Field survey of municipal solid waste dumpsites in residential area in Kabul city

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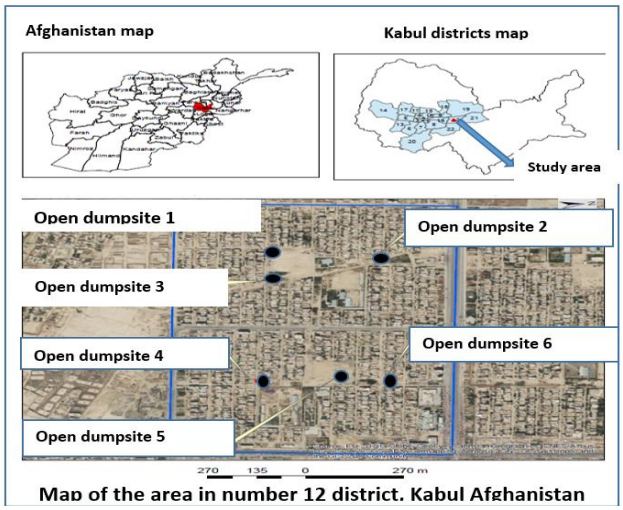
1.Introduction

Open dumpsites of solid waste located within urban area have been proved to be a cause of environmental problem to residents in developing cities in the world. Kabul city of Afghanistan is no exception. Open dumpsites are one of the sources of groundwater and soil pollution due to the production of leachate and its transportation causes contamination of water sources. Such contamination of groundwater resources can pose substantial health risks, including water borne diseases such as typhoid, cholera and infectious dysentery, to the local groundwater users. Management of open dumpsites remains one of the major challenges in Afghanistan especially in Kabul the capital of the country. The aim of this research was to evaluate whether the groundwater has been contaminated by the open dumpsites leachate or not. Leachate samples from the studied open dumpsite, and groundwater samples around the studied open dumpsite, were collected and water quality tests were conducted. Results were compared with the standard given by World Health Organization (WHO) for drinking water. Also, a multiple regression analysis was performed to evaluate relation between ground water quality and volume of waste in dumpsites its leachate water quality.

2. Material and methodology

2.1 Study Area Description: Kabul is the capital city of Afghanistan, located in the eastern section of the country with 22 districts. The study area was set in a specific part in District-12 which has about 1.7 km^2 of area with 12,968 populations and 1,621 households. There are about 200 dumpsites of municipal solid waste according to local municipality office in the mentioned area. Among many dumpsites, 6 sites which are relatively big and locate near residential housing were chosen as target sites of this study.

Figure1 Study area map



2.2 Estimation of volume and weight of waste used SfM method: A filed survey was carried out in September, 2017 to estimate volume of solid waste in open dumpsites. In each site, more than 150 photos were taken having over-rapping between photos for SfM analysis which is a photogrammetric technique that automatically solve the geometry of the scene and the camera positions to estimate 3D model of target object. PhotoScan and EasyMeshMap were used for this purpose. Then, weight of the waste was also measured using hanging balance. Table1 shows a result of estimation of unit weight of dumped waste. Table 2 shows result of estimated covered area, volume and weight of dumped waste in study area. From the result, 235.6 tons of waste was remaining in those dumpsites.

Table1 Estimation of unit weight of dumped waste using SfM method

Waste sample No.	Volume m^3	Weight m^3	Unit weight kg/m^3
1	0.229	210	917.0
2	0.226	50	221.2
3	0.300	55	183.3
4	0.078	53	679.5
5	0.087	45	517.2
Average			503.7

Table2 Estimation of Covered area, volume and weight of dumped waste using SfM method

Dumpsite No.	Covered area m^2	Volume m^3	Weight t
1	518	18	9.0
2	1,158	139	70.0
3	4	15	7.6
4	351	154	77.4
5	157	71	35.5
6	150	72	36.2
Total	2,337	468	235.6

2.3 Sampling of leachate and groundwater: Dug wells and bore wells were selected for sampling, which are functional and continuously used for drinking and domestic purposes. Groundwater samples were collected from 6 dug wells and bore wells in the study area, and 12 leachate samples were collected from 6 open dumpsites which locate nearby wells.

Figure 2 A photo of open dumpsite 2

The average distance from the open dumpsites and well water was around 15 meter, and the average depth of groundwater is 14 meter from the ground surface respectively. Storage of groundwater and leachate samples were performed in manners that maintain sample quality. Samples were cooled to 4°C as soon as after samples were collected. These conditions were maintained until the samples were received at the laboratory.

3. Result and discussion

3.1Quality of groundwater: Metals concentration in groundwater and leachate were measured by Inductively Coupled Plasma/Mass Spectrometry (ICP-MS). Samples were diluted 1000 times before the measurements. Table 3 presents the summary of analytical result of the groundwater samples and comparison of groundwater quality parameter with WHO water quality standard. The metal concentration shown in table 3, which are Al, B, Cd, Cr, Cu, Fe, Ni, K, Zn, exceeded WHO standards.

Table3 Metal concentration in groundwater

No	Gw1	Gw2	Gw3	Gw4	Gw5	Gw-6	WHO
Al	3	1.2	0.7	2.1	1.8	1.5	0.2 mg/l
B	1.8	3.3	0.8	1.5	1.4	0.7	2.4 mg/l
Cd	0.1	-	0.1	0.1	0.1	0.08	0.003
Cr	9.2	0.1	-	-	0.7	-	0.05 mg/l
Pb	-	-	-	-	-	-	-
Mn	0.1	0.04	-	0.05	0.1	0.1	0.4 mg/l
Mo	-	-	-	-	-	-	-
Cu	12	2.3	2.3	2.8	10	1.8	2 mg/l
Fe	16	16.2	10	12.7	21	7.5	0.3 mg/l
Ni	1.8	0.7	1.3	0.3	1.8	0.4	0.07 mg/l
Zn	23	6.1	4.9	7.1	13	8.1	3.00 mg/l

Table4 Metal concentration in leachate

No	Heavy metals result from leachate Samples											
	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
Al	5.8	6.3	7.8	2.2	6.2	3.8	3.5	2.1	5.8	4.9	4.7	4.1
B	4.9	1.2	4.1	-	5.2	-	-	4.5	2.3	-	-	3.7
Ba	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.4	0.3	0.2
Cd	-	-	-	-	-	-	-	-	-	-	-	0
Cr	0.2	1.4	0.2	-	0.2	0.7	0.2	0.2	-	0.8	0.7	0.7
Cu	-	-	-	-	-	-	-	-	-	-	-	-
Fe	-	-	-	-	-	-	-	-	-	-	-	-
K	-	-	-	-	-	-	-	-	-	-	-	-
Li	0.3	0.3	0.6	0.5	0.5	0.5	0.5	0.5	0.2	0.4	0.3	0.3
Mn	1.2	1.5	0.2	0.04	0.2	0.2	0.2	0.1	0.9	2.4	2.5	2.9
Mo	-	-	-	-	-	-	-	-	-	-	-	-
Ni	0.4	0.8	0.9	0.6	0.9	0.6	1.2	0.5	0.9	0.8	0.8	0.7
P	156	97	18	-	49	-	18	-	92	174	175	197
Pb	0.7	0.9	0.4	-	0.4	0.9	-	-	-	-	-	-
Si	9.4	14	4.4	9.6	24	14	9.5	5.9	11	11	13	26
Ti	1.4	0.9	0.9	0.7	0.4	1.3	0.7	0.9	0.3	0.7	0.6	0.5
V	0.1	0.3	0.2	0.1	0.1	-	-	-	-	-	-	0.9
Zn	2.1	-	0.5	0.5	1.3	1.7	2.5	0.7	1.6	-	-	-

WHO: drinking water standard1)

3.2 Influence of dumpsites on groundwater quality: In order to evaluate influence of dumpsite on groundwater quality multiple regression analysis was conducted. Groundwater quality was set as variable y, called dependent variable, and volume of dumped waste was set as variable x1, leachate quality was wet as x2, called the explanatory variables. As we can see P-Values of each of these parameter in table 5, it was resulted that there was no clear relationship was found between groundwater quality and dumped waste. Since the survey was carried out in dry season, there were very small amount of leachate generated from the dumped waste, and its influence to groundwater is not so significant. Another survey is necessary in rainy season.

Table5 Result of multiple regression analysis on ground water, dumped waste and leachate

Y	X1	X2	R Square	Coefficients			P- Value		
				Intercept	X1	X2	Intercept	X1	X2
Al - GW	Volume of dumped waste	Al-LC	0.061	0.353	0.002	0.239	0.924	0.8219	0.6964
B- GW	Volume of dumped waste	B-LC	0.291	1.483	0.008	-0.15	0.4608	0.3536	0.7554
Cr- GW	Volume of dumped waste	Cr - LC	0.32	0.872	-0.02	4.285	0.9091	0.6845	0.6421
Ni- GW	Volume of dumped waste	Ni-LC	0.524	0.621	-0.01	1.623	0.8458	0.1949	0.737
Zn- GW	Volume of dumped waste	Zn-LC	0.399	8.362	-0.03	3.804	0.3684	0.5679	0.4096
TOC GW	Volume of dumped waste	TOC-LC	0.025	64.538	-0.07	-0	0.2648	0.8431	0.8377
TN Con	Volume of dumped waste	TN-LC	0.169	31.232	0.974	-0.03	0.8366	0.4916	0.8134
PH - GW	Volume of dumped waste	PH - LC	0.436	9.2	-0.01	-0.1	0.0066	0.273	0.659
EC- GW	Volume of dumped waste	EC	0.069	1.979	0.002	-0	0.2585	0.779	0.925
Cl - GW	Volume of dumped waste	Cl-LC	0.366	581.559	1.743	0.247	0.2771	0.304	0.633
PO4- GW	Volume of dumped waste	PO4-LC	0.414	390.919	2.481	-0.36	0.3405	0.442	0.553
F Con	Volume of dumped waste	F- LC	0.228	84.744	-0	-0	4.008	0.976	0.421
Mg GW	Volume of dumped waste	Mg - GW	0.077	55.91	0.557	0.071	0.8499	0.681	0.856

4. Conclusion:

Result of groundwater quality analysis said that Al, B, Cd, Cr, Cu, Fe, Ni, K, Zn concentration were higher than WHO standard. However, result water quality analysis of leachate taken from waste dumpsites does not show high concentration of metals. This study has shown that the groundwater source within the study area is contaminated but it is not due to existence of solid waste open dumpsites in the number 12 district of Kabul. This can be considered as a menace for people who daily intake the corresponding waters, as drinking water.

References: 1) WHO: Guidelines for drinking-water quality: http://www.who.int/water_sanitation_health/publications/drinking-water-quality-guidelines