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Sedimentary infill dynamic and associated trace element temporal trends in a dam reservoir: evidence of high polluted sediment storage after major flood events (Upper Loire river, France)

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The Villerest Dam, was built in the Upper Loire river during the early 1980's, 80 km downstream of the most important industrial and coal mining area of the basin. It constitutes an important trap of sediments and associated pollutants since its operation in 1984. A 154 cm long core was sampled in 2010, in a former channel levee in the reservoir. This study highlights (i) important sediment accumulation rate during flood events in the reservoir, (ii) the influence of high discharge events in sedimentary infill in terms of stored sediment quality, geochemical markers and anthropogenic sources influence.

Coupling sedimentological analyses and 137Cs datation allows to define 3 sedimentary units in this core. The deepest unit corresponds to transported and/or reworked fluvial sediments undated, the uppermost unit to lacustrine sediments post 1984 and between, to a transition unit resulting from the reservoir water infilling in 1983-1984. In addition, the upper unit shows 3 turbiditic-like layers (of 6, 20 and 13 cm thick) corresponding respectively to 1996, 2003 and 2008 major flood events (more than 20-year flood average daily outflow). These flood sequences result from underflow sedimentary inputs and contribute to 43% of the 151 kg/m^2 of accumulated sediments since 1984.

Over the 1984-2010 period, sediments show a general contamination decrease but major flood events transport highly impacted sediments (highest enrichment factor > 20 for Hg and >10 for Cd and Bi), never reached during interflood periods. During these events, trace elements (TE) are mostly associated to organic fraction and clays. Rich-TE solid sources appear to be only solicited, and/or severely amplified, during important flood events over the recording period.

In addition to these pollutants inputs, floods also bring an important detrital fraction, diluting anthropogenic TE signal. In details, flood deposits show variations of sedimentological and geochemical signals delimiting two distinct phases in relation with flood hydrogram. The first one corresponds to the increasing discharge phase, when grain size and silico-clastic material increase up to a maximum. The second one, attributed to the decreasing discharge phase, is characterized by a grain size fining trend, associated with a depletion of silico-clastic inputs. It is followed by Fe-rich clays decantation.