OSR

THE RHONE SEDIMENT OBSERVATORY (OSR):

A MULTI-PARTNER PLATFORM FOR BASIC AND APPLIED RESEARCH ON THE RHONE RIVER VALLEY (FRANCE)

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The Rhone river

One of the largest european rivers

First freshwater input to the western Mediterranean basin

560 km in France

(800 km in total)

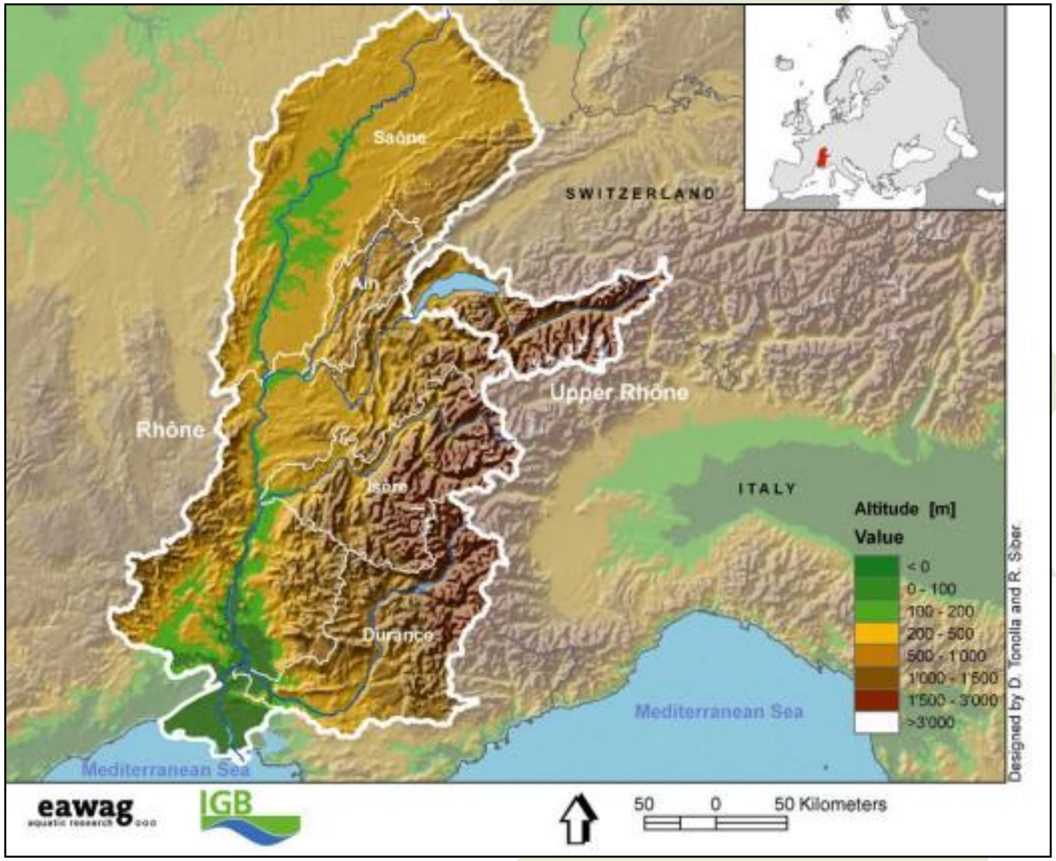
Watershed: 98 000 km^2

Mean discharge at the mouth:

1700 m^3/s

Annual flood :

4000 m^3/s

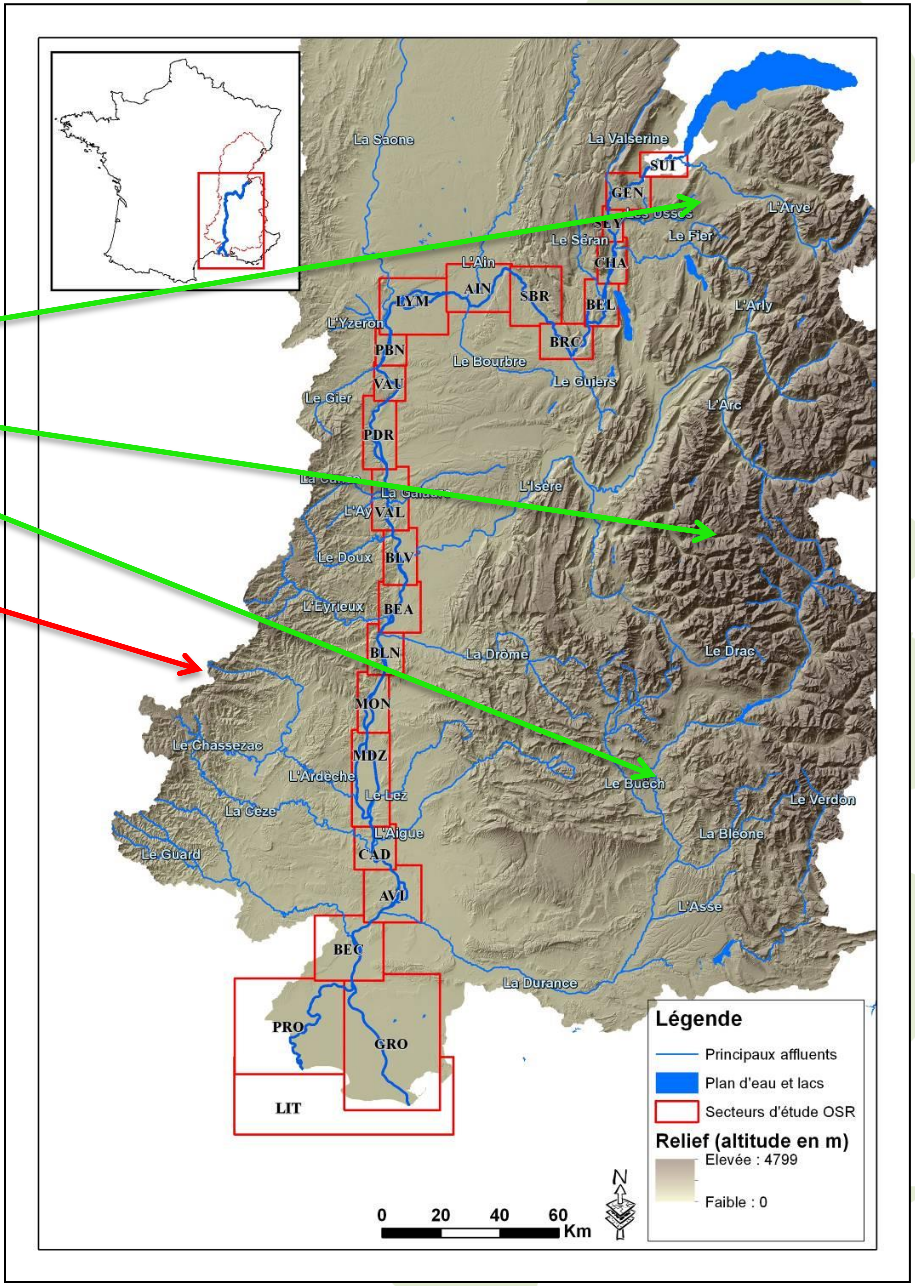


J.M. Olivier et al., 2009

The Rhone river

Flash-flood events (few hours to days) occur regularly on the Alps and Massif Central Mountains (≈ 60% of the annual discharge)

Poor knowledge of the time and spatial scales and fluxes of sediment transported or stored within the river !



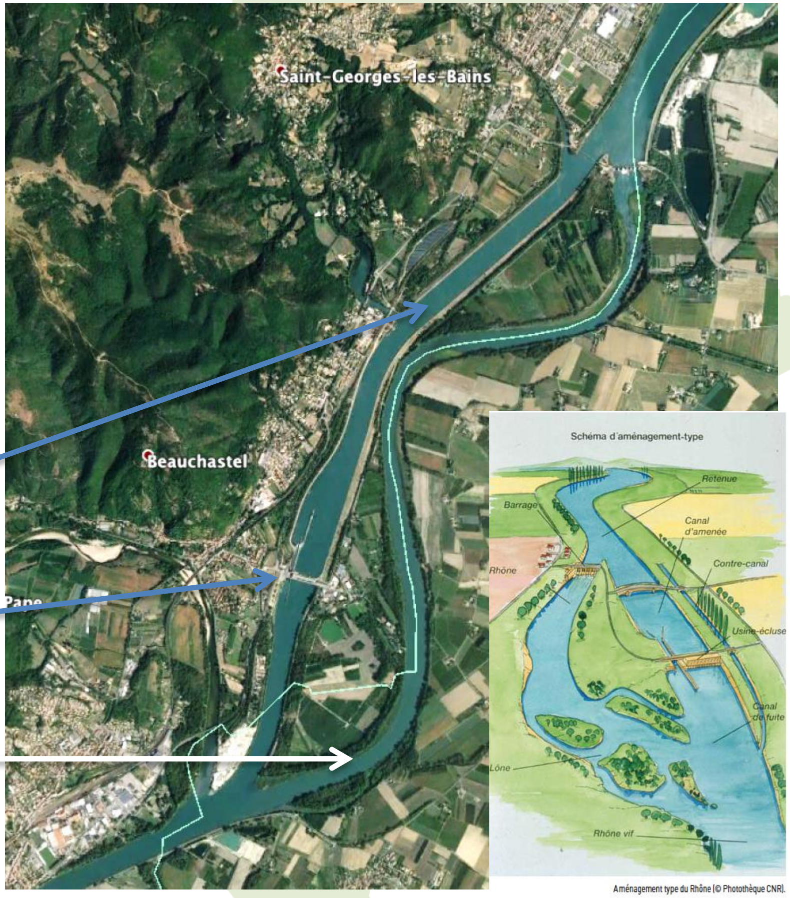
Regulated between 1850 and 1930 for navigation purposes...
(embankments, groynes, walls)

… then dammed for producing electricity (1948-1986: 19 hydroelectric dams)

Embanked reach

Hydroelectric power plant

« Old Rhone » or by-passed reach



Why an observatory on sediments ?

Le Rhône inonde près de 8 000 habitants au nord d'Arles

"Le Pays d'Arles, et surtout la ville d'Arles, sont les seuls points noirs qui restent dans les Bouches-du-Rhône. C'est là que je vais mobiliser tous les moyens disponibles". Christian Frémont, préfet de région n'a pas hésité. Avec raison car, depuis hier matin, le nord de la cité est inondé par trois trémies (orifices de 6 m sur 4 environ, sous la voie SNCF Arles-Tarascon). Au total, plus d'un million de m³ d'eau a déferlé dans la plaine agricole et surtout dans la zone industrielle, les quartiers de Monplaisir et du Trébon. Et hier soir, la situation restait malheureusement inchangée. C'est en vain que des Puma de la sécurité civile ont largué une partie de la journée des sacs de sable. Fétus de paille face au Rhône qui, même en baissant rapidement, atteignait, à 21 heures, 9 000 m³/s, ils n'ont servi à rien. Seul espoir : parvenir à ...

Si hier les habitants du nord d'Arles gardaient le sourire, ils ont senti l'angoisse grimper au fur et à mesure que l'eau montait dans les quartiers. Photo Jérôme REY

Succession of damaging floods 1993-1994-2003

Stakes and questions related to the sediment transfer and morphology.

- What is the impact of the river geometry and existing infrastructures on the flooding risk or the ecological potential of the river ?
- How has the geometry of the channel evolved over the last two centuries?
- What is the annual bedload transport ?
- What is the impact of development and management activities such as dredging, channel maintenance or sediment flushing ?
- What suspended sediment and contaminant fluxes are transferred to the Mediterranean Sea ? Where do they come from and what are their temporal patterns ? Are they stored on the continuum and do they affect the geometry of the bed?
- Can we predict the sediment transfer and deposition ?
- How can we share data and information for public ?

Objectives jointly built by scientists and managers

Multidisciplinary scientific team

- Hydrologists
- Geochemists
- Geomorphologists
- Sedimentologists
- Modelers
- Geophysicians
- Database managers

Europe

Water agency and stakeholders

Regional councils

Workpackages and related issues –OSR 4

WP I – Bedload and river channel geometry

Benthic habitats, flood, chanel restoration (dredging, sediment replanshiment)

WP II – Sedimentation and floodplain morphology

Benthic habitats, restoration of channel banks and re-erosion, stock of past contaminants in the overbank fine sediments

WP III – Fluxes of suspended particulate matter and associated contaminants

Past and present SPM fluxes
Contributions from tributaries

WP IV – Sources of contaminants

Tracking contaminant sources
Knowledge on emerging pollutants

WP V.a – Modelling and web tools

Prediction and construction of scenario for decision
Database and metadabase

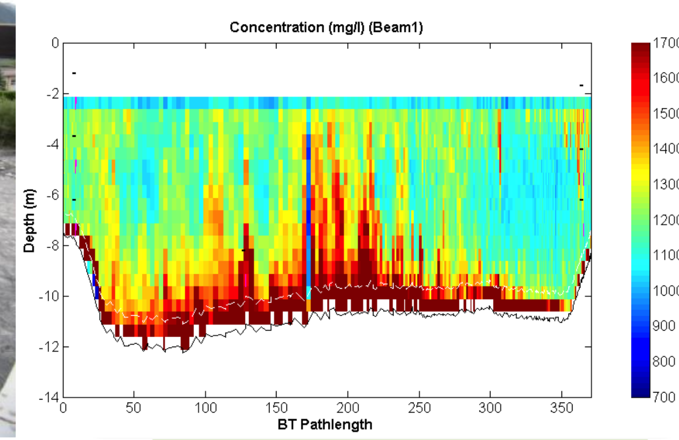
WP V.b – Coordination/Dissemination

Communication, dissemination of scientific knowledge

WP I – Evaluate the bedload transfer: sand and pebbles

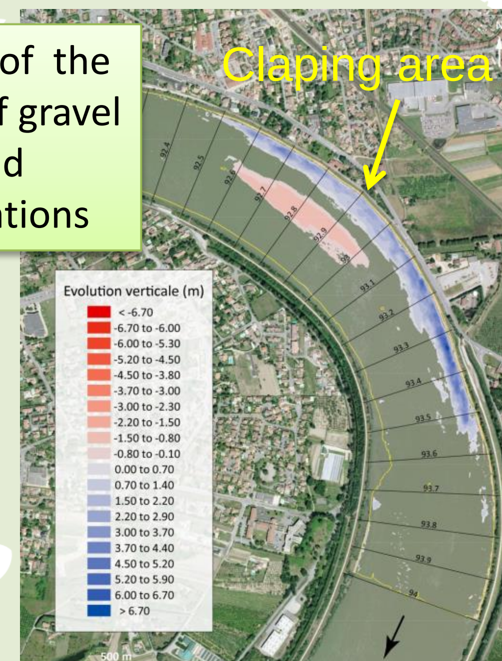
Development of technics to quantify and understand the bedload transfer

SPM extracted from ADCP signal



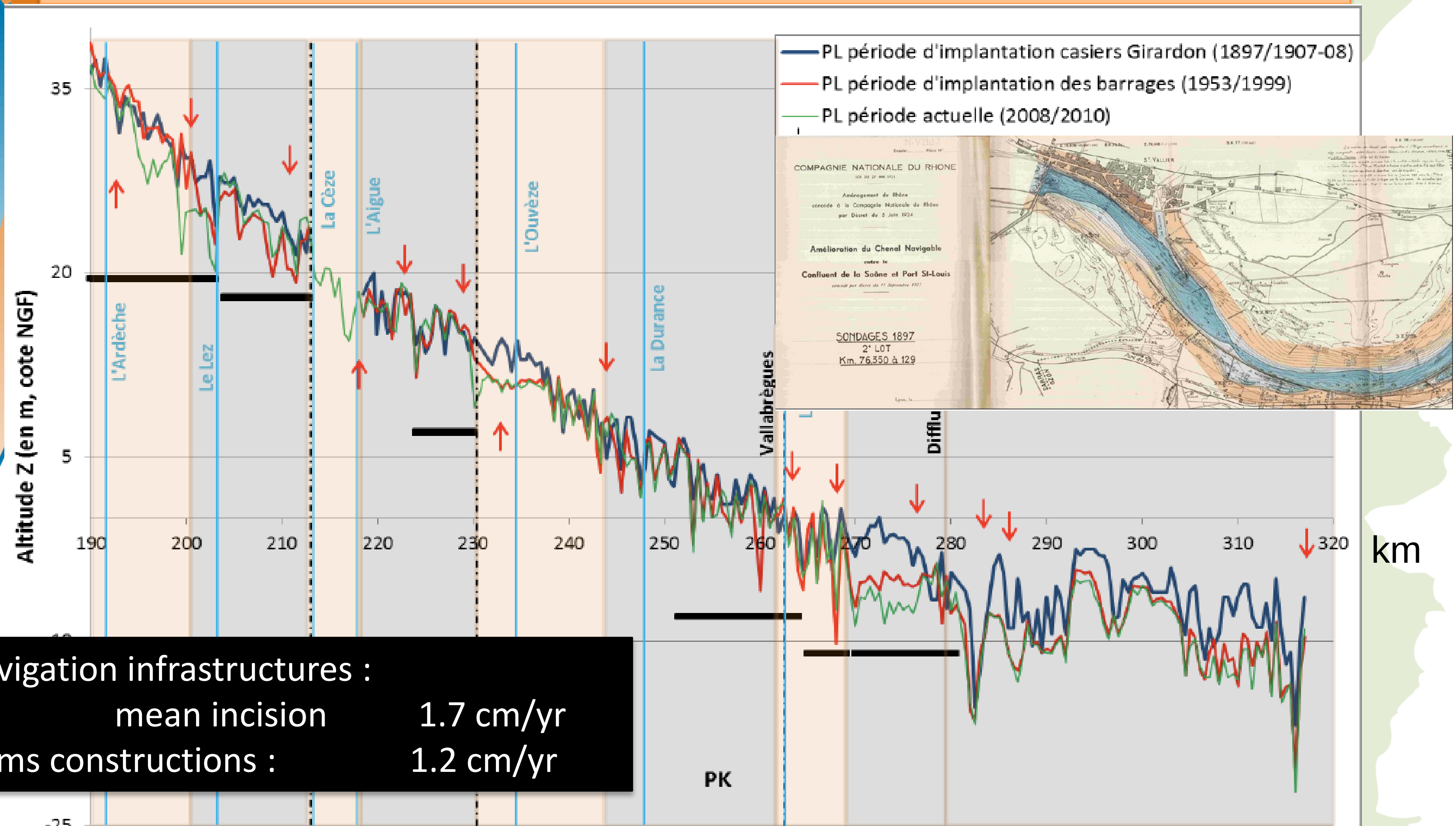
Creation of artificial pebbles with passive and active RFID to monitor their transport

Evaluation of the efficiency of gravel or sand augmentations



WP I – Understand the long term evolution of river bed elevation

Reconstruction of the talweg altitude from bathymetric charts to evidence the influence of the various phases of management

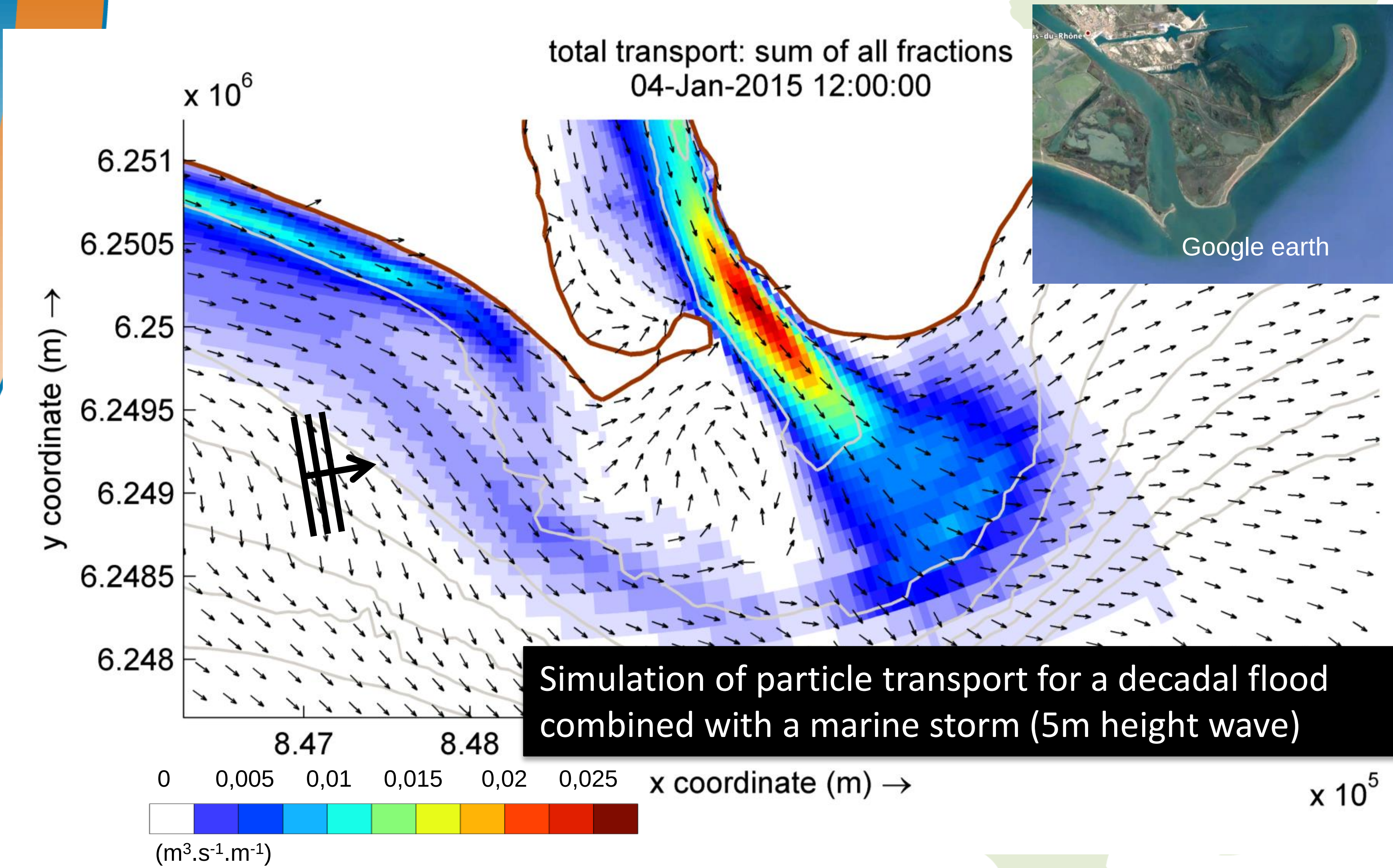


Navigation infrastructures :
mean incision 1.7 cm/yr
Dams constructions : 1.2 cm/yr

LYON → MEDITERRANEAN SEA

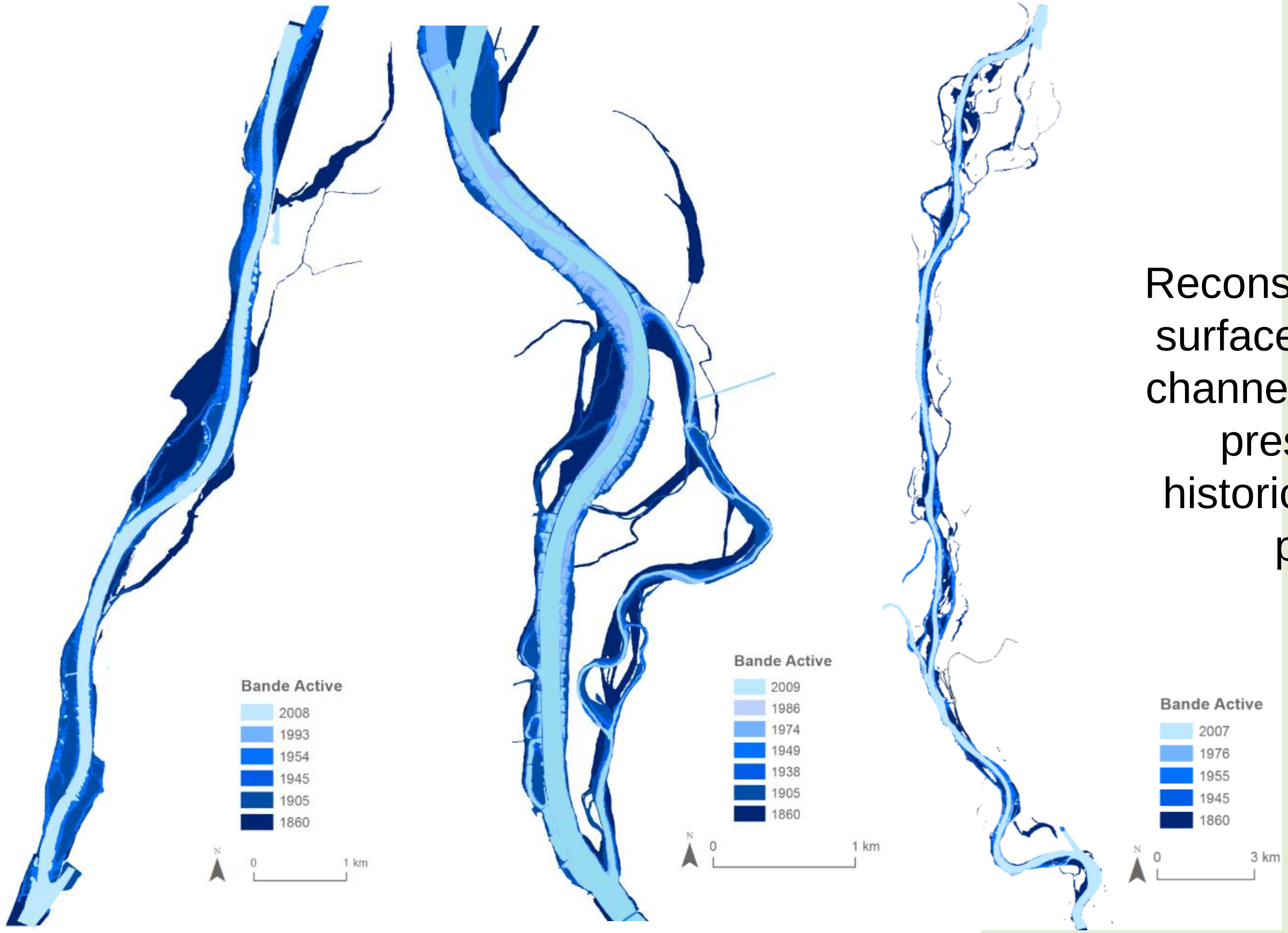
WP I – Understand the deposition of sand on delta and adjacent coasts

Development of a hydrosedimentary model to predict the transport and deposition of sands on the delta, including the influence of floods and marine storms



Simulation of particle transport for a decadal flood combined with a marine storm (5m height wave)

WP II – Define the long term evolution of the river morphology

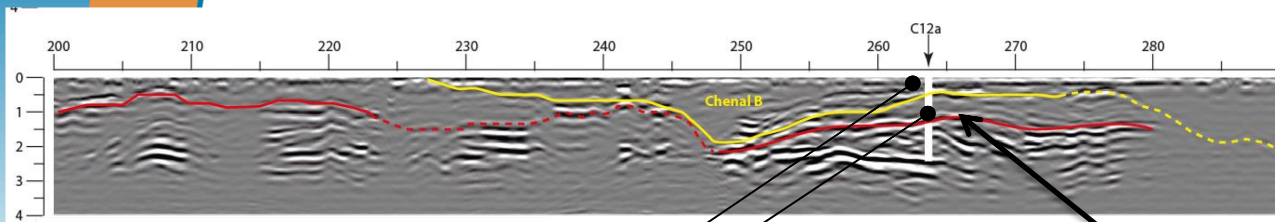


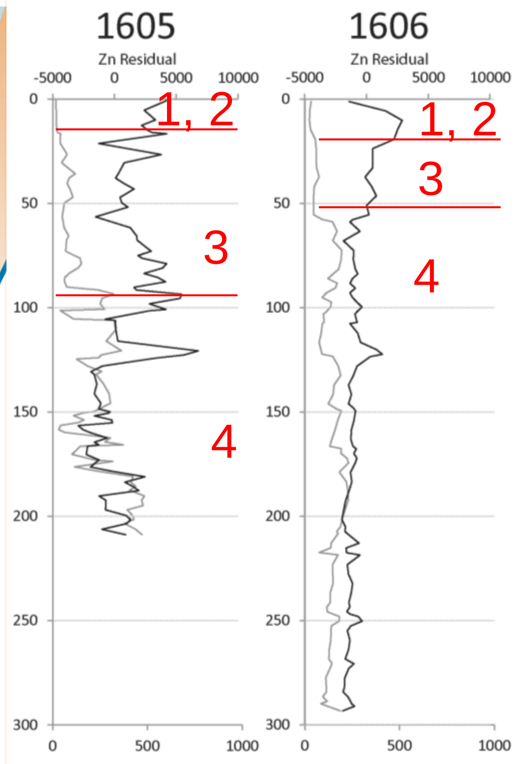
Reconstruction of the surface of the active channel from 1860 to present using historical maps and pictures

Reduction of ≈ 50 % during the period of regulation for navigation (1860-1954)
Reduction of 10-20 % during the period of dam construction (1954-2008)

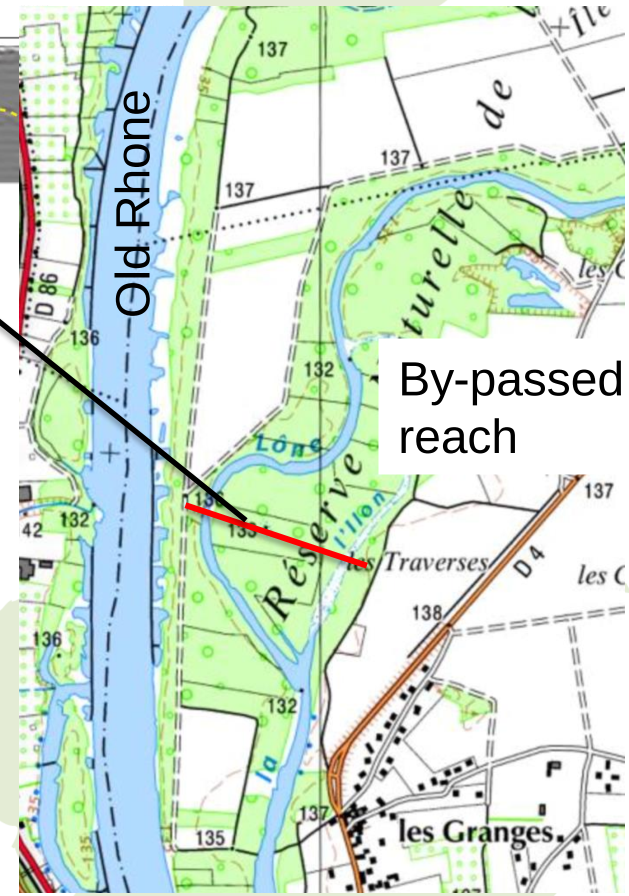
WP II – Knowledge of sediment and contaminants stored in the river network

Geophysical surveys, sediment coring and geochemistry to better evaluate the volume of sediments and contaminants stored in the alluvial margin and the risk in case of margin reactivation.





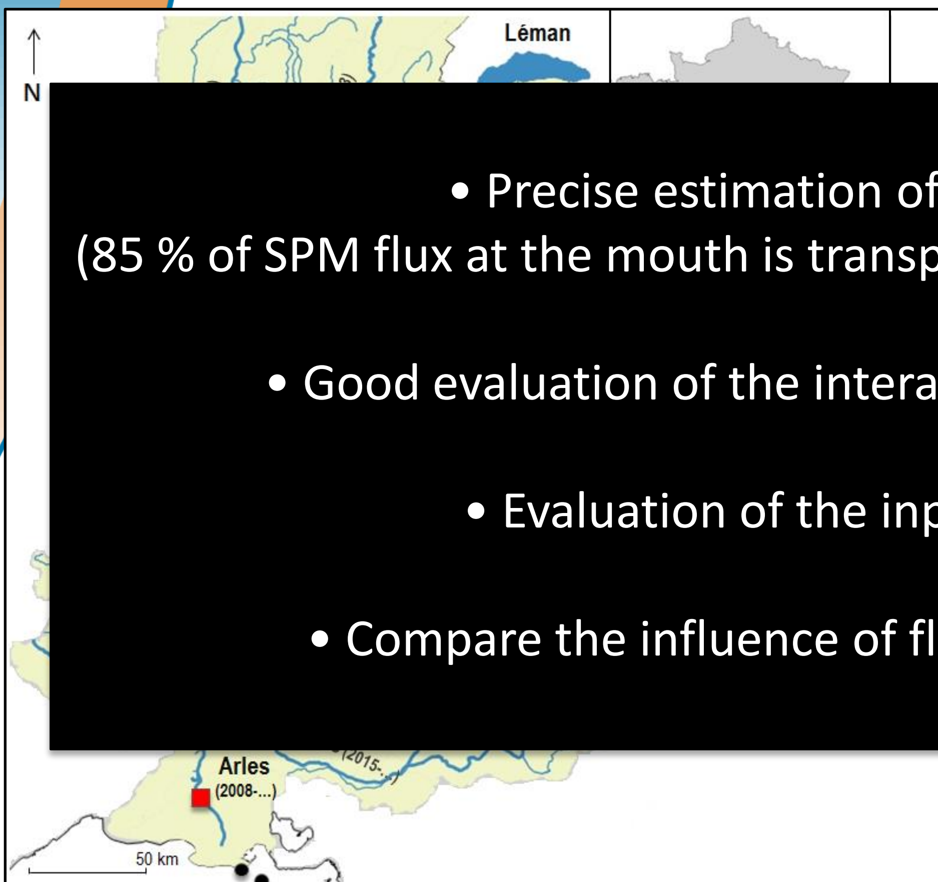
- 1. Post 1980's slow decrease of contaminants
- 2. 1980's, peak of contaminants (PCB, Zn, Pb, Cu)
- 3. Early 20th, progressive increase of chronic contaminants
- 4. 19th only rare contaminant peaks (Zn)



Péage de roussillon

WP III – Evaluate the fluxes of suspended particulate matter and associated contaminants along the whole river

A network of permanent and temporary stations has been developed to measure SPM transfer and to collect samples for the analyses of contaminants and geochemical tracers



2 automated stations with centrifugation

• Precise estimation of the annual SPM flux
(85 % of SPM flux at the mouth is transported during floods = 5 % of the time)

• Good evaluation of the interannual variability : 2 – 8 Mt/yr

• Evaluation of the inputs from tributaries

• Compare the influence of floods vs flushing operations

tributaries
(floods or month sampling)

Continuous Turbidity measurement

The SPM values and contaminants concentrations are available through a specific website (https://bdoh.irstea.fr) where fluxes can be calculated and data exported

Recherche avancée

Period of interest

Période de recherche

N'afficher que les chroniques ayant des mesures : de Effacer à Effacer

Afficher 10 lignes par page Mots-clés :

Station en activité | Commune | Sites expérimentaux | Paramètres étudiés | Producteur

Arles (13200) | Co. en Cadmium

Type

Bassin | Cours d'eau

Selection of station

Code chronique	Paramètres étudiés	Unité	Producteur	Type	Début [UTC]	Fin [UTC]	Nb mesures
Station ARLES - « Rhône_Arles »	Arles (13200)		*80 chronique(s)*				
CCD	Co. en Cadmium	mg/kg	Cerege	Discontinue	20/09/2011	31/08/2016	131
CCD-2	Co. en Cadmium	mg/kg	Cerege	Continue	20/09/2011	17/12/2015	518

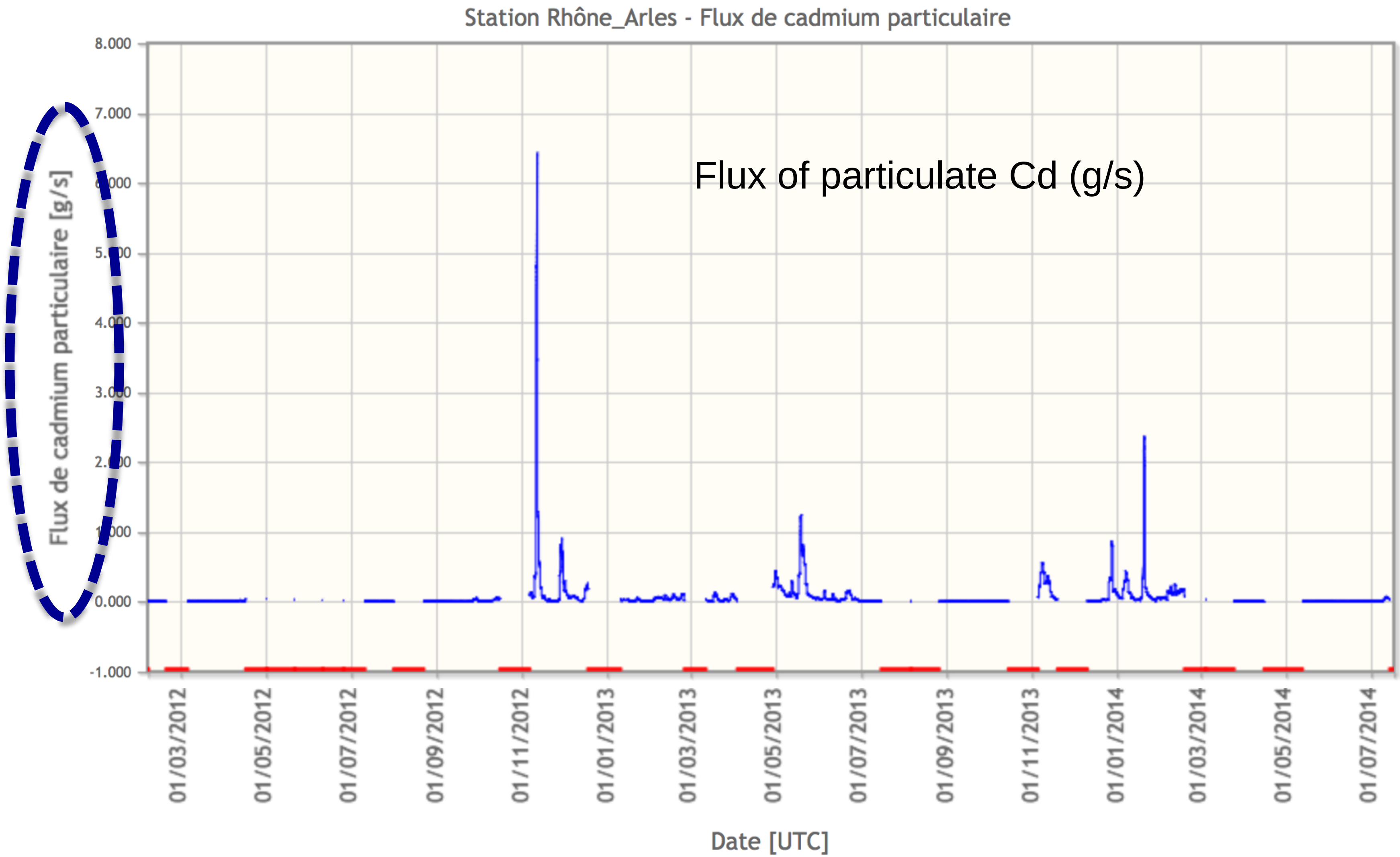
Selection of dataset

Contaminant concentrations are combined with SPM data for the calculation of fluxes.
Anyone (including partners and public) may now use the same values .

Période : de 07/02/2012 à 17/07/2014 Effacer Visualiser Export → Txt file

Visualisateur

Pour revenir au niveau de zoom initial, double-cliquez sur le graphe.



WP III-IV Expertise on the state of contamination

Contaminants provided into BDOH :

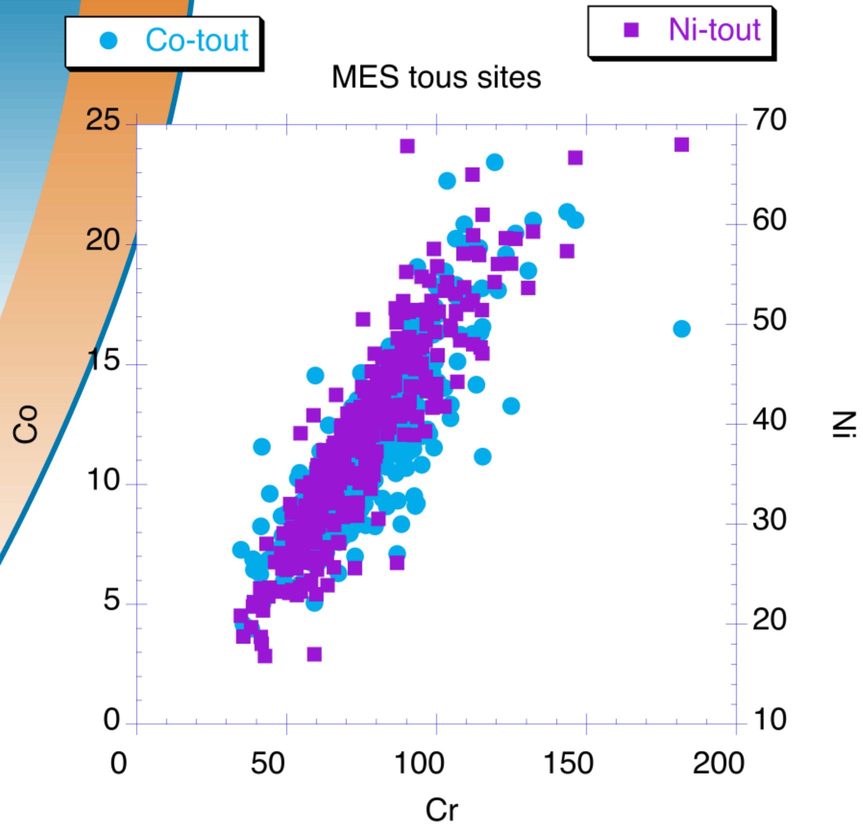
`

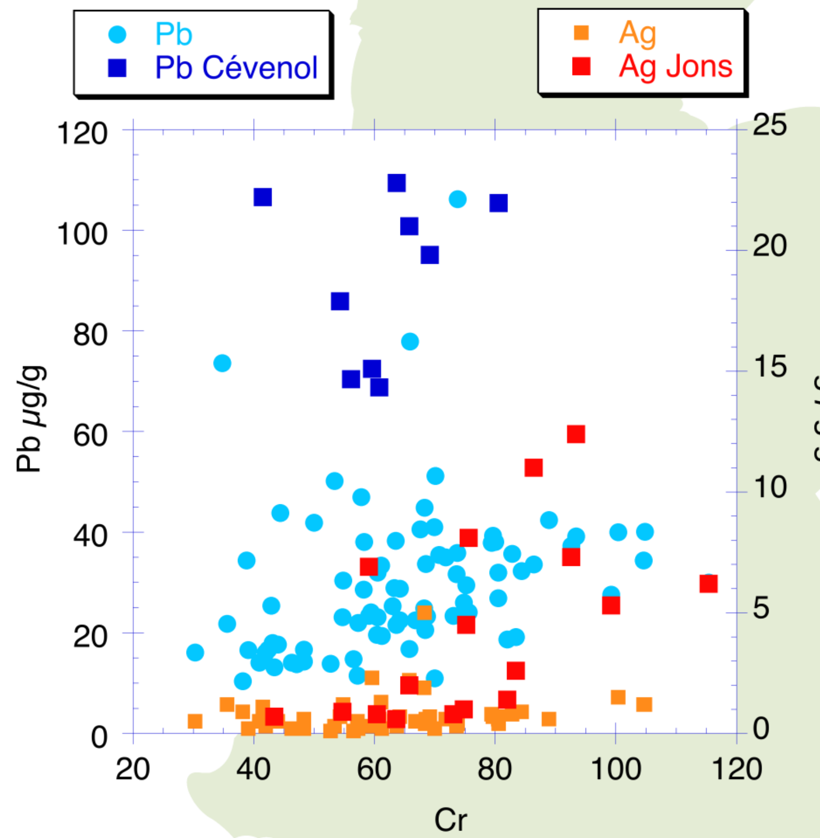
- Co, Cr, Ni, Cu, Zn, Pb, Cd, Hg
- PCB
- artificial radionuclides associated to the nuclear power plants (^{134}C,^{137}Cs, ^{54}Mn...)

Other contaminants or tracers measured :

- Numerous TME, rare earth elements, methylHg
- PHA
- PBDE
- Pesticides
- « Urban tracers » : pharmaceutics + pesticides `

The important dataset for metals (>500 samples of SPM) allowed to distinguish those associated to the geochemical background from those still affected by anthropic inputs.

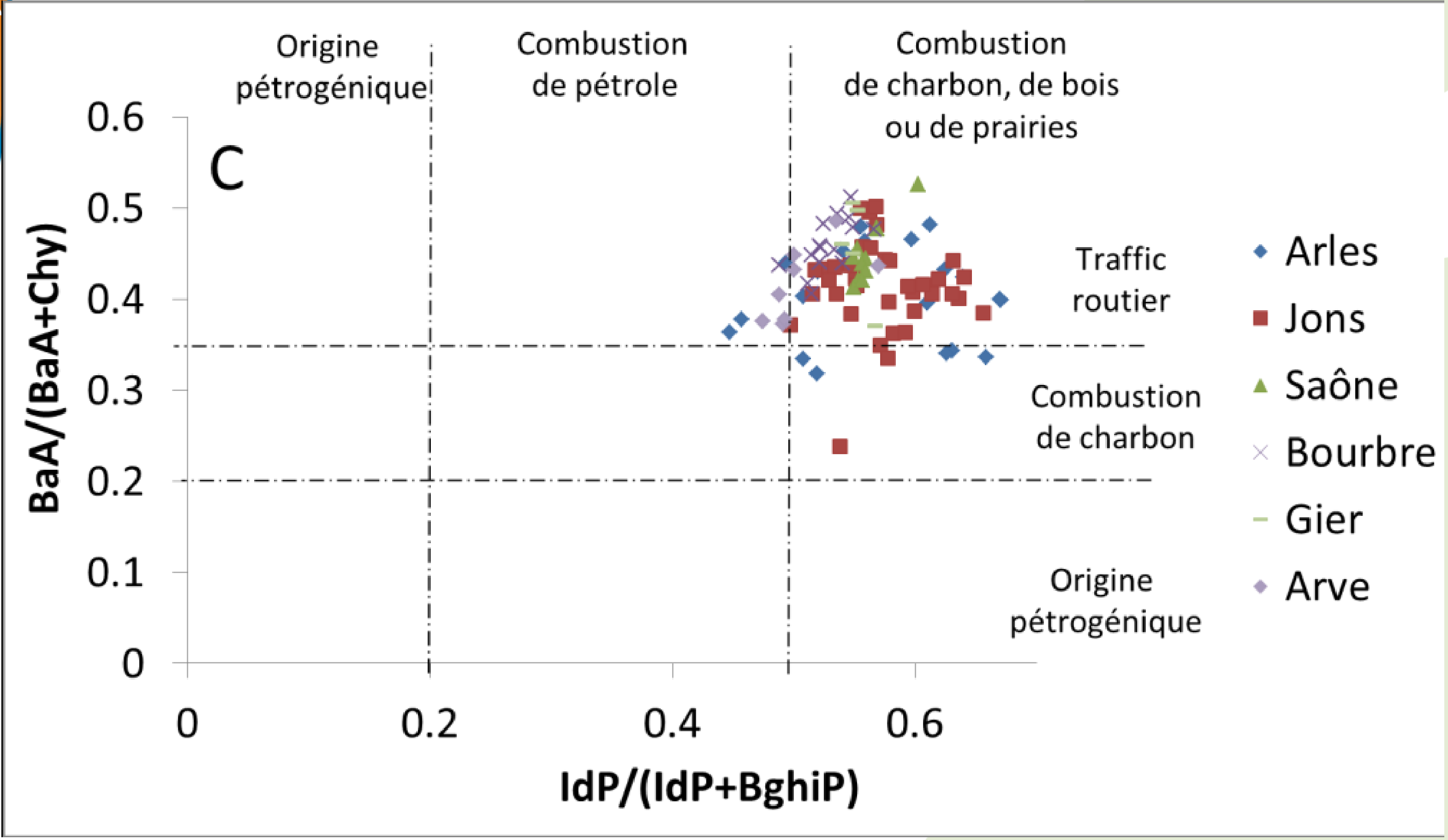




Natural: Co, Ni, V, U, Th, *Cr*

« *Anthropic* »: Pb, Ag, Sn, Sb, Zn, Cu, Cd, Hg

The characterisation (diagnostic ratios) of PAH and PCB signatures help to understand their origins



- PAH mainly issued from road trafic and house heating system
- PCB issued from atmospheric deposit and waste water treatment plants (urban and industrial)

WP V.a – Modelling and web tools

The objective is to model water and SPM transfer and fluxes over the whole river:

545 km

21 hydroelectric dams

6 major and 26 minor tributaries

.

1D hydraulic model : MAGE

1D sediment model: ADIS-TS

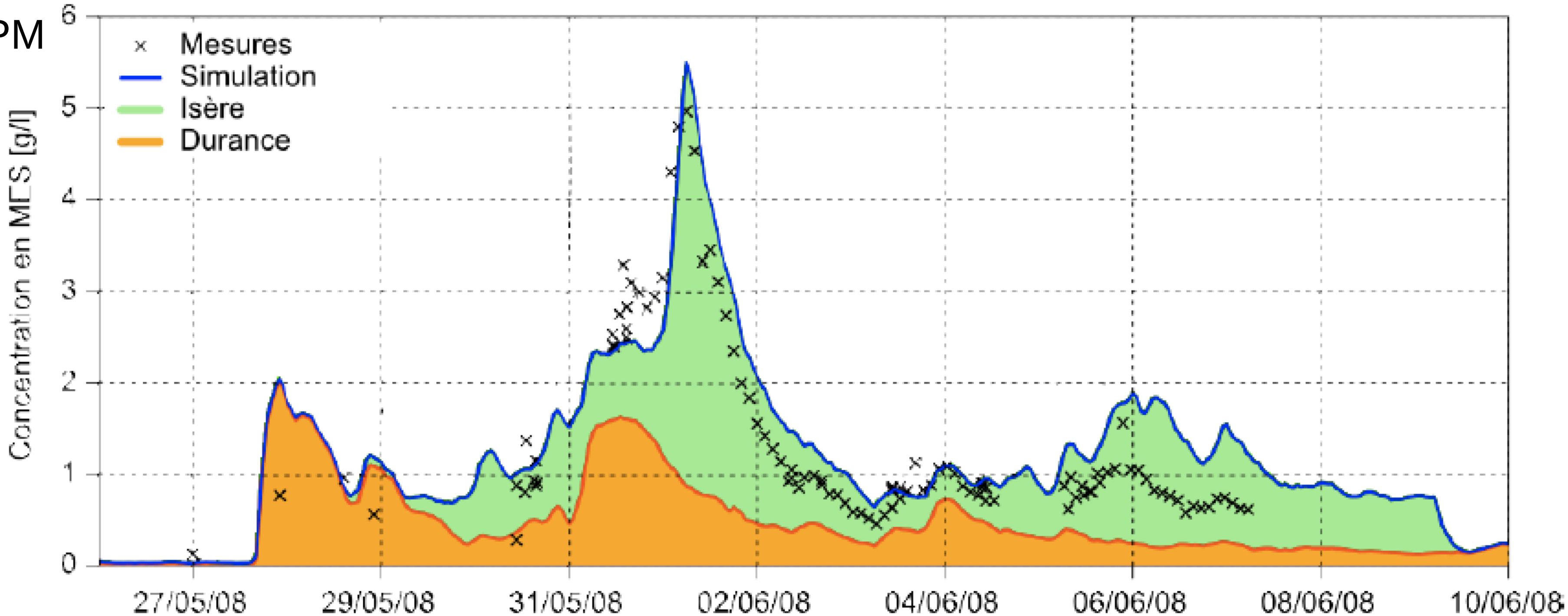
Very fast calculation !

5mn running time for a 16 days simulation over 300 km (Lyon → sea)

Another objective is to reproduce the transfer and deposition during floods or flushing operations

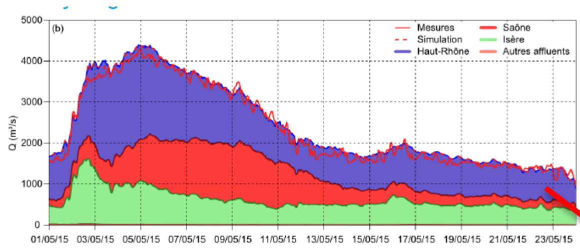
Simulation of the SPM content in Arles —— compare to real measures X during a flood in 2008 due to Isere and Durance tributaries

SPM g/l

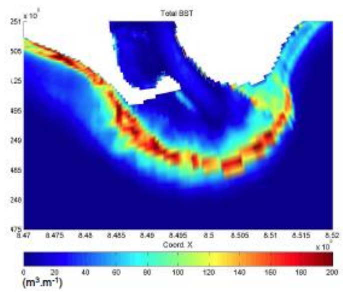


A final objective will be to combine three hydrosedimentary models to get a source-to-sink simulation : RIVER→ ESTUARY →CONTINENTAL MARGIN

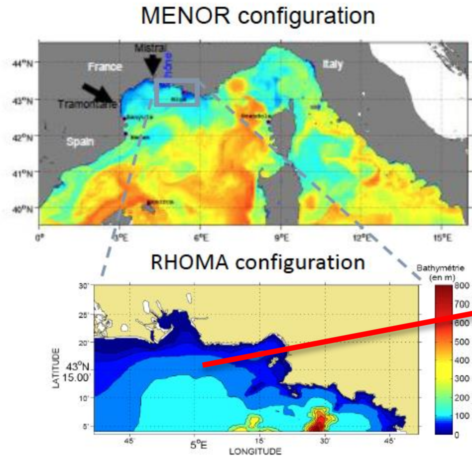
1D-MAGE +ADIS-TS

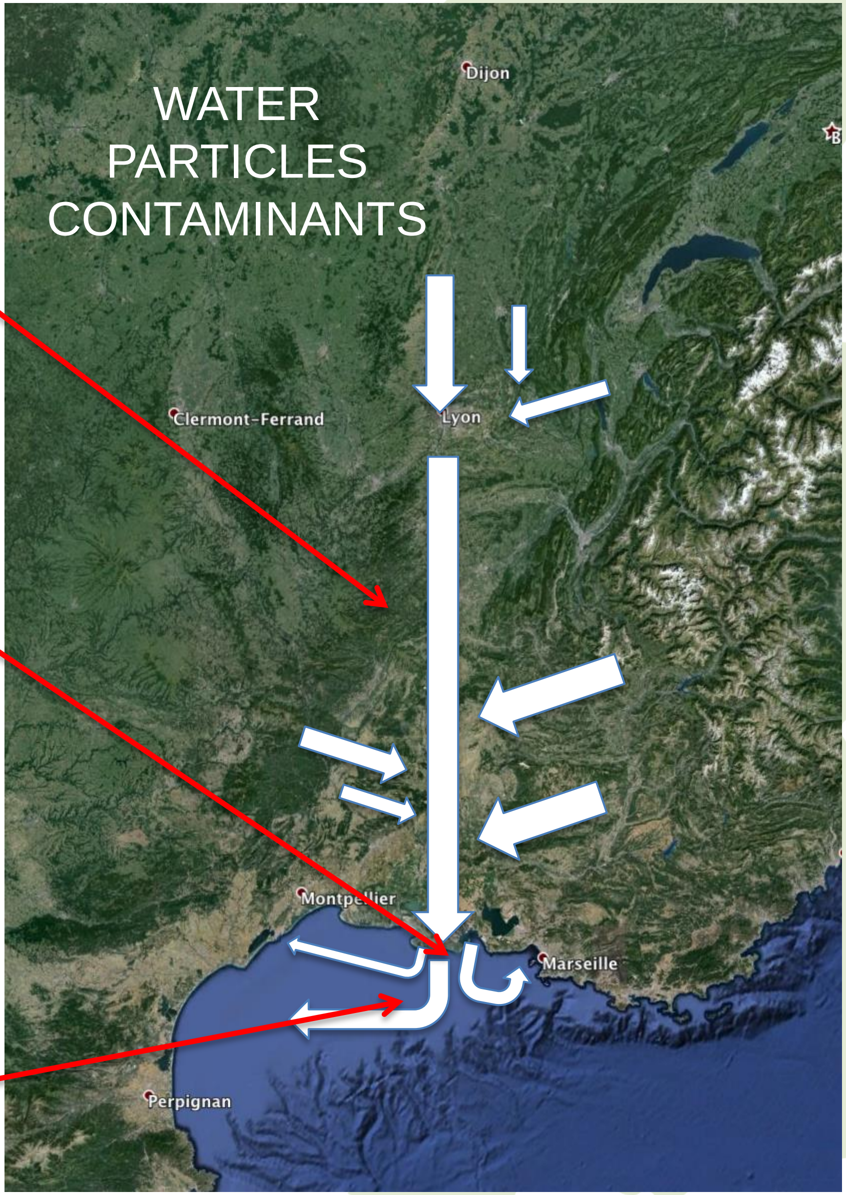


2D DELFT Deltares



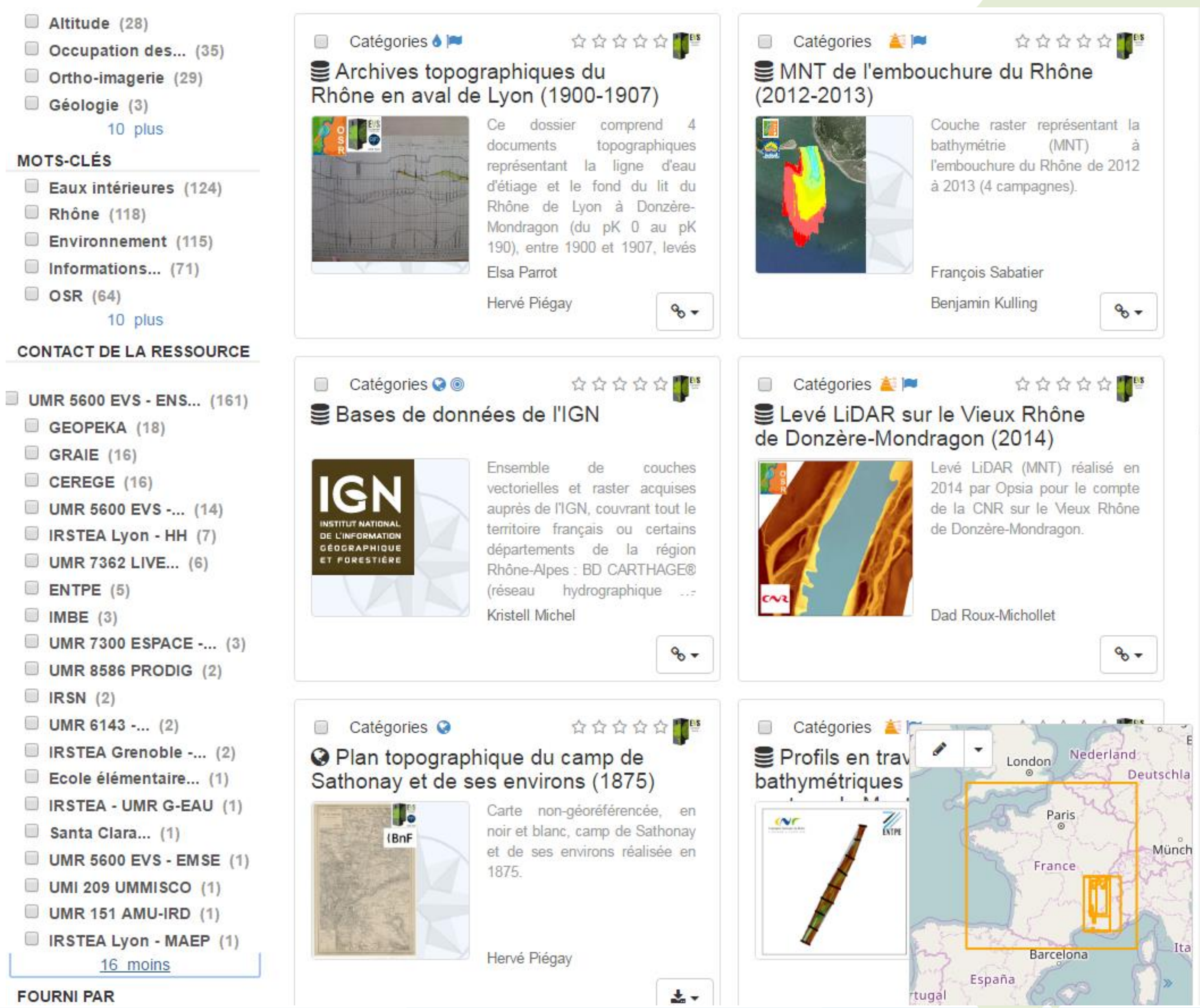
3D – RHOMA + MARS





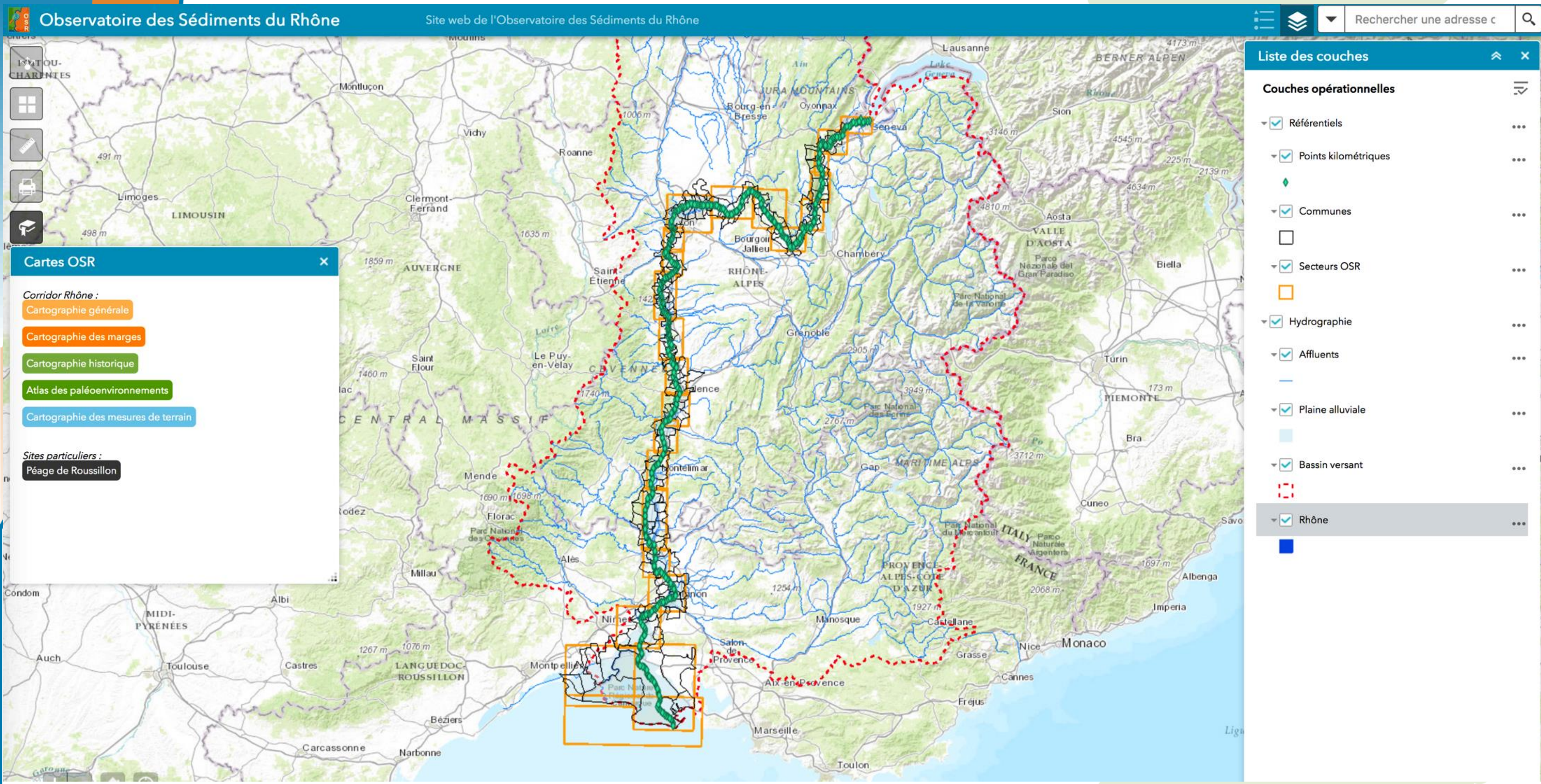
WP V.b –Dissemination

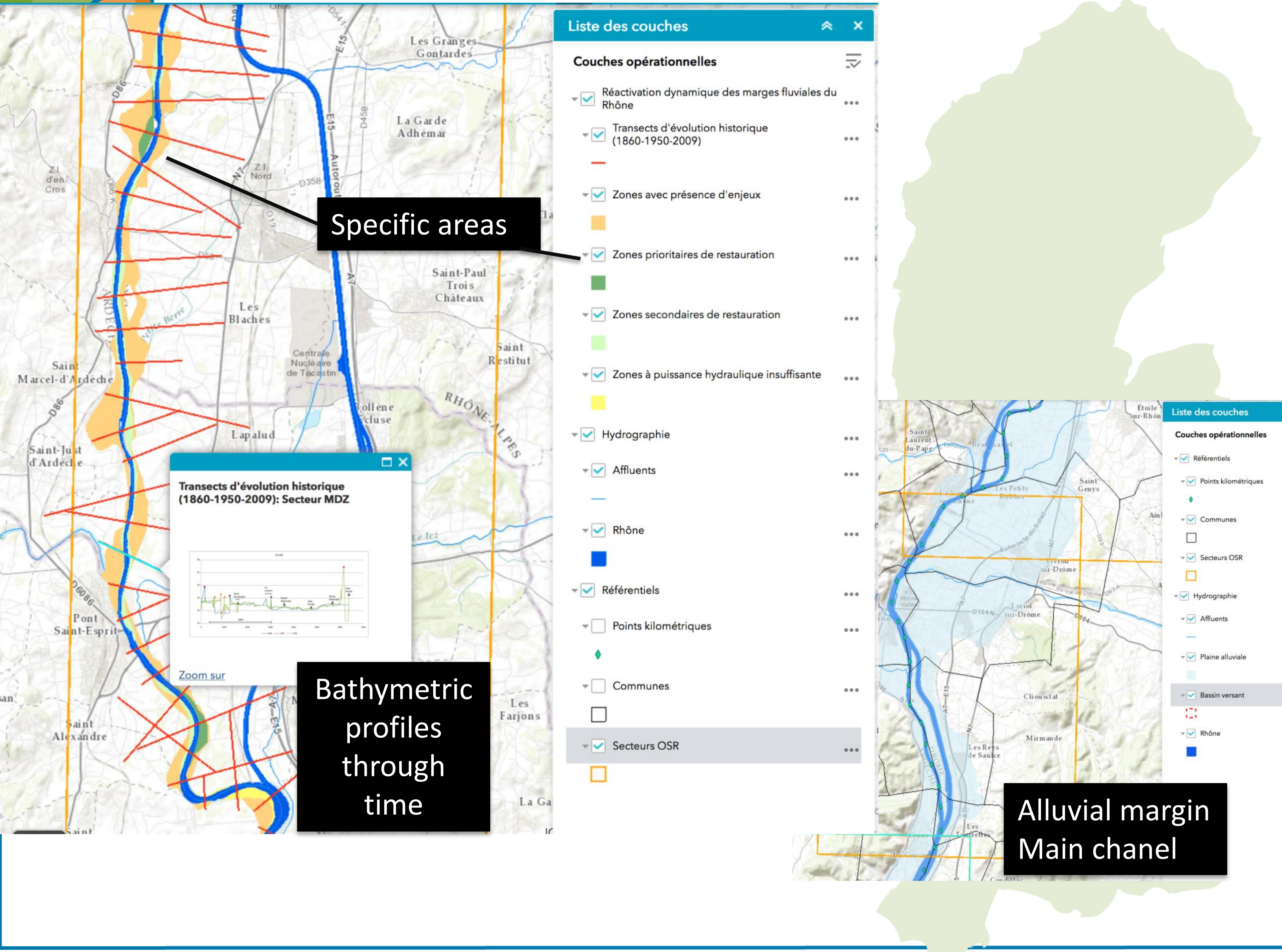
A metadatabase allow to find the producers of data and products: http://elvis.ens-lyon.fr

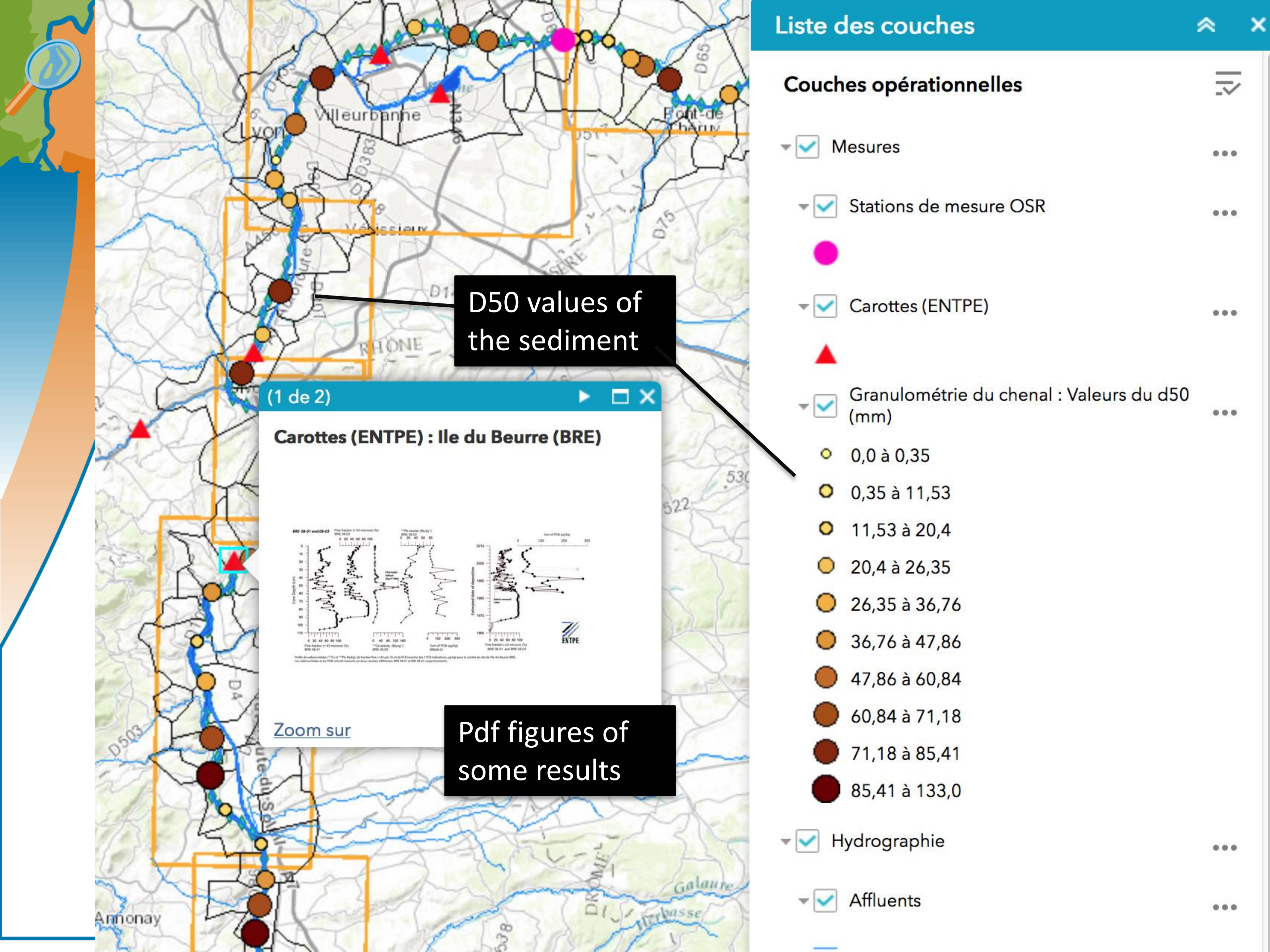


A webmapping system provides an access to some geographical informations: maps and figures

https://websig.ens-lyon.fr:3344/webappbuilder/apps/39/




Specific areas
Bathymetric profiles through time
Alluvial margin Main chanel
Liste des couches
Couches opérationnelles
Réactivation dynamique des marges fluviales du Rhône
Transects d'évolution historique (1860-1950-2009)
Zones avec présence d'enjeux
Zones prioritaires de restauration
Zones secondaires de restauration
Zones à puissance hydraulique insuffisante
Hydrographie
Affluents
Rhône
Référentiels
Points kilométriques
Communes
Secteurs OSR
Transects d'évolution historique (1860-1950-2009): Secteur MDZ
Zoom sur
Plaine alluviale
Bassin versant



Liste des couches
Couches opérationnelles
Mesures
Stations de mesure OSR
Carottes (ENTPE)
Granulométrie du chenal : Valeurs du d50 (mm)
0,0 à 0,35
0,35 à 11,53
11,53 à 20,4
20,4 à 26,35
26,35 à 36,76
36,76 à 47,86
47,86 à 60,84
60,84 à 71,18
71,18 à 85,41
85,41 à 133,0
Hydrographie
Affluents
(1 de 2)
Carottes (ENTPE) : Ile du Beurre (BRE)
Zoom sur
D50 values of the sediment
Pdf figures of some results
Villeurbanne
Lyon
Vénissieux
RHONE
Annonay
Pont-de-Chéruy
Galaure


http://www.graie.org/osr/
Special issue
« Science of the Total Environment »
2018
The results presented here were obtained by the numerous scientists involved in OSR 1 to 4