World Academy of Science, Engineering and Technology
International Journal of Urban and Civil Engineering
Vol:17, No:12, 2023

Understanding the Accumulation of Microplastics in Riverbeds and Soils

Authors : Gopala Krishna Darbha

Abstract : Microplastics (MPs) are secondary fragments of large-sized plastic debris released into the environment and fall in the size range of less than 5 mm. Though reports indicate the abundance of MPs in both riverine and soil environments, their fate is still not completely understood due to the complexity of natural conditions. Mineral particles are ubiquitous in the rivers and may play a vital role in accumulating MPs to the riverbed, thus affecting the benthic life and posing a threat to the river's health. Apart, the chemistry (pH, ionic strength, humics) at the interface can be very prominent. The MPs can also act as potential vectors to transport other contaminants in the environment causing secondary water pollution. The present study focuses on understanding the interaction of MPs with weathering sequence of minerals (feldspar, kaolinite and gibbsite) under batch mode under relevant environmental and natural conditions. Simultaneously, we performed stability studies and transport (column) experiments to understand the mobility of MPs under varying soil solutions (SS) chemistry and the influence of contaminants (CuO nanoparticles). Results showed that the charge and morphology of the gibbsite played an significant role in sorption of NPs (108.1 mg/g) compared to feldspar (7.7 mg/g) and kaolinite (11.9 mg/g). The Fourier transform infrared spectroscopy data supports the complexation of NPs with gibbsite particles via hydrogen bonding. In case of feldspar and kaolinite, a weak interaction with NPs was observed which can be due to electrostatic repulsions and low surface area to volume ration of the mineral particles. The study highlights the enhanced mobility in presence of feldspar and kaolinite while gibbsite rich zones can cause entrapment of NPs accumulating in the riverbeds. In the case of soils, in the absence of MPs, a very high aggregation of CuO NPs observed in SS extracted from black, lateritic, and red soils, which can be correlated with ionic strength (IS) and type of ionic species. The sedimentation rate (Ksed(1/h)) for CuO NPs was >0.5 h−1 in the case of these SS. Interestingly, the stability and sedimentation behavior of CuO NPs varied significantly in the presence of MPs. The Ksed for CuO NPs decreased to half and found <0.25 h−1 in the presence of MPs in all SS. C/C0 values in breakthrough curves increased drastically (black < alluvial < laterite < red) in the presence of MPs. Results suggest that the release of MPs in the terrestrial ecosystem is a potential threat leading to increased mobility of metal nanoparticles in the environment.

Keywords : microplastics, minerals, sorption, soils
Conference Title : ICMUPP 2023 : International Conference on Microplastics and Urban Plastic Pollution
Conference Location : Goa, India
Conference Dates : December 11-12, 2023