

# Human-induced sedimentation patterns of a channelized lowland river

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**Introduction:** Forest clearance, arable land cultivation and discharge of untreated sewage effluents result in increased sediment supply to river channels. The sediments are further transported downstream and mixed with sediments eroded from river bed and banks, particularly intensively during and following to river training works. This effects in floodplain sedimentation accelerated even by two orders of magnitude which, may be identified and reconstructed from overbank sediment profiles.

The Odra and Vistula being, except the uppermost reaches large lowland rivers of Poland, experienced since the end of XVIII century intensive human-induced changes in channel length and width as well as the progressive catchment industrialization and urbanization. The processes altogether, produced sediment accumulation patterns, which differ markedly from the natural ones in respect to contamination with heavy metals, stratigraphy and the sedimentation rate.

**Methods:** Vertical sediment profiles have been sampled in the upper Vistula river valley from the bank outcrops and in the upper and middle Odra river both from bank and more distant floodplain locations outcropped with a spade, which enabled recognition of the sediment stratigraphy. Sediments have been sampled from particular layers, which varied from 2 cm to over 0,5 m of thick. In each sediment layer losses on ignition, grain size distribution and zinc, lead, cadmium and copper concentrations have been determined. In selected profiles cesium 137 activity was analyzed. The age of sediments was estimated basing on <sup>137</sup>Cs, artifacts, historical maps and heavy metal distribution. Profiles analyzed were 50 cm to over 6 m of long.

**Results:** Sediment profiles in the upper reaches of both rivers are 3 to 6 m long over the water table. Typically, sediments consists of bright, medium grained sands, which alternate with dark silt or silty-sand layers characterized by high organic matter content, which in some cases reaches 70%. In sandy layers organic matter content does not exceed usually 5-10%. The sediment sequences overly fine gravels which, occur about 2 m over the present water table. Finer sediments contain usually more heavy metals than sands however, metal concentrations decrease in

top layers of profiles closer to the present river channel and only in topmost layers in profiles from more distant locations. Overbank sediments in Legnica Copper Mining District in the middle Odra reach, are dominated by contaminated with Cu, Zn and Pb fine-grained silty deposits containing relatively high organic matter content, which overlay medium-grained sands, uncontaminated with heavy metals. There are some peaks of the lead and copper in the upper fine grained sediments, which fits to the maximum emission of metals in early 70s of 20<sup>th</sup> century. Decrease of zinc is correlated to progressive declining of water consumption and sewage production in the upper and middle Odra catchment.

**Discussion:** Stratified, long sediments sequences representing 19<sup>th</sup> and 20<sup>th</sup> century are characteristic for reaches of both rivers where marked channel shortening and narrowing by even 3 times, increased valley slope and stream power producing rapid channel erosion and accumulation. In the upper reaches periods of rapid erosion were parallel to the highest stream contamination by untreated effluents from highly urbanized two large coal mining districts in Upper Silesia and Ostrava (Czech Republic). The large river pollution plume is responsible for accumulation of polluted organic layers during recession of flood waves. The sediment dating suggests that average rate of sediment deposition took place in 20<sup>th</sup> century and reach 5-10 cm/year in the levee zone. Moreover, due to lateral channel stabilization the pattern of sediment accretion changed from lateral, which was observed in natural river valleys, to overbank accumulation mode.

In contrary to the upper reach, in the middle river course channelization of 19<sup>th</sup> century resulted in accumulation of massive sandbars, which in 20<sup>th</sup> century had been covered with rather uniform contaminated, organic rich deposits. Position of metal peaks suggest recent average accretion rate of the order of few mm/year even in the levee zone. The only exception is a river reach impacted by rapid industrialization during communistic times. There, black, organic and heavy contaminated with heavy metals layers have the thickness of over 2 m.