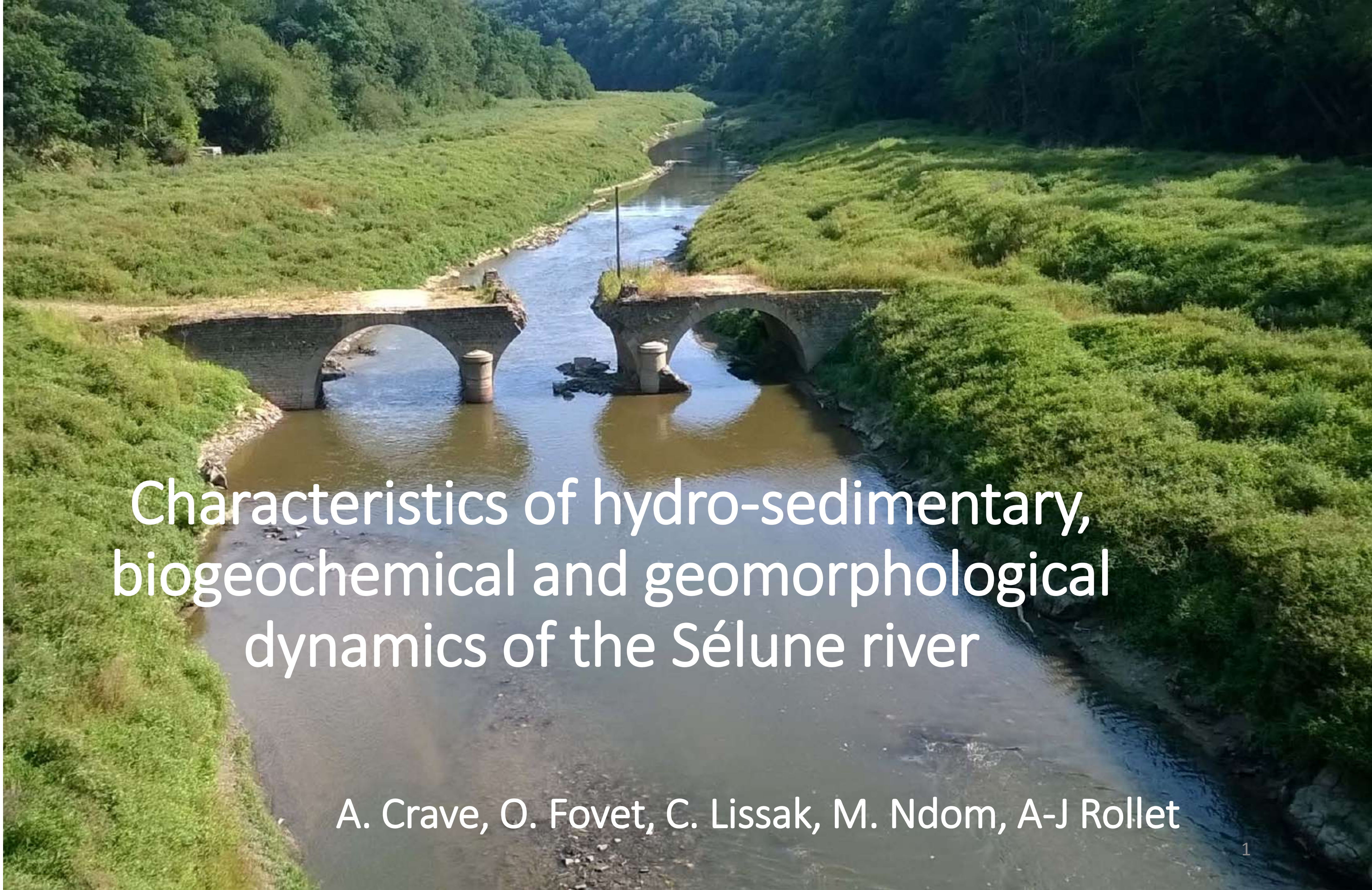


# Characteristics of hydro-sedimentary, biogeochemical and geomorphological dynamics of the Sélune river

A. Crave, O. Fovet, C. Lissak, M. Ndom, A-J Rollet

# Objectives

## Characterizing pre-removal state:

- Lakes as source/sink > Upstream/downstream fluxes
- Modified hydraulic power > longitudinal geomorphological dynamics

Characterizing the response of removal operations

## Studying the restoration process:

- Impact on water quality > catchments exports/river processes without lakes
- Impact on sedimentary dynamics > aquatic habitat & recolonization processes

# Approach

## Concentrations & fluxes monitoring

- Continuous monitoring upstream & downsntream of the dams of solutes and fine sediments

How dams affect the transfer of matter?

Do they modify the storm event and seasonal dynamics of water quality?

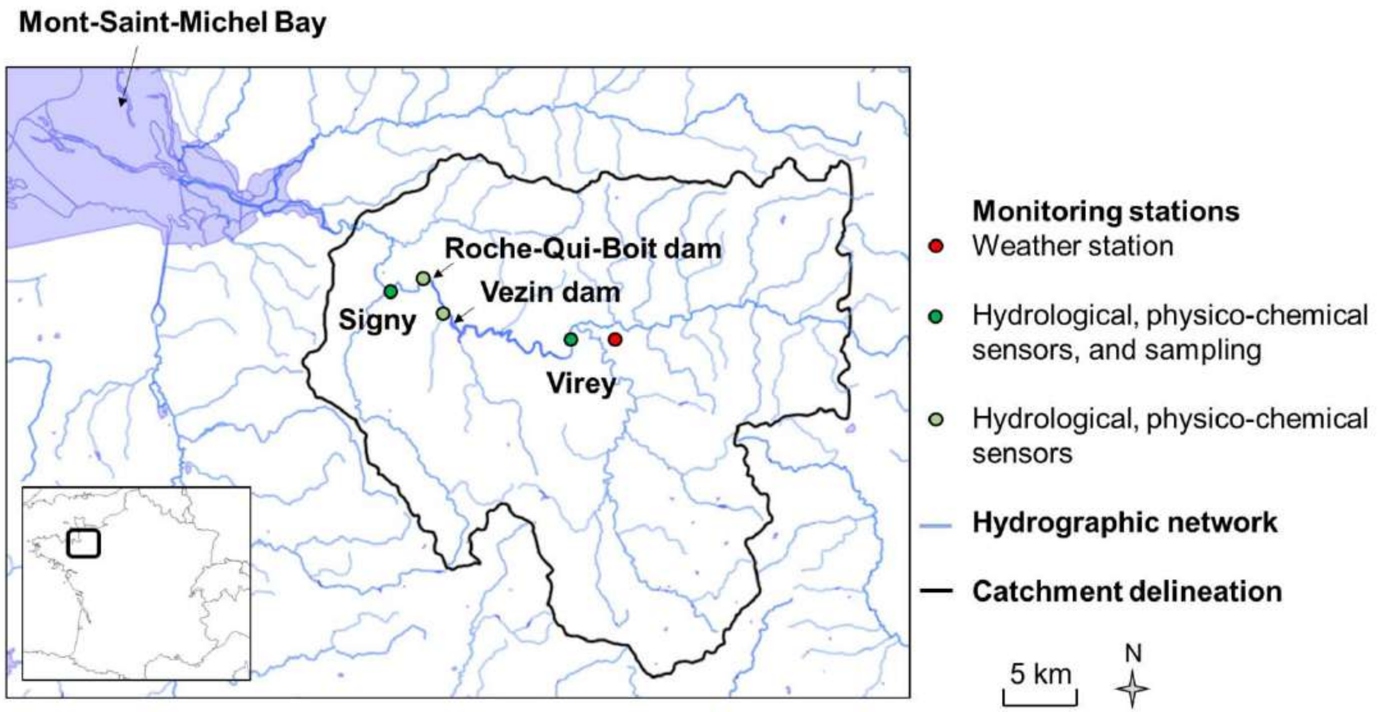
## Geomorphological diagnosis

- Spatial analysis of geomorphological variables
- Measurement of the mobility of bed load from RFID transponders

Is there any signal of a sediment deficit of bedload ?

What is the average mobility of coarse sediments ?

# Concentrations and flux monitoring upstream & downsntream of the dams




**Water Sampling**

- weekly + storm events (10 to 24 points/storm)
- SS, PO4, PT, Si, Anions, NH4

**Virey (up. station)**

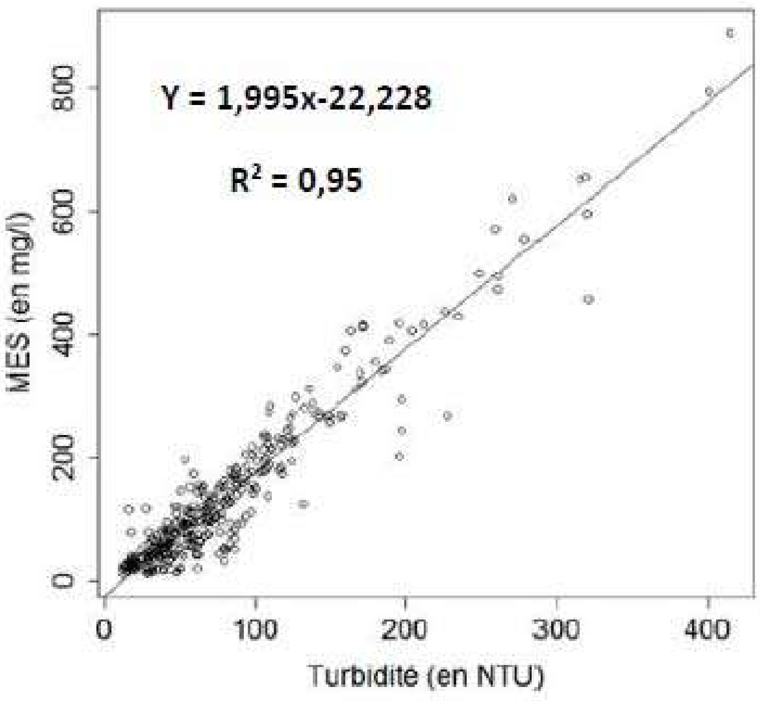
Sensors dt=1h : Q, Turbidity, T°, EC, pH, O2

**Signy (dwn. station)**

Sensors dt=10 min : Q, Turbidity, T°, EC, Chl a

# Flux estimates

## Suspended sediment – turbidity regressions

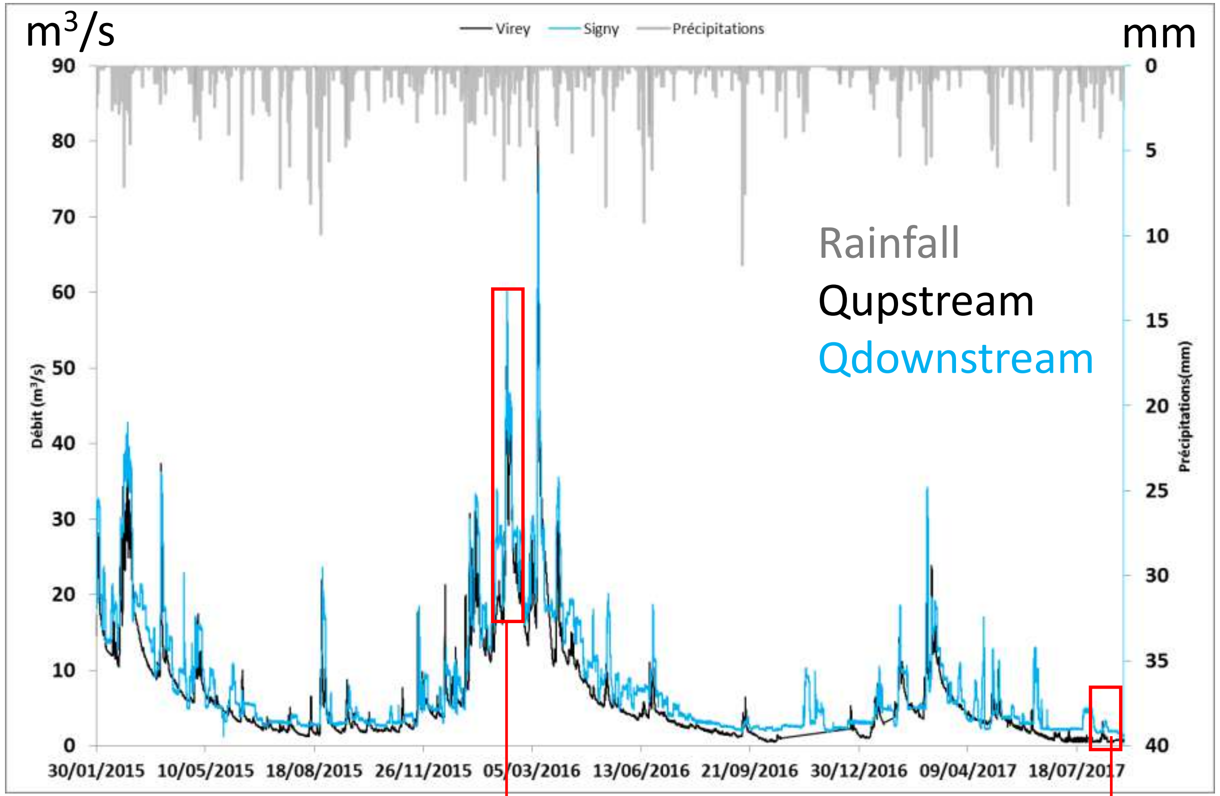


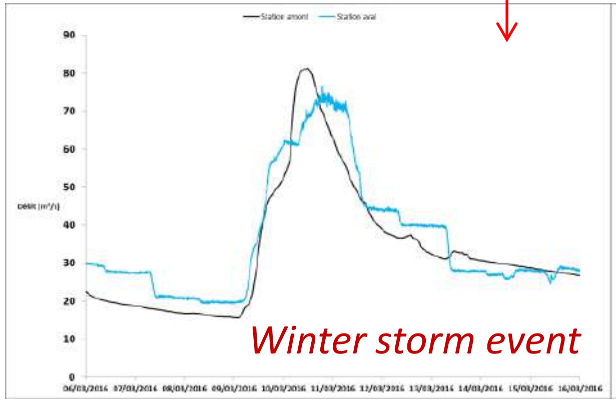

## Discharge-Weighted Concentration method for solutes

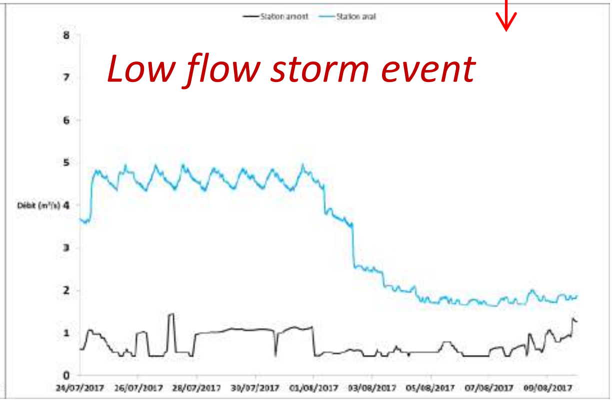
$$DWC = K * \left( \frac{\sum_{i=1}^{12} Ci * Qi}{\sum_{i=1}^{12} Qi} \right) * \left( \frac{\sum_{j=1}^{365} Qi}{365} \right) = K * C^* * \overline{Q}$$

[kg/ha/yr]

# Dams effect on water discharge




Rule of management:

- $Q_{dwn} < 30$ m³/s if $Q_{up} < 30$ m³/s,
- Releasing a discharge similar to the inflow

**Low effet on specific discharge:**

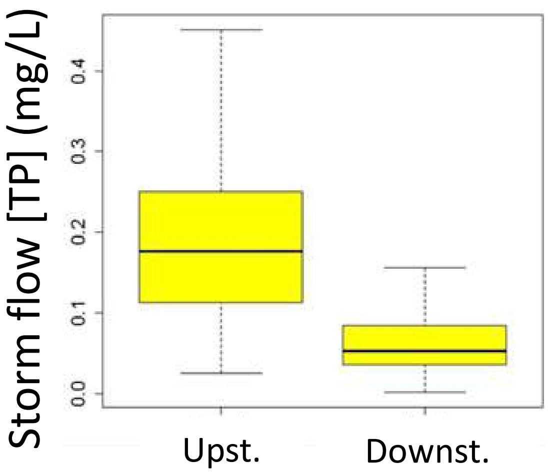
| mm/year | 2015-2016 | 2016-2017 | 2017-2018 |
|---|---|---|---|
| Rainfall | 757 | 587 | 1064 |
| Q upstream | 429 | 145 | 651 |
| Q dowsntream | 443 | 173 | 652 |

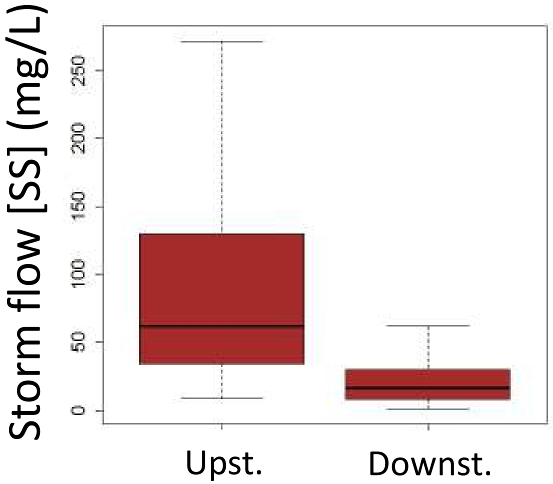
**Regulated storm flow**:

- Light damping of peak discharge
- Delays
- Recession by stages

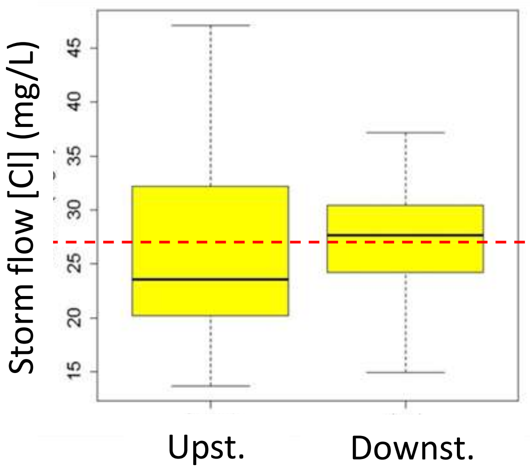
# Dams effect on storm event concentrations

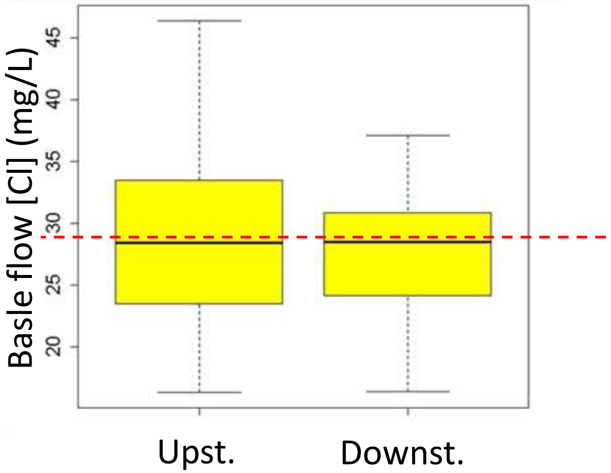
## Retention of particles

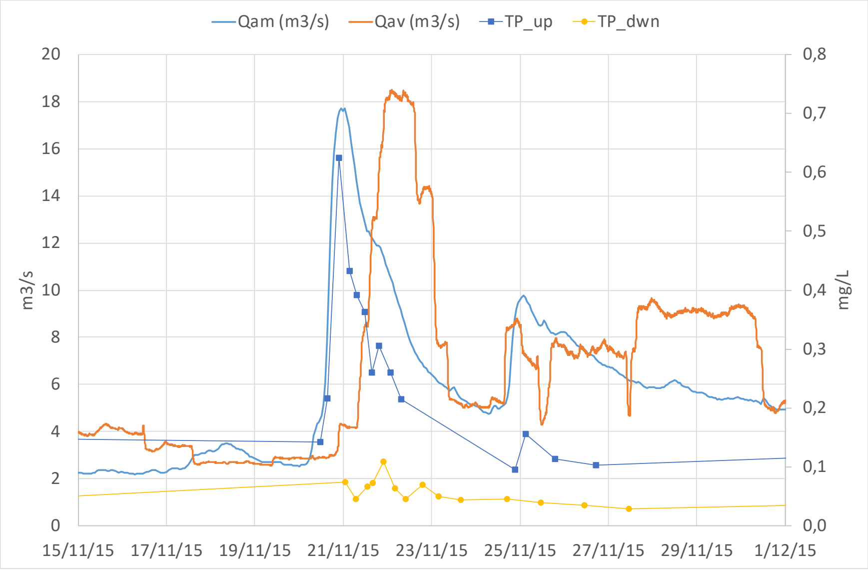



## Mixing of dissolved species

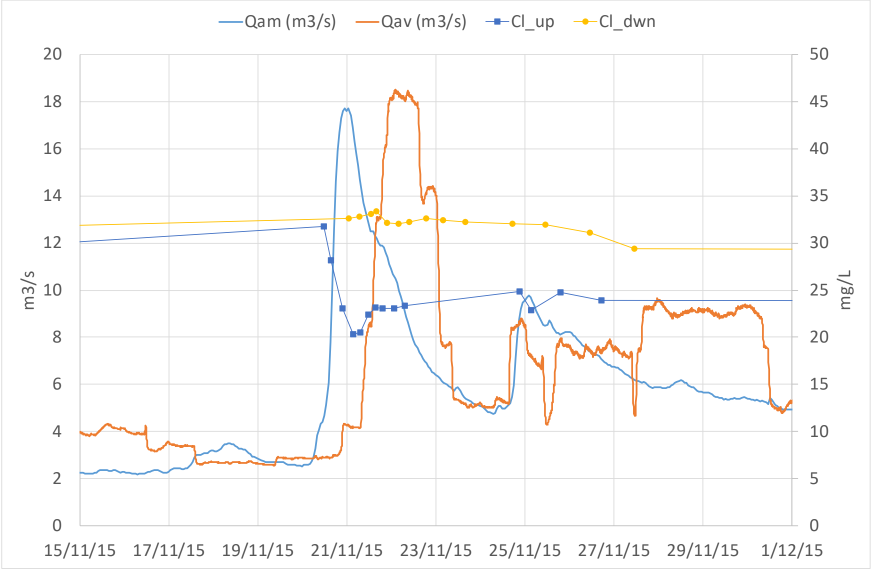


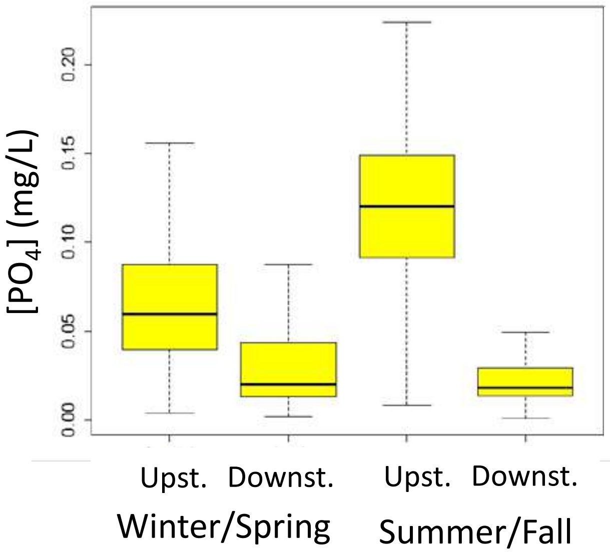

Qupst.
Qdwnst.

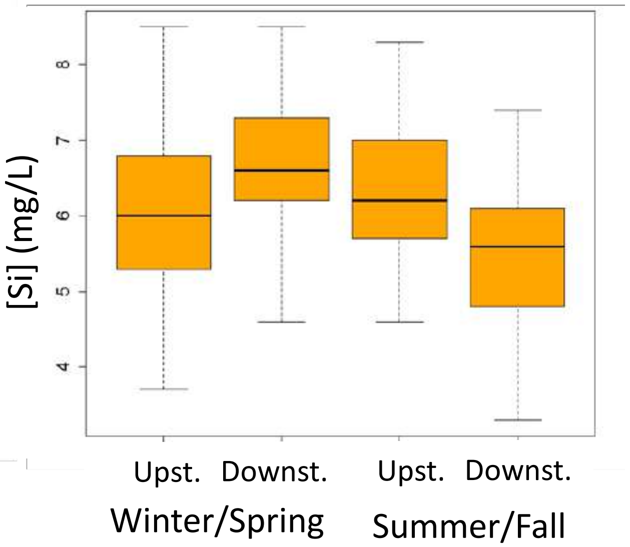
Cupst.
Cdwnst.

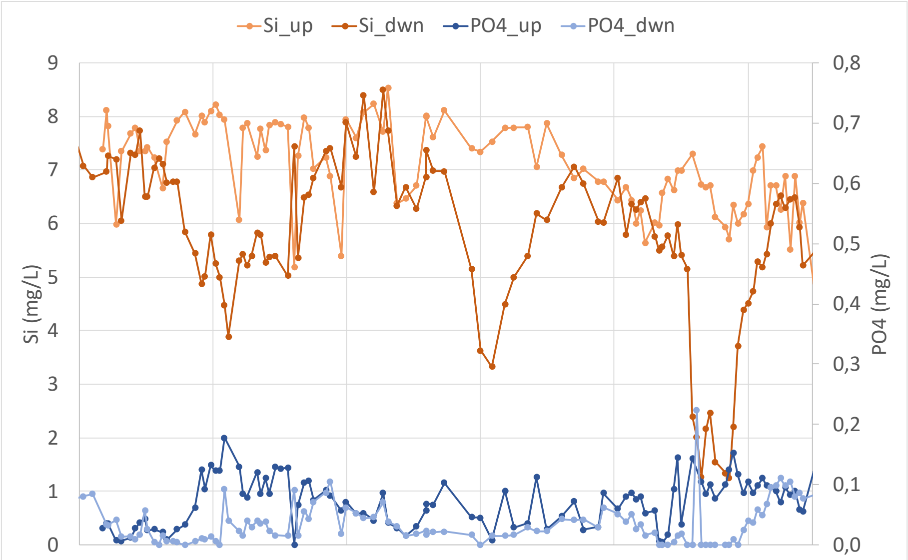


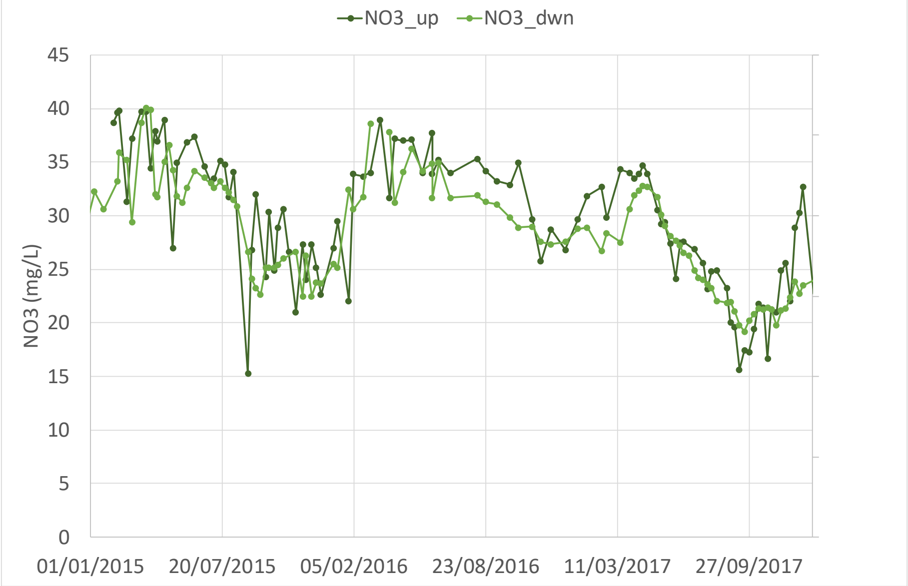
# Dams effect on seasonal concentrations

## Consumption of Si (and $PO_4$)



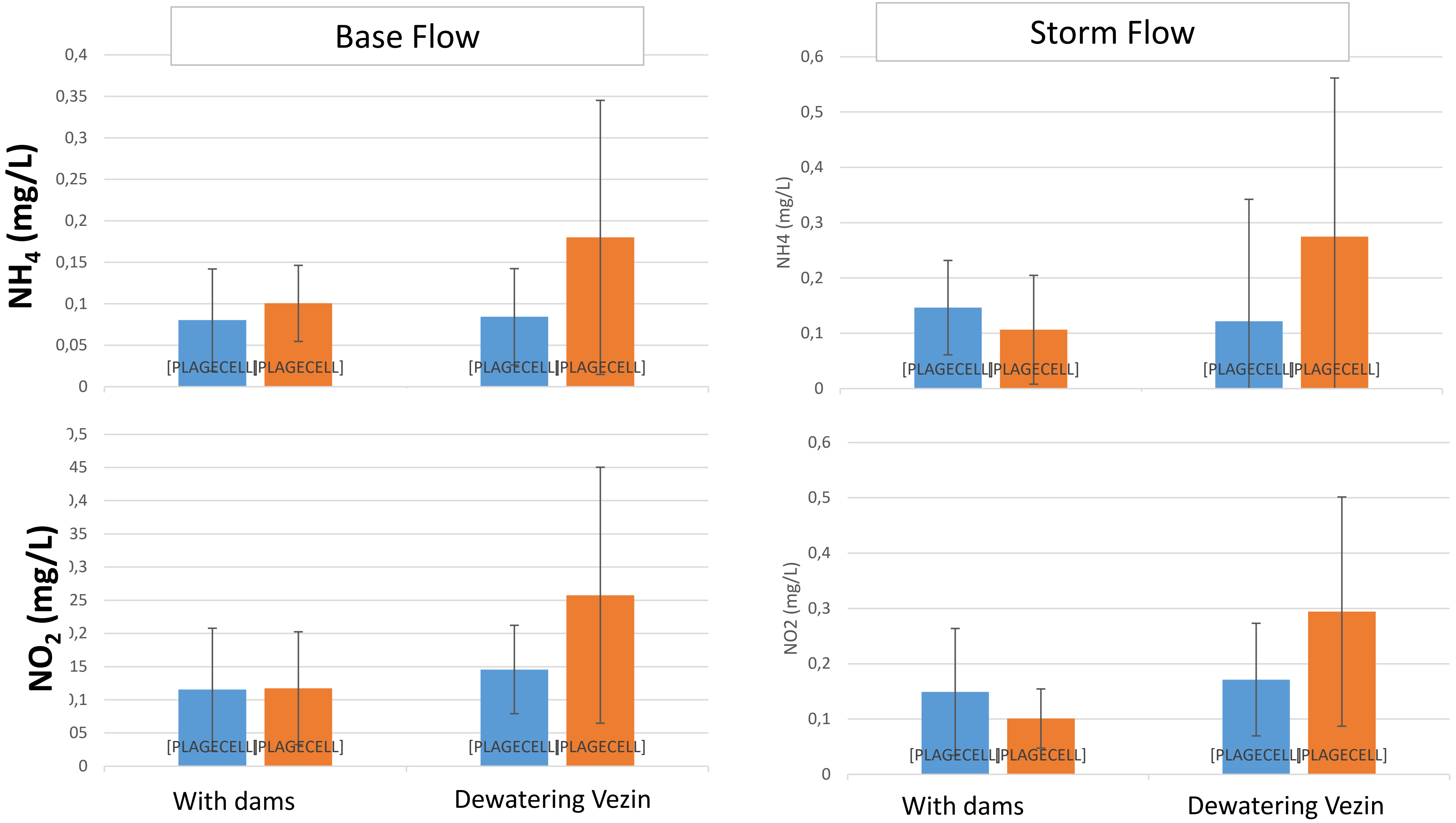




**Annual specific loads**

| | 2015-2016 | 2016-2017 | 2017-2018 |
|---|---|---|---|
| Upstr. / Dwnstr. | | | |
| N-$NO_3$ (kg/ha/year) | 31 / 31 | 10 / 11 | 43 / 46 |
| Cl (kg/ha/year) | 100 / 107 | 45 / 52 | 123 / 137 |
| $SO_4$ (kg/ha/year) | 43 / 47 | 15 / 21 | 61 / 70 |
| Si (kg/ha/year) | 32 / 31 | 10 / 9 | 37 / 40 |
| $PO_4$ (kg /km²/year) | 0,3 / 0,2 | 0,1 / 0,1 | 0,6 / 0,4 |
| TP (kg /km²/year) | 0,4 /0,2 | 0,1 / 0,1 | 1 / 0,6 |

# First observed water quality response to dewatering Vezin dam



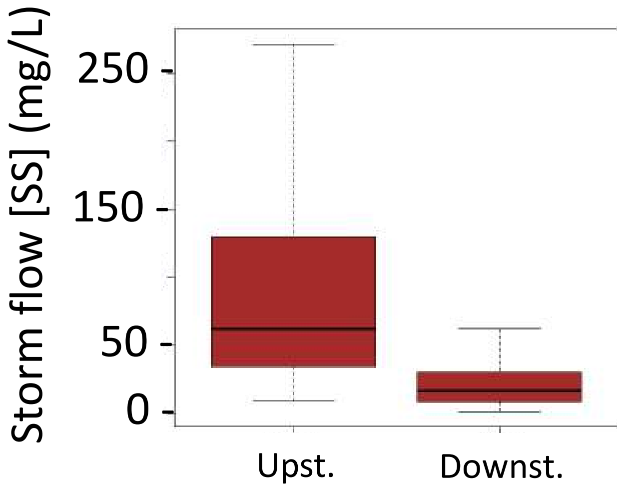

Upstream
Downstream

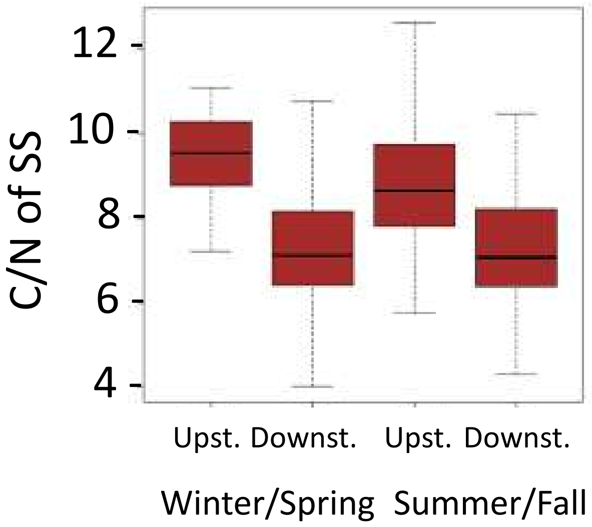
**No significant changes on other solutes**

# Dams effect on fine sediments

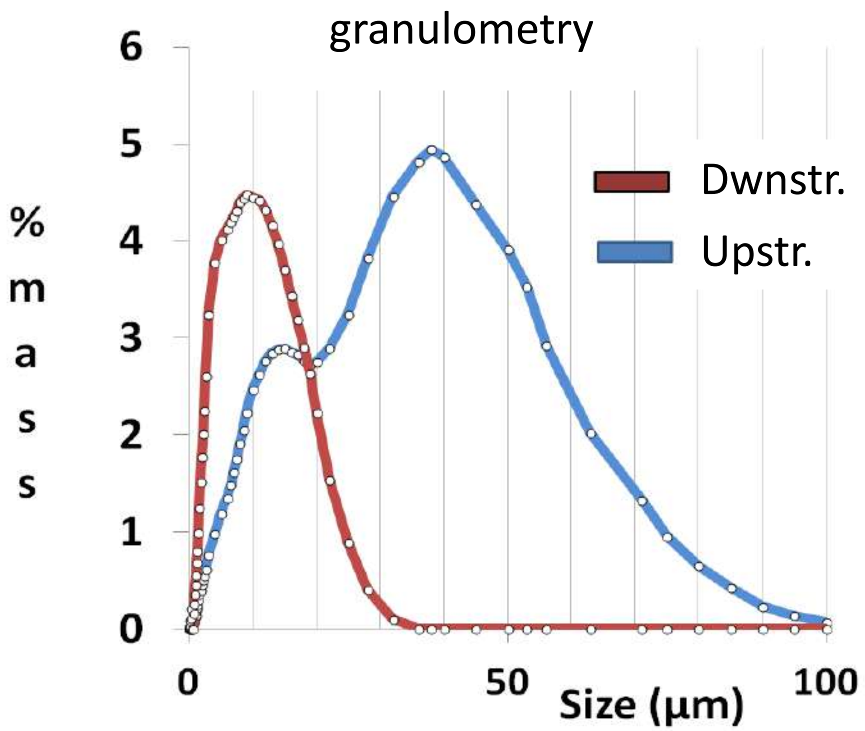
**Retention of sediments from upstream**

**Production of organic material**

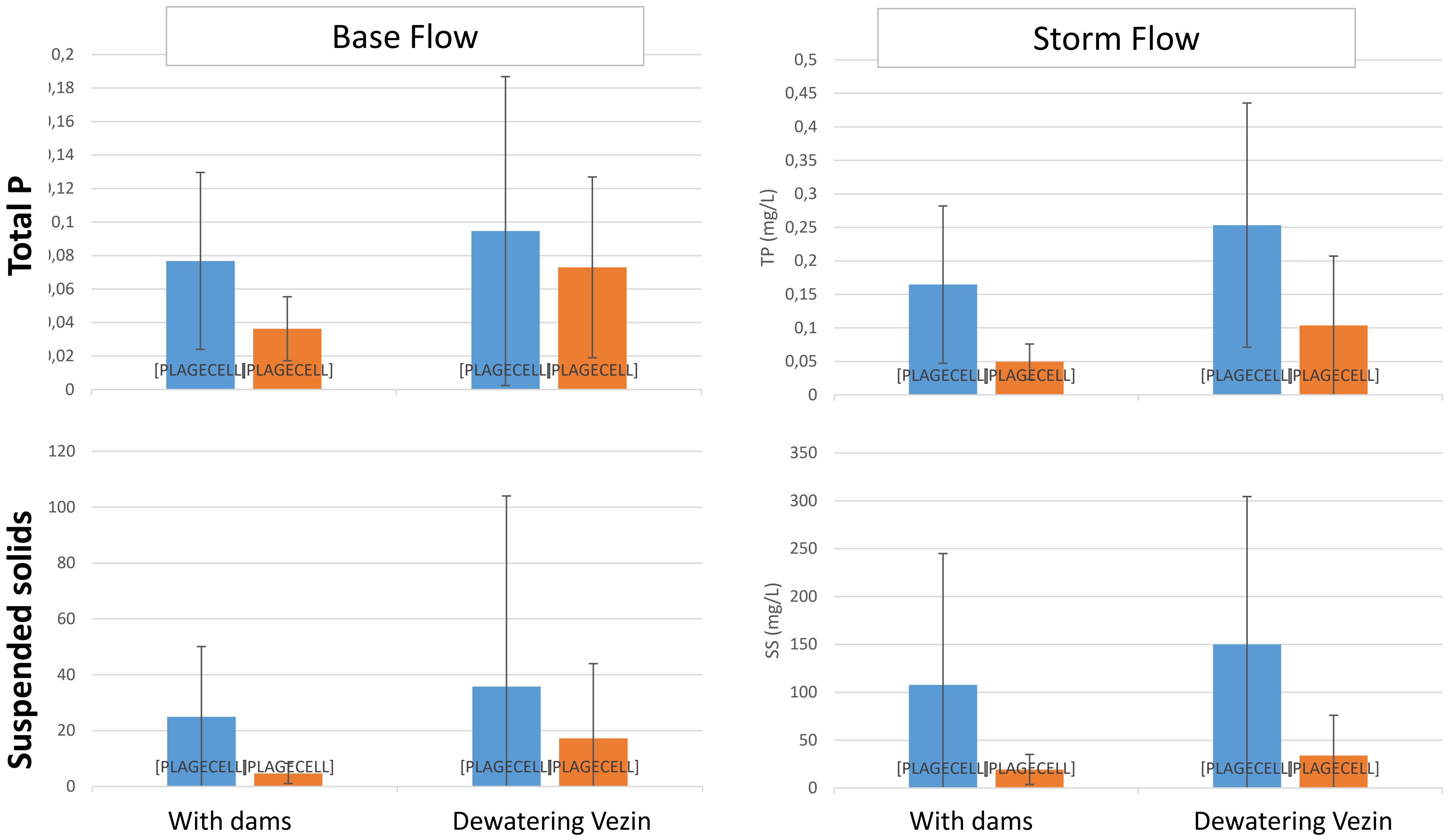



**Only the finest sediment pass through (10 µm).**



# First observed response to dewatering Vezin dam

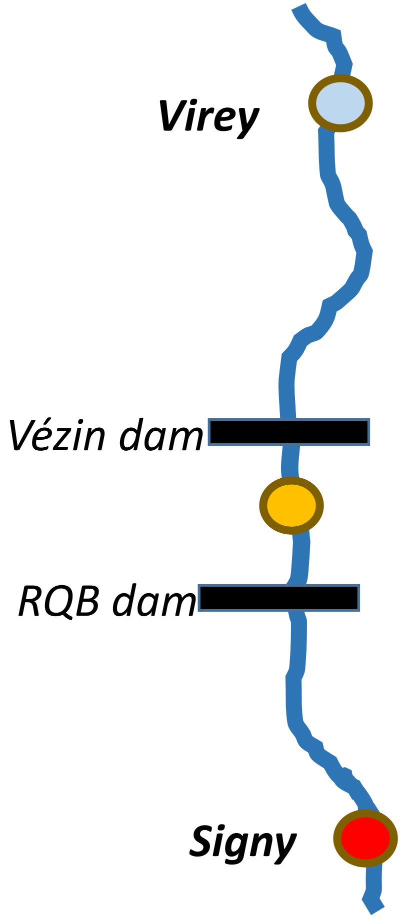


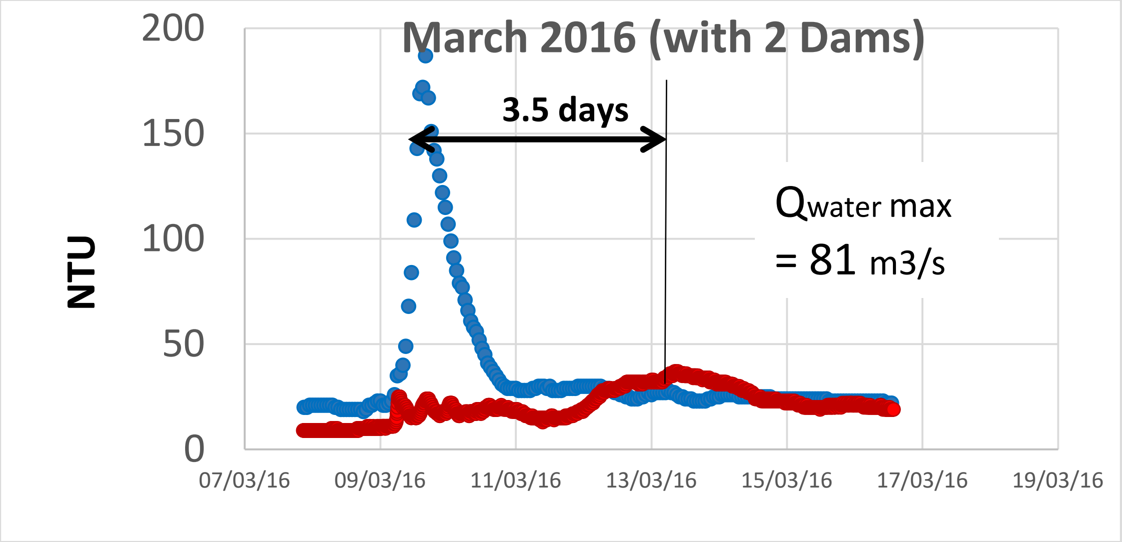

Upstream
Downstream

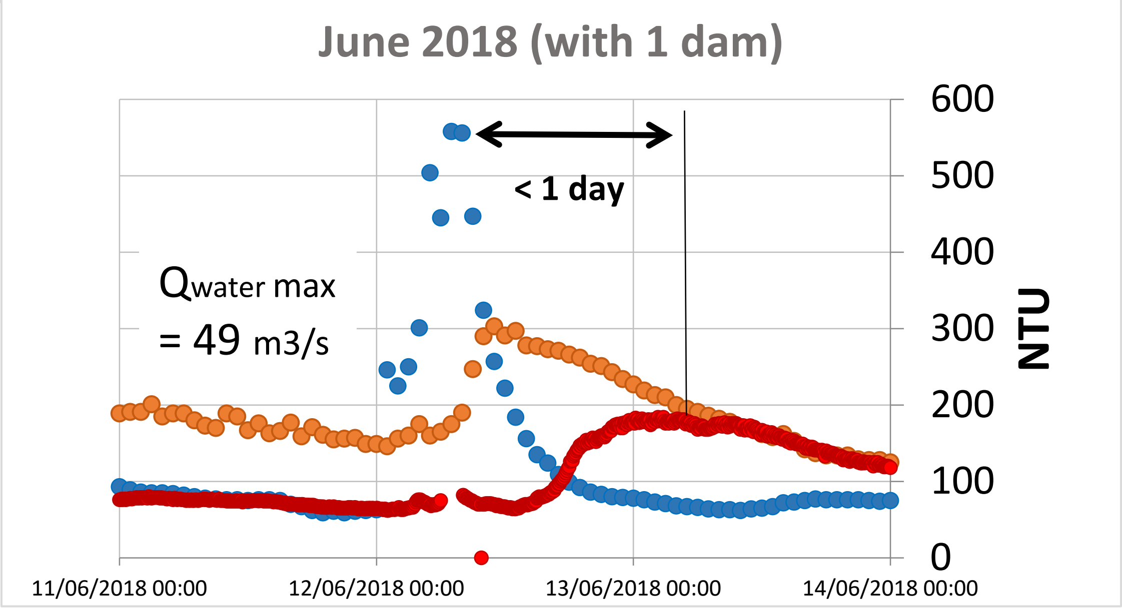
- **Higher base line**
- **Increased level in storm flow but retention in the 2nd dam**

# First observed response to dewatering Vezin dam

Turbidity stations

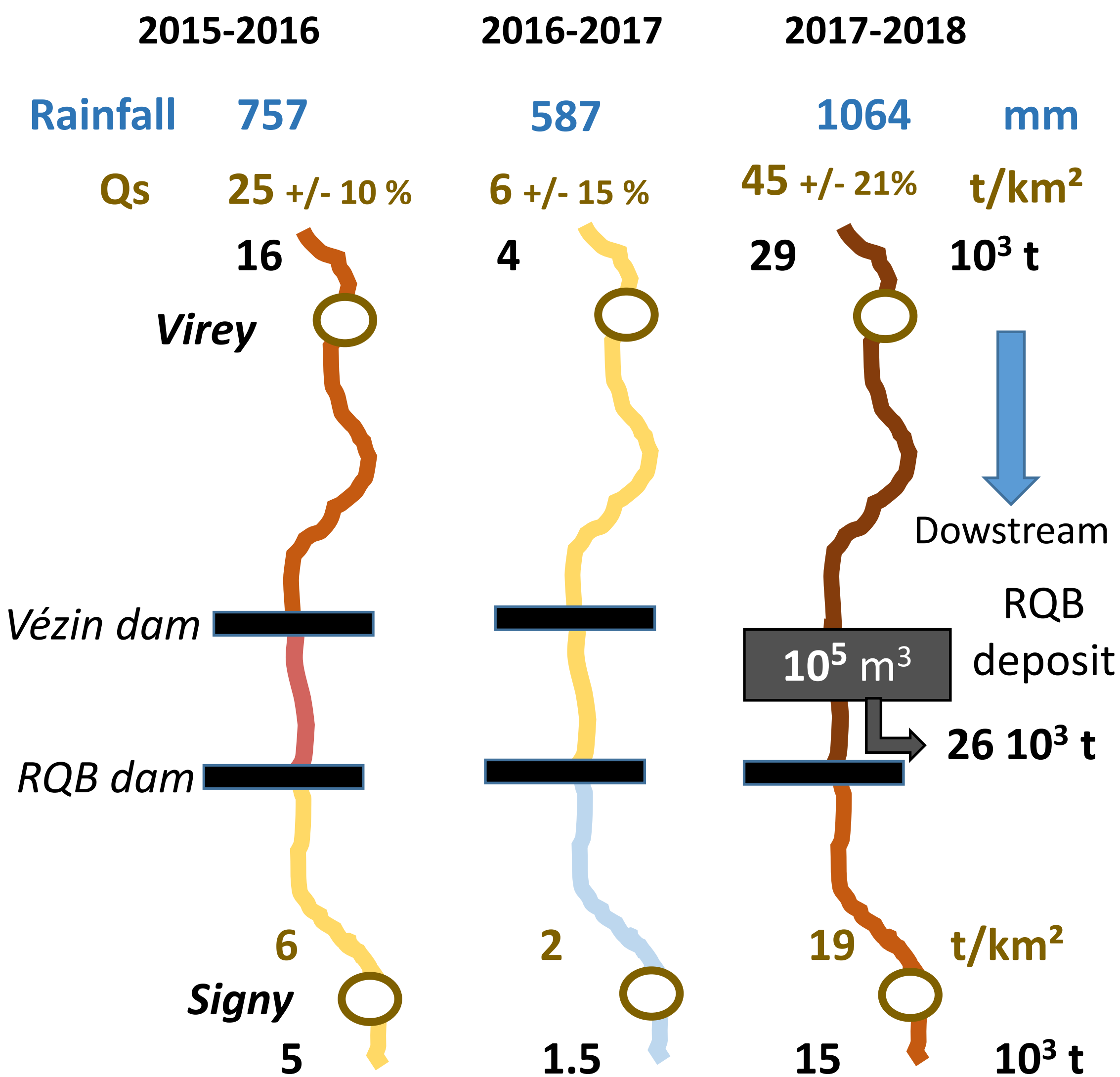



**Dewatering Vézin dam has divided by 4 the transit time between upstream and downstream stations**

# Fine sediments mass balance




**Before 2017:**

**both dams retained ~ 70-75 % of fine sediment**

**During 2017 - 2018:**

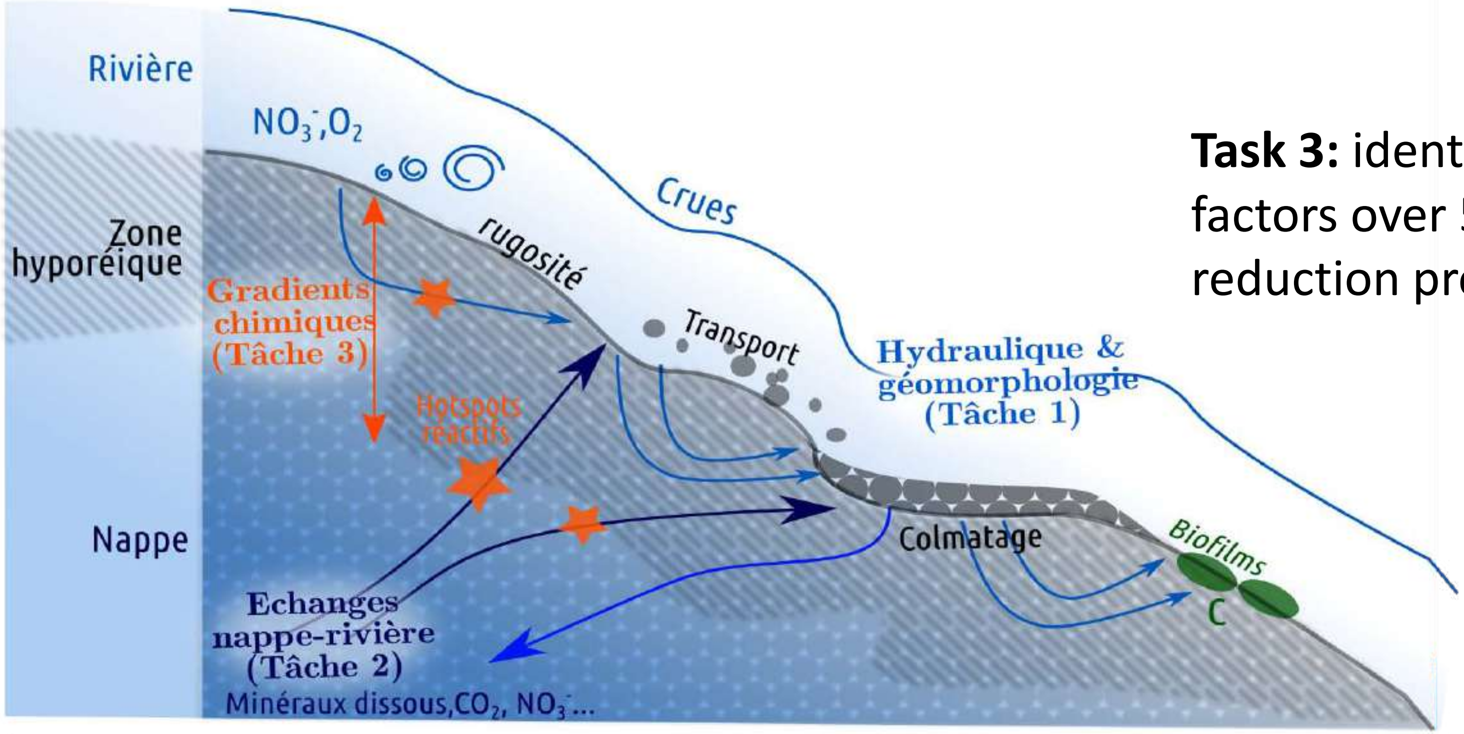
- **upstream fine sediment flux increases with rainfall**
- **% Vézin dam Stock → % La Roche Qui boit dam stock**

# Perspectives (1): Impact of dewatering dams on hyporheic transfer

## LEARN project

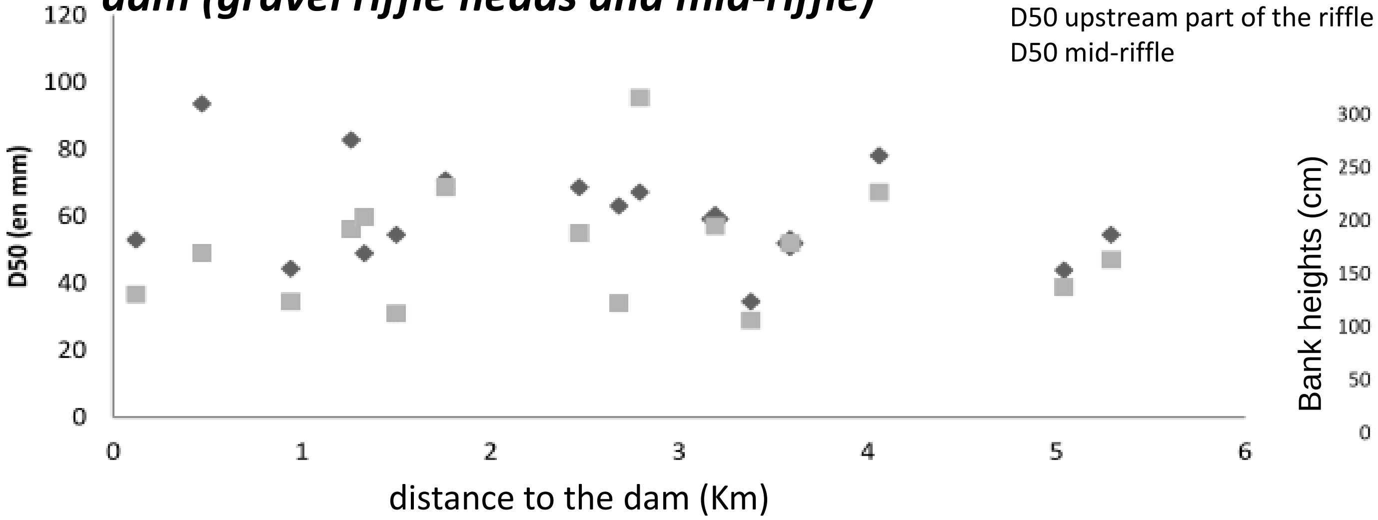
**Task 1:** hydraulic properties into 50 cm of the bed river: roughness, porosity, granulometry, hydraulic conductivity, biofilm.

**Task 2:** monitoring hyporheic fluxes, river/groundwater fluxes (PhD N. Simon)

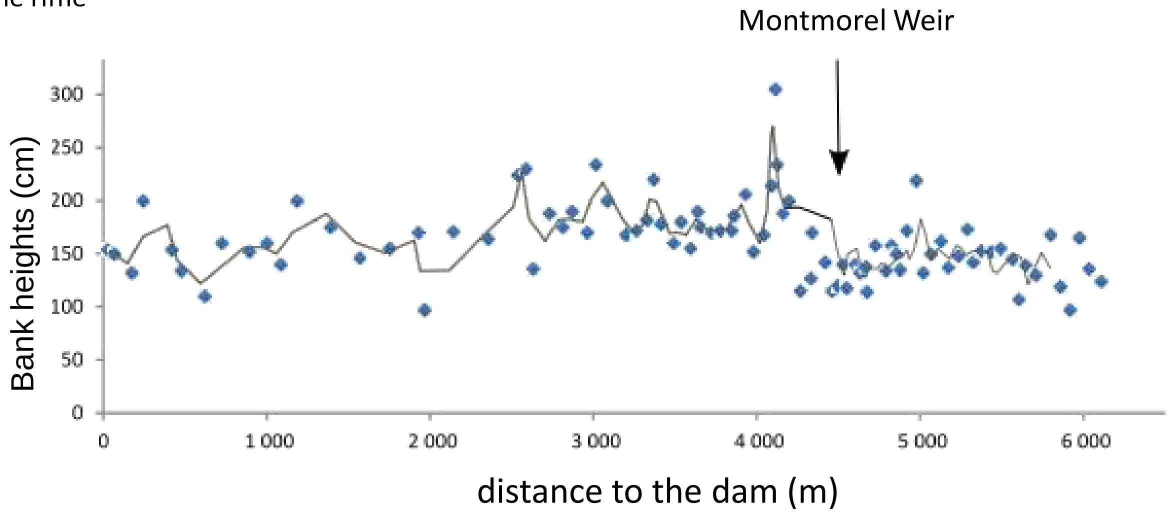


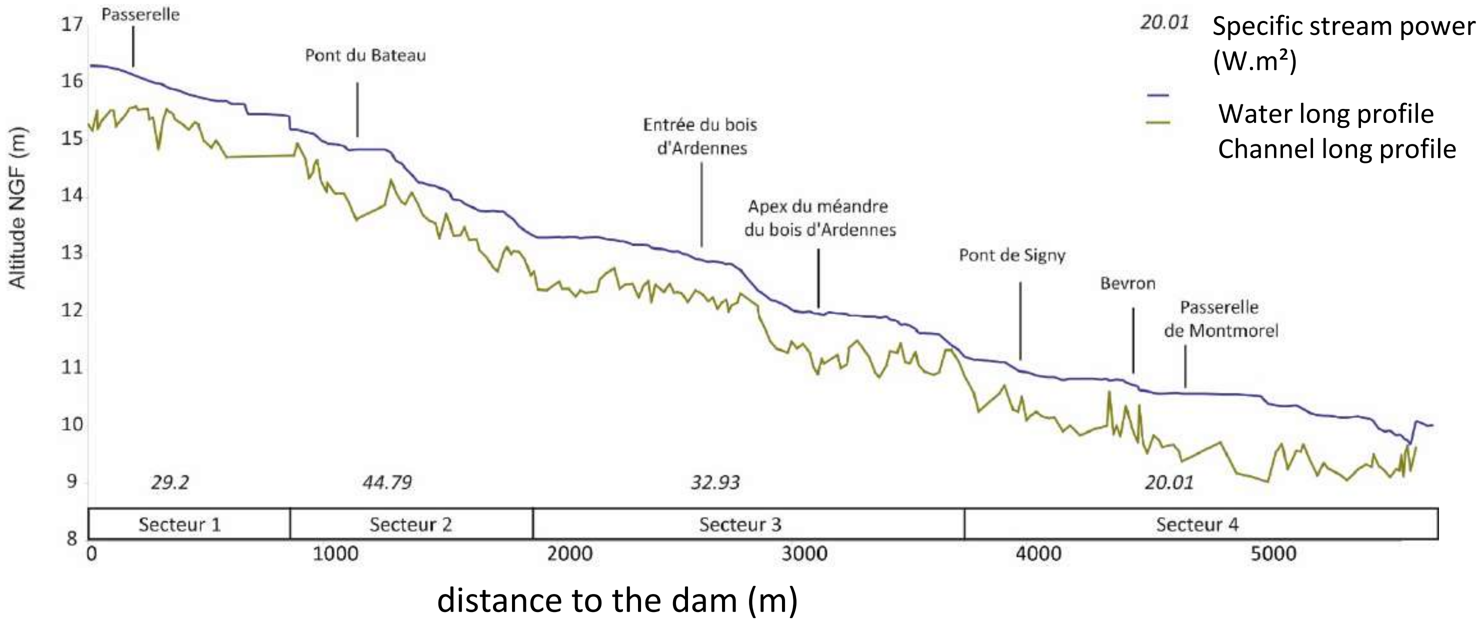

**Task 3:** identification of physical and chemical control factors over 50 cm of depth → modelling oxydo-reduction processes. Dissolve gaz monitoring.

### *Longitudinal grain size variation downstream of the RQB dam (gravel riffle heads and mid-riffle)*



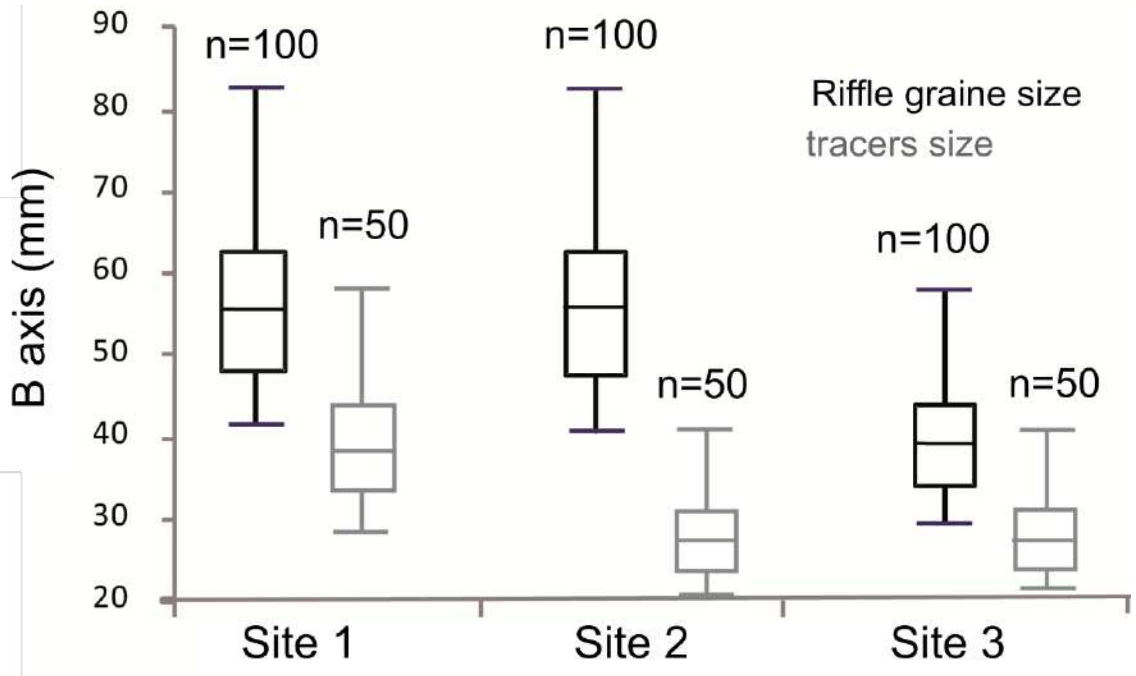

### *Longitudinal variation in bank heights (right bank) between the La Roche Qui Boit dam and Ducey*



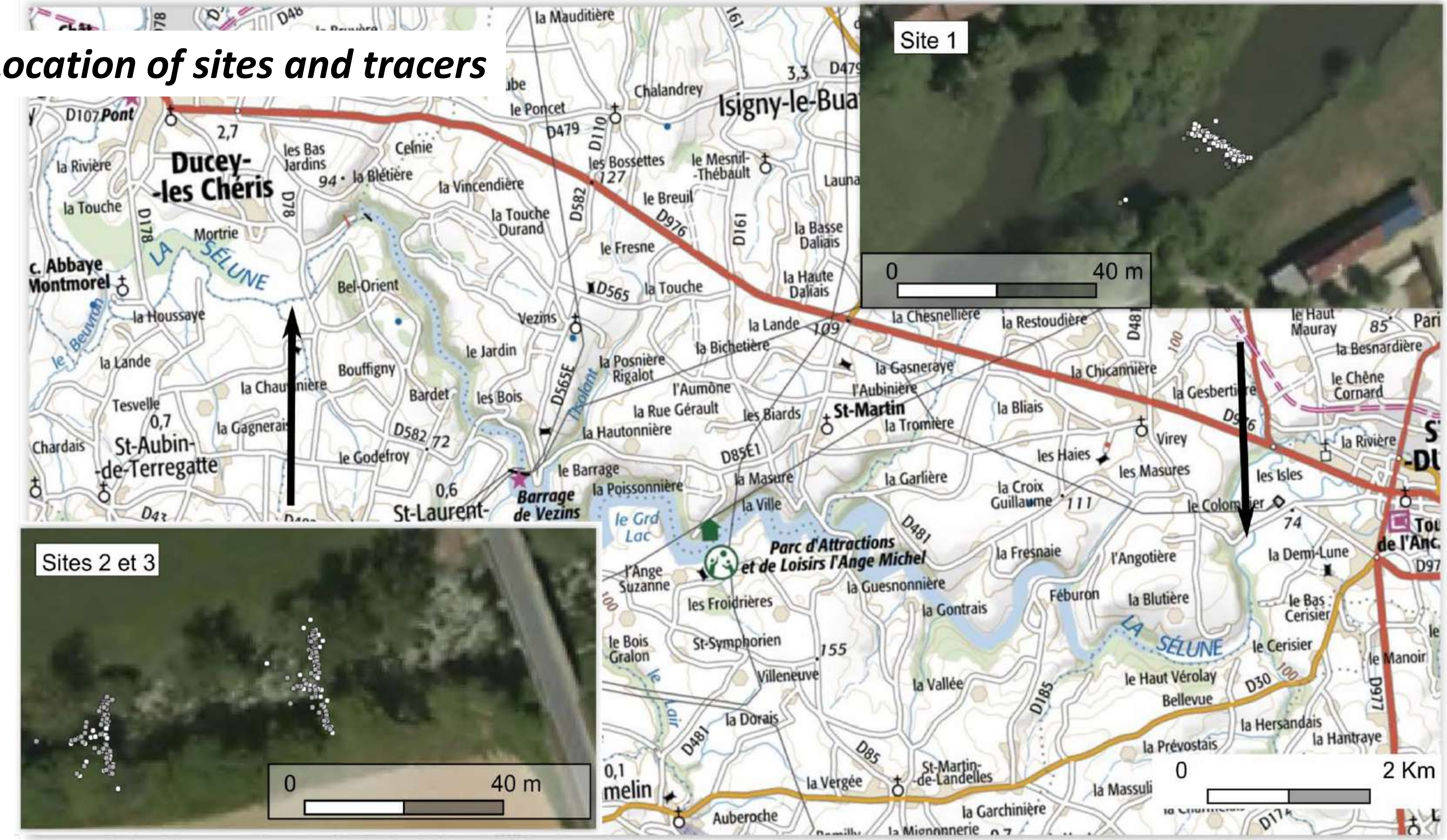

### *Long profiles of the channel and the water line of the Selune between the dam of La Roche qui Boit and Ducey*

***Site and tracers characteristics for coarse sediment monitoring***

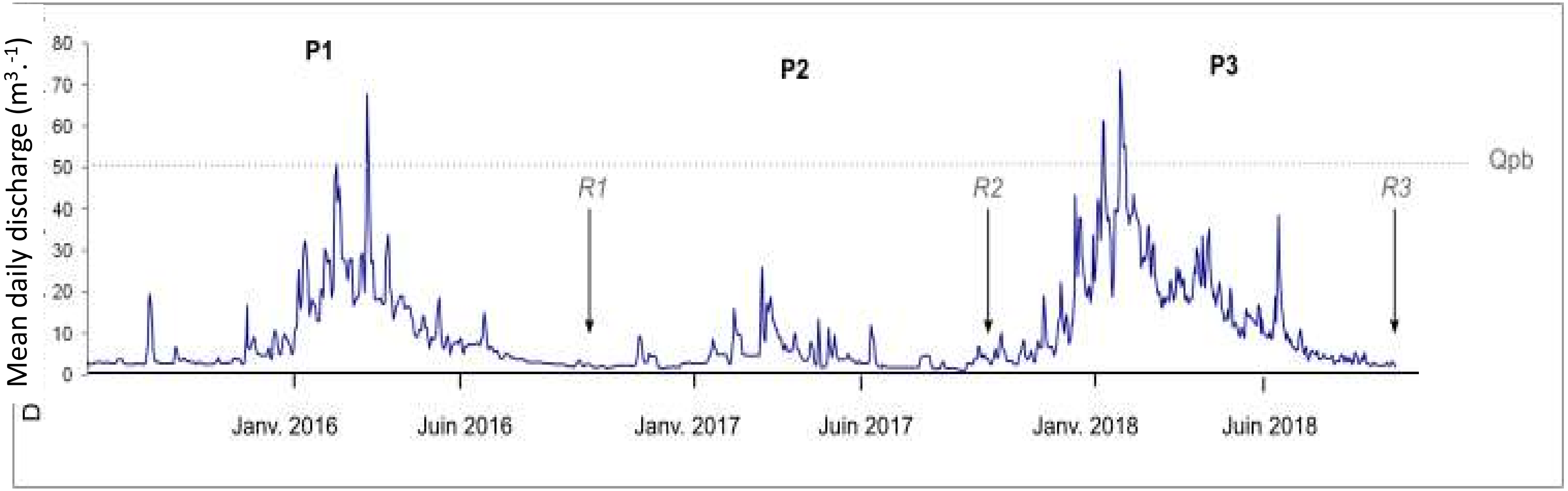



| | Watershed (km²) | Slope (m/m) | Specific stream power (W.m²) |
|---|---|---|---|
| Site 1 | 627 | 0,0032 | 73,19 |
| Site 2 | 761 | 0,0023 | 50,03 |
| Site 3 | 761 | 0,0023 | 60,38 |

# *Location of sites and tracers*



## *Mean daily discharges from July 2015 to september 2016(P : surveyed period, R : surveys)*



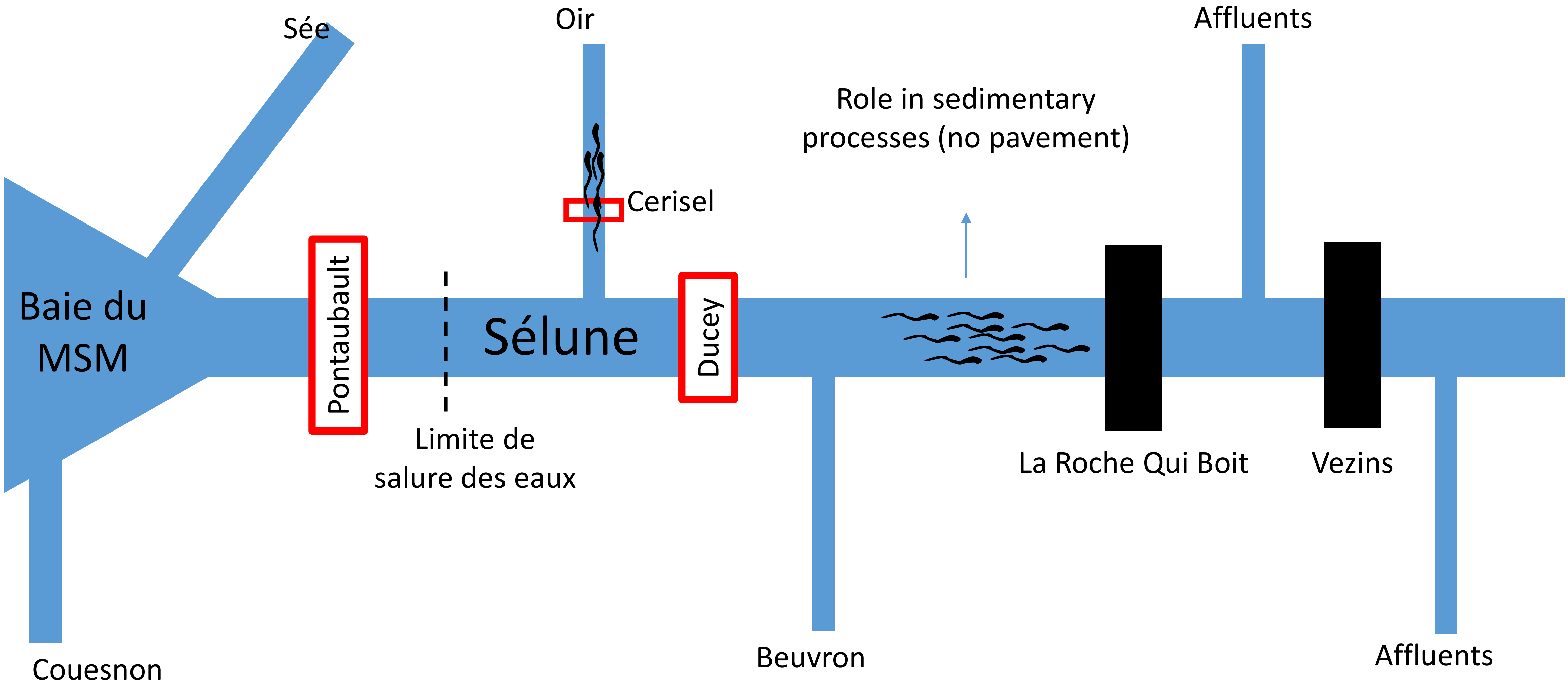

## *Main results of the PITtags tracing from July 2015 to September 2018*

| | Site 1 | Site 2 | Site 3 |
|---|---|---|---|
| Mean distance(m) | 3.7/0.9/0.9 | 0.6/1.0/1.1 | 1.2/0.5/1.3 |
| Max distance (m) | 9.6/14.1/3.1 | 9/3/5.8 | 6.8/3.4/9.3 |
| Min distance (m) | 0 | 0 | 0 |
| Recovery rate (%) | 94/92/78 | 96/100/96 | 96/90/96 |
| % mobilized | 89/48/51 | 23/82/56 | 69/47/38 |

Upcoming project –

**Role of engineering species (Lampreys and salmon) in the restoration of fish habitats and sedimentary processes**

Collaboration Rennes2-UMR6554 / UMR ESE (co porteurs A-J Rollet / E. Lasne)



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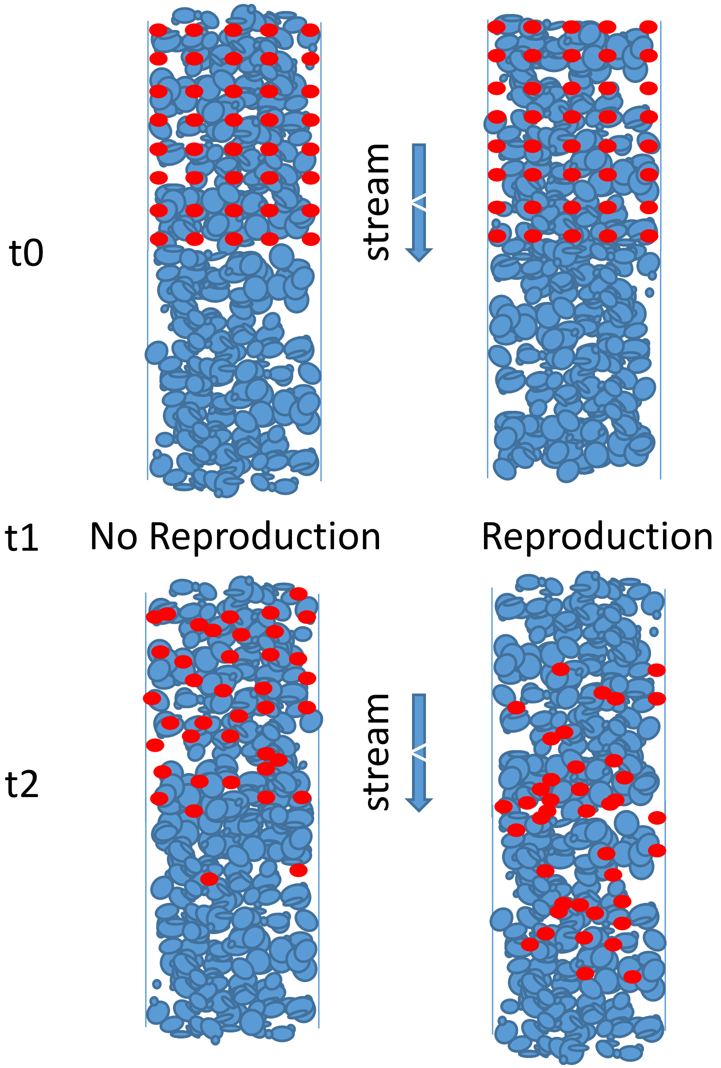
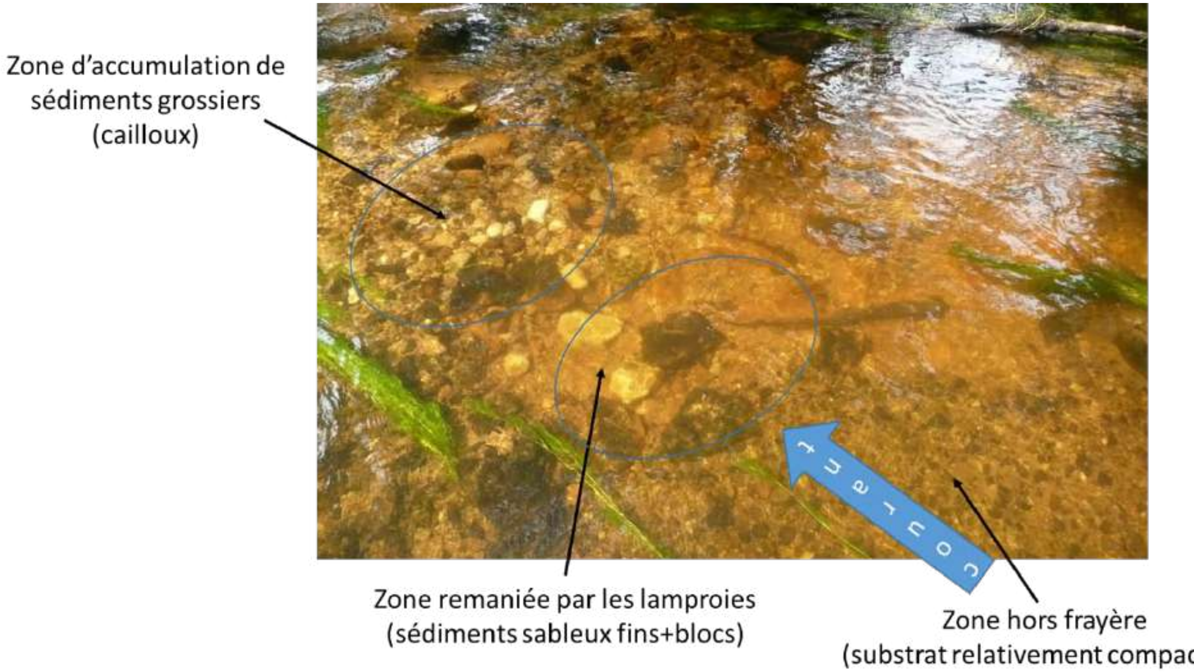
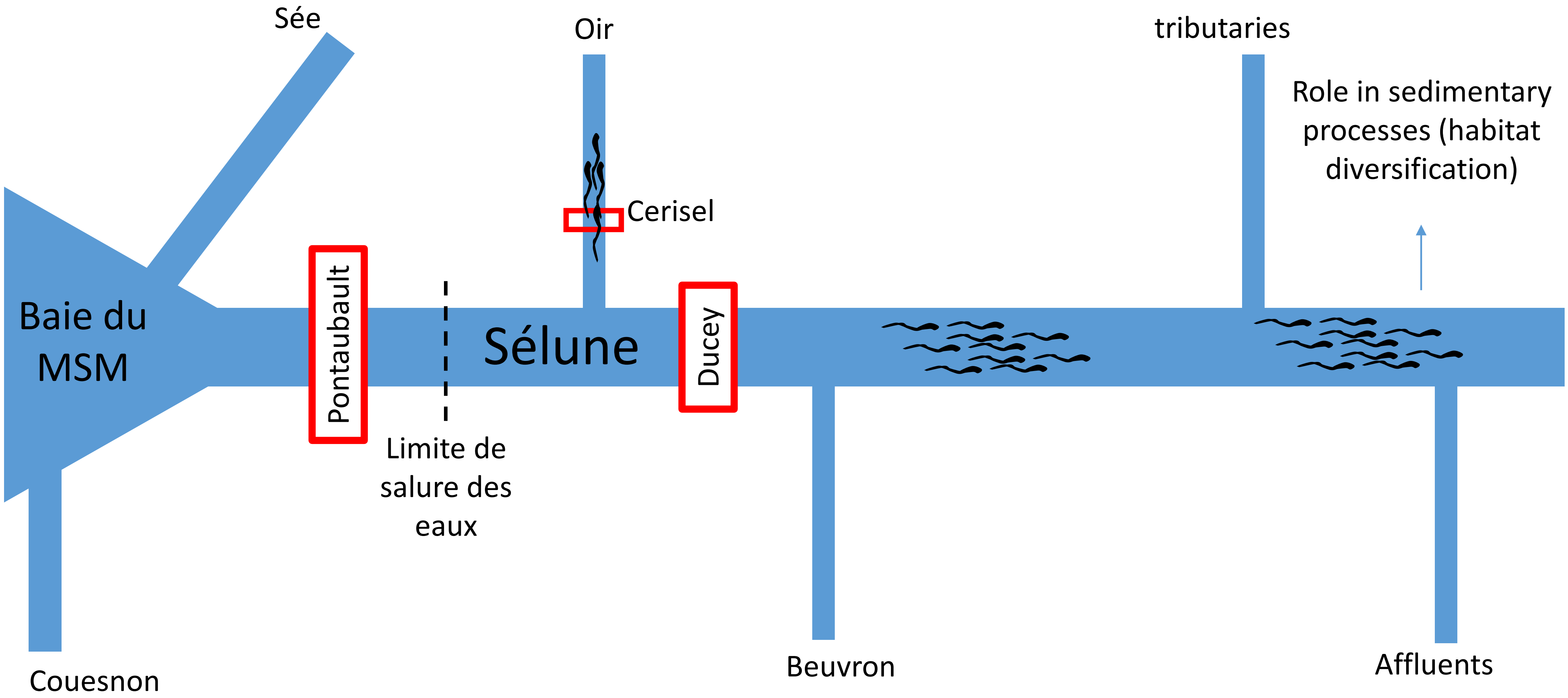



Problematic 1 :

What is the role of engineering species (Lampreys and salmon) in morphological and sedimentary processes?



Upcoming project - **Role of engineering species (Lampreys and salmon) in the restoration of fish habitats and sedimentary processes**



Upcoming project - **Role of engineering species (Lampreys and salmon) in the restoration of fish habitats and sedimentary processes**

Problematic 2: What are the modalities of recolonization of the old reservoir (velocity, preferential sites, etc.) taking into account the hydro-geomorpho potential?

Intervention - → Intervention +

# Pushing the boundaries of Topo-Bathymetric Lidar with Full Waveform analysis

*D. Lague, B. Feldmann*

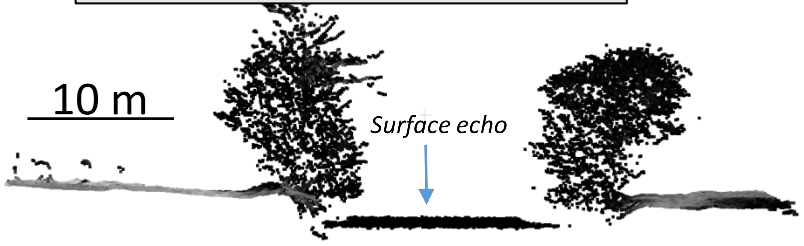
Plateforme **LIDAR topo-bathymétrique** Nantes-Rennes

**The Selune challenge**:

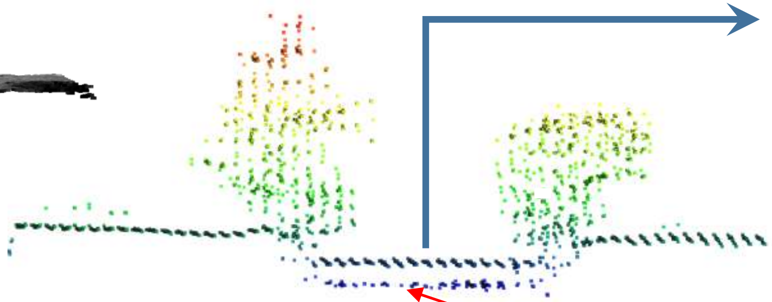
- high canopy interception
- low bed reflectance bed
- turbid water

***very limited bathymetric cover with standard processing***

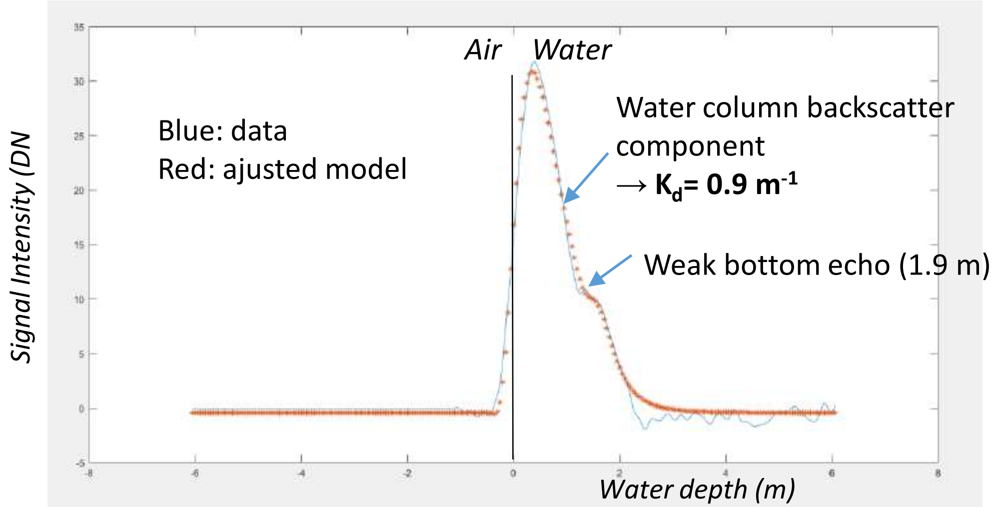
*Standard Green laser data*



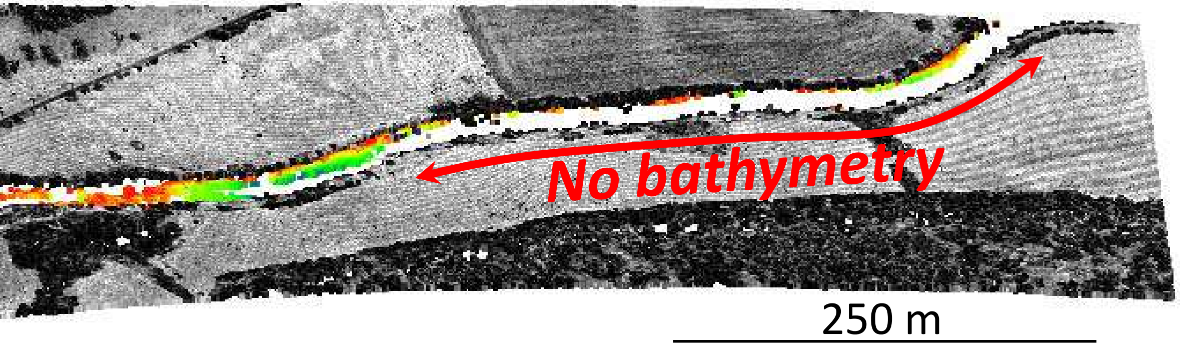

*Reprocessed FWF data*




*Inversion of FWF data with physical model of laser interaction with turbid water*




*Standard Processing (30% cover)*




*Reprocessed FWF (max depth = 1.7 m, 80 % cover)*