Towards an international comparison of river sediment pollution:

Key factors influencing metal concentrations along seven Western European Rivers (1945-2020)

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Online abstract: https://meetingorganizer.copernicus.org/EGU22/EGU22-2928.html?pdf

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Introduction

- The composition of sediments in rivers provides indicators on the critical zone such as pollution
- Metal monitoring in river sediments began in the 1980s in many countries, achieved by:
  - Regional Directorates / Water Basin Agencies (WBA) / International Commissions
  - Other stakeholders (public or private)
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- Different matrices:
  - Bed and Flood Deposits (BFD)
  - Suspended Particulate Matter (SPM)
  - Dated sediment cores (DSC)
- Variable frequencies & analytical protocols

Coring on the backwaters of the Rhône River (FR)

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Main aim & Research Questions

Intercomparison of particulate pollution along rivers over time (post-1945)

- How the different matrices and protocols influence metal concentrations?
- What trends can be deduced from such heterogenous data?

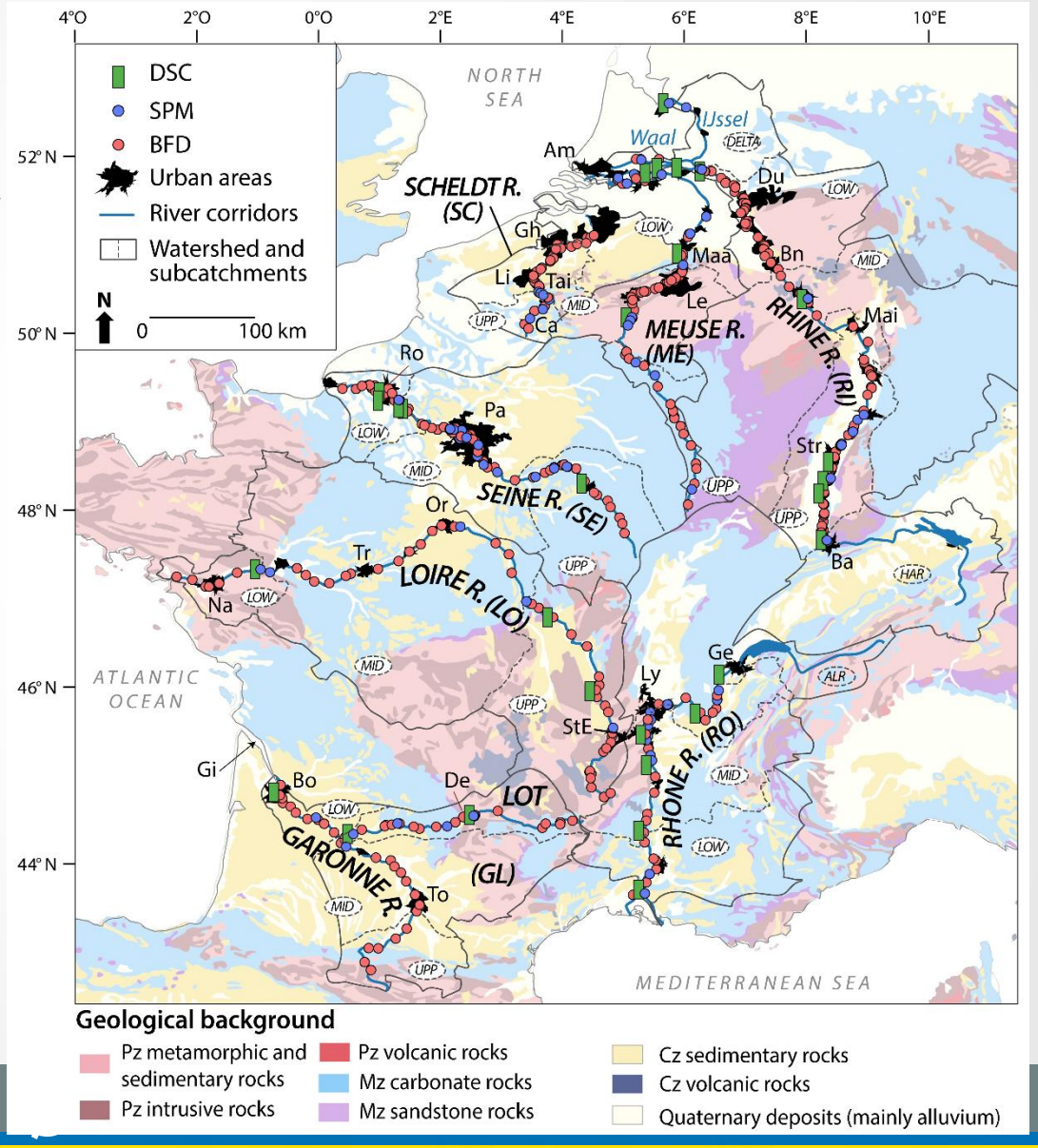
Material and Methods

- More than 12,000 analyses on SPM, DSC and BFD at 623 sites!

- **Sources:**
  - Naiades database, DREAL, OSR
  - SPW-WMM RWS BAFG
  - Research lab data (papers & reports)

- **Seven rivers**
  - SC and SE: Alkaline rivers, highly industrialised & populated
  - LO, GL and ME: mining & industrial heritage, diffuse population
  - RO and RI: complex rivers with high discharge, highly populated and industrialised

Open Access Data:
10.1594/PANGAEA.935416



Meta-analysis of the collected data

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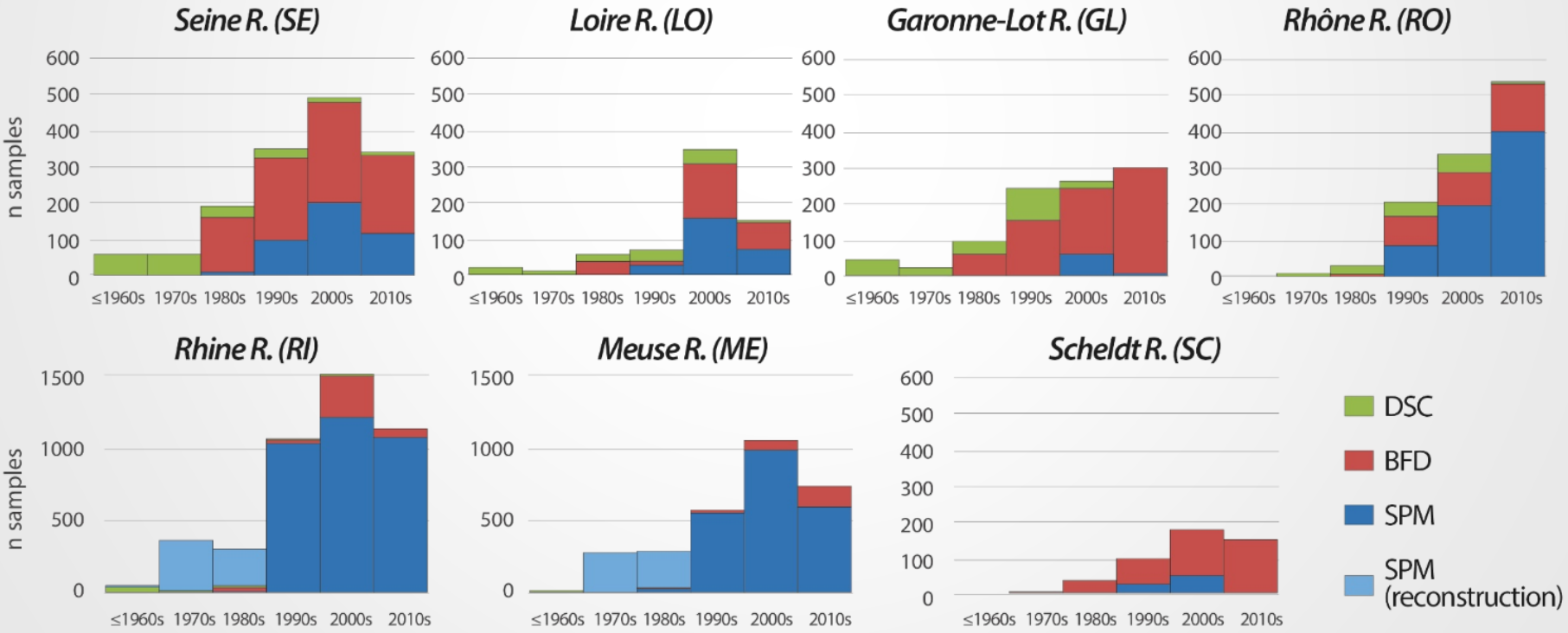
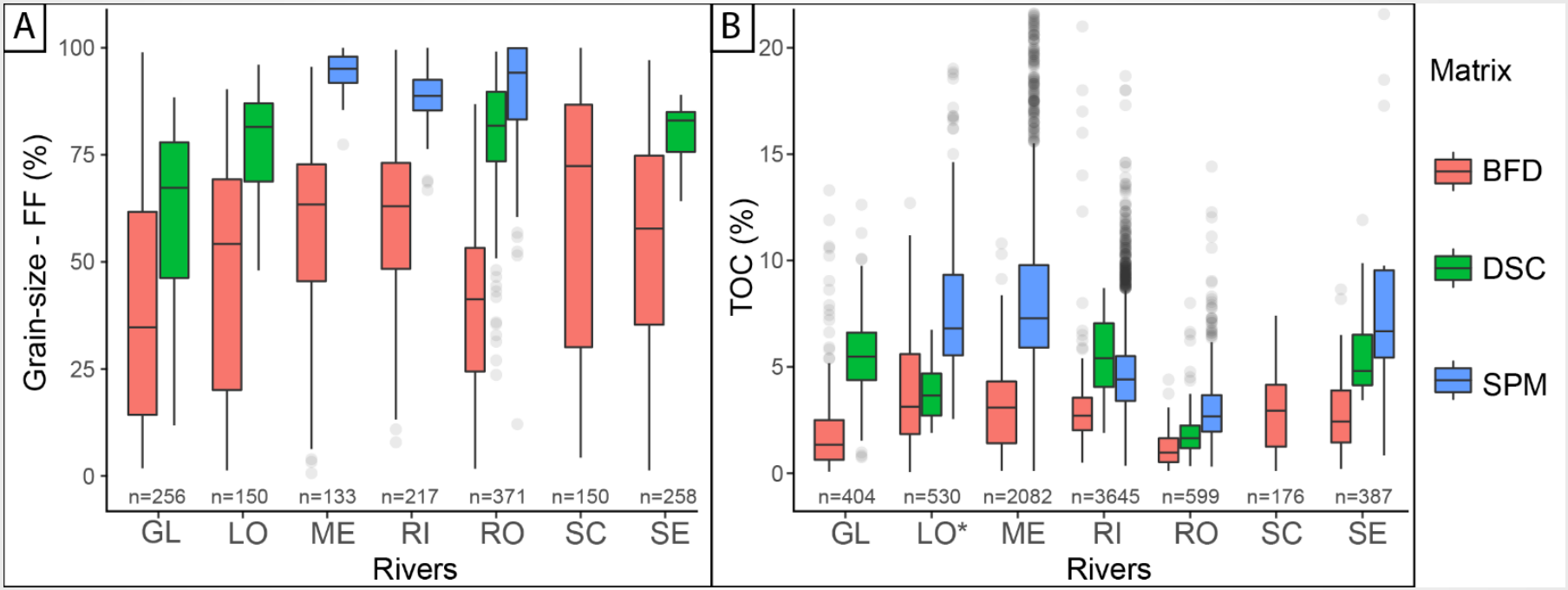
- A large dataset covering the 1945-2020 period
  - Regulatory trace metals (Cd, Cr, Cu, Hg, Pb, Zn)
  - Major elements (Al, Fe) and other ancillary data (grain-size, TOC)
- Before the 1990s, data is based on dated sediment cores (ca. 15%)
- Since the 1980s, increasing importance of BFD data (ca. 29%)
- Very high number of SPM data along the Rhine and Meuse Rivers (56%)



Results and Discussion

Dendievel et al., 2022

Grain size and TOC contents for the studied river sediments



Fine Fraction (<63µm) = 90% for SPM, 78% for DSC, 72% for BFD; well correlated with most of the metallic elements, especially Fe, Ni, Zn, Al

Total Organic Carbon (TOC) = 5% in SPM, 4% in DSC, 3% in BFD; rarely correlated with metals

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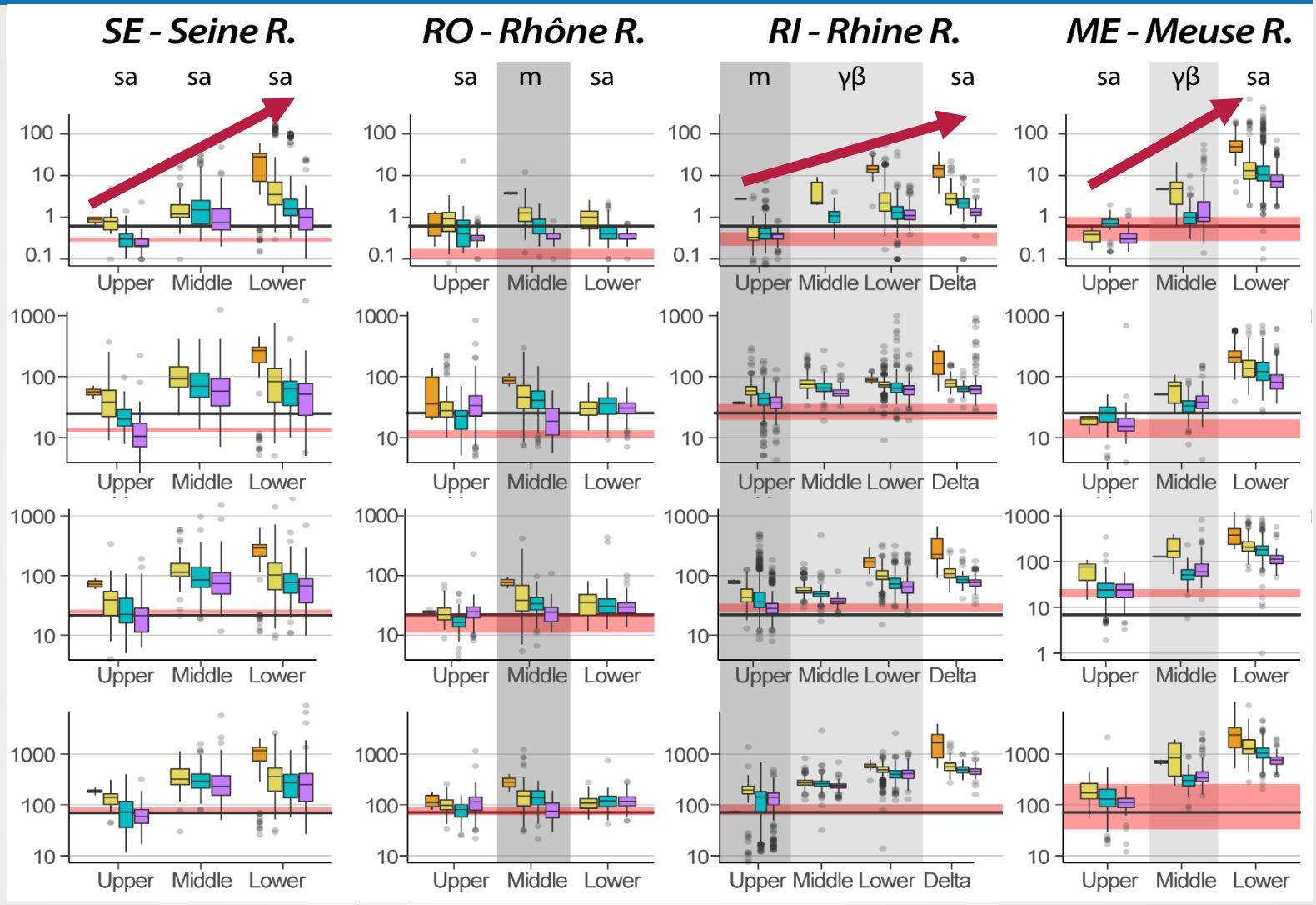

1) **Increasing metal concentrations in the downstream direction**

Results and Discussion

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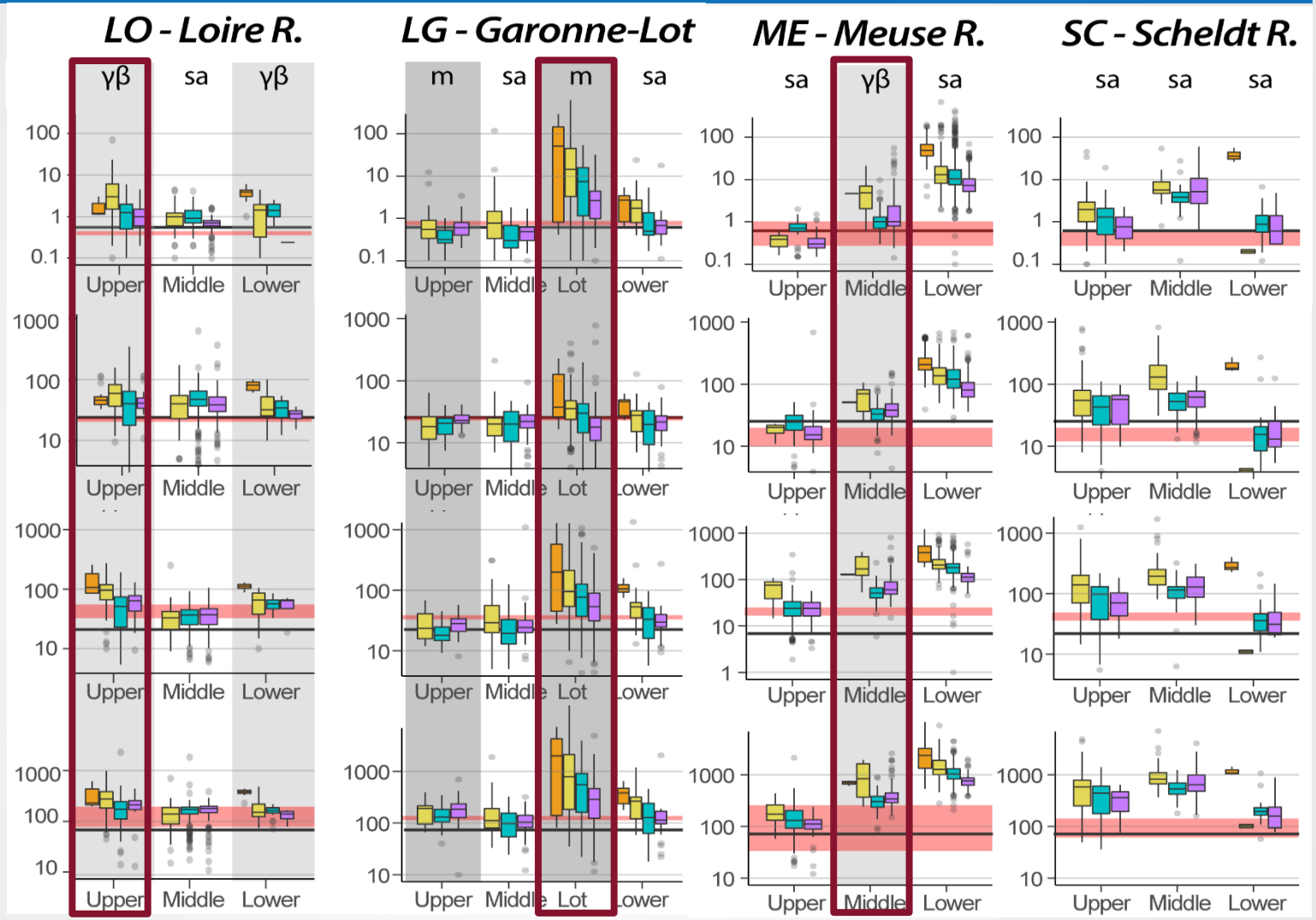

2) Metal pollution in mined or heavily industrialized sections impacting rivers over the long time

Results and Discussion

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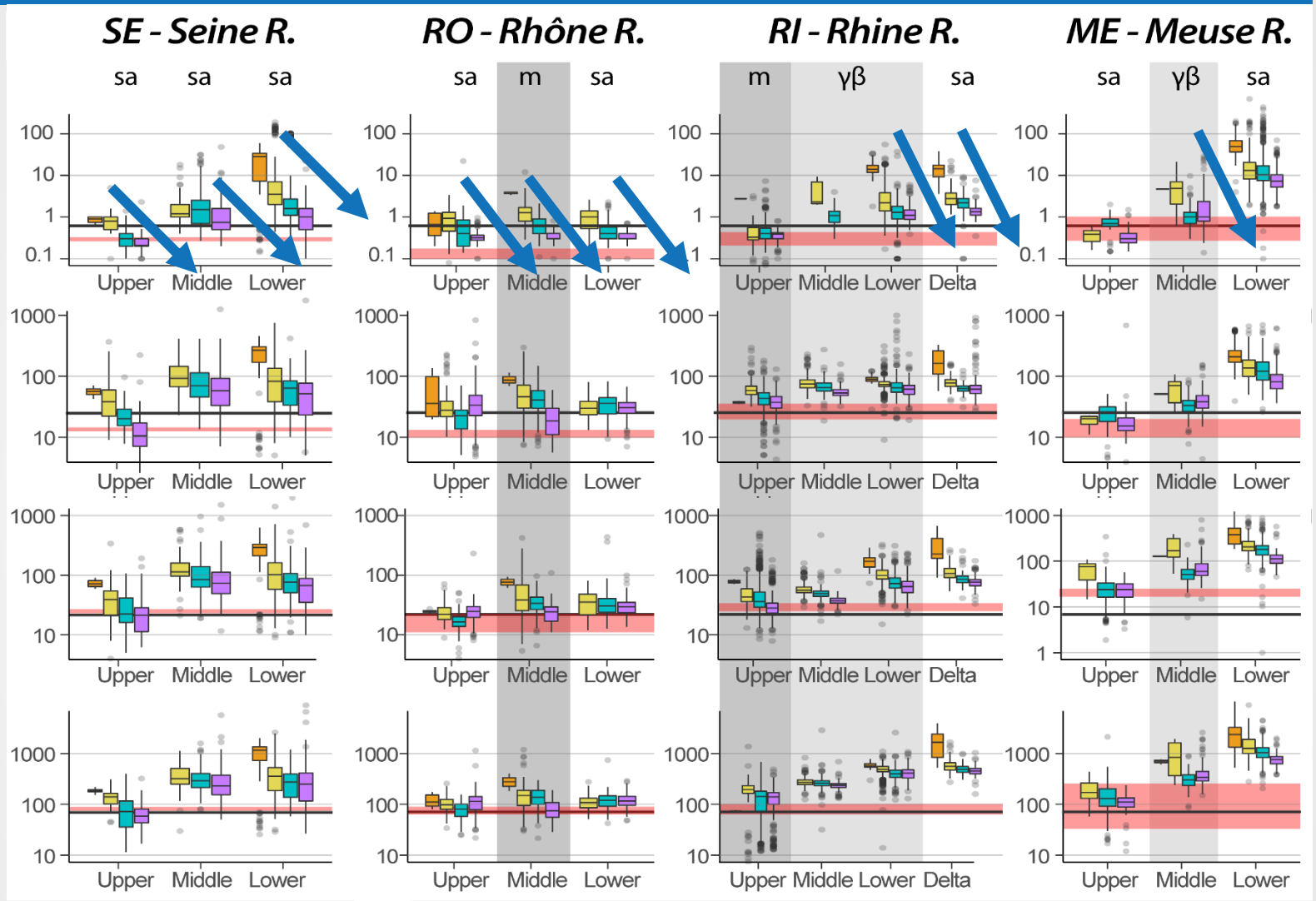

3) Significant temporal decrease of metal concentrations since the 1980s

Results and Discussion

Influence of analytic and environmental settings

Metal concentrations significantly vary according to:

3) Extraction methods (PP = Partial procedure, i.e. Aqua Regia; TE = Total Extraction with multi-acids)

2) Matrix composition

1) Time (decades)

1) Location in the watershed (Upper, Middle, Lower)

Time and location are driven by:

- Geology & Historical mining
- Urbanized or industrial sections
- Quality recovery due to regulations

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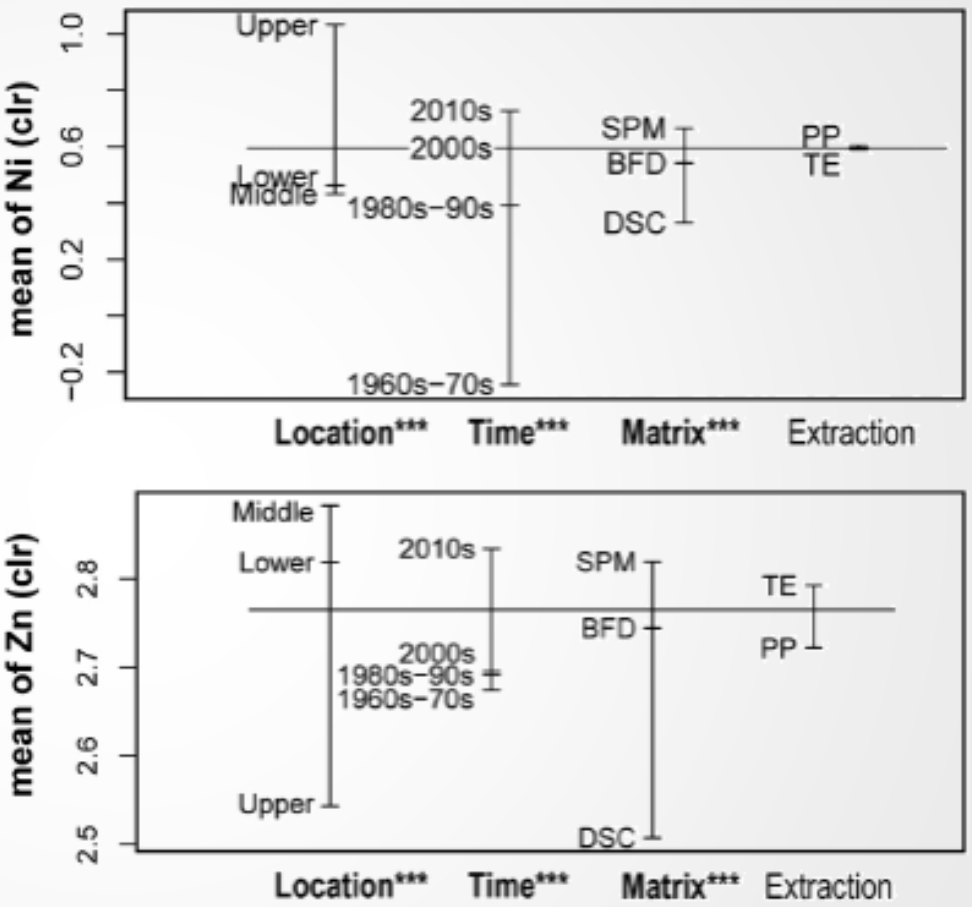

Plot of univariate effects of the four factors on metal concentrations (example for Ni and Zn)

Synthesis

- ✓ This work has made all the data compiled available to the scientific and stakeholder community; it provides new results concerning the effectiveness of regulations
- ✓ Intercomparison results
  1. Time and spatial factors are the most significant
  2. At this scale, matrix and extraction influence the data secondarily
- ✓ Spatio-temporal trends
  - Increase of [Cd, Cu, Hg, Pb, Zn] along most of the rivers with a major impact of some mined or urban-industrial sections
  - Significant temporal decrease along the rivers since the 1980s = regulation and deindustrialization effects in Western Europe

Thank you for your attention!

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