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Impact of Leachate on Soil Properties in the Dumpsite

(A Case study of Greater Visakhapatnam)

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Abstract - Soil pollution is one of the grave consequences of the inevitable municipal solid waste dumping especially in a country like India which is one among the densely populated. The developing trend of industrialization and modernization is generating tons of solid waste of different categories posing severe environmental threat. The activities of both the developed and developing countries are equally affecting the soil fertility. Though there are many factors affecting the soil characteristics the unscientific disposal and dumping of solid waste has become one of the major concerns due to the irreversible leachate affect. In this context a comprehensive knowledge on the soil fertility and the extent of soil contamination is very much awaited aspect. The present paper is an attempt to analyze the impact of leaching on the soil physico-chemical properties of an active dumpsite in Visakhapatnam.

Key words - Dumpsite, MSW, leachate, soil pollution, soil physico-chemical properties, soil macro-nutrients, comparative study, etc;

INTRODUCTION

Open and unscientific dumping of municipal solid waste is one of the most common methods adopted since years in almost all the cities. Municipal solid waste generally constitutes of both the degradable and non-degradable substances which find their way into the under groundwater resources and soil strata. Though all natural resources have their own importance in the environment, soil has a major role to play. Ever since life existed soil played a vital role in the growth of microbes useful for the nutrient cycling to make available all the essential nutrients required for the plant growth and nourishment. Micro-organisms in waste dumpsites use waste constituents as source of nutrients thereby detoxifying the materials as their digestive processes breakdown complex organic molecules into simpler less toxic molecules [1]. In addition the soil organic matter helps in maintaining soil quality [2]. Soil provide a suitable natural environment for biodegradation of wastes and therefore serve as a sink for the adsorption and absorption of ions and as a medium for the restoration of vegetation and normal land use [3].Though there are different ways how a soil is defined by different experts, for agriculturalists it is a part of earth's crust or a layer useful for the plant growth. Misuse of the soil by various anthropogenic activities will result in drastic impacts in the near future that are damaging to the ecosystem and the environment on the whole. Although solid waste can be an asset when properly managed, it poses the greatest threat to life and health due to its potential of contaminating terrestrial, aquatic and aerial environments [4]. This contamination of surface water, groundwater, soil and air is associated with wide range of human health and ecological impacts thereby contributing to the degradation of vital natural resources [5]. The dumpsites in most developing countries are usually unlined shallow hollow excavations arising from abandoned burrow-pits and quarry-sites without any environmental impact assessment studies [6]. Eventually these waste dumpsites with waste heaps become a potential threat to the soil and the underground water resources due to the leachate percolation in course of time. The leachate from

open dumps and landfills contain both chemical and biological constituents [7]. Million tons of solid wastes from different sources like industrial, agricultural, commercial, residential, etc; pave their way onto the soil interfering with the natural activity of the soil. While the proliferating population and demand of food is making the farmers to use high yielding fertilizer varieties which are expensive yet yield farmers the intended production percentage. In this context the economically meager farmers are compelled to use the soils from the dump yards as the soils are rich in organic matter required for the crop growth unnoticed of the future problems. Several wastes from different sources find the way into the environment and finally end up in the dump sites posing severe contamination of soil due to the heterogeneity. Soils serve as a natural sink for the pollutants released from both natural and man-made sources. Though the municipal solid waste in developing countries like India is mostly food wastage, the decomposition of the organic matter will change the physico-chemical properties of the soil affecting the underlying groundwater sources through leachate percolation. Assessment of soil pollution becomes difficult when contaminants belong to different sources and their products are variably distributed [8]. Solid waste pollutants serve as an external force affecting the physico-chemical characteristics of soil ultimately contributing towards the poor production of vegetation [9].The disturbances of higher intensity sometimes endanger the survival of some species and yield to low richness [10].Therefore it is utmost important to understand the soil geology and chemistry to assess the impact of the pollutants released onto the fertile layer. Many works were carried throughout the world to interlink and establish the connection between the soil quality to microbial, plant, animal, and human health. The efforts made by the authorities in the study site still need some expertise to solve the problems arising out of the municipal solid waste disposal.

The present paper is an attempt to analyze the physico-chemical parameters of the soil samples collected from the dump yard of the Visakhapatnam city.

METHODOLOGY:

STUDY AREA

Visakhapatnam the urban agglomeration covers an area of 545 km^2 and is one of the fast growing metropolitan in the state of Andhra Pradesh with an estimated population of 20 lakhs. The city is nestled between Eastern Ghats and Bay of Bengal. Greater Visakhapatnam city stands for its natural beauty and often known as the "***City of Destiny***". Geologically the study area has a variety of soil forms like sandy, clayey, alluvial etc; but most predominantly dominated by the Khondalites group. The city generates a total of 1000 MT/day of municipal solid waste which is unscientifically managed since 20 yrs. The municipal dump yard lies between latitude $17^0$50'45 26"N and longitude 83^0 22' 03 27'E in Kapuluppada village located in Bheemunipatnam of Visakhapatnam district, Andhra Pradesh. The dump yard is located 25 kms away from the city in about 100 acres. The dump yard has a thick coppice and is in close propinquity to the Bay of Bengal on one side and bounded by agricultural villages on the other side which is a basis for the selection of this site. Though Visakhapatnam is one of the major industrial zones still lacks in few service deliveries like sewerage systems, medical facilities and sanitation which makes it a rationale for selection of this area for the study.

Fig 1 – Location of the Andhra Pradesh state

Fig 2 – Location of district

Fig 3 - Satellite imagery of the dump yard

SAMPLE COLLECTION:

Approximately 1kg of composite soil samples were collected at a depth of 15cms from the waste disposal site at different distances into clean polythene air-tight bags to prevent any further changes in moisture and volatile matter. The soil samples were brought to the laboratory air- dried and the lumps of the air dried samples were broken down in a porcelain motor. The soil samples were sieved using a 2mm sieve as per standard methods. The soil samples were later analyzed for pH, EC, moisture, N, P and K. A comparative study has been made between the control soil collected far from the activity of municipal solid waste dumping and the soils collected from the dump yard within huge heaps.

RESULTS:

Physico- chemical properties of soil samples at the dump yard

Parameter	**S1** Close proximity to MSW activity	**S2** 1km distance	**S3** 2km distance	**S4** 3km distance	**S5** Control sample away from dumpsite
pH	6.18	7.63	7.84	7.86	8.34
EC (mmhos/cm)	1.24	1.18	1.14	1.09	1.03
Moisture (%)	36.04	31.12	28.03	24.02	18.10
Organic Carbon	3.04	2.13	2.04	1.42	0.8
Nitrogen(Available) Kg/acre	262	187	144	115	62
P_2O kg/acre	91	84	76	73	34
K_2O kg/acre	363	235	179	157	15

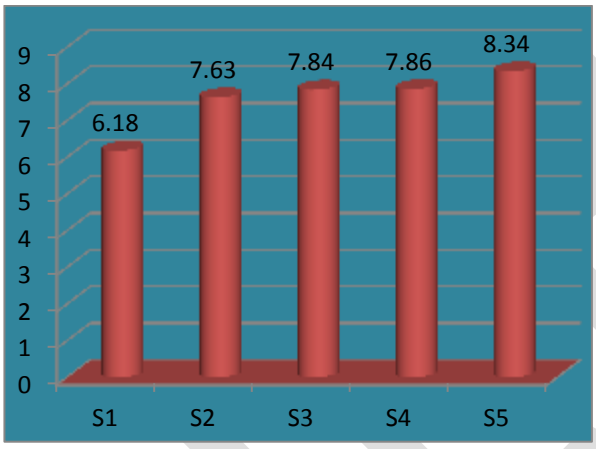

Fig 4 – pH

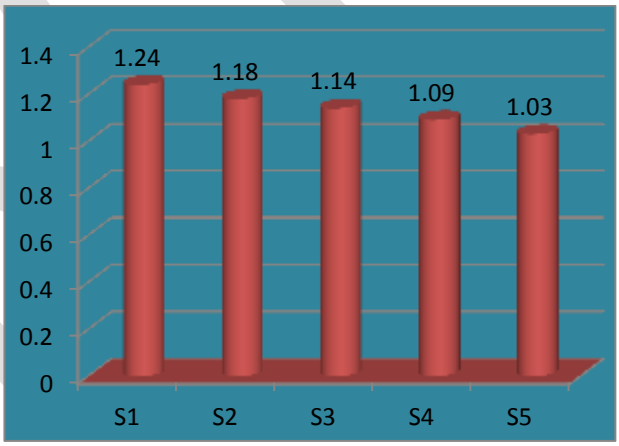

Fig 5 – EC

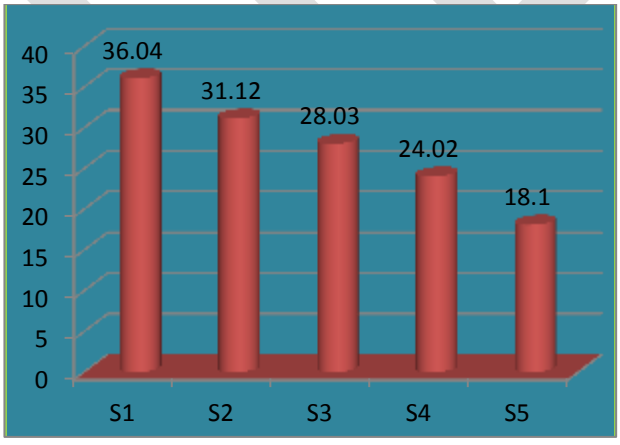

Fig 6 – Moisture

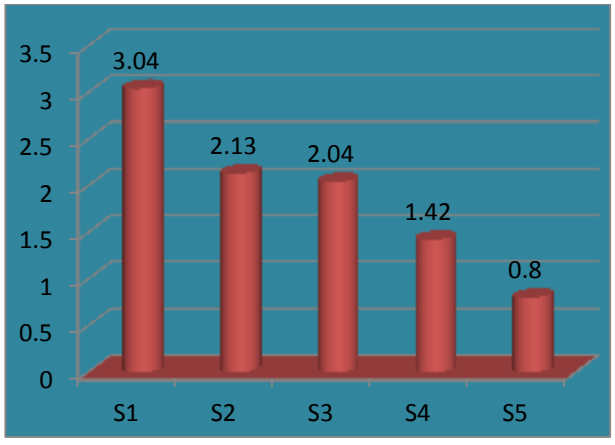

Fig 7 - Organic Carbon

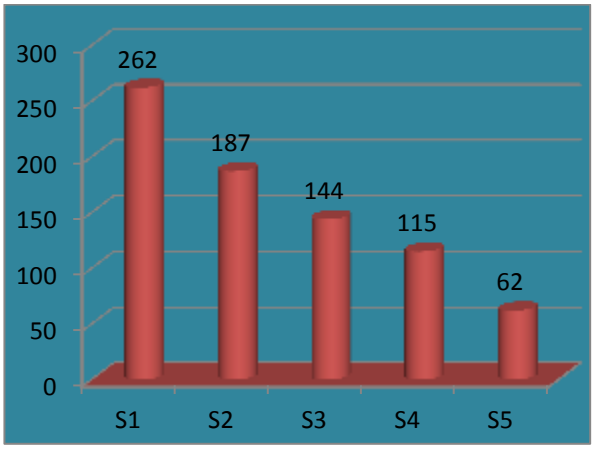

Fig 8 - Available Nitrogen

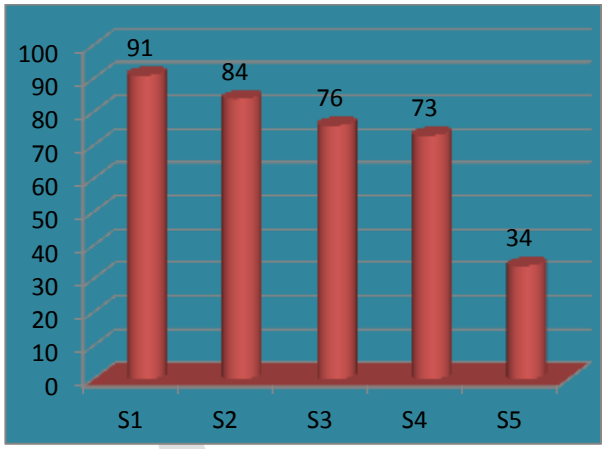

Fig 9- Available Phosphorus

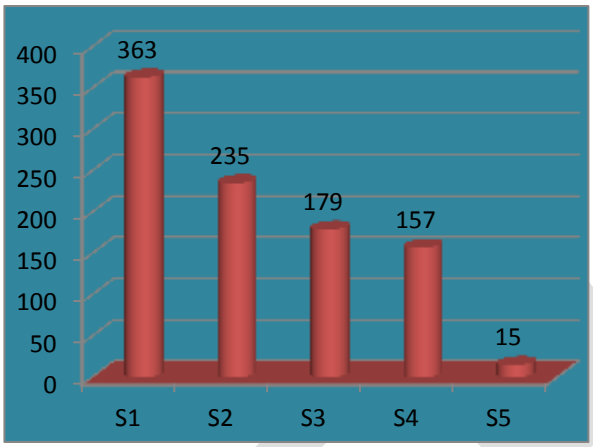

Fig 10 - Available Potassium

Fig 11 - View of dump yard

DISCUSSION:

The soil samples collected from the dump yard showed variation in physico-chemical parameters. The pH is a basic measure for identification of the chemical nature of the soil. The sample collected close to the MSW activity showed pH of 6.18 due to the decomposition of organic matter leading to the formation of organic acids which indicated slightly acidic soils. In general, leachate generated from young acidogenic landfills are characterized by high concentrations of organic and inorganic pollutants [11].The acidification of soils could possibly affect the nutrient supply to the plants and increase in soil micro-nutrients toxic for the growth of crops. While the samples collected at regular distances in the dump yard showed alkaline pH with increasing trend which usually depends on soil texture, porosity and infiltration capacity of the water in the dump yard. The alkaline nature of the soil samples collected slightly away from the dumping activity showed increasing pH level which is very often encountered at landfills aging 10 years after disposal [12]. However the increase in soil pH decreases the soil micro-nutrient availability to the plants. While either of the extreme pH conditions can affect the survival of plants which has to be modified for specific crops. The electrical conductivity of the soils close to the dumpsite was high compared to the soil sample at the control site. The high EC is due to the increase in the salts and ions. Conductivity value of less than 0.5milliScm^{-1} is perfectly safe and it doesn't have any negative effect on plant growth. The study identified that the soil samples both at the dump yard and the control site are above the permissible range which is toxic to plants and may prevent them from obtaining water from soil [13]. Moisture content was high in the soils close to the activity of MSW due to

high organic matter and soil microbial activity [14], which showed a considerable decrease within the dump yard at specific distances and at the control site. The result obtained agree with the findings of [15], who reported decrease in moisture content with increase in distance from the refuse dump site. The percentage organic carbon ranged from 1.42 to 3.04% with the highest value at the functional area due to decomposition of organic matter and lowest organic carbon percentage at the control site. The soils were found to be highly enriched with the nitrogen levels which ranged between 115kg/acre to 262kg/acre with the lowest value of 62kg/acre in the control soil sample. The phosphorus content in the dump yard soils ranged between 73 to 91kg/acre with the lowest value of 34kg/acre at the control site. The high nitrogen and phosphorus content recorded in dump site soil could be attributed to high organic matter found in dump soil [16]. Potassium content in the dump site soils ranged between 157 kg/acre to 363 kg/acre while lowest of 15 kg/acre at the control site. Though potassium is a soil nutrient helpful for the plant growth the anthropogenic activities could result in increase in the potassium levels which is source of groundwater contamination.

CONCLUSION

The indiscriminate dumping of municipal solid waste revealed a considerable change on the soil qualities in the dump yard. The study showed that all the parameters are in high concentration as per the Indian Agricultural Standards which could be deteriorated further by dumping of municipal solid waste thereby increasing the toxic substances in the dump yard soils. The study also revealed that the fertility of the soil in dumpsite has been altered and thus show both positive and negative aspects which have to be further investigated.

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