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Monsoon Controlled Mercury Transportation in Ganga Alluvial Plain, Northern India and Its Implication on Global Mercury Cycle

Authors : Anjali Singh, Ashwani Raju, Vandana Devi, Mohmad Mohsin Atique, Satyendra Singh, Munendra Singh

Abstract : India is the biggest consumer of mercury and, consequently, a major emitter too. The increasing mercury contamination in India's water resources has gained widespread attention and, therefore, atmospheric deposition is of critical concern. However, little emphasis was placed on the role of precipitation in the aquatic mercury cycle of the Ganga Alluvial Plain which provides drinking water to nearly 7% of the world's human population. A majority of the precipitation here occurs primarily in 10% duration of the year in the monsoon season. To evaluate the sources and transportation of mercury, water sample analysis has been conducted from two selected sites near Lucknow, which have a strong hydraulic gradient towards the river. 31 groundwater samples from Jehta village (26°55'15''N; 80°50'21''E; 119 m above mean sea level) and 31 river water samples from the Behta Nadi (a tributary of the Gomati River draining into the Ganga River) were collected during the monsoon season on every alternate day between 01 July to 30 August 2019. The total mercury analysis was performed by using Flow Injection Atomic Absorption Spectroscopy (AAS)-Mercury Hybride System, and daily rainfall data was collected from the India Meteorological Department, Amausi, Lucknow. The ambient groundwater and river-water concentrations were both 2-4 ng/L as there is no known geogenic source of mercury found in the area. Before the onset of the monsoon season, the groundwater and the river-water recorded mercury concentrations two orders of magnitude higher than the ambient concentrations, indicating the regional transportation of the mercury from the non-point source into the aquatic environment. Maximum mercury concentrations in groundwater and river-water were three orders of magnitude higher than the ambient concentrations after the onset of the monsoon season characterizing the considerable mobilization and redistribution of mercury by monsoonal precipitation. About 50% of both of the water samples were reported mercury below the detection limit, which can be mostly linked to the low intensity of precipitation in August and also with the dilution factor by precipitation. The highest concentration (> 1200 ng/L) of mercury in groundwater was reported after 6-days lag from the first precipitation peak. Two high concentration peaks (>1000 ng/L) in river-water were separately correlated with the surface flow and groundwater outflow of mercury. We attribute the elevated mercury concentration in both of the water samples before the precipitation event to mercury originating from the extensive use of agrochemicals in mango farming in the plain. However, the elevated mercury concentration during the onset of monsoon appears to increase in area wetted with atmospherically deposited mercury, which migrated down from surface water to groundwater as downslope migration is a fundamental mechanism seen in rivers of the alluvial plain. The present study underscores the significance of monsoonal precipitation in the transportation of mercury to drinking water resources of the Ganga Alluvial Plain. This study also suggests that future research must be pursued for a better understand of the human health impact of mercury contamination and for quantification of the role of Ganga Alluvial Plain in the Global Mercury Cycle.

Keywords : drinking water resources, Ganga alluvial plain, india, mercury
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