

Chemical quality of river sediments in France

Summary of available databases

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Introduction: This study realized for the ONEMA (French national office for water and aquatic environments) presents the conventional chemical analysis data (8 heavy metals, PAHs, PCBs, TOC, particle size) available from river and waterway sediments and their possible correlations, their geographical differences and their regulatory compliance.

Methods: A database of chemical analysis of river sediments has been compiled from data of Voies Navigables de France (French waterways), Water Agency Adour Garonne, Artois Picardie, Loire Bretagne, Rhin Meuse, Rhone Méditerranée Corse and data from Service Public of Wallonia (Belgium). It has 314,856 lines and 12,850 samples covering a period of 28 years.

All parameters show skewed distributions (either normal or lognormal) dominated by few particularly contaminated samples (up to 15% for lead ...) and are best approximated by the median and other quantiles. The dispersion is maximum for cadmium, mercury and PAHs. The sites are mostly sampled only once. Only 4,753 samples are analysed both for the 8 heavy metals, PAHs, and PCBs (regulatory compliance). These data do not come from a monitoring network, but probably from one-shot measurement campaigns based on punctual objectives. This may induce a bias with an over-representation of contaminated areas in the sample.

Results: The median levels of contaminants are as follows: As 7.27 mg/kg, Cd 0.65 mg/kg, Cr 36.0 mg/kg, Cu 21.7 mg/kg, Hg 0.13 mg/kg, Ni 19.0 mg/kg, Pb 32.6 mg/kg, Zn 130 mg/kg, sum of 16 PAH 1.47 mg/kg and sum of 7 PCBs 0.057 mg/kg. The median granulometric fractions are 11.9% clay, 52.3% silt, and 29.5% sand, with 3.4% organic carbon.

Correlations between parameters (correlations in pairs and principal component analysis) are determined by a few extreme values distributions, and seem somewhat unoperational. Cadmium, nickel, lead and zinc are correlated ($p=0.99$), without clear relationship with neither the granulometry nor the TOC. Organic contaminants are loosely related to

TOC ($p=0.99$), but not to the granulometry. A possible explanation is that contamination inputs are mainly of human origin and occurs probably at spot point and there from are not related to the retention capacity of sediment (clay, organic matter). So, of course, the fact that a sediment is clay-rich or carbon-rich does not mean that it is contaminated. The PAH are the most widely disseminated organic contaminants.

The rate of bulk concentrations exceeding the regulatory threshold S1 (French quality thresholds¹) per parameter is 11.7%, mainly due to cadmium, zinc and lead, while the exceeding rate is smaller for arsenic, chromium, copper, mercury, nickel and organic contaminants. The exceeding is rare and mostly due to one parameter for Water Agencies and VNF, but it concerns the majority of samples, and for more than one parameter, for VNF Nord-Pas-de-Calais and the Public Service of Wallonia, a legacy no doubt of past industrial activity. Overall, the rate of French samples exceeds the threshold S1 with at least one parameter is 36 %.

Leaching test of metals (567 samples) and ecotoxicological test (*Brachionus* sp.) (322 samples) are available from the Seine watershed. They don't show operational correlations with total metals and TOC. The leached metals exceed the value for acceptance in landfills for inert waste¹ for between < 1 and 5% of the samples tested, depending on the parameter. All together, 12.0 % of the samples exceed at least for one metal the allowed leachable concentration for inert waste. According to the assessment criteria² set up by the French Ministry in charge of Environment, the results of the ecotoxicological tests collected show a rate of hazardous sediments of 3.6%.

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References: [1] European Commission (2003), *Décision n° 2003/33/CE of 19/12/02 (criteria for landfilling of waste)* [2] MEEDDM (2006) *Arrêté du 09/08/2006*