Sedimentary phosphorus dynamics along two temperate eutrophic estuaries: Modeling and experiments

F. E. AIT BALLAGH [1,2,*], C. RABOUILLE [2], F. ANDRIEUX-LOYER [3], K. SOETAERT [4], K. ELKALAY [1], K. KHALIL [1]

[1] Université Cadi Ayyad/Ecole Supérieure de Technologie d'Essaouira, Km 9, Route d'Agadir, BP. 383, Essaouira Aljadida, Morocco
(*correspondence: fz.aitballagh@gmail.com)
(elkalay_khalid@yahoo.fr) (khalil_karima@yahoo.fr)
[2] Laboratoire des Sciences du Climat et de l'Environnement, Laboratoire mixte CNRS-CEA, Orme des merisiers, 91191, Gif sur Yvette, France. (christophe.rabouille@lsce.ipsl.fr)
[3] Ifremer – DYNECO PELAGOS, ZI Pointe du Diable, 29280 Plouzané, France. (Francoise.Andrieux@ifremer.fr)
[4] Department of Estuarine and Delta Systems, Royal Netherlands Institute for Sea Research (NIOZ) and Utrecht University, P.O. Box 140, 4400 AC Yerseke, The Netherlands. (karline.soetaert@nioz.nl)

Sediments play an important role in dissolved inorganic phosphorus (DIP) recycling, but in eutrophic estuaries this is poorly quantified. A coupled field data and diagenetic modeling approach was used to study P dynamics in two estuaries (Elorn and Aulne, Brittany, France). An existing model (OMEXDIA) was extended with phosphorus (P) benthic cycle by adding DIP and particulate P fractions. The model was fitted to porewater oxygen, nitrate, ammonium, oxygen demand units (ODU), DIP, and sediment organic P and C, Fe-bound P and Ca-bound P data from four seasons (February, May, July and October 2009) along the Elorn and Aulne estuaries.

The model calculations for sedimentary P along these estuaries for each season, highlighted different patterns at the estuarine upstream stations (E1 and A1) in October. Higher reaction rates of organic P mineralization and net Fe-bound P release in Elorn compared to Aulne sediments, contributing to the higher DIP production in E1. In the midstream stations (E2 and A2), the integrated rates of organic P mineralization and net Fe-bound P release showed a converging trend in comparison with upstream stations. The recycled DIP fluxes from sediments were still larger in Elorn estuary. This converging trend was confirmed in the downstream stations (E3 and A3) where P budgets were similar in both estuaries. Therefore, the sedimentary P budgets highlighted important sources of DIP in these estuarine sediments. On the other hand, the organic P fluxes with a mineralization turnover time of 27 years showed that these estuarine sediments act as a delayed source of nutrient (nutrient legacy).