Innovative driftwood retention device on the Aire river in Geneva, Switzerland

Zsolt Vecsernyes, PhD[1]; Nicolas Andreini, PhD[2]; Jean-Louis Boillat, PhD[3]

INTRODUCTION

The main goals of the Aire River revitalization program in Geneva are: hazard and risk mitigation. Inundation risk, bed sedimentation and driftwood transit had to be mitigated, in order to protect Geneva up to T=300 years floods. Inundation risk is mitigated for the Q300y=120 m³/s design discharge by an orifice-weir structure yielding a 400'000 m³ flood retention (Figure 1). A free transit flow is achieved for all hydrological conditions by an innovative two-stage driftwood retention device preserving the orifice of driftwood clogging.

THE DRIFTWOOD RETENTION DEVICE

An innovative driftwood retention concept was developed on a hydraulic physical model (length scale 1:40; Froude similarity) at the Laboratory for Applied Hydraulics (LHA) of hepia-CH (Vecsernyés et al., 2014) and realized on the Aire River in Geneva. The scaling choice yielding a 20m long and 10m large model allowed an accurate analysis of the hydrodynamic conditions. Shape and size of driftwood were determined with respect of statistics provided by Lange et al. (2006). The total driftwood volume was determined as a function of the catchment area (see Rickenmann (1997) and Uchiogi et al. (1996)).

As shown in Figure 2, the driftwood retention is achieved in two stages: a) up to ten-year return period floods (Q10y=60 m³/s), driftwood is stopped behind a rack installed at the downstream end of a gravel pit; b) for higher floods (T >10 years), inducing higher water depths, the driftwood is transferred to a screen, implemented with a bottom opening on the upstream face of the flow control work.

In comparison with traditional single driftwood retention devices, the main advantages of the two-stage one are: i) low rack is efficient during usual floods; ii) screen remains clean most of the time; iii) flow transit is guaranteed below the screen for all hydrological conditions, even for high floods when driftwood forms a floating carpet.

The case study achieved on physical model yielded the implementation of the two-stage driftwood retention structural measure on the Aire River in Geneva. As shown in Figure 3, the risk mitigation structure was realized according to the modelled one. The rack (first stage) was built of 0.25 m diameter and 2.0 m high larch stakes in the Aire River, with a 1.0 m horizontal spacing. The screen (second stage) was modelled with 0.5 m horizontal spaced sloping bars of 0.1 m diameter, preserving a 1.0 m bottom opening. In the Aire River the screen will be implemented in October 2015, according to the design illustrated in Figure 3b. Dynamic computations pointed out high impact forces due to wood impact during floods which may deform the bars and beams and induce high embedding constraints in the concrete frame structure. A flexible structure has been proposed, using metallic cables. Since May 2014 the constructed risk mitigation structure has undergone only effects of low floods of the Aire River, remaining under the T<1 year occurrence. No severe driftwood transport has been observed yet. Middle sized branches and floated waste have been stopped by the rack. During those flood events a free transit flow was observed throughout the Aire River.

CONCLUSION

The innovative driftwood risk mitigation measure realized on the Aire River in Geneva could be developed and optimized thanks to physical modelling in Laboratory. Its behaviour under various flood and driftwood supply conditions could then be documented. The observations gained during the first flood events underline the good operation of the constructed two-stage retention device. Its efficiency should be pointed out during future flood events occurring with heavy driftwood charges.

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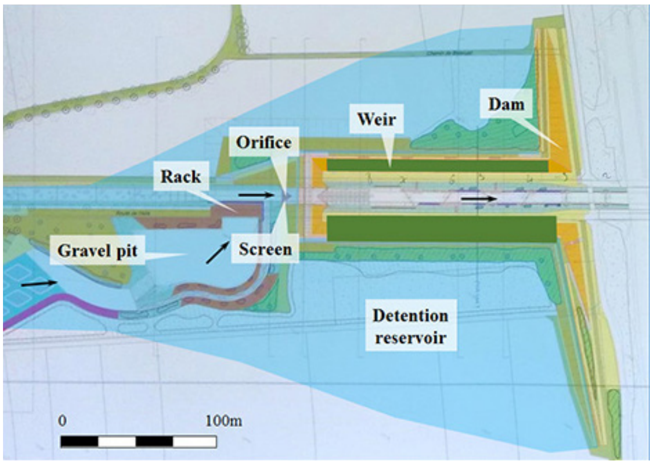

Figure 1. Partial overview of the Aire River revitalization project (third stage), with the flow retention work. Driftwood retention is achieved by a two-stage device composed of a rack and a screen upstream from the orifice.

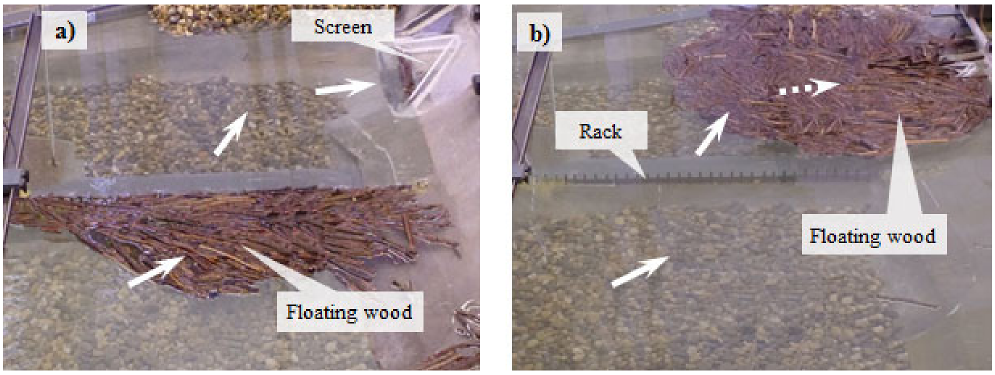

Figure 2. Results from the physical model of the two-stage driftwood retention device. a) floating woods stopped behind the rack for T < 10 years; b) floating woods transferred to the screen for T > 10 years, forming a floating carpet.

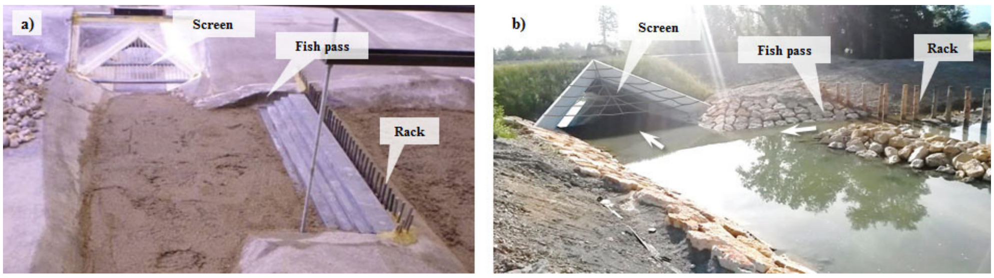

Figure 3. Upstream view of the two-stage driftwood retention device. a) On the physical model. b) In the Aire River, where the rack is constituted of larch stakes and the screen by a metallic cable structure (photomontage).

KEYWORDS

driftwood retention; Flood control;debris; two-stage device; floating woods

1 HEPIA, Geneva, Geneva SWITZERLAND, zsolt.vecsernyes@hesge.ch
2 hepia University of Applied Sciences Geneva Western Switzerlan, SWITZERLAND
3 EPFL Swiss Federal Institute of Technology Lausanne, SWITZERLAND