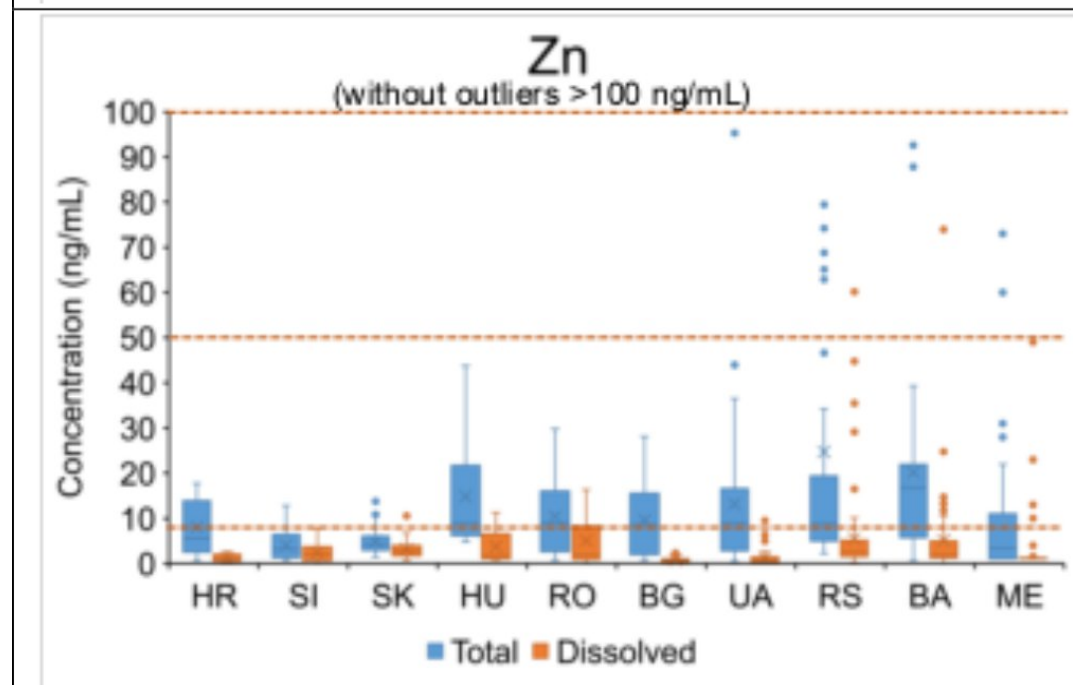
Mjedenički Stream (ME) — abandoned zinc and lead mine, rich in sulfide minerals.

Sampling site	Zn (ng/mL)
RIV-MEMP-01T	506690
RIV-MEMP-01D	499520
RIV-MEMP-02T	426020
RIV-MEMP-02D	401690
RIV-MEMP-03T	352743
RIV-MEMP-03D	290898
RIV-MEMP-04T	397510
RIV-MEMP-04D	386774



Mojkovac, Rudnica River (ME) — former lead and zinc ore mining.

Sampling site	Zn (ng/mL)
RIV-MERU-02T	1610
RIV-MERU-02D	922
RIV-MERU-03T	1742
RIV-MERU-03D	996
RIV-MERU-04T	1723
RIV-MERU-04D	255



Foča, Drina River (BA) — municipal influence and rafting activities. Wastewater discharged untreated into the river.

Sampling site	Zn (ng/mL)
RIV-BA-RSFO-02T	165
RIV-BA-RSFO-02D	73,9

Mojsinje, Južna Morava River (RS) — municipal influence, metal and chemical industry. Wastewater discharged mostly untreated into the river.

Sampling site	Zn (ng/mL)
RIV-RSMO-03T	79,4
RIV-RSMO-03D	60,1

EC Environmental Objectives 272/2009 – Specific Pollutants

EQS for Zn with regard to water hardness:
 ≤10 mg/L CaCO₃ (soft).....8 ng/mL Zn
 10–100 mg/L CaCO₃ (medium-hard).....50 ng/mL Zn
 >100 mg/L CaCO₃ (hard).....100 ng/mL Zn



Highly contaminated site Mjedenički Stream, ME

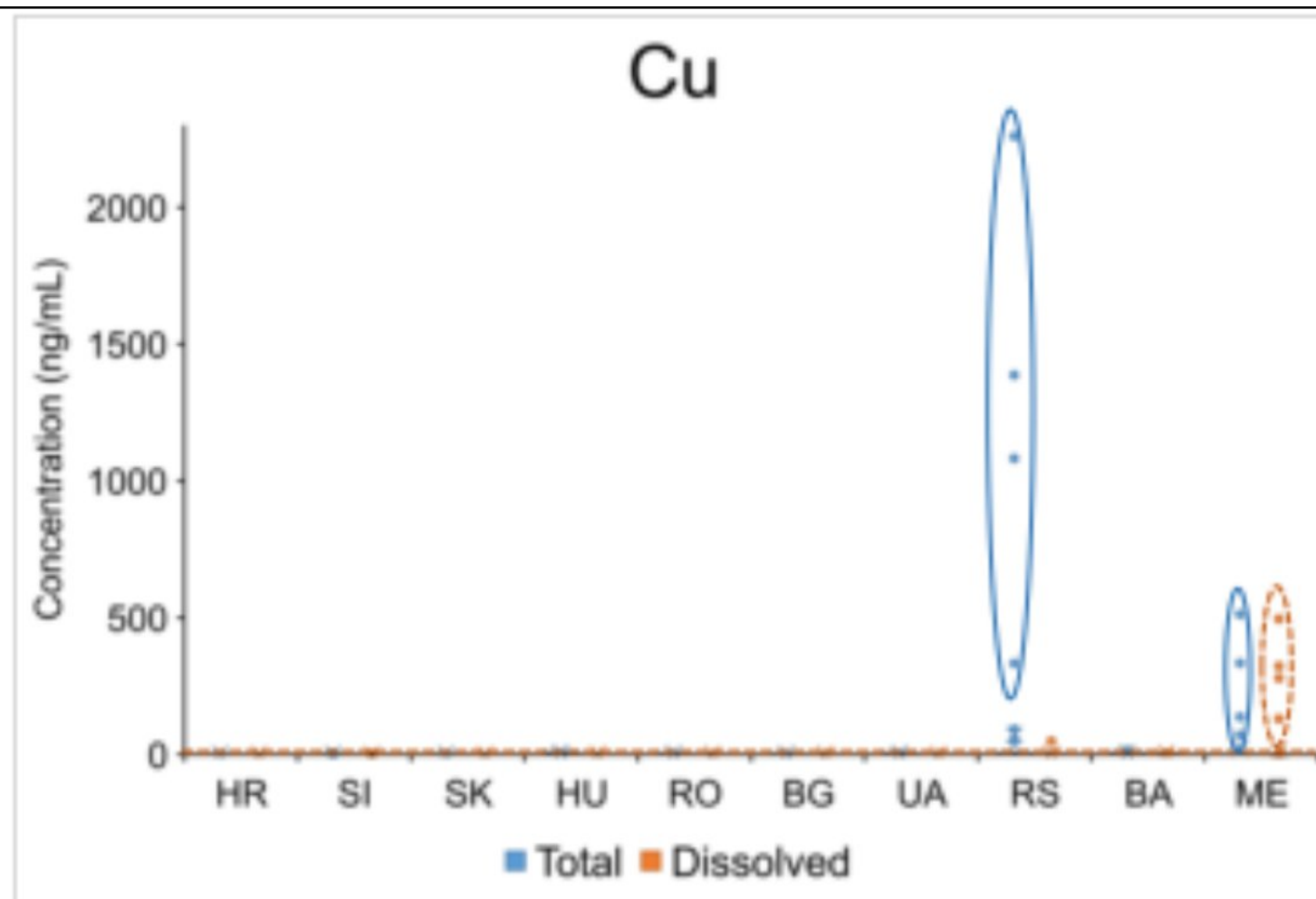
- Abandoned zinc- and lead-mining area, affected by bioleaching from *Acidithiobacillus* bacteria.



Contaminated site Mojkovac, Rudnica River, ME

- Area impacted by former lead and zinc ore mining activities.

Copper – River water

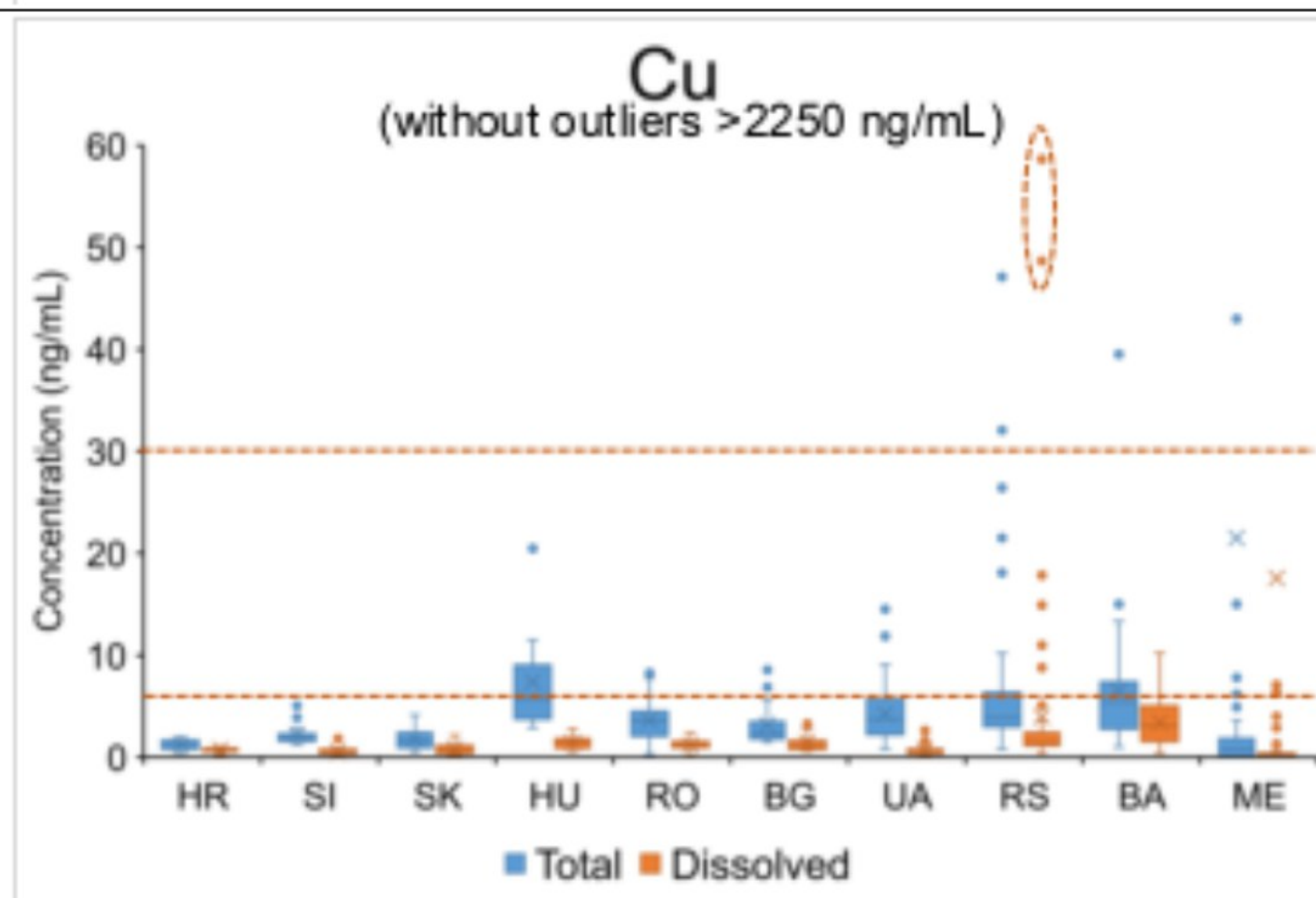


Mjedenički Stream (ME) — abandoned zinc and lead mine, rich in sulfide minerals.

Sampling site	Cu (ng/mL)
RIV-MEMP-01T	334
RIV-MEMP-01D	323
RIV-MEMP-02T	350
RIV-MEMP-02D	280
RIV-MEMP-03T	513
RIV-MEMP-03D	496
RIV-MEMP-04T	138
RIV-MEMP-04D	131



Rogotina, Borska River, RS
 • Area impacted by intensive gold and copper mining.



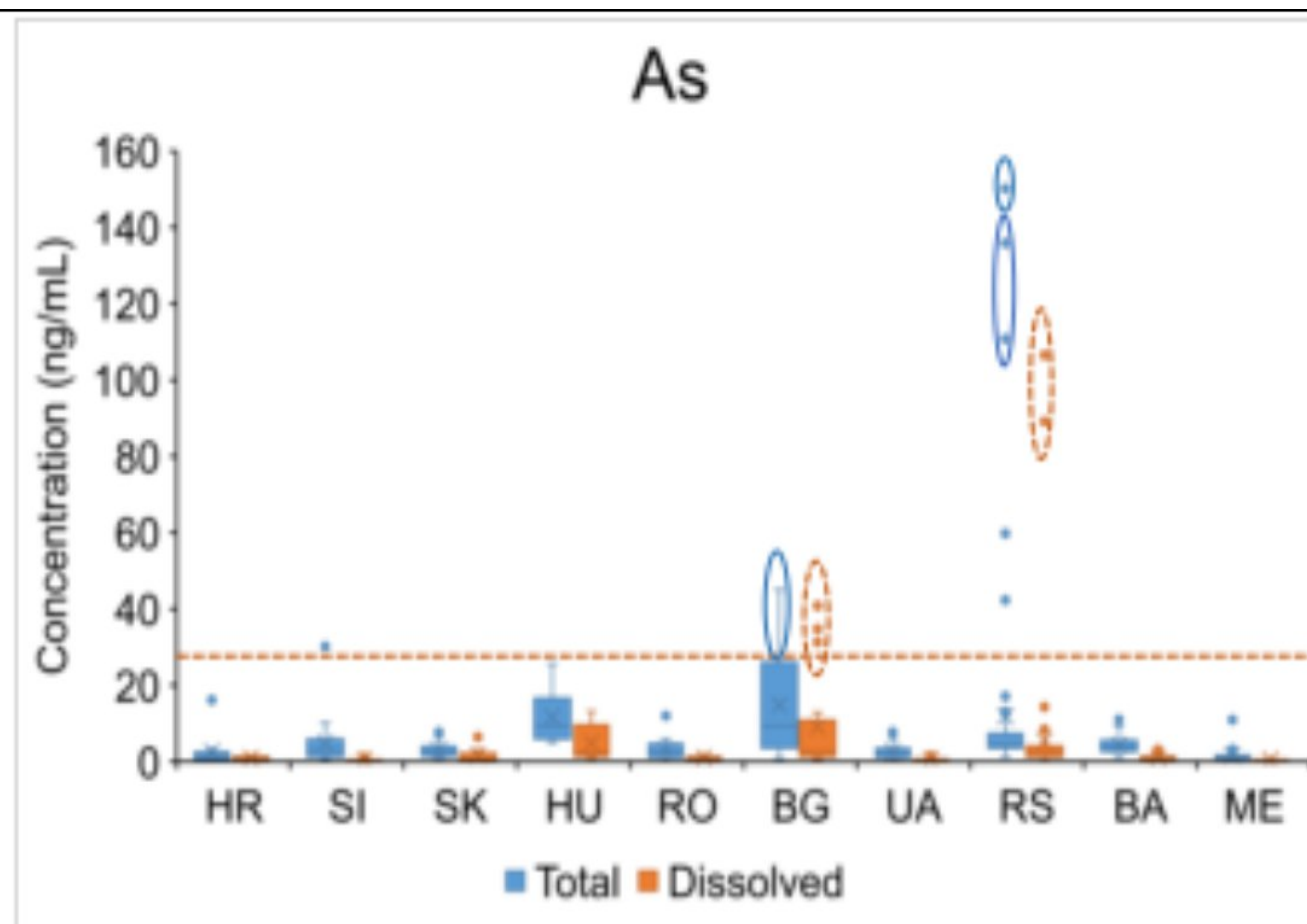
Rogotina, Borska River (RS) — intensive gold and copper mining.

Sampling site	Cu (ng/mL)
RIV-RSBR-01T	2260
RIV-RSBR-01D	14,9
RIV-RSBR-02T	1386
RIV-RSBR-02D	11,0
RIV-RSBR-03T	1082
RIV-RSBR-03D	58,7
RIV-RSBR-04T	332
RIV-RSBR-04D	48,7

EC Environmental Objectives 272/2009 – Specific Pollutants

EQS for Cu with regard to water hardness:
 ≤100 mg/L CaCO₃ (medium-hard).....5 ng/mL Cu
 >100 mg/L CaCO₃ (hard).....30ng/mL Cu

Arsenic – River water



Rgotina, Borska River (RS) — intensive gold and copper mining.

Sampling site	As (ng/mL)
RIV-RSBR-01T	150
RIV-RSBR-01D	4,60

Draževac, Kolubara River (RS) — lignite open-pit mining and a thermal power plant.

Sampling site	As (ng/mL)
RIV-RSBR-01T	150
RIV-RSBR-01D	4,60

Butan village, Ogosta River (BG) — processing of the lead and zinc ore mobilized geogenic As.

Sampling site	As (ng/mL)
RIV-BGOG-01T	35,5
RIV-BGOG-01D	34,8
RIV-BGOG-03D	31,3
RIV-BGOG-04T	45,1
RIV-BGOG-04D	40,8

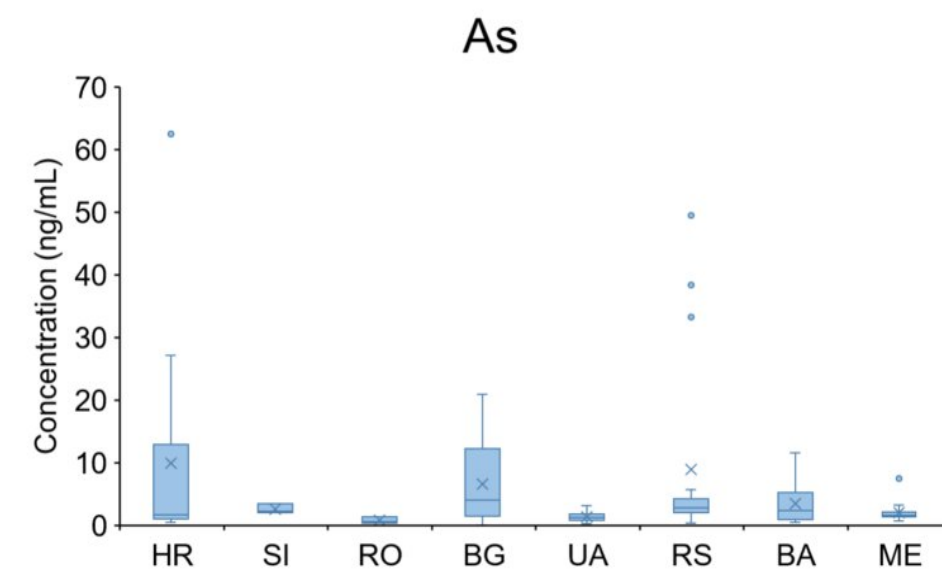
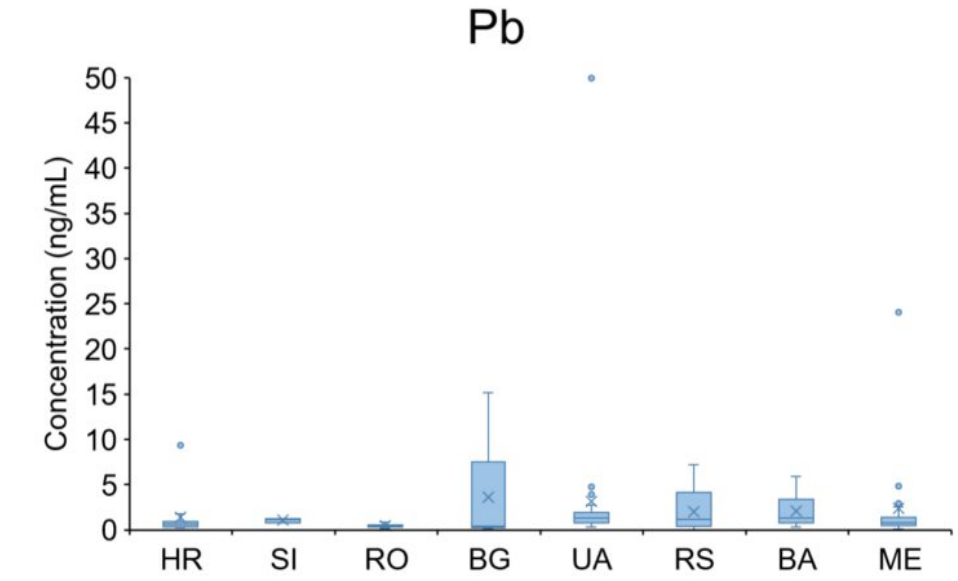
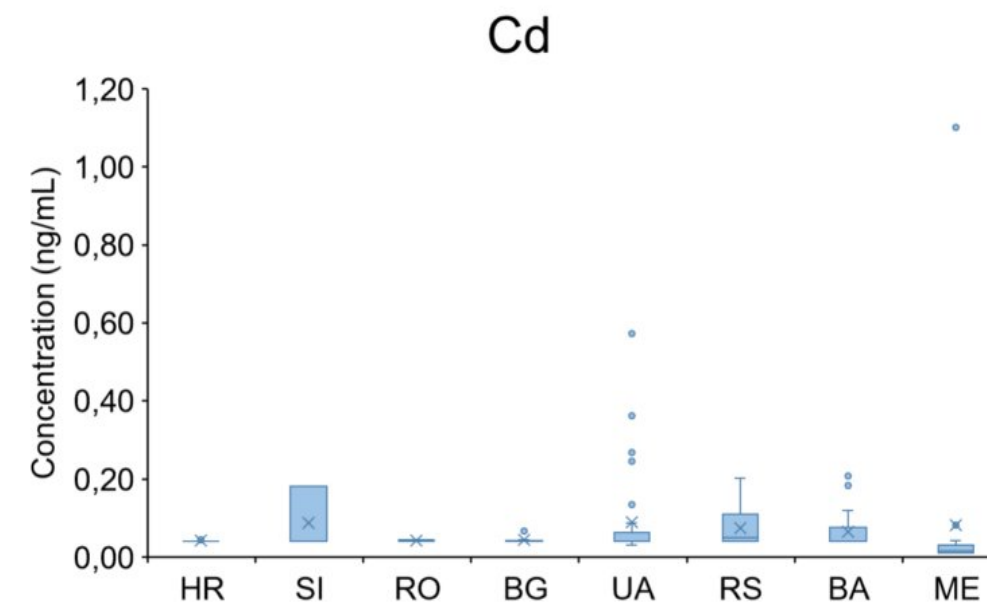
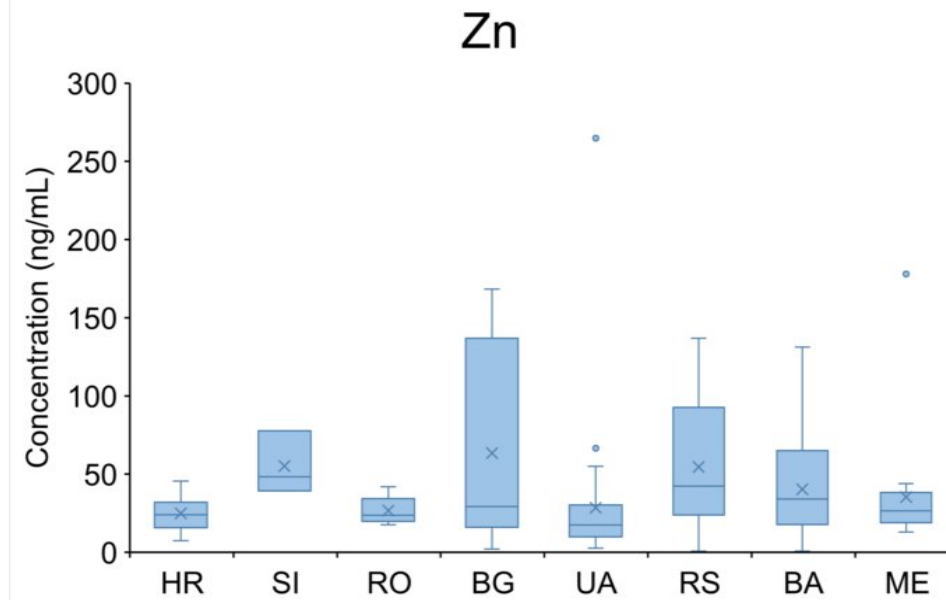
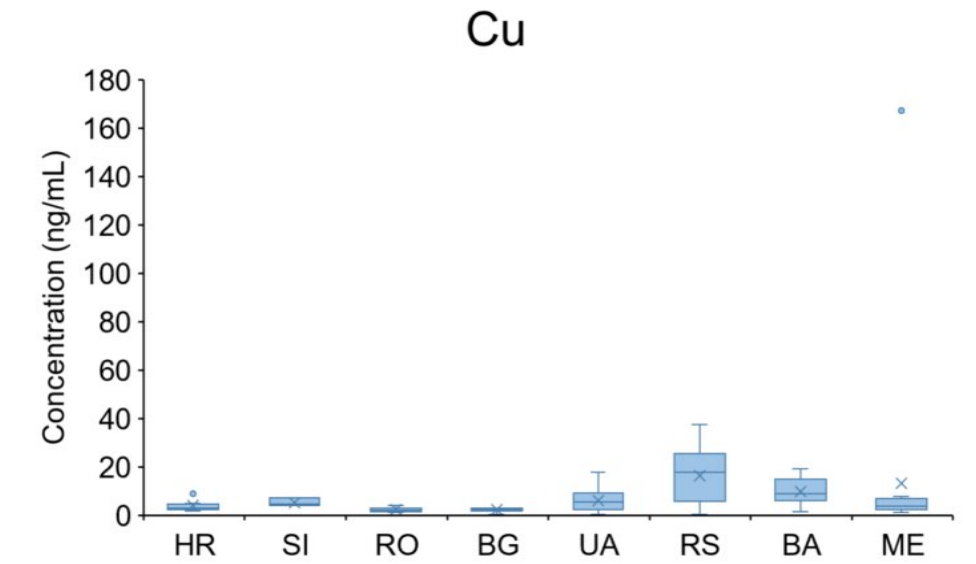
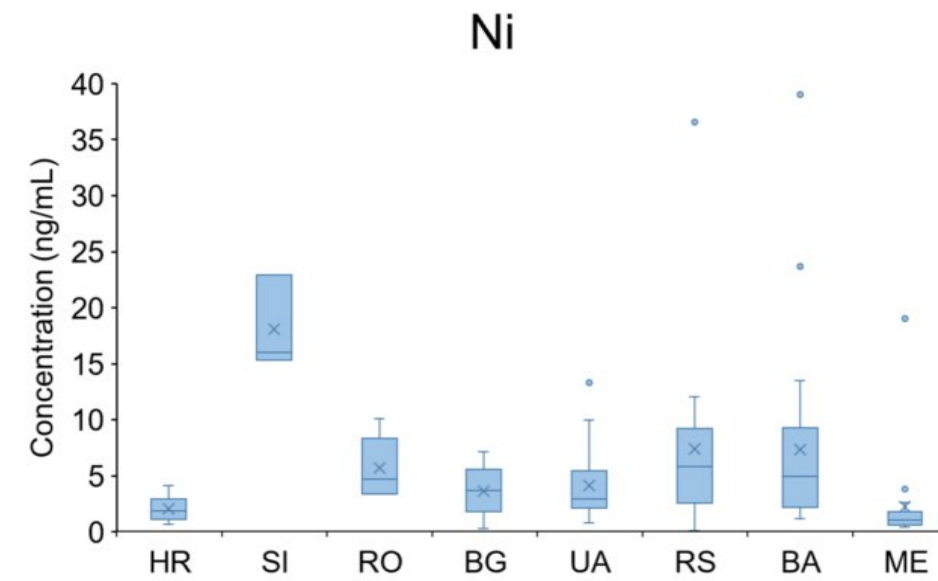
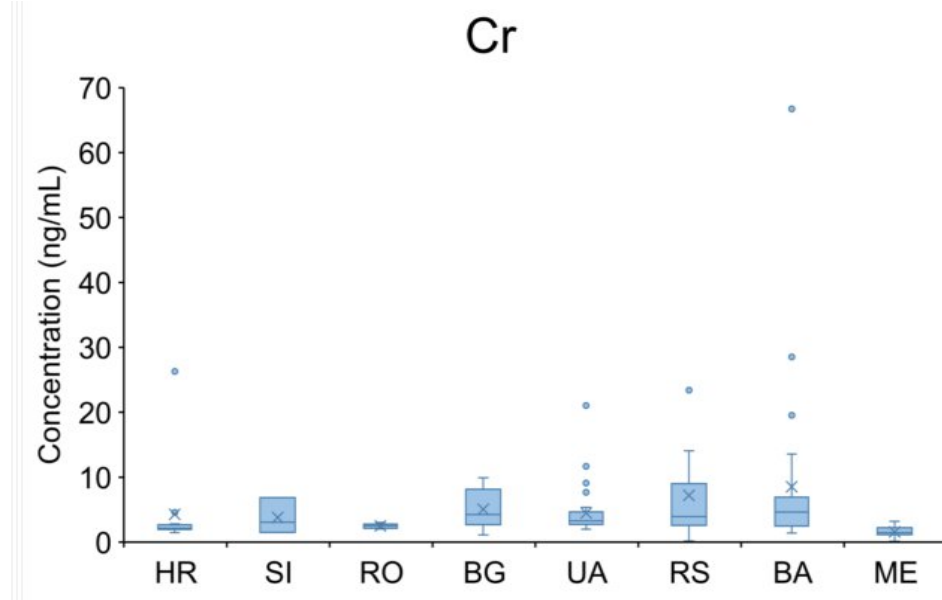
EC Environmental Objectives 272/2009 – Specific Pollutants

EQS for As:

As.....25 ng/mL

With the exception of results from Mjedenički Stream, ME, concentrations of Cr, Ni, Cd, and Pb in river water samples across the investigated countries in general did not exceed EQS standards.

Wastewater

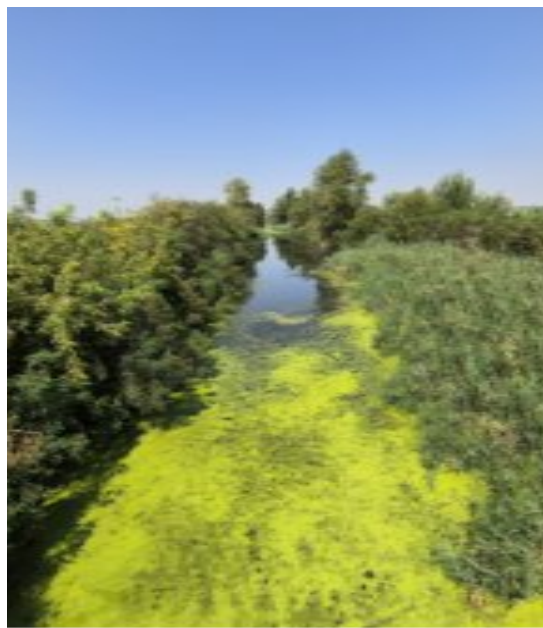
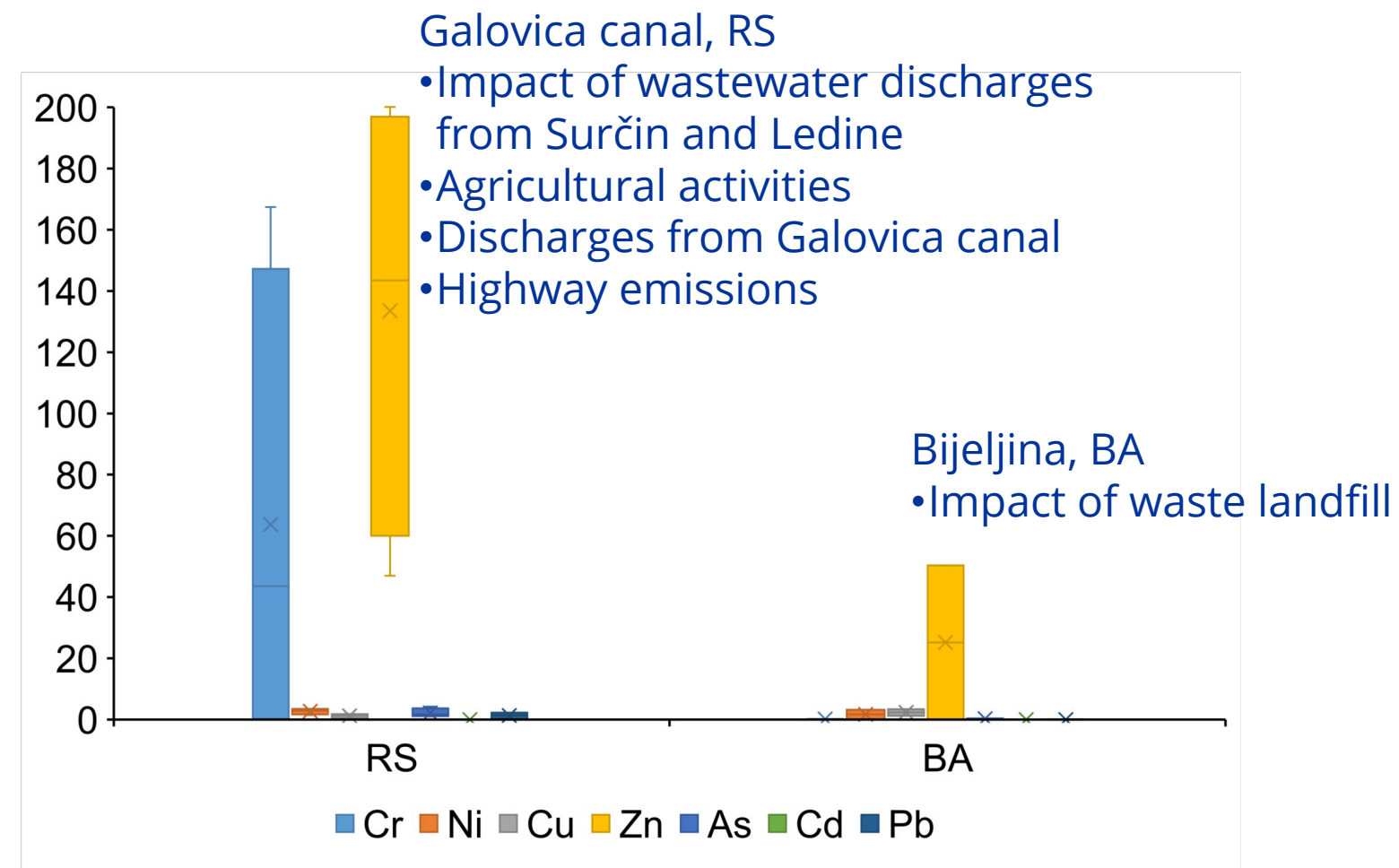


The Urban Wastewater Treatment Directive (EU) 2024/3019 does not specify permissible concentrations for metals. It emphasizes the need for effective treatment of urban wastewaters.

Metal concentrations in wastewater were relatively low at all sampling sites across the PP countries, indicating effective wastewater treatment.

In some countries, untreated wastewater is still discharged directly into receiving water bodies.

Groundwater

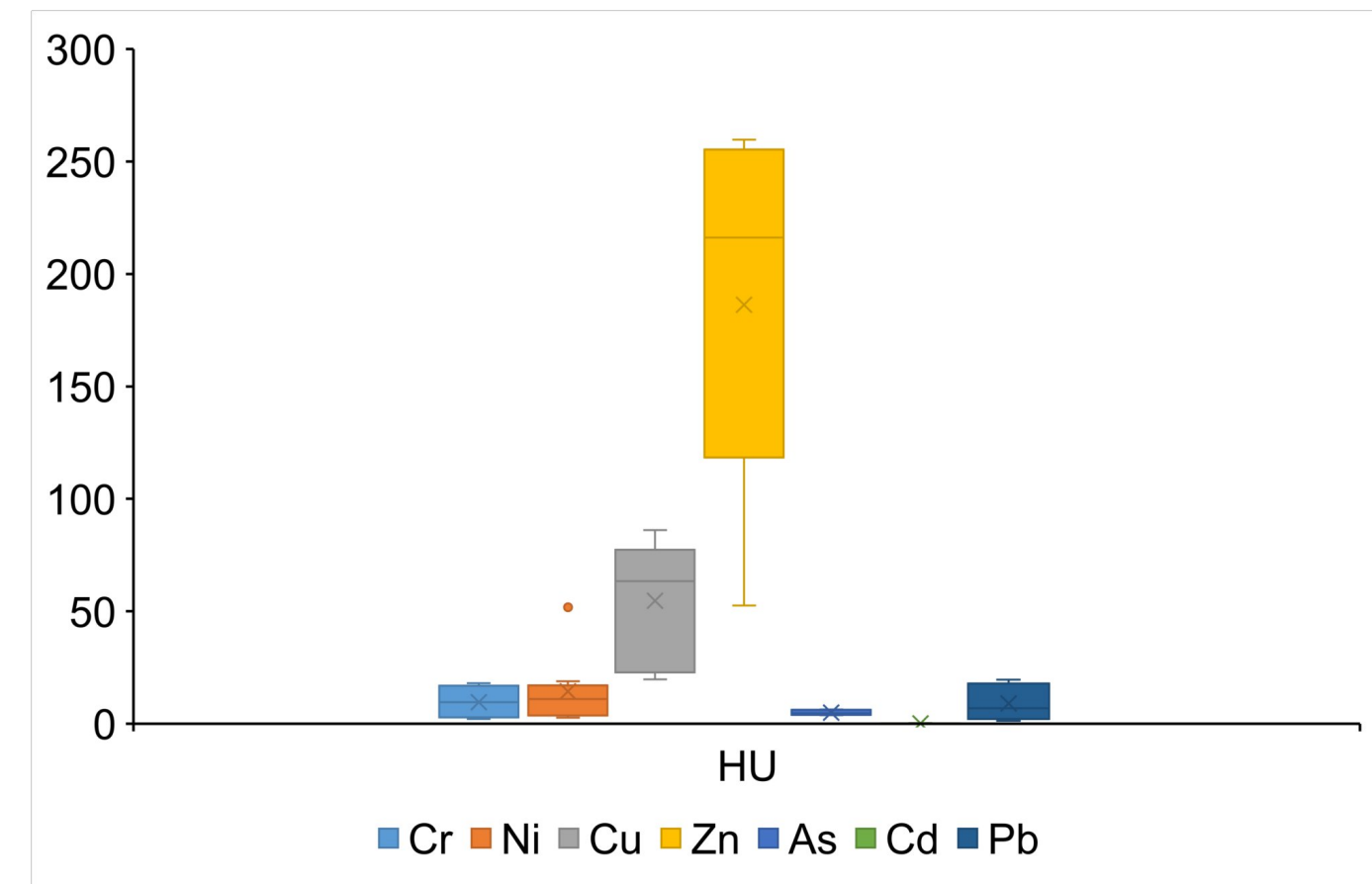


Galovica canal

The new EU groundwater directive does not specify threshold levels for metals.

Regarding water quality, the monitored groundwater is not suitable for human consumption.

Urban storm runoff water



There is no legislation prescribed for urban storm runoff water

- Zn – car tires (ZnO)
- Cu – car breaks
- Cr, Ni – car breaks industrial emissions

Summary – metals

The monitoring campaigns revealed that metal concentrations in river waters generally meet the EQS criteria set by the WFD, except for known hotspots associated with industrial, mining, or municipal activities.

- Both, total and dissolved metal concentrations in the Tethys project are significantly higher compared to data from the Danube Hazard m3c projects.
 - *Influence of highly contaminated sites – Mjedenički Stream and Rudnica River, ME; Borska River, RS.*
 - *High Zn and Cu concentrations were determined in the Danube Hazard m3c project at the mining area along the Cisla River, RO.*
- Hotspots at sampling sites in the Tethys project are significant contributors to the deterioration of river water quality, particularly in ME and RS, with lesser effect in BA.

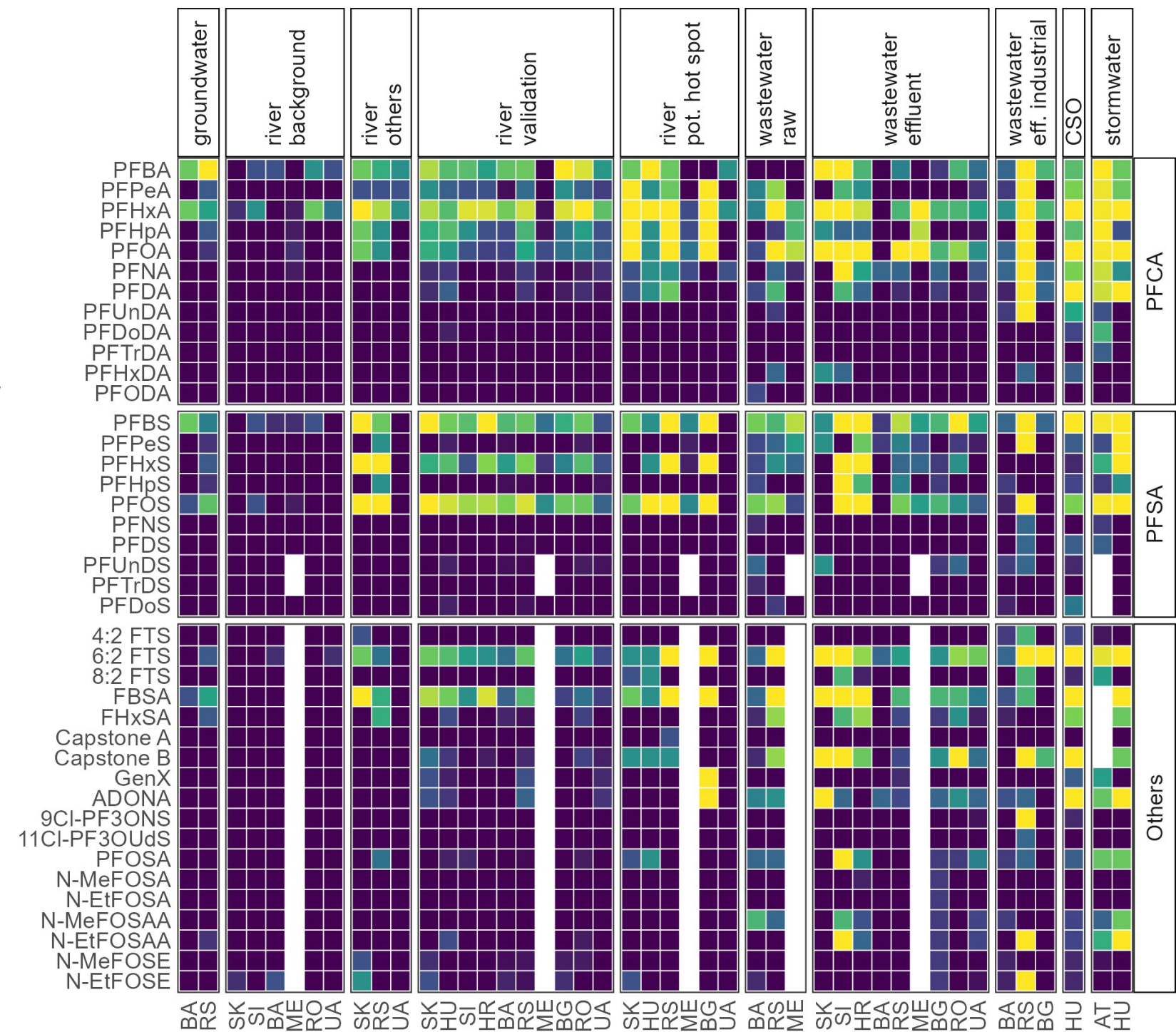
*To support the understanding of element transport in river water and for modelling purposes, it is essential to determine both **total and dissolved element concentrations**. Such measurements have already been conducted in GLOBAQUA, Danube Hazard m3c, StraMoS, HU-SI bilateral projects.*

Recommendation: National environmental agencies should adopt this approach, even though the WFD currently considers only dissolved element concentrations.

- Wastewater treatment in both EU and non-EU countries is largely effective with respect to metals.
- Discharges of untreated wastewater into rivers contribute to elevated metal concentrations in river waters.
- Insufficient wastewater treatment contributes to elevated metal concentrations and reduced groundwater

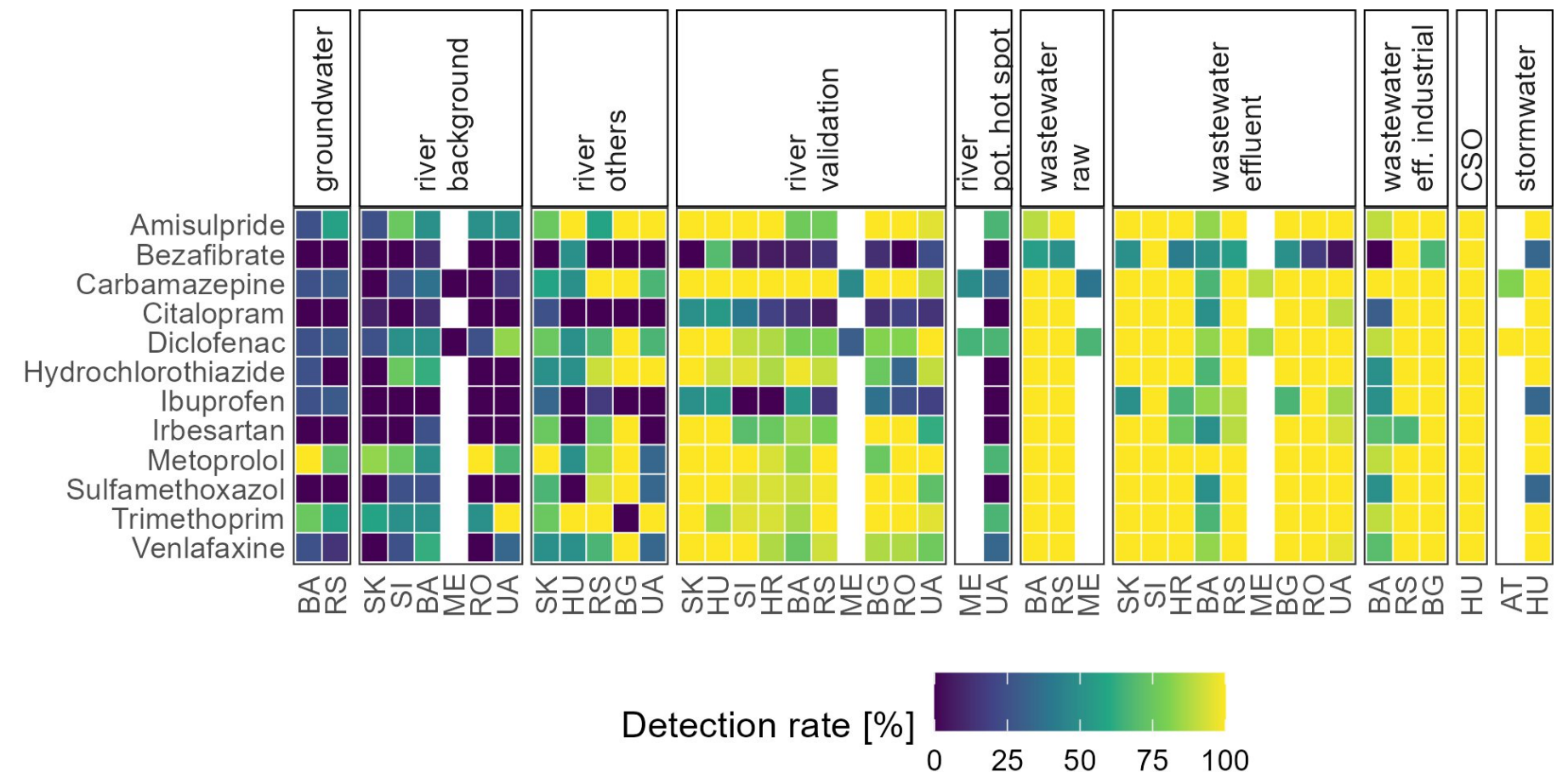
Monitoring results: PFAS

- Widespread detection of short-chain PFAS and of main substitute of PFOS and PFOA; seldom detection of long-chain compounds
- High detection rate of PFAS and pharmaceuticals in WWTP effluents and CSOs
- River sites selected as potentially affected by hotspots in the catchments show more elevated concentrations particularly for PFCA (up to 30 ng/l for PFBA) and detection of long-chain PFDA and PFNA
- Substance-specific high concentration variability in rivers and wwtp effluents (about one order of magnitude) among countries
- High concentration variability (up to 3 orders of magnitude) in urban stormwater runoff and CSO
- Similar levels of PFBS, PFOS and 6:2 FTS in CSO and stormwater; higher levels of PFBA, PFOSA, N-MeFOSAA, N-EtFOSAA in stormwater; higher level of many other compounds in CSO



Monitoring results: Pharmaceuticals

- Bezafibrate, citalopram and ibuprofen mostly < LOQ in surface waters; other pharmaceuticals mostly > LOQ
- Low detection rates in groundwater and background river water
- Concentrations in river samples varied widely (from 1 ng/L to peaks of 10,000 ng/L)
- In wwtp effluents, concentrations have high substance-specific variability (up to 3 orders of magnitude) among countries
- Sites selected as potential hotspots do not show elevated concentrations (other pharmaceuticals emitted? wrong hypothesis?)



Monitoring | Outputs

- Detailed description of monitoring design and sampling sites in the countries
- Detailed description of applied methods (from sampling to lab analyses)
- Detailed presentation of all results

Proposal and recommendations for future coordinated actions in Output 3.1 (Strategy)

<p>Interreg Danube Region  Co-funded by the European Union</p> <p> Tethys</p> <h2>Output 1.1</h2> <p>Testing and demonstration of harmonized and cost-efficient monitoring strategies in non-EU countries and in new critical compartments as a basis for HS emissions and pollution inventories</p>	<p>Interreg Danube Region  Co-funded by the European Union</p> <p> Tethys</p> <h2>Output 1.7</h2> <p>Harmonized and cost-efficient monitoring strategies as a basis for HS emissions and pollution inventories</p>
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Advancement and harmonisation of chemical analyses Led by the Water Research Institute (SK)

Workshop to exchange know-how
and experience on analysis of
PFAS and pharmaceuticals
October 2024

First interlaboratory
comparison
February 2025

6 labs participated

Hands-on workshop in
Bratislava
June 2025

Second interlaboratory
comparison

13 labs participated

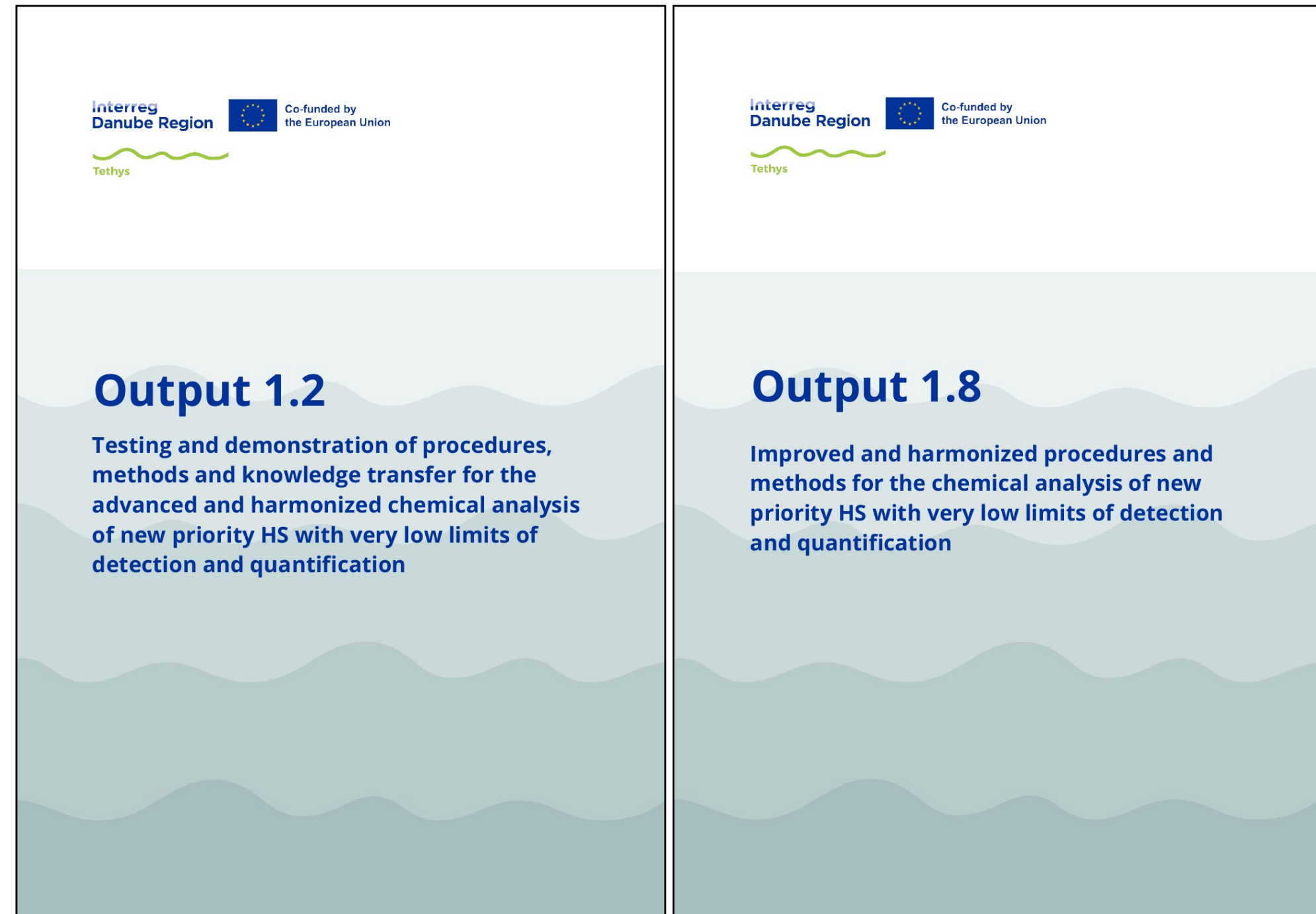





Advancement and harmonisation of chemical analyses Led by the Water Research Institute (SK)

Selected content and highlights

- Review of standardized methods and of methods applied by PPs in Tethys for the analysis of PFAS
- Experiences and recommendations for the analysis of PFAS gathered during project workshops
- Results of interlaboratory studies (anonymous)
- Lessons learned on good methodologies and approaches during interlaboratory comparison studies
- Outlook and advice to improve implementation of analytical methods for new pollutants monitoring in the Danube River Basin




Proposal and recommendations for future coordinated actions in Output 3.1 (Strategy)



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Output 1.2

Testing and demonstration of procedures, methods and knowledge transfer for the advanced and harmonized chemical analysis of new priority HS with very low limits of detection and quantification

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Output 1.8

Improved and harmonized procedures and methods for the chemical analysis of new priority HS with very low limits of detection and quantification

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