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ORIGINAL ARTICLE

Open dumping of municipal solid waste and its hazardous impacts on soil and vegetation diversity at waste dumping sites of Islamabad city

Syeda Maria Ali [a,*,1], Aroma Pervaiz [a], Beenish Afzal [a], Naima Hamid [a], Azra Yasmin [b]

[a] *Department of Environmental Sciences, Female Campus, International Islamic University, Islamabad, Pakistan*
[b] *Department of Environmental Sciences, Fatima Jinnah Women University, The Mall, Rawalpindi, Pakistan*

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Abstract Deteriorating soil quality and decrease in vegetation abundance are grave consequences of open waste dumping which have resulted in growing public concern. The focus of this study is to assess the contribution of open waste dumping in soil contamination and its effect on plant diversity in one of the renowned green cities of Pakistan. Surface soil samples ($n = 12 + 12$) were collected from both the open waste dumping areas allocated by Capital Development Authority (CDA) and sub- sectors of H-belt of Islamabad city (representative of control site). The diversity of vegetation was studied at both sampling sites. Significant modifications were observed in the soil properties of the dumping sites. Soils at the disposal sites showed high pH, TDS and EC regime in comparison to control sites. Various heavy metal concentrations i.e., Lead (Pb), Copper (Cu), Nickel (Ni), Chromium (Cr) and Zinc (Zn) were also found to be higher at the dumping sites except for Cadmium (Cd) which had a higher value in control site. A similar trend was observed in plant diversity. Control sites showed diversified variety of plants i.e., 44 plant species while this number reduced to only

* Corresponding author. Permanent address: Department of Environmental Sciences, Faculty of Basic and Applied Sciences, Female Campus, International Islamic University, Sector H-10, Islamabad, Pakistan. Tel.: +92 519019816.
E-mail address: maria.ali@iiu.edu.pk (S.M. Ali).
[1] Present address: Department of Biology, Environment Resource Center, Indiana University Purdue University, IPFW, 2101 E Coliseum Blvd, Fort Wayne, 46805 IN, USA.

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32 plant species at the disposal sites. This is attributed to changes in soil characteristics at disposal sites and in its vicinity areas.

1. Introduction

The menace of environmental pollution has been haunting the human world since early times and is still growing due to excessive growth in developing countries. Municipal solid waste (MSW) normally termed as ''garbage'' or ''trash'' is an inevitable byproduct of human activity. Population growth and economic development lead to enormous amounts of solid waste generation by the dwellers of the urban areas (Karishnamurti and Naidu, 2003). Urban MSW is usually generated from human settlements, small industries and commercial activities (Singh et al., 2011). An additional source of waste that finds its way to MSW is the waste from hospitals and clinics. In majority of countries most of the smaller units do not have any specific technique of managing these wastes. When these wastes are mixed with MSW, they pose a threat for health and also they may have long term effect on environment (Pattnaik and Reddy, 2009).

In developing countries open dumpsites are common, due to the low budget for waste disposal and non-availability of trained manpower. Open dumping of MSW is a common practice in Pakistan. It also poses serious threat to groundwater resources and soil. The contamination of soil by heavy metal can cause adverse effects on human health, animals and soil productivity (Smith et al., 1996). Over the last many years, heavy metals have considerably damaged the soil quality and fertility in consequence of increased environmental pollution from industrial, agricultural and municipal sources (Adriano, 1986). Metals cause physiological disorders in soils as absorption through root system consequently retards plant growth and deprives it of vigour (Moustakas et al., 1994). Waste carries different metals which are then transferred to plants by different ways (Voutsa et al., 1996). Depending on the tendency of the contaminants they end up either in water held in the soil or leached to the underground water. Contaminants like Cd, Cu, Ni, Pb and Zn can alter the soil chemistry and have an impact on the organisms and plants depending on the soil for nutrition (Shaylor et al., 2009).

Diversity of vegetation is directly influenced by soil characteristics. Many studies show evidence of seriousness of hazards caused by open waste dumping ultimately affecting the plant life on the planet leading towards an irreversible erosion trend unless the present land use pattern is checked (Phil-Eze, 2010). Solid waste pollutants serve as an external force affecting the physico-chemical characteristics of soil ultimately contributing towards the poor production of vegetation (Papageorgiou, 2006). The pollutants, in the first place, hinder the normal metabolism of plants which is an invisible injury and owing to which the visible injury appears in the aftermath (Ahmed et al., 1986). It is depriving our ecosystem of the natural balance and bear result beyond any repair. Assessment of soil pollution becomes difficult when contaminants belong to different sources and their products are variably distributed (Partha et al., 2011). Chemical properties of soil serve as main reason of vegetation changes (Neave et al., 1994). In plants accumulation of chemical elements depends not only on their absolute content in a soil but also on the level of fertility, acidic–alkaline and oxidative-reductive conditions and on the presence of organic matter (Subbiah and Asija, 1976). The disturbances of higher intensity sometimes endanger the survival of some species and yield to low richness (Hussain and Palmer, 2006). In this regard, developing countries are even deeper into the chaos as having poor financial resources to upgrade their disposal facilities and turned out to be more vulnerable to the hazards of dumping for their environment (Hazra and Goel, 2009).

Pakistan is generally faced with rapid deterioration of environmental conditions due to the conventional system of collection and dumping of solid wastes. Therefore urban waste management has become a major concern in cities. Little efforts have been made in order to improve the waste collection and disposal facilities. This has some grave consequences ranging from deterioration of soil quality to reduced plant diversity. The present study has been conducted in order to assess the prevailing condition of soil physico-chemical characteristics and its impact on vegetation.

1.1. Description of the Study Area

The dumping site is located in Sector H-10 of Islamabad city. Geographically it is situated at 33° 42' 0'' northern latitude and 73° 10' 0'' eastern longitude at 540 m above sea level (asl) (Fig 1). According to the master plan one fourth of the city's land was reserved as green area. The city is characterized by a grid pattern which divides the city into eight basic zones viz., administrative, diplomatic enclave, residential areas, educational sectors, industrial sectors, commercial areas, rural and green areas, along with protected green belts. The plan concentrated on the division of the city into equal sized sectors, each of which is subdivided into four sub-sectors separated by green belts and parks. The total area of each sector is 4 km square. Each sector is facilitated with its own shopping area and public and recreational parks (Islamabad Census Report, 1998). The Sector H-10 lies in the Capital Territory of Islamabad (ICT) and the waste dumping site is situated in an open reserved area.

Climatically the area falls in the semi-arid zone having moderate summers and winters. The mean maximum temperature of the region reaches 45 °C during the summer and the mean minimum temperature is 24 °C falling below zero occasionally in winters. Monsoon prevails from July to September. The records of the Pakistan Department of Meteorology indicate a monsoonal climate of rainy hot summers and cool dry winters, with an annual average rainfall of 60–64 mm.

Geologically Islamabad is in the South margin and leading edge of the Hazara fault zone. The terrain in the metropolitan area of Islamabad consists of plains and mountains. Geology of Islamabad is dominantly controlled by the convergence and collision of the Pakistan, India and Eurasian tectonic plates that produce complex structures (Williams et al., 1999).