Abstract

Increasing dependence on thermal power in India has resulted in the production of enormous quantities of coal ash. Most of the coal ash in India is disposed off in ash ponds. Even though they are kept within the designated ash ponds still there is a potential to contaminate the surrounding soil, sediment and water media due to this ash disposal.

The present study was carried out around an ash pond of a major thermal power plant in a major coal producing region of India. The study aimed at determining the levels of element contamination of topsoil, groundwater around the ash pond and the water and sediment from adjacent river in order to delineate the extent of contamination through various physicochemical analyses and application of geographical information system.

Samples of feed coal and ash from the power plant, ash and effluent from the disposal pond, soil and groundwater around the ash pond, surface water and sediments from the river were collected and analyzed. From the various observations and laboratory analyses, it is established that the ash from the disposal pond is significantly enriched with environmentally sensitive elements with respect to the crust as well as the power plant ash. The leaching studies carried out on coal ash in the laboratory under simulated conditions for a suite of elements indicated that Co, Cr and Ni are non-leachable from ash while Cu, Pb and As are either sparingly soluble or below method detection limits in most of the leachates. Most of the leachable elements showed a decrease in their concentrations with increasing liquid to solid ratio.

The topsoil in the area and also the sediments of the nearby river are found to be contaminated from ash disposal to varying degrees. The soil drawn from various profiles is observed to be largely contaminated by ash fall out, predominantly in the prevalent direction of wind. Iron, Pb, Zn, Cu, Ni, Co, Mn, Cr, V and Ba are found to be enriched in the topsoil

around the ash pond with respect to the crust as well as the background; while Mn, V, Cr, Co and Ni are enriched compared to their maximum permissible concentrations prescribed for agricultural soils. Higher contamination of profile soils in the predominant wind direction was further deciphered from the contamination index map and lognormal distribution pattern of the elements.

Using the characteristic spherical morphology and the low Si/Al ratio on the ash particles as micro-signature, the presence of coal ash has been delineated in the top soil around the area and river sediments.

As a consequence of this contamination, many of the important physicochemical properties of soil in the direction of the wind and river sediments in the downstream of the effluent confluence have been modified significantly.

A good agreement has also been observed between the leachability of elements from coal ash and their dissolved concentrations determined in the groundwater. Arsenic, Co, Cr and Ni are found to be below method detection limits in most of the samples of open well water in both pre- and post-monsoon periods in both the years of study. Sulphur, Al, Mn, Fe, Ba, and Zn are present in significant concentrations in the groundwater while Cu, Pb, Ti and V are below detection limits in many of the water samples. The contribution of these elements from ash disposal has been further delineated from their poor linearity and low square correlation coefficients in the lognormal distribution plots. It is established from the present study that, Al, Mn, Fe and Pb are the major contaminants in the groundwater in comparison to the World Health Organization guidelines for drinking water. From the spatial distribution of elements as well as the contamination index maps, it has been delineated that the contamination of groundwater appears to be more pronounced in the direction of the flow while the predominant wind also contributes to this aspect mostly in case of open wells. The river water is also found to be contaminated with respect to Al, Fe, Mn and Pb

as observed from the lognormal distribution pattern and their enrichment compared to the World Health Organization guidelines for drinking water. A gradual increase in the concentrations of elements in river water has also been observed in the downstream direction.

It is, therefore, established that the soil, groundwater, river water and sediments in the vicinity of the ash pond are contaminated to varying degrees from coal ash disposal. The extent of contamination is largely controlled by both the groundwater flow and wind.

The soil and water characterized and the contamination delineated above is alarming since the area is densely populated and the people depend mainly on groundwater and the nearby river water for their daily needs while extensively using the soil for agriculture.