Cadmium and mercury sediment pollution along the British coastline of the Channel: A first spatio-temporal integrated approach

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Introduction and objectives

Cd and Hg are 2 widespread trace metals occurring in both terrestrial and marine environments. They play no physiological role and are often toxic even at low concentrations and were therefore identified as priority hazardous substances under the European Water Framework Directive and included in the European List I of Dangerous Substances. Marine sediments are considered as the ultimate sink of non-degradable metals, where they can accumulate in considerable quantities. The UK coastline has been polluted with metals for decades or even centuries and, although many studies have monitored sediment metal loads in specific locations, there has been no recent systematic monitoring approach along the whole of the south coast. In addition, few reliable data exist on decadal temporal trends for most sediment pollutants. Focusing on Cd and Hg, the aim of this study was to investigated their spatial distribution and their temporal evolution in sediment samples collected along the English coast of the Channel.

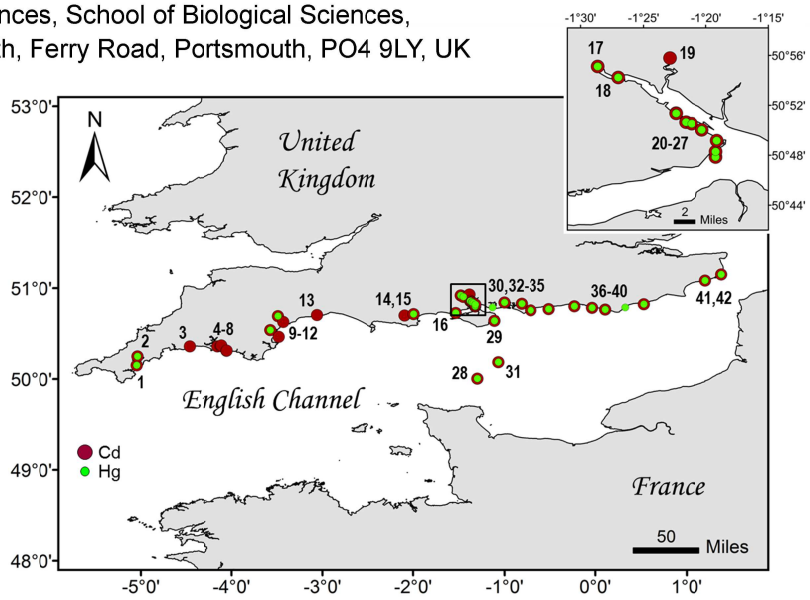

Fig. 1. Map showing the 42 sites along the Channel monitored for Cd and Hg levels in sediments. Sites are numbered from 1 to 42 according to their west-to-east distribution.

Material and methods

The spatial distribution and the temporal evolution of Cd and Hg concentrations were monitored in sediment samples collected from 42 sites along the English coast of the Channel from 1990 to 2010 (**Fig. 1**). The < 90 µm or the < 63 µm sediment grain-size fractions were analysed after HNO_3, *Aqua regia* or HF (normalization against the concentration of Al) digestion procedures.

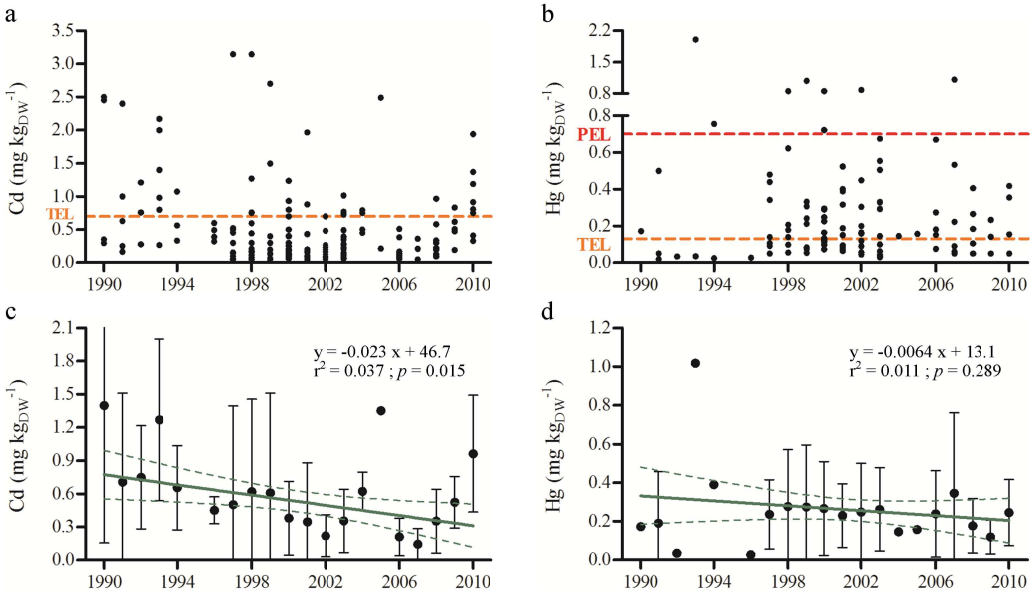

Fig. 2. Temporal evolution of metal levels in sediment samples collected from 42 sites along the Channel from 1990 to 2010. (a, b) Cd and Hg mean concentrations (in mg kg$_{DW}^{-1}$), by year and by site. The Probable Effect Level - PEL - and/or the Threshold Effect Level - TEL - are reported on graphs. (c, d) Cd and Hg mean concentrations (± SD, in mg kg$_{DW}^{-1}$), by year all sites considered. Temporal linear regression models and their fitting parameters (r^2 and *p*-values) are reported on graphs.

Results and discussion

From a temporal point of view, data analyses showed that mean Cd levels in sediments significantly decreased by 59 % during the 22 years monitored period, from 0.78 to 0.32 mg kg$_{DW}^{-1}$ of sediments (**Figs. 2a,c**). This reflects a decrease globally to below the 0.70 mg kg$_{DW}^{-1}$ Cd Threshold Effect Level (TEL). Adverse effects caused by Cd on the biota should, therefore, be rare. Spatially, Cd displayed an east-to-west increase of its levels, with several western sites with Cd still above the TEL (**Fig. 3a**). Regarding Hg, sediment levels did not significantly change from 1990 to 2010 (**Figs. 2b,d**), remaining approximately twice as high as the corresponding 0.13 mg kg$_{DW}^{-1}$ Hg TEL. Hg also displayed an east-to-west increase of its levels, whilst 55 % of monitored sites had a mean sediment Hg concentration in average 3.5 times higher than the TEL (**Fig. 3b**)

Conclusion and perspectives

Despite regulations, non-degradable metals such as Cd and Hg that have accumulated in sediments over considerable periods of time may still pose threats to aquatic organisms, highlighting the need for continued extensive spatially and temporally integrated monitoring approaches. Such an environmental survey, valorizing large databases available from UK agencies (EA, BODC), is currently under process in the Channel for a range of trace elements (*e.g.* Pb, As, Cr, Cd, Hg, Cu, Ni, Zn).

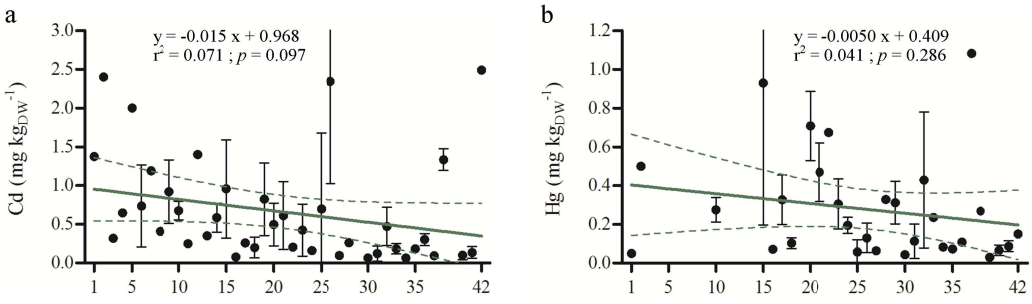

Fig. 3. Above - West-to-east spatial distribution of (a) Cd and (b) Hg mean concentrations (± SD, in mg kg$_{DW}^{-1}$) in sediment samples collected from 42 sites along the Channel and integrated over a 22 years period, from 1990 to 2010. Spatial linear regression models and their fitting parameters (r^2; *p*-values) are reported on graphs.

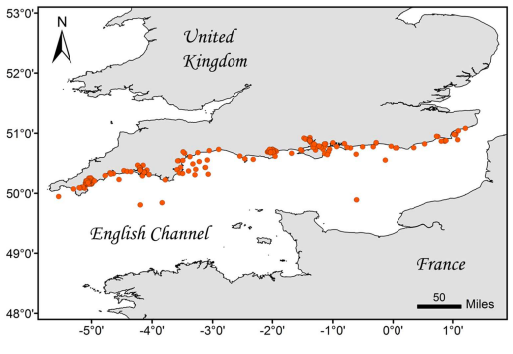

Fig. 4. Right - Map showing sites along the Channel currently surveyed for the spatial distribution and the temporal evolution of their trace element levels monitored in sediment samples.