

RESUSPENSION OF METAL CONTAMINATED SEDIMENTS AND CAGED GAMMARID RESPONSES IN NAVIGATED CHANNELIZED RIVERS

E. Prygiel^{1,2}, David Dumoulin², G. Billon², A. François³, A. Chaumot³, O. Geffard^{3*}, J. Criquet², J. Prygiel^{2,4}

¹ CEREMA, Direction Territoriale Nord-Picardie, 151 rue de Paris, 02100 Saint-Quentin, France

² University Lille 1, LASIR – UMR CNRS 8516, Cité Scientifique, 59655 Villeneuve d'Ascq, France

³ IRSTEA, UR MAEP Ecotoxicology, 5 rue de la Doua, 69626 Villeurbanne Cedex, France

⁴ Agence de l'Eau Artois-Picardie, 200 rue Marceline, 59500 Douai, France

david.dumoulin@univ-lille1.fr

Introduction

Former metallurgical activities in the Artois-Picardie River Basin (Northern France) caused an important trace metal enrichment of rivers sediments. Some watercourses, such as the Deûle River at the ex Metaleurop location, still present high levels of Cd, Pb and Zn in the sediments. Furthermore, the important fluvial traffic that occurs on navigated rivers calls into question the impact of sediment resuspensions on water quality and biota.

Methods

To determine the impacts of sediments resuspensions, 3 rivers (Deûle, Sensée and Scarpe Rivers) were selected according to their level of sediment contamination and to the boat traffic. Sediment cores were sampled on each river, in May 2011 and in April 2012. Trace metal concentrations were determined in sediments, as well as in the porewaters and in surface waters. Acid volatile sulfides (AVS) were also assessed to calculate Toxicity Index (TI) (USEPA, 2004). Caged gammarids originated from a controlled population (Irstea Laboratory, Lyon, France) were deployed on each river during 2 weeks in May and October 2011 and in April 2012. Metal bioaccumulation were determined on caged gammarids for the 3 campaigns. Additionally, in April 2012, a comparison with an other gammarid population, sampled in Northern France (Rhônelle River), was carried out to compare biological responses.

Results

The boat traffic was investigated at locks: the 2 navigated rivers, the Deûle and the Sensée Rivers, presented the same traffic conditions, with a mean of 30 boats per day in 2011-2012 (Prygiel et al, 2015). High levels of trace metals were measured in the sediments of the Deûle and the Scarpe rivers, especially for Cd, Pb and Zn (37 and 72 mg kg⁻¹ for Cd; 1500 and 400 mg kg⁻¹ for Pb; 2900 and 2200 mg kg⁻¹ for Zn, for the Deûle and the Scarpe Rivers respectively). By contrast, the Sensée sediments were poorly contaminated (Prygiel et al, 2015). The TI calculated from the AVS concentrations always exhibited values below 1, thus allowing to conclude that the risk of trace metal remobilization in the water column was low whatever the studied river. Despite the high concentrations differences in the sediments, dissolved metals levels in the water column were in the same order of magnitude and relatively low for the 3 channels compared to the sediments levels. Mean values (2011-2012) were compared to the Equivalent Quality Standards (EQS) of the Water Framework Directive: Cd and Pb concentrations contributed to downgrade the Deûle and Scarpe Rivers; Zn and Cu concentrations both downgraded the 3 rivers (Prygiel et al, 2015).

Concerning gammarids exposure (Prygiel et al, in preparation), survival rates were satisfying for the 3 monitoring campaigns (> 80 %) excepted in the Scarpe River in May 2011, where all the gammarids died after 3-days exposure, probably due to low oxygen concentrations. Trace metals concentrations were measured in the organisms: Co, Cr, Cu and Zn never exceeded the contamination thresholds defined in Besse et al (2013). Cd was poorly bioaccumulated in 2011, whereas high bioaccumulation levels were measured in the Deûle and in the Scarpe rivers in 2012. Pb was systematically highly accumulated in the gammarids exposed in the 3 rivers, both in 2011 and 2012. The high hardness of water (> 200 mg L⁻¹) probably contributed to reduce the availability of trace metals, especially for Cd that was responsible of water down-graduation. These results confirm that trace metals are efficiently trapped with sediments particles, and that regular resuspensions by boating do not significantly enrich the water column in trace metals. Otherwise, the responses obtained from the 2 gammarids populations were similar for all studied markers and proved that the “gammarid tool” is reliable to an application in the framework of water survey.

Conclusion

This study did not permit to observe any toxic effect of navigation resuspensions on caged gammarids. The biological responses were more influenced by seasonal effect than by boating activities. It also demonstrated the difficulties to assess the metal bioavailability, dependent on several parameters such as water hardness, organic matter complexing capacity... and suggested that the exceeding of EQS do not always induce a water toxic effect. Finally, the caged gammarids were proved to be an interesting tool to complete the chemical status of water systems.

References

- Besse J.P., Coquery M., Lopes C., Chaumot A., Budzinski H., Labadie P., Geffard O., 2013. Caged *Gammarus fossarum* (Crustacea) as a robust tool for the characterization of bioavailable contamination levels in contaminated waters: towards the determination of threshold values. *Water Research* 47:650-660.
- Prygiel E., Superville P.J., Dumoulin D., Lizon F., Prygiel J., Billon G., 2015. On biogeochemistry and water quality of river canals in Northern France subject to daily sediment resuspension due to intense boating activities. *Environmental Pollution* 197:295-308.
- Prygiel E., Billon G., François A., Dumoulin D., Chaumot A., Geffard O., Criquet J., Prygiel J., in preparation. Impact of metal polluted sediment resuspension on gammarids during fluvial traffic.
- USEPA, 2004. The incidence and severity of sediment contamination in surface waters of the United States, national sediment quality surveys: second edition, US Environmental Protection Agency, Washington pp 280.