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Transport and storage of anthropogenic contaminants in the Red River Delta, Vietnam

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Suspended particulate matter (SPM) in large rivers is the main source of material into delta river ecosystems and the world's oceans, and is the primary carrier of heavy metals. Large rivers are therefore important sources of pollutant transport through the watershed and potentially alter natural riverine biogeochemical cycling. Asian mega-deltas are some of the most densely populated and urbanizing environments in the world, with pollution, erosion, and anthropogenic catchment modifications changing sediment fluxes and pollutant transport across their catchments. The River Delta (RRD), northern Vietnam, comprises 14,300 km², making it the fourth largest delta in Southeast Asia. The area has a large population of >22 million and has seen a rapid increase in industry and agriculture with waste products from domestic activities, agriculture, and industry entering the river network often unregulated and untreated. To estimate the impacts of industrialisation in the RRD delta, we measured downriver suspended sediment and pollutant flux from 21 locations over a 17 month period from March 2018 to July 2019. Previous studies suggest sediment retention in the RRD, which is supported here in 2019 with ~30% of sediments retained in the delta. Increased precipitation in 2018, however, led to a ~40% increase in sediment delivery between the inlet and the outlets of the delta, most likely attributed to erosion. Anthropogenic contaminant loads between the inlet and outlets suggest the retention of heavy metals within the delta irrespective of the sediment flux (e.g. a reduction by ~4 and ~14% of SPM bound Cr between sites in 2018 and 2019). This may, in part, be due to spatial variations across the delta revealing 'hotspots' of pollution, with a progressive increase in the Cr concentration of SPM between Son Tay (a predominantly agricultural landscape) and Hanoi (a major industrialised urban area) suggesting domestic and industrial waste are major sources of heavy metal pollution. XRF data from upstream Hoa Binh reservoir sediment cores (collected 2017) will permit a comparison of background contaminant storage in the RRD catchment, to better quantify downstream impacts of anthropogenic activity as well as underpin the effects of impoundments on sediment export from

the riverine system. Results highlight the role of deltas in 'filtering' contaminants to protect coastal areas, but the retention of high loads of pollutants also has potential consequences for the bioaccumulation of heavy metals through the food chain and could ultimately have severe consequences for aquatic and human health in these areas.