High frequency biogeochemical monitoring in a polluted water system, the Deûle canal (Northern France)

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Introduction

Industrial activities have introduced a certain level of metal pollution in river systems. The Deûle river, which passes through a former smelting plant (Metaleurop) near Douai city in northern France, has been impacted from 1894 to 2003 by lead and zinc discharges. Since 2003, Sita France (Suez Environnement) via AGORA project is decontaminating the area to install eco-industries devoted to waste recovery.
This study was done to have a better understanding of both trace metal behavior and evolution of algae specific pigments in a polluted water system by developing a high frequency monitoring experiment.

Monitoring strategy

A monitoring station and a clean lab were directly deployed in the field from 20th April to 17th May 2009. Physico-chemical and biological parameters were registered every 10mn while trace metal concentrations were measured several times a day depending on the method used.

A monitoring station belonging to the Water Agency "Artois-Picardie" permitted on line measurements of physico-chemical parameters: T, pH, dissolved O_2, turbidity, conductivity, total organic carbon, PO_4^{3-}, NO_3^-, NO_2^-, NH_4^+, luminosity, algae pigments.

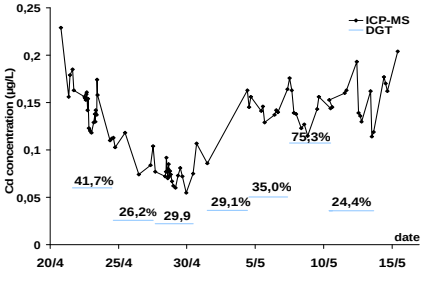
A clean lab built in a container was used to measure trace metal concentrations (Zn, Pb and Cu) with voltammetric technique onto an hanging mercury drop electrode (HMDE).

ICP-MS measurements of trace metals (Mn, Fe, Ni, Co, Pb, Cr, Cd and Cu) were also done on filtrated water samples and on DGT (Diffusive Gradient in Thin film) pistons.

Trace metal lability

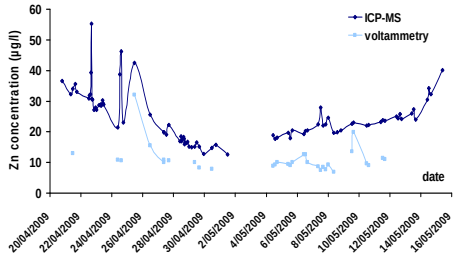
$$f_L = [Me]_{DGT\ or\ volt.} / [Me]_{ICP\text{-}MS}$$

1. With DGT piston



Labile Cd measured by DGT represents in average 37% of the total dissolved fraction (ICP-MS) and may have a real impact on the organisms because of its high toxicity.

2. With voltammetric technique



Electrolabile fraction of Zn measured by voltammetry varies with time and corresponds to an average value of 50%. The electrolabile concentrations range from 10µg/l to 30µg/l and show that organisms may be exposed significantly to Zn, and probably also to other trace metals.

Acknowledgements

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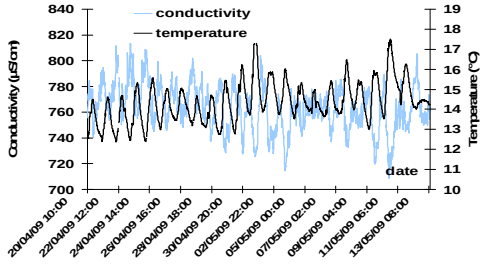
Study area

Variations of chemical and biological parameters

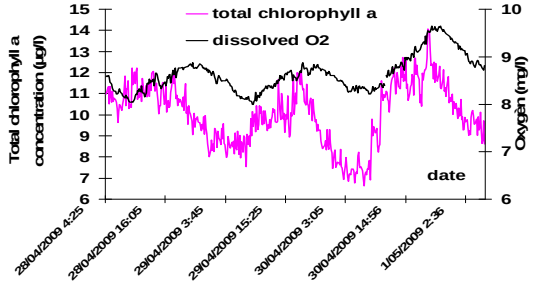
Chemical and biological parameters were monitored during one month every 10 min.

1. Long time scale



➢ Temperature values increase unsurprisingly during daytime with an average amplitude of 1,6 °C.
➢ Conductivity decreases during the afternoon due to CO_2 consumption by organisms which encourages pH increase.

2. Short time scale



➢ Total chlorophyll a concentrations have a maximum around 13h and 16h. The concentration starts increasing just before dissolved oxygen production.
➢ Maximal dissolved oxygen concentration is registered around 20h. During the night, the absence of photosynthesis causes a decrease of $[O_2]_{diss}$.
➢ Photosynthetic production from early morning results in an increase of dissolved oxygen around 8-9 h.

Conclusion / perspectives

➢ Labile metal concentrations are variable and indicate that organisms are exposed irregularly to toxicants.
➢ Significant fractions of trace metals are labile in the Deûle river and the following ranking has been established: Cu > Co > Ni = Cd >Fe > Cr .
➢ Primary production occurs in such polluted river and leads to pH variations that may change the lability of trace metal within 24 hours.
➢ On line trace metal monitoring at high frequency is still in development in our laboratories to better understand trace metal dynamic in aquatic environments in relation to biological processes.

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