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Time-integrated sediment quality monitoring in large rivers. Temporal variations in suspended and floodplain sediments in the Drava River.

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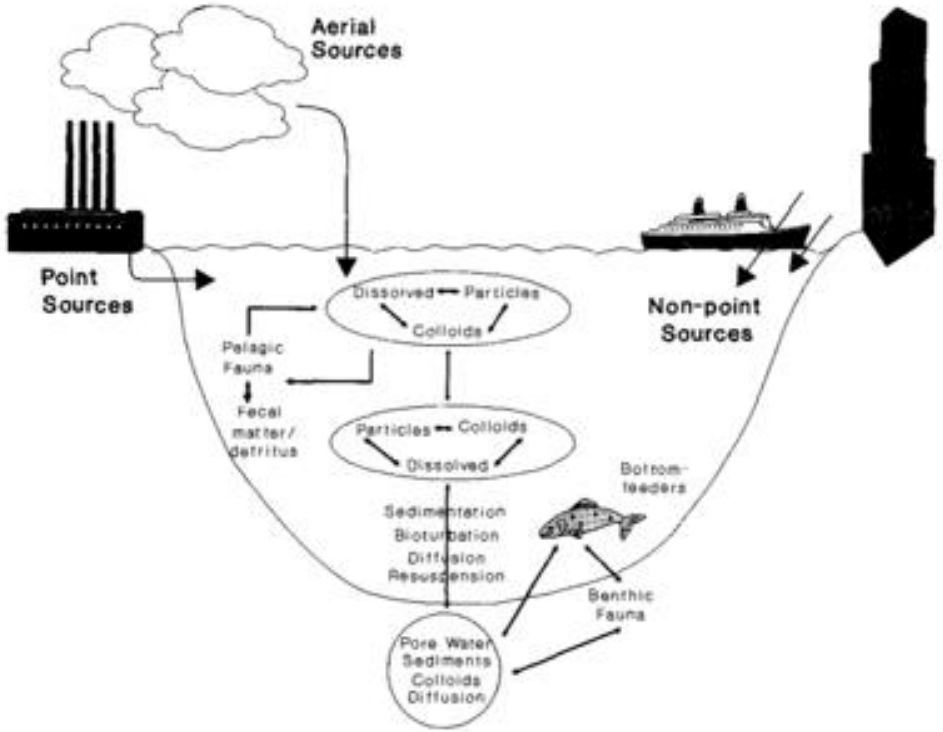
Background and aims

- Sediments are an essential, integral and dynamic part of our river basins
- Sediments may integrate information on contamination over a long time, and they pose potential secondary sources of contamination to the aquatic environment.
- A reliable estimation of the overall amount of contaminated sediment in Danube Basin countries is hard to give.
- The reason is the absence of uniformity in sampling methods, analytical techniques and sediment quality standards. Typically, countries along the same river basin use different methods.
- This study aimed to evaluate temporal variations of examined elements in both suspended and floodplain sediments over a one-year monitoring period at the Barcs station in the Croatia-Hungary border section of the Drava River.



Schematic of fate of a contaminant in the aquatic environmenment (Elizabeth and Chapman, 1992).

SIMONA PROJECT

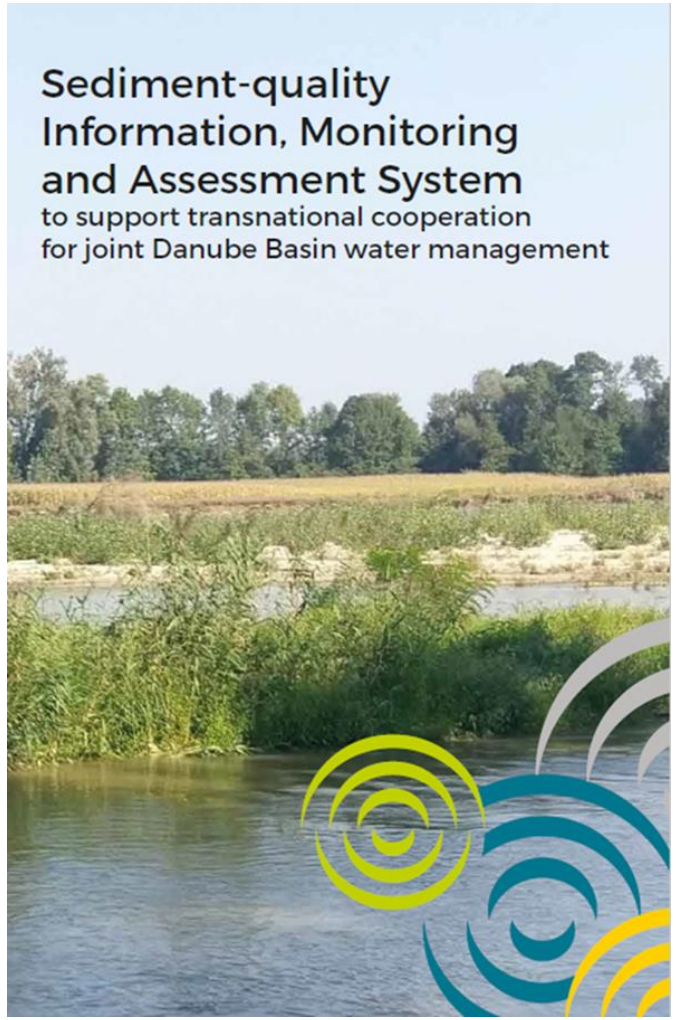
Sediment-quality Information, Monitoring and Assessment System

to support transnational cooperation for Danube Basin water management

- ✓ **largest** of its kind in Europe (2018-2022)
- ✓ **ready-to-use sediment-quality monitoring system delivered**
- ✓ **harmonized** in the River Basin Countries (13 countries)

METHODS - SIMONA SYSTEM:

- ✓ sampling,
- ✓ laboratory analysis,
- ✓ evaluation protocols and
- ✓ SIMONA-tool (online IT application)
- ✓3 Test Areas, 30 sampling sites
- ✓26 Baseline Sites - Harmonization

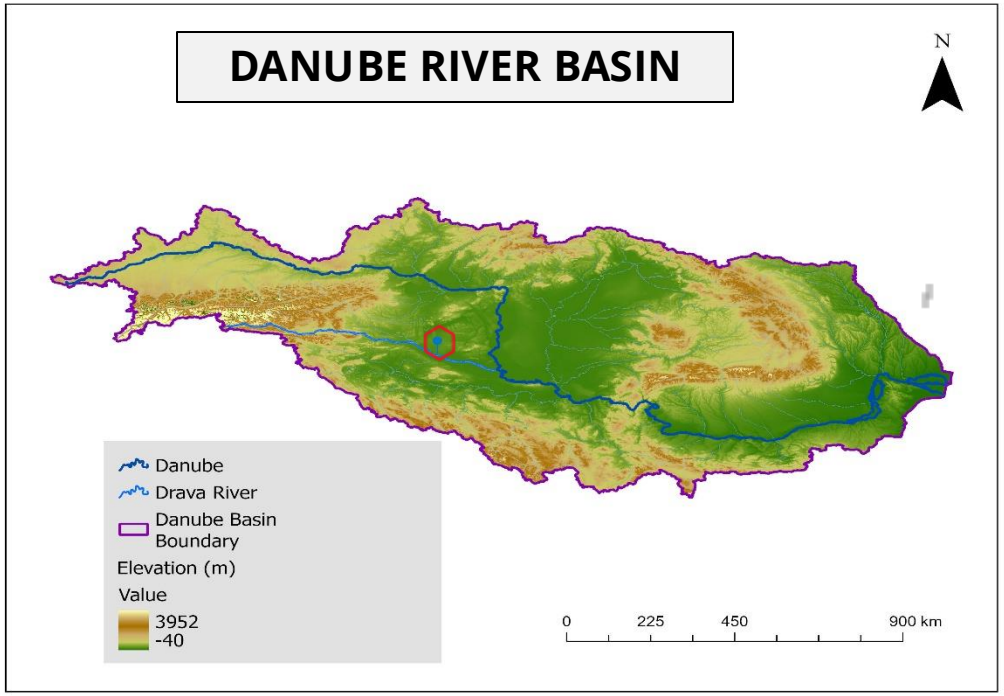


http://www.interreg-danube.eu/approved-projects/simona

Monitoring Station

Drava River

- 730 km
- historical pollution: mining and smelting industry
- **22** hydroelectric power plants (HEPPs): 11 in Austria, 8 in Slovenia and 3 in Croatia.
- Highest water levels in between May and July and lowest in January and February.
- Higher discharge in autumn period is due to the more Mediterranean precipitation trend



3 Test Areas

- **Drava River**
- Upper Tisa
- South Danube

Sampling methods

SIMONA SAMPLING APPROACHES:

1. Sediment trap box (Metals, PAHs)

- JDS4 standard sediment trap box - in river water
- JDS4 standard sediment trap box - on floodplain

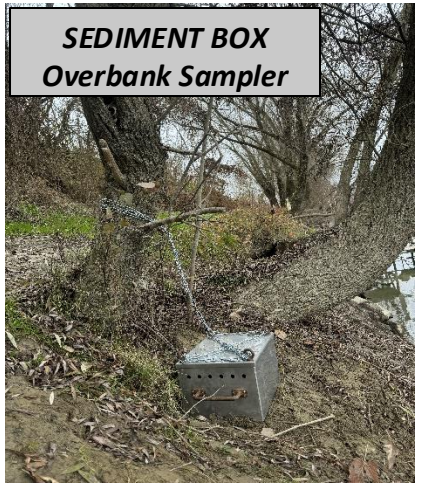
Barrel: suspended sediment point sampling into plastic water tank (30 L) every month.

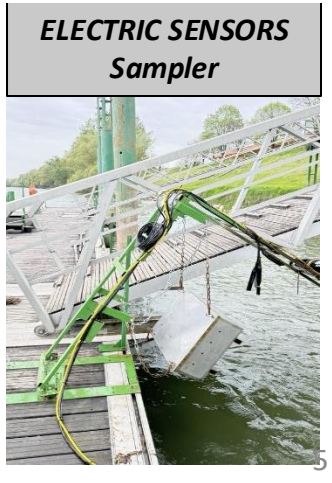
~~2. Passive Membrane Sampler/Absorbents (Metals, PAHs, Pesticides)~~

3. Electric sensors /Water quality monitoring sensors: pH, Redox, **Turbidity, Flow velocity,** Dissolved oxygen, Temperature, Conductivity

4. **Online data communication system** (15 minutes sampling frequency)

Operation: 12 months (4 seasons)



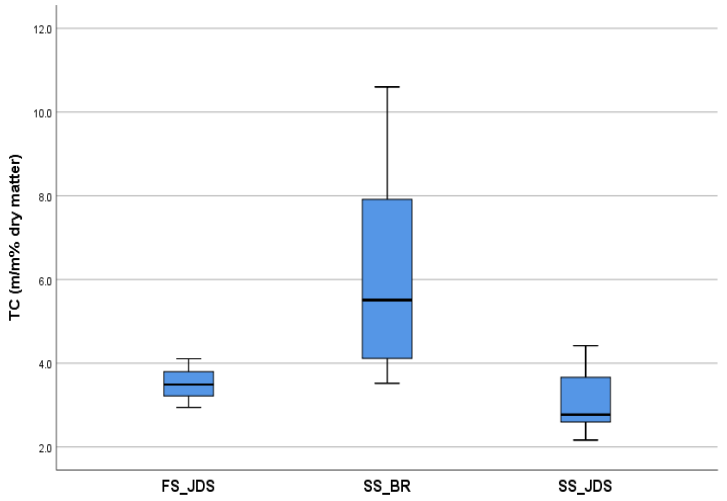


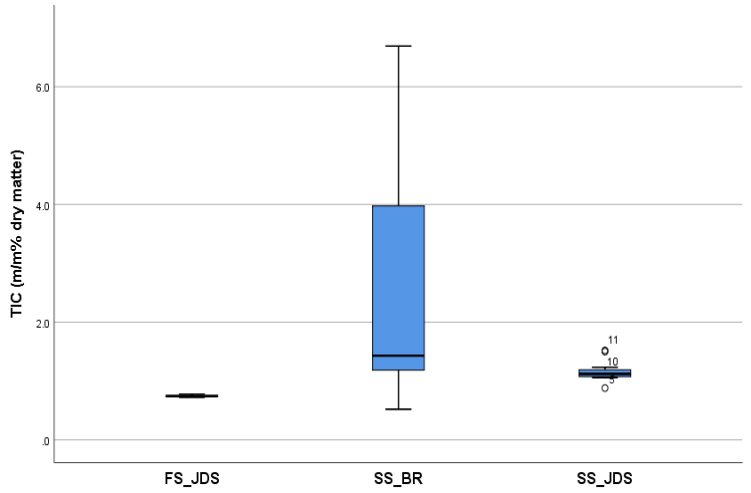
Laborotory and data analysis

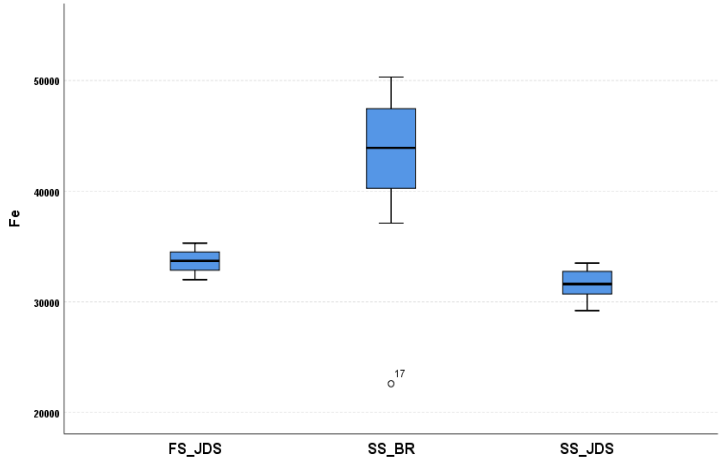
All chemical analyses of the samples (coarse fraction < 2mm) and were carried out at the Balint Analitika Ltd. in Budapest, Hungary.
The concentrations of selected **21** elements were measured by inductively coupled plasma mass spectrometry (**ICP-MS**) after **acid digestions**.
Organic matters parameters (**TC**, **TIC**, **TOC**, dry matter, **LOI**) are also determined.
Graphical representations, regression, and trend analysis were carried out using MS Excel 365, IBM SPSS, and Statgraphics 19.

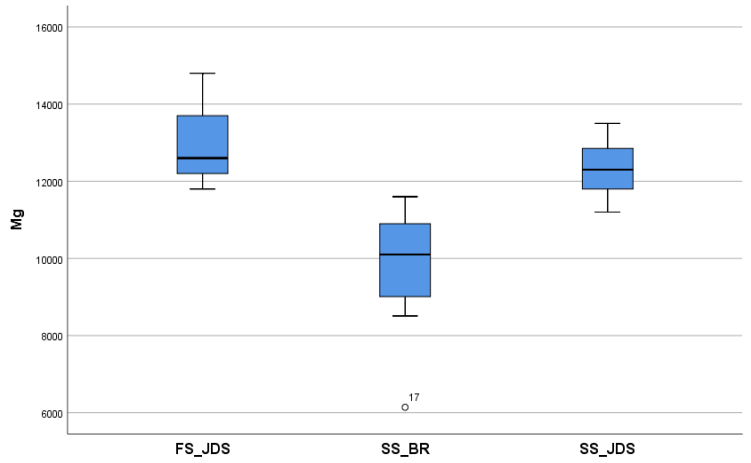
Results: Conc. of major elements by sample types

Detected **higher** concentrations of **TC, TIC, TOC, Ca, P, Fe and Mn except for Mg, Na, Al, and K in suspended sediments collected by Barrel sampling method**, **SS_BR** than those FS_JDS and SS_JDS.





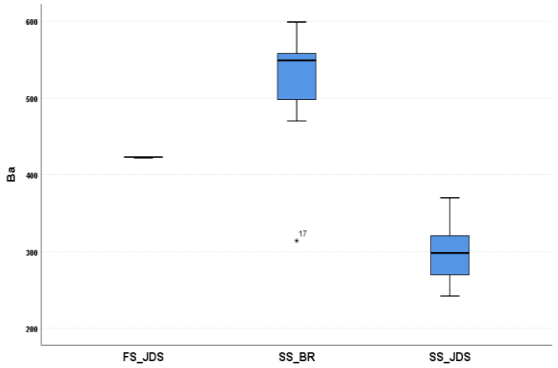


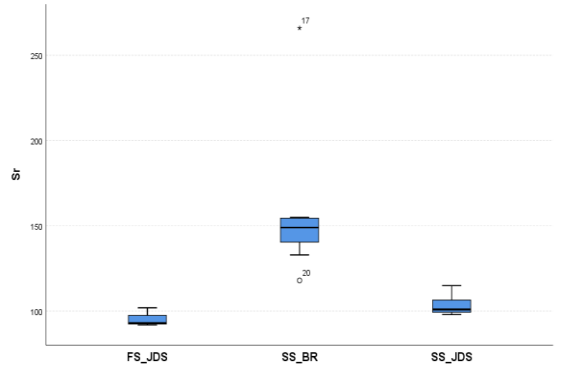


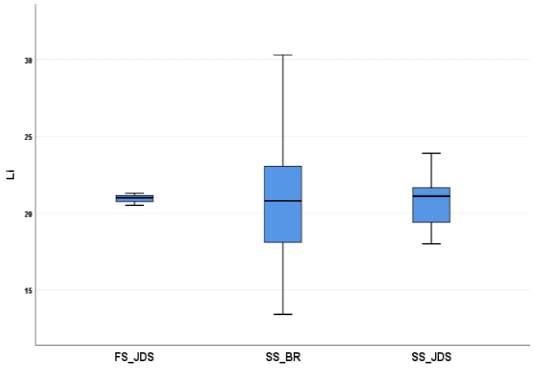
Note: All elements are expressed in mg/kg.

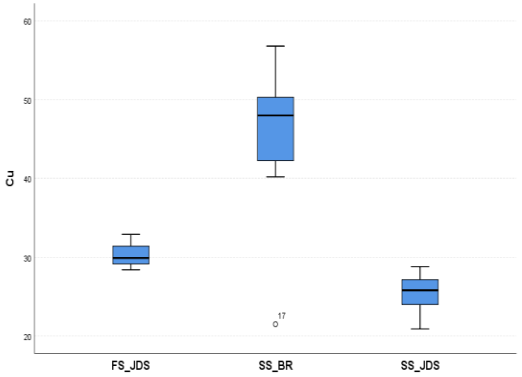
Metals concentrations by sample types

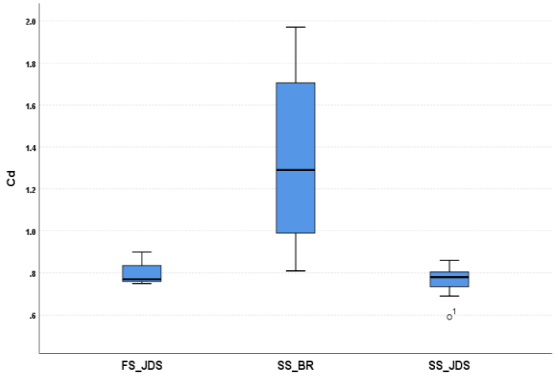
Detected **higher concentrations** of the elements in **suspended sediments_Barrel** than those sediment trap boxes both in floodplain and river.

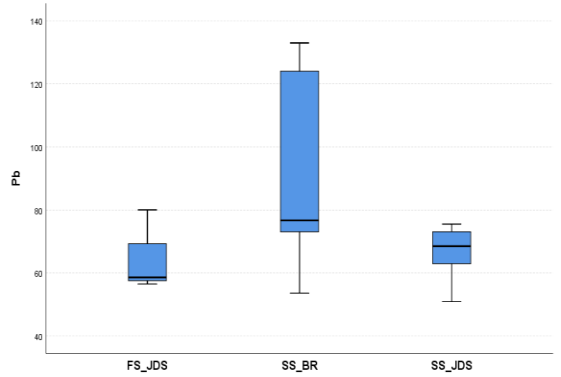


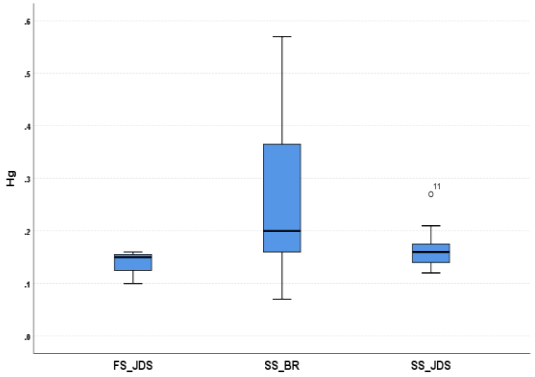


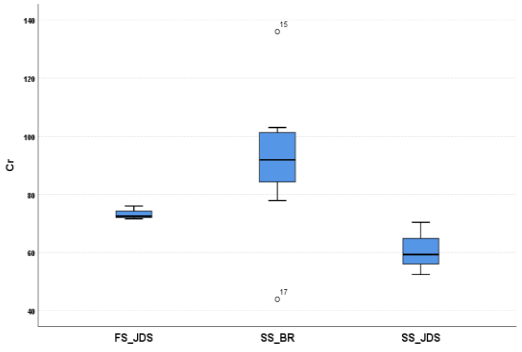


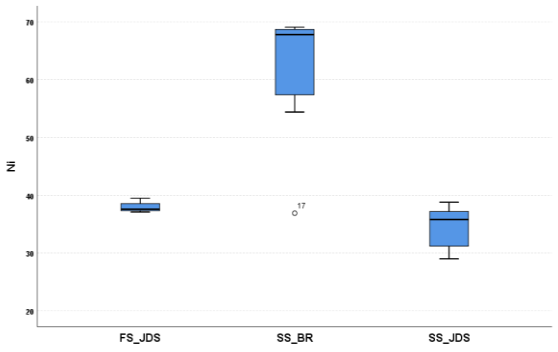


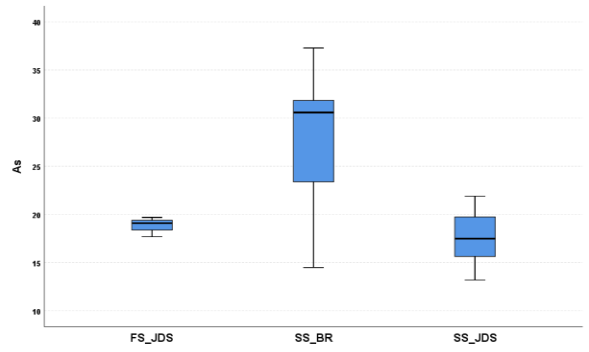


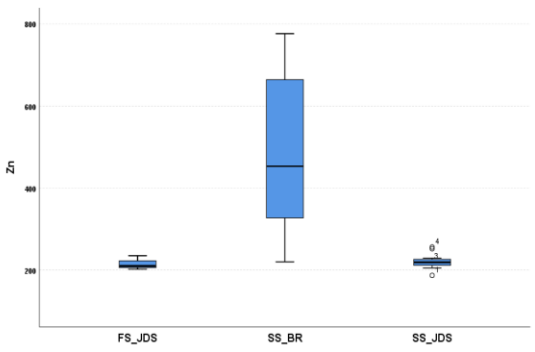








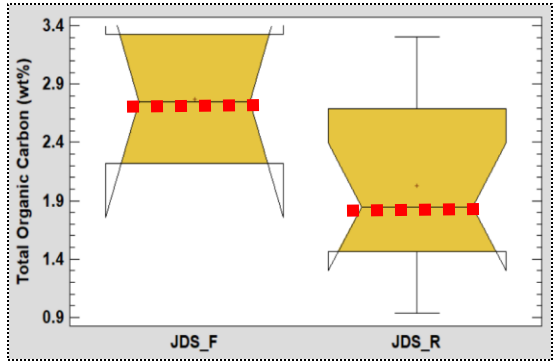


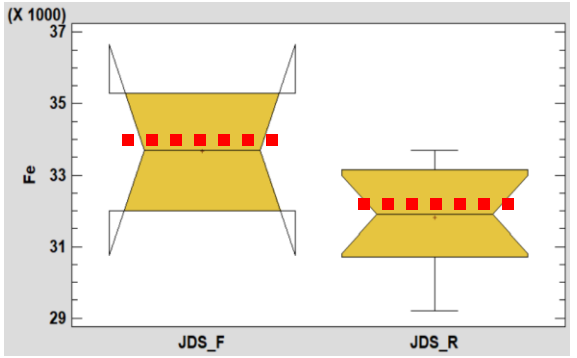


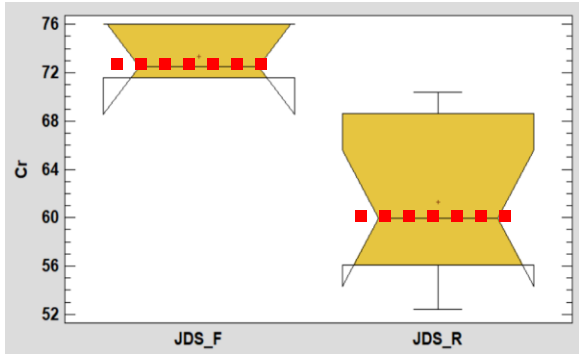
Note: All elements are expressed in mg/kg.

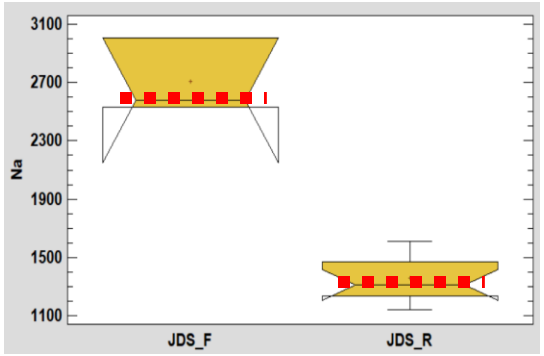
Floodplain- and suspended sediments (JDS4 boxes)

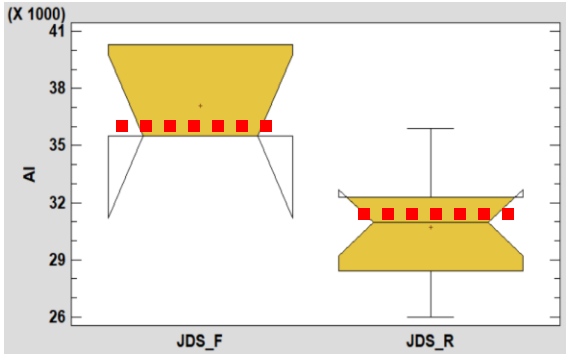
- Detected **higher** concentrations of **TOC, Na, K, Fe, Al, P, Cr, Cu, and Co** in floodplain sediment trap box than those in river.

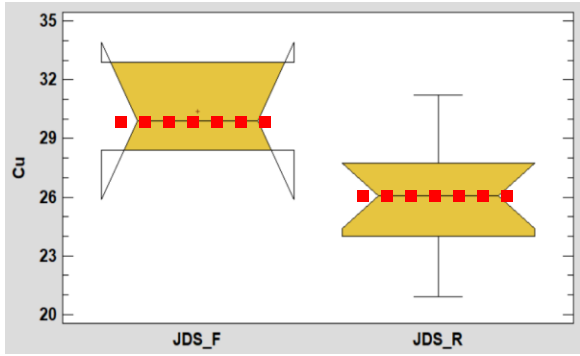


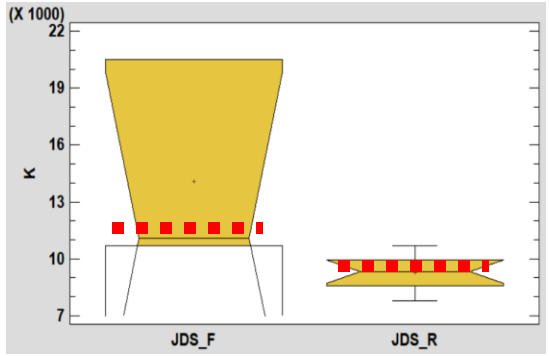


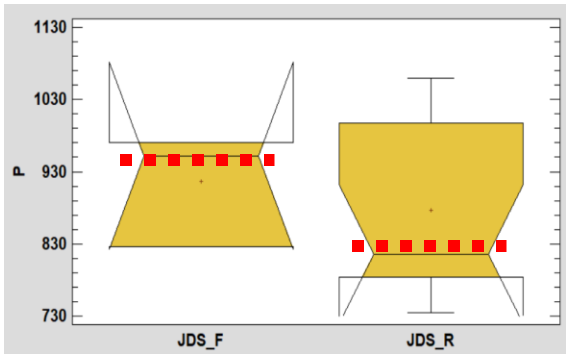


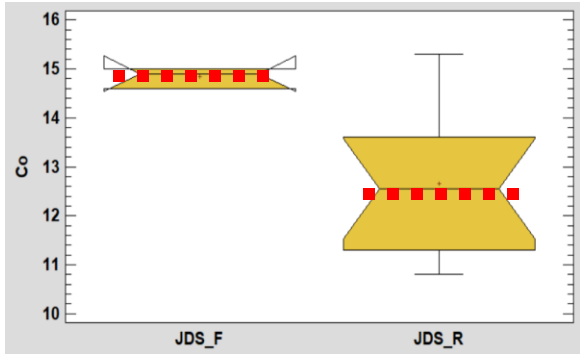








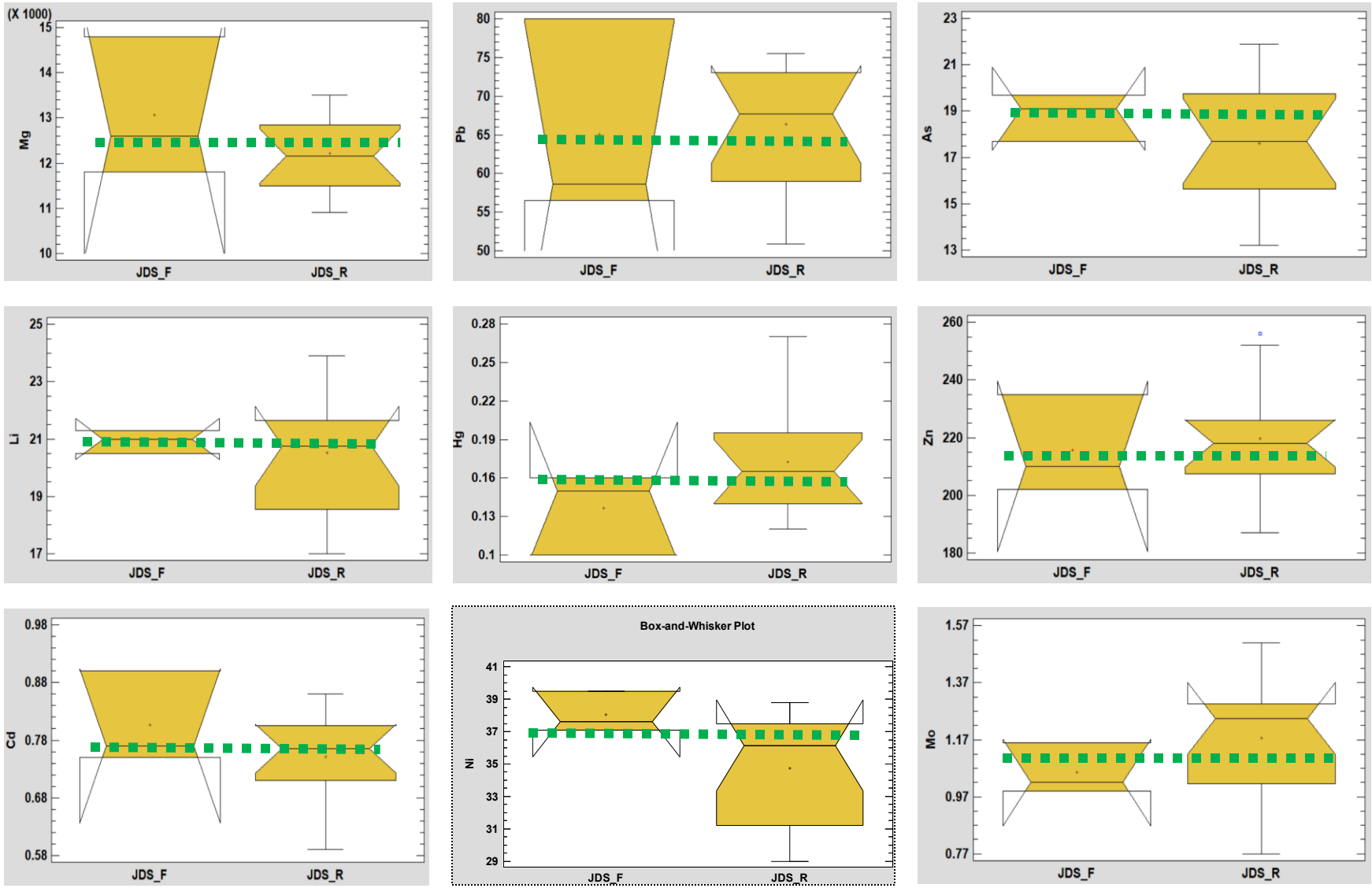




Note: All elements are expressed in mg/kg.

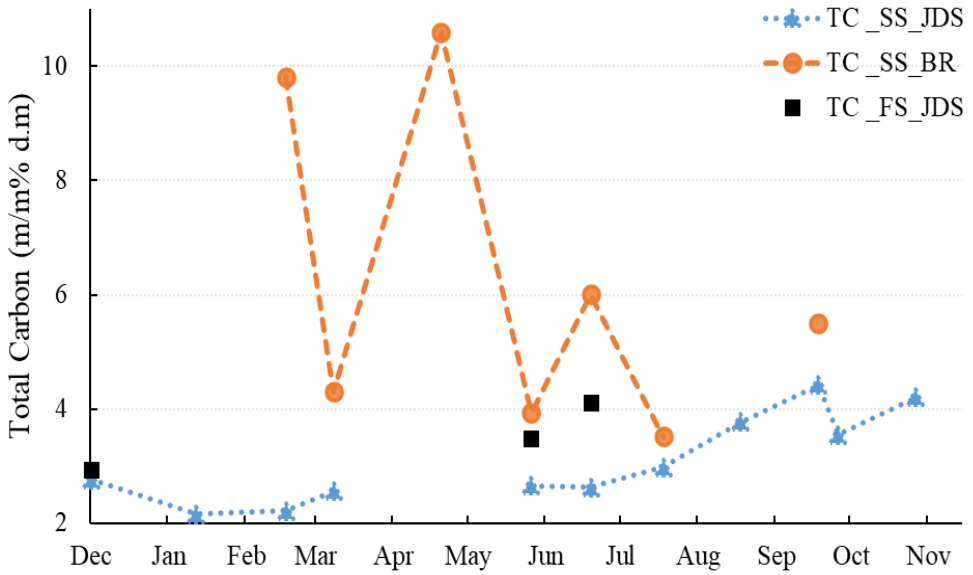
Floodplain- and suspended sediments (JDS4 boxes)

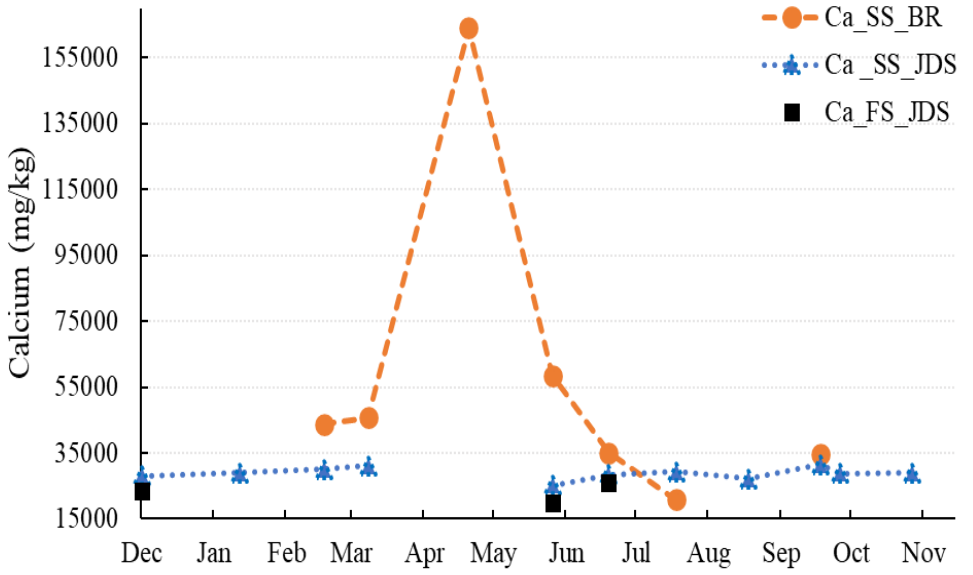
- **Identified constant** levels (mg/kg) of **Mg, Li, Cd, Pb, Hg, Ni, As, Zn, Mo** in both in river- and floodplain sediment trap box.

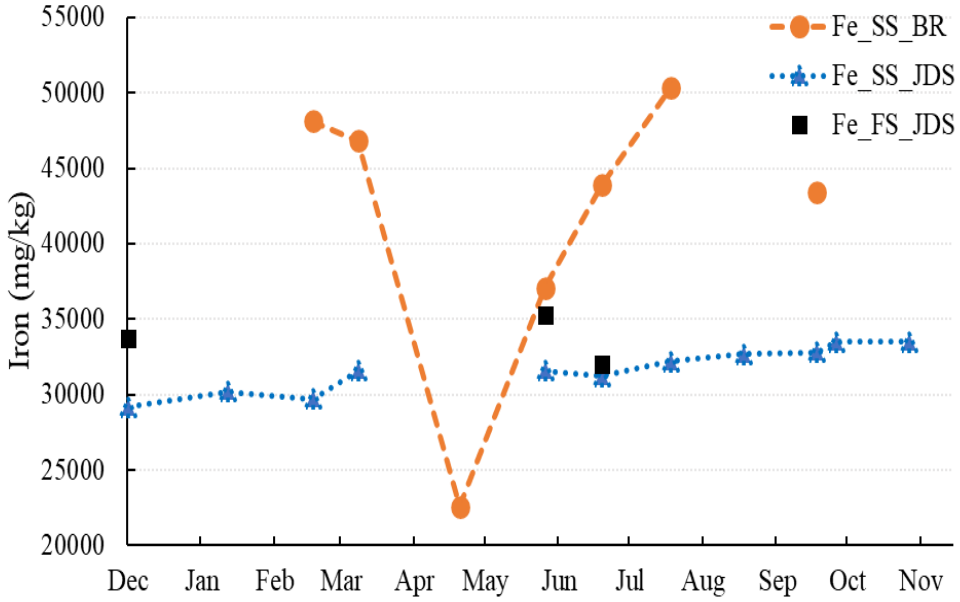


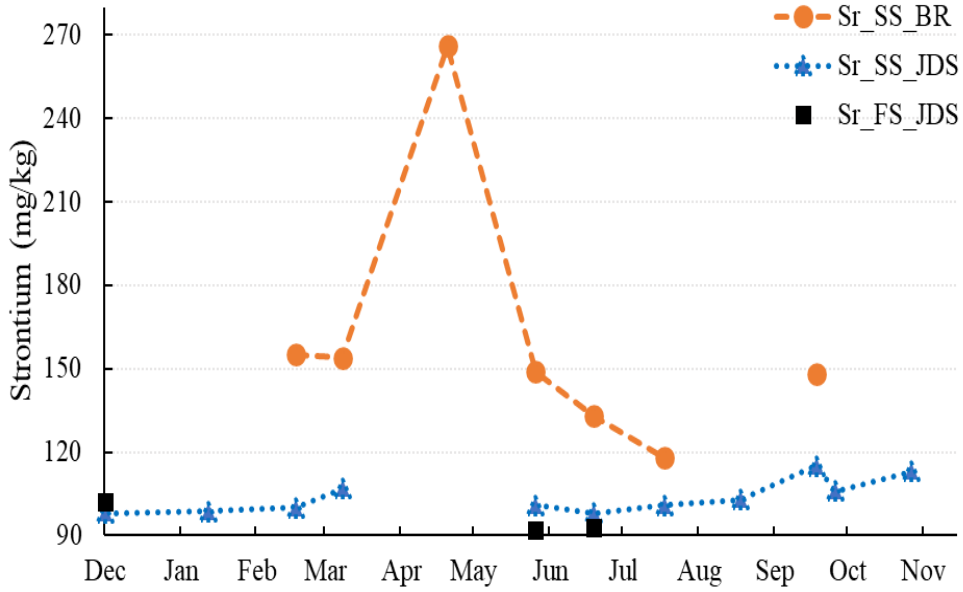
Note: All elements are expressed in mg/kg.

Trends in suspended sediments (JDS4 box and Barrel samplers)









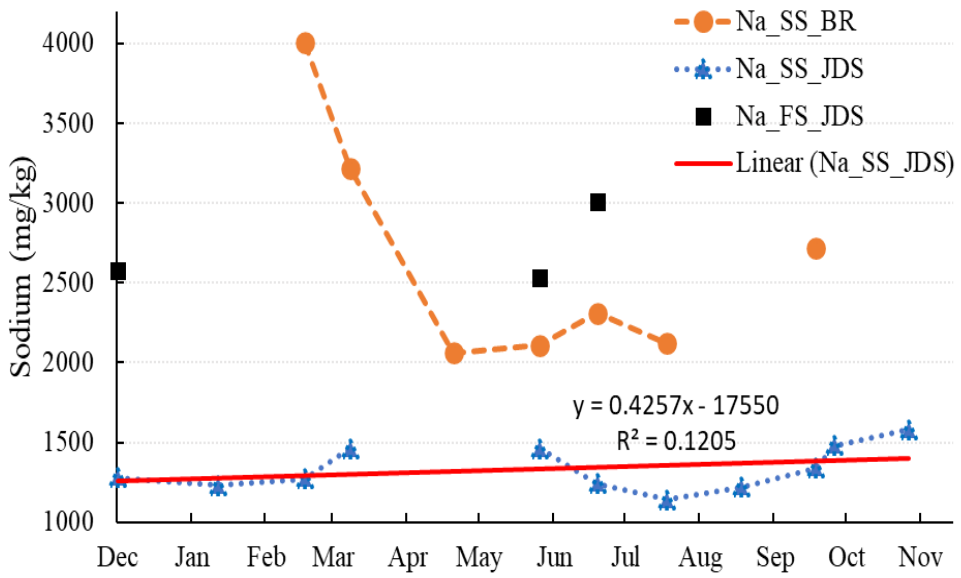
Barrel samples (SS_BR)

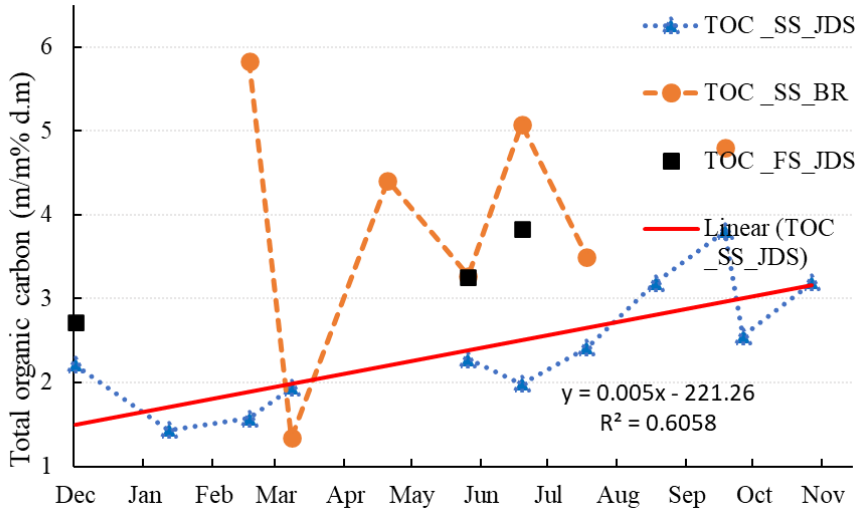
- Scattered data, no clear trend.
- **Peak** of **TIC**, **Ca**, **Sr** were in May 06.
- **Highest** Mg, Na, K, P, Fe, Mn, Al, Br, Li, Mo, Co were in **Mar 05 & Mar 24**; **lowest** in **May**, then gradual increase afterward.

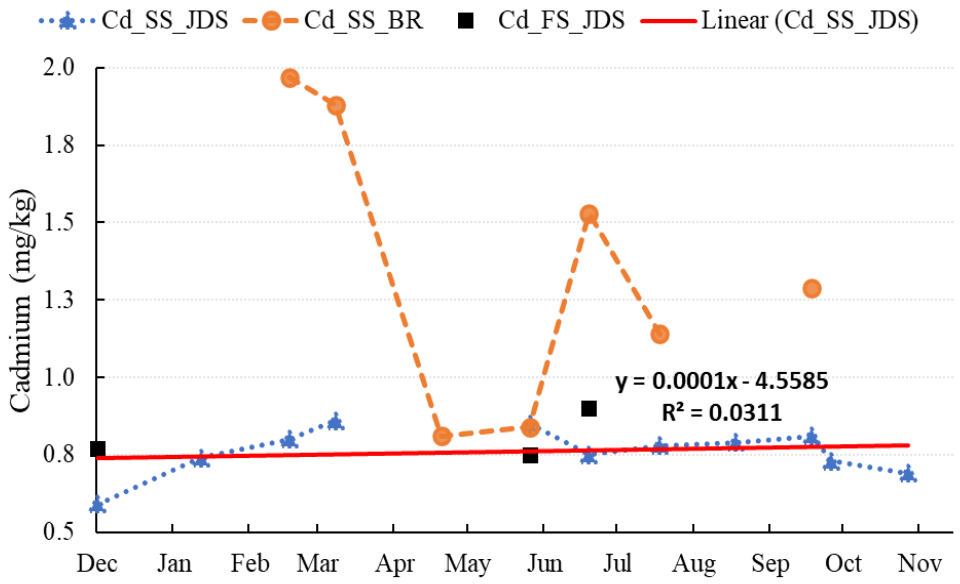
JDS4 trap box (SS_JDS)

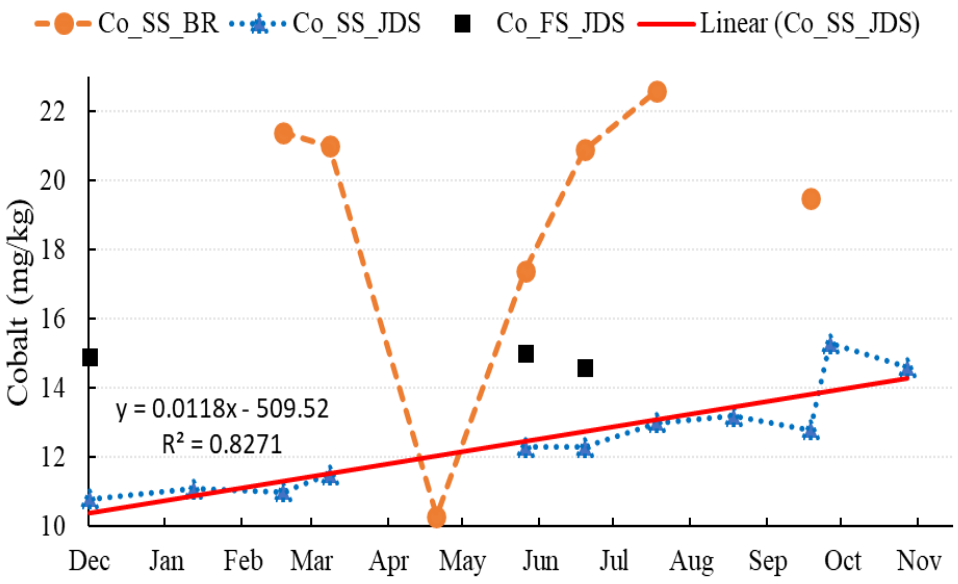
- Mn concentration higher in SS_JDS than in SS_BR.

Temporal trends of studied parameters



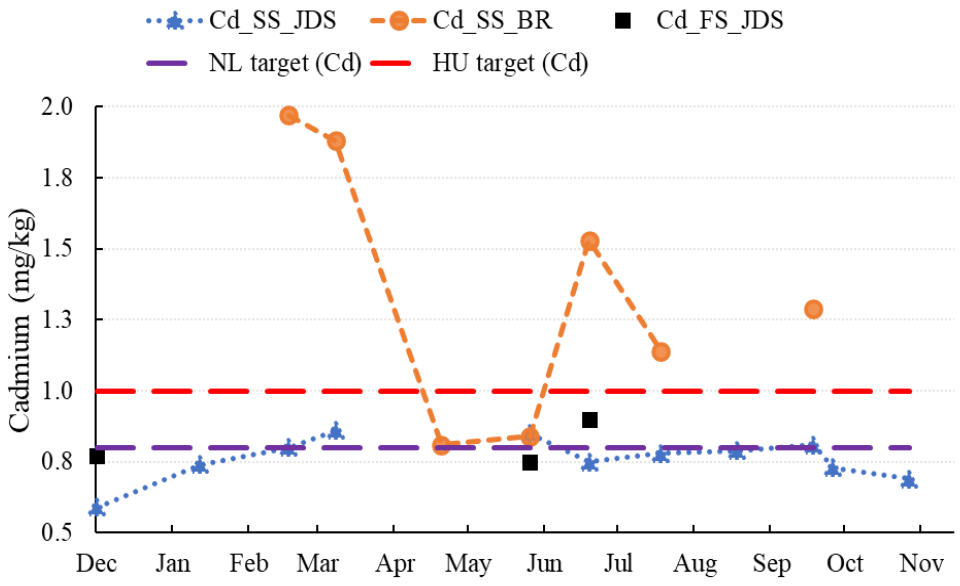


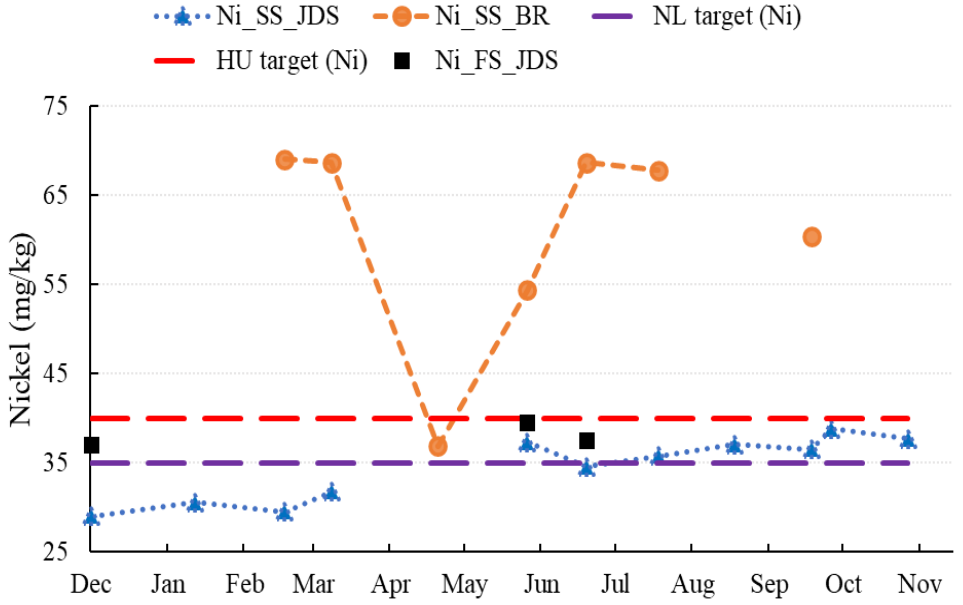


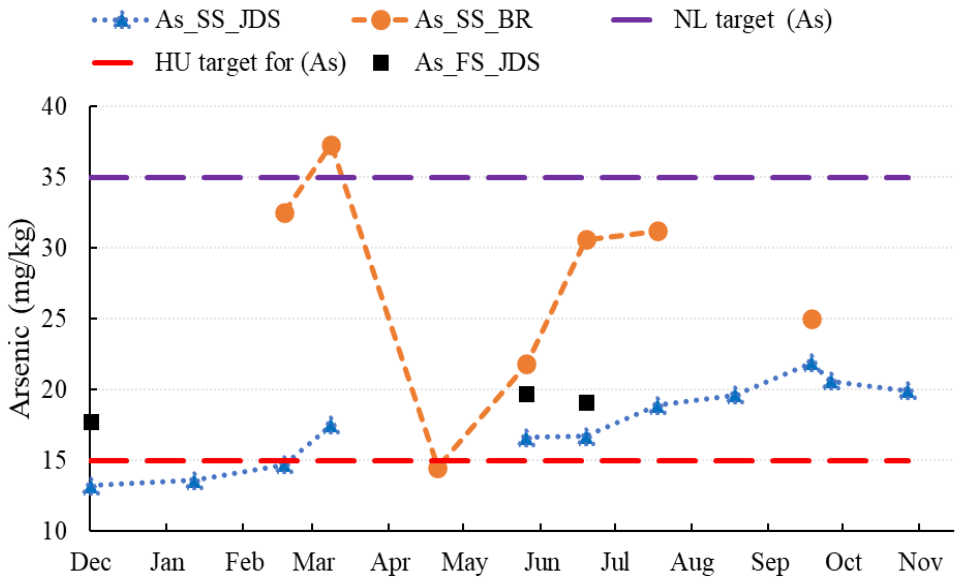


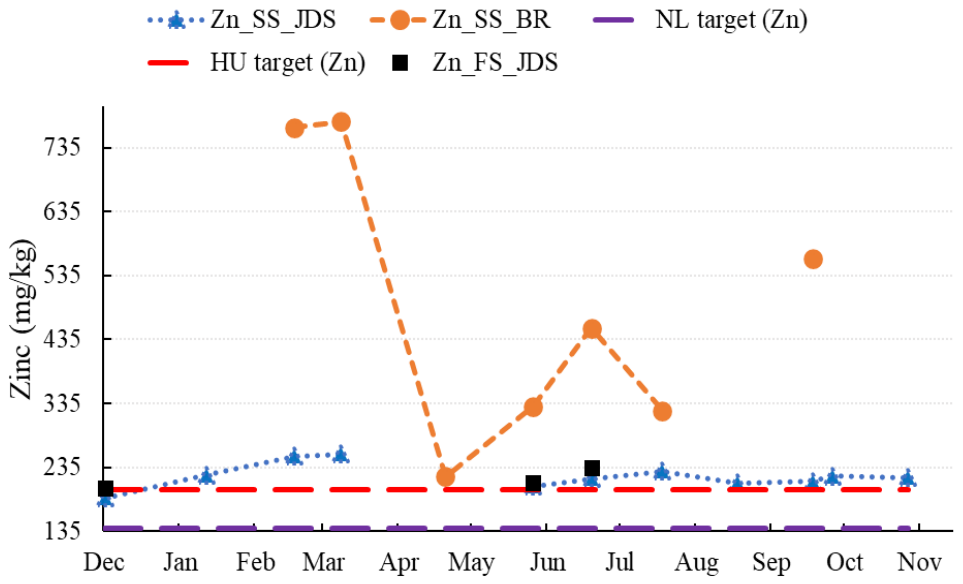
- Increasing trend: TOC, Mg, K, Mn, Fe, Al, Ba, Sr, Li, Mo, Co, **Ni, As, Cr, Cu**
- Stable concentrations: Ca, Na, P, **Cd, Zn, Pb, Hg**

PTEs exceedances (HU Target Values)









- Increased contents of elements (**Cd, Pb, Ni, Cr, Co**) except for **Hg** (Mar-24) and **Co** in **SS_Barrel** samples exceeded the HU target values.
- **As, Zn** conc. exceeded HU target values in all three sample types. types.

Conclusions

- **Passive sampling** could help to better understand the distributions and quantity of element contamination and trends through time.
- Passive sampling is effective for tracking temporal variations in sediment contamination and understanding long-term trends in sediment quality.
- Comparable **pollution levels** were observed in both **floodplain** and **suspended** sediments, indicating dominance of **natural geochemical background** (e.g., Mg, Li, Cd, Pb, Hg, Ni, As, Zn, Mo).
- **Stable** concentrations of Ca, Na, P, Cd, Zn, Pb, and Hg were recorded in suspended sediments throughout 2021.
- **Increasing** trends were detected for TOC, Mg, K, Mn, Fe, Al, Ba, Sr, Li, Mo, Co, Ni, As, Cr, and Cu during 2021.
- **Barrel samples** showed **high variability** and were sensitive to outliers or local pollution events. **JDS4** trap boxes provided **more stable** and **representative** data, supporting consistent long-term monitoring.

Thank you for your attention!

Acknowledgements:

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