

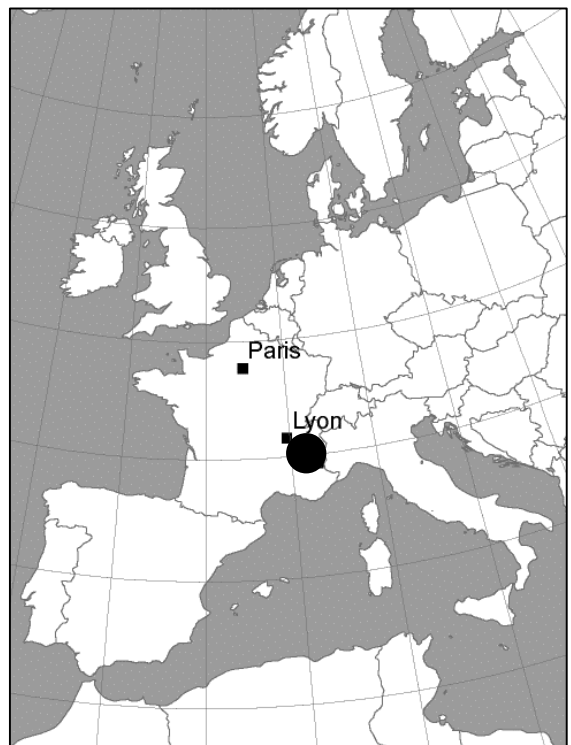
**Combined Contribution of Active RFID  
Technology, Time Lapse Camera and DTM for  
the Monitoring of the Haut-Drac River  
Restoration (Southern Alps, France)**



- 1 - Research context**
- 2 - Why restore - How to restore ?**
- 3 - Monitoring of the restoration operation**
- 4 - Preliminary results**
- 5 - Conclusions**

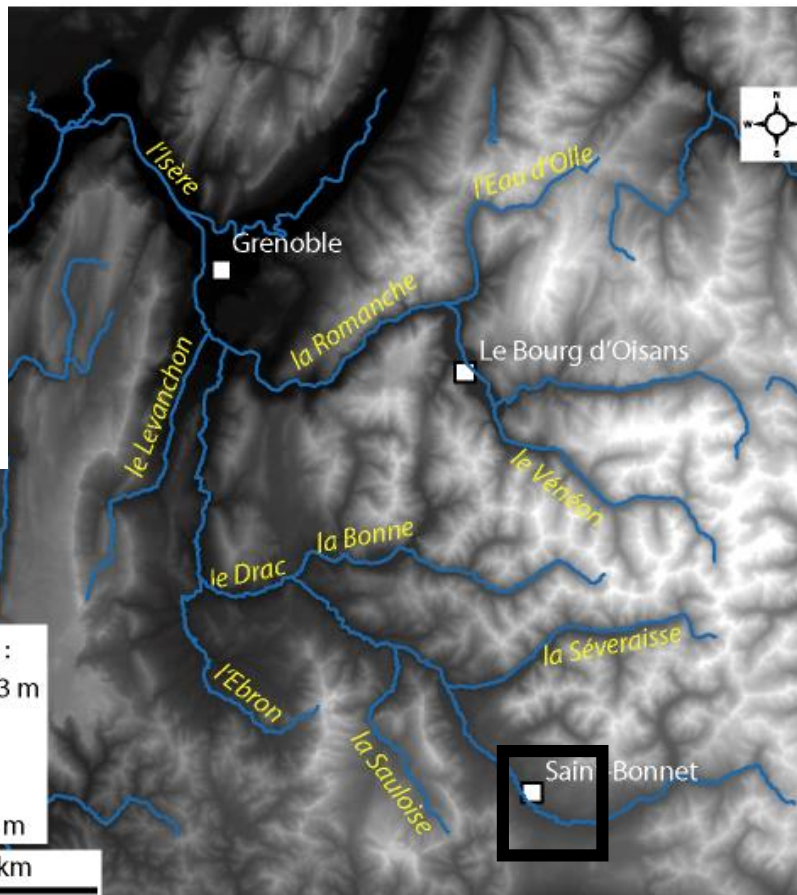


## Location



French Alps  
Rhône catchment  
Left bank tributary of the Isère  
River

	Drainage area (km <sup>2</sup> )	Lenght (km)	Mean slope (%)
Drac River	2401	130	1,7



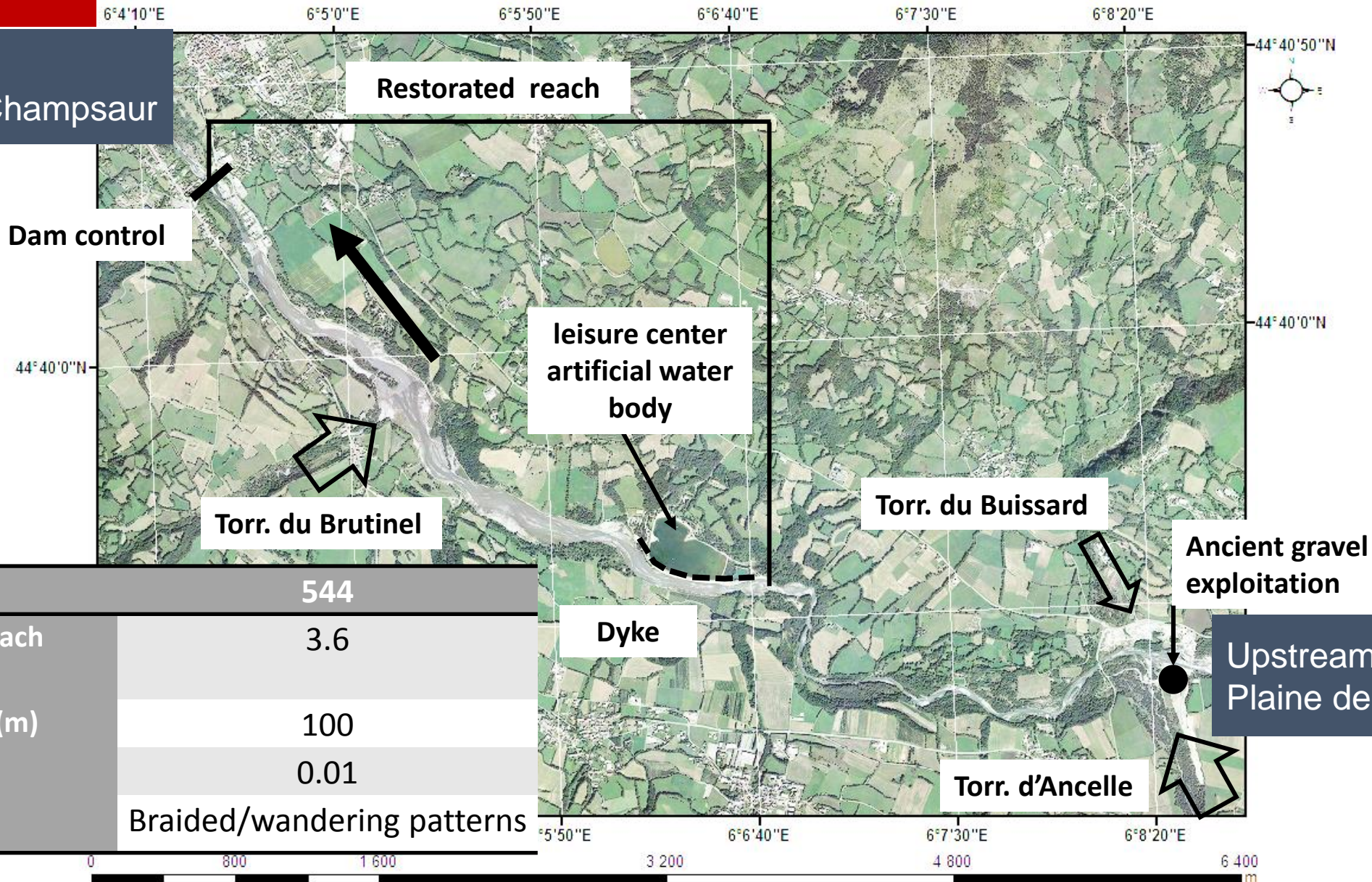
(CLEDA ©)

Glacial valley  
Granitic rocks  
Black marls

# 1 - Research context

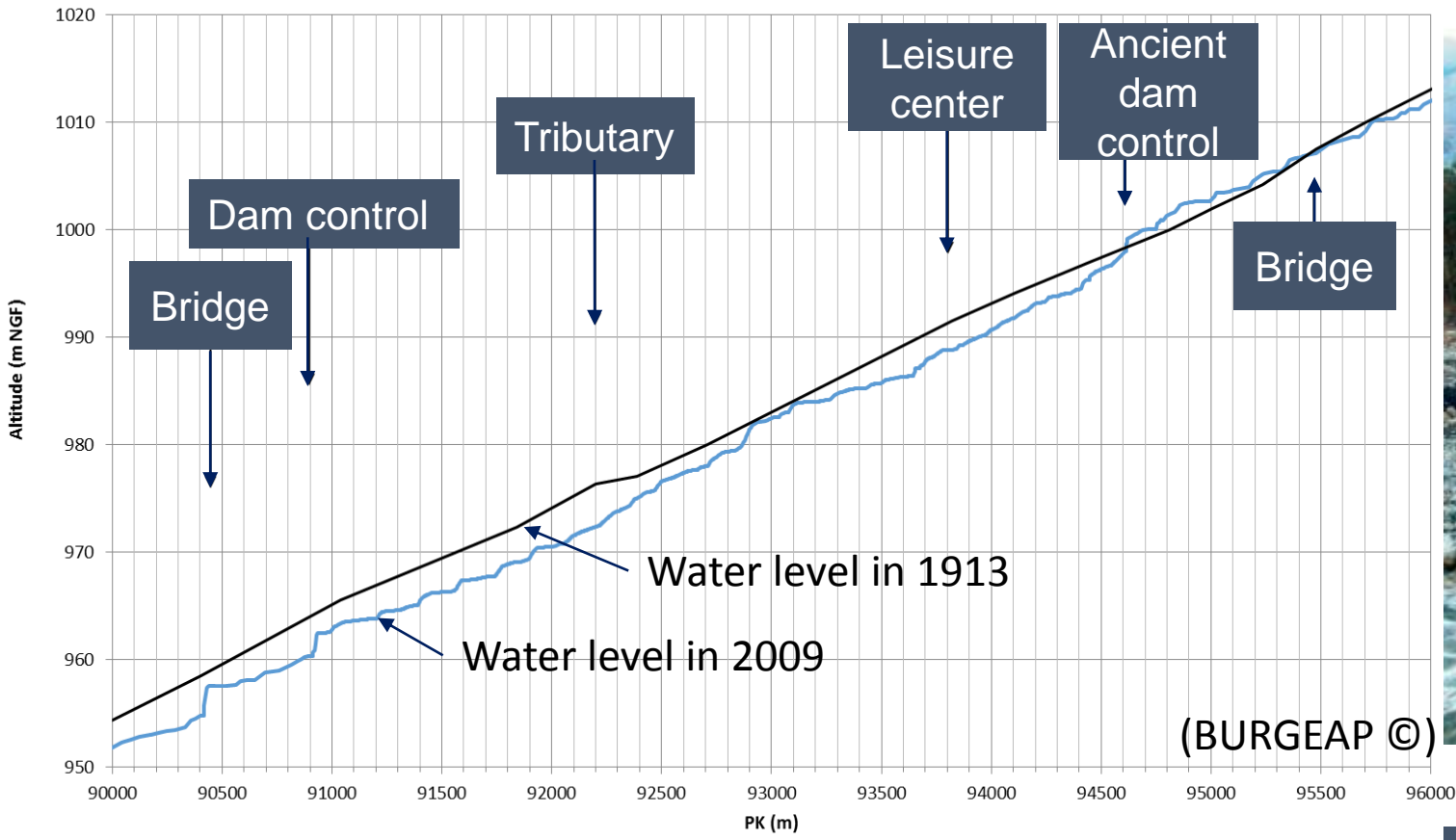
## Study reach

Downstream:  
Saint-Bonnet-en-Champsaur



Drainage area (km <sup>2</sup> )	544
Length of the study reach (km)	3.6
Active channel width (m)	100
Channel slope (m/m)	0.01
Planform morphology	Braided/wandering patterns

# Why restore - How to restore ?



(CLEDA ©)

(BURGEAP ©)

Presence of fluvio-glacial clays close to the bed level

Downstream and upstream historical extractions

A dramatic channel incision

A shift from a braided to a wandering pattern

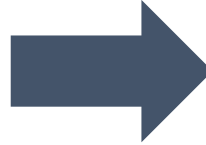
Important ecological and human risks

# Why restore - How to restore ?

1



(AFB ©)



4.8 million € (2013-2014)  
450 000 m<sup>3</sup> excavated and replenished



2

(AFB ©)

One objective : **Stop channel degradation**

Same longitudinal profile and width as in 1913

Elevation of the downstream dam control (+1.65 m)

Mean aggradation = 3 m  
Mean elargissement = 80 – 200 m

## Local monitoring

### Objectives :

- 1) Capture the geomorphic and biological responses of the degraded reach to the artificial gravel recharge
- 2) Evaluate time-scale for a natural recovery

#### 1 Topographic survey:

- Sequential LiDAR
- Drone survey
- Terrestrial and classical topography

#### 2 Field data:

- Granulometry
- Clays outcrops
- Time lapse

#### 3 RFID device:

- Sediment tracking
- Active layer

## Local monitoring

1

### LiDAR data

Date	Type	Discharge (m <sup>3</sup> /s)
08/02/2011	LiDAR	1.48 m <sup>3</sup> /s
15-28/11/2013	LiDAR	15 à 4.5 m <sup>3</sup> /s
11-17/04/2014	DGPS	No problem
10/09/2015	LiDAR	1.6 m <sup>3</sup> /s
22/09/2016	LiDAR	1.5 m <sup>3</sup> /s

Raster calculations for recent sedimentary budget

### Bathymetric data

40 cross section at each Lidar Survey since 2013

Possibility to compare error due to water level

Exemple of Braided Index

2

5 cameras along the study reach



1 photo by hour  
Battery life : 6 months

3



RFID scour chains

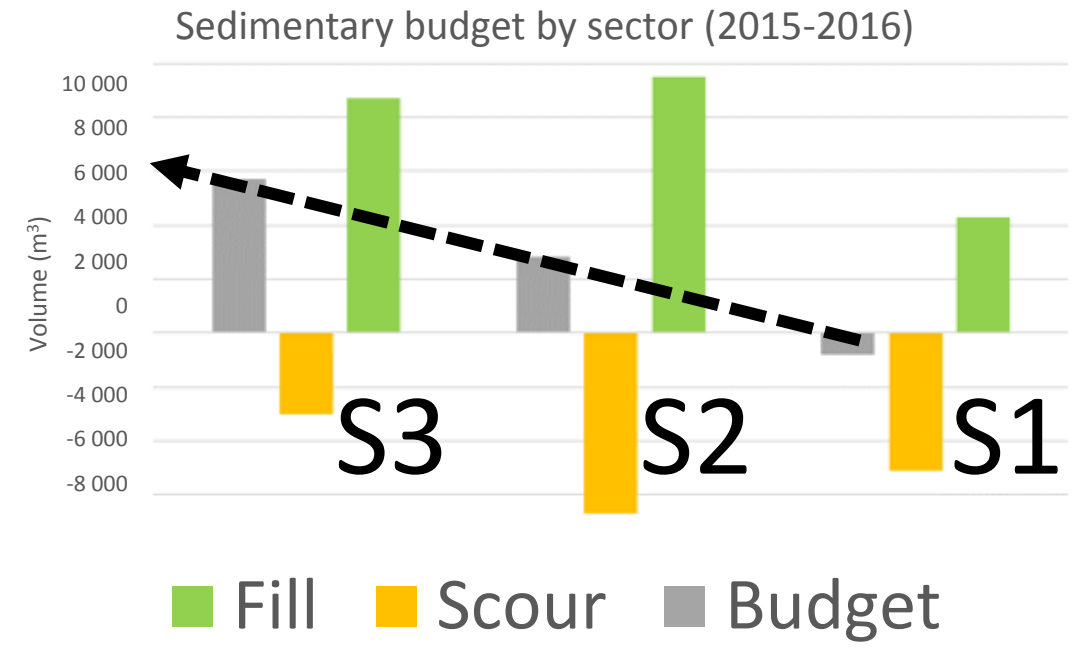
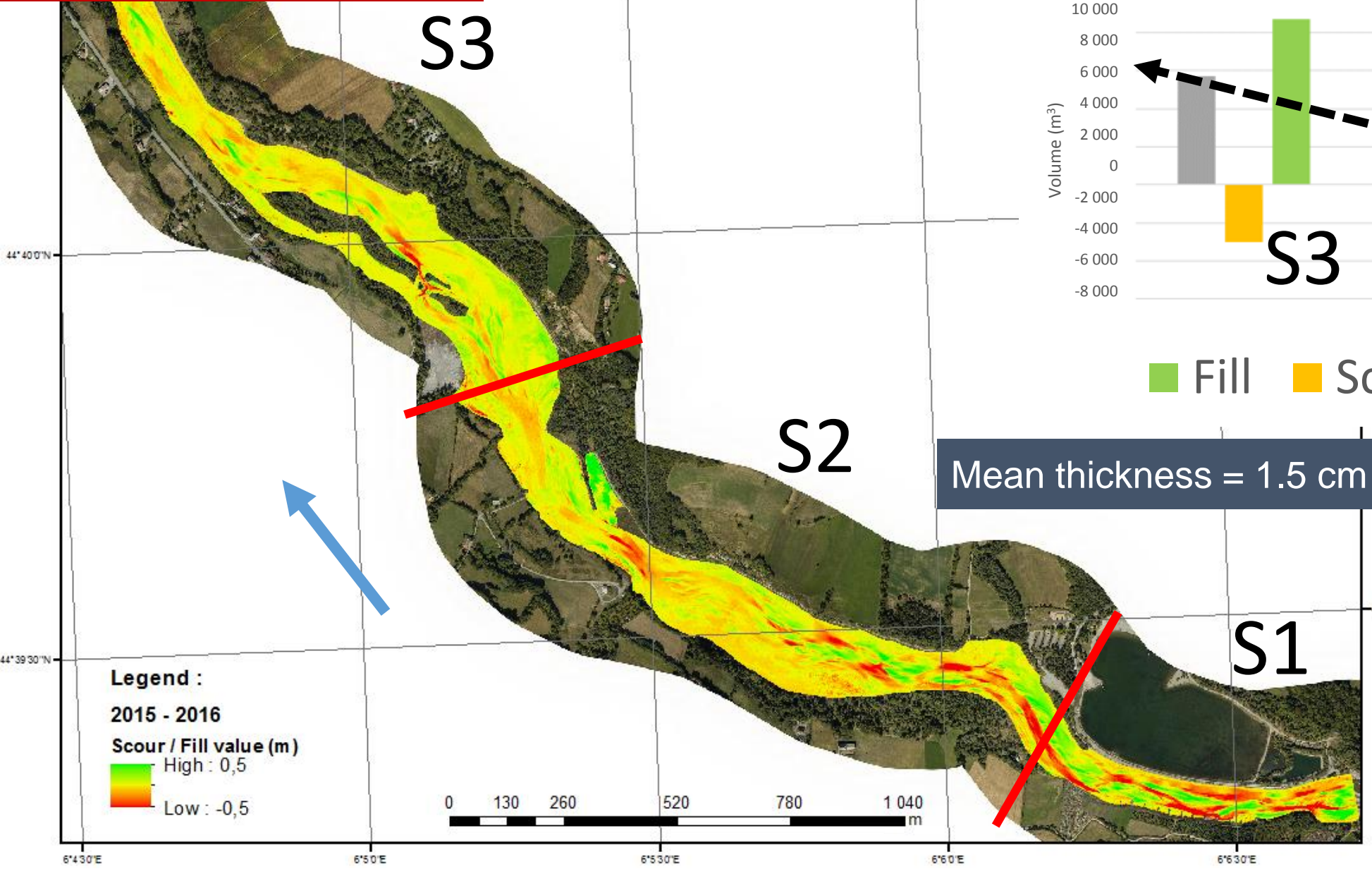


Artificial RFID cobble pebble



# Preliminary results

## Recent sedimentary budget



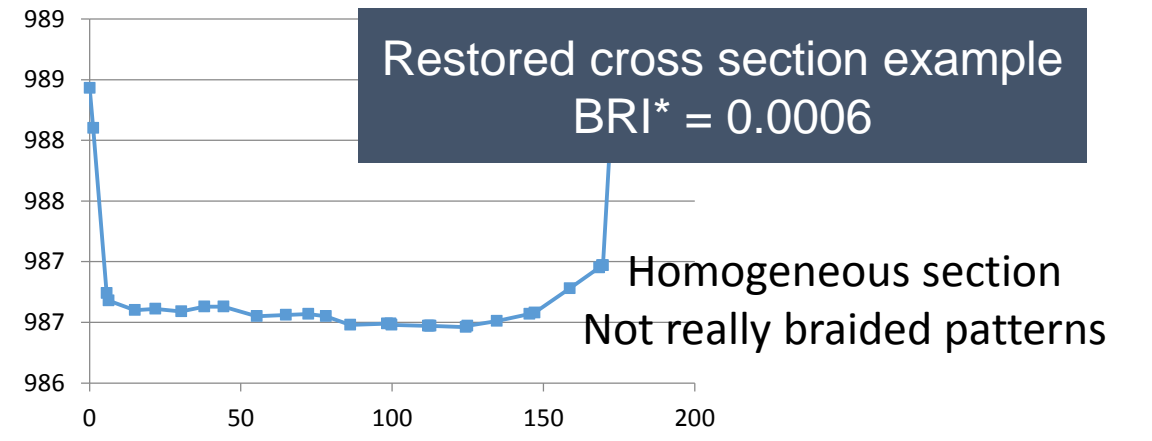
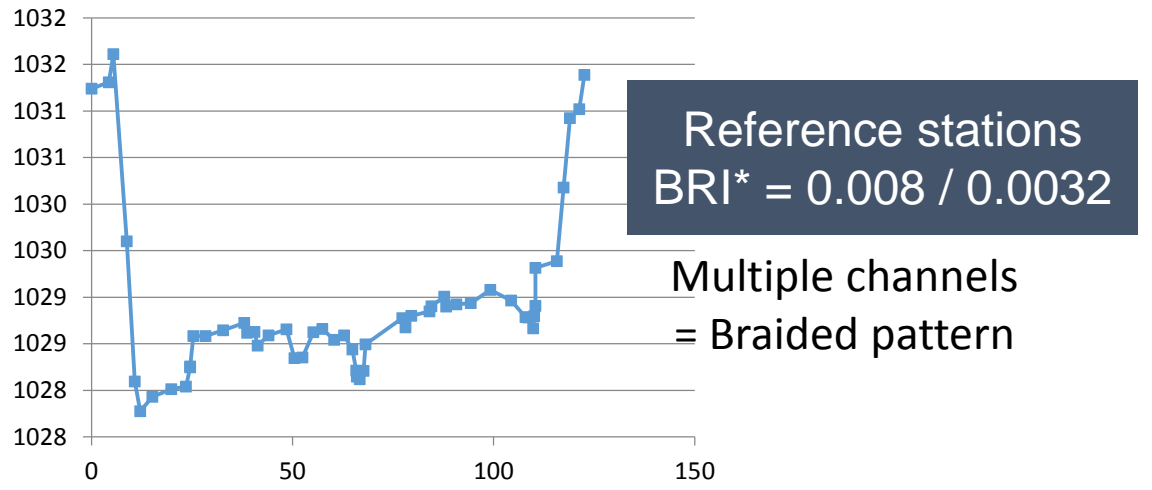
Mean thickness = 1.5 cm

- S1: - 800 m<sup>3</sup>
- S2: + 2,900 m<sup>3</sup>
- S3: + 5,200 m<sup>3</sup>
- Total : + 7,700 m<sup>3</sup>**

# Preliminary results

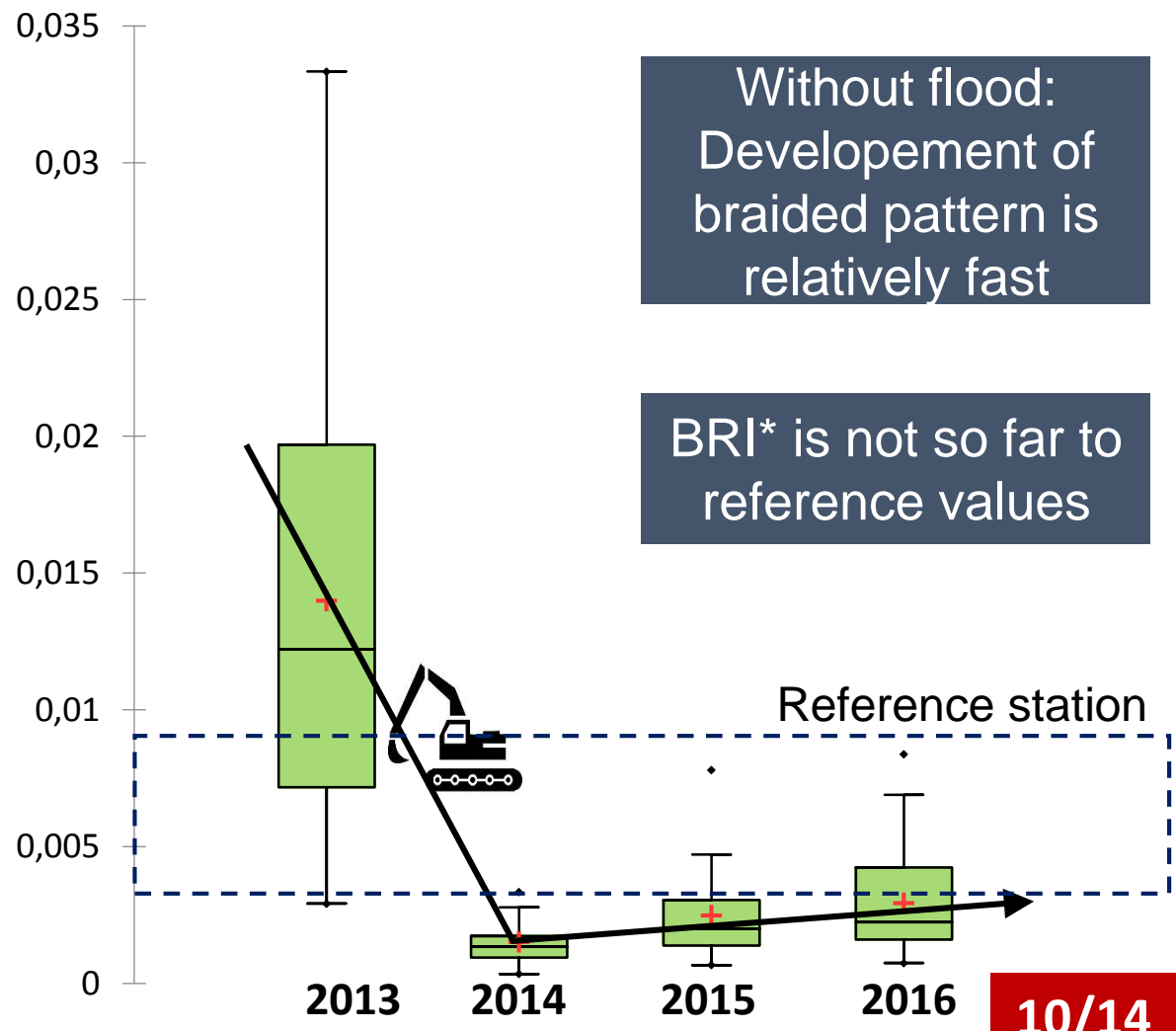
## Braided index

$$BRI^* = \frac{1}{x_n - x_1} \sqrt{\frac{1}{n} \sum_{i=1}^n (z_i - Z)^2}$$



Undimensional standard deviation of active channel altitudinal variations

- 2 reference stations
- 40 cross sections in the restored reach



## Sediment tracking

How long time for a natural replenishment ?

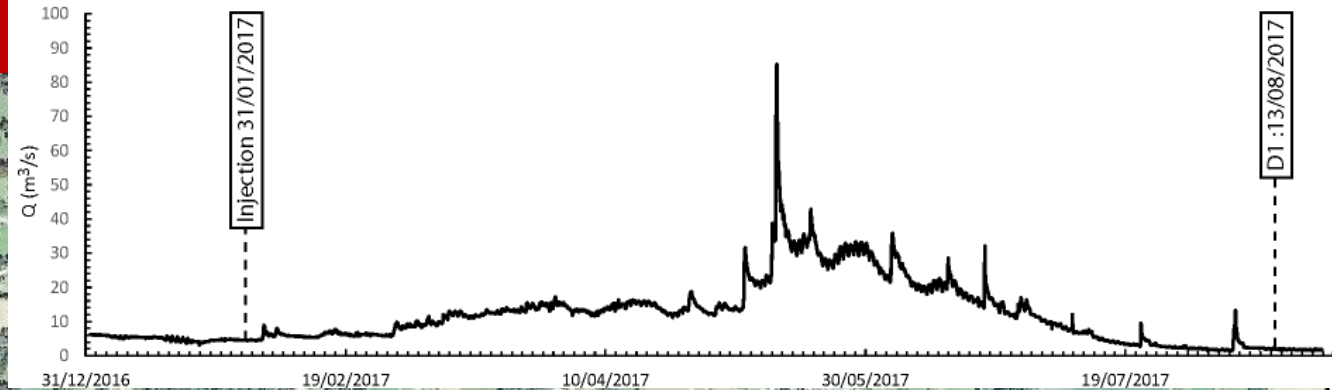
### Legend

#### Prospection

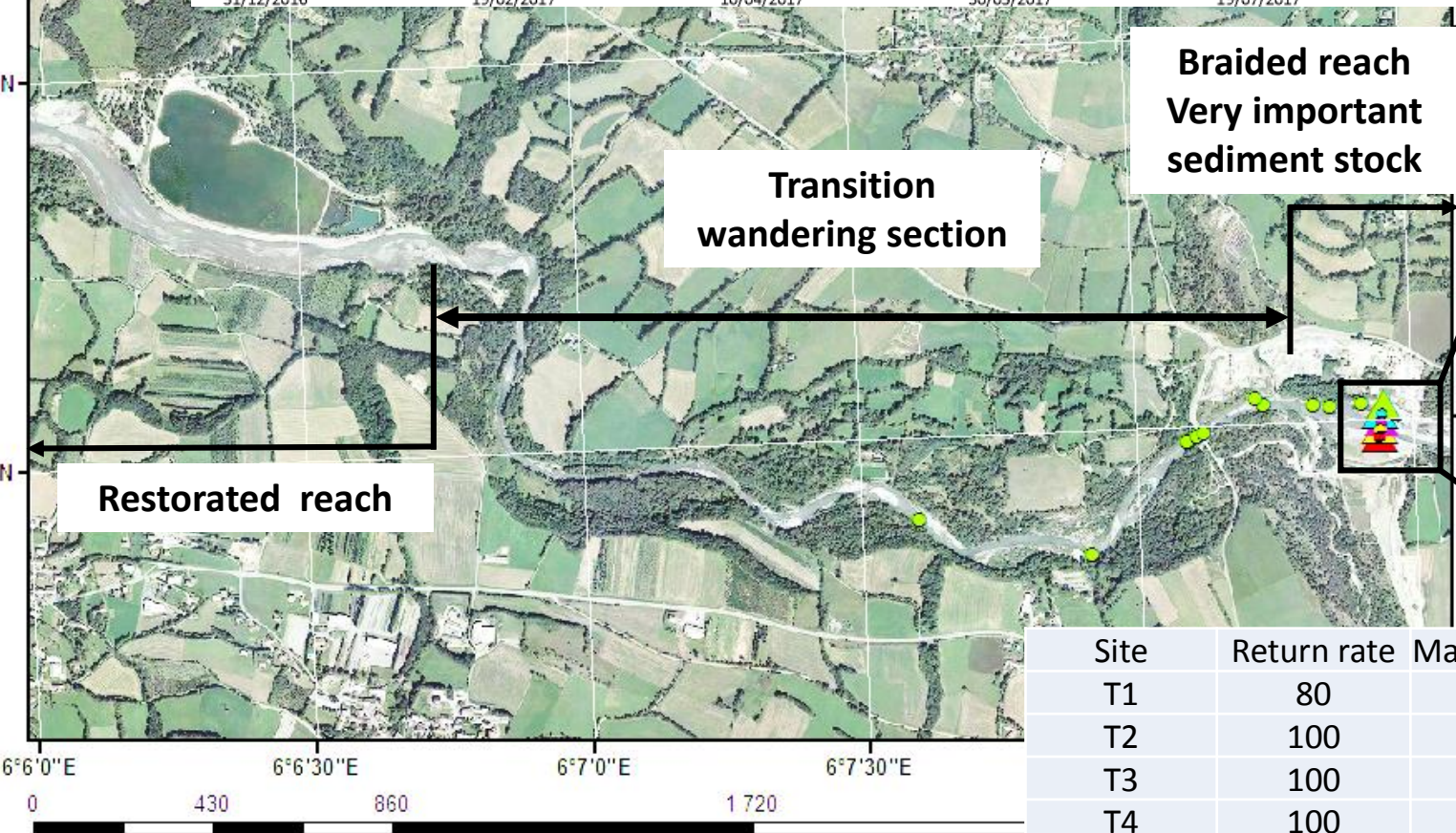
- T1
- T2
- T3
- T4
- T5

#### Injection

- ▲ T1
- ▲ T2
- ▲ T3
- ▲ T4
- ▲ T5

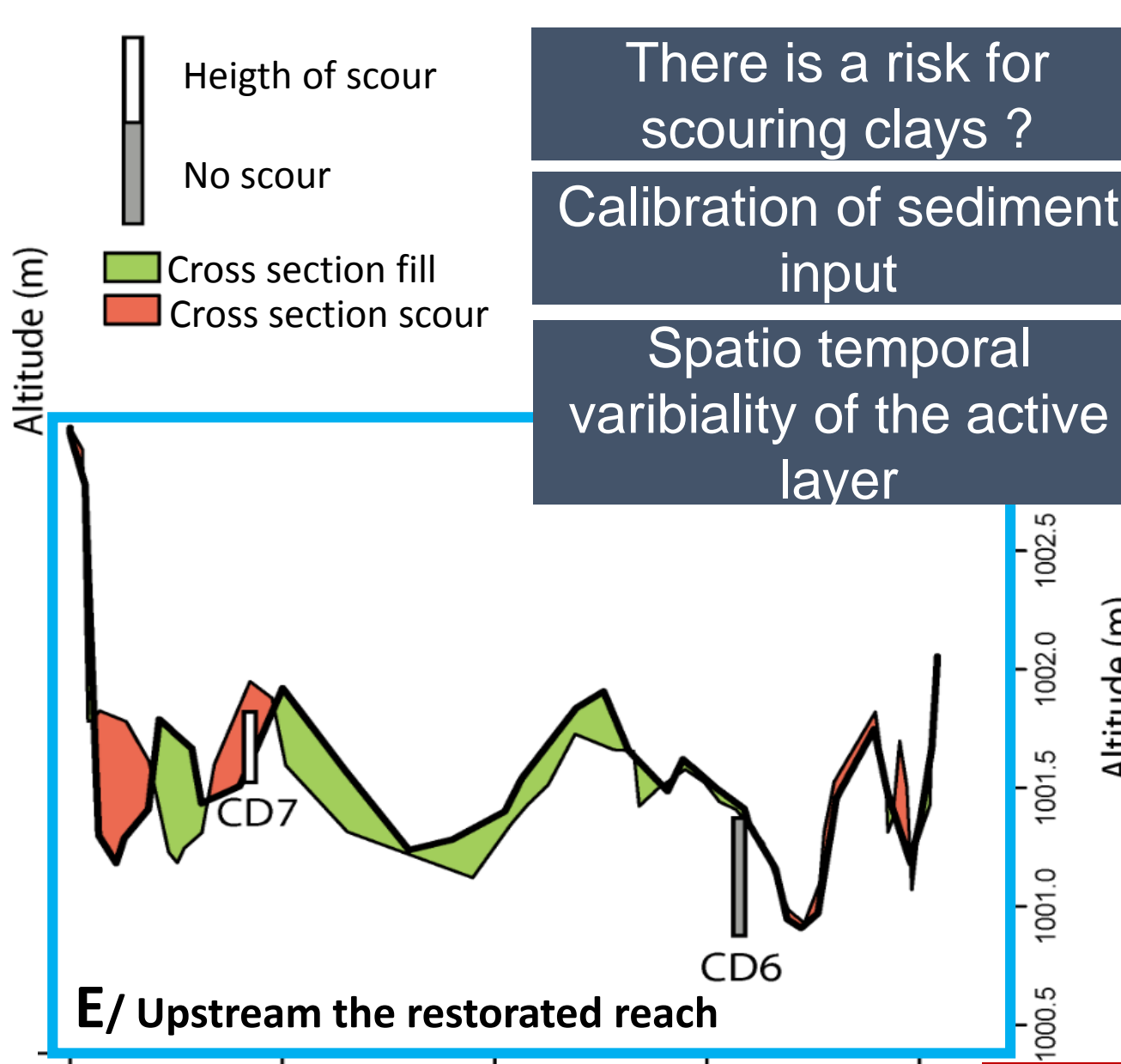
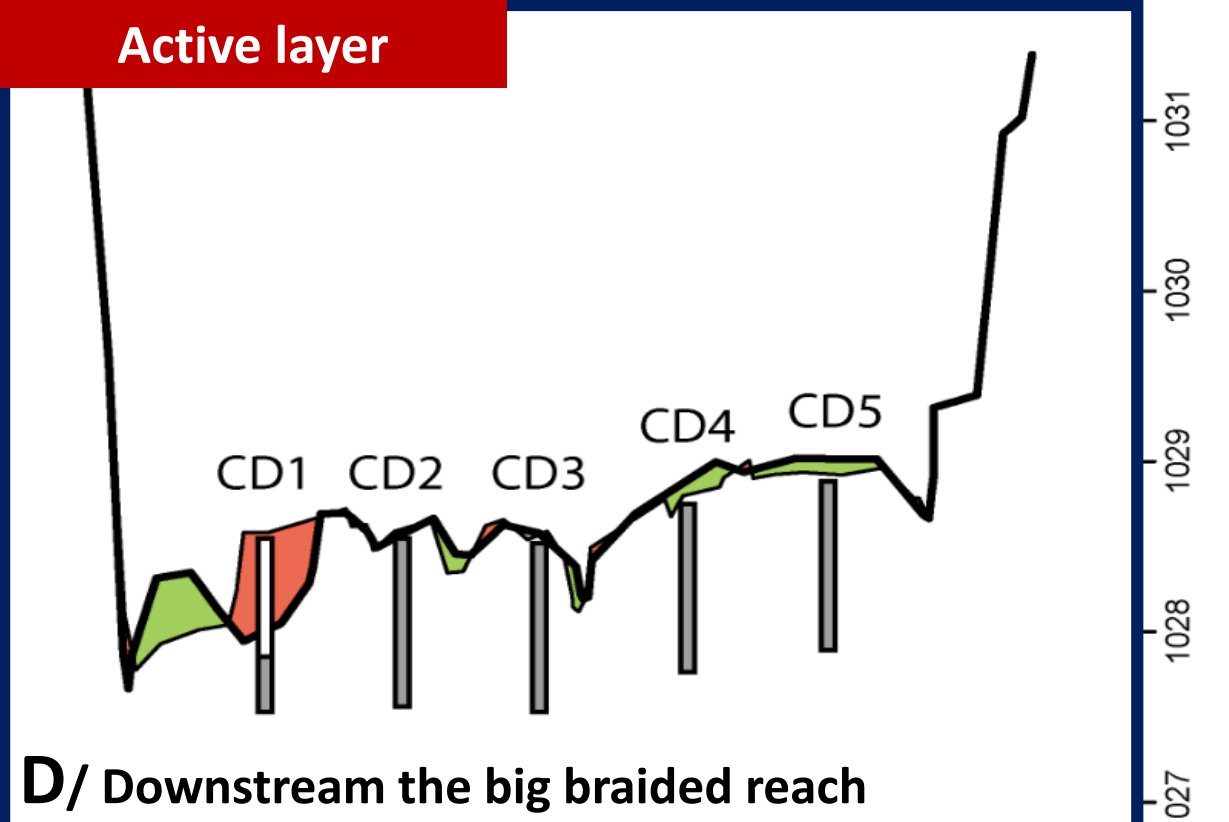


	M0	M+6
Cobble-Pebble	75	72
%	100	96



Site	Return rate	Max length	Min length	Mean length
T1	80	1275	55	456
T2	100	0	0	0
T3	100	0	0	0
T4	100	5.5	5.5	5.5
T5	100	4.7	3.5	4.1

# Preliminary results



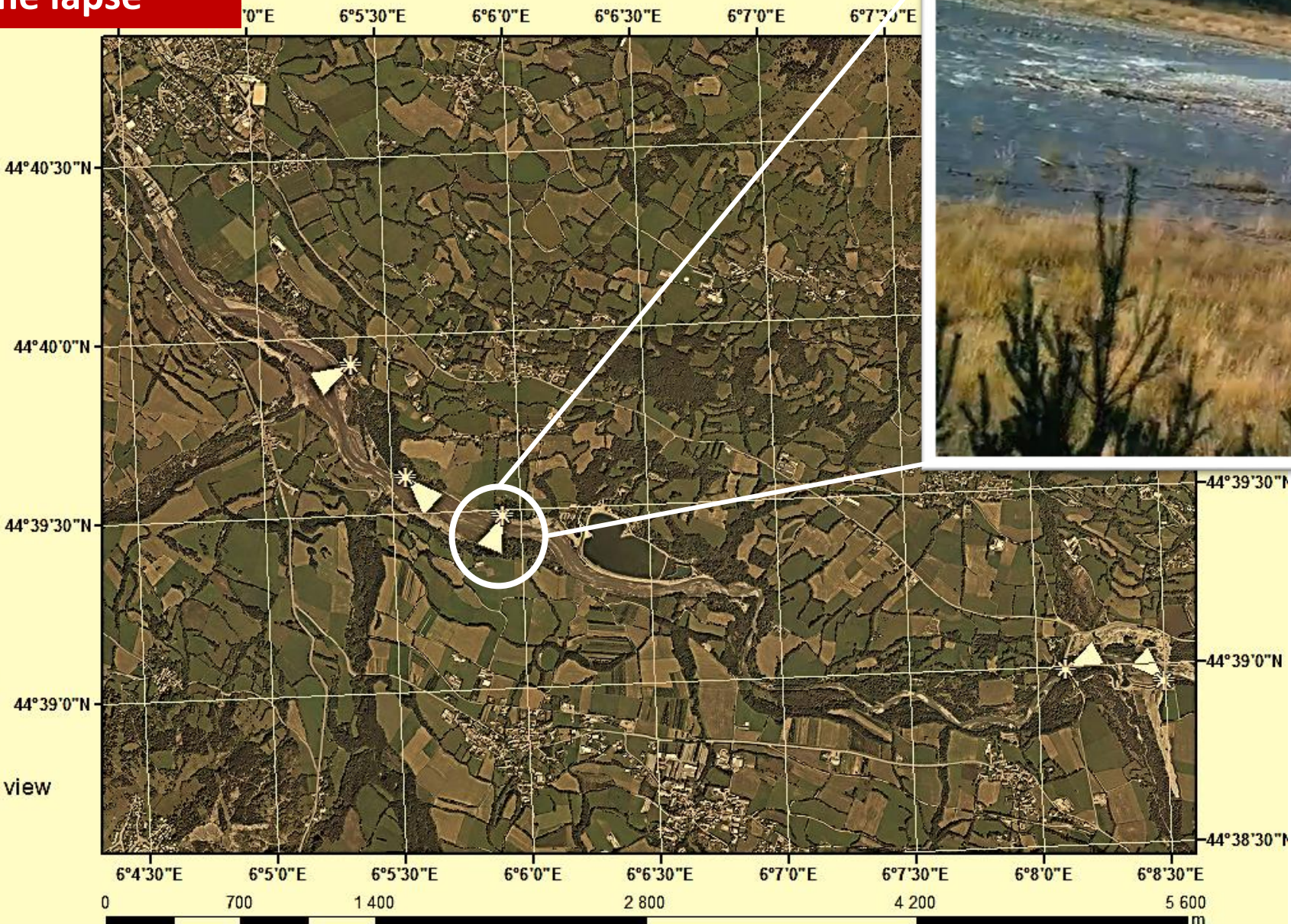
There is a risk for scouring clays ?

Calibration of sediment input

Spatio temporal variability of the active layer

Site	Drac (CHAB)					Drac (ZR)		
Graph	D					E		
Column	CD1	CD2	CD3	CD4	CD5	CD6	CD7	CD8
Scour (m)	0,70	0,00	0,00	0,00	0,00	0,00	0,30	0,30
Fill (m)	0,21	0,02	0,01	0,10	0,10	0,06	0,14	0,11
Active layer (m)	0,91	0,02	0,01	0,10	0,10	0,06	0,44	0,41

## Time lapse



Qualify geomorphic response

Verify hydraulic conditions

Quantify habitats evolutions

After 3 years:

Sediment budget is positive but almost stable

Most of evolutions are located in upstream

Braided patterns are forming relatively quickly

RFID device shows that low flow conditions allow significant sedimentary mobility



Continuation of monitoring

Use time lapse to quantify habitat spatio temporal evolutions

**Our results attest of a good potential recovery rate**

**Thank you for your attention**

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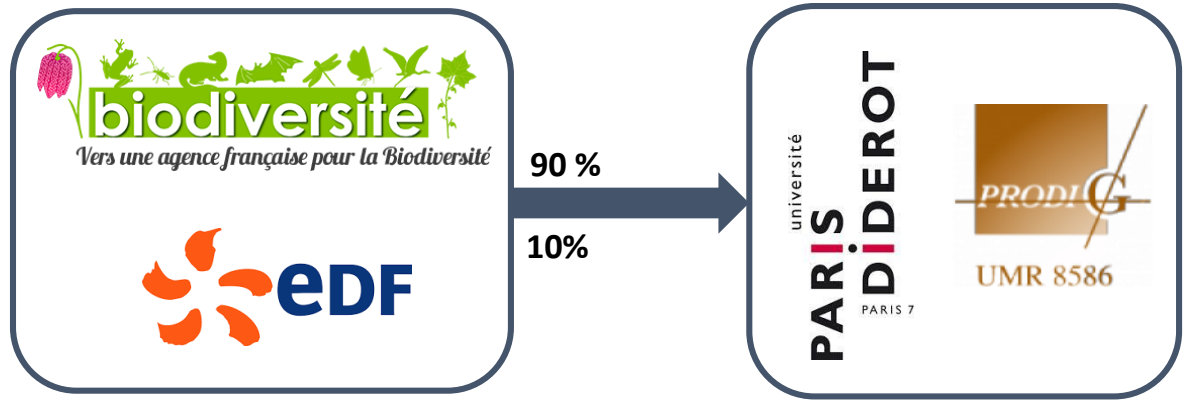
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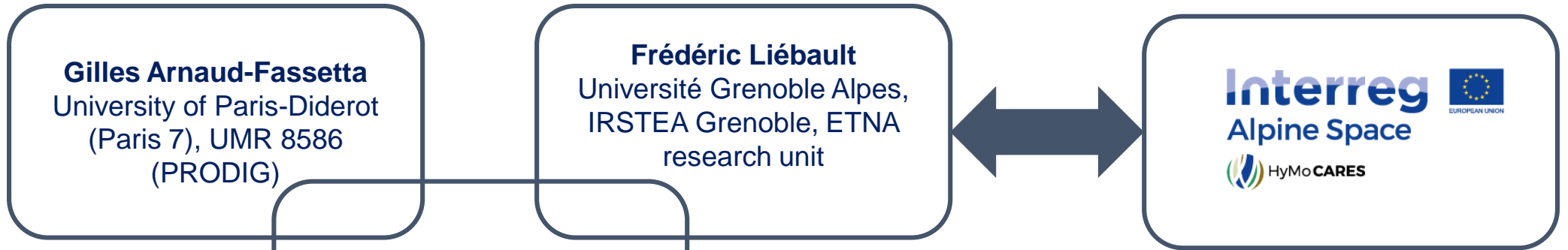
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## Team project

### Funding



### Direction



HyMoCARES - HydroMorphological assessment and management at basin scale for the Conservation of Alpine Rivers and related Ecosystem Services

### Phd student