Environmental Impacts of Fly Ash Generated from a Coal Fired Power Plant in Indian Sub-continent

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INTRODUCTION

The major sources of heavy metal pollution in urban areas are anthropogenic which also include those associated with the fossil fossil and coal combustion (Galloway, 2003). The thermal power plants generate huge amount of fly ash as a solid waste material of coal combustion. These fly ash are usually collected in the ESPs and disposes off in the ash ponds or in the open lands and some of these enter into atmosphere by passing through the stacks along with the flue gases.

The atmosphere is an important transport medium for heavy metals from thermal power plants. A high proportion of the toxic metals in the fly ash deposition has been found around thermal power plants (Ure, 2004). Fly ash and some of the re-suspended ash from ash ponds deposited in the nearby environments (5-10 km) of coal fired power plants.

These fly ash have high surface concentrations of several toxic elements, have high atmospheric mobility and are deposited over a large area around coal fired power plants. These fly ashes enter the terrestrial or aquatic environment by wet or dry deposition (Galvan et al.,2000). In a study it is reported that about thirty seven trace elements pass from a coal fired power plant to the ecosystem (Klein et al.,1989). The most of the toxic metals are concentrated on the surface of fly ash (Singh, 2000).

Environmental pollution in industrial clusters has been an important issue particularly in a period which is witnessing a rapid industrial growth. The environmental problem in a cluster is a complex multi-dimensional problem which is often difficult to measure and manage.

In Orissa three industrial clusters; Angul-Talcher, Ib-valley and Jharsuguda are identified with compréhensive Environnemental Pollution Index (CEPI). CEPI score of more than 70, thus considered as critically polluted area. Central Pollution Control Board (CPCB) has calculated the CEPI Score of Angul-Talcher area as 82.09.

Industrialization started in Talcher quiet early with operation of coal mines and subsequently several other industries were established in this region due to its close proximity to coal mines.

Combustion of coals in thermal power plants is one of the major sources of environmental pollution due to generation of huge amounts of ashes, which are disposed of in large ponds in the vicinity of the thermal power plants. This problem is of particular significance in India, which utilizes coals of very high ash content (Approx. 40-55 wt%).

The Thermal power station under study is situated at Talcher of Orissa state. There are some villages around the power plant and the general occupation of the villagers is rice cultivation and business. The land is generally a rough terrain with few hills hills.

Angul-Talcher area in the state of Orissa is one of the oldest industrial cluster of the country. This area is located in the central part of Orissa about 120km from the state capital Bhubaneswar and 160km from the Bay of Bengal. It is 139m above the Mean Sea Level (MSL) and is bounded between 20°37´N to 21°10´N and 84^{0}28´E to 85^{o}28´E.

The power station has a production capacity of 460 Mw electricity with a coal consumption of nearly 8000 tones/day. This plant uses coal from coal washery having ash concentrations in the range of 40-55%. The total amount of ash generated per annum is approximately 15 lakh tones.

The emitted fly ash spread over a large area around the power plant. In view of release of such a very large amount of fly ash from the power plant, It was felt to study the presence of toxic elements in the soil.

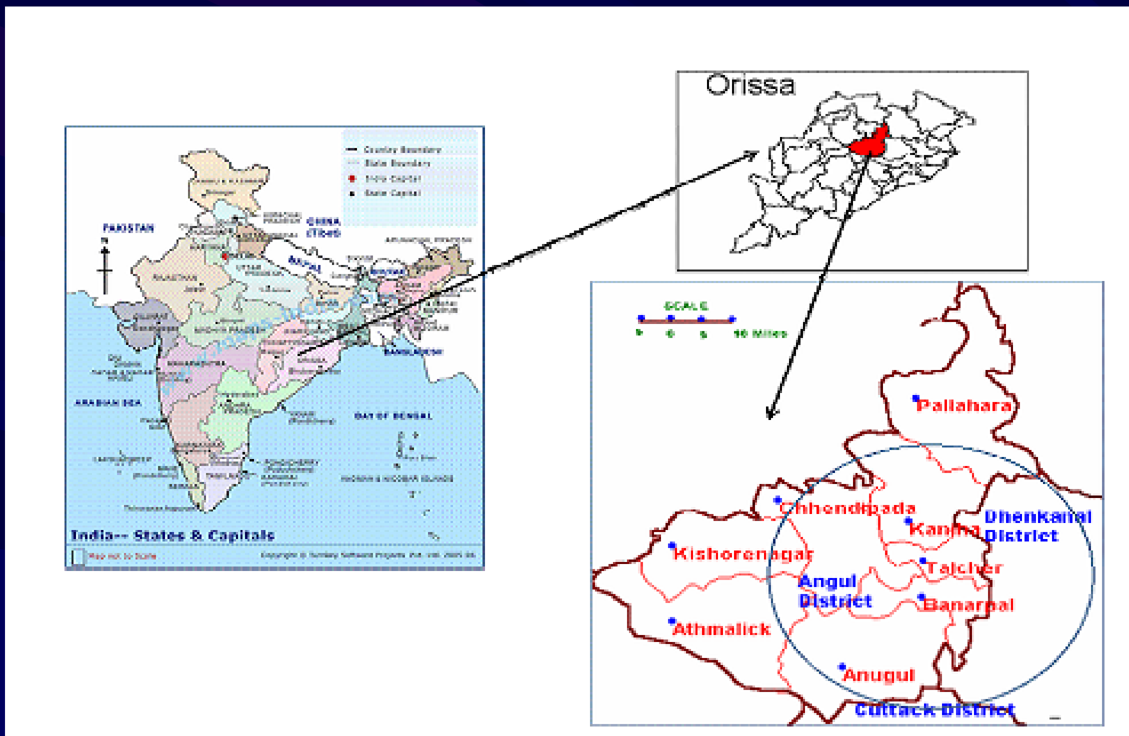

Figure. 1 Location Map of Angul- Talcher industrial belt.

METHODOLOGY

Sample collection

Topsoil (0-5 cm) samples were collected around the ash ponds from four radial profiles, in each of the ash ponds. Samples were collected from each profile at regular intervals of 6 m. Besides the topsoil, soil samples were also collected from two vertical profiles at depths of 0, 25, 50 and 100 cm from the surface. Back- ground soil samples were collected at distance of about 20 km east of the ash ponds. The background samples are selected from areas which are not affected by fly ash disposal, i.e. these are the areas where the ash from the ponds is not dumped by either wet or dry disposal methods. As stated earlier the ash are dumped 2.5 km near the power plant, so at 5 km distance the soil is almost unaffected by ash pile.

Laboratory methods

The soil samples were homogenized by coning and quartering, air-dried at 100-110°C for about 24 h and then finely powdered and sieved using standard sieves of (70, 100, 140, 200, 270, 325) mesh size before analysing for trace element concentration using Shimadzu AAS.

RESULTS AND DISCUSSION

Chemical composition of the top soils from the four soil profiles

The pH of the soil was in the acidic range 4.5-5.2 in all the soil samples studied. The pH of ash deposited was also acidic in nature ie 4.5. The pH of the background soil was alkaline (8.2), which showed that the acidic nature of the pH of the soils near the ash ponds was due to the effect of ash disposal. The top soils of all the soil profiles from all the ash ponds are characterized by dominance of SiO_2 followed by Al_2O_3, Fe_2O_3, K_2O and TiO_2.

The trace elements analysed in the profile soils around the four ash ponds and the background . The trace elements in decreasing order of abundance in all the soil profiles around the four ash ponds are Mn, Ba, Rb, Sr, V, Zn, Cr, Ni, Cu, Pb, Mo, Be and As. It is observed that the element concentrations are varying from profile to profile around the ash pond while their variations within the same profile did not show any particular trend. Among the trace elements Mn, Ba, V, Cr, Cu, Zn Pb showed much higher concentrations in the top soils from all the profiles around the four ash ponds than the background soils.

Trace elements in the depth profiles

The concentrations of trace elements in soils collected with depth (e.g., 0, 25, 50, 75 and 100 cm) from two profiles are shown in Fig. 2a, b. It is seen in that in all the depth profiles the concentration of the trace elements decreases with depth. The concentration of the trace elements Mn, Ba, V, Cr, Cu, Zn, As decreases below the surface layer, i.e. from 0 to 25 cm. It is significant to note that all these elements are abundantly present in the coal ash and are enriched 2-10 times with respect to their crustal abun- dances (Table 4). The pond ash, which is mixed with the top soil layer in all the ash ponds, is characterized by high concentrations of toxic trace elements (As, Cd, Cr, Ni, Co, Cu, Sb, V, Zn, Mn, Mo) (Mandal and Sengupta 2002).

Therefore, it may be inferred that the topsoil, with high concentration of trace elements in both the depth profiles, is possibly contaminated by ash from the pond. Since there are no other industrial emissions in the study area, the high concentrations of the trace ele- ments in the top soils implies input from the ash piles, which lie uncovered and exposed to the atmosphere.

carried away due to their fineness and deposited as a layer on the top soils of the surrounding areas.

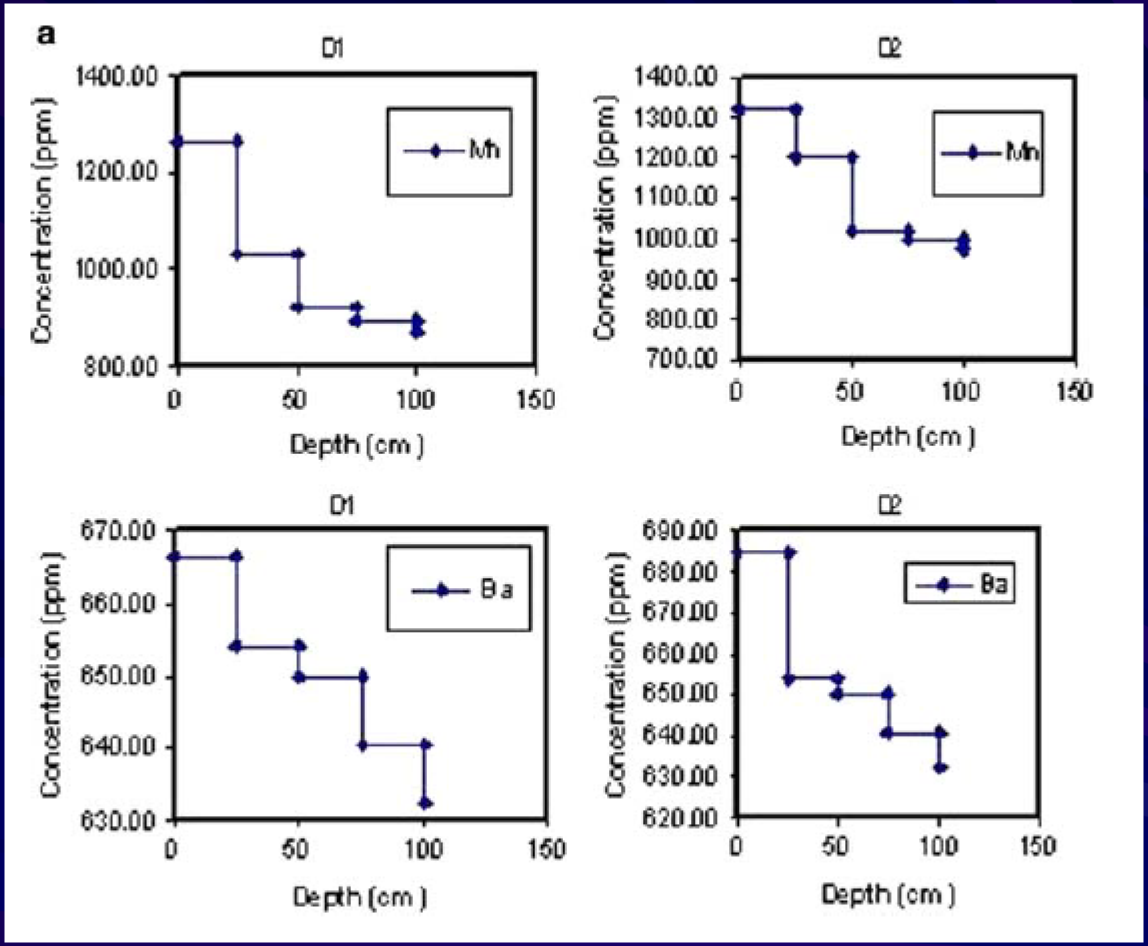

Figure 2a. Depth wise distribution of (Ba, Mn) in the two soil profiles D1 and D2. b Depth wise distribution of (Be, As,Mo, Ni, Co, Cr, Cu, Pb, V, Zn,Rb, Sr) in the two soil profiles D1 and D2.

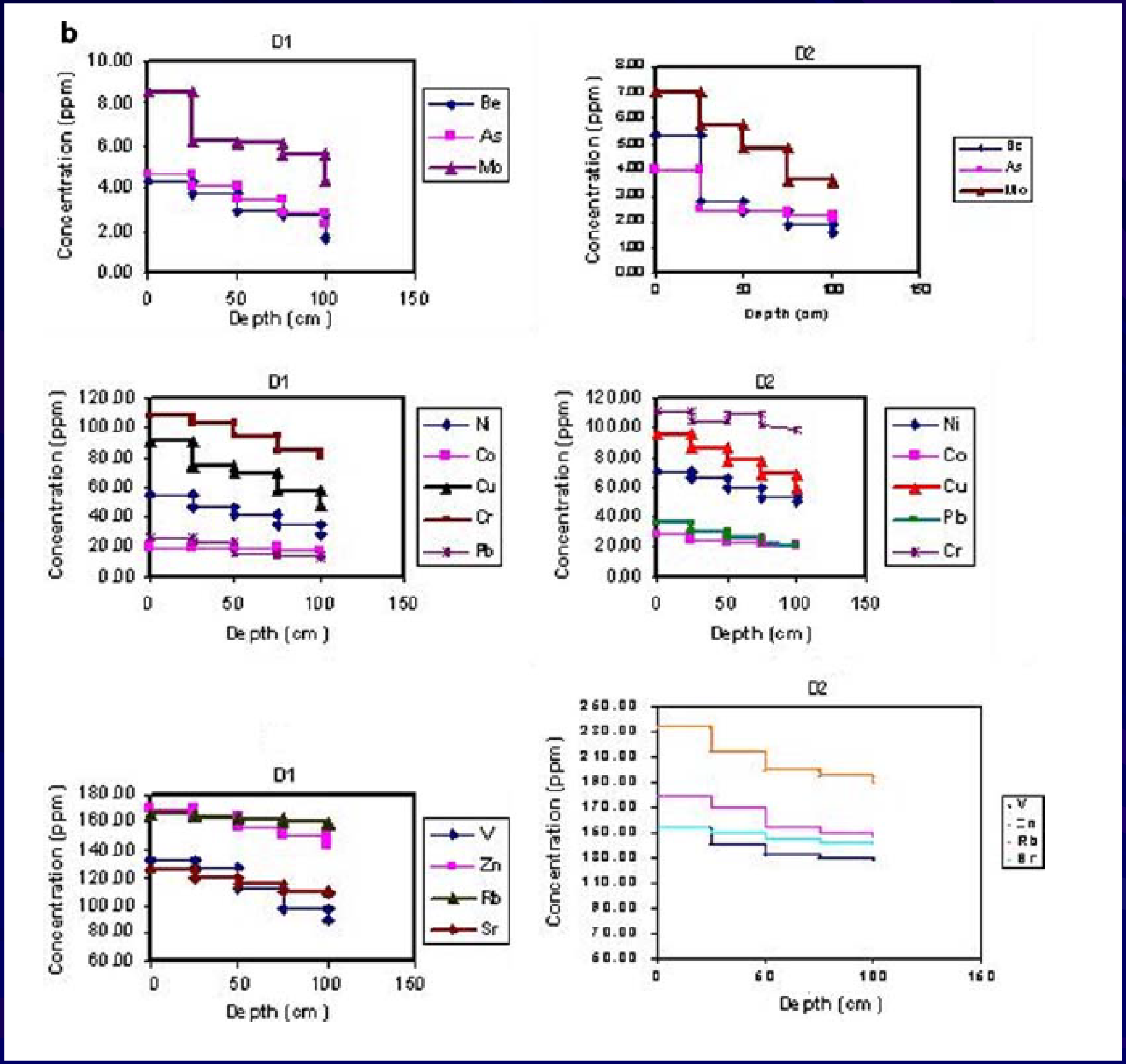

Figure 2b. Depth wise distribution of (Be, As,Mo, Ni, Co, Cr, Cu, Pb, V, Zn,Rb, Sr) in the two soil profiles D1 and D2.

CONCLUSIONS

A comparison of the analysed data of the soil samples collected from the contaminated and uncontaminated areas confirm that the soil horizon around the thermal power plant has received an intake of toxic elements from the fly ash emitted by the power station.

REFERENCES

Baba A (2002) Assessment of radioactive contaminants in by-products from Yatagan (Mugla, Turkey) coal-fired power plant. Environ Geol 41:916–921

Carlson CL, Adriano DC (1993) Environmental impacts of coal combustion residues. J Environ Qual 22:227–247

Forstner U (1983) Applied environmental geochemistry. Academic Press, London, p 395

Jones KC (1991) Contamination trends in soils and crops. Environ Pollut 69:311–325

Satyanarayana Raju MV (1993) Pollution status of soils near ash pond of a thermal power station. Indian J Environ Health 35(1):9–14