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ORIGINAL ARTICLE

Evaluation of the impact and contamination of Ghaemshahr Landfill on surrounding groundwater

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ABSTRACT: In the current study, the possibility of contamination of groundwater resources of Ghaemshahr plain resulting by leachate from the main landfill of the city has been studied. Considering plain's alluvial type which is mostly composed of sand, gravel, clay, etc. there is a possibility of contamination of ground water by leachate of wastes, particularly considering the fact that groundwater flow direction is from landfill to water resources located in the north. In order to study the effect of leachate on underground water, the sampling was done from water resources at risk in two stages: the first one in June of 2014 and the other one in October of 2014. The parameters of total hardness, total alkalinity, Mg, COD, PH, NO_3, SO_4, Cd, Zn, Cu, and Ca were examined and the results were compared with those of National Standards of Iran (No. 1053) and International Standards of WHO. The results indicates that the amount of salts in well water samples are increasing.

Keywords: municipal waste, landfill, leachate, groundwater contamination, Ghaemshahr

INTRODUCTION

Groundwater is an important source of water supply in all countries of the world and it is used increasingly in irrigation and agriculture as well as municipal and industrial uses (Davraz and Ozdemir, 2014). Rapid population growth and increase of consumption manifesting comprehensive development in recent years have increasing quantity of waste. Nowadays, the hygienic disposal of waste has particular significance. One of the important issues about landfill is related to leachate and its effects on the environment and water resources in lives of citizens and villagers. The movement of underwater is slow and it takes several years for water to be influenced and contamination of a well shows itself. If the underground spaces are contaminated, observation of them would be difficult and therefore, the concerns about it would increase. The elimination of contamination in water resource is difficult and time-consuming and one can never do it completely. Accordingly, it takes several years that a contaminated aqueous layer is restored to its initial condition after removal of contamination resource (Dehkordi and Poormoghaddas, 2006). The process of development in Iran has created a wide range of issues about water contamination and this issue reveals its importance when we see that more than 52 percent of water consumption of the country relies on groundwater. Among the

resources that contaminate groundwater, one can point to the disposal of solid waste by burying them under the ground which is main resource of water contamination. The associated studies indicate that this method accounts for 92 percent of disposal of urban solid wastes in the world (Abedi Kohpayi, 2001). As groundwater slowly moves among inter-granular pores of soil layers, it solves the elements included in them and it is expected that the amount of salts increases in the direction of the water flow. Accordingly, the increase of salts can influence the chemical and physical properties of water including amount of chlorine, smell, taste, color, etc.

Landfill leachate also contains contaminant elements and materials that penetrates to groundwater due to fluidity of leachate which contaminates the water. Usually, there are particular contaminants in leachate of landfills which should be analyzed to assess the effects of the urban landfills on public health and quality of groundwater (Mosavi, 2009).

Ghaemshahr City with an area of 8.458 square kilometers is located between longitude of 52 degrees and 43 minutes to 53 degree and 3 minutes east and latitude of 36 degrees and 21 minutes to 36 degrees and 38 minutes north. This city is limited to cities Juybar in the north, Savadkuh in the south, Babol in the west, and Sari in the east. This city includes 10.1 percent of Mazandaran population and it has been divided into three areas of lowland plains, midsection, and foothills according to type of the weather and habitat. The mean annual precipitation of this city is 9.724 mm and its mean annual temperature is 16.7 °C. The altitude of this city is also 41.2 m (Mosavi, 2009). Considering the logs of drinking water wells in the region, it has sand, gravel, clay, etc. in geological terms.

MATERIALS AND METHODS

To better understand the geology of the area, the log of drilling wells and maps were studied by gathering information followed by field visit to examine the area. Then, considering the amount of the existing wastes, the landfill location (based on closeness to the village, river, agricultural training center, and farming lands) was investigated. In addition, the gradient map of region which is from south to north, was plotted by using Arc GIS Software and with regard to this fact that Ghaemshahr landfill is 871m away from the first drinking well (downstream of landfill), 50 m from Hall River, 1334 m from the nearest village, and 752 m from the first training centers, the sampling was done from various regions. Two samples from downstream well of landfill, one sample from dike in vicinity of landfill (since the dike had water and landfill leachate flowed into it, the water is finally used in agriculture and it gradually penetrates into aquifer), one sample from leachate, and one sample from well located in the east of landfill (municipal well) were taken. These samples were collected by plastic containers which were rinsed with water of the sampling place.

They were sent immediately (less than 12 hours) to laboratory to be tested. The tests carried out in this research included: Values of Mg, Ca, Cu, Zn, Cd, SO_4, NO_3, PH, Ec, C0D, total alkalinity and total hardness.

To obtain the amounts of heavy metals, furnace atomic absorption device (GBC SAVANTA AE model) with ppb scale for level of electrical conductivity of the water was used. In addition, EC meter device (Model: WTW, Germany) was used to determine the value of EC while for level of water PH, PH meter device (WTW) was utilized. To obtain the levels of sodium and potassium, CORNING FLAMEPHOTOMETER 41O was used. The Ion Chromatography device of IC (Mode: compact IC plus 882) was also used in this test.

FINDINGS

Groundwater level curves in the studied area have an east-west trend and regarding the feeding effect of rivers, the curves tend toward north. Therefore, the direction of groundwater flow is generally from south to north and finally towards the Caspian Sea. The rivers in the northern regions of and downstream of plains drain alluvial aquifer in which the level of groundwater is high, and in these regions the lines of flow is convergent (Norozi, 2012). Figure (1) illustrates the position of sampled wells and landfill. The first sample was obtained from a well that was 40 m deep and located in the downstream of landfill. This well is used for agriculture purposes and it is 100 m away from landfill.

The second sample was obtained from a dike in vicinity of the landfill. It should be noted that landfill leachate is being transferred to this dike and its water contaminates these regions as it passes through surrounding villages. This water is also being used for irrigation of farmlands and orchards and it contaminates their products. The third sample was obtained from personal well in downstream of landfill which has household applications. This well has located in 400 m away from landfill.

The forth sample was obtained from landfill leachate.

The fifth sample was obtained from a municipal well which had previously industrial application (carpet washing).

The sixth sample was obtained from a well-used for drinking water which is located in the downstream of the landfill.

RESULTS

The analytical diagram of samples are shown in figures (2) to (17). According to the results, the amount of COD and EC has increased which indicates that substances of water increase. As a result, it leads into increased oxidation of water and water hardness. The increase of agricultural pesticides is one of the reasons of the increase of water nitrate (NO3). The results indicated that leachate has been penetrated into groundwater as a result of increase of nitrate in October in comparison with its amount in June.

The high concentrations of sulfate (SO_4) in drinking water can have laxative effect on people who are not used to drink water containing high sulfate (Davraz and Ozdemir, 2014). Cadmium (Cd) and its compounds are highly toxic. It usually can be found in the surfacial water and groundwater. The waters that have less than 1 u.gr per liter cadmium are non-contaminant. Its high concentration is a result of discharge of sewage contaminated by cadmium Cd (Matlock, Howerton, Henke and Atwood, 2001).

Cadmium (Cd) and its compounds are highly toxic. Usually, it exists naturally in copper. Copper is one of the essential elements that has vital importance for the body. It is found in liver, kidney, liver, brain, heart and bones of our body. Copper is a heavy metals which is toxic in its free form. The high level of copper leads into abnormal metabolism (Sonmez, Divrikli and Elci, 2010). The high concentrations of this ion not only endanger the growth of aquatic plants and animals and prevents from water purification but also harms the health of humans (Xue and Li, 2008). Calcium is considered as the main the main elements of water hardness. Calcium deficiency may cause osteoporosis while its excessive amounts lead to toxicity which might cause kidney stones (Sonmez, Divrikli and Elci, 2010). The alkalinity of water refers to its low capacity to neutralize a strong acid to the level of desired pH. The source of total alkalinity of water includes Hydroxide ions (OH-), carbonate (CO_3^{-2}), and bicarbonate (HCO_3^-) and it sometimes includes phosphate, borates and silicates. One negative effect of alkalinity is to give bitter taste to water when its amount is high. In addition, a fundamental concern about alkaline water is those reactions that can occur between alkalinity and some cations in water. The resulting sediment can clog pipes and other facilities of water supply network.

DISCUSSION AND CONCLUSIONS

It is believed that the type of earth layers, making surface layers of drinking wells impenetrable, and increase of distance from the landfill might decrease the contamination and also prevents from penetration of leachate into the underlying layers of ground. Therefore, drilling of drinking and agricultural wells in downstream of the landfill is regarded as permissible. It should be noted that while underground layers of the region prevent from penetration of leachate into underneath layers naturally, one shouldn't regard it as sufficient since the results of present study indicated that leachate has penetrated into underneath layers and contaminated the groundwater.

The aging the accumulated wastes was associated with increase in the amounts of gases such as methane, carbon dioxide, ammonia, hydrogen sulfide and nitrogen released from the waste and this has created a stinking smell in the area. If these gases are not transferred from wastes to outdoor spaces, these gases would penetrate into underground layers and groundwater which leads into increase of the water hardness. Generally, the reactions in the landfills include the following: the biodegradation of organic and corruptible materials in the aerobic and anaerobic forms that are associated with the production of gas and leachate, the movement of leachate as a result of gravity, and the dissolution and leakage of organic and inorganic liquids by water and leachate, relocation of solutions as a result of change in density and osmotic reactions , earth subsidence in interactions, development of solvents such as chloride, nitrate and sulfate that can pass easily through the soil and penetrate into groundwater, heavy metals such as lead, chrome and iron that are absorbed into the soil, carrying of leachate by drainage and runoff into groundwater and surface water, increase of birds and wild animals, and unpleasant appearance of the region.

The comparison of results of analyses in the two stages as well as with Iranian standards and international standard of WHO indicates that the amounts of salts in the water are increasing which can create problems in the long run and make the water of this region non-potable. Therefore, some recommendations are offered in this regard:

- Further studies to determine utilization area and health control of wells of this region.
- Compacting of wastes and separation of dry wastes from wet ones (separation from source).
- Serious warnings to residents at risk via IRIB and media.
- Appropriate preparation of landfill and prevention from flow of leachate into groundwater.
- Setting up composting plants and refinement of leachate.

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Figure 1. Position of landfill and sampled wells

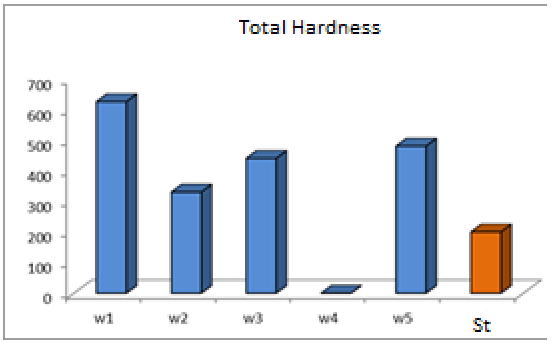

Figure 2. Total hardness in June (ppm)

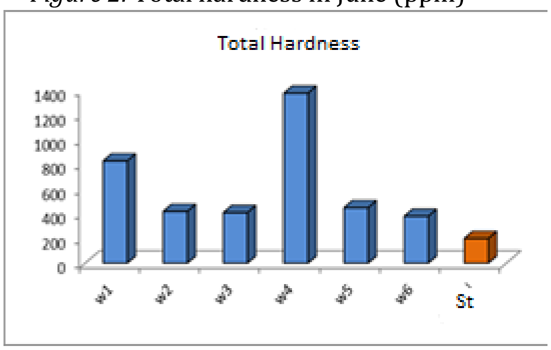

Figure 3. Total hardness in October (ppm)

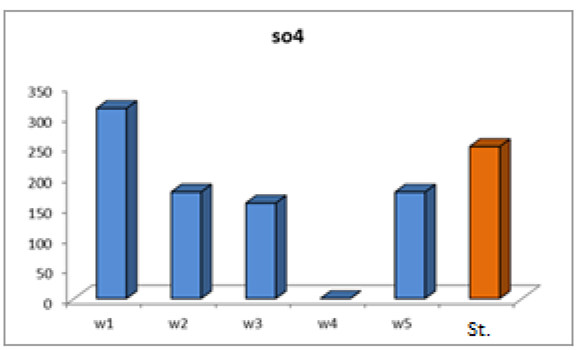

Figure 4. SO_4 in June (ppm)

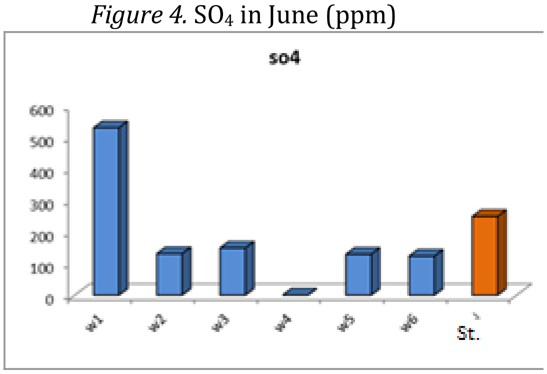

Figure 5. SO_4 in October (ppm)

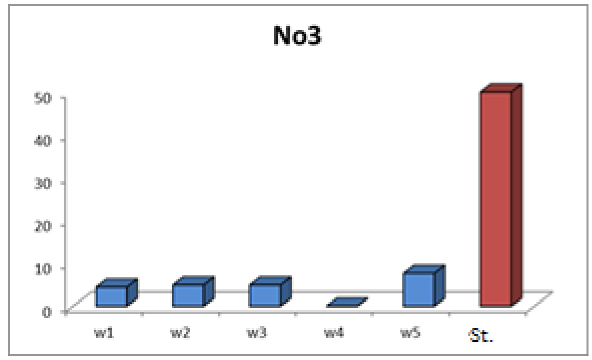

Figure 6. NO_3 in June (ppm)

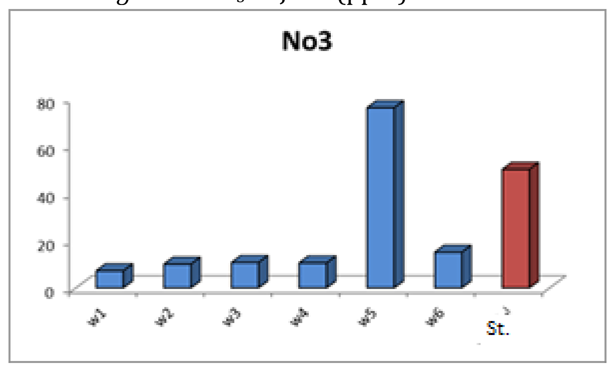

Figure 7. NO_3 in October (ppm)

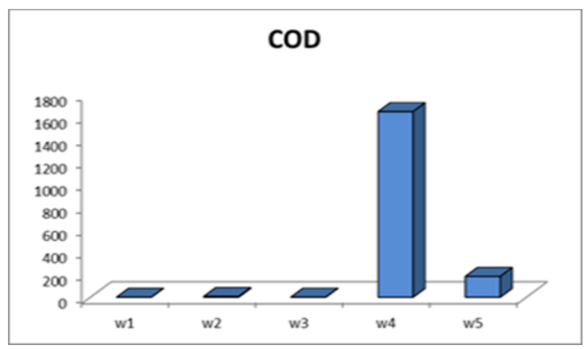

Figure 8. COD in June (ppm)

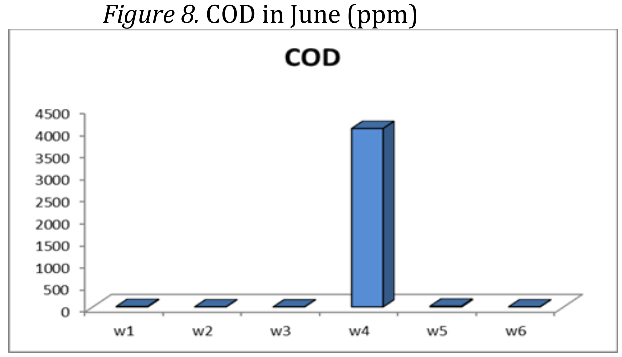

Figure 9. COD in October (ppm)

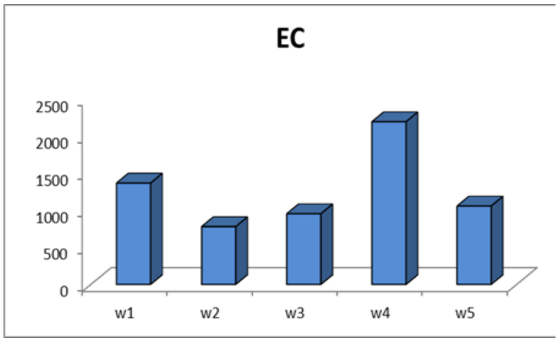

Figure 10. EC in June (ppm)

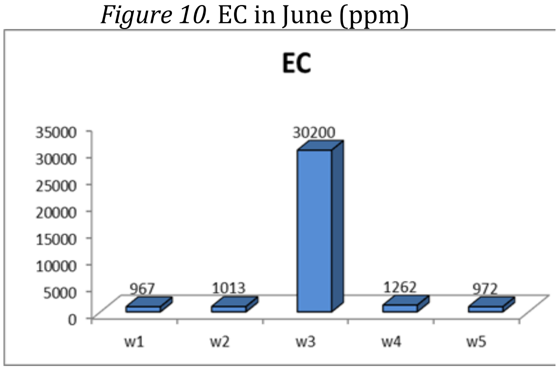

Figure 11. EC in October (ppm)

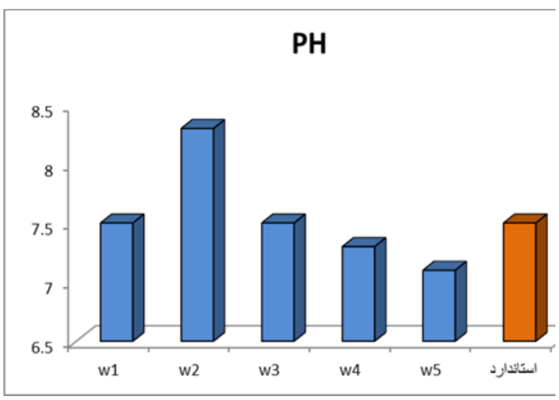

Figure 12. PH in June (ppm)

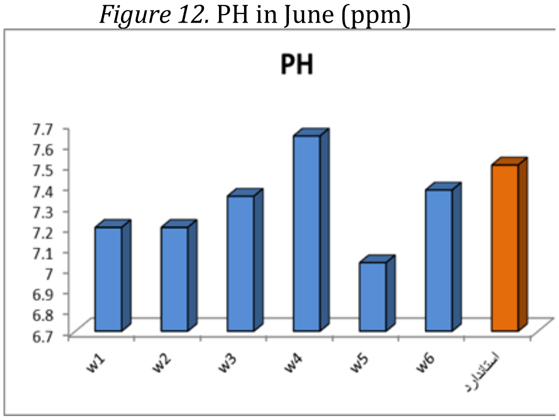

Figure 13. PH in October (ppm)

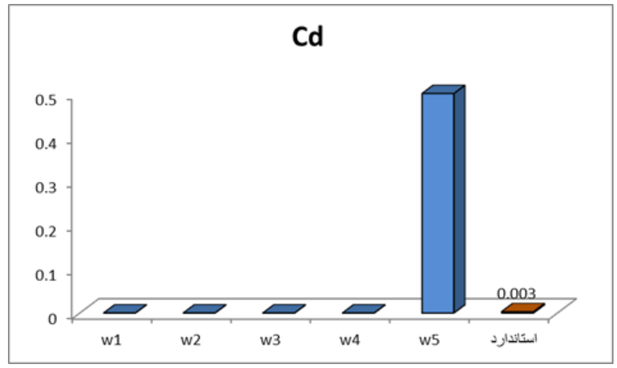

Figure 14. Cd in June (ppm)

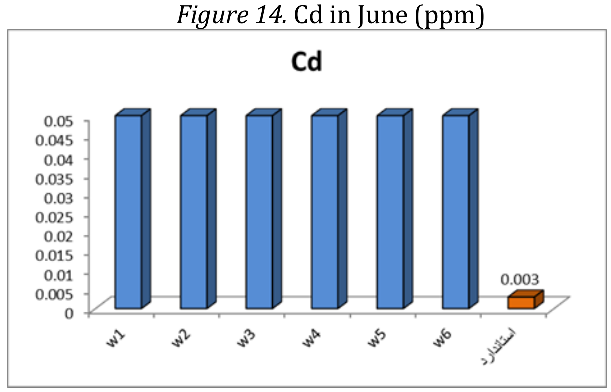

Figure 15. Cd in October (ppm)

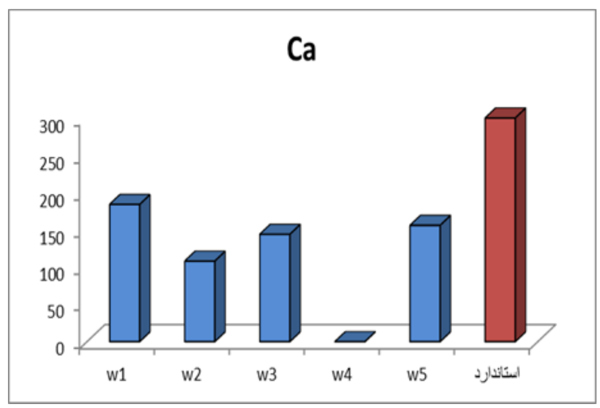

Figure 16. Ca in June (ppm)

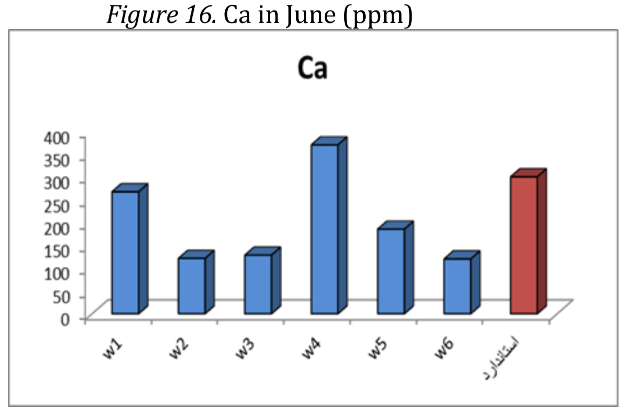

Figure 17. Ca in October (ppm)