Metal pollution risk of water and soil due to the open-beach recycling of end-of-life ships

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Ship-breaking and recycling industries (SBRI) deal with end-of-life ships, and recover 95 % of ships' materials for reuse or to recycle [1, 2]. The SBRIs in Bangladesh, India and Pakistan employ the beaching technique to bring ships ashore to dismantle them in the open [2]. The environmental pollution risk due to the open-beaching by SBRIs is yet to be validated through comprehensive research. In this research, we aimed to assess the risk of soil and water pollution due to the release of toxic metals, such as, As, Cd, Cr, Cu, Ni, Pb, and Zn from SBRIs in Bangladesh which are located in the Sitakunda-Bhatiary area of Chittagong. The soils from the dismantling zones of SBRIs, surface waters from the adjacent coasts during tide and ebb, and underground waters drawn at shipyards by shallow tubewell were collected.

The concentrations of metals in the surface waters were within the regulatory limits of WHO. The underground waters also seem unpolluted except some showing higher content of As. The correlation coefficient study confirms that the higher As-values are attributable to the geogenic contamination rather than the activities of SBRIs. The soils from the SBRIs have higher metal concentrations compared to the respective natural abundances. A comparison with NYS DEC soil cleanup objective values, which is indicative of the risks to human health, indicated that soils from SBRIs are not suitable for unrestricted use in terms of the contents of As, Cd, and Cr. However, the SBRIs cannot be marked as contaminated sites due to the lower metal concentrations than the US-EPA soil screening levels. The metals are mostly immobilized in the residual fraction of the soil-solid-phase, as determined using the Tessier protocol [3]. Hence, the toxic elements are not available for immediate environmental interaction, and might pose fewer risks to the ecosystems.

[1] Gregson *et al*. (2010) *Geoforum* **41**, 846–854. [2] Sujauddin *et al*. (2015) *J Mater Cycles Waste* **17**, 72–83. [3] Tessier *et al*. (1979) *Anal Chem* **51**, 844–851.