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## **Gravel sediment tracing from small torrents to trunk channels using pit-tags method: A case study from the upper Guil catchment (Queyras, French Alps)**

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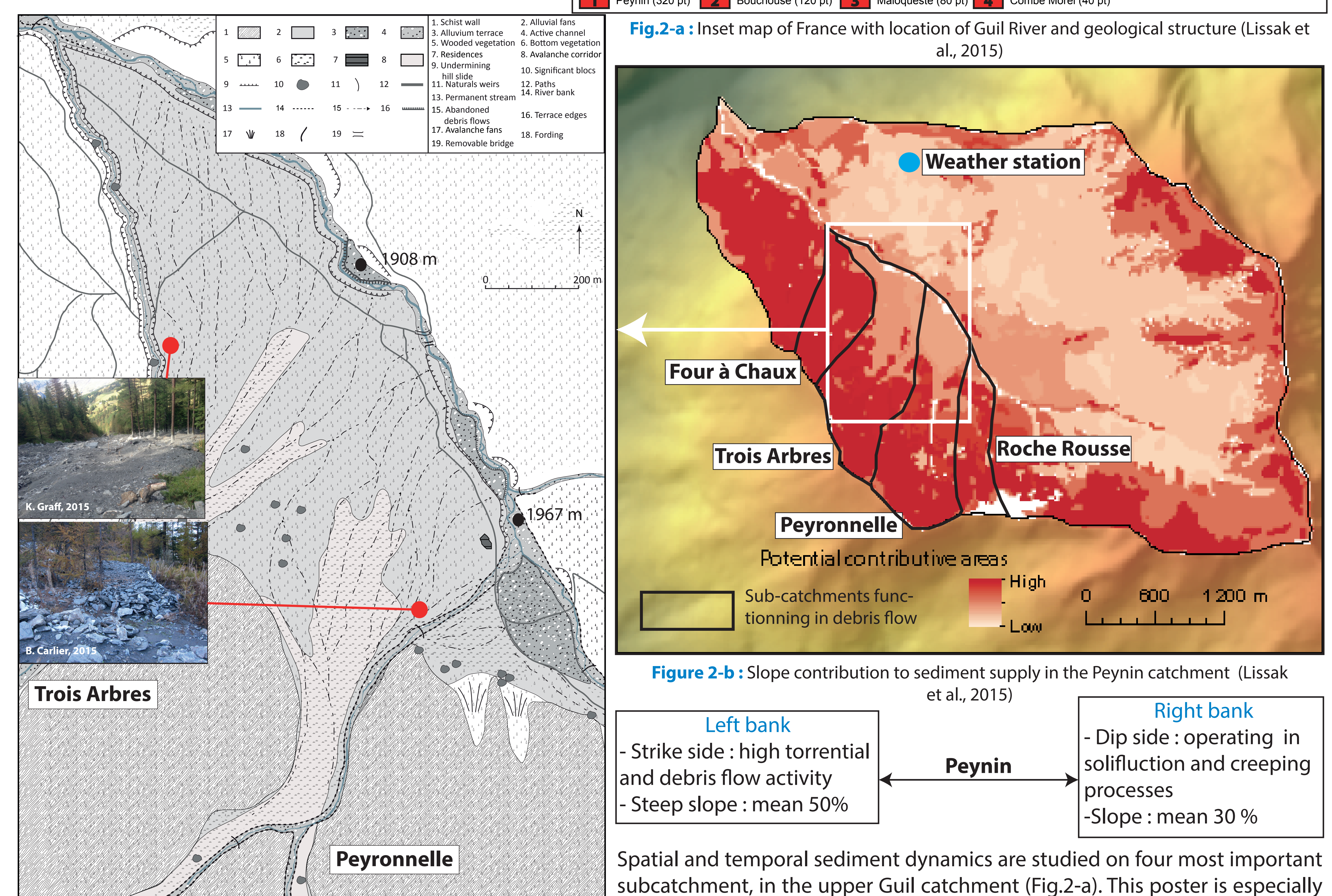
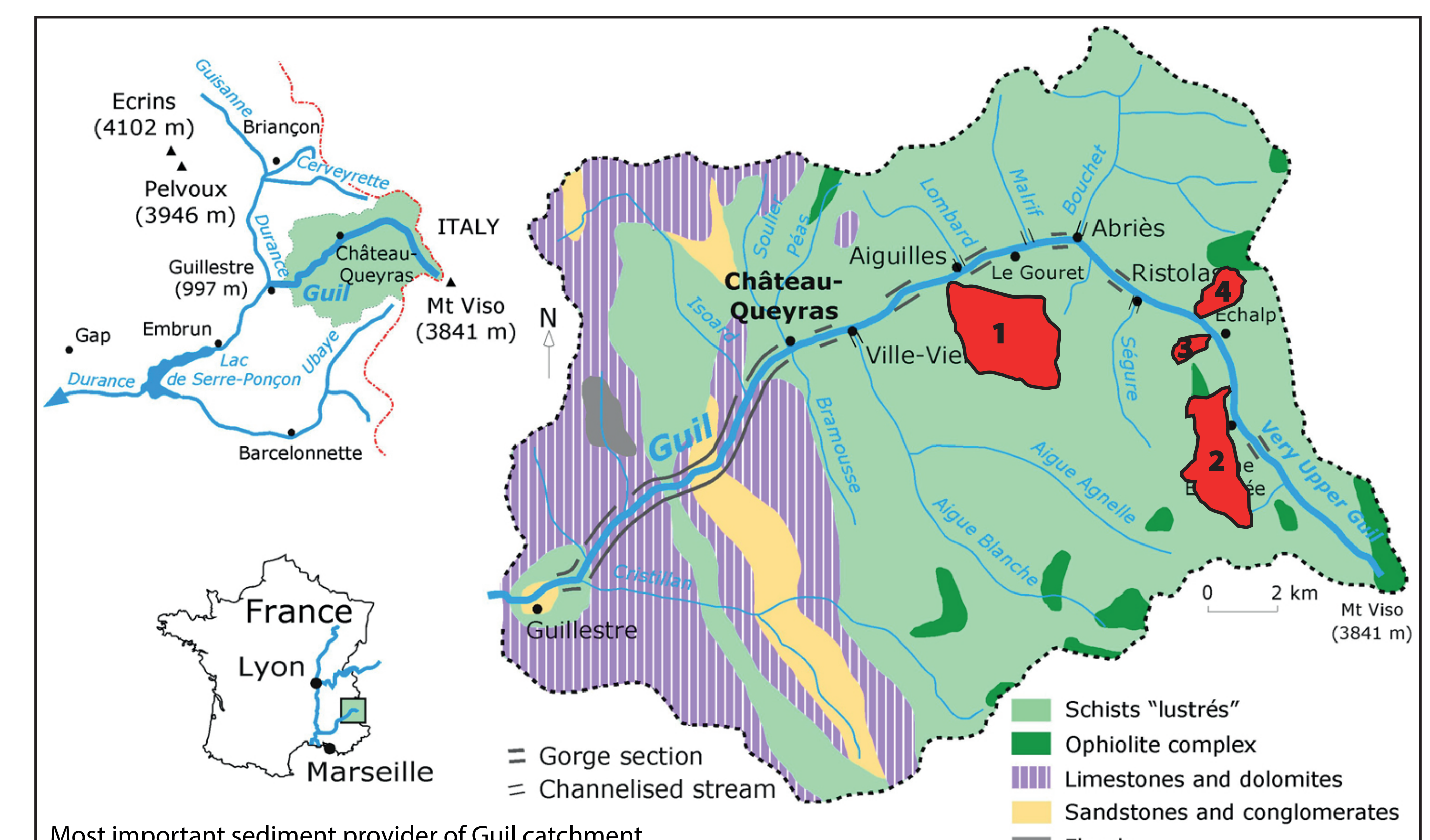
## 1 Background and scientific context

In mountainous areas, especially in large catchments with torrential tributaries, the production and sediment transport significantly increase flood impacts in the valley bottoms. The quantification and characterisation of sedimentary transfers are therefore major challenges to provide better flood risk management. As a part of SAMCO (ANR 12 SENV-0004 SAMCO) project, for mountain hazard assessment in a context of global changes, we tried to improve the knowledge of these hydromorphological systems at both spatial and temporal scales, by identifying sediment supply and sediment dynamics from torrential tributaries to the trunk channel. A sediment budget was used as a tool for quantifying erosion, transport and deposition processes.

This research is focused on a part of the sedimentary budget to understand the torrential processes and to define debris-flow's contribution. It is localized on the Upper Guil catchment, prone to catastrophic flash floods in active channel and alluvial fans. It is characterised by huge sediment transport coming from small torrential tributaries. In this study, we intend to highlight sediment dynamic between small torrential channels and its connection with gravel-bed streams, and characterize the sediment volume mobilized during a large debris-flow event.

## 2 Study area

The upper Guil catchment (Queyras - 317 km<sup>2</sup>) is characterised by a lithology composed of 90-95% of shale (Fig.2-a), supplying the river bed in huge fine and coarse sediment. Functioning in high magnitude/low frequency (Fort et al., 2002), the Guil River is subjected to flash-flood events. The volumes of sediment mobilized during the 100-year flood in 1957 have been estimated at 330.000 m<sup>3</sup> (Kouliniski, 2002). Sediment load in the main channel of the Guil River results from erosion in small torrential tributaries, as the Peynin catchment (Fig.2-b). Operating in debris flows, the volumes deposited during June 2000 (10-30 year flood event) have been estimated at 12.000 m<sup>3</sup> aggraded on the Peyronnelle fan (Fig.2-c) (Einhorn, 2003).



**Figure 2-b:** Slope contribution to sediment supply in the Peynin catchment (Lissak et al., 2015)

**Left bank**  
 - Strike side : high torrential and debris flow activity  
 - Steep slope : mean 50%

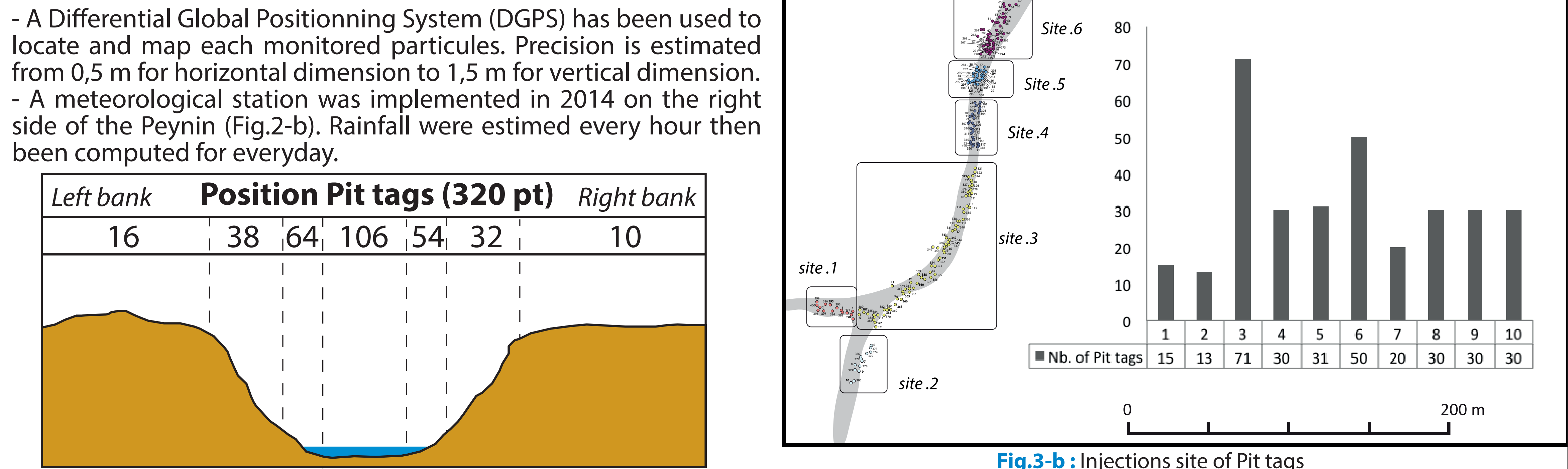
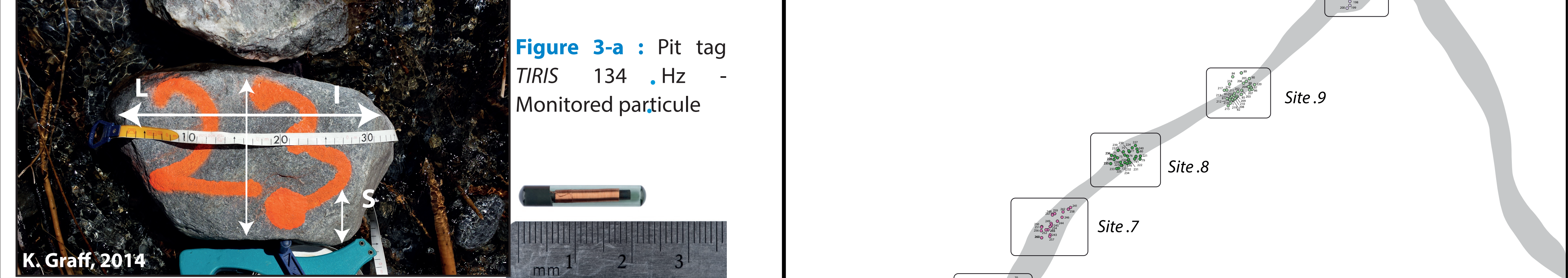
**Right bank**  
 - Dip side : operating in solifluction and creeping processes  
 - Slope : mean 30%

Spatial and temporal sediment dynamics are studied on four most important subcatchment, in the upper Guil catchment (Fig.2-a). This poster is especially focused on the Peyronnelle catchment (Fig.2-b) where an important debris-flow event has been observed during August 2015.

## 3 Materials and methods

### a) Pit tags setting in the Peyronnelle catchment

Grain-size representativity of the Peyronnelle has been tested in order to estimate the size of the bedload transported (Graff, 2015). Pit-tags (p.t.) method has been used to estimate spatial dynamics in the Peyronnelle catchment during a debris flow event (fig.3-a). In the Peyronnelle stream, 320 p.t. were installed in 10 injection sites along the thalweg (Fig.3-b). Each monitored particle was measured (3 axes- Long/Intermediate/Short) (Fig.3-a). Pit tags have been spreading around 30% in the thalweg, and 70% in left and right banks. Five injection forms were determined and recorded to trace source of receivers displacement.



### b) Estimation of debris flow volumes

Three equations have been used to estimate volumes mobilized during the debris flow of August 2015. The first equation used (1) is estimated from field mapping and observations on alluvial fan. Equations (2) and (3) are theoretical estimations of the mean and maximum volume mobilisable by the torrential catchment. From these equations we will estimate the volume mobilized in the Peynin during a debris flow.

(1)  $V_f = SH$   
 Where  $V_f$  is the volume dropped on the Peyronnelle fan (in m<sup>3</sup>),  $S$  is the area of debris flow (in m<sup>2</sup>),  $H$  is the height of debris flow (in m).

(2)  $V_m = 39 A_d^{0.61} S_f^{1.5} IG$   
 Where  $V_m$  is the average of debris flow mobilisable (in m<sup>3</sup>),  $A_d$  is surface of catchment (in m<sup>2</sup>),  $S_f$  is the slope of the fan (in %),  $IG$  is a geological index (in Remaitre, 2006).

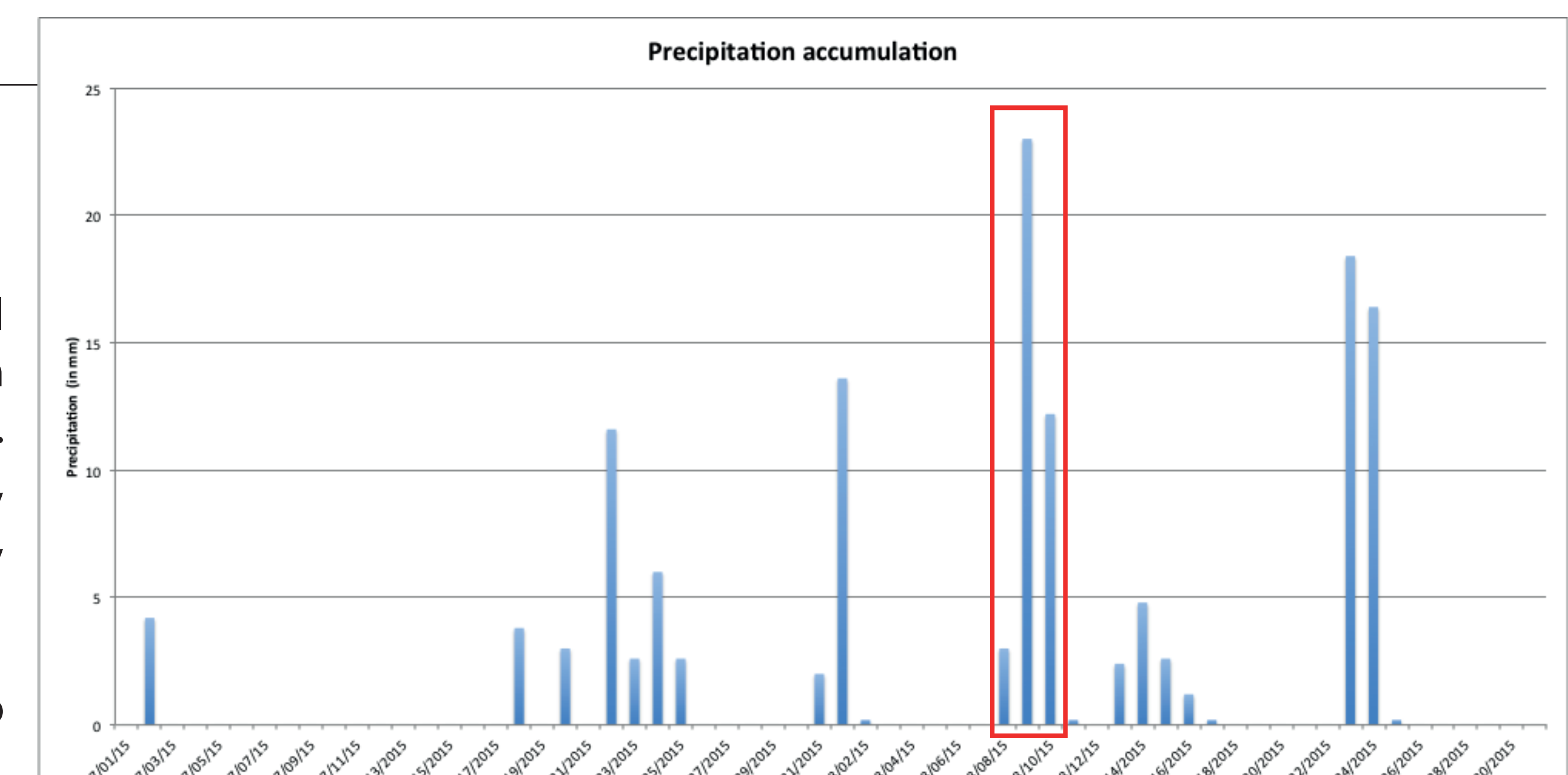
(3)  $V_{max} = \begin{cases} L_c(110 - 2.5 S_f) & \text{if } 15 < S_f < 40\% \\ L_c(6.4 S_f - 23) & \text{if } 7 < S_f < 15\% \end{cases}$   
 Where  $V_{max}$  is the maximum debris flow mobilisable (in m<sup>3</sup>),  $L_c$  is the length of the torrent (in m) (in Remaitre, 2006).

## 4 Results

### a) Meteorological context of the debris flow (August, 2015)

Overnight on August 8 and 9, 2015, an important rainfall event (23 mm) has been recorded at the weather station in the Peynin catchment, due to intense storm cells (Fig.4-a). Debris particules have been found in all sub-catchment, located on the left bank of the Peynin River (Four à Chaux, Trois Arbres, Peyronnelle, Roche Rousse - Fig.2-b).

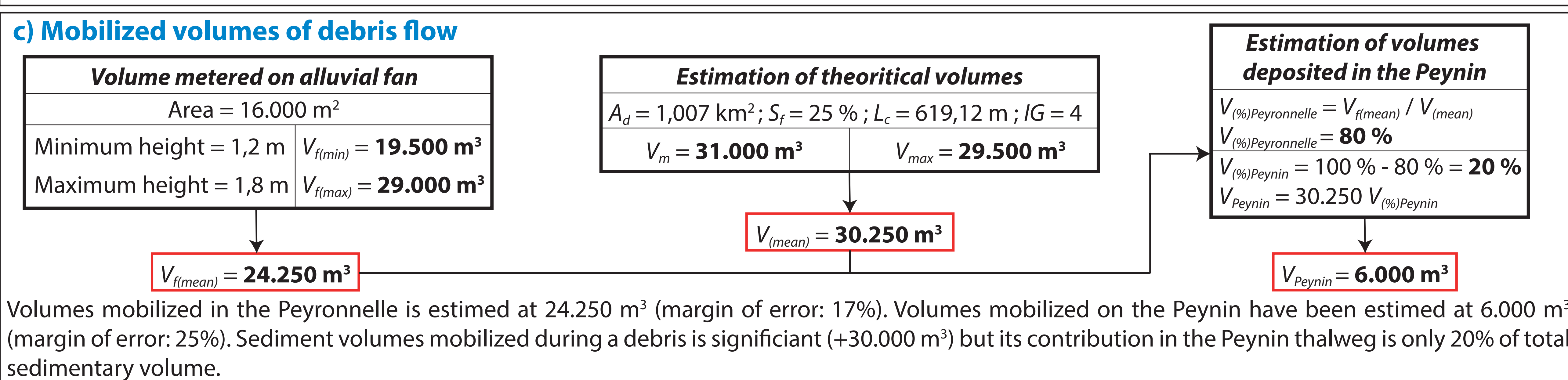
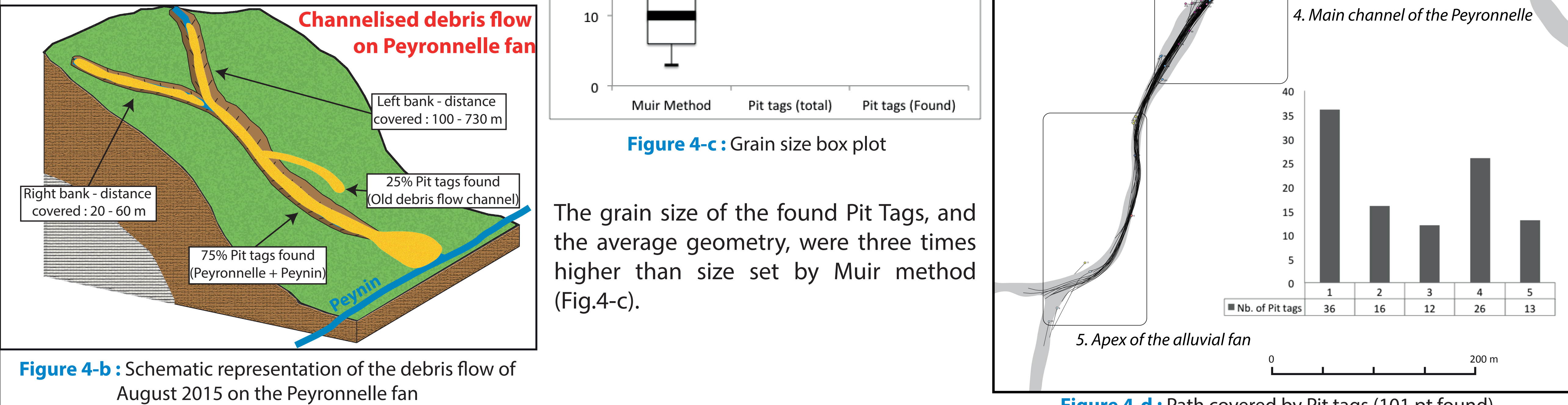
Rainfall recorded in the upper Guil was not sufficient to switch to flash-flood regime in the Guil and tributaries.



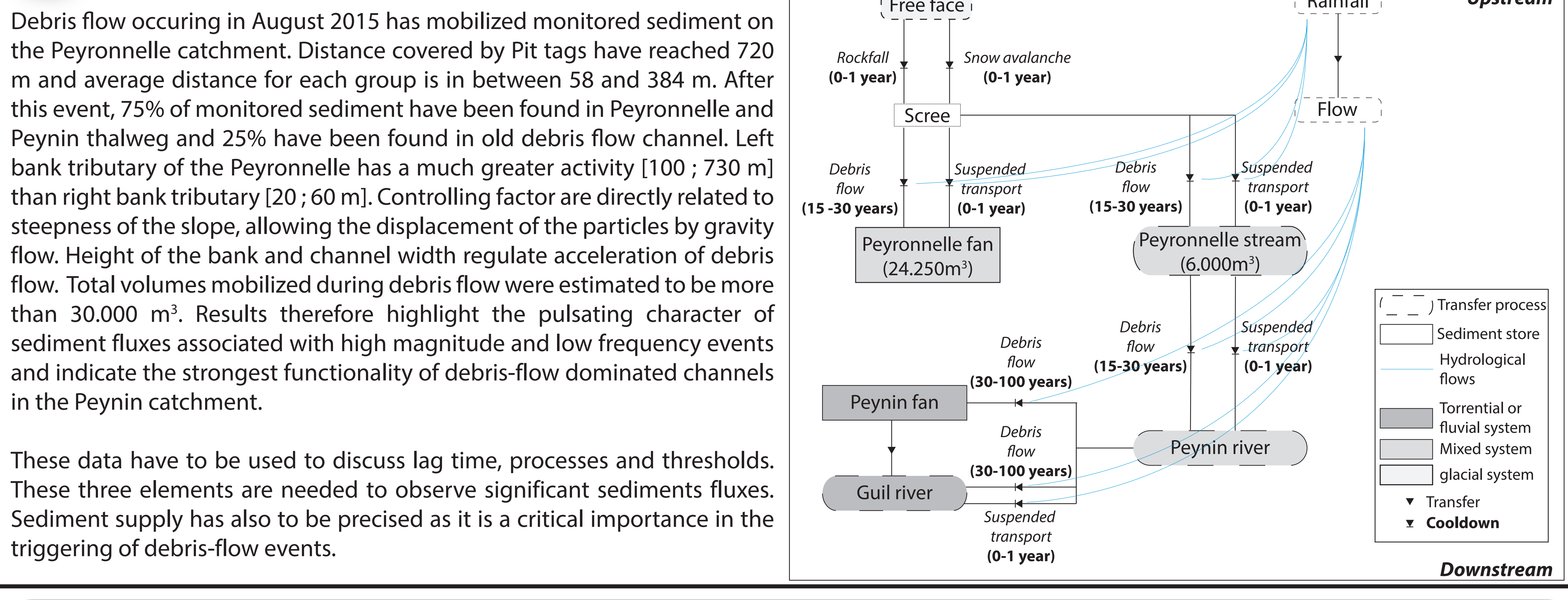
## 5 Conclusion

Debris flow occurring in August 2015 has mobilized monitored sediment on the Peyronnelle catchment. Distance covered by Pit tags have reached 720 m and average distance for each group is in between 58 and 384 m. After this event, 75% of monitored sediment have been found in Peyronnelle and Peynin thalweg and 25% have been found in old debris flow channel. Left bank tributary of the Peyronnelle has a much greater activity [100 ; 730 m] than right bank tributary [20 ; 60 m]. Controlling factor are directly related to steepness of the slope, allowing the displacement of the particles by gravity flow. Height of the bank and channel width regulate acceleration of debris flow. Total volumes mobilized during debris flow were estimated to be more than 30.000 m<sup>3</sup>. Results therefore highlight the pulsating character of sediment fluxes associated with high magnitude and low frequency events and indicate the strongest functionality of debris-flow dominated channels in the Peynin catchment.

These data have to be used to discuss lag time, processes and thresholds. These three elements are needed to observe significant sediments fluxes. Sediment supply has also to be precised as it is a critical importance in the triggering of debris-flow events.



Volumes mobilized in the Peyronnelle is estimated at 24.250 m<sup>3</sup> (margin of error: 17%). Volumes mobilized on the Peynin have been estimated at 6.000 m<sup>3</sup> (margin of error: 25%). Sediment volumes mobilized during a debris is significant (+30.000 m<sup>3</sup>) but its contribution in the Peynin thalweg is only 20% of total sedimentary volume.



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