



Observatoire
des Sédiments
du Rhône

The Rhône Sediment Observatory (OSR) monitoring network for suspended sediment and contaminants long-term assessment

Marina Coquery, INRAE, France

Fabien Thollet, Jérôme Le Coz, Hugo Lepage, Jérôme Labille, Aymeric Dabrin, Matthieu Masson, Cécile Miège, Hugo Delile, Bertrand Morandi, Olivier Radakovitch

Un dispositif de recherche animé par le **graie**

15th International SedNet Conference, Healthy Sediments, Madrid, Spain, 6-10 October 2025

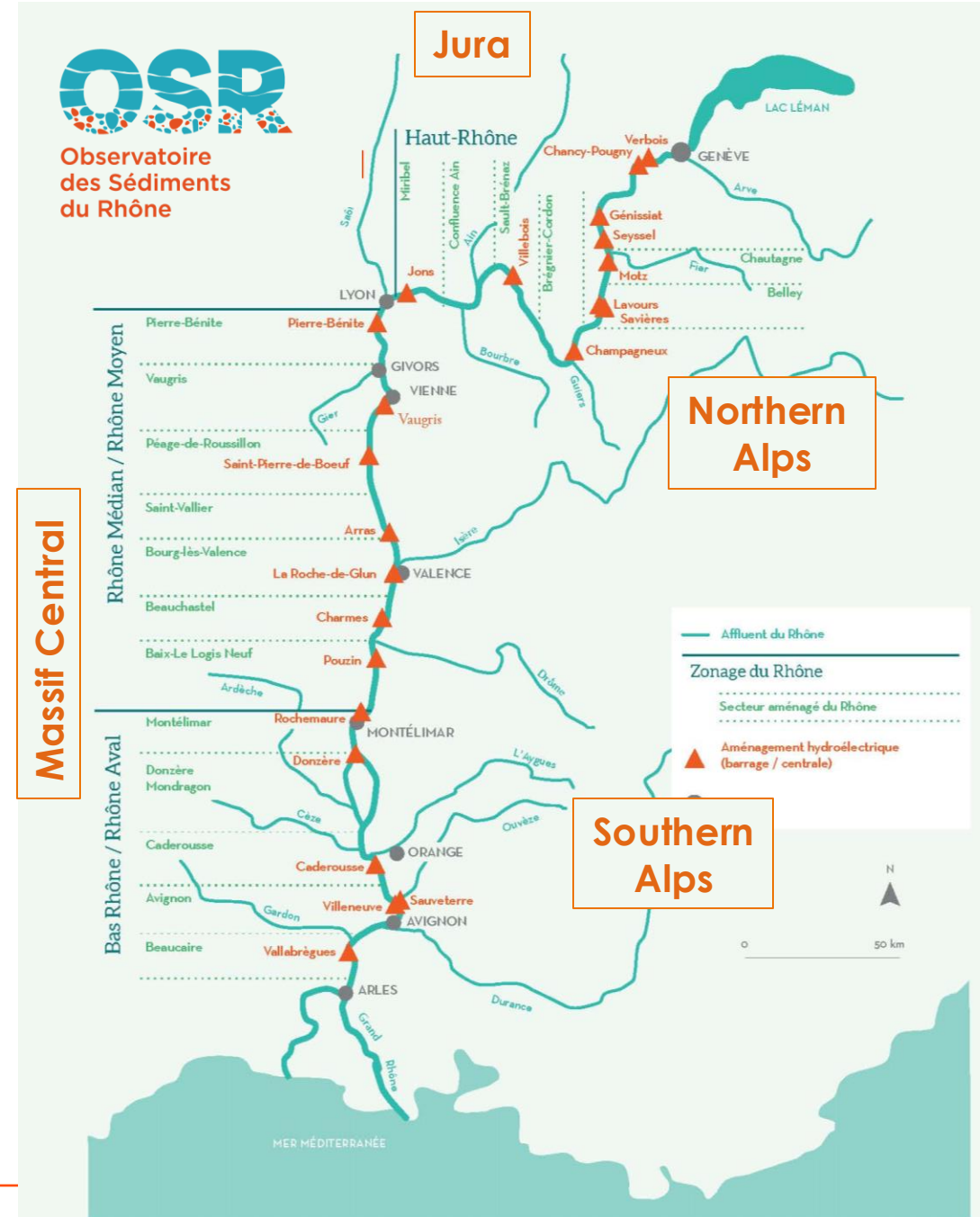
The Rhône River

- Large river in Europe (814 km long, 1700 m³/s) and main tributary of the Mediterranean Sea
- Drains 4 mountain areas
- Major anthropic impacts on the sediment transport:
 - Regulated for navigation (1840-1940)
 - Gravel extraction (1950-1990)
 - Hydroelectric dams and by-passed section (1950-1995)



Major issues in:

- Sediment delivery and storage
- flooding risk
- Socio-economic activities
- Natural environments
- **Sediment and associated contaminants inputs to the sea**



The Rhône Sediment Observatory

2009 - ongoing

Why ?

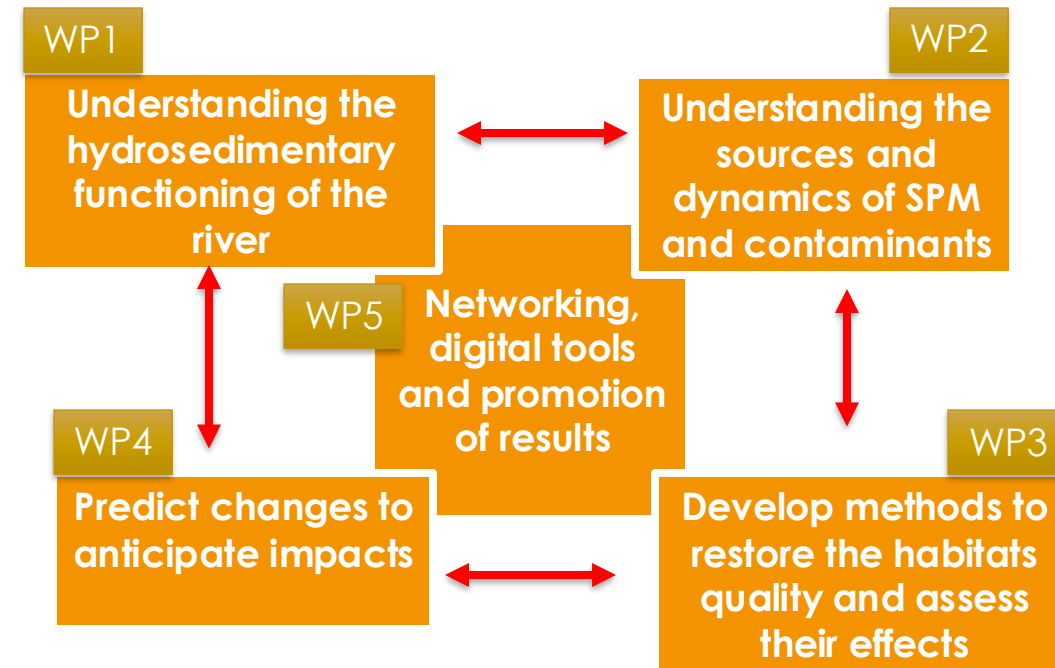
- Provide answers to stakeholders on questions related to the sediment & associated contaminants transfer, restoration of habitats, and future impacts due to climate change

Who ?

- 5 public research institutes (*CNRS, INRAE, ASNR, ENTPE, IFREMER*)

How ?

- Developments of sampling methods, analyses, models...
- Long-term research including focus during hydrological events and at representative sites / tributaries
- Effort on samples and data management + webtools for free access
- Dissemination of knowledge: 21 PhD, 142 reports, 102 papers



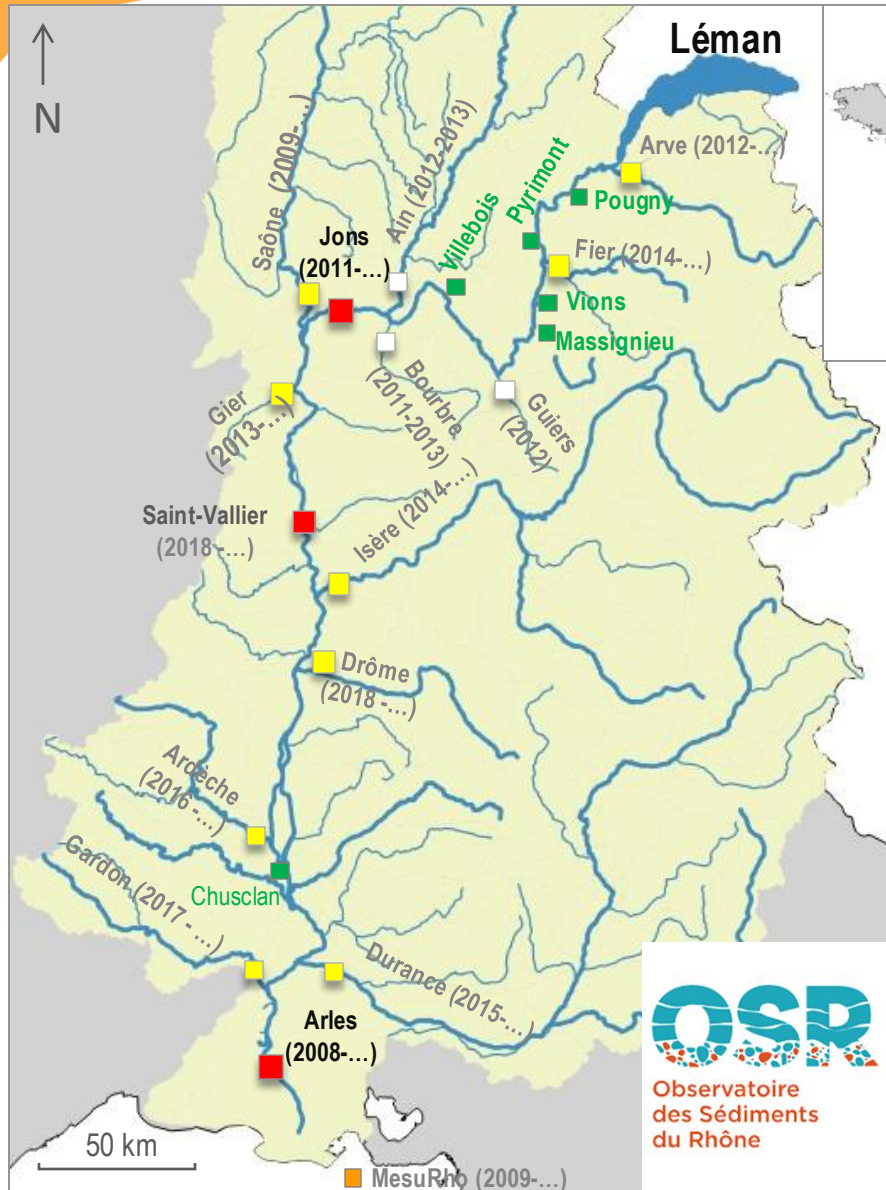
Main objectives on particulate contaminants flux

- Measure the concentration and flux of suspended particulate matter (SPM) and associated contaminants to the Rhône River outlet and Mediterranean Sea
- Determine the respective role of the main tributaries inputs in the catchment area
- Define the upstream-downstream balance of SPM and contaminant inputs
- Evaluate the inter-seasonal dynamics of contaminants flux transferred to the sea



The OSR network to monitor SPM and associated contaminants flux

(2010 – ongoing)



- SPM / contaminant permanent station on Rhône River
- SPM / contaminant permanent station on Rhône tributaries
- SPM / contaminant temporary station on Rhône tributaries
- SPM permanent station on Rhône & tributaries
- SPM permanent station in the Rhône Delta
- (2013-...) Flux monitoring period

□ Permanent network of 19 permanent monitoring stations on the Rhône and its tributaries:

- ✓ 3 main stations on the Rhône River for SPM and contaminants
- ✓ 1 station in the Rhône delta to monitor SPM flux
- ✓ 6 stations for SPM monitoring alone (5 stations on the Upper Rhône and Chusclan on the Lower Rhône)
- ✓ 12 stations for SPM and contaminants monitoring

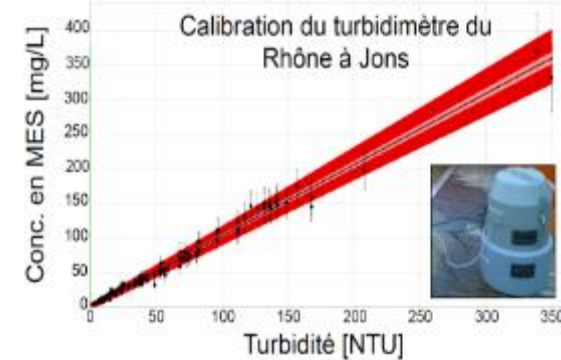
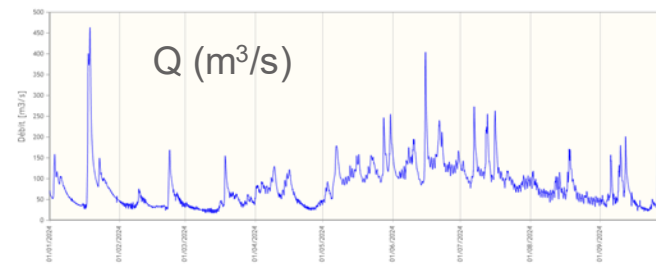
Evaluate SPM and associated contaminants flux

1

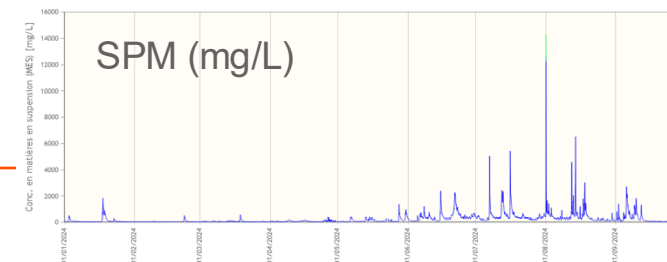
Continuous discharge and SPM flux measurements



$$\text{Flux}_{\text{contaminants}} = Q \times \text{Conc}_{\text{SPM}} \times \text{Conc.}_{\text{contaminant}}$$



- OSR network deployment
- Continuous flow data
- Continuous turbidity data
- Calibration SPM (automatic samplers)



Poulier et al 2019, STOTEN

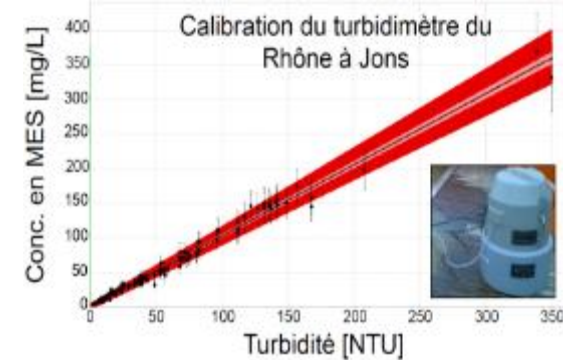
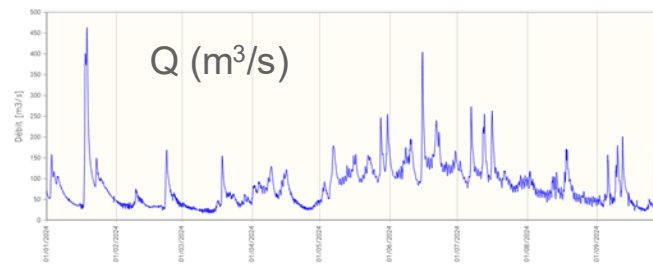
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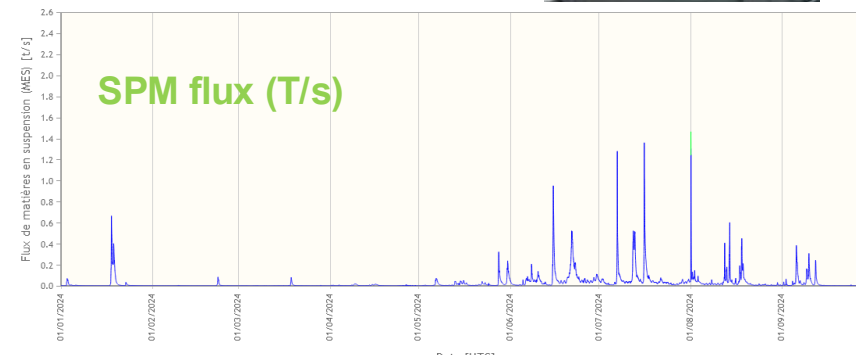
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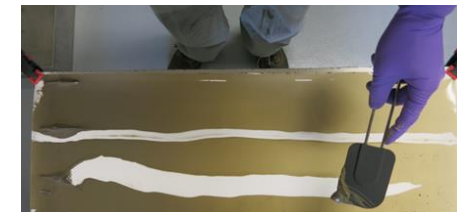
Evaluate SPM and associated contaminants flux

2

Integrated contaminants concentrations measurements

$$\text{Flux}_{\text{contaminants}} = Q \times \text{Conc}_{\text{SPM}} \times \text{Conc.}_{\text{contaminant}}$$

- SPM sampling: particle traps + continuous flow centrifuge on the Upper Rhône and Rhône outlet
- Sample processing: sieving, freeze-drying, grinding
- Chemical analyses: POC, TMEs, PCBs, PAHs, PBDEs, radionuclides, ...



Database and samples banking

Public data access: <https://bdoh.inrae.fr/OBSERVATOIRE-DES-SEDIMENTS-DU-RHONE/>

“ Observatoire des Sédiments du Rhône ” Welcome

Rhône Sediment Observatory (OSR)

The Rhône Sediment Observatory (OSR) was established in 2009 to address issues that had emerged in the integrated project Plan Rhône. Over the 500 km-long Rhône river from Lake Geneva to the Mediterranean Sea, the Observatory aims at producing, collecting and managing data for documenting stocks and fluxes of sediments and the associated contamination.

OSR is a project funded by the Plan Rhône and several partners, and supported by the European Fund for Regional Development research program. It is a research platform that combines scientists (CNRS, Irstea, ENTPE, IRSN, Ifremer) and the main managers of the river (governmental authorities, water agency, CNR, EDF and the regional councils of Auvergne Rhône-Alpes, Provence-Alpes-Côte d'Azur and Occitanie). It is one of the observatories of the Rhône catchment research community (ZABR).

To cite these data you may refer to the following DOIs:

- Thollet, F.; Le Bescond, C.; Lagouy, M.; Gruat A.; Grisot, G.; Le Coz, J.; Coquery, M.; Lepage, H.; Gairoard, S.; Gattacceca, J.C.; Ambrosi, J.-P.; Radakowitch, O.; Dur, G.; Richard, L.; Giner, F.; Eyrolle, F.; Angot, H.; Mourlet, D.; Bonnefoy, A.; Dugué, V.; Launay, M.; Troudet, L.; Labille, J.; Kleffer, L. (2021): Rhône Sediment Observatory (OSR); INRAE. https://dx.doi.org/10.17180/OBS_OSR
- Concentrations and fluxes of suspended particulate matters and associated contaminants in the Rhône River from Lake Geneva to the Mediterranean Sea <https://dx.doi.org/https://doi.org/10.15454/RJCQZ7>

Experimental sites

• Réseau de mesure des flux de l'OSR

This experimental site brings the monitoring of flows, concentrations of suspended solids and concentrations of micropollutants on the Rhône and its tributaries.

Parameters

▼ Hydrology

- Discharge
- Stage
- Water temperature

▼ Sediment

- Characteristic diameter d10
- Characteristic diameter d90
- Median diameter D50
- Suspended solid concentration (SSC)
- Suspended solid flux (SSC)
- Turbidity

▼ Chemistry

- Major ions and nutrients
 - Conc. of particulate organic carbon (POC)
- Metals and metalloids
 - Conc. of particulate arsenic (As)
 - Conc. of particulate cadmium (Cd)
 - Conc. of particulate chromium (Cr)
 - Conc. of particulate cobalt (Co)

Download this time series

Help

Period

01/01/2024 00:00:00

01/01/2025 00:00:00

Format

BDOH

Download type

Mean

Time step

1 hour

Time zone

UTC +00

Period in this time zone 01/01/2024 00:00:00 - 01/01/2025 00:00:00

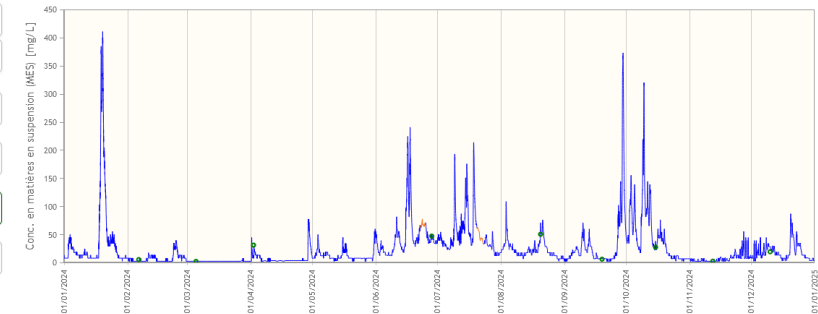
Time series

FIER / CMES

☒ I agree with [The terms of uses.](#)

Download

Close



Sediment/SPM samples banking:

- ✓ Codification (station, date, sampling method)
- ✓ Inventory (sample mass,...)
- ✓ Long-term storage at -80°C
- ✓ More than 1700 SPM samples stored today !

OSR



freezer -80°C



stored SPM samples

Collect-Science interface

Rechercher des échantillons

UID ou Identifiant : Collection : OSR Retrait : Choisir

UID entre : Type :

Lieu de prélèvement : JON - Rhône s. Motif de déslocation : Choisir Statut : État normal

Recherche par date : Date d'échantillon : 03/12/2018 à 03/12/2018

Verifonnez :

Nouvel échantillon

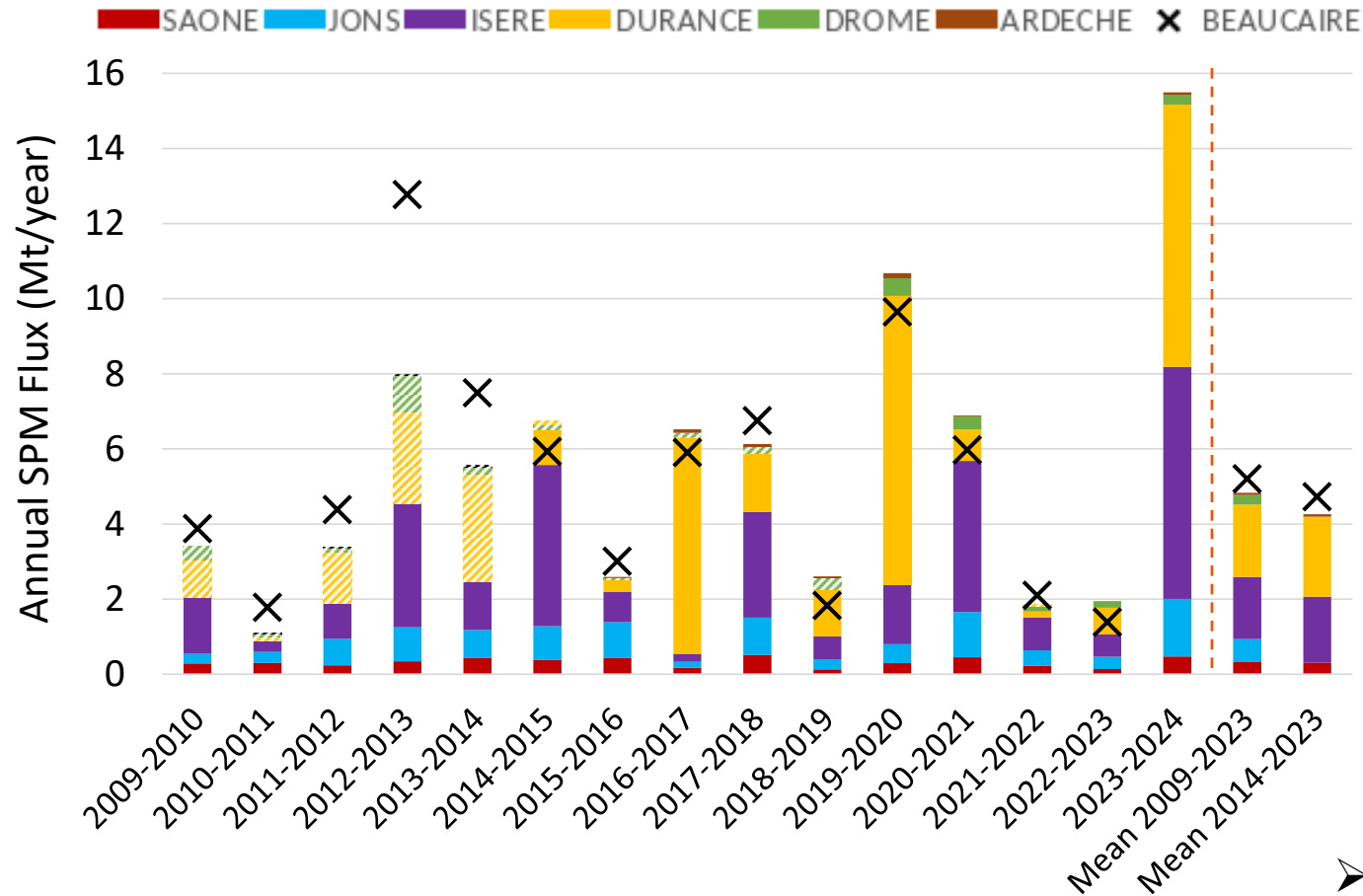
Tout désarchiver : Etiquette par défaut : Etiquettes Brady SP35 Printer Impression directe Fichier CSV

Export vers autre base

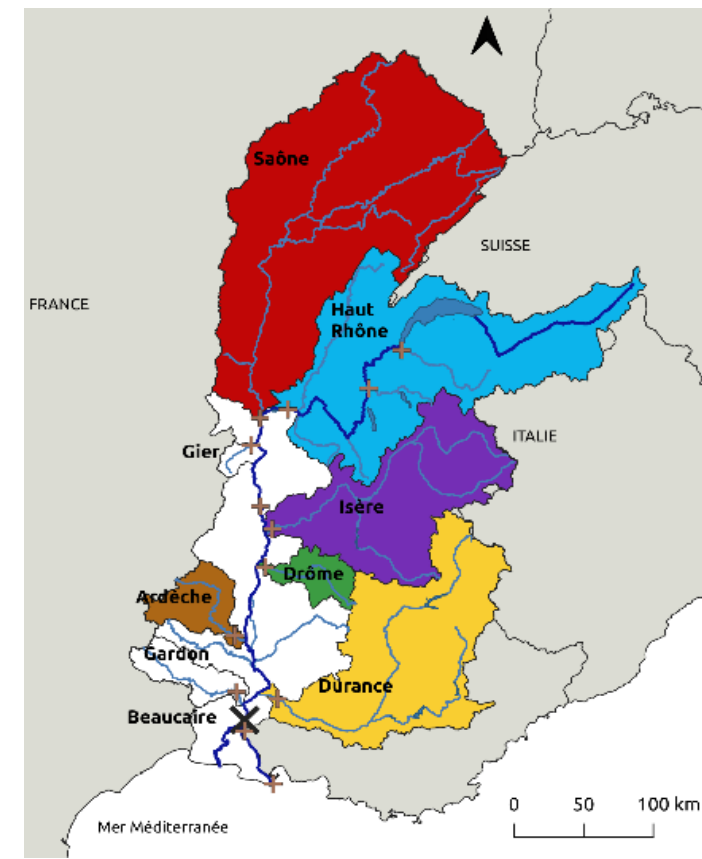
UID	Identifiant ou nom	Autres identifiants	Type	Dernier mouvement	Emplacement
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Collect-Science interface

SPM flux budget at the outlet of the Rhône (annual average)



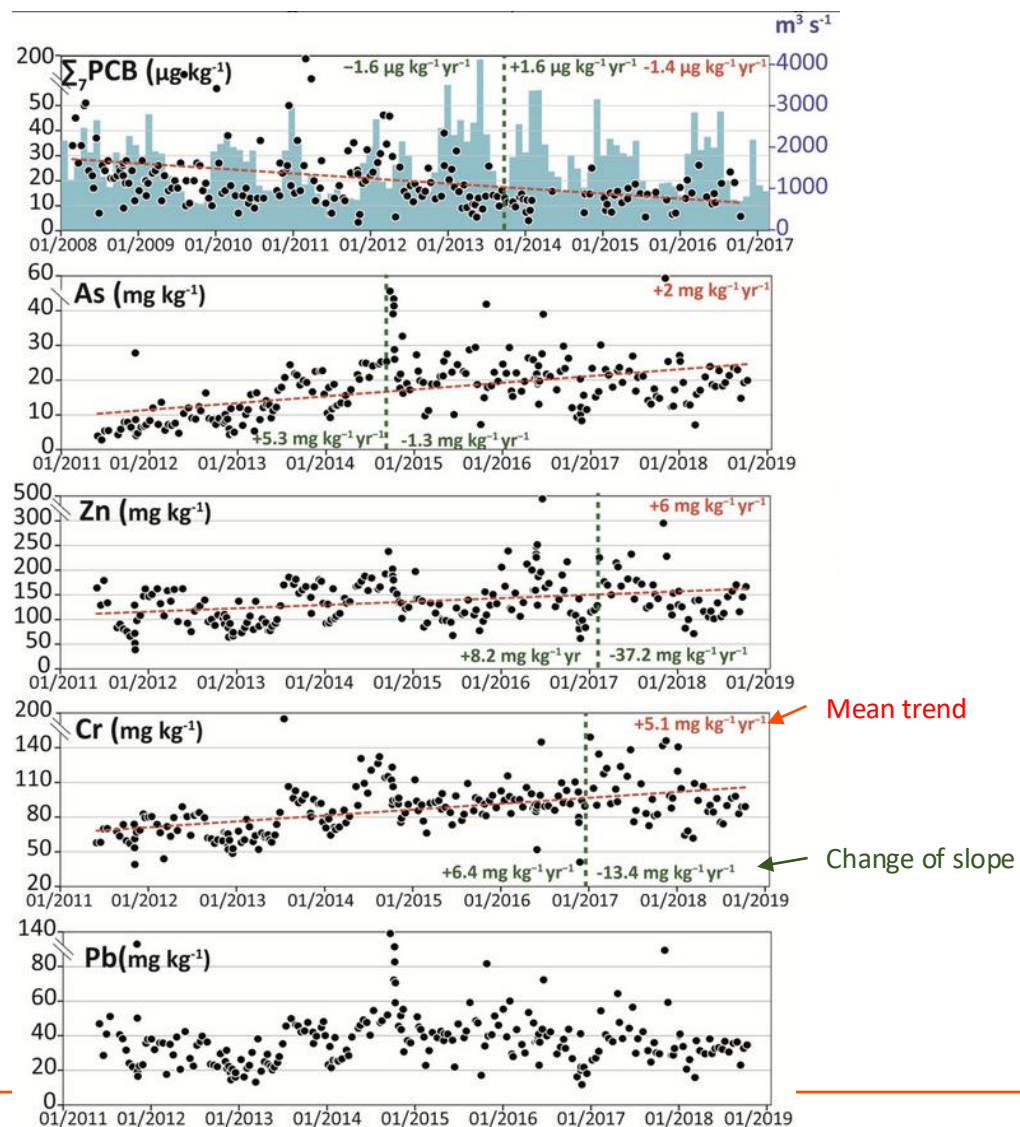
Mean SPM flux 2014-2023
4.7 Mt/year



Annual budget ≈ balanced
High annual & spatial variability
On-going: use of AI for missing data reconstitution

- Annual budget close to balance, with high variability at Isère and Durance stations (floods, dam reservoirs flushing)
- Before 2014, more uncertainty for the reconstruction of Durance flows using the Cs(Q) law

Temporal trends of SPM contaminants concentration Rhône River outlet (2008 – 2019)



Concentration range:

- Σ₇PCBi = 15 μg/kg/yr
- As = 20 mg/kg/yr
- Zn = 100 mg/kg/yr
- Cr = 80 mg/kg/yr
- Pb = 30 mg/kg/yr

Seasonal trends:

- ✓ Higher concentrations in summer
- ✓ Lower in winter

Still a decreasing trend:

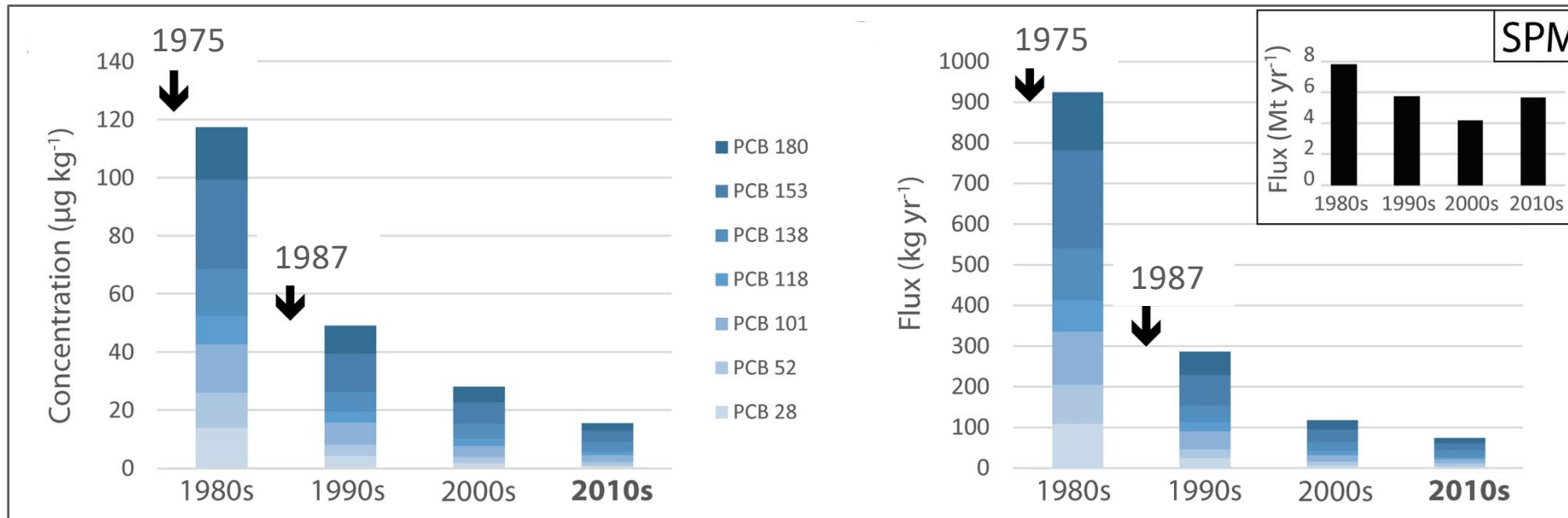
- ✓ PCBs -9% per year

Slight increasing trends for some TMEs:

- ✓ As, Cr, Co, Ni, Zn -

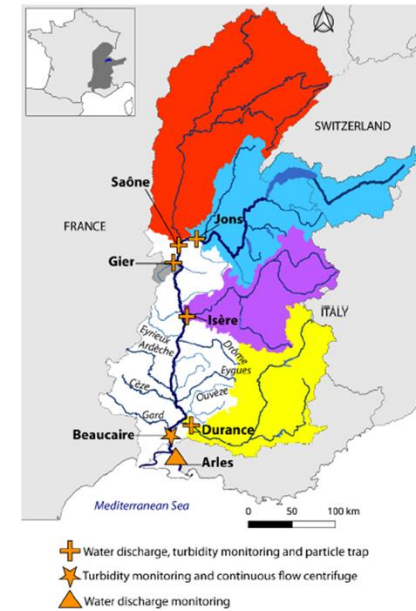
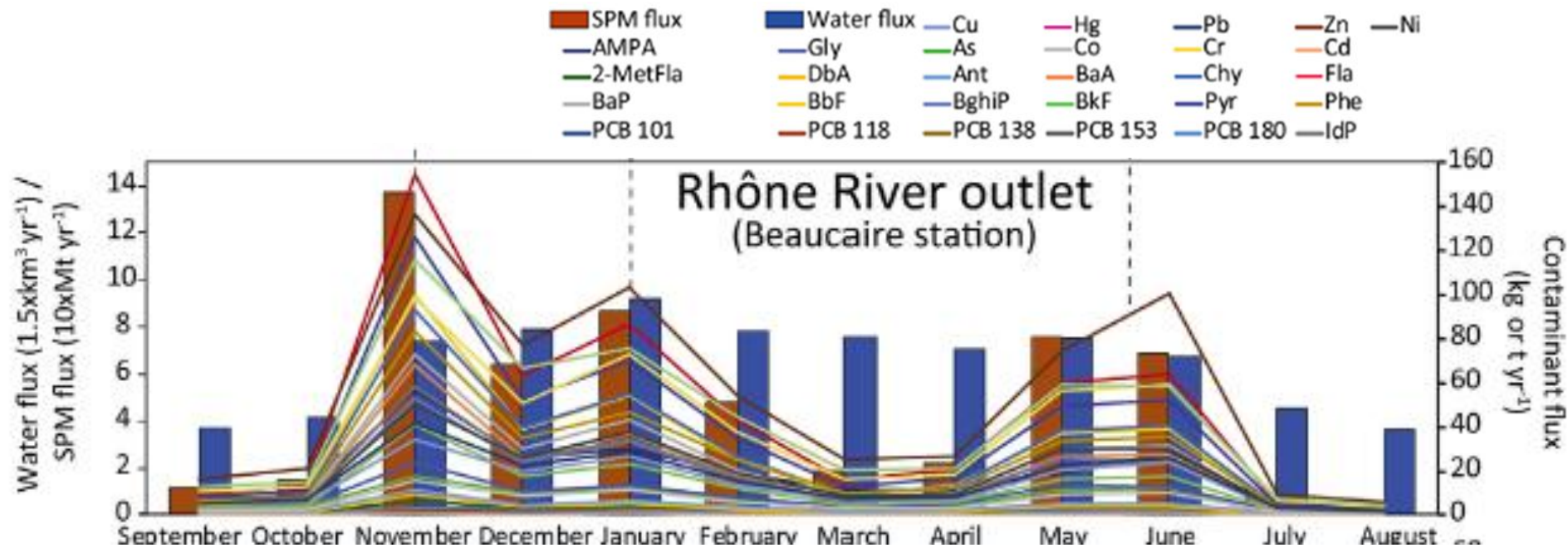
Long-term trends of SPM contaminants concentration and flux Rhône River outlet (from 1980s)

Σ PCBi concentrations and flux



- ✓ Similar decreasing trends for PCBs concentration and flux
=> linked to successive restriction of use
- ✓ Similar observation for PAHs, Hg and Cd
- ✓ For other TMEs, flux trends follow SPM

Inter-annual particulate contaminant fluxes (seasonal averages 2008-2018)

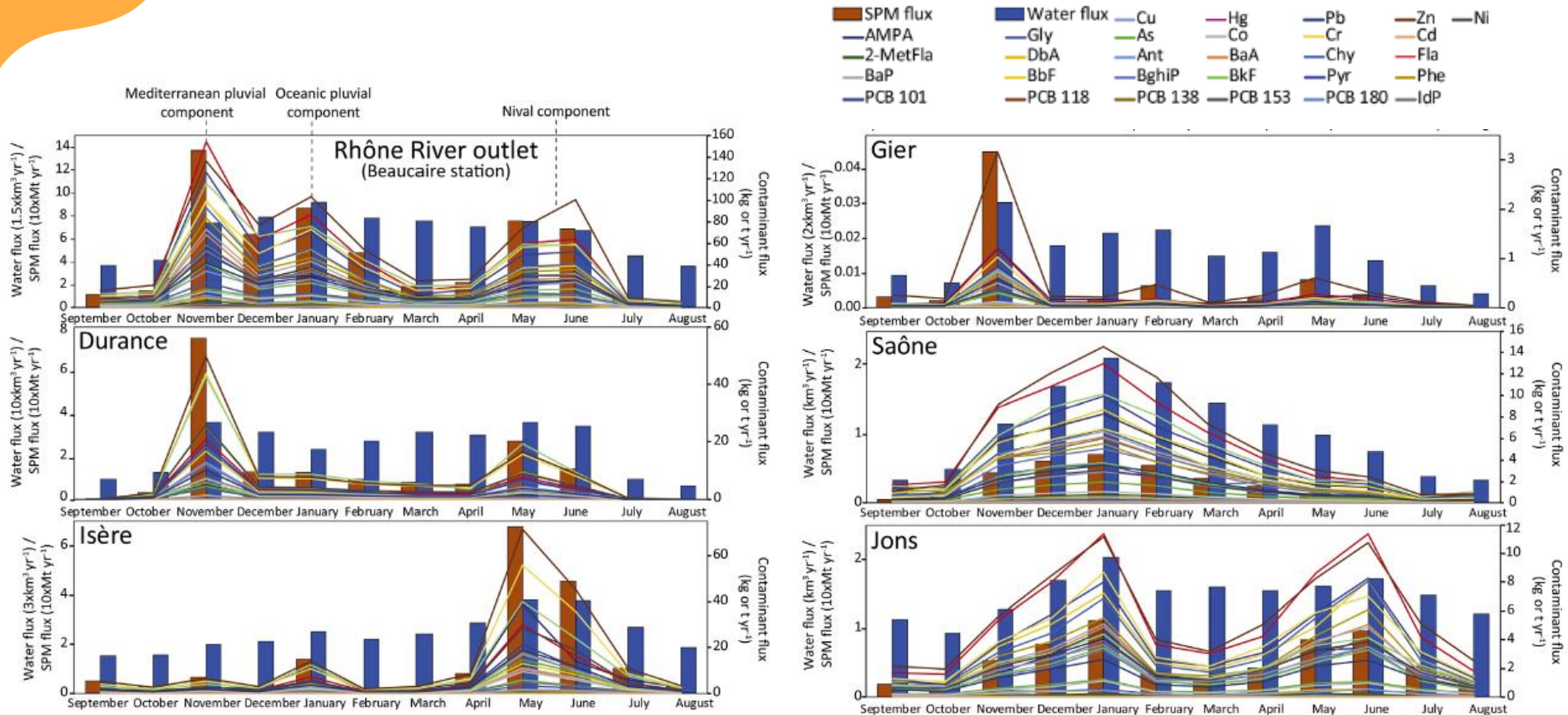


- $\Sigma(\text{ETM}) = 1800 \text{ t/yr}$
Zn = 645t/yr; Hg = 498 t/yr; Cr = 439 t/yr
- $\Sigma(\text{HAP}) = 3 \text{ t/yr}$
- $\Sigma(\text{PCBi}) = 61 \text{ kg/yr}$
- $\Sigma(2 \text{ pesticides}) = 320 \text{ kg/yr}$

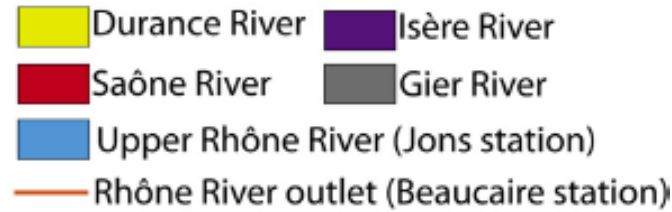
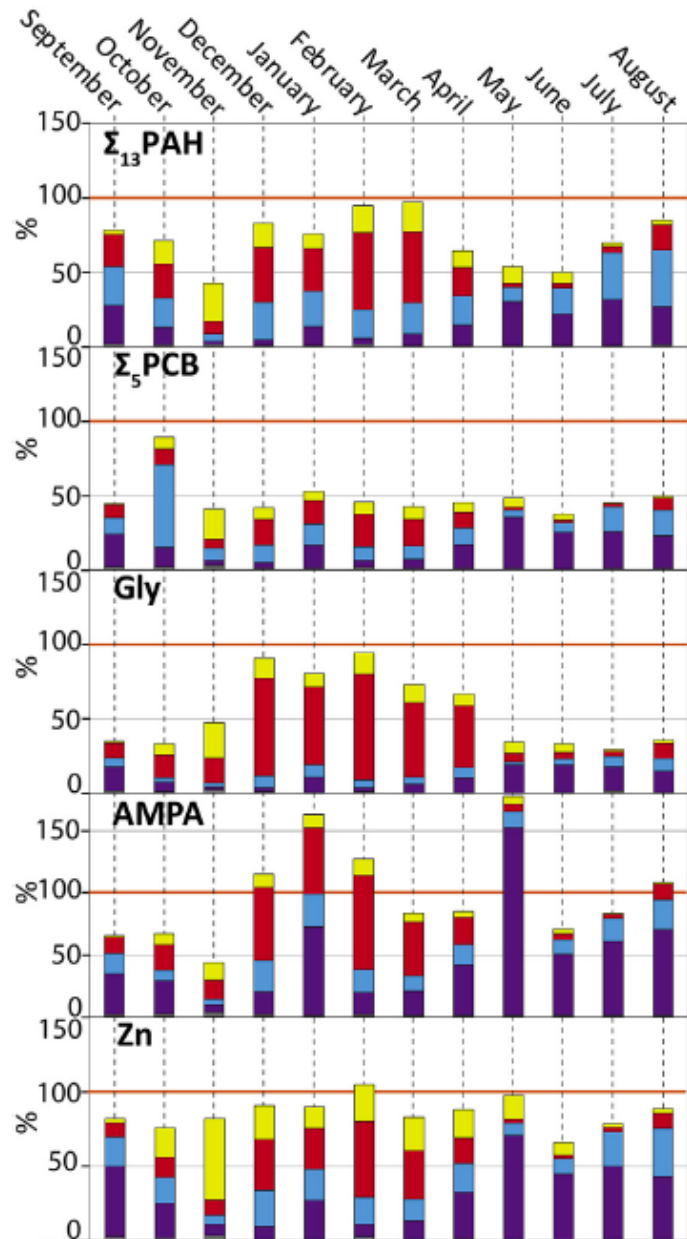
Seasonal dynamics of contaminants fluxes:

- Contaminants fluxes $\Leftrightarrow$ SPM fluxes
- Hydroclimatic influence of tributary watersheds
- 2/3 of annual fluxes discharged during 1/3 or the year
- 70% of total flux at the outlet during floods ($Q > 2900 \text{ m}^3 \text{ s}^{-1}$)

Seasonal dynamics of contaminants fluxes => tributary contributions



Inter-annual budget of contaminants fluxes => additional sources



Annual budget not balanced for most contaminants

- ✓ Deficit => PCBs from historical pollution stocks in alluvial margins
=> PAHs and some TMEs from urban areas direct sources
- ✓ Excedent => degradation (AMPA)

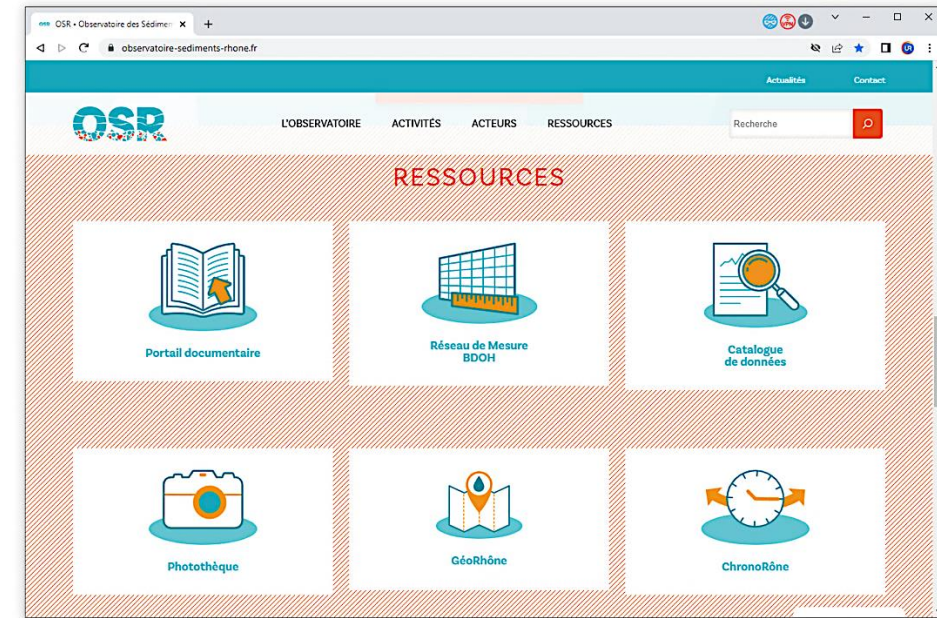
Conclusion

The long-term research of the OSR allows to:

- Construct a comprehensive database of samples, analyses, maps
- Perform experiments during specific events (ex: floods) or on specific sites (ex: by-passed reaches)
- Develop methods and models by continuously improving them (ex: SPM reconstruction for missing values, cf. Taha Hamadene)
- Provide better answers to the stakeholder questions

Perspectives

- Sustain the OSR observation network and continue to acquire knowledge on emerging substances of interest: targeted and non-targeted analyses, PFAS, microplastics, ...
- Evaluate direct SPM-contaminants inputs from urban areas (ex: Lyon Metropolis)
- Predict the influence of climate change on the liquid and solid transport (ex: change in SPM & metals inputs from the Alps?)



<https://observatoire-sediments-rhone.fr/>

Open access publications - OSR collection:

<https://hal.science/OSR>

Data base access:

<https://bdoh.inrae.fr/OBSERVATOIRE-DES-SEDIMENTS-DU-RHONE/>

Thank you for your attention



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Confluence Rhône - Arve

