Braiding-like pattern initiation in a steep slope sediment trap

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BRAIDING-LIKE PATTERN INITIATION IN A STEEP SLOPE SEDIMENT TRAP

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General context

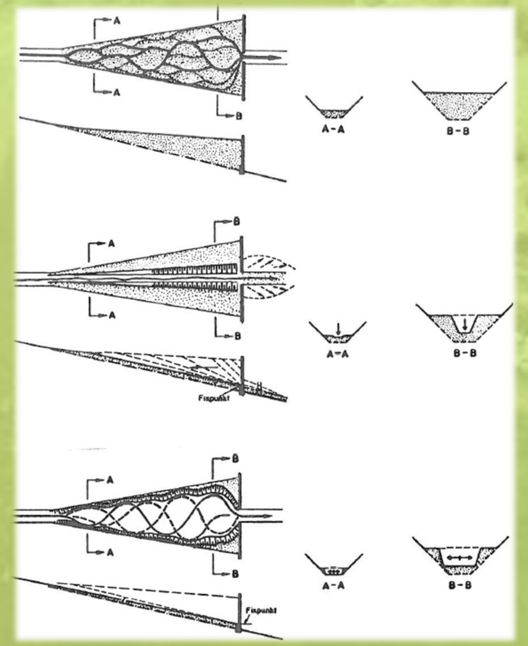
Torrential hazard mitigation consists mainly in controlling **large amounts of sediments released by streams** on urbanized fans and valleys (Armanini et al., 1991). Research on efficient bedload traps started in the 80' when Japanese and European researchers proposed **basic description of debris flow** (Watabe et al. 1980) and **bedload trapping facilities** (e.g. Van Effenter, 1982; Zollinger, 1983). Today little is known about the hydraulics associated with these structures in which sediments develop braiding-like morphology.

June 18th 2013 Bastan flood, Barège camp site (french Pyrénées)

Trap filling shows braided-like patterns

Few field observations of trap filling are reported in the literature. However available information suggest that sediment trap hydraulic look like the one associated with fast fan and delta development or transient braided watercourses (Zollinger, 1983).

In order to optimize existing facilities and to propose efficient design criteria, a **better understanding of massive deposit dynamic** and his braided patterns component.



Sediment trap filling and self cleaning steps, braided pattern? (Zollinger 1983)

July 10th 2013 Torrent des Moulins filled sediment trap, Epierre (french Alps)

Small scale design experiment (Koulinski et al. 2011)

Materiels and methods

Experimental set-up

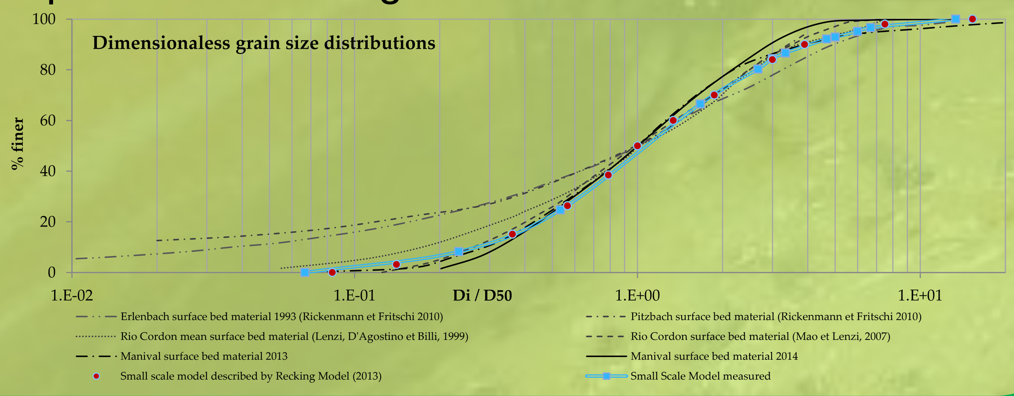
The sediment mixture consists in natural poorly sorted sands and gravels (D_{50} = 3mm).

The Grain size Distribution shape was chosen in accordance with some thoroughly studied steep slope streams (Manival, Rio Cordon, Erlenbach, Pitzbach).

A 8% steep, 1.1 m wide and nearly 3 m long flume was used in constant feeding condition. A slit open check dam was built at the flume outlet with a slit width of 6 cm ≈ $3D_{max}$.

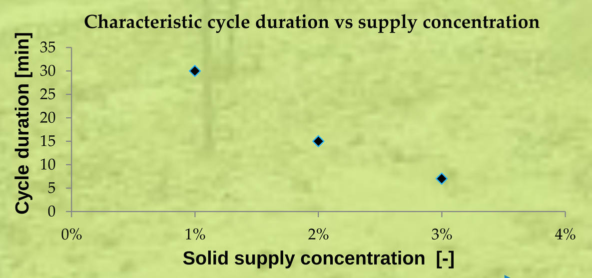
Water discharge was set to 3.0 l/s and three different concentrations were tested : [C]=1; 2 & 3 %.

Photogrammetry analysis of the deposit were performed with Agisoft™ software.

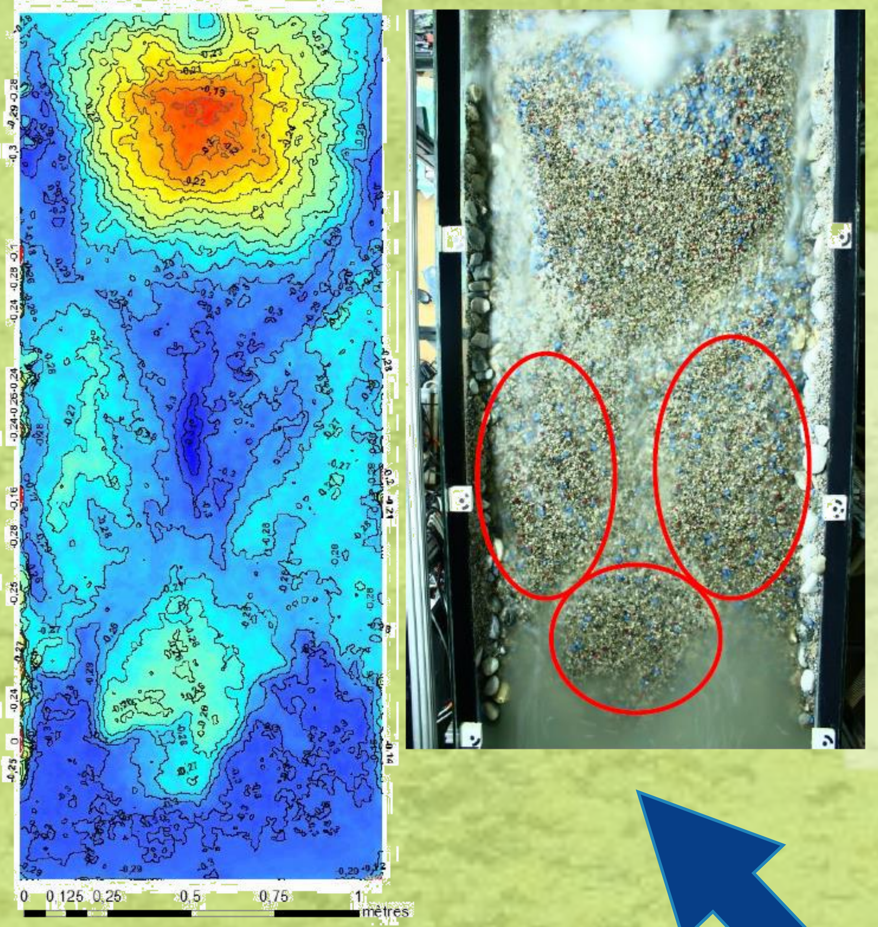


Instable braiding induced by strong sediment pulses

Morphological cycles were observed in all experiments. Characteristic time duration being correlated to the sediment supply concentration.

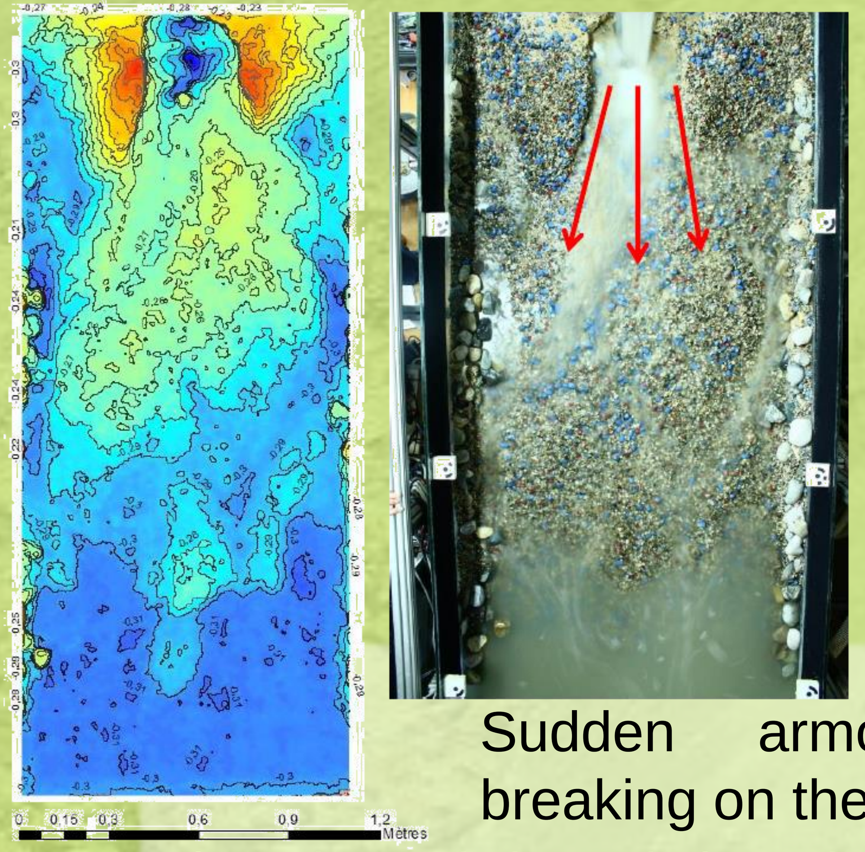


The slit backwater effect lately plays a role in the deposition process, at the beginning, the transition from a narrow to a wide and leveled basin seems much more influent.



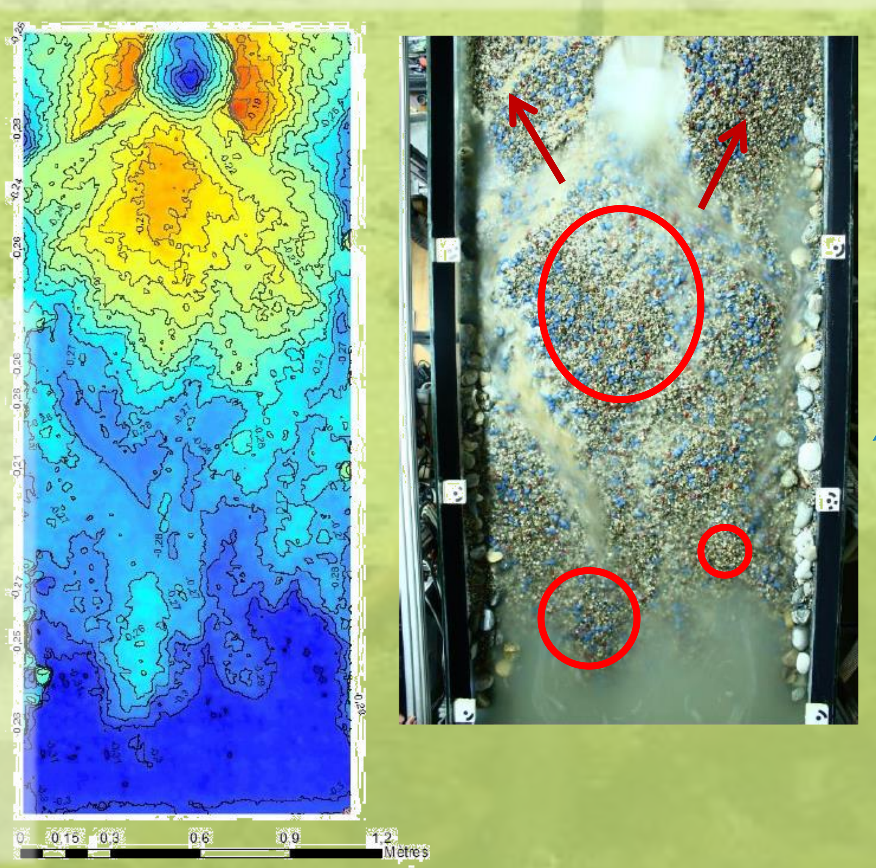
A massive fan-shaped deposit take place at the trap inlet obtructing the flow natural path. Two channels go round it and tend to create small bars and lobs prograding in the slit backwater influenced area.

Braided like pattern are observed, with confluences and bifurcations. They would probably fully develop in a larger trap.



Sudden armor breaking on the fan-shaped deposit free the fine sub-surface material through bedload sheets.

They allow a very effective sediment transport and a deep erosion forming a **single channel**. The formerly sediment at rest spread downstream toward the slit backwater area. The channelized flow become a sheet flow on the new wider and flatter deposit.



Prograding lobes and sheet flows showing weak sediment transport capacity lead to nearly total deposition. Self channelized flows settle on each deposit side. They gradually move toward sides as the majority of supplied sediments tend to be stored in the middle.

Grain size sorting , the trouble maker

Vertical grain size sorting on deposit: a) in small scale experiment and b & c) in the field

Strong grain size sorting effects were observed. It lead to **armored deposits** thank to kinetic sieving and natural percolation (Frey and Church 2011) allowing steep slope morphology. Similar steep slope sorted deposits were observed in the Manival torrent (see pictures).

However, once unstable slope is reached, armor breaking is triggered and **bedload sheets** are released. The more efficient solid transport taking place in such conditions allow large morphological perturbations (Bacchi et al., 2014).

Conclusions

Despite **occasional multi-channel morphologies,** massive deposits taking place in sediment traps probably show different processes than braided rivers. Cycles of sheet flow and almost total deposit are followed by dramatic erosion events spreading sediments downstream. **No stable active channel was observed.**

Grain size sorting play a key role in the dynamic. Aggradation armoring and bedload sheets being the main processes leading to the cycles.

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