ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 1. No. 2. May 2012
ASIAN JOURNAL OF SOCIAL SCIENCES & HUMANITIES

GROUND WATER QUALITY ASSESSMENT NEAR MEHMOOD BOTI LANDFILL, LAHORE, PAKISTAN

Butt, Ibtisam.[1] and Ghaffar, Abdul.[2]

[1] Lecturer, Department of Geography, University of the Punjab, & [2]Chairman, Department of Geography, University of the Punjab Lahore, PAKISTAN.
ibtisambutt2009@gmail.com, ghaffarpu@yahoo.com

ABSTRACT

Municipal disposal sites pose serious environmental threats to their surroundings and nearby residents. One of the most dangerous threat is in the form of ground water pollution through leachate percolation in soil that not only makes ground water unfit for certain domestic uses but also unsafe for drinking as well. The present research examined the level of ground water pollution on temporal basis near Mehmood Boti Landfill site in Lahore city, Pakistan. Water samples were collected in the study area during dry and wet seasons from September to December 2010 and were analyzed for microbiological parameters including Total Coliforms (TC), Fecal Coliforms (FC), E.coli, Salmonella spp. and Pseudomonas spp. and selected physical parameters such as pH, total hardness, turbidity, conductivity and total dissolved solids. The effect of depth and distance of water sample sources from the landfill was also investigated. Laboratory results of collected water samples for both seasons show that the ground water is not potable within WHO guidelines particularly in wet season due to high bacterial contamination that may result in many waterborne diseases and other environmental problems. A detailed study of ground water pollution levels and leachate assessment and their effects on environment in the study area is recommended.

Keywords: Ground water pollution, landfill, open dumping, leachate, bacterial contamination, water borne diseases

INTRODUCTION

Landfills and open dumps are a common municipal solid waste management practice and one of the cheapest methods for organized waste management in many parts of the world (Longe & Balogon, 2010; Jhamnani & Singh, 2009). Where these landfills rescue the urban centers in managing their large quantities of dirt, they are identified as one of the major threats to the ground water resources as well (Longe & Balogon, 2010; Sabahi *et al.*, 2009; Fatta *et al*., 1999; Christensen & Stegmann, 1992; US EPA, 1984). Areas near landfills and municipal disposal sites have a greater possibility of ground water pollution because of the potential pollution source of leachate that originates from the decomposition of the organic wastes disposed at these sites and finally percolates into the local aquifers. Such contamination of ground water resources has a substantial risk to the natural environment and to the health of local residents who use these water resources for drinking and other domestic purposes (Mor *et al.,* 2006). Many water borne

ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 1. No. 2. May 2012

diseases including diarrhea, cholera, typhoid, paratyphoid, hepatitis A, dermatitis, enteric fever, and many more are permanent health risks to the nearby residents especially children and elderly people (Butt & Iqbal, 2007).

In recent years many studies have been carried out on the assessment of ground water quality near landfill sites using different approaches and methodologies to find out the level of ground water pollution, bacterial contamination and concentration of heavy metals etc (Mor *et al,* 2006) A number of scholars (Akinbile & Yusoff 2011, Kumar *et al.* 2011, Karanchanawong et al. 2010, Longe & Balogon 2010, Jhamnani & Singh 2009, Sabahi *et al.* 2009, Kumar 2008, Vasanthi *et al.* 2008, Abid & Jamil 2005, Rukah & Kofahi 2001) have examined the possible water contamination around municipal landfills by using the microbiological examination and phyisco-chemical analysis of leachate and ground water. The main focus of these scholars has been to find out the impact of landfills on ground water quality, quantitative analysis of level of water contamination and the identification of possible threats to the local environments and residents as well. Mehmood Boti Landfill is the oldest municipal disposal site of Lahore and though officially named as landfill but still it is non-engineered landfill where open dumping is carried out. It does not possess any kind of bottom liner and no proper system of leachate collection or any other proper treatment system. This leachate flows to the adjacent low lying areas and depressions and therefore large ponds of leachate are a permanent feature throughout the year within the study area. The situation becomes bitter in summers when monsoon rains intensify the amount of leachate. In the present study an attempt is made to assess the ground water quality nearby Mehmood Boti landfill, Lahore and to figure out the possible ground water pollution and bacterial contamination by using microbiological and physical analysis of ground water samples, as previously no research has been carried out within the study area.

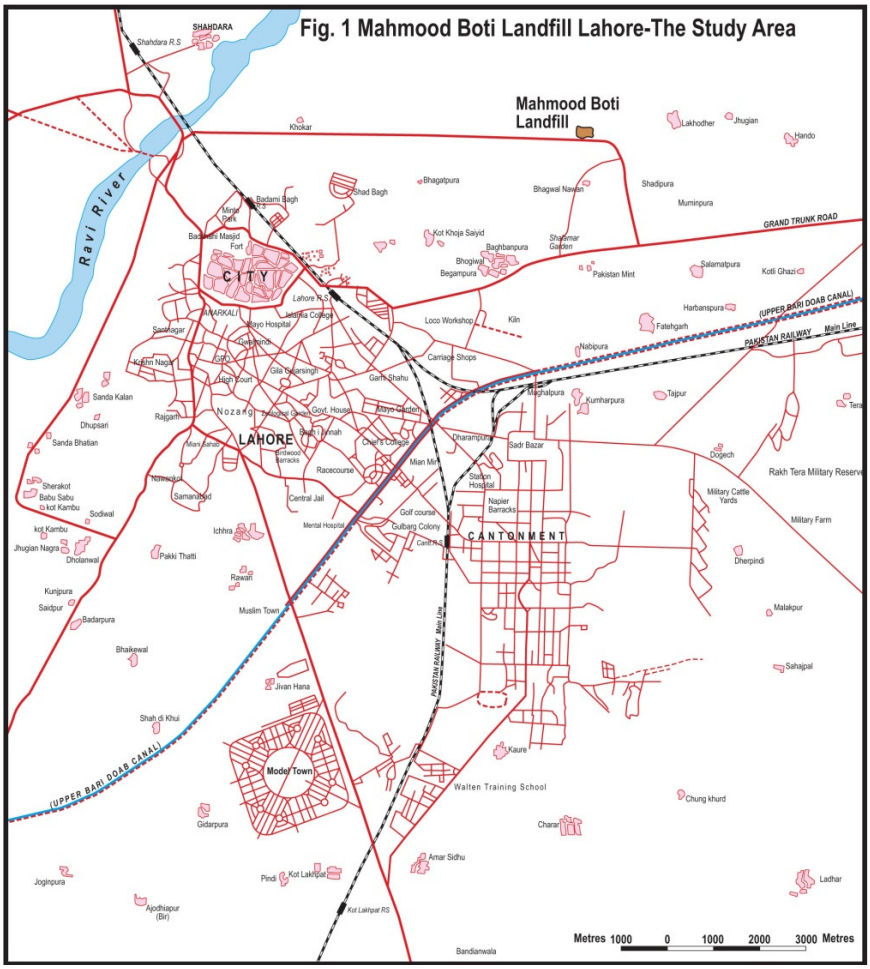
Objectives of the study

The objectives of the study were to examine the quality of ground water in order to figure out the possible water contamination particularly the bacterial contamination due to landfill activity, within the study area and also to identify the seasonal variations found in the ground water particularly bacterial contamination.

The study area

Mehmood Boti Landfill site was selected as the study area in the current research (figure 1). It is situated along Rind road in the north eastern part of Lahore city- capital of Punjab Province of Pakistan is located between 31° 43’ north latitude and 74°39’ east longitudes. It is a flat alluvial plain and has extreme climate mainly sub tropical in nature with two distinct seasons. Summers are intensely hot from April till September with an average temperature of 38° C and mild winters from December till March with an average temperature of 21°C. Lahore receives an average annual rainfall about 470.1mm maximum of it however occurs in July, August and September due to monsoons thereby getting two third of the annual rainfall. November and

December remain the driest months of the year in Lahore (LDA, 2004). The population of the city is estimated as 9,226,092 persons with an average growth rate of 3.5 % per annum (CDGL, 2011). Mehmood Boti Landfill site became operational since 1995 and it covers an area approximately 630 kanals. It receives nearly 1200 to 1500 tons of municipal solid waste per day almost 30 to 40 % of the city's total daily solid waste. Though officially it was announced to be the first sanitary landfill of the provincial capital but unfortunately up till now merely open dumping is carried out which is further facilitated with soil cover and composting at a very limited level and no method of leachate collection at all.



Source: Butt & Ghaffar, 2011

MATERIALS AND METHODS

In order to study the effects of municipal landfill sites on the ground water quality 03 water sample sites were selected within 01 km distance from Mehmood Boti landfill site. The details of water sample sites are presented in table 1 and their locations are shown in figure 2. The samples were carried out from the houses near the landfill which were using local ground water for drinking and other domestic uses. Sources of water samples were either hand pumps or motor

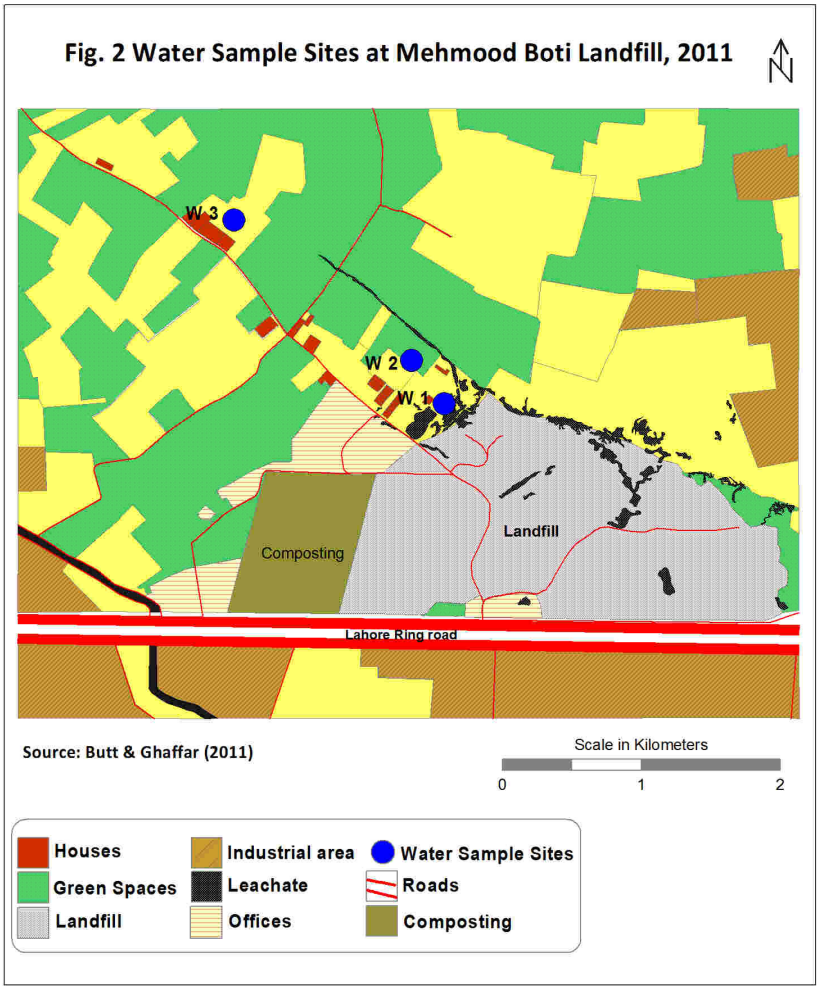
ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 1. No. 2. May 2012

operated tube wells as no other source was available to the people living there. The depth of the water sample sites varied between 25 to 45 meters and their distance from landfill ranged between 15 to 1000 meters.

Table 1: Sampling locations and their distance from landfill

Sample sites	Distance from landfill (m)	Depth of water level (m)	Source
W 1	15	25	Hand pump
W 2	30	35	Tube well
W 3	1000	45	Tube well

Source: Butt & Ghaffar, 2011



In order to find out the temporal variations in the water quality, sampling was carried out in two phases i.e. Phase I in late summers wet monsoon season during September, 2010 and Phase II during dry winter season in December, 2010. Two samples were collected from each sample site in each season. The samples were collected in clean 1.5 liters plastic bottles and after collection they were immediately sent for laboratory examination to Pakistan Council of Scientific and

Industrial Research (PCSIR) Labs at Lahore and were stored in cold room (4°C). The analysis was started without delay for selected microbiological parameters i.e. Total Coliforms (TC), Fecal Coliforms (FC), E. coli, Pseudomonas spp. and Salmonella spp and selected physical parameters such as pH, total hardness, turbidity, conductivity, and total dissolved solids. All the analysis of the water samples for selected parameters was carried out according to the procedures and techniques outlined by APHA 2005 and AOAC 2005. The results were further tabulated in MS Excel 2010 and were represented in form of maps. An imagery of the study area dated 14th May 2011 was initially downloaded from the Google Earth. The obtained imagery was further used to prepare the base map of the study area by using Map Viewer 7. Finally, the excel worksheet were attached with the base map for the graphical representation of data through maps. Some relevant facts were also gathered from the reports prepared by the Municipal solid waste department of City District Government, Lahore (CDGL) and Lahore development authority (LDA).

RESULTS AND DISCUSSIONS

The selected physical and microbiological parameters exhibit certain variations from sample to sample. The physical characteristics of the collected water samples are shown in tables 2 and 3 for wet and dry seasons along with maximum permissible limit recommended by World Health Organization (2004). The ph value is a good indicator of whether water is hard or soft. The pH values of all collected water samples in both seasons ranged between 7.27 to 8.16 and were found to be within limits set by WHO (2004). This shows that ground water is found to be slightly alkaline particularly in dry season (figure 3). Total hardness was found to be within the prescribed limits by APHA (2005) and WHO (2004) except at W1 where it ranged 547.66 mg/l and 609.20 mg/l in wet and dry seasons respectively. This is probably due to the close proximity of the sample site to the landfill, thus making the water unfit for certain domestic uses (figure 4). Values for turbidity were found to be exceeding the WHO limits at two sample sites in wet season i.e. 5.74 NTU at W1 and 8.69 NTU at W3 (figure 5). During winter only one site i.e. W1 showed exceeded limit with 5.57NTU while the turbidity values for other sample sites were within limits set by WH0. The exceeded limits for turbidity especially at W1 in both seasons exhibit the presence of pollutants in the ground water which might be due to the leachate percolation.

Table 2: Physical characteristics of water samples (wet season)

Sample	pH	Total Hardness (mg/l)	Turbidity (N.T.U.)	Conductivity (µS/cm)	Total dissolved solids (mg/l)
WHO(2004)	6.5-8.5	500	5.00	----	<1000
W 1	7.43	547.66	5.74	1543	790
W2	7.82	194.80	4.74	372	190
W3	7.27	218.60	8.69	453	230

Source: Butt & Ghaffar, 2011

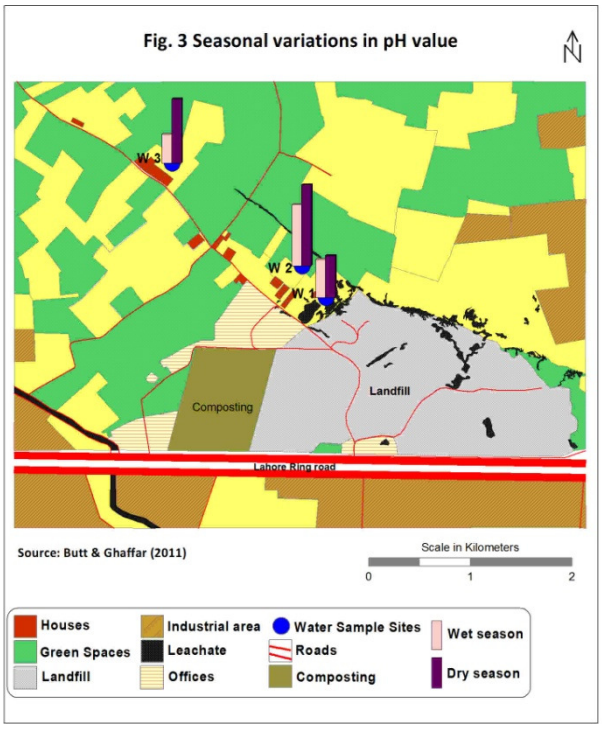
ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 1. No. 2. May 2012

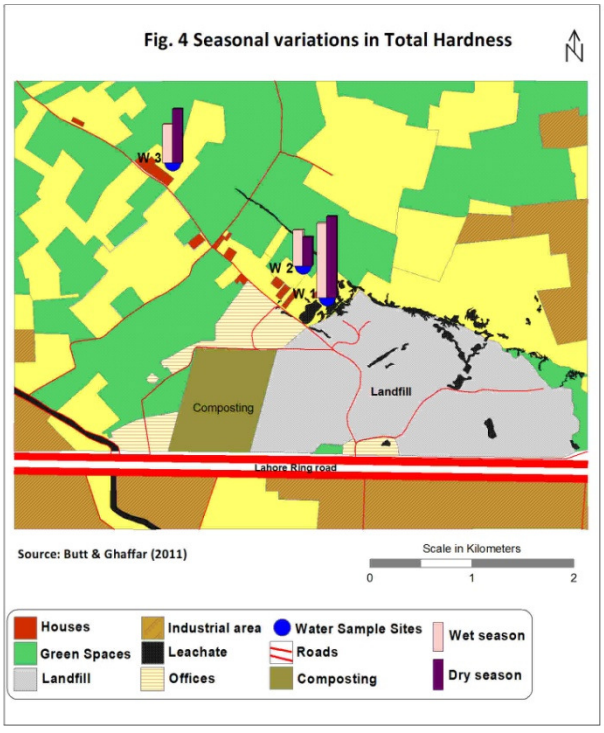
Table 3: Physical characteristics of water samples (dry season)

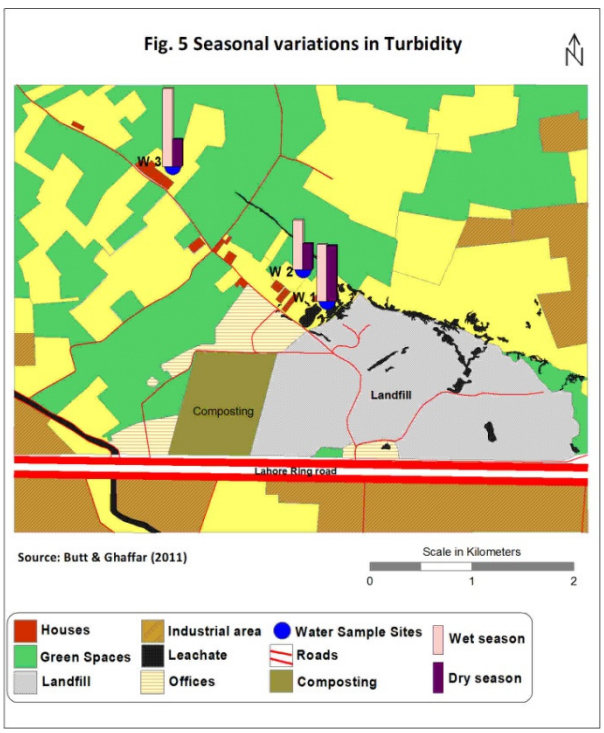
Sample	pH	Total Hardness (mg/l)	Turbidity (N.T.U.)	Conductivity (µS/cm)	Total dissolved solids (mg/l)
WHO(2004)	6.5-8.5	500	5.00	----	<1000
W 1	7.49	609.20	5.57	1263	670
W2	8.16	132.20	1.50	372	190
W3	7.87	356.00	1.67	536	290

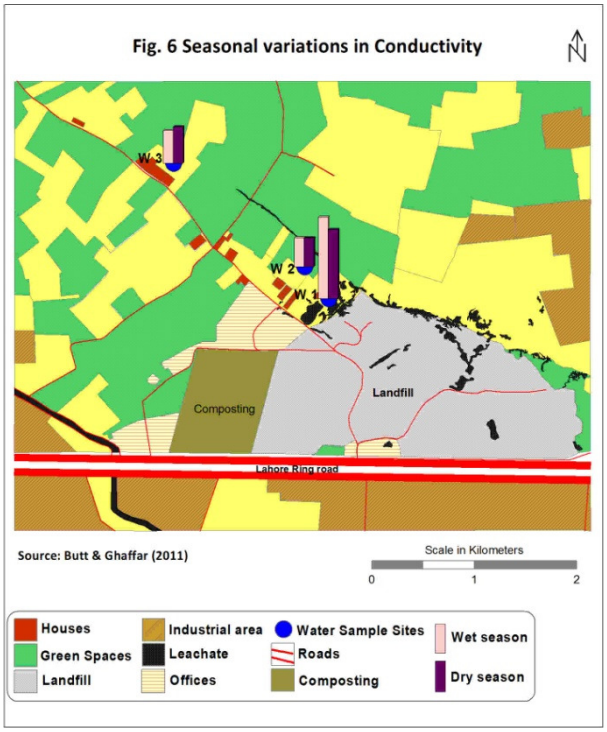
Source: Butt & Ghaffar, 2011

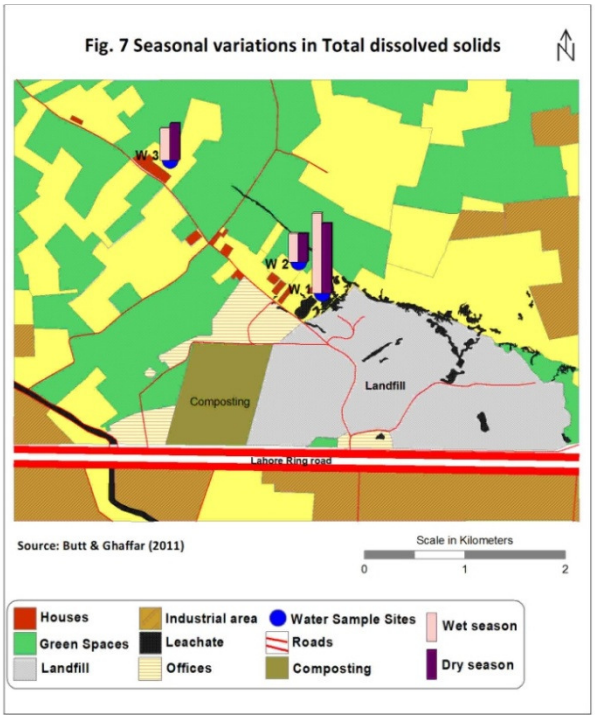
Conductivity is a valuable indicator of the amount of the materials dissolved in water. The conductivity in the study area ranged between 372 to 1543(µS/cm) in both seasons. As it can be fully analyzed from tables 2 and 3 and figure 6 that values for conductivity were found to be high especially at W 1 i.e. 1543 µS/cm and 1263 µS/cm in wet and dry seasons. These high conductivity values obtained at W1 that is closest to landfill indicate the effect of landfill on water quality in form of leachate seepage and inorganic pollution at this specific site. Based on the results for total dissolved solids (TDS) as shown in table 2 and 3 ranged between 190 to 790 mg/l during both seasons thus within permissible limits of WHO(2004). However the concentration was found to be quite higher at W1 with 790 mg/l and 690 mg/l in wet and dry seasons as compared to W2 and W3 (see figure 7). The over whelming values for TDS have also increased the conductivity values particularly at W1.











The microbiological analysis of the water samples showed that significant amount of organic matter is present in ground water at all sample sites which provided nutrition for the growth and multiplication of microorganisms. Table 4 and table 5 show the results of microbiological examination of water samples for wet and dry seasons. Total Coliforms and fecal Coliforms were

ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 1. No. 2. May 2012

found in all water samples and in both seasons with significantly high ranges particularly in wet season thus exceeding WHO limits (see figure 8 and figure 9).

Table 4: Microbiological analysis of water samples (wet season)

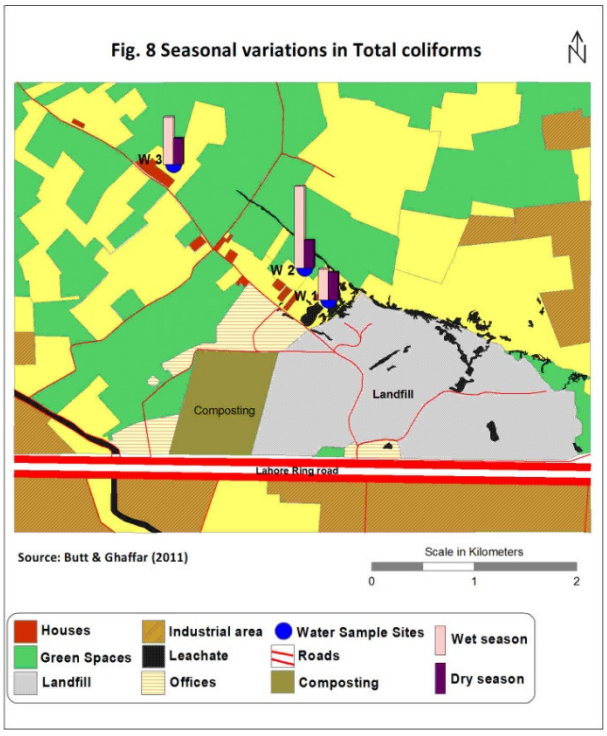
Sample	Total Coliforms (MPN/100ml)	Fecal Coliforms (MPN/100ml)	E.coli (MPN/100ml)	Pseudomonas spp. (MPN/100ml)	Salmonella spp./25ml
WHO(2004)	Zero/100ml	Zero/100ml	Zero/100ml	----	----
W 1	39.0	39.0	33.0	4.5	Detected
W2	350.0	140.0	94.0	17.5	Detected
W3	140.0	94.0	34.0	N.D.	Detected

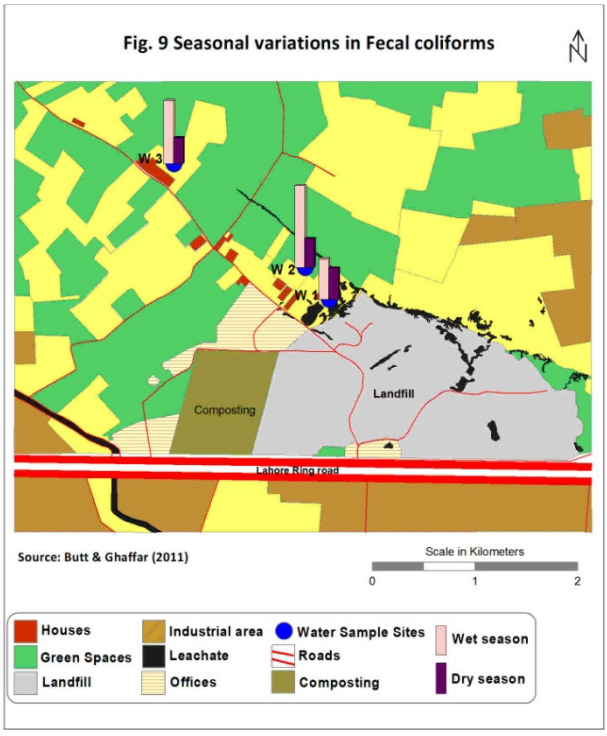
Source: Butt & Ghaffar, 2011 (N.D. not detected)

Table 5: Microbiological analysis of water samples (dry season)

Sample	Total Coliforms (MPN/100ml)	Fecal Coliforms (MPN/100ml)	E.coli (MPN/100ml)	Pseudomonas spp. (MPN/100ml)	Salmonella spp./25ml
WHO(2004)	Zero/100ml	Zero/100ml	Zero/100ml	----	----
W 1	21.0	17.0	7.8	4.0	N.D.
W2	21.0	11.0	4.0	2.0	N.D.
W3	11.0	4.5	4.0	2.0	N.D.

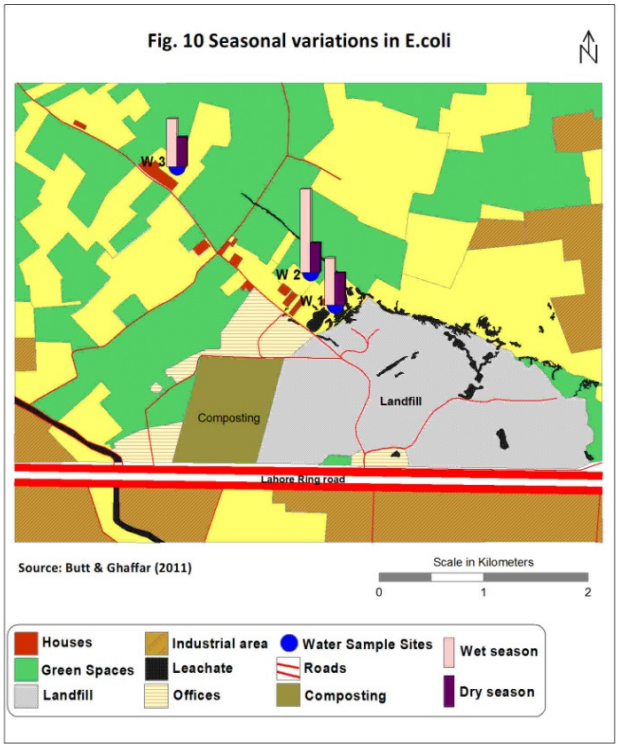
Source: Butt & Ghaffar, 2011 (N.D. not detected)





A similar situation was found in case of E.coli. The presence of E.coli in all water samples and in both seasons with comparatively high values in wet season makes the ground water within the

study not potable and unfit for drinking due to bacterial contamination and poor microbiological quality (see figure 10). The results showed that the collected samples do not meet the WHO limits for bacteriological characteristics that must be zero count per 100ml but all the samples that were analyzed had Coliforms count over 4/100ml. The ranges found for Total Coliforms and Fecal Coliforms and presence of E.coli in all samples indicates the contamination of ground water by leachate. The percolation of leachate has greatly affected the ground water quality particularly in wet season because of heavy summer monsoon rains thus by increasing the health risks associated with using this ground water of deteriorated quality. Though presence of Fecal Coliforms and E.coli in the ground water sample was enough to determine the potential health risks to the individuals exposed to this water, as Fecal Coliforms can cause Hepatitis A and Typhoid while E.coli are considered responsible for diarrheal illnesses. Two further tests were also performed in this regard i.e. Pseudomonas spp. and Salmonella spp. Pseudomonas spp. are considered to be responsible for causing inflammatory skin diseases such as Dermatitis and Salmonella spp. can cause serious illnesses like Typhoid fever, Paratyphoid fever and certain food borne illnesses. The results of both parameters are quite obvious from Table 4 and Table 5. Pseudomonas spp. were found at two sample sites i.e. W1 and W3 during wet season and at all sample sites during dry season thereby increasing the risk of skin rash and other associated diseases. Salmonella spp. were detected only in wet season but at all sample sites therefore increasing the health risks during the season and further more they were found to be completely absent during dry season.



ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 1. No. 2. May 2012

This is clearly evident from the results that Mehmood Boti landfill is greatly affecting the ground water quality of its surroundings through careless handling of solid waste and leachate. There is a great need of ground water monitoring within the study area and the concerned authorities must take certain remedial measures not only to control the existing ground water pollution at the moment but also to prevent further water contamination in future.

CONCLUSION

Municipal landfills are considered a serious threat to their surrounding urban environments and a great source of pollution especially ground water pollution. The present research was carried out to assess the ground water quality near Mehmood Boti landfill through selected physical and microbiological examination of water samples collected from the study area. The major findings of the present research are as following:

1. A high concentration of TDS, conductivity, turbidity, and hardness is found in most water samples especially those obtained from W1 and W3.
2. Seasonal variations are also noticeable in the concentration above mentioned physical parameters with high values of TDS, conductivity, and turbidity more in wet season than in dry season and relatively high range of total hardness in dry season thus exceeding the prescribed WHO (2004) Limits.
3. The microbiological situation of ground water is highly unsatisfactory as all of the water samples have shown the presence of total Coliforms, fecal Coliforms and E.coli along with detection of Salmonella spp. and Pseudomonas spp. and not potable as per WHO standards.
4. Heavy bacterial contamination within the study area is observed during wet season when heavy rains of summer monsoons accelerate the leachate production and seepage into subsoil.
5. Reduced levels of bacterial contamination are found in dry season with total absence of Salmonella spp. still the water remains unfit for drinking.
6. The presence of Fecal Coliforms, E.coli, Salmonella spp. and Pseudomonas spp. show a significant threat to public health and can result in outbreak of many waterborne diseases especially those associated with monsoon and post monsoon seasons.

It can be concluded that the ill practices of waste management carried out at Mehmood Boti landfill site and the absence of leachate collection system has a great impact on the ground water quality of local aquifers. It is strongly suggested that the concerned authorities should take serious steps for the control of ground water pollution and for the safety of local environment and public health as well through improved techniques of solid waste management, leachate collection and ground water monitoring on regular basis.

REFERENCES

Abid, M.A. and Jamil, A. (2005). *The assessment of drinking water quality and availability in NWFP*, Rural water supply and sanitation programme, Peshawar, KPK.

Akinbile, C.O. and Yusoff, M.S., (2011). Environmental impact of leachate pollution on groundwater supplies in Akure, Nigeria, *International Journal of Environmental Science and Development,* 2(1) http://www.ijesd.org/papers/101-F10106.pdf retrieved on 02-01-2012.

Eaton, A.D. APHA, and AWWA, and WEF (2005). *Standard methods for the examination of water and waste water: 21st edition.* American Public Health Association (APHA), American Water Works Association (AWWA), & Water Environment Federation (WEF), Washington D.C. USA.

Butt, I. and Iqbal, A. (2007). Solid waste management and associated environmental issues in Lahore. *Pakistan Geographical Review,* 62(1), 45-50.

Jhamnani, B. and Singh S.K. (2009). Groundwater contamination due to Bhalaswa landfill site in New Delhi, *International Journal of Environmental Science and Engineering,* (1), 121–5.

Kahlown, M.A., Tahir, M.A. and Sheikh, A.A. (2004). *Water quality status in Pakistan: second report 2002 – 2003*, Pakistan council of research in water resources, Islamabad.

Karanchanawong, S., Koottatep, S., and Ikeguchi, T. (1993). Monitoring and Evaluation of Shallow well water quality near a waste disposal site, *Environment International,* 19(6), 579-587. http://www.sciencedirect.com/science/journal/01604120 retrieved on 12-09-2010.

Kumar, S. (2008). Studies on ground water pollution from dumping of municipal solid wastes at Muzaffarpur, Journal of Institution of Public Health Engineers, Kolkata, India. 2008-09(4) http://www.sciencedirect.com/scoence/journal/01401963 retrieved on 08-07-2011.

Kumar, S., Tripathi, V.R., and Garg, S.K. (2011). Physiochemical and microbiological assessment of recreational and drinking waters. *Environmental Monitoring and Assessment,* 29, http://www.ncbi.nim.nih.gov/pubmed/21713494 retrieved on 07-07-2011.

Longe, E.O., and Balogun, M.R. (2010). Groundwater quality assessment near a municipal landfill, Lagos, Nigeria. *Research Journal of Applied Sciences, Engineering and Technology,* 2(1), 39–44. http://www.maxwellsci.com/print/rjaset/v2-39-44.pdf retrieved on 12-09-2010.

Mor, S., Ravindra K., Dahiya, R.P., and Chandra, A. (2006). Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site. *Environmental Monitoring and Assessment,* http://www.uhra.herts.ac.uk/dspace/bitstream/2299/2039/1/902166.pdf retrieved on 12-10-2011.

ISSN: 2186-8492, ISSN: 2186-8484 Print
Vol. 1. No. 2. May 2012

Palamuleni, L.G. (2002). Effect of sanitation facilities, domestic solid waste disposal and hygiene practices on water quality in Malawi's urban poor areas: a case study of South Lunzu township in the city of Blantyre, *Physics and Chemistry of the Earth,* 27, 845-850. http://www.elsevier.com/locate/pce retrieved on 11-09-2011.

Rukah, A.Y. and Kofahi.O.A. (2001). The assessment of the effect of landfill leachate on ground-water quality-a case study. El-Akader landfill site-North Jordan. *Journal of Arid Environments*, 49(3), 615-630. http://www.sciencedirect.com/science/journal/01401963 retrieved on 08-07-2011.

Sabahi, E.A., Rahim, S.A., Zuhairi, W.Y.W., Nozaily, F.A., and Shaebi, F.A. (2009). The characteristics of leachate and groundwater pollution at municipal solid waste landfill of Ibb city, Yemen, *American Journal of Environment Sciences,* (3), 256-266. http://www.amazon.com/characteristics-leachate-groundwater-pollution-municipal/dp/B002QWSV7O5 retrieved on 14-02-2012.

Vasanthi, P., Kaliappan, S., and Srinivasarghavan, R. (2008). Impact of poor solid waste management on ground water, *Environmental Monitoring and Assessment,* August(1-3), 227-238 http://www.ncbi.nlm.nih.gov/pubmed/17999155 retrieved on 12-07-2010.

WHO (2008). *Guidelines for drinking water quality: third edition,* World Health Organization, Geneva Vol.1 http://www.who.int/water_sanitation_health/dwq/gdwq3rev/en/ retrieved on 13-10-2011.