Investigating the infrastructure-induced legacy sediments on 3 bypassed areas along the Rhône River (France)

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Introduction: Legacy sediments are sediments for which the location, volume and/or presence of contaminants result from past and contemporary human activities [1]. They can derive from a large range of alterations such as changes in land use, mining, large dam implementation, etc. This work focuses on the effects that in-stream engineering works (groynes, dykes, etc.) might have had on the river margins sedimentation. Through a combination of geophysical methods, sediment cores and geochemical characterization [2], it aims to prove the existence of infrastructure-induced legacy sediments on a large scale along the Rhône River.

Methods: The 3 study areas share a common configuration: the Rhône is equipped with an artificial canal bypassing the former main channel that is characterized by navigation infrastructures built in the 1860s. These infrastructures induced numerous lateral backwaters and a minimum flow due to the upstream diversion. 27 km of Ground Penetrating Radar and 16 cores (taken in the Rhône floodplain established since the 19th c. and earlier) were used to investigate sub-surface structure and sediment characteristics in the 3 areas. The stratigraphy and grain-size distribution of the core sediments were determined, X-Ray Fluorescence core scanner analysis were realized at a high resolution and environmental chemistry (PCBs, trace metals) and radionuclides (^{137}Cs and ^{14}C) analyses were conducted more punctually. Compositional statistics were used to study the grain-size (e.g. End-Member Modelling Analysis) and the geochemical composition (e.g. PCA, MANOVA).

Results: A sudden change in the grain-size distribution patterns is observed in most sediment cores (orange line in figure 1.b). A similar change can also be observed in the EMMA analysis, and it coincides with an increase in contamination in the XRF and trace metals results. This limit also corresponds to a major reflector on the GPR profiles. ^{137}Cs and PCBs trends indicate that the upper 30-40 cm of the cores correspond to the 1940s-1970s. Radiocarbon dating results confirmed that the cores are mostly recent (15th century and later).

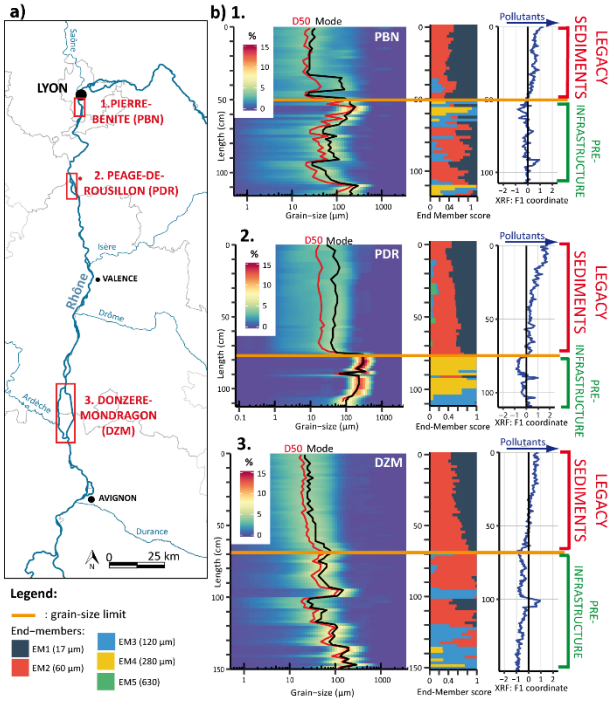

Fig. 1: *a) Study areas location; b) Characterization of a sediment core from each of the study area. From left to right: grain-size distribution, EMMA, PCA result from XRF data.*

Discussion: A grain-size break is consistently observed in the cores from the 3 study areas. We interpret it as an effect of the implementation of the navigation infrastructures in the late 19th c.: the homogeneous sediments above the limit are therefore legacy sediments induced by the infrastructures. Being finer than the pre-infrastructure sediments, the legacy sediments indirectly caused a relative increase in the areas contamination. This phenomenon might be present all along the Rhône, as well as in most engineered rivers.

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References: [1] Wohl, E. (2015) *Earth-Science Reviews* **147**:30–53; [2] Bábek et al. (2008) *Journal of Soils and Sediments* **8**:165–176.