BEST: Journal of Humanities, Arts, Medicine and Sciences (BEST: IJHAMS)
ISSN Applied
Vol. 1, Issue 1, Jun 2015, 1 8

IMPACT OF MUNICIPAL WASTE DUMPING ON SOIL AND WATER AROUND A DUMP SITE IN RAJSHAHI CITY

MOHAMMAD ZAKIR HOSSAIN KHAN, M. G. MOSTAFA&A. K. SAHA

Institute of Environmental Science, Rajshahi University, Bangladesh

ABSTRACT

This study was conducted to understand the impact of open dumping of municipal waste on surface water, groundwater and soil due to the open dumping of solid waste at a site in Rajshahi, Bangladesh. Surface water samples were collected from two locations and ground water samples were collected from one tube well near the dump site. Also soil samples were collected from three locations near the dump site. All the samples were collected at two months interval from August, 2010 to July, 2012. The collected surface and groundwater samples were analyzed for the parameters including pH, EC, DO, BOD_5, COD, CO_3^{2-} and HCO_3^-, Cl, K, Ca, Mg, Na, Cu, Fe, Mn, Zn and As. The major cations of Na^+ and Zn^{2+} were found in the surface water at location S1, 310 mg/L and 0.1 mg/L. Among anions, HCO_3^- and Cl^- were found at concentrations of 446 mg/L and 570 mg/L. The concentration of K^+ and Zn^{2+} were found in the surface water at location S2 1130 mg/L and 0.1 mg/L. Among anions, HCO_3^- and Cl^- were found to be 684 mg/L and 390 mg/L. Mg^{2+} was the dominant ionic species among the cations of the shallow tube well water samples, and at the end of the study it was found at a concentration of 230 mg/L; among the anions, HCO_3^- and Cl^- were found at a concentration of 210 mg/L and 14 mg/L at the end of the study. The concentrations of Fe^{3+} and K^+ were found in the soil in the highest and lowest quantities among cations, respectively at location A and at the end of the study the amount were 165.7 µg/g and 3.12 µg/g respectively at top soil and among anions, S and P were found at concentrations of 255 µg/g and 188 µg/g at the end of the study.

KEYWORDS: Highest and Lowest Quantities

INTRODUCTION

Solid waste consisting of everyday items, predominantly includes food wastes, yard wastes, containers and product packaging, and other miscellaneous organic and inorganic wastes from residential, commercial, institutional, and industrial sources. Sehker and Beukering (1998) stated that the generators of municipal solid waste are broadly classified as residential, industrial, commercial, institutional, construction, demolition, municipal and agricultural types. Glawe et al. (2005) and Erdogan et al. (2008) stated that management of municipal solid waste resulting from rapid urbanization has become a serious concern for government departments, pollution control agencies, regulatory bodies and public in most of the developing countries. Kansal (2002) stated that the quantity of municipal solid waste in developing countries has been consistently rising over the years. Khajuria et al. (2008) stated that ecological impacts such as land degradation, water and air pollution are related with improper management of municipal solid waste.

Historical accounts on waste management suggest that waste disposal methods such as open dumping, burning, burying a rudimentary form of land filling, and composting were practiced from as early as 2000 BC by both the Chinese and the Greeks stated in Environmentalists, Every Day, 2011. Rushbrook (1999) stated that three types of landfills are an integral part of most solid waste systems. These are the open dump, the semi-controlled landfill, and the sanitary landfill. The dumped soild waste produce leachates which contains variety of chemicals like detergents inorganic chemicals and complex organic chemicals and metal.

These components are themselves very much toxic elements which were not present in a free reactive form in the waste. During infiltration of water by rainfall, water already present in the waste, or water generated by biodegradation cause the leachate to leave the dumping ground laterally or vertically and find its way into the ground water or nearby surface water thereby causing contamination. Reinhart (1993) stated that pollutants found in leachate include organic contaminants which are soluble refuse components of decomposition products of biodegradable fractions of municipal solid waste and a variety of heavy metals. Suman Mor (2005) stated that dumped solid wastes release its initial interstitial water gradually and some of its decomposition by- products gets into water moving through the waste deposit. Due to solid waste disposed off on land in open dumps or in improperly designed landfills, it may cause huage impacts on the environment. Ground water contamination by the leachate generated from the dumped site is very common phenomena in recent time.

A WHO Expert Committee (1967) condemned dumping as “a most unsanitary method that creates public health hazards, a nuisance, and severe pollution of the environment. Dumping should be outlawed and replaced by sound procedures”. This study focuses on the Land disposal of solid waste and how current practice of open dumping could be improved to sustainable landfills in a phased manner. The main objective was to carry out a comprehensive baseline assessment of solid waste dumping impact scenario on soil and water around an open dump site in the Rajshahi City.

MATERIALS AND METHODS

The study area was a open dump site for municipal waste of Rajshahi City Corporation, located at Nawdapara City By Pass highway in Rajshahi City, Bangladesh. It is about 8 km away from the city center and almost 3 km away from the nearest community. Everyday about 350 MTs of solid waste are generated in Rajshahi City Corporation (RCC) and about 230 MTs are dumped at dumping site.

There were three water samples, one was from a shallow tubewell and two others were from surface water bodies collected in every second month covering two years (July 2010 to June 2012) to evaluate the seasonal variations, water quality, water type and geochemical process. Water samples collection points are namely S1, S2 and S3 are shown in figure 1. Location points S1 and S2 are the surface water bodies near the dump site. Location point S3 is ground water from 35m depth shallow tube well. The samples were collected in 1 L pre-washed. The groundwater samples were collected after 10 minutes pumping of the shallow tubewell to remove groundwater stored in the well. The collected surface and groundwater samples were analyzed for the parameters including pH, EC, DO, BOD_5, COD, CO_3^{2-} and HCO_3^-, Cl, K, Ca, Mg, Na, Cu, Fe, Mn, Zn and As.

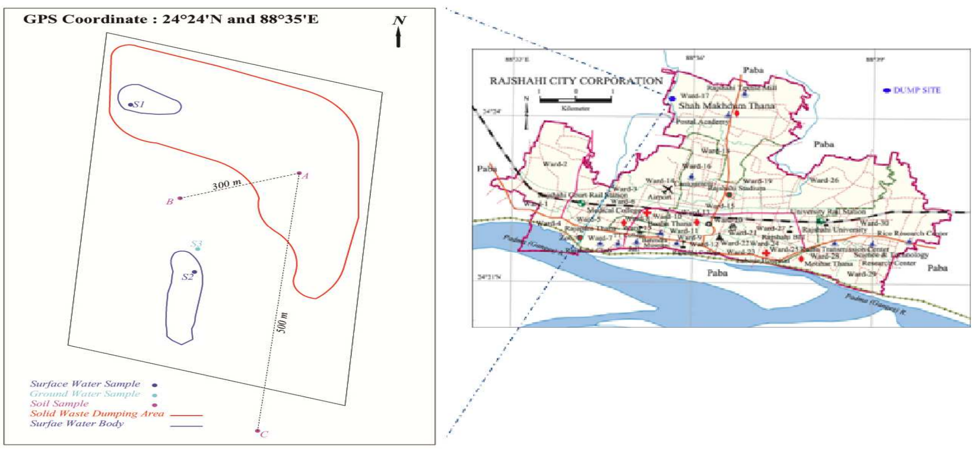

Figure 1: Soil and Water Sampling Location

Soil samples from the study area were collected using hand auger. Samples were taken from three location points of the dumping site namely A, B and C. Location point A was the middle of the dump site, location point B was 100 m away from location A and Location point C was 300 m away from the location point A. The three sampling location points at the dumpsite are shown in figure 1. From each location point, three soil samples were collected, the first one was from the top soil, the 2nd one was from half meter (0.5 m) depth and the 3rd one was from one meter depth. Then collected samples were stored in plastic bags and transported to the laboratory for physical and chemical analysis using standard methods of analysis. pH, K, Ca, P, S, Cu, Fe, Mn and Zn were measured in all soil samples.

RESULTS & DISCUSSIONS

In the beginning at location S1, the mean concentrations of the cations in surface water samples were followed in the order: $Na^+ > K^+ > Mg^{2+} > Ca^{2+} > Mn^{2+} > Fe^{3+} > Cu^{2+} > Zn^{2+}$ and at the end they were followed the order: $Na^+ > Mg^{2+} > K^+ > Ca^{2+} > Fe^{3+} > Mn^{2+} > Cu^{2+} > Zn^{2+}$. The analyses results illustrate that the concentration of all the cations such as Na^+, K^+, Ca^{2+}, Fe^{3+}, Mg^{2+}, Mn^{2+}, Cu^{2+} and Zn^{2+} were increased with time. The concentration of most of the analyzed cations changed rapidly considering their initial value. The results show that Na^+, K^+**,** Mg^{2+} and Ca^{2+} increased about 6, 3, 15 and 21 times, respectively in two years during the study period for the location S1 and they were increased about 7, 10, 18 and 8 times, respectively during the same period at location S2 . Similarly, in the beginning, the mean concentrations of cations for the location S2 were followed in the order: $Na^+ > K^+ > Mg^{2+} > Ca^{2+} > Fe^{3+} > Mn^{2+} > Cu^{2+} > Zn^{2+}$ and at the end of the study, they were: $K^+ > Na^+ > Mg^{2+} > Ca^{2+} > Fe^{3+} > Mn^{2+} > Cu^{2+} > Zn^{2+}$.

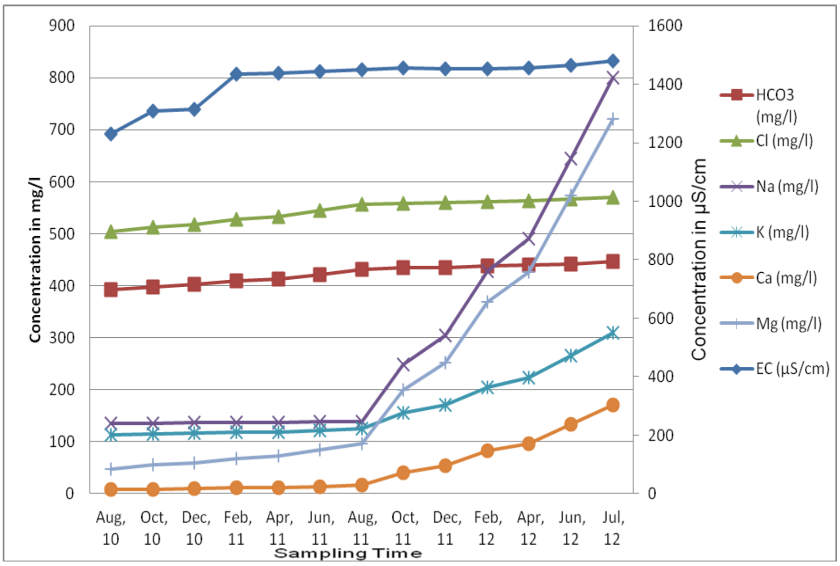

Figure: 2 Variation of EC, Major Cations and Anions with time at Location S1

Variations of EC, major cations and anions with time are shown in figure 2. In the begining concentration of all cations and anions were increased slowly with time, but after August, 2011 major cations were increased rapidly with time due to wash out leachate in surface water during monsoon. The figure illustrates that Na^+ and Cl^- were the dominant ionic species influencing EC values. Azim (2011) stated that landfill leachate was also the main source of high Cl^- concentration in the water body. Birge (1985) reported that in order to protect aquatic life and its uses, for any consecutive 3-day period, the chloride concentration should not exceed 600 mg/L. Cow HAAT is near to the dump site, salt is used for food of cow, therefore that may be one of the reason for increasing of Na^+ at the area. Relatively high Na^+ content in water reduces the infiltration rate at which irrigation water enters soil to such an extent that sufficient water cannot be infiltrated to supply the crop adequately from one irrigation to the next, stated by R.S. Ayers and D.W. Westcot (1998).

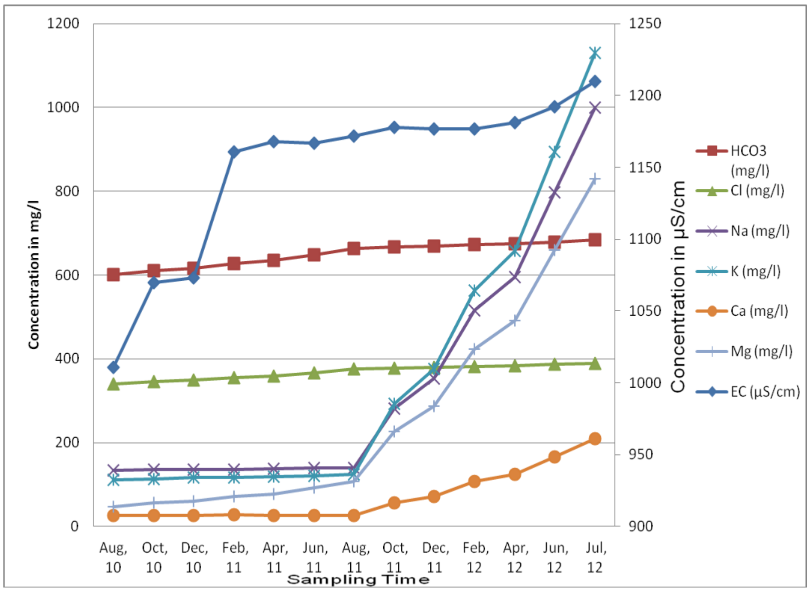

Figure: 3 Variation of EC, Major Cations and Anions with time at Location S2

Water samples Variation of EC, major cations and anions with time are shown in Figure 3. In the begining concentration of all cations and anions were increased slowly with time, but after August, 2011 major cations were increased rapidly with time considered to be washed out of leachate in surface water. The dominent species in the samples were Cl^-, Na^+ and K^+ influencing EC value to increase. High concentration of K^+ indicating the pollution of water bodies by landfill leachate stated by Md. Azim (2011). K^+ salts may kill plant cells because of high osmotic activity stated in CRC (1990)..

Ground water samples were collected from a tube well located around 100 m away from center of dump site. At the beginning of the study cations of the shallow tube well water samples were found Mg^{2+} (46 mg/L), K^+ (10 mg/L), Ca^{2+} (39 mg/L), Na^+ (135 mg/L), Cu^{2+} (0.01 mg/L), Fe^{3+} (0.02 mg/L), Mn^{2+} (0.26 mg/L) and Zn^{2+} (0.01 mg/L). Among the anions, HCO_3^- and Cl^- were found 220.4 and 15.99 mg/L. During study, Mg^{2+} was the dominant ionic species among the cations of the shallow tube well water samples, and it was found 230 mg/L at the end of the study whilst the other determined cations were K^+ (6 mg/L), Ca^{2+} (112 mg/L), Na^+ (114 mg/L), Cu^{2+} (0.24 mg/L), Fe^{3+} (0.55 mg/L), Mn^{2+} (3.44 mg/L) and Zn^{2+} (0.2 mg/L). Among the anions, HCO_3^- and Cl^- were found 210 and 14 mg/L, respectively at the end of the study. In the beginning, the mean concentrations of the cations in the groundwater samples were followed in the order: $Na^+ > Mg^{2+} > Ca^{2+} > K^+ > Mn^{2+} > Fe^{3+} > Cu^{2+}$ and Zn^{2+} and at the end, they were followed in the order: $Mg^{2+} > Na^+ > Ca^{2+} > K^+ > Mn^{2+} > Fe^{3+} > Cu^{2+} > Zn^{2+}$. The results show that concentrations of K^+ and Na^+ were decreased at the end but other cationic concentrations were increased with time. It was also identified that, the concentration of Fe^{3+} was lower than Na^+, Mg^{2+}, Ca^{2+}, K^+ and Mn^{2+} in the beginning of the study but it was changed rapidly compare to others cations.

Shallow tube well was very near to the surface water body S2. It was observed that Fe^{3+} decreased with time at location S2 during study period, it was decreased from 8.84 mg/L to 2.42 mg/L from beginning to end of the study. Therefore that may be the main reason for increase of groundwater concentration of Fe^{3+}. At the end of the study, concentration of Mg^{2+} higher than that of other observed cations. Variation of EC, major cations and anions are shown by figure 3. EC concentration in ground increased with time, and at the same time K^+ and Ca^{2+} concentration in ground water also increased which might be the reason to increase EC. Increase of EC of ground water is the contribution of leachate on the groundwater stated by S. Shenbagarani (2013).

The analyzed results of the study for soil showed for location A that in the beginning of the study the mean concentrations of cations at one meter depth were followed in the order: $Fe^{3+} > Mn^{2+} > Zn^{2+} > Cu^{2+} > Ca^{2+} > Mg^{2+} > K^{+}$ and at the end they were followed in the order: $Fe^{3+} > Mn^{2+} > Zn^{2+} > Cu^{2+} > Mg^{2+} > Ca^{2+} > K^{+}$. Similary the analyzed results of the study showed for location B that at the beginning of the study the mean concentrations of cations at one meter depth were followed in the order: $Mn^{2+} > Fe^{3+} > Ca^{2+} > Mg^{2+} > Cu^{2+} > K^{+} > Zn^{2+}$ and at the end of the study cations were followed in the order: $Fe^{3+} > Mn^{2+} > Ca^{2+} > Mg^{2+} > Cu^{2+} > K^{+} > Zn^{2+}$. At location C, the analyzed results of the study showed that at the beginning of the study the mean concentrations of cations at one meter depth were followed in the order: $Ca^{2+} > Mn^{2+} > Mg^{2+} > Fe^{3+} > Cu^{2+} > K^{+} > Zn^{2+}$ and at the end of the study cations were followed in the order: $Fe^{3+} > Mn^{2+} > Ca^{2+} > Mg^{2+} > Cu^{2+} > K^{+} > Zn^{2+}$. As executed previous reports supported the study results and stated that leachate from surrounding waste dumps increased pollution level of soil (M. Banar et al., 2006; B. J. Alloway, 1990; F. Tahri et al., 2005; Y. P. Lin et al., 2002; N. Amadi et al., 2010; L. Bacud et al., 1994 and J. A. Awomeso et al., 2010).

Excessive level of pollutant present in water capable of causing harm to living organisms. The physical parameters BOD_5 and COD both were increased with time and exceeded the standard limit and they the ground water should be within the limit due to public health concern. The people in and around the dumping site are depending upon the ground water for drinking and domestic purposes. The Contamination of ground water and surface water is the major environmental risk related to unsanitary land filling of solid waste.

Many local people were engaged with solid waste dumping. Also some local people collect materials from dumping site called TOKAI. There is a cow Haat (Haat is a weekly market) adjacent to study area and many people's come to that place during Haat time. There are also small restaurant and tea stall for Haat day. All people of that area at risk from the unscientific disposal of solid waste especially waste workers. Other high-risk group includes population living close to a waste dump and those, whose using surface and ground water has become contaminated either due to waste dumping or leakage from landfill sites. Decomposition of organic waste creates conditions favorable to the survival and growth of microbial pathogens.

CONCLUSIONS

A total of two surface water, one gounndwater (shallow tube well) and three soil samples were collected from study area, respectively from August 2010 to July 2012 at two months interval.

The concentrations of Na^{+} and Zn^{2+} were found in surface water at location S1 in the highest and lowest quantities among cations, respectively and at the end of the stuady the amount were 310 mg/L and 0.1 mg/L. Among anions, HCO_3^- and Cl^- were found 446 mg/L and 570 mg/L. At the same time, the concentration of K^{+} and Zn^{2+} were found in surface water at location S2 in the highest and lowest quantities among cations, respectively and at the end of the stuady the amount were 1130 mg/L and 0.1 mg/L. Among anions, HCO_3^- and Cl^- were found 684 mg/L and 390 mg/L.

The analysis results of the hydro-chemical composition of the shallow tube well water in the study area showed that BOD_5 and COD of the groundwater were too high than the standard of DoE, Bangladesh. Mg^{2+} was the dominant ionic species among the cations of the shallow tube wells water samples. From above result, it was found adverse effect of solid waste on surface water and ground water. As the public health concern, tested all parameters of the ground water should be within the limit. The people in and around the dumping site are depending upon the ground water for drinking and other domestic purposes. The Contamination of ground water and surface water is the major environmental risk related to unsanitary land filling of solid waste. Presence of high concentration of some cations, BOD_5 and COD suggesting that the ground water sample collected from dump site is not suitable for human consumption.

The study concludes that there has adverse impact of open dumping surrounding environment of study area. Lots of local people working there without using personal protecting equipment and improper management of solid waste may create direct health effect. Surface water and ground water pollution caused by improper solid waste open dumping. Leachate generated from solid waste not only contaminated surface water but also contaminated ground water.

This study recommends for proper solid waste disposal and also imposing restrictions to people entering the site without having proper personal protective equipments. There are lots of agricultural lands around study area. To prevent environmental pollution should have to adopt proper solid waste dumping method.

REFERENCES

1. Md. Azim, M. Mahabubur Rahman, Riaz Hossain Khan and A.T.M.M. Kamal, 2011. Characteristics of Leachate Generated at Landfill Sites and Probable Risks of Surface and Groundwater Pollution in the Surrounding Areas: A Case Study of Matuail Landfill Site, Dhaka. Journal of Bangladesh Academy of Sciences, Vol. 35, No. 2, 153160.
2. B. J. Alloway, 1990. Heavy metals in soil. John Wiley and sons Inc., New York, 339p.
3. Birge, W.J., J.A. Black, A.G. Westerman, T.M. Short, S.B. Taylor, D.M. Bruser, and E.D. Wallingford, 1985. Recommendations on numerical values for regulating iron and chloride concentrations for the purpose of protecting warm water species of aquatic life in the Commonwealth of Kentucky. Memorandum of Agreement No. 5429. Kentucky Natural Resources and Environmental Protection Cabinet. Lexington, KY.
4. CRC. 1990. Handbook of Chemistry and Physics, seventy-first edition. D.L. Lide (editor). CRC Press, Boca Raton, FL.
5. ECR, 1997. The Environmental Conservation Rules, Bangladesh
6. Environmentalists Every Day, 2011. History of Solid Waste Management, Available online at, http://www.environmentalistseveryday.org
7. Erdogan, R., Z. Zaimoglu, M. Yavuz Sucu, Fuat Budak and Secil Kekec, 2008. Applicability of leachates originating from solid-waste landfills for irrigation in landfill restoration projects. J. Environ. Biol., 29, 779-784.
8. F. Tahri, M. Benya, E. I. Bounakla and J. J. Bilal, 2005. Multivariate analysis of heavy metal in soils, sediments and water in the region of Meknes, Central morocco. Environ. Monitor. Asses., 102, 405 – 417.
9. Glawe, U., C. Visvanathan and M. Alamgir, 2005. Solid waste management in least developed Asian countries - A Comparative Analysis International Conference on Integrated solid waste management in Southeast Asian cities, Siem Reap, Cambodia.
10. J. A. Awomeso, A. M. Taiwo, A. M. Gbadebo and A. O. Arimoro, 2010. Waste disposal and pollution management in urban areas: A workabale remedy for the environment in developing countries. American Journal of Environmental Sciences, 6(1), 26 – 32.
11. Kansal, A., 2002. Solid waste management strategies for India. Ind. J. Environ. Protect., 22, 444 - 448.
12. Khajuria, A., Y. Yamamoto and T. Morioka, 2008. Solid waste management in Asian countries: problems and issues. Proc. of 4th International Conference on Waste management and environment, 109, 643-653.
13. L. Bacud, F. Sioco and J. Majam, 1994. A descriptive study of the water quality of drinking wells around Payatas dumpsite. Unpublished BSc Thesis, University of the Philippines College of Public Health, 12 – 24.

14. M. Banar, O. Aysun and K. Mine, 2006. Characterization of the leachate in an urban landfill by physicochemical analysis and solid phase microextraction. GC/MS. Environ. Monitor. Assess., 121, 439 – 459.
15. N. Amadi, M. I. Ameh, and J. Jisa, 2010. The impact of dumpsites on groundwater quality in Markurdi Metropolis, Benue State. Natural and Applied Sciences Journal, 11(1), 90 – 102.
16. R.S. Ayers and D.W. Westcot, 1998, Water quality for agriculture, 29 (1).
17. Reinhart, D.R., 1993. A review of recent studies on the sources of hazardous compounds emitted from solid waste landfills: a U.S. experience. Waste Management Research, (11), 257-268.
18. Rushbrook, P., 1999. Getting from subsistence landfill to sophisticated landfill. Waste Management and Research, 17(4), 4-9.
19. S. Shenbagarani, 2013. Analysis of Groundwater Quality near the Solid Waste Dumping Site.
20. Sehker, M. and P.V. Beukering, 1998. Integrated solid waste management: A perspective on Bangalore (India). CREED Working Paper, Series No. 24, 277-295.
21. Suman Mor, Khaiwal Pavindra, R.P.dahiya and A.Chandra, 2005. Leachate characterization and assessment of groundwater pollution near municipal solid waste landfill site. Environmental Monitoring and Assessment, 118, 435–456.
22. Y. P. Lin, T. P. Teng and T. K. Chang, 2002. Multivariate analysis of soil heavy metal pollution and landscape in Changhua Country in Taiwan. Landscape Urban Plan, 62, 19 – 35.