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Consequences of a dam flushing operation on concentration and fluxes of suspended sediment and associated contaminants in the Rhône River

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Management of a sediment observatory : specific case of the Rhône River in France

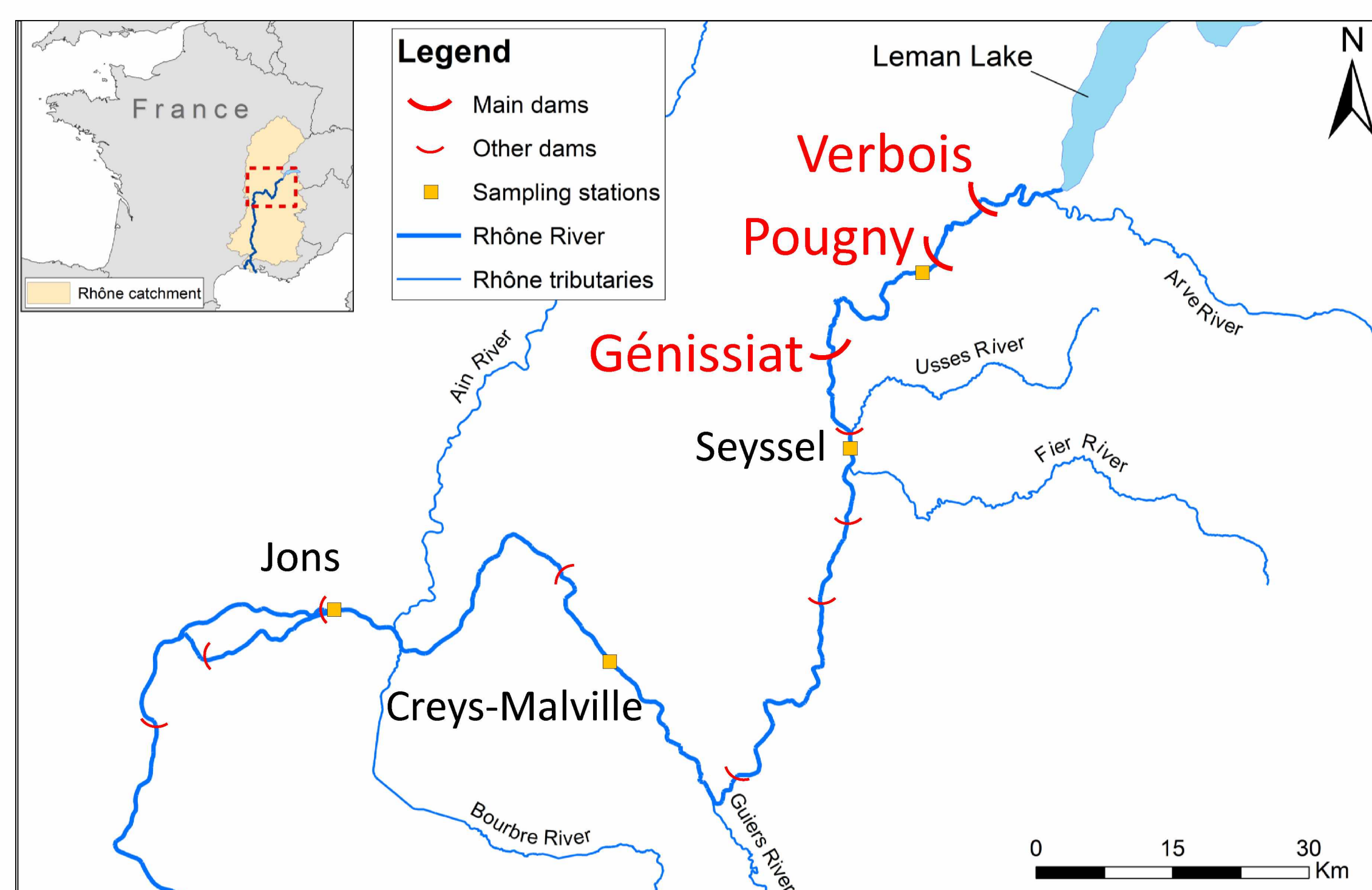
Context

- Rhône Sediment Observatory (OSR):** investigate the dynamics of sediments and quantify suspended particle matters (SPM) and the associated contaminant fluxes (metals, radionuclides, organic compounds...).
- Rhône River:** from Lake Geneva to the Mediterranean Sea (~500 km); 21 dams impact sediment transport and **dam flushing operations are regularly organized to remove sediments stored in reservoirs.**

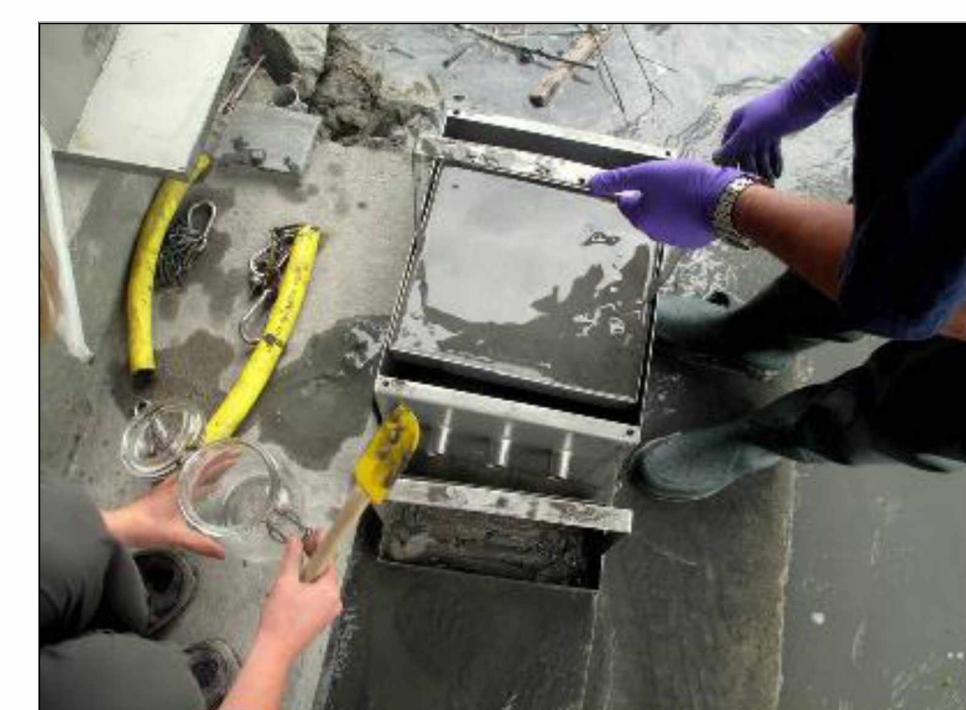
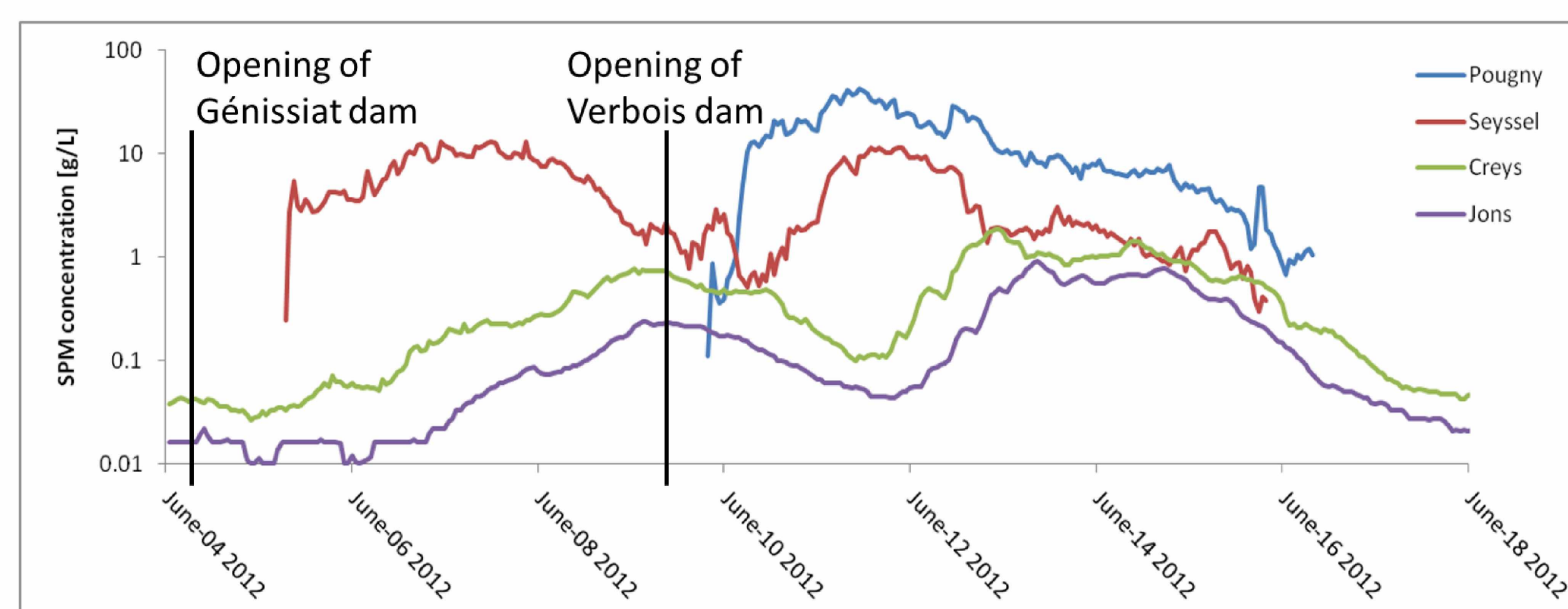
Objectives

- ☐ Evaluate the impacts of dam flushing operations on concentrations and fluxes of SPM and associated contaminants
- ☐ Investigate the origins of spatial and temporal variations of concentrations observed during dam flushing events

Flushing operations in June 2012



Flushing process (2 weeks)



Monitoring operations

Sampling location:

- Near the dams : Pougny and Seyssel
- Intermediate station : Creys-Malville
- Permanent monitoring station : Jons

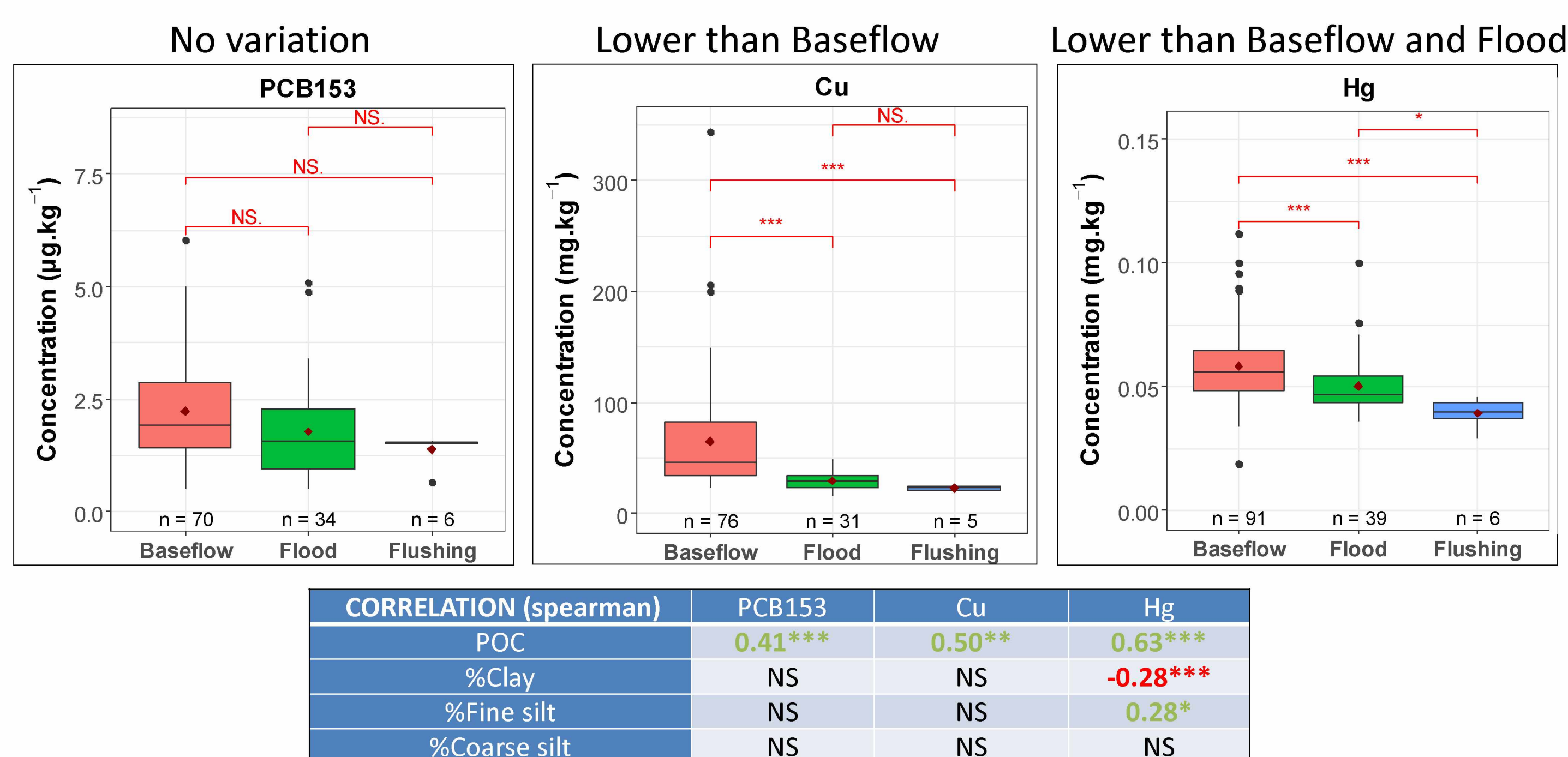
Parameters measured:

- Discharge
- SPM content
- Particle size
- POC

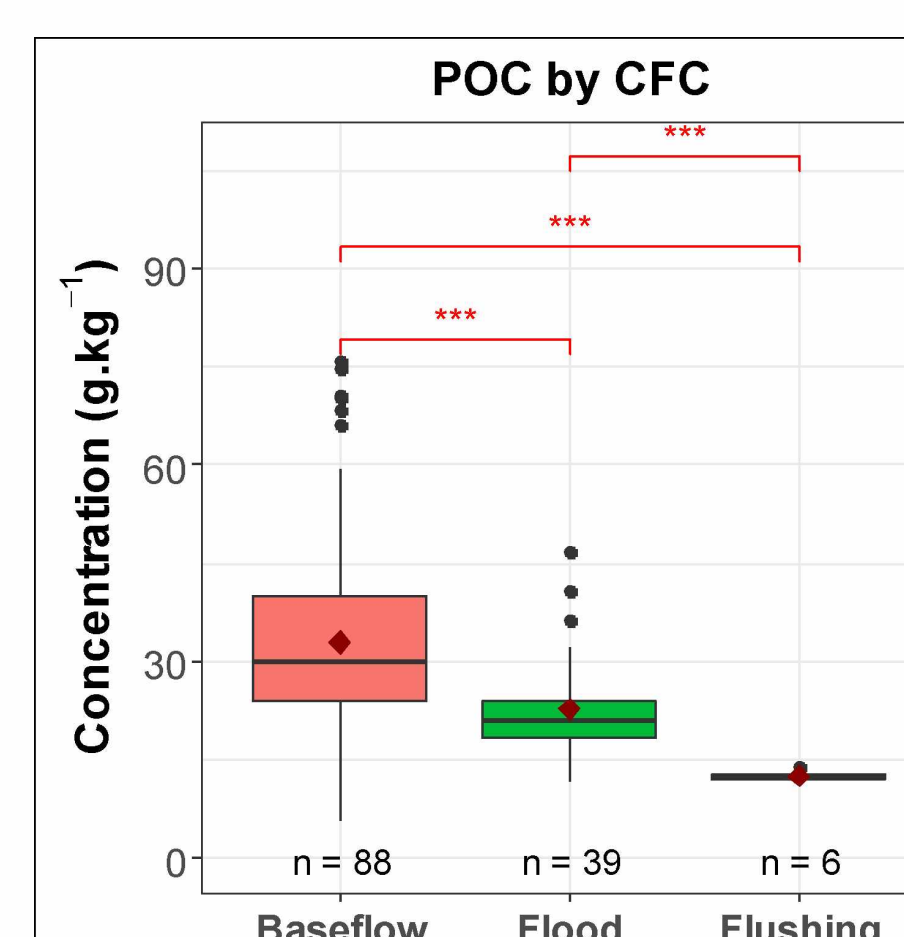
Contaminants characterized:

- Heavy metals
- Trace elements
- Organic compounds
- Radionuclides

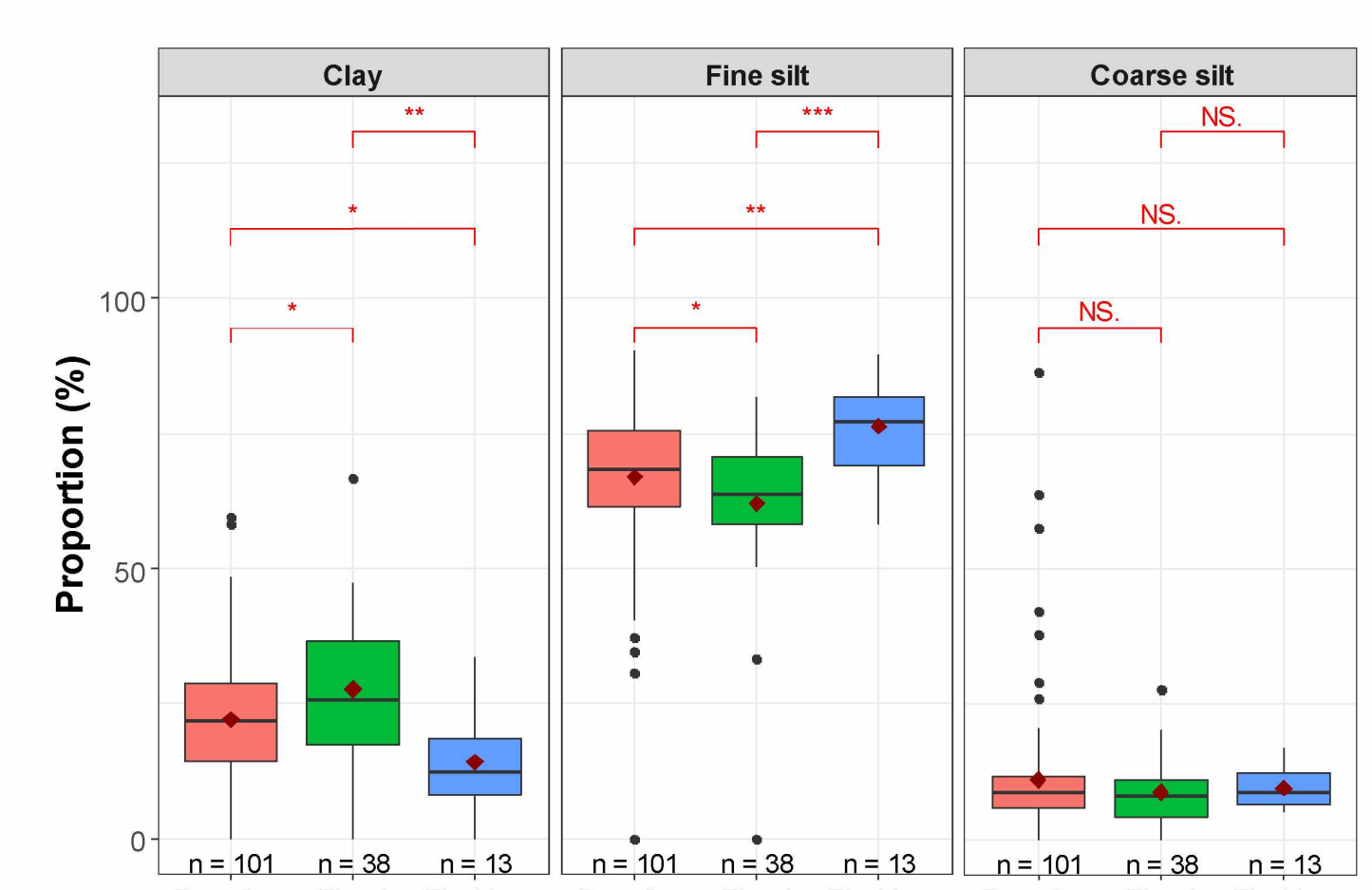
Are the contaminant concentrations different during dam flushing than during flood or baseflow ?



Particulate organic carbon:



Particle size distribution:

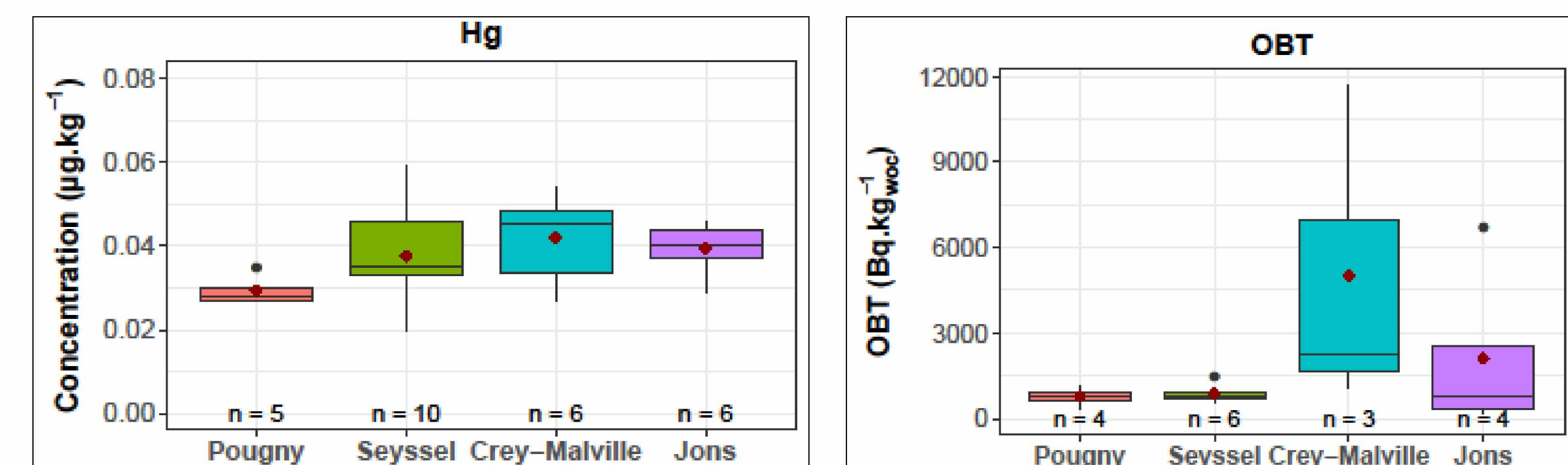


- Remained constant during the flushing events
- Concentration lower than flood and baseflow
- Degradation during resuspension¹ ⇔ Dilution.

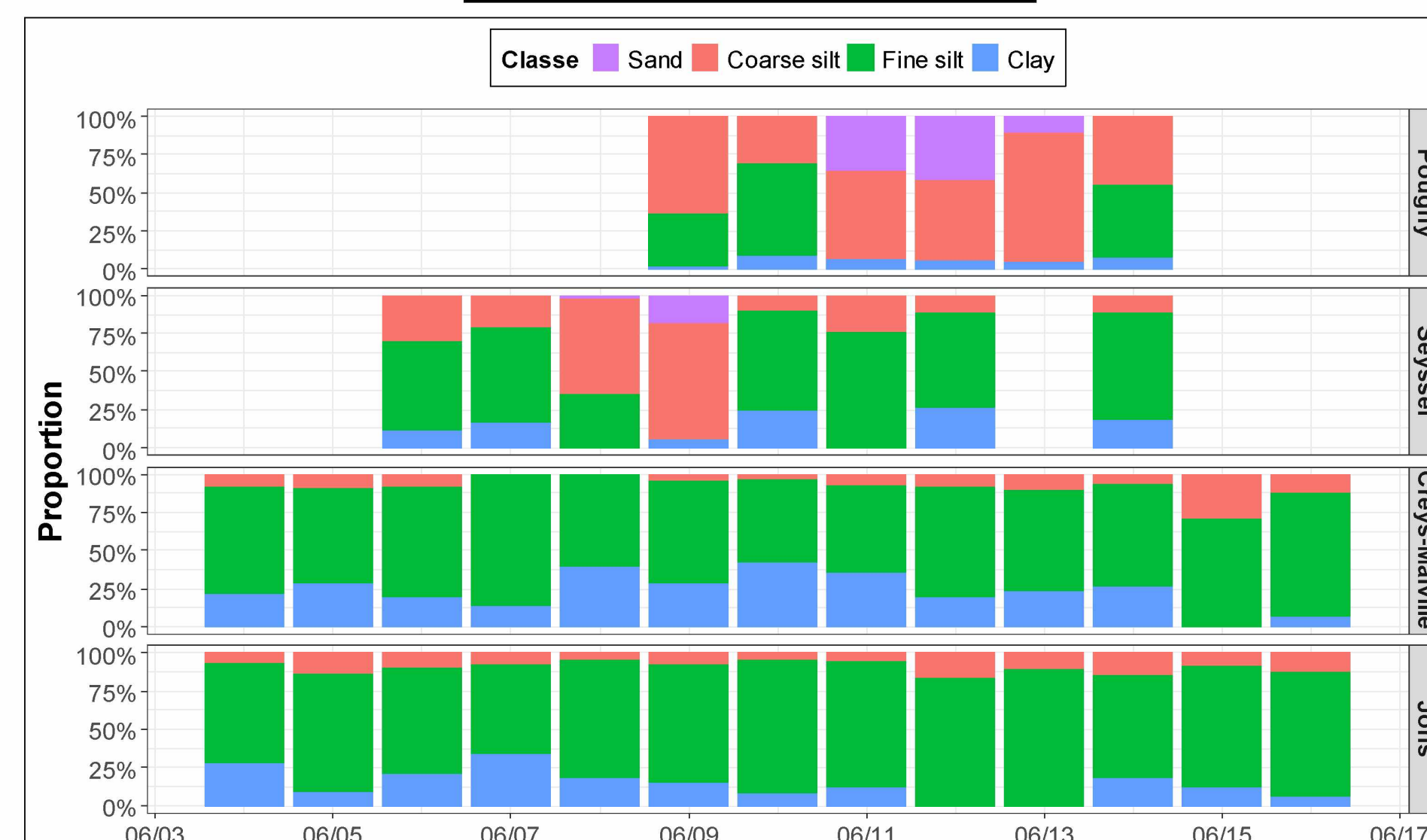
- Mostly silt, no sand
- Less clay and more fine silt than flood and baseflow
- Variation of the origin of the sediments.

Most of the contaminant concentrations were constant or decreased during the flushing events. These variations are mainly related to POC content that were also lightly correlated with particle size.

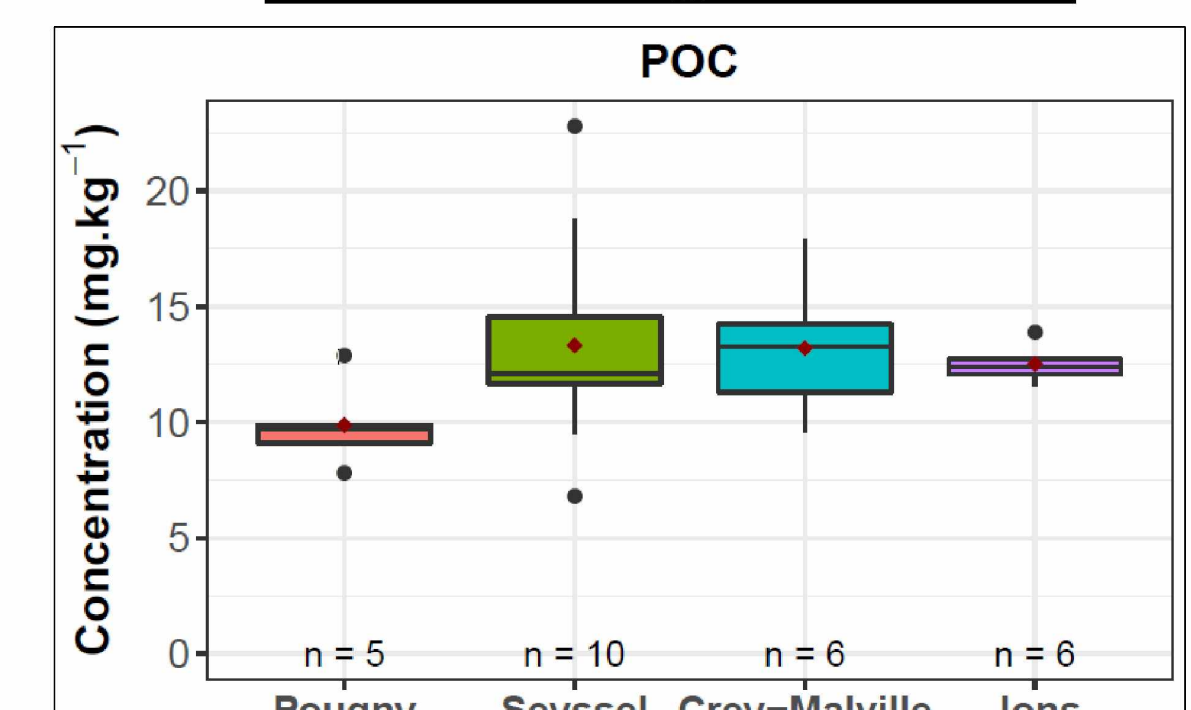
Are the contaminant concentrations spatially different during dam flushing ?



Particle size distribution:



Particulate organic carbon:

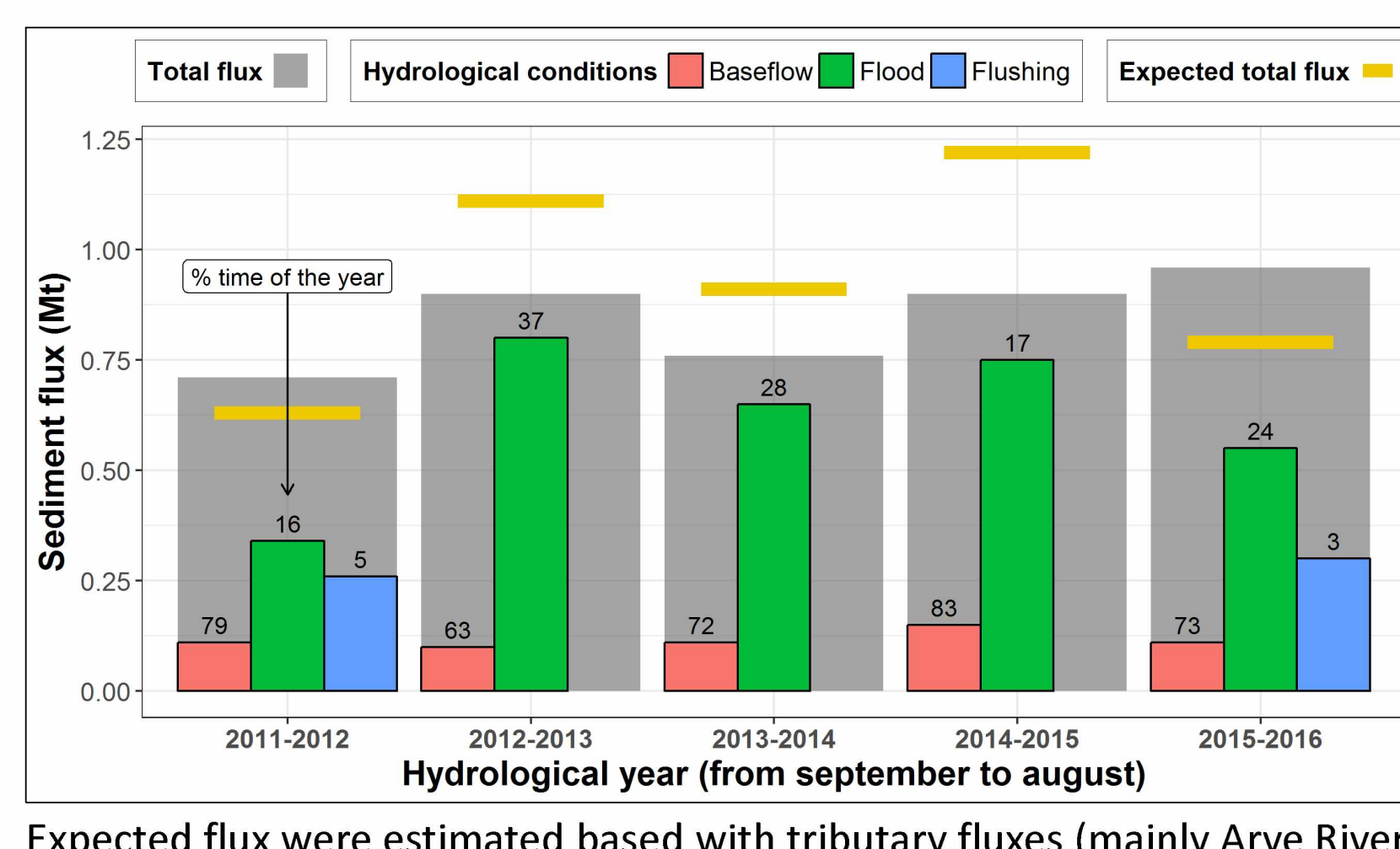


- General increase of the concentration after Pougny as POC.
- High values of Organically Bound Tritium (OBT) downstream:
 - Resuspension of old sediments (contamination by watch industries²) ?
- Low values of OBT upstream:
 - Dilution by depleted sediments originated from the Arve River ?

- Sandy particles were only observed upstream
- Dilution in upper stations.
- Variation of POC is related to the tributary Arve characterized by low content of POC.
- Most of upstream sediments originated from the Arve River.

Lower contaminant concentrations upstream were related to coarse particles as sand. Most of them were also correlated with POC and were originate from the Arve River depleted in POC.

What do dam flushes add to annual fluxes ?



- Flushing flux is not negligible
 - Highest flux regarding the annual contribution in time
- Flushing event conduct to the export more sediment as expected
 - Resuspension of stored sediment
- Equilibrium of annual budget balance

Highlights

- Monitoring flushing event is necessary to understand sediments and associated contaminants transport and behavior,
- Variation observed are mainly related to the POC concentration,
- Particle size correlations were only observed when studying the spatial variation,
- In the vicinity of the dams => sediments are mostly newly eroded but were rapidly stored in the upstream reservoirs,
- For downstream stations => old sediment previously stored and resuspended by high discharge,
- Fluxes during flushing crucial to balance the annual budget.

Reference:

¹Liu, S., Lu, X.X., Xia, X., Zhang, S., Ran, L., Yang, X., et al., 2016. Dynamic biogeochemical controls on river pCO₂ and recent changes under aggravating river impoundment: an example of the subtropical Yangtze River. Global Biogeochem. Cycles 30, 880–897.
²Eyrolle, F., Lepage, H., Copard, Y., Ducros, L., Claval, D., Saey, L., Cossonnet, C., Giner, F., Mourier, D., 2018. A brief history of the origins and contents of Organically Bound Tritium (OBT) and 14C in the sediments of the Rhône watershed. Sci. Total Environ. in review.

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 More information about OSR Project <http://www.graie.org/osr/> - Data used are available here: DOI [10.17180/OBS.OSR](https://doi.org/10.17180/OBS.OSR)