

Geographical Distribution of Landfills in the Outskirts of Baghdad Governorate using the GIS

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Abstract

The problem of solid waste from domestic, industrial, commercial and medical sources is one of the most important problems facing the local administration in all Iraqi cities. The danger of this problem increases with the rapid increase in the population, changing lifestyles, consumption patterns, limited land suitable for landfill, and high costs of collection and disposal. This research aims to solve these problems by determining the locations of current landfills located in the outskirts of Baghdad Governorate. The ArcGIS program was used, where the sites of the landfills were determined on the map and through the available data about the areas. It was concluded that the existing landfill sites do not meet environmental conditions and standards. According to the statistics of 2016/2020, which the amount of waste in some areas has increased, and decreased in others. The results show that each of 16 municipalities at the outskirts of Baghdad Governorate has only one landfill. The Al-Zuhur district is one of the most waste-producing areas, according to the statistics of the years 2016/2020, due to the high population ratio in that area. Mahmudiyah was recorded among high rate waste production areas, as the amount of waste in 2016 was 49,000 tons, but decreased slightly in 2020 to 48,000 tons. The research recommends following the health and environmental foundations in proper planning for the establishment of waste dumps, as well as the necessity of activating the role of geographic information systems in the field of proper waste management and environmental planning.

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1. Introduction

A Geographic Information System (GIS) is the science concerned with collecting, processing, and studying geographic information. The benefits of geographic information systems are that they reduce the time spent preparing maps, the number of working hours, and financial costs. GIS applications are involved in many fields, including medical, military, commercial, and agricultural. Optimizing land use planning and environmental protection, such as identifying sources and causes of pollution and setting appropriate plans, as well as selecting the best sites for establishing waste dumps and this will be covered in this research [1].

The technology of geographic information systems has a vital role in managing the ecosystem, which can be applied in various environmental fields by studying real-life examples, such as water hydrology, soil management, vegetation cover, and pollution. In this research, the focus will be on the pollution caused by unsanitary landfills, as the environment of Iraq is heading towards more pollution due to the adoption of unhealthy waste disposal methods. The importance of geographic information systems in identifying landfills and the information that pertains to them on the map and taking the necessary measures to construct healthy landfills according to the required standards, where the presence of nearby population centres, different land

uses, topography, soil, and ground wells, distance from public roads, wind direction, and amount of rain to reach at the end to options that do not cause harm or reduce the damage caused by landfills to a minimum.

2. Related Work

Zqlam, in 2013, assessed the geographical distribution of waste containers in the Palestinian city of Nablus using geographic information systems. ArcGIS-10.1 program was used. The research concluded that the number of current containers is sufficient if they were emptied daily with performing the necessary maintenance and replacing the damaged ones, but their spatial distribution is not commensurate with the amount of waste produced daily in some neighbourhoods [1].

Elbaba et al. in 2015, studied the location of solid waste dumps in the Gaza Strip. They used the geographic information systems as an assistive technology in evaluating solid waste landfill sites in the Gaza Strip to produce a digital map of the best sites suitable for establishing sanitary landfills. The result of the research was that the current landfill sites are of low suitability [2].

Study conducted by Shtayah, in 2017 [3], to select the best sites for landfills in the West Bank using geographic information systems. The result of the study was determined after applying the various criteria using the GIS to the best sites for the establishment of landfills, which were represented by appropriate maps.

The analysis conducted by Chabuk et al. 2017 [4] using geographic information systems and multi-criteria decision analysis (MCDA), also known as the analytical hierarchy (AHP), revealed that seven intermediate collection stations could be recommended as the best locations to make the collection and delivery of municipal solid waste to the landfill site easier.

In their study, Aslam et al. used remote sensing techniques and geographic information systems to determine the most appropriate place to be established as a garbage dump in the city of Faisalabad. In order to assist municipal decision-makers in evaluating, locating, and creating a digital map of the best suitable sites for the establishment of a healthy landfill, researchers used geographic information system purification [1] and remote sensing technology. Three sites were identified as a result of the study; one was chosen as a location for collection and sorting, while the other two were preferred for their ownership and proximity to wells [5].

3. Problem Statement

The research aims to shed light on the problem of pollution in some areas at the outskirts of Baghdad governorate as a result of the presence of unhealthy random and non-random landfills. Geographic information system was used to solve this problem by identifying landfills in those areas on the map and studying their location well and then choosing the best sites for the construction of new healthy landfills.

4. Methodology

The ArcGIS program is a software platform related to geographic information systems and sciences. It is a set of programs provided by Esri that creates, manages, shares, and collects geographic data, analyzes geographic information, and displays it in the form of accurate maps [6]. The system relies in its work on creating aggregated layers of geographical data, designing maps, or stereo models of an area, and then performing geographical analysis. Among the most important features of the ArcGIS program using SAR data [7, 8]:

- 1- It allows clearly and easily seeing the infrastructure in the city and its arrangements, as well as providing a detailed view of the plans of each street, border, facility, and sidewalk.
- 2- It provides information on the age of the materials used in the infrastructure, and its previous maintenance records, which facilitates its follow-up and management.
- 3- The geographic mapping system produces maps with a high degree of accuracy, which aids the user in precisely determining the limits ownership in the lands.

4.1. Study Area

The Directorate of Municipalities of Baghdad Governorate \ Planning and Follow-up Division \ GIS Unit [9], as well as the Solid Waste Division using Landsat TM and ETM images downloaded from USGS, were consulted. Maps of the study areas were downloaded and worked on using the GIS program, version (10.7). The locations of the landfills were accurately determined on the maps using shape files (Point).

5. Results and Discussion

Table 1 shows the locations of the landfills and whether they are inside or outside residential areas. The percentage of waste in each region according to (2016/2020) statistics is shown in Tables 2 and 3. The tables show 16 districts on the outskirts of Baghdad governorate, which are affiliated with Baghdad governorate.

Table 1: Location of landfills.

Sequence	Municipality name	Sanitary landfill site	Inside or outside area
1	Al-Yusufiya	sorting lab	outside
2	Al-Mahmudiyah	sorting lab	outside
3	Al-Rashid	sorting lab	outside
4	Al-Latifiya Outside	sorting lab	
5	Al-Tarmiyah	Almashroa Alebis	inside
6	Al-Naser and Al-Slam district	District center	Inside
7	Abu Ghraib	Abo-Sgaer	inside
8	Al-Mdain	Serbijan	inside
9	Al-Nahroan	Al-Amanah website - Nahrawan	outside
10	Al-Wheda	Baghdad-Kut road	inside
11	Al-Jaser	Al-Mansey	outside
12	Al-Taje	Industrial Area	inside
13	Al-Zohour	Hammadi Chehab camp	outside
14	Al-Rashidiya	Rashidiya camp	outside
15	Al-Abache	Rafee	outside
16	Al-Moshoda	Abu Saryol	outside

5.1. Landfills

The term "landfill" does not only refer to the location where waste is dumped; it also has meanings related to waste recycling plants in general and locations that house crushed stone or rock fragments left over from demolition projects. The landfill is not only used to get rid of garbage; some factories take advantage of the large area of the landfill to recycle this, but they are not more important than the original, and the basic principle is that we know the environmental conditions for establishing such places so that they become healthy and more convenient to use. Using Landsat TM and ETM images downloaded from the USGS [8], as shown in the pictures of Fig. 1.

5.2. Waste

There are different types of waste: liquid, gaseous, medical, radioactive, and solid waste, such as paper, wood, metal, glass, and plastic. The role of GIS in the solid waste management process is significant because many aspects of waste planning and management processes depend on spatial data and information. Thus, with the help of this system, solid waste and its disposal can be managed effectively, safely, and economically, with minimal environmental impact on the surrounding area in the present and future. GIS helps restructure the solid waste management system (collect, transport, process, and control) [7]. The efficient disposal of solid waste can be accomplished by classifying the waste into non-degradable waste that can be recycled and degradable waste that can be embedded. This can be accomplished by sorting the waste into these two categories using a geographic information system (GIS) [8]. The waste amount can be calculated according to:

$$\text{No. of containers} = (\text{waste amount (kg)}) / (\text{volume of one container}) \quad (1)$$

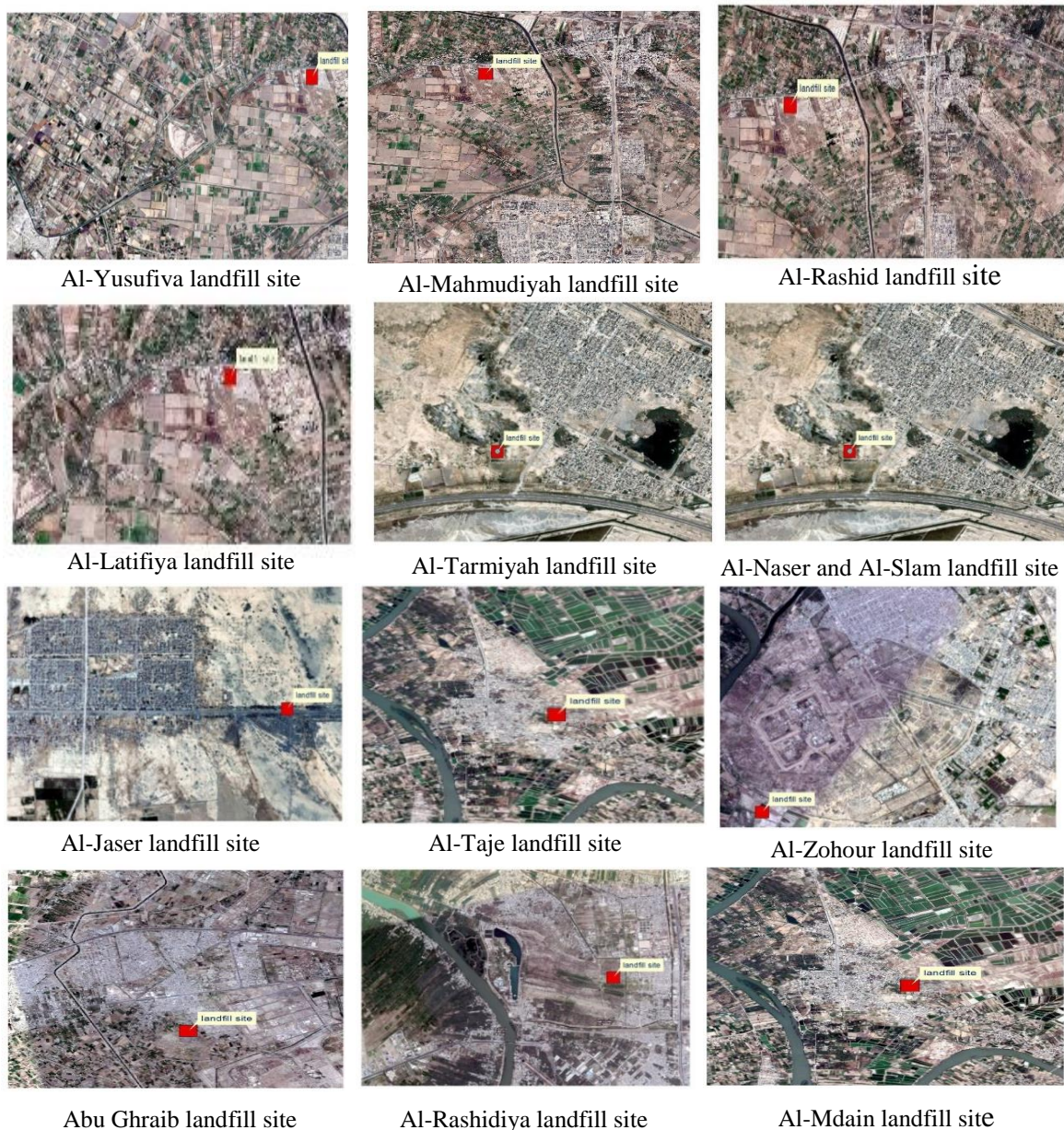


Figure 1: Landfill sites.

Table 2: The amount of waste produced in the outskirts of Baghdad governorate, according to 2016\2020 statistics.

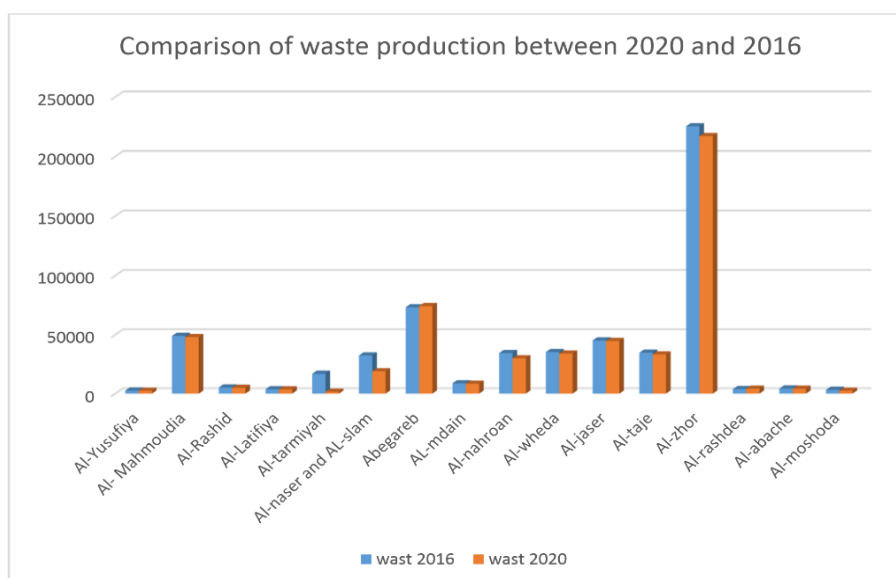
Municipality	Amount of waste in tons
Al-Yusufiya	2645
Al-Mahmudiyah	49000
Al-Rashid	5240
Al-Latifiya	3715
Al-Tarmiyah	16900
Al-Naser and Al-Slam	32400
Abu Ghraib	73320
Al-Mdain	8760
Al-Nahroan	34450
Al-Wheda	35310
Al-Jaser	45200
Al-Taje	34800
Al-Zohour	225400
Al-Rashdea	3850
Al-Abache	4350
Al-Moshoda	3250

Tables 1, 2, and 3 show the amount of waste produced in different places in Baghdad. A comparison was made of the amount of waste produced between 2016 and 2020. It was found that the amount of waste has increased in some areas and decreased in others. Al-Zohour is the most waste-producing area according to statistics, where the amount of waste was 225,400 tons in 2016 that decreased to 217,200 tons in 2020.

The production of waste increased from 73,320 tons in 2016 to 74,341 tons in 2020 at Abu Ghraib, which came after. Al-Mahmudiyah was also listed as having a high rate of waste production because there was 49,000 tons of waste there in 2016, but 48,000 tons in 2020. The landfills in the Al-Zohour and Al-Mahmudiyah districts are located outside the residential area, while the landfill in the Abu Ghraib district is located inside. According to the current maps, these three areas are among the most waste-producing areas, which harm the nearby residential areas. The remaining waste-producing regions are depicted in Fig. 2 based on statistics.

Table 3: The amount of waste produced in 2020.

Municipality	Amount of waste in tons
Al-Yusufiya	2460
Al-Mahmudiyah	48000
Al-Rashid	4932
Al-Latifiya	3612
Al-Tarmiyah	1600
Al-Naser and Al-Slam	19000
Abu Ghraib	74341
Al-Mdain	8400
Al-Nahroan	30000
Al-Wheda	34000
Al-Jaser	44724
Al-Taje	33300
Al-Zohour	217200
Al-Rashdea	4200
Al-Abache	4200
Al-Moshoda	2496

**Figure 2: Waste producing statistics.**

The Abu Ghraib district produces the most waste after the Al-Zohour district, followed by the Al-Mahmoudiyah district and then the Al-Jisr district. The presence of landfills inside residential areas poses a danger to the population. The research showed that the current landfill sites do not comply with environmental conditions and standards. Most municipal institutions do not have regular landfill sites except for the waste sorting plant of the Al-Mahmoudiyah Municipality Directorate, located in the Al-Yusufiya district and operated by the following municipalities: Al-Mahmudiyah, Al-Yousifiya, Al-Latifiyah, and Al-Rasheed). The research proved that GIS applications

are highly efficient and effective in locating waste dumps and contribute to helping decision-makers choose new dumps.

6. Conclusions

The research revealed many results about the areas of the province of Baghdad's outskirts, in which the sites of waste dumps were studied and identified by the ArcGIS programs. The outskirts of the Baghdad Governorate consist of 16 municipalities, each with only one landfill. It turns out that the districts of Al-Mahmudiyah, Al-Yusufiya, Al-Rashid, and Al-Latifiyah all have one landfill, as shown on the maps. Al-Zohour district is one of the most waste-producing areas, according to the statistics in the years 2016–2020, due to the high population ratio in that area, where the percentage in 2020 reached 532,000 people.

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Conflict of interest

Authors declare that they have no conflict of interest.

References

1. R. I. Z. Ibrahim and R. G. Ahmad, PhD Thesis, An-Najah National University, 2013.
2. M. El Baba, P. Kayastha, and F. De Smedt, Arab. J. Geosciences **8**, 7499 (2015).
3. D. A-L. H. Shtayah, PhD Thesis, An-Najah National University, 2012.
4. A. J. Chabuk, N. Al-Ansari, H. M. Hussain, S. Knutsson, and R. Pusch, Envir. Earth Sci. **76**, 1 (2017).
5. B. Aslam, A. Maqsoom, M. D. Tahir, F. Ullah, M. S. U. Rehman, and M. Albattah, Buildings **12**, 605 (2022).
6. Ministry of Construction and Housing and Municipalities and Public Works, (2022).
7. A. A. Othman, A. K. Obaid, D. M. Al-Manmi, M. Pirouei, S. G. Salar, V. Liesenberg, A. F. Al-Maamar, A. T. Shihab, Y. I. Al-Saady, and Z. T. Al-Attar, Sustainability **13**, 12602 (2021).
8. S. L. Kareem, S. K. Al-Mamoori, L. A. Al-Maliki, M. Q. Al-Dulaimi, and N. Al-Ansari, Cogent Eng. **8**, 1863171 (2021).
9. Baghdad Governorate Municipalities Directorate / Planning and Follow-up Division / GPS Unit, (2020).

التوزيع الجغرافي لمدافن النفايات في ضواحي محافظة بغداد باستخدام نظم المعلومات الجغرافية

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الخلاصة

تعد مشكلة النفايات الصلبة سؤالاً كانت الصناعية والتجارية او حتى النفايات الطبية من أهم المشاكل التي تواجه السكان المحليين في جميع المدن العراقية ويزداد خطر هذه المشكلة مع الزيادة السريعة في عدد السكان، وتزداد خطورة هذه المشكلة مع الزيادة السريعة في عدد السكان، وتغير أنماط الحياة، وأنماط الاستهلاك، ومحدودية الأراضي الصالحة لطررها، وارتفاع تكاليف جمعها والتخلص منها،

لذلك يهدف هذا البحث إلى حل هذه المشاكل من خلال تحديد مواقع المدافن الحالية التي تقع في ضواحي محافظة بغداد. تم استخدام برنامج ArcGIS، حيث تم تحديد مواقع مدافن النفايات على الخرائط ومن خلال البيانات المتاحة التي توفرت من بيانات محافظة بغداد. وتم التوصل إلى أن مواقع المكبات الحالية لا تستوفي الشروط والمعايير البيئية، فضلا عن اكتشاف المناطق التي زادت فيها كمية النفايات، وغيرها من المناطق التي انخفضت فيها النفايات، وفقا لإحصاءات عام 2016/2020. يوصي البحث باتباع الأسس الصحية والبيئية في التخطيط السليم لإنشاء مكبات النفايات، فضلا عن ضرورة تفعيل دور نظم المعلومات الجغرافية في مجال الإدارة السليمة للنفايات والتخطيط البيئي.