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Geochemical risk assessment of a case study of climate change adaptation policy: the managed realignment of an island in the Gironde Estuary (SW France)

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During the last millennium, poldering had consisted to reclaim land from the sea by pumping and creating dike to develop, for example, agricultural lands (e.g. tidal marshes, estuarine island). During 1980's, gain land from the sea stopped in Europe because of the concern of rising sea level and for better controlling flood events.
This study aims at evaluating the impact of an accidental realignment due to a dam-break on the "Ile Nouvelle" in the Gironde Estuary (France) during the "Xynthia" storm (27-28 February 2010). After this accident, the General Council of Gironde and the national office for coastal territory preservation ("Conservatoire du Littoral"), which own this island, have adopted a new policy of managed realignment allowing soil submersion by estuarine water during each high tide in order to promote rehabilitation of a wetland ecosystem. This management policy has resulted in the re-inundation of formerly agricultural embanked soils. The regular tidal re-inundation of formerly agricultural embanked soils has induced strong biological and morphological changes (mechanical erosion, siltation). Based on 50 soils samples, spatial distribution of priority metal contaminants (Ni, Cr, Zn, Cu, As, Cd, Pb and Hg) was conducted using GIS (Arcview®). Metal concentrations were compared to local geochemical background measured at the bottom of a sediment core in the Gironde Estuary. Only a moderate Cd enrichment was observed (∼2 to 7 times) and attributed to former deliberate submersion of vineyard soils on the island to fight off the damage caused by Phylloxera. Leaching experiments simulating episodic immersion during winter (salinity 0) and summer (salinity 12) were performed for investigating metal reactivity during soil suspension. Part of Cu and As were released from the soils at whatever salinity, whereas Cd release occurred only for salinity 12. Such desorption processes present potential geochemical risk to the Gironde Estuary. In contrast, during winter submersion events the studied soils would act as Cd sinks, adsorption being the dominating process. Coupling Acoustic Doppler Current Profiler (ADCP) and 2 multi-parameters probes (OBS and SMATCH) during 2 spring-tide cycles allowed estimating residual metal fluxes, suggesting that under these conditions the Ile Nouvelle acts as a metal sink receiving ∼5 kg of Cd, 440 kg of Cu et 480 kg of As. A bathymetry mapping of the corridor (mechanical erosion of the de-poldering area) was used to estimate the annual sedimentary and metals fluxes exported due to its erosion. Annual fluxes related to corridor erosion, compared to fluxes into the Gironde Estuary are significant for Cu and As. With climate change adaptation policies, managed realignment is becoming more common in the future. Consequently, it will be necessary before this management policy to assess the geochemical risk of the re-inundation of formerly embanked soils.