"Large scale" application of passive samplers and evaluation of DGT technique as a monitoring tool for the assessment of the chemical status of water bodies

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ABSTRACT

The aim of this study was to provide a reliable, fast and low cost assessment of contamination of water bodies by application of passive sampling techniques. These techniques can be used for continental waters (ground and surface), marine and estuarine waters. The implementation of the Water Framework Directive (WFD) and the many control programs related to the directive results in a significant increase in time and money spent on operations of sampling and analysis of these different water masses. In the first part of this study, the operational assets of these techniques are showed in a large scale monitoring and in a wide variety of field conditions. More than 200 different water masses: coastal waters, harbors, marinas, lagoons, estuaries and rivers were assessed along the French coast and overseas colonies. In the second part of this study, the functionality of passive samplers was tested for the chemical evaluation of highly dynamic systems. Diffusive Gradient in Thin Films (DGTs) were deployed in triplicates in the inner and outer part of 13 estuaries (Southeastern Bay of Biscay), characterized by different hydrological features (i.e. water residence time, river flow, flushing time). The results obtained show the operational capability of these techniques and the reliability of the obtained measurements. Based on the proven advantages, passive samplers are likely to be suitable monitoring tools for water chemical evaluation of transitional and marine waters within the WFD.

INTRODUCTION

In the aquatic environment, most chemical contaminants occur at trace levels, especially in the dissolved (and labile) concentrations. The use of passive samplers enables in situ the extraction and pre-concentration of many compounds, reducing some of the difficulties and costs related to the analysis of contaminants at trace levels (sampling, treatment of the sample before analysis, possible contamination during the various stages). These techniques also ensure low disturbance of the speciation of sampled contaminants (no water sampling, filtration or storage steps) [1,2]. Another considerable advantage is that these techniques can be easily implemented by non-specialist (but previously sensitized and trained) staff. Furthermore, traditional monitoring programs in waters normally rely on the collection of water samples and the determination of dissolved/particulate concentrations. However, spot sampling only provides a snapshot of the situation at the exact sampling time and may not be the most adequate method for chemical evaluation in water bodies characterized by important spatial and temporal variability (lack of representativeness) [3]. On the other hand, passive samplers provide the labile concentration of contaminants which is the most available to the biota and thus the most important for the quality evaluation within the WFD. For many contaminants, the use of passive sampling techniques is already contributing to develop strategies to implement in the WFD [4,5]. In this study, several passive sampling techniques were applied in a "large scale" and in different field conditions to test the operational capability of these systems in terms of cost reduction, reliability of the measurements and speed results acquisition, but also in terms of ease of implementation (by non-specialist personnel).

MATERIAL & METHODS

Since 2008, various projects supported by French government agencies were dedicated to test the potential use of different passive samplers for the assessment of chemical contamination of water bodies. DGT (Diffusive Gradient in Thin Films), POCIS (Polar Organic Chemical Integrative Sampler), SBSE (Stir Bar Sorptive Extraction) were applied by Ifremer in more than 200 different water masses to assess the chemical contamination of water bodies by trace metals, pesticides, PAHs, PCB, alkylphenols and pharmaceutical compounds. On the other hand, DGTs were deployed in triplicates in the inner and outer part of 13 estuaries located at the Southeastern Bay of Biscay to evaluate the chemical contamination in waters by Cd, Cu, Ni and Zn.

RESULTS & DISCUSSION

Results obtained by the large scale monitoring exercises showed the operational advantages of the passive samplers as low quantification limits required by the WFD are reached and ensure measurement of metals and organic pollutants at trace levels, which are generally difficult to quantify with classical methods (particularly in marine waters). The DGTs deployed in the Bay of Biscay provided reliable average labile metal concentrations that are comparable with the results obtained in other areas and in accordance with the historical contamination of the studied area. Fig. 1 represents the labile copper concentrations in the inner and outer part of the estuaries.

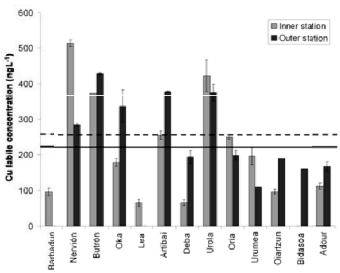

Fig. 1. Distribution of labile Cu concentrations in the estuaries of the Southeastern Bay of Biscay. Concentrations are measured using DGTs after 10 days of deployment. The data are expressed as the mean ± SEM (n = 3). The dashed and solid lines represent the operational inner and outer thresholds for copper, respectively.

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