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Effect of Mehmood Booti Dumping Site in Lahore on Ground Water Quality

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Abstract

A study was carried out to elucidate the effects of Mehmood Booti dumping site in Lahore on the quality of groundwater in conterminous areas and recommend improvement measures. For this purpose, five tube wells were selected for collection of water samples. One of these was located within the premises of Mahmood Booti dumping site while another tubewell at a distance of 8km near Mall Road was selected as the control point to compare the test results. Three samples from each sampling point were collected before monsoon and three after monsoon with a total of thirty (30) samples for statistical significance. To find out the effect of leachate on groundwater quality, five parameters i.e. turbidity, pH, hardness, total dissolved solids and fecal coliform were tested. Mean value of test results was compared with the World Health Organization (WHO) guidelines for drinking water. It was indicated by the test results that physico-chemical quality of all sources (tubewells) was satisfactory. The test results indicated that 20% of water samples collected from the tube wells before monsoon contained fecal contaminant and that percentage rose to 60% after monsoon. The analysis of results showed that Mehmood Booti dumping site has no significant effect on the selected water quality parameters.

Key Words: Landfill**;** Water quality; Lahore; WASA; Physiochemical characteristics; Bacteriological characteristics.

1. Introduction

Water is undoubtedly the most essential element for survival of humans and other species. Human health and survival is so dependent on the availability of safe, clean and uncontaminated water that a human can survive for only about 4 days without it (Kendall, 1992). Water is the fundamental requirement for several processes taking place in human body like digestion of food, transportation of nutrients, absorption, building of tissues and regulation of temperature. Generally a water consumption of about two liters per capita per day for a person weighing 60 kg is cited (WHO, 1996).

The quality and quantity of water resources in a country are generally affected by the rapid population growth, urbanization, industrialization, agricultural practices, sanitation facilities and unsustainable water consumption practices. The main sources of ground water contamination in a country are poor sanitation services, improper solid waste management, lack of wastewater treatment facilities, poor drilling of wells, and extensive use of fertilizers, pesticides and other chemicals for agriculture.

On the basis of population, Pakistan, at present, is the sixth largest country of the world with a population of 175 million and a population growth rate of 2.1 percent (NIPS, 2002). Pakistan is blessed with adequate surface and ground water resources which have ensured a water supply coverage of about 91 percent of population and sanitation coverage of about 59 percent of population (WHO & UNICEF, 2008). Unfortunately, only about 66 percent of total population in Pakistan has access to safe drinking water (PMDG Report, 2005). In Punjab groundwater is the major source of water supply. Nevertheless the quality of groundwater is subject to deterioration due to the reasons cited above. With particular reference to Lahore, groundwater is suspected to be polluted due to the dumping site at Mehmood Booti. A research study was therefore initiated with the following objectives: (1) To find out the effect of Mehmood Booti Landfill Site, Lahore on the quality of ground water in adjoining areas. (2) Suggest and recommend remedial measures if the research results show any adverse effects on the groundwater.

2. Materials and Methods

2.1 Parameters Tested

Five water quality parameters were selected for this research work. Physicochemical parameters pH, Turbidity, hardness, TDS and one bacteriological parameter fecal coliform was tested. Disinfection process effectiveness depends upon pH and turbidity of water. Turbidity also decreases the aesthetic quality of water and imparts colour in water. High TDS concentration may produce taste. Hardness causes reduction in soap leather production feature and also produces scaling problems in pipes and pumps. Bacteriological parameter fecal coliforms tells the possible bacterial contamination in water. All these parameters were tested according to the methods laid down in Standard Methods (1998).

2.2 Sampling Area

Mahmood Booti is the only authorized dumping site owned by the City District Government Lahore (CDGL) and is located north of Bund Road. The site is in flood plane of river Ravi which flows at a distance of 5 km away. The site is spread over an area of 32 hectare which includes 15 hectare of the Lahore Compost Plant (Lahore Compost ESIA, 2008). The solid waste collected from the Aziz Bhatti Town, Shalimar Town, Data Town and a part of Gulberg Town is handled by Mehmood Booti dumping site. The direction of flow of ground water in the study area is from North to South and the velocity of flow lie in range of 1-1.5 cm/day (Schnoor, 1996). The composition of the dumping material is shown in Table 1 (Hayat and Haydar, 2011). As regards the characteristics of dumping site, it is pertinent to mention that it is neither a stable nor a controlled type site. The solid waste is presently being openly dumped and no measures are being exercised to control or treat the leachate produced. However, there are future plans to convert this dumping site into a properly controlled landfill site.

Table 1: Composition of dumping material.

Sr.#	Component	% by wt
1.	Vegetable + Fruit residues	30.32
2.	Paper	2.7
3.	Plastic and rubber	5.63
4.	Leaves, grass, straws	20.32
5.	Rags	7.5
6.	Wood	1.24
7.	Bones	1.03
8.	Animal waste	2.37
9.	Glass	0.7
10.	Metals	0.32
11.	Dust, Ashes, stones, bricks	27.83
12.	Unclassified	0.04

Typical characteristics of the leachate have been exhibited in Table 2 (Tchobanoglous et. al., 1993).

Table 2: Typical characteristics of leachate

Parameter	Value (mg/L)
BOD	10,000
COD	18,000
Total suspended solids	500
Total Phosphorous	30
Total hardness as $CaCO_3$	3500
Chlorides	500
sulfate	300
Total Iron	60
pH	6
Total Nitrogen	400

To determine the effect of leachate produced from biodegradation of organic matter in the dumping site, on groundwater, five tube wells locations were selected for the evaluation of drinking water quality. Location plan of these tube wells is shown in Fig 1(Faragh, 2011).

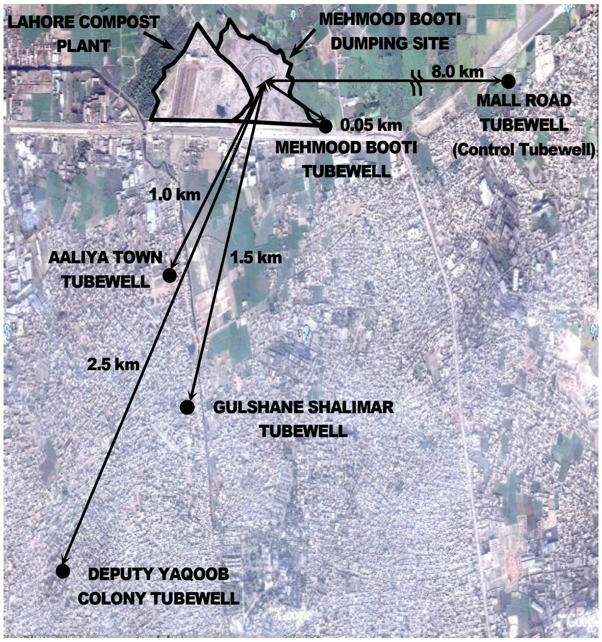

Fig 1: Location plan of tubewells

Water samples from these tubewells were collected and analyzed to evaluate their physical, chemical and bacteriological quality. One tube well was located inside the premises of Mahmood Booti dumping site. A tube well near Mall Road, at a distance of about 8km from Mehmood Booti, was selected as control tube well to compare the test results. All tube wells were 600 ft deep. Arial distance of selected tubewells from Mehmood Booti dumping site including tubewell capacity is given in Table 3.

Table 3: Tube wells description

Sr. No	Tubewells	Capacity	Arial Distance from Mehmood Booti
		(cusecs)	(km)
1	Mehmood Booti Tubewell (T1)	4	0.05
2	Aaliya Town Tubewell (T2)	4	1
3	Gulshane Shalimar Tubewell (T3)	4	1.5
4	Deputy Yaqoob Colony Tubewell (T4)	4	2.5
5	Mall Road Tubewell (T5)	4	8

Solid waste at Mehmood Booti is not properly covered with clay layer to avoid rain water penetration. Thus rain, during monsoon season, falling on the solid waste could have increased the amount of leachate entering the sub-surface water. Therefore, in order to take into account the possible effect of monsoon rains, it was decided to take samples before and after monsoon. Three samples were collected from each tube well before and after the monsoon. In this way, a cumulative number of 30 samples were collected and tested for this study.

2.3 Sampling Methodology

Sampling was done in a way to eliminate chances of any external contamination which could affect the test results. Cleaned plastic polyethylene bottles, rinsed with distilled water, were used for pysico-chemical parameters. For bacteriological parameter, the bottles were sterilized at 121 °C for 15 minutes as directed in section 9030 and 9040 of Standard Methods, 1998. For bacteriological and physicochemical analysis, plastic bottles of 0.5 liter capacity and 1.5 liter capacity were used, respectively.

Only those taps were used for sampling from tubewells that were directly connected with the delivery pipes. Water was allowed to run for at least 10 minutes from the tap before the sampling bottles were filled without splashing.

During sampling, ample air space (at least 2.5 cm) was maintained in the bottles to allow mixing and shaking before the laboratory examination. The bottles were immediately closed and sealed after taking samples to avoid any external contamination.

For reporting results of various selected parameters, mean values of the three samples before and after the monsoon were used.

3. Results and Discussion

3.1 Turbidity

Turbidity results of all the samples taken from each tubewell are plotted in Fig 2. It can be seen in Fig. 2 that mean values of turbidity varied from 0.7 NTU to 1.3 NTU before monsoon and 0.9 NTU to 1.8 NTU after monsoon. It can be concluded that turbidity increased after monsoon and decreased as distance from Mehmood Booti dumping site increased from tubewell T1 to control tubewell T5. Turbidity of all the sources lie within the range of WHO guide lines value i.e. 5 NTU.

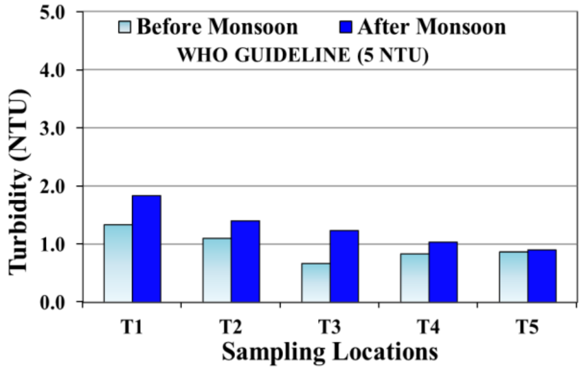

Fig 2 Comparison of mean values of turbidity before and after monsoon at various sampling locations

3.2 pH

pH results of each tubewell water are plotted in Fig 3. It can be observed that mean values of pH varied from 6.9 to 7.3 before monsoon and 7.0 to 7.6 after monsoon. The test results show that pH slightly increased after monsoon. pH values above 8 are not suitable for effective disinfection while values less than 6.5 enhance corrosion of pipe network. Mean values of pH are within the range of WHO guide lines i.e. 6.5 – 8.5. It can also be observed that pH value of tubewell T1 is slightly higher than other tubewells. Perhaps this may be due to some effect of the dumping site.

3.3 Hardness

Hardness detected in samples taken from all the tubewell is plotted in Fig 4. The mean values of hardness of all the samples varied from 140.3 to 209.7 mg/L as $CaCO_3$ before monsoon and 174.3 mg/L to 250.7 mg/L after monsoon. The effect of monsoon has also been found on test results and hardness of all the samples increased after monsoon. It can also be seen that hardness of samples first decreased as distance increased from tubewell T1 to T3 from the dumping site. However, the hardness values again rose for T4 and T5. Therefore, no definite correlation between the distances of dumping site with the increase of hardness can be established. This change of hardness may be attributed to the change in the underground lithology of the earth crust. Upon comparison of the mean values of hardness with WHO guide lines value (500 mg/L as Ca CO_3), quality of all the samples were found satisfactory.

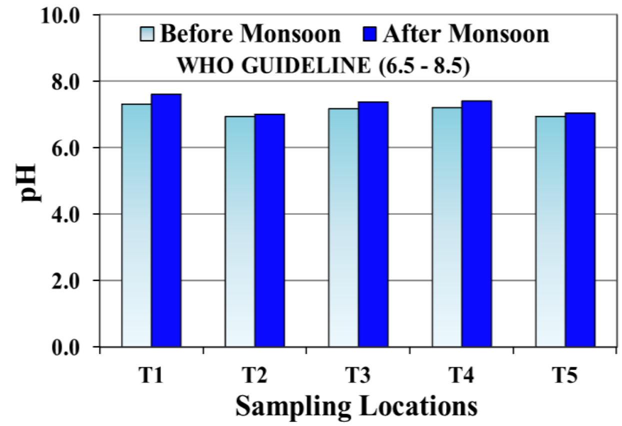

Fig.3 Comparison of mean values of pH before and after monsoon at various sampling locations

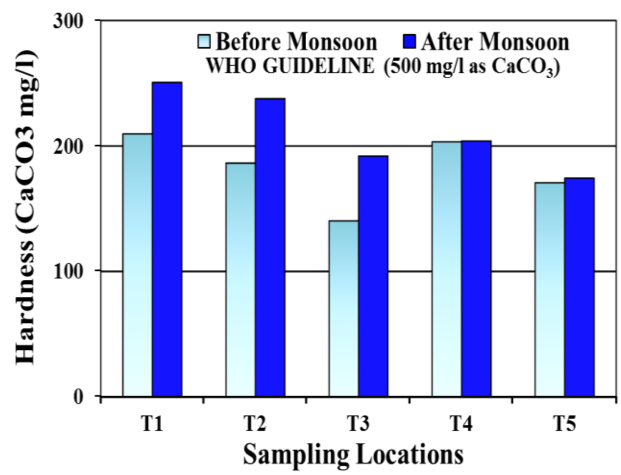

Fig.4 Comparison of mean values of hardness before and after monsoon at various sampling locations

3.4 Total Dissolved Solids (TDS)

Total dissolved solids present in all the samples taken from tubewells are plotted in Fig. 5. From Fig. 5 it can be observed that mean values of TDS are influenced by monsoon and the values varied from 218.0 mg/L to 347.7 mg/L before monsoon and 227.0 mg/L to 407.7 mg/L after monsoon. The test results showed that TDS value of tubewell T1 is higher than all other tubewells. It can also be seen that TDS decreased as distance increased from tube well T1 to control tube well T5. This may be due to close proximity of tube well T1 with the Mehmood Booti dumping site. TDS of all the sources are satisfactory as compared to WHO standard value of 1000 mg/L.

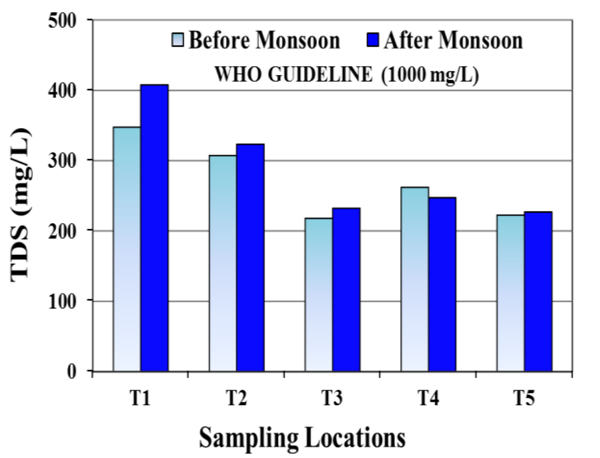

Fig.5 Comparison of mean values of TDS before and after monsoon at various sampling locations

3.5 Fecal Coliform (FC)

The fecal contamination detected in each tubewell is plotted in Fig 6. The test results showed the fecal contamination at tube well T1 varied from 3 MPN/100ml to 10 MPN/100ml after monsoon. Fecal Coliform at tube wells T2 & T3 were detected only after monsoon, and were not detected at tube wells T4 & control tube well T5 before as well as after monsoon. Whether the fecal contamination is due to the solid waste dumping site or due to unhygienic conditions of taps from which the water was drawn, is hard to say. Furthermore, leakages observed in pumping assembly due to old and rusted parts and inadequate maintenance of the tube wells may be another cause of fecal contamination. Further research is needed to ascertain the causes of fecal contamination.

It can also be seen in Fig.6 that fecal contamination rose after monsoon in T1. Furthermore, it was not present in T2 and T3 before monsoon, however, it appeared in both these tubewells after the monsoon. While no fecal contamination was found in tubewell T4 and T5 before and after the monsoon. In terms of percentage, 20% of the samples were focally contaminated before monsoon and this contamination rose to 60% after the monsoom.

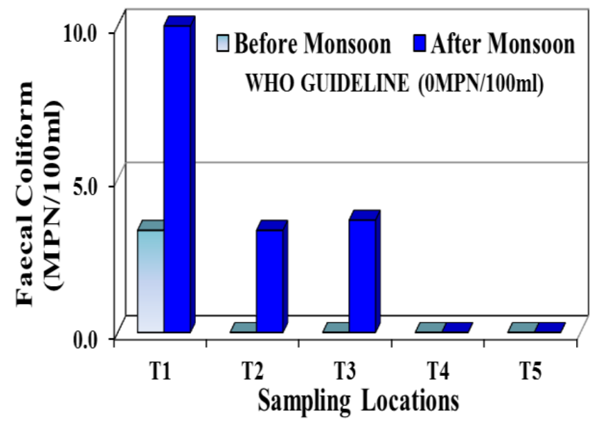

Fig.6 Comparison of mean values of fecal coliform before and after monsoon at various sampling locations

4. Conclusions & Recommendations

1. All the samples collected from sources (tubewells) before and after monsoon and tested for physicochemical parameters (turbidity, pH, hardness, TDS) were found within the desirable limit of drinking water quality as mentioned in WHO guide lines. This shows that Mehmood Booti dumping site has no appreciable effect on the adjoining groundwater quality. Perhaps this may be due to the ground water being at a depth of more than 100 ft and overlain by clayey strata.

2. The test results indicated that the physicochemical parameters (turbidity, pH, hardness, TDS) for all sources (tubewells) increased after monsoon in comparison to the values obtained before monsoon.

3. The test results showed that turbidity and TDS for all sources (tubewells) decreased as distance increased from tubewell T1 (Mehmood Booti Tubewell) to control tubewell T5 (Mall Road Tubewell).

4. The test results indicated that 20% of collected water samples from the tubwells before monsoon contained bacteriological contaminants i.e fecal coliforms. Moreover, this

percentage rose to 60% after monsoon. Furthermore, the bacteriological quality of tubewell T1 was unsatisfactory before and after monsoon. It was also concluded from test results that water samples from tubewells T2 & T3 that were not fecally contaminated before monsoon, however, became contaminated after monsoon. Fecal Coliforms were not detected at tubewell T4 & control tubewell T5 before and after monsoon. It can therefore, be concluded that the water from tubewells T1, T2 & T3 is not suitable for drinking.

5. Upgrade the existing open dumping of solid waste to a properly managed sanitary landfill according to Solid Waste Management Guideline keeping in view the groundwater table and soil strata.

6. The leakage problems in pumping assembly should be rectified by replacing old and rusted parts and using chemical sealants at the earliest.

7. Disinfection of water at source is strongly recommended to stop bacteriological contamination. The use of Chlorine chemicals as disinfectant is common in the world. Chlorination equipment must be installed at every tubewell with the surety of effective operation and maintenance.

8. The effective training programmes for operational/field staff and public awareness campaigns for water related issues should be launched.

5. Acknowledgements

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