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Eroding coastal landfill sites: the relative contribution of coastal and inland mining wastes to metal flux along a post-industrial coastline

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Historically, coastal areas of the United Kingdom were extensively used for the disposal of wastes from a range of municipal and industrial sources, including coal mining, metal mining, and mineral processing. Many of these deposits are releasing metal-rich wastes to coastal waters, with climate forecasts predicting an increase in the rate of coastal erosion in the future. However, these environments also receive mining-impacted waters from upstream processes, notably through the transport of contamination from mine water discharges and eroding waste rock heaps through rivers draining former orefields.

Long-term water quality monitoring data and experimental metal leaching rates from legacy wastes were used to model the total annual flux of metal(loid)s to the North Sea along a formerly-mined coastline of North-East England (River Coquet to River Tees). The extent of metal flux from inland sources was characterised using annual flux data from the tidal reaches of major rivers in the region, some of which draining major orefields of the North Pennines and the Great Northern Coalfield. The annual flux of metal(loid)s from coastal mining waste landfills was estimated using modelled leaching rates to quantify the relative contribution of contaminants from both inland and coastal sources.

Flux estimations indicated that within the study region, a total of <217 tonnes Zn, <69 tonnes Pb, and <30 tonnes each of Cu and Ni entered the North Sea per year, alongside <9 tonnes of As and <1 tonne Cd. Despite many eroding landfills along this stretch of coastline, the majority of each metal(loid) flux (56-97%) was apportioned to inland sources, particularly riverine transport from mining-affected catchments (e.g. Tyne, Tees, and Wear). However, contaminant flux from coastal landfill sites was non-trivial, particularly for problematic metal(loid)s such as As (<4 t/year), Cr (<1 t/year), and Ni (<8 t/year).

This work represents the first attempted source apportionment of metal(loid) flux to the North Sea along a formerly-mined section of coastline, and takes a holistic view of the interactions and transport of mining wastes reaching coastal waters from a range of sources. Such assessments are vital for informing the future management of both inland and coastal mining wastes.