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A Comparative study of Heavy Metals in Leachate and Groundwater near Solid Waste Dumpsite in Kalyan (MS)

Sonal Tawde
Birla College of Arts, Science and Commerce, Kalyan, Maharashtra, India

ABSTRACT

Solid wastes are useless, unwanted or discarded materials that arise from man's activities and cannot be discarded through sewer pipe. A designated place for dumping of refuse is known as dumpsite. The municipal solid waste into our environment has contributed greatly to the increase in levels of heavy metals in soil and vegetations grown in dumpsites. Health risks of heavy metals include reduced growth and development, cancer, organ damage, nervous system damage, and in extreme cases, death. Dump sites have been identified as one of the major threats to groundwater resources. This leachate accumulates at the bottom of the dump site and percolates through the soil. Areas near dump sites have a greater possibility of groundwater contamination because of the potential pollution source of leachate originating from the nearby site. In the present study, the impact of leachate percolation on groundwater quality is estimated from an unlined dump site at Kalyan, Maharashtra. Heavy metals are analyzed in well water samples in different seasons to understand the possible link of groundwater contamination. The concentrations of heavy metals were determined by ICP OES.

Keywords: Solid Waste, Dumpsite, Leachate, Percolation, Ground water, Heavy Metals, ICP OES.

I. INTRODUCTION

Water plays an important role for existence of mankind. The demand of water is rapidly increasing for drinking, irrigation and industrial uses. Large geographical area of Maharashtra State is occupied by hard rock. Kalyan city is nowadays suffering from availability of drinking water due to increase in population. If water from selected sources, is potable then the load on municipal water supply can be reduced. According to [11], solid wastes are useless, unwanted or discarded materials that arise from man's activities and cannot be discarded through sewer pipe. The non-flowing or sticky nature of solid waste gives rise to the accumulation of solid waste on some habitable parts of the earth surface. The soil and plants on these dumpsites will constitute a serious threat to the health of people living around such areas [2].

The placement and compaction of municipal in landfills facilitates the development of facultative anaerobic conditions that promotes biological decomposition of land filled wastes. Hence, leachates of diverse composition are produced, depending on site construction and operational practices, age of the land filled [5]. Solid waste management has become a major environmental issue in India. The growth in Municipal Solid Waste (MSW) in urban centers has outpaced the population growth in recent years. The unsanitary methods adopted for disposal of solid wastes is, therefore, a serious health concern. Dump sites have been identified as one of the major threats to groundwater resources [10, 18]. The dumped solid wastes gradually release its initial interstitial water and some of its decomposition by-products get into water moving through the waste deposit. Such liquid containing innumerable organic and inorganic compounds is called 'leachate'. The impact of dump site leachate on the surface and groundwater has given rise to a number of studies in recent years [1, 6, 8, 12, 14, 17]. The disposal of heavy metals is a consequence of several activities like chemical manufacturing, painting and coating, mining, extractive metallurgy, nuclear and other industries. Those metals exert a deleterious effect on fauna and flora of lakes and streams [9]. The extent of soil pollution by heavy metals and base metal ions some of which were soil micronutrients is very alarming. It has been observed that the larger the urban area, the lower the quality of the environment [9]. Heavy metals may enter the human body via food, water, air, or absorption through the skin in agriculture, industrial or residential settings [7, 13].

Kalyan city now a days suffering from availability of drinking water. Municipal Corporation of Kalyan is not able to supply drinking water for 24 hrs. for the city. Kalyan area is rich in ground water level. From olden times there are large number of wells which were in use. Water from wells near the dumpsite was used for various purposes including drinking. There are some sources, wells and bore wells which are still used by local people.

The present study is aimed at analyzing ground water samples at different dumpsites for their heavy metals concentration. In the present study, the impact of leachate percolation on groundwater quality is estimated from an unlined dump site at Kalyan, Maharashtra. Heavy metals are analyzed in leachate and in well water samples to understand the possible link of groundwater contamination. The objective of this study is to evaluate the groundwater pollution due to the dump site leachate. Such study could aid in quantifying information on the environmental impact of these metals. The data generated will serve as baseline data for future studies which will help in suggesting various techniques that could be used to clean-up these metals from such harsh environment.

II. METHODS AND MATERIAL

The quality of the ground waters from wells of five areas near Adharwadi Dumpsite of Kalyan where ground water is used at a considerable quantity were assessed for heavy metals using 'Standard methods for water and waste water treatment' [3]. The water samples were collected in summer and monsoon seasons. Leachate samples were collected from dumpsite at Adharwadi, Kalyan, Maharashtra State. Five groundwater wells within proximity of 1(one) Kms. from dumpsite which are used for drinking were selected as representative wells. Three samples were obtained from each well at different times. The samples were transported to the laboratory for analysis. In the determination of the availability and composition of heavy metals in the leachates and ground water from each sampling station, the digestive method, as recommended by [15] was used. The procedure was repeated for all the samples. The concentrations of heavy metals were determined by ICP OES (Agilant Technologies 700 series ICP OES). The samples were then analyzed for the metals Lead, Iron, Nickel, Cadmium, Chromium and Copper. Each sample was analyzed three times and the results are expressed as mean ± SD (SD: standard deviation).

III. RESULTS AND DISCUSSION

For the observations Refer Table 1. The graphs obtained from the analysis of metal concentrations are depicted in the figures 1, 2, 3, 4, 5, 6, 7 and 8 respectively.

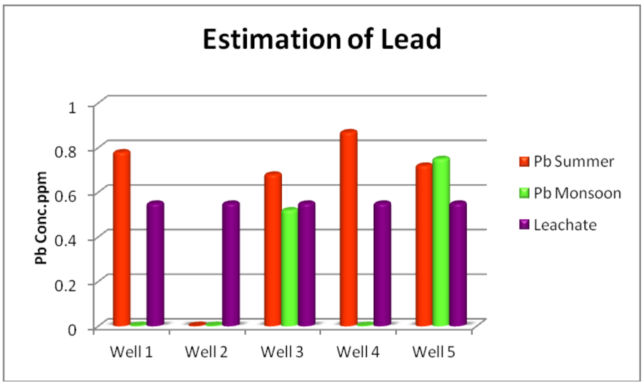

Figure 1. Estimation of Lead (Permissible Limit: 0.01ppm)

The drinking water standard (0.01 ppm) for Lead indicates that the water in the wells is highly contaminated in terms of Lead Pollution. The Lead levels are higher in the summer season than the monsoon season indicating dilution of well water in monsoon. When compared to lead present in leachate, the lead is more in summer as well as monsoon than the leachate. Out of the five wells only Well No. 3 and Well No.5 show high lead concentrations in monsoon. In Well No. 2 the lead levels are below detectable limits.

The risk of Lead poisoning through the food chain increases as the soil lead levels. [16]

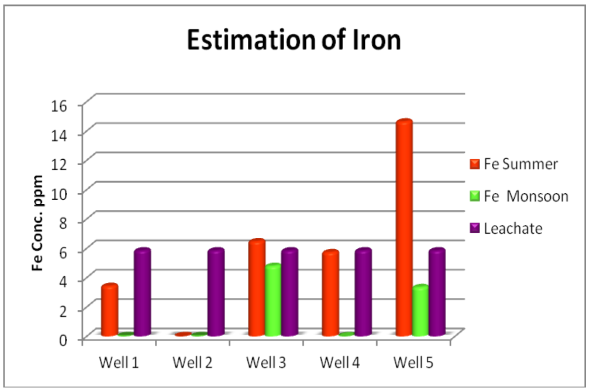

Figure 2. Estimation of Iron (Permissible Limit: 0.3 ppm)

The drinking water standard (0.3 ppm) for Iron indicates that the water in the wells is contaminated in terms of Iron Pollution. The Iron levels are higher in the summer season than the monsoon season indicating dilution of well water in monsoon. When compared to iron present in leachate, the iron present in well water is more or less of similar concentration as the leachate, except in Well No. 5 where the iron concentration is extremely high. Out of the five wells only Well No. 3 and Well No.5 show lesser iron concentrations in monsoon. In Well No. 2 the iron levels are below detectable limits.

Iron may be hazardous to the environment; special attention should be given to plants, air and water. It is strongly advised not to let the chemical enter into the environment because it persists in the environment.

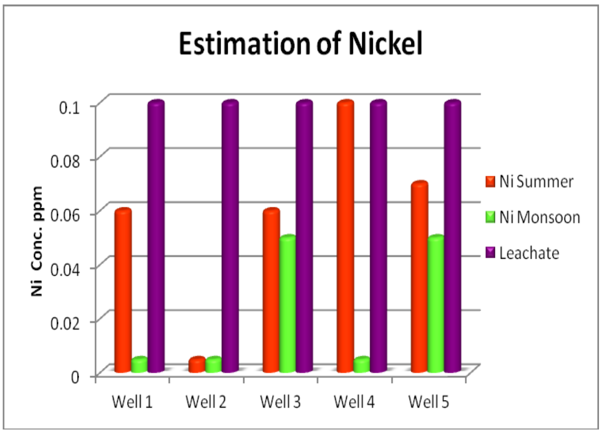

Figure 3. Estimation of Nickel (Permissible Limit: 0.02 ppm)

The drinking water standard (0.02 ppm) for Nickel indicates that the water in the wells is highly contaminated in terms of Nickel Pollution. The Nickel levels are higher in the summer season than the monsoon season indicating dilution of well water in monsoon. When compared to nickel present in leachate, the Nickel concentration is more in leachates as compared to well water except in Well No. 4, where the concentrations are similar in both. Out of the five wells, only Well No. 3 and Well No.5 show higher nickel concentrations in monsoon. In Well No. 2 the nickel levels are below detectable limits both in summer and monsoon. The highest concentration of nickel is more in Well No. 4. Acid rain increases the mobility of nickel in the soil and thus might increase nickel concentrations in groundwater [13].

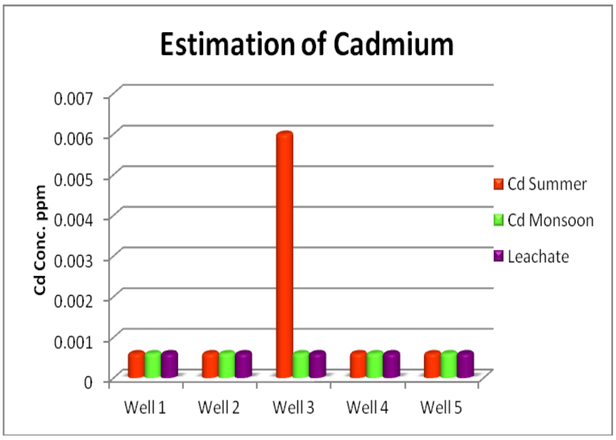

Figure 4. Estimation of Cadmium (Permissible Limit: 0.003 ppm)

The concentration of cadmium in all wells is below detectable limits and permissible limits in all seasons with an exception. Only in Well No. 3 the cadmium limits are higher and reach 0.006 ppm in the summer season. The cadmium limits in leachates is also below detectable levels.

Cadmium (Cd) leaching to water from contaminated soil is very low although it varies from soil to soil depending upon the textural and chemical properties which is evident in the above result showing concentrations below detectable levels.

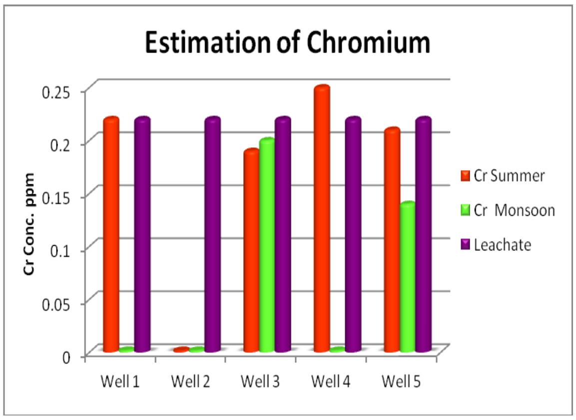

Figure 5. Estimation of Chromium (Permissible Limit: 0.05 ppm)

The drinking water standard (0.05 ppm) for Chromium indicates that the water in the wells is highly contaminated in terms of Chromium Pollution. The Chromium levels are highest in the summer season in Well No. 4. Out of the five wells, the chromium concentrations above permissible limits in monsoon are found only in Well no. 3 and Well no. 5. Comparing the concentrations in summer and monsoon, in Well No. 3 the concentrations in monsoon are slightly higher than in summer. When compared to chromium present in leachate, the chromium is more in leachates in summer and monsoon, except in well no. 4. In Well No. 2 the chromium levels are well below detectable limits both in summer and monsoon.

Soluble and un-adsorbed chromium complexes can leach from soil into groundwater. This can be indicated in increased levels of chromium in the ground water which may be possible due to leaching from the dumpsite leachates.

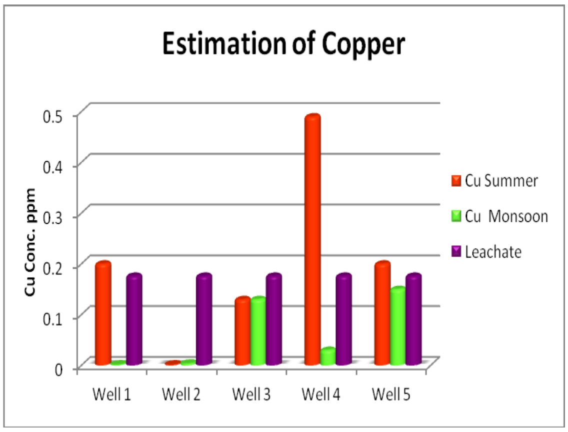

Figure 6. Estimation of Copper (Permissible Limit: 0.05 ppm)

The drinking water standard (0.05 ppm) for Copper indicates that the water in the wells is highly contaminated in terms of Copper Pollution. The Copper levels are higher in the all wells except Well No. 2, the highest concentration being in Well No. 4. Out of the five wells, the Copper concentrations above permissible limits in monsoon are found only in Well No. 3 and Well No. 5. When compared to Copper present in leachate, the Copper is more or less similar to the summer concentration levels except in Well No. 4 where it is highest. In Well No. 2 the chromium levels are well below detectable limits both in summer and monsoon.

In the soil, Cu strongly complexes to the organic fraction implying that only a small fraction of copper will be found in solution as ionic copper, Cu(II).

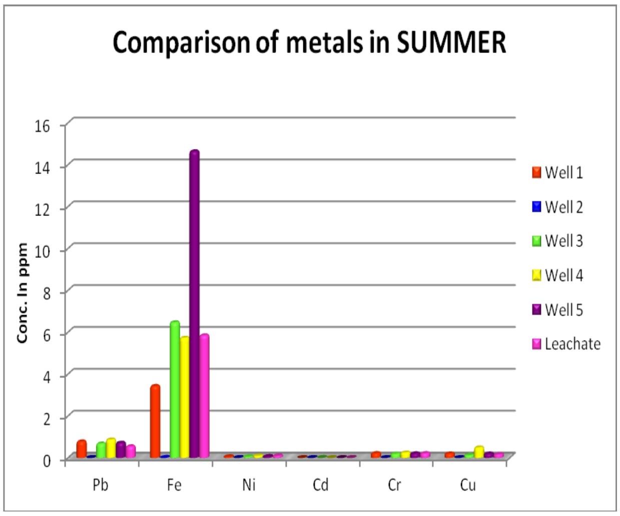

Figure 7. Comparison of all metals in Summer

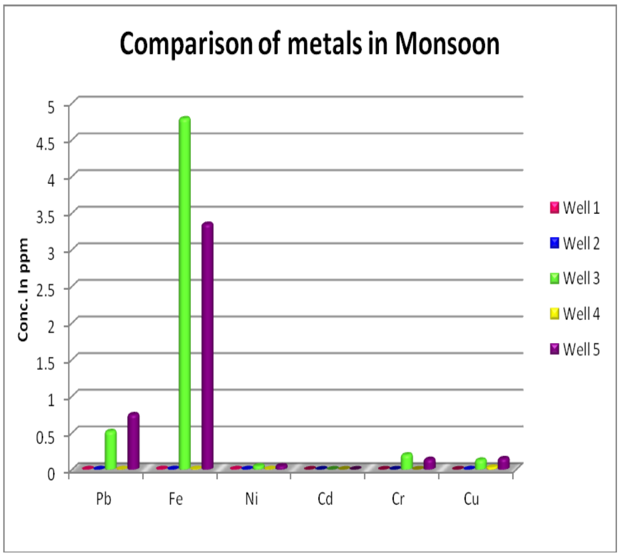

Figure 8. Comparison of all metals in Monsoon

The overall analysis of metals indicates that Iron is present in higher concentrations compared to other metals. Cadmium is below detectable limits in all wells. Well No. 3 and 5 are more contaminated than the other wells as contamination is observed even in monsoon season indicating lesser dilution. Well No. 2 does not show any metals contamination indicating its usefulness. The metal contamination is observed more during summer than in monsoon for the wells. The percolation of metals from the leachates of the dumpsite to the wells is a possible reason for increase in metal concentrations.

IV. CONCLUSION

All the wells are being used for water usage by the local people. Presence of these heavy metals in ground water is showing the serious toxic risks of contamination due to percolation of leachate.

From the groundwater monitoring it is clearly evident that the leachate generated from the dumping site is affecting the groundwater quality in the adjacent areas through percolation in the subsoil. Therefore, some remedial measures are required to prevent further contamination. This can be achieved by the management of the leachate generated within the dumping site. Leachate management can be achieved through effective control of leachate generation, its treatment and subsequent recycling throughout the waste.

Adharwadi dumping site will soon be closed for MSW disposal since it has already received waste beyond its capacity. Remedial measures should be considered by taking this into account. Adharwadi dumping site is non-engineered landfill. It is neither having any bottom liner nor any leachate collection and treatment system. Therefore, all the leachate generated finds its paths into the surrounding environment. In such conditions only feasible options that could be followed are to limit the infiltration of the water through the landfill cover by providing impermeable clay cover. Due to this less water will enter and subsequently less leachate will be generated, thereby reducing the amount of leachate reaching the landfill base.

V. REFERENCES

[1] Abu- Rukah, Y. and O. Al- Kofahi, (2001). The assessment of the effect of landfill leachate on ground-water quality—a case study. El-Akader

landfill site—north Jordan, Arid Environ. 49, 615-630.
[2] Adefemi OS, Awokunmi EE (2009). The impact of municipal solid waste disposal in Ado Ekiti metropolis, Ekiti State, Nigeria. Afr. J. Environ. Sci. Tech. 3(8): 186-189.
[3] APHA, AWWA & WEF, 20th Ed. (1998). Standard Methods for the examination of water and wastewater, American Public Health Association, Washington, D.C.
[4] Bureau of Indian Standards (BIS) (2012), Indian standard specification for drinking water, IS: 10500, pp. 2-4.
[5] Campbell DJV (1993). Environmental Management of Landfill Sites. J.I.W.E.M. 7(2): 170 - 173.
[6] Christensen, J. B., D. L. Jensen, C. Gron, Z. Filip and T. H. Christensen, (1998). Characterization of the dissolved organic carbon in landfill leachate-polluted groundwater, Water Res., 32, 125-135.
[7] D. Dupler, (2001), "Heavy Metal Poisoning," In: J. L. Longe, Ed., *Gale Encyclopedia of Alternative Medicine*, Gale Group, Farmington Hills, pp. 2054-2057.
[8] DeRosa, E., Rubel, D., Tudino, M., Viale, A., and R.J. Lombardo, (1996). The leachate composition of an old waste dump connected to groundwater: Influence of the reclamation works. Environ. Monit. Assess. 40 (3): 239-252.
[9] Eddy NO (2004a). Physicochemical parameter of water and heavy metal content of water, sediment and fishes from Qua Iboe River Estuary. M.Sc Thesis. Michael. Okpara University of Agriculture, Umudike. Nigeria.
[10] Fatta D., A Papadopoulos and M., Loizidou, (1999). A study on the landfill leachate and its impact on the groundwater quality of the greater area. Environ. Geochem. Health 21 (2): 175-190.
[11] Federal Environmental Protection Agency (FEPA) (1995). Corporate profile. Metro prints Ltd, Port Harcourt.
[12] Flyhammar, P. (1995), Leachate quality and environmental effects at active Swedish municipal landfill, in: R. Cossu, H. T. Christensen and R. Stegmann (eds) Regulations, Environmental Impact and Aftercare. Proceedings Sardinia '95, Fifth International Landfill Symposium. Vol. III, Sardinia, Italy, pp. 549–557.
[13] H. Roberts, (2013). "Lead Poisoning," http://www.setlet.com IPCS (1991) Nickel. Geneva, World Health Organization, International Programme on Chemical Safety (Environmental Health Criteria 108).
[14] Looser, M.O., A. Parriaux, and M. Bensimon, (1999). Landfill underground pollution detection and characterization using inorganic traces. Water Res. 33, 3609-3616.
[15] Nwajei PE, Gagophein PO (2000). Distribution of heavy metals in the sediments of Lagos Lagoon. Pak. J. Sci. Ind. Res. 43: 338-340.
[16] Rosen, C.J. (2002). Lead in the home garden and urban soil environment, Communication and Educational Technology Services, University of Minnesota Extension.
[17] Saarela, J., (2003). Pilot investigations of surface parts of three closed landfills and factors affecting them Environ. Monit. Assess. 84,183-192.
[18] W. H. O (World health organization) (1993). Guidelines for drinking water quality 2nd edition, Vol. 1, Recommendations.

Table 1. Concentrations of Metals analyzed from water of the five wells and three sampling points of leachate collected from the Dumpsite.

Summer	Well No.	**Conc. of Pb**	**Conc. of Fe**	**Conc. of Ni**	**Conc. of Cd**	**Conc. of Cr**	**Conc. of Cu**
	Well 1	0.78 ± 0.02	3.43 ± 0.026	0.06 ± 0.011	0.0006 ± 0	0.22 ± 0	0.2 ± 0.025
	Well 2	0.004 ± 0.002	0.01 ± 0.002	0.0049 ± 0.0002	0.0006 ± 0	0.002 ± 0.0002	0.002 ± 0.001
	Well 3	0.68 ± 0.03	6.47 ± 0.026	0.06 ± 0.02	0.006±0.001	0.19 ± 0.005	0.13 ± 0.02
	Well 4	0.87 ± 0.02	5.73 ± 0.06	0.1 ± 0.057	0.0006 ± 0	0.25 ± 0.023	0.49 ± 0.02
	Well 5	0.72 ± 0.02	14.64 ± 0.23	0.07 ± 0.02	0.0006 ± 0	0.21 ± 0	0.2 ± 0.1
Monsoon							
	Well 1	0.004 ± 0.002	0.007 ± 0.002	0.0049 ± 0.0005	0.0006 ± 0.0001	0.002 ± 0.0002	0.002 ±0.0007
	Well 2	0.004 ± 0.002	0.006 ± 0.002	0.0049 ± 0.0009	0.0006 ± 0	0.002 ± 0.001	0.004 ± 0.002
	Well 3	0.52 ± 0.03	4.79 ± 0.055	0.05 ± 0.02	0.0006 ± 0	0.2 ± 0.057	0.13 ± 0.01
	Well 4	0.004 ± 0.002	0.008 ± 0.002	0.0049 ± 0.0009	0.0006± 0.0001	0.002 ±0.00048	0.03 ± 0
	Well 5	0.75 ± 0.21	3.35 ± 0.158	0.05 ± 0.025	0.0006 ± 0.0002	0.14 ± 0.02	0.15 ± 0.02
Leachate							
	Point 1	0.49 ± 0.02	9.88 ± 0.79	0.11 ± 0.037	0.0006 ± 0.0001	0.19 ± 0.02	0.17 ± 0.015
	Point 2	0.69 ± 0.09	7.08 ± 0.74	0.12 ± 0.02	0.0006 ± 0	0.23 ± 0.02	0.19 ± 0
	Point 3	0.49 ± 0.05	7.56 ± 0.46	0.1 ±0.03	0.0006 ± 0.0001	0.2 ± 0	0.17 ± 0.0057