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Stratégie d'observation pour la quantification des flux de contaminants particulaires dans le Rhône : l'Observatoire des Sédiments du Rhône (OSR)

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INTRODUCTION

Most of the suspended particulate matter (SPM) and associated contaminants delivered to the Mediterranean Sea is carried by the Rhône river. However, accurate estimations of particulate contaminant fluxes along the Rhône river and its tributaries are complex due to:

- Difficulties to assess river fluxes because of temporal and hydrological variabilities;
- Incomplete available data on SPM and particulate contaminant concentrations.

A long-term goal of the Rhône Sediment Observatory (2009-2017) is to **produce dense datasets** in order to **quantify both SPM and associated contaminants fluxes** (trace metals, polychlorobiphenyls) in a **robust way**, from hydrological events to annual scales.

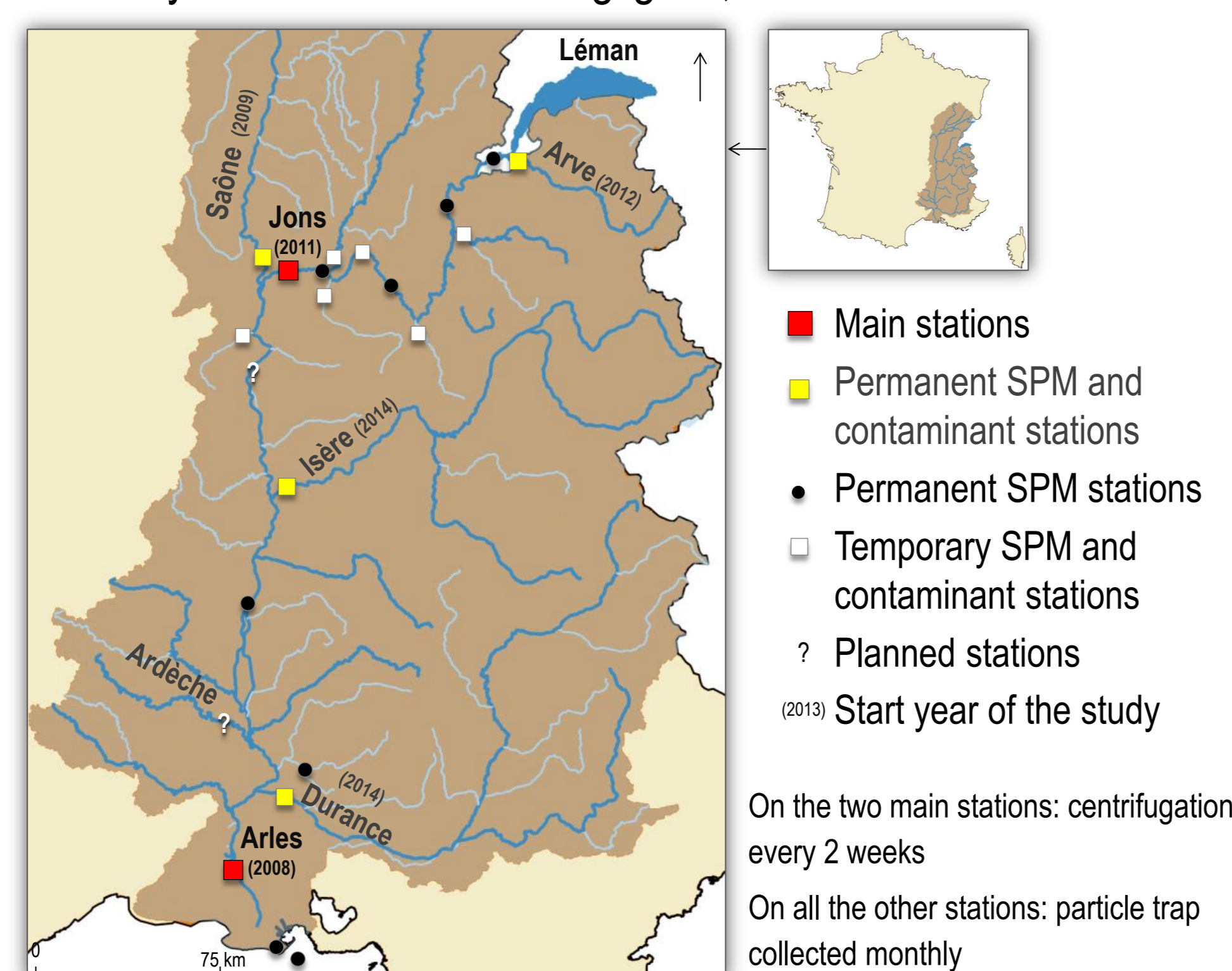
A STRATEGY FOR EVALUATING CONTAMINANT FLUXES

Through a distributed network of permanent and temporary stations in the Rhône river and its main tributaries, the observation strategy developed in the OSR program consists in **monitoring the 3 parameters** required in the calculation of the particulate contaminant flux $\Phi_{contaminant}$ ($\mu\text{g/s}$):

$$\Phi_{contaminant} = \int_T Q \cdot C_{SPM} \cdot C_{contaminant} \cdot dt$$

▪ **Q**: the **water discharge** (m^3/s):

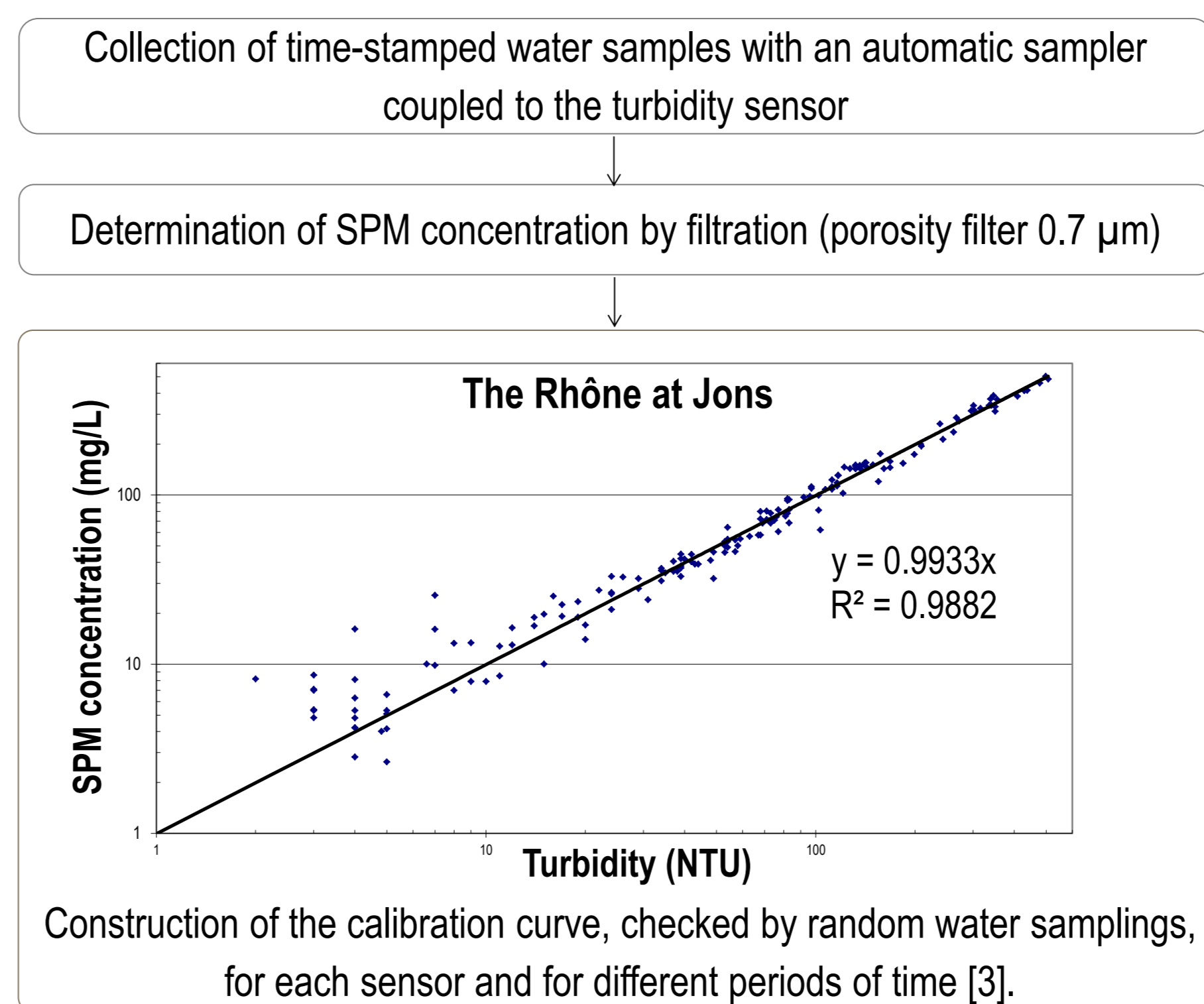
- Continuously measured at **hydrometric stations** with a stage-discharge rating curve checked by stream gauging;
- The systematic errors are negligible, within 2%-6%.



The French Rhône river observatory network

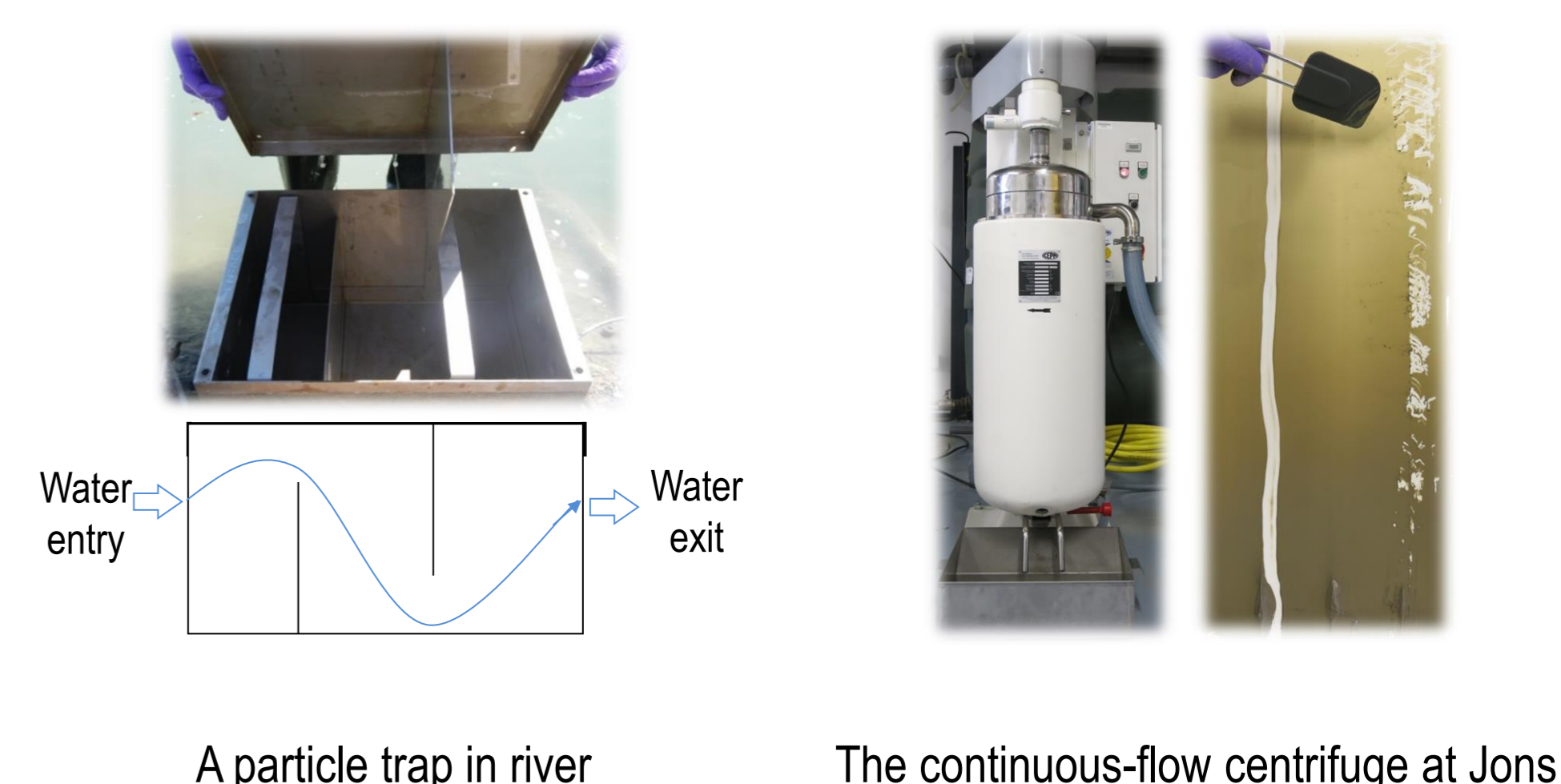
▪ **C_{SPM}**: the continuous **SPM concentration** time-series (g/L) established from:

- A **turbidity** dataset, recorded continuously every ten minutes;
- A **calibration curve**, to convert turbidity into SPM concentration.



▪ **C_{contaminant}**: the **contaminant concentrations** ($\mu\text{g/kg}$) in SPM collected with different techniques:

- A continuous-flow **centrifuge**, used as the reference;
- An integrative **particle trap** in the rivers [2], allows to complete the network in a cheap and handy way.

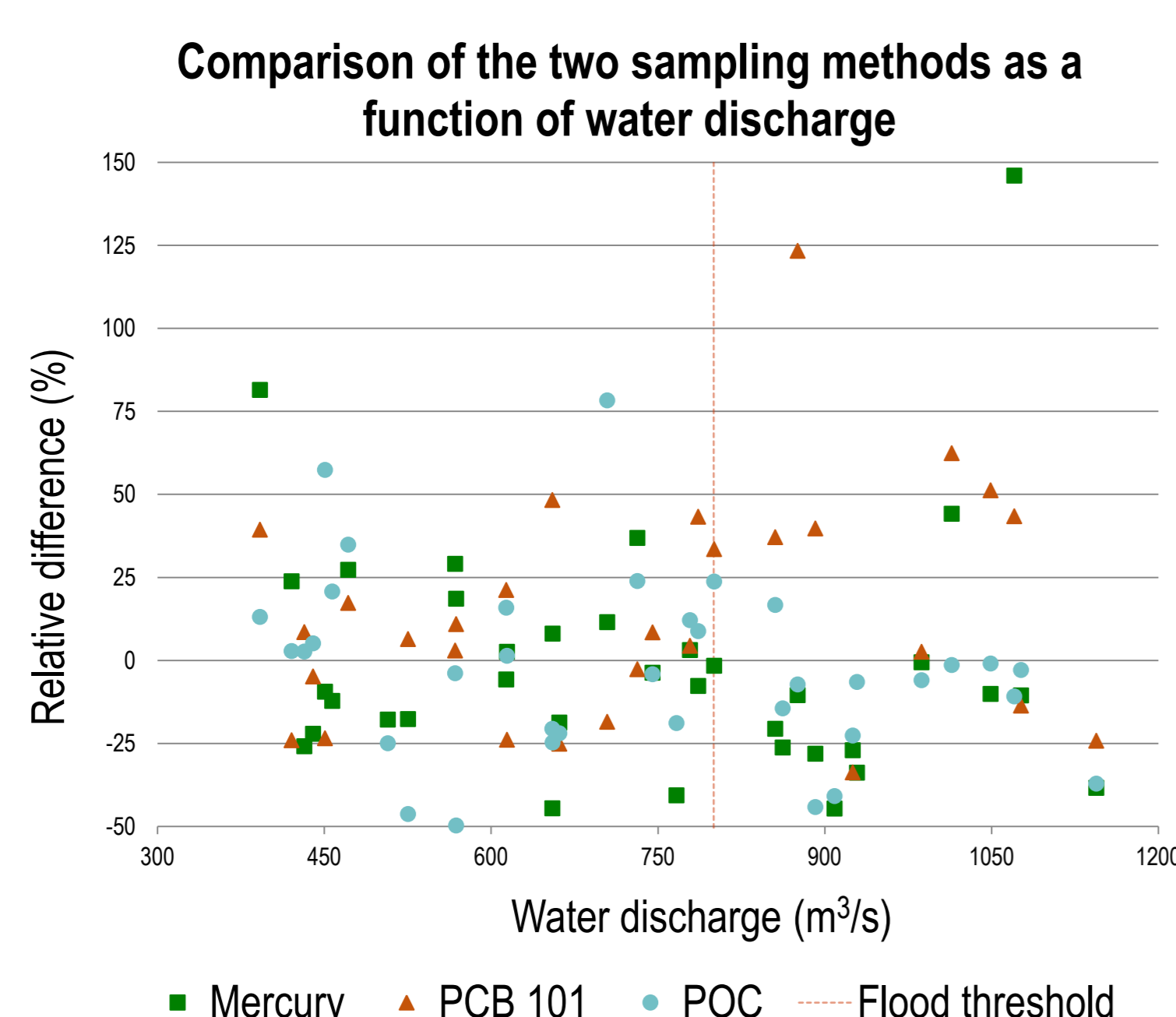


The performed analyses on SPM are: PCBs, mercury, metallic trace elements, particulate organic carbon (POC) and grain-size distribution.

RESULTS

▪ **Complementarity of the SPM sampling methods**

We compared particulate contaminants and POC concentrations in SPM sampled together with a centrifuge ($n=43$) or a particle trap ($n=40$) from August 2012 to April 2014.

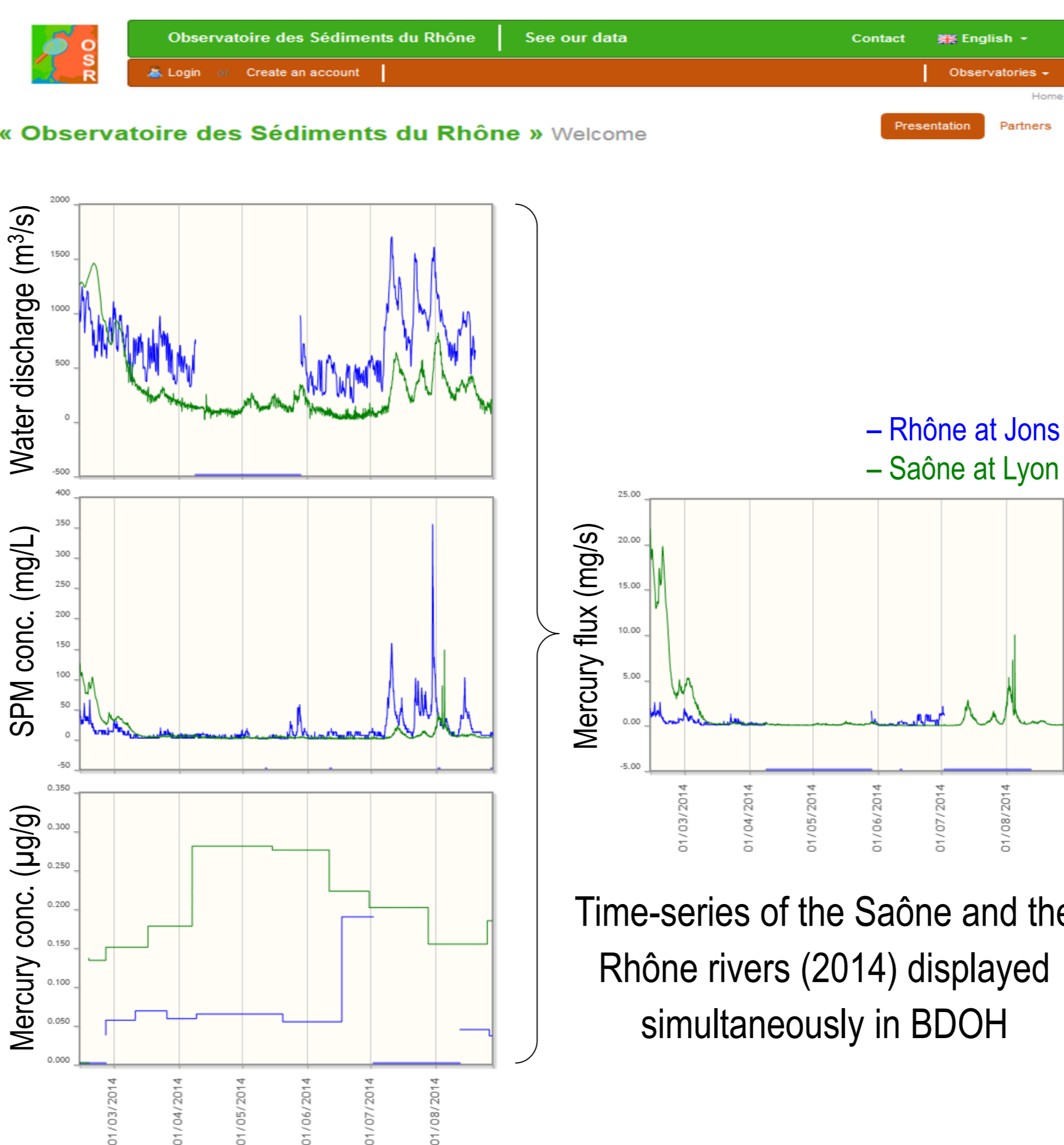


- Concentrations of mercury (Hg), PCB 101 and POC are **comparable for the two sampling techniques**, even during floods, as the analytical uncertainties are 15% for Hg, 30% for PCB 101 and 10% for POC.

→ However, the sedimentation process in particle traps remains unknown and will be **studied** in an experimental flume **under controlled conditions**.

▪ **Data storage**

Particulate contaminant fluxes are calculated using continuous time-series in a dedicated online database: <https://bdoh.irstea.fr>



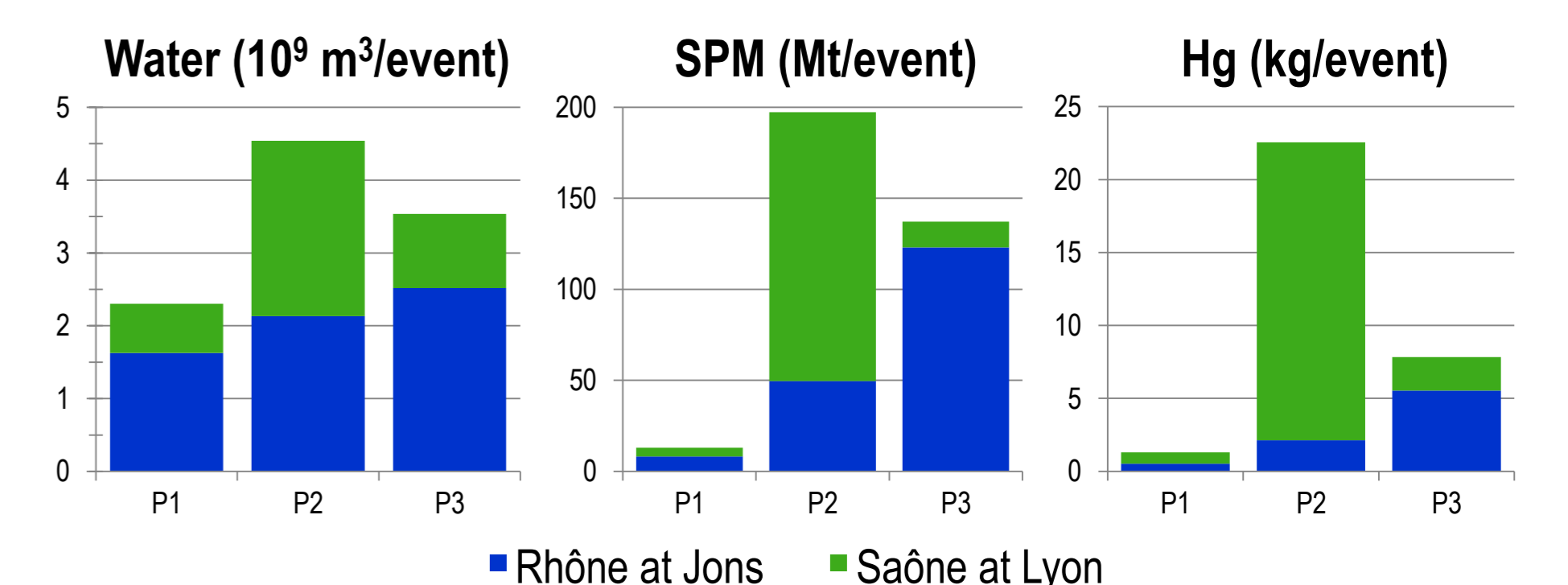
Time-series of the Saône and the Rhône rivers (2014) displayed simultaneously in BDOH

→ The datasets had permitted to develop a **1-D hydraulic-SPM numerical model** of the Rhône to understand and predict the propagation and fate of particulate fluxes.

▪ **Example of fluxes assessments**

We calculated fluxes assessment on the Saône at Lyon and the Rhône at Jons, on 3 periods with various hydrological conditions.

Hydrological condition	Period	Duration (days)	Q mean (m^3/s)	[SPM] mean (mg/L)	[Hg] mean ($\mu\text{g/g}$)
P1 Low water	08/03/14	31	588	4.6	0.063
	08/04/14		243	6.1	0.175
P2 Flood event on the Saône	11/02/14	28	850	20.3	0.048
	11/03/14		959	52.0	0.143
P3 Flood event on the Rhône	20/07/14	31	939	40.9	0.045
	20/08/14		380	11.1	0.168



- Contaminant fluxes are mainly governed by **SPM fluxes**, and to a lesser extent by **contamination levels**.

• Although the water discharge is lower on the Saône, the **contribution** of both rivers regarding **particulate contaminant fluxes** is **similar**.

→ **Each main tributary needs to be monitored** to quantify its SPM and associated contaminants inputs to the Rhône river.

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