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Environmental impact of an accidental Acid Mine Drainage spill in the Estuary of Huelva (SW Spain)

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The current study examines the input and evolution of contaminants in the Estuary of Huelva during the La Zarza spill occurred in May 2017, where approx. 270,000 m^3 of acid mine drainage (AMD) waters contained in an open-pit lake were released to the already AMD-impacted Odiel River. The results are compared with data from a sampling campaign one year later under similar fluvial-marine conditions. Key findings reveal significant insights into the behavior of pollutants during the mixing of the spill waters with seawater in the estuary and the associated environmental impact.

Most relevant results include: (1) The spill led to a substantial increase in the concentration of various contaminants in the river just before entering the estuary, particularly Fe, As, and Pb, with values 15, 10, and 5 times higher, respectively, than those observed one year later. (2) The pH and contaminant behavior in the Odiel river sub-estuary were influenced by the acidic river water mixing with alkaline seawater, leading to pH neutralization (from 2.5 to 8.0) and a decrease in dissolved contaminants. This process is typical in the chronically polluted sub-estuaries of the Odiel and Tinto rivers but was intensified during the spill. From a mixing model it was possible to distinguish between non-conservative (Al, Fe, Cu, and Pb) and conservative (Cd, Co, Mn, Ni, and Zn) behaviors of contaminants during estuarine mixing. Particularly interesting was the behavior of As, since it first precipitated together with Fe and later desorbed around circumneutral pH values and was released back to water. (3) Concentrations of Co, Fe, Ni, Pb, and Zn were significantly higher in the nearby coast during the spill, suggesting a notable impact on the Atlantic Ocean.

Overall, the study underscores the significant environmental impact of the La Zarza spill on the estuary, demonstrating the necessity for ongoing monitoring and management of such incidents to mitigate long-term ecological damage.

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