Evaluation of the impact of municipal landfills on soil

S. Alganimi¹, J. Alshibee⁹*
¹ College of Science, University of Kerbala, Iraq.

Email: mohammed@uokerbala.edu.iq

Abstract. Enormous quantities of municipal waste are produced around the world and the majority of that waste is disposed of into municipal landfill. These wastes have significant impacts on the environment surrounding them including soil. Many researchers focusing their attention to study the effects on municipal landfills on the surrounding environment. Therefore, the aim of this study was to determine the heavy metal pollution effects of a municipal solid waste landfill located in Kerbala, Iraq. The concentration of two heavy metal amounts that are chromium and nickel, were investigated at two sites near the landfill during 2020. The investigation sites were located about 15 and 30 meters from the edge of the targeted landfill. Disturbed soil samples were collected form the two sites a 2 meters depth. Then, the gathered samples were dried using in room temperature (20 °C) sieved through a 2 mm mesh. The levels of the selected heavy metals were calculated by means of plasma optical emission spectroscopy and linked to the standards of the environmental protection administration. It was found that the concentrations of both metals in close site (site 1) were the higher than the far site (site 2). The analyses also revealed that the concentration of the Nickel is higher than the concentration of the Chromium in both sites. Comparing the concentrations of the selected heavy metals in Kerbala landfill with standards of the environmental protection administration, it was found that all of the assessed heavy metals were found to be within the set standards.

1. Introduction
The Heavy metals are an important part of the earth's ecosystem and naturally exist in fresh water, groundwater and soil[1-3]. According to research literature, iron, for example, can be found high levels up to 50 ppm in surface and ground water [4-7]. The presence of the heavy metals does not pose a direct danger to the human and eco-system since the environment will naturally keep the heavy metal concentrations at balance [8-11]. But, the cumulative impacts of people activity, have greatly changed the normal cycles of many heavy and other elements in the environment, making the eco-systems incapable of balancing the concentration of the heavy metal concentrations in the environment (water, air and soils)[12-15].
In general, the Heavy metals can come from a variety of sources and activated like transportation, agricultural, industrial, mining, planting etc. [16-22]. Heavy metals pollution is large linked with severs health impacts including Alzheimer, cancer, lung diseases, etc. [23-26], as well as harming the environment [13, 27, 28]. Recently, it has been reported that the impacts of heavy metals increased...
significantly global warming on water supply [29-32]. Various treatment techniques like biological[33-37], chemical [33, 38, 39], electrochemical [34, 40-43] and biodegradation [35, 44-46], recovery technologies [30, 31, 36, 37] have been applied to strip heavy metals and other toxic contaminants from water. As the earth population is uncontrolledly expanding, the number and scale of sites used as landfills have risen significantly in order to handle the quantity of municipal solid waste directed to municipal landfills [19, 32, 47]. For instance, it was reported that the average annual production of solid waste in the urban areas of India is about 50 million tonnes. These huge quantities are predicted to be over 240 million tonnes by 2050. The same trend is observed in Iraq by researchers. Researchers revealed that solid waste generation is steadily increasing over the last two decades and the quantity of the solid waste is continually growing [1, 22, 48, 49]. Moreover, extreme quantities of demolishing solid waste are produced which is also disposed of in municipal landfills [2, 50-55]. In the city of Kerbala the quantity of solid waste disposed in landfills increased form 340 thousand tonnes per year during 2005 to reach about 700 thousand tonnes during 2018. These quantities are expected to be near 1 million tonnes per year during 2035. Additionally, Kerbala is affected by many events where the city is faced with instant increase in the quantity of solid waste due to the dramatic increase in the visitor population of the city. one example of large event is the Arba’een religious event where more than 18 million visitor enters the city over 15 days to do religious activities and in the same time produce large quantities of solid waste [3, 7, 19].

Unfortunately, most solid waste generated around the world is poorly managed. About 90 percent of the solid waste generated in India, for example, is poorly managed and disposed of without proper management unit [16, 18]. Solid waste disposal is only contaminating water bodies with a wide variety of contaminants, but also significantly contaminated the underlying soils with many types of pollutants, it has thus become an important issue to the green establishments. Furthermore, disposal sites produce many types of gasses that could lead to serious ecological hazards and higher water usage [26, 28, 56, 57]. Therefore, the current research investigation aims to study the impact of municipal landfill site located in the city of Kerbala on the surrounding soil. The concentration of two heavy metals that are chromium, and nickel in the areas surround the landfill site in order to understand the effects of the landfill on the surrounding soil.

2. Selected landfill site

The target landfill site in this investigation is situated in the southwest of the city of Kerbala (32° 32' 0” N and 32° 28' 0” N as shown in figure 1. This site collects various forms of urban solid waste, fluctuating from plain food refuse to building waste. Generally, the depth of the trenches used for waste disposal was calculated to be between 2 and 4 m at the disposal site. The landfill of Kerbala has been selected to examine the effects of municipal landfills on the surrounding soils because the landfill poorly maintained like the majority of landfills in Iraq. The waste is discarded lacking an appropriate disposal procedure. The landfill is regarded as dumping site without good engineering practice. Besides, the sit contains many rag pickers who market the recently discarded waste to the related businesses, who recycles bottles, canisters, metals and plastic wastes.
3. Materials and methods
In this research, two soil samples were collected from two sites located about 15 and 30 meters from the landfill site. The soil samples were obtained from about 2 meters from the top level of the soil in each site. Plastic containers were used to keep the samples in isolated space and preserve its characterise. The samples were transported to labs for analyses and examination in terms of heavy metals pollution.

At the lab, the related research literature was followed in terms of processing and preparation of the gathered samples [58]. Firstly, the obtained samples were dried out for one day at oven temperature of 65 °C. A 2 mm mesh was used for separating waste and stones/gravels to sew the dry samples. The seven samples were digested with inductively coupled plasma optical emission spectrometry before checking for Cr, Cu, Ni and Pb concentration (model: OPTIMA-2000). After drying, the samples were passed through 2 mm sieve to remove rubble and gravels/chippings. Finally, the samples were examined to find the consecration the chromium and nickel using optical spectroscopy.

4. Results and discussion
Two soil samples collected from two sites that are spread about 15 meters and 30 meters from the landfill site. Table 1 presents the concentration levels of the selected pollutants near the landfill site. The findings gotten shows that, as the distance from the landfill site increases, the concentration levels of the targeted heavy metals (chromium and nickel) are reduced. The connection between the distance from the selected landfill site and the reduction in the concentration of the heavy metal can be regarded from several aspects. One, there has been a drop in rainfall over recent years and a high drought that considerably restricted the penetration of surface rinse into the site and wash out the toxins into nearby land and water bodies. Besides, the water leaching from the accumulated waste in the dump site is normally move for very short distances. Thus, it can be seen that the concentration of the pollutant is increased near the landfill site and drops when the distance increases. Comparing the concentration of the heavy metals around the site with the standard limits, it is clearly the concentrations is below the limits which acceptable sign about the impact of the landfill on the surrounding soils [58].

| Pollutant | Site | Distance (m) | Concentration (mg/kg) | Average (mg/kg) | Limitations |
|-----------|------|--------------|-----------------------|-----------------|-------------|
| Cr        | 1    | 15           | 37.7                  | 31.1            | 250 mg/kg   |
|           | 2    | 30           | 24.5                  |                 |             |
| Ni        | 1    | 15           | 46.1                  | 38.5            | 60 mg/kg    |
|           | 2    | 30           | 30.9                  |                 |             |
5. Conclusions
The present research centred on investigating the effects of metal accumulation on the underlying soil within municipal landfill sites, concentrating mostly on chromium, and nickel levels. The findings revealed that the level of contaminants surveyed were negatively related the distance from the sites, at which the concentrations of chromium, and nickel was observed to be decreased as the location of the sampling site be distanced form the landfill site. In addition, the concentration level of the assed heavy metals were below guidelines prosed by the environmental protection. The Nickle have the highest concentration level in the sites investigated. Future researches are recommended to investigate the presence of other heavy metals like cadmium and arsenic near the landfill site.

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