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Fine sediment dynamics in a enginerred mountain river characterized by a alternate gravel bar system.
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The embankment of alpine rivers and the construction of hydraulic structures strongly affect the morphology of the riverbeds. The morphology of such rivers often shifted from initially braided rivers to a system characterized by alternate gravel bars. A large amount of fine sediments transported in alpine rivers interacts with such macroforms and is thus associated with environmental, hydraulic structure safety and flood risk issues. It is therefore important to better understand the dynamics of fine sediments in embanked alpine rivers in order to achieve a more efficient and sustainable sediment management for these rivers.

In this context, this PhD work deals with the dynamics of fine sediments (clay, silt and sand) and the role of the riverbed on these dynamics in alpine rivers. The first part of this work aims at understanding such dynamics on a single gravel bar during hydro-meteorological events. Using a new image analysis method calibrated and validated during this PhD work, a high frequency two-year database of fine deposits on the surface of the studied bar is constructed. It highlights the drivers which trigger the erosion and deposition processes of fine sediments on a bar after a hydrological event, i.e. some equilibrium between suspended sediment concentrations and bed shear stresses. Moreover, this study also shows that valley breezes can winnow fine sediment deposits on the surface of the studied bar and disperse them towards the river channel. This finding illustrates the importance of aeolian transport on the dynamics of fine sediments in alpine rivers.

The second part of this PhD work extends the study area from one bar to a river reach with several bars. It aims to understand the role of bars on the dynamics of fine sediments in relation to the river bed mobility. In this study, thanks to a new field protocol developed during this PhD work, surface and sub-surface stocks of fine sediments including sand fractions are quantified along the river system. This study shows that a large amount of sand is stored in alpine rivers. It also confirms the importance of the riverbed on the fine sediment transport when erosion occurs during a flood due to channel avulsion and scouring.

The last part of this PhD work consists of a numerical study on the global fine sediment dynamics in an alpine river in mid and long term. A special effort is made to investigate the dynamics of different classes of fine sediments and the potential exchanges with the riverbed. Results of the dam flushing model show that there are significant fine sediments exchanges with the bed during dam flushes, especially for sands. These dynamics are very sensitive to both the initial stocks in the riverbed and the bed roughness. A ten-year simulation is also carried out to understand long-term fine sediment dynamics. The results show that the dynamics of the very fine sediments are mainly linked to the upstream sediment inputs, with an equilibrium in river bed stocks reached after a few years. One the other hand, gravel bars play an important role for sand transport and stocks varies significantly with sand supplies during floods. At this multi-annual scale, we showed the effect of vegetation on the transport of fine sediments as well. However, this issue would need a more specific study.