

Assessment of the environmental reality of household solid waste on the right side of the city of Mosul

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ABSTRACT— This study aims to estimate the amount of solid waste produced by an individual and to evaluate and analyze the solid waste problem in the city of Mosul, The study included all areas of the right side of the city of Mosul, and in each residential district, two sites were randomly selected, where samples are collected on a daily basis after distributing the bags to the specified sites, or for a period of four months, as the results of the research conducted in the year (2021-2022) showed that The right side of the city of Mosul produces approximately (527) tons per day of municipal solid waste, which contains four municipal sectors. The results of the study, through the field survey process, showed that the study area contains more than 370 waste dumps within residential neighborhoods, which occupy an area of more than 11774 m². The largest among the components, with a percentage of (64.52%), plastic, nylon (7.35%), paper and cardboard (8.39%), glass (3.47%), metals (2.18%), textiles (2.46%), wood (2.21%), and nappies (9.46%), Therefore, some of them must be recycled and others re-used and treated to produce other materials, thus reducing the volume of waste and producing other materials such as organic fertilizers and soil conditioners, and in the end we reduce the use of land as landfill sites, as well as providing an economic resource for the city and the country in general.

KEYWORDS: solid waste, Mosul city, production rate, random landfills.

1. INTRODUCTION

In fact, solid waste constitutes one of the most prominent environmental problems in the world and a source of environmental pollution that most Iraqi cities suffer from, including the city of Mosul. The negative to what is underground, such as groundwater, for example, especially when it is disposed of in incorrect ways, such as the burial method, The quantities of solid waste increased in different countries of the world, due to industrial and civilized development and population growth, and this development was accompanied by an increase in the amount and diversity of waste generated as a natural response to the great acceleration in economic growth and population growth and the accompanying release of huge and increasing amounts of various wastes such as household solid waste, which It means that they are any unwanted surplus materials or they are broken, damaged or polluted materials that must be disposed of [1]. Therefore, waste must be treated and disposed of in safe and environmentally friendly ways at the lowest costs, The city of Mosul is one of the Iraqi cities that suffers from the problem of waste due to the lack of financial disciplines available to treat it, in addition to the shortcomings in the work of municipal cadres in some neighborhoods of the city, and the lack of environmental awareness for some.

A balance must be achieved between the following elements, protecting the environment from pollution, the cost required to dispose of waste, and saving energy and natural resources. To achieve these goals, it is necessary to know the quantity and quality of waste produced, the method of waste collection in the places

of production or outside, the method of transportation to deliver it to the intermediate stations, treatment places or places of disposal, as well as reducing the volume of waste, in addition to the safe disposal method, and finally the scientific method of regular sanitary landfill.

The problem of solid waste management in the city of Mosul faces several challenges, including the continuous increase in the population with the increase in economic activity, which leads to a difference in components and an increase in production, and the change in the lifestyles of different families leads to a difference in the proportions of waste components and the quantity produced. The growth of environmental awareness and the increasing awareness of the negative effects of the presence and spread of solid waste plays an active role in dealing with waste. It is also not possible to neglect the view of local governments and municipal departments to waste as an economic resource and not just an environmental burden or waste, as the integrated management of solid waste plays a key role in achieving many economic, health and media benefits in addition to various environmental benefits [2].

2. OBJECTIVE

Estimating the amount of solid waste produced by the individual, as well as estimating the number and area of landfills within residential neighborhoods and determining their location on the map, in addition to evaluating the mechanisms of solid waste management in the region, starting from the source of the waste to the landfill, and ways to treat it afterwards.

3. MATERIALS AND WORKING METHODS

The study included an assessment of the environmental reality of solid waste in all areas of the right side of the city of Mosul, which is located within the service of four municipal sectors (Al-Rabee Sector - New Mosul - Old City - Ghazlani) to know the quantity of waste produced, its components, methods of collection, transportation, treatment or disposal. Where the study samples were elected to include different people of different economic, social, cultural and other levels, and the samples were chosen randomly and in two houses from each region, containing a different number of individuals and of different age groups, as waste collection bags were distributed to the specified houses to be collected on the day The second after 24 hours. The method adopted in this study was the method used by [3]. And [4], as well as a questionnaire form was distributed, to help obtain some information, including regarding the serviced areas or not, the amount of solid waste produced by each individual per day, and the number of times of waste collection per week, and identifying the areas that use the direct transport system, and so on.

The process of collection and sorting of waste continued for four months, starting from the beginning of October until January. During this period, (200) samples were collected from different regions of the right side of the city of Mosul. And Figure No. (1) Represents the neighborhoods that were elected to conduct the study

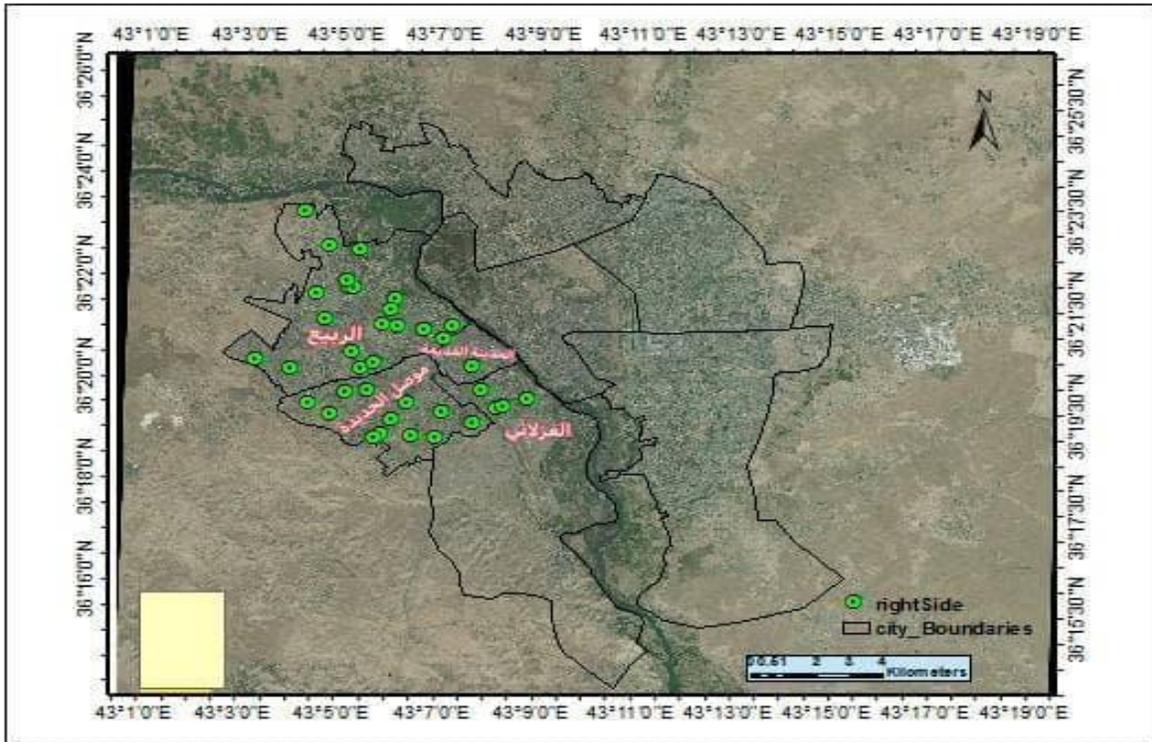


Figure No. (1) An aerial map showing the residential neighborhoods on which the study was conducted on the right side of the city of Mosul

4. RESULTS AND DISCUSSION

After research and conducting a field survey, it was found that most of the neighborhoods on the right side of the city of Mosul suffer from weak or lack of proper solid waste management, as the spread of random dumps within residential neighborhoods, especially near schools, health centers and abandoned lands, and this indicates a weak environmental awareness among citizens, so it is necessary to From activating the integrated management of solid waste and in joint cooperation between citizens and municipal cadres to get rid of its health, environmental, economic and social risks, in addition to activating the system of direct transport of waste from the source to get rid of the problem of the spread of landfills within residential neighborhoods, Among the neighborhoods that follow the direct transportation system on the right side of the city of Mosul are (Al-Thawra, the first Yarmouk, Al-Dandan, Al-Tayaran, Al-Jawsaq). As for the reasons for the lack or absence of mechanisms, capsules and containers in some neighborhoods of the city of Mosul, it is due to the lack of financial specialization, and that the containers and capsules that were distributed to most neighborhoods are supported by international organizations in cooperation with the Mosul municipality, and not from the municipality itself. Also, in every meeting of the Mosul municipality, the issue of waste recycling is raised, but it is not implemented due to the lack of financial specialization.

4.1 Domestic solid waste generation rate

Table (1) shows the rate of per capita production of solid waste in most or all areas of the right side of the city, and this represents the rate of residential productivity. As for the rest of the industrial, commercial, agricultural, medical and institutional activities, they represent twice the residential productivity in the city, as stated by the source [5] for countries it was confirmed that the city's productivity of population waste in developing countries represents 50% of the total productivity.

The rate of production per capita of total household solid waste on the right side of the city of Mosul after

analyzing 200 samples was (0.779) kg/person.day, and this is consistent with what was found by [6] for developing countries. But if we compare this figure with local studies, we find it within the limits of [7], [8] as the rate of production per capita of household solid waste in the city of Mosul, according to these two studies, was (0.35-0.70). Kg/person per day and (0.43-0.75) kg/person per day, respectively. Thus, the right side of the city of Mosul produces approximately (527) tons per day of municipal solid waste, and the city's population is 1471353 according to the statistics of the Nineveh Governorate Statistics Directorate [9], where the right side represents about 46% of the city's population [10]. The reason for the difference in the results of local studies is attributed to several factors, the most important of which are the factors of time and place, which clearly affect the results, in addition to the economic and cultural situation and others.

Waste components were also sorted and diagnosed, and the weight ratios were calculated for each component of the samples taken. Organic waste represented the largest proportion of the components, at 64.52%, paper and cardboard by 8.39%, plastic and nylon by 7.35%, metals by 2.18%, glass by 3.47%, textiles by 2.46%, diapers by 9.46%, wood and the rest Components: 2.21%. Figure No. (2) Shows the percentages of household solid waste components.

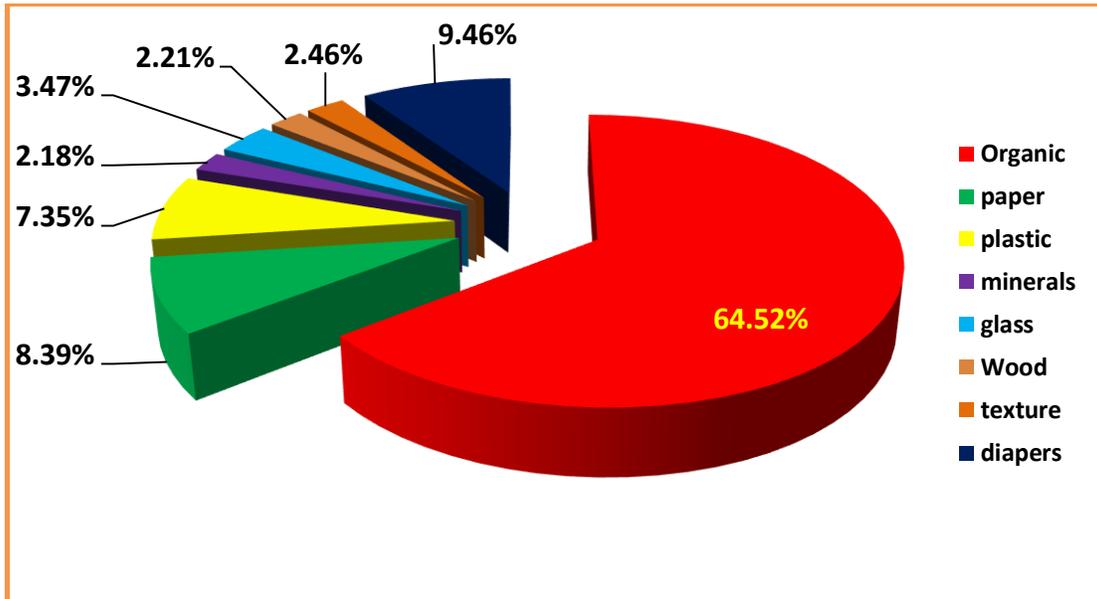


Figure No. (2) Percentages of household solid waste components on the right side of the city of Mosul

Table No. (1) The rate of solid waste production on the right side of the city of Mosul (kg/person/day)

Study date	October (kg/person/day)		November (kg/person/day)		December (kg/person/day)		January (kg/person/day)		Residential production rate (kg/person/day)	Total production rate (kg/person/day)
	1	2	1	2	1	2	1	2		
Al -Shifa	0.518	0.342	0.315	0.44	0.408	0.314	0.399	0.458	0.399	0.799
Al -Zanjali	0.42	0.458	0.418	0.382	0.305	0.327	0.335	0.383	0.379	0.757
Al -Saha	0.438	0.492	0.408	0.42	0.470	0.342	0.408	0.39	0.421	0.842
Al -Thawra	0.505	0.464	0.523	0.439	0.418	0.423	0.403	0.435	0.451	0.903
Al-Rifai + Al-Araibi	0.469	0.598	0.436	0.494	0.445	0.424	0.407	0.418	0.461	0.923
Hawi church +Al-Najjar	0.495	0.428	0.43	0.433	0.452	0.313	0.302	0.552	0.426	0.851
Tammuz -17	0.503	0.598	0.482	0.525	0.437	0.458	0.504	0.621	0.516	1.032
Mushairfa	0.537	0.383	0.617	0.553	0.412	0.496	0.38	0.883	0.533	1.065
Al -Haramat	0.314	0.327	0.291	0.325	0.404	0.347	0.35	0.298	0.332	0.664
Al -Aslah alzyray	0.392	0.337	0.356	0.329	0.355	0.313	0.367	0.39	0.355	0.710

Yarmouk -Al	0.569	0.483	0.54	0.436	0.424	0.843	0.71	0.405	0.551	1.103
Al -Nahrawan	0.219	0.284	0.268	0.257	0.263	0.287	0.221	0.202	0.250	0.500
rjm haded	0.295	0.302	0.301	0.297	0.331	0.328	0.281	0.296	0.304	0.608
Nablus	0.352	0.337	0.342	0.329	0.323	0.342	0.335	0.316	0.335	0.669
New Mosul	0.52	0.374	0.428	0.336	0.514	0.485	0.378	0.374	0.426	0.852
Al-Amel + Al-Shuhada	0.323	0.251	0.292	0.302	0.35	0.299	0.293	0.333	0.305	0.611
Tal Alrman	0.296	0.249	0.296	0.306	0.286	0.281	0.291	0.299	0.288	0.576
Al -Mamoun	0.263	0.297	0.282	0.295	0.296	0.307	0.312	0.301	0.294	0.588
Al -Samoud	0.312	0.388	0.361	0.4	0.418	0.368	0.378	0.335	0.370	0.740
Wadi Hajar	0.406	0.327	0.402	0.37	0.298	0.304	0.328	0.311	0.343	0.687
Al-Tayaran + Al-Ghazlani	0.64	0.452	0.58	0.498	0.515	0.534	0.432	0.468	0.515	1.030
Al-Dandan +Al-Jawsaq	0.53	0.662	0.553	0.513	0.418	0.553	0.503	0.442	0.522	1.044
Al -Mansour	0.343	0.447	0.434	0.394	0.308	0.329	0.327	0.331	0.364	0.728
Al -Nafet	0.307	0.324	0.302	0.313	0.252	0.254	0.274	0.282	0.289	0.577
Old City	0.291	0.35	0.289	0.342	0.302	0.283	0.299	0.312	0.309	0.617
									0.3895	0.7790

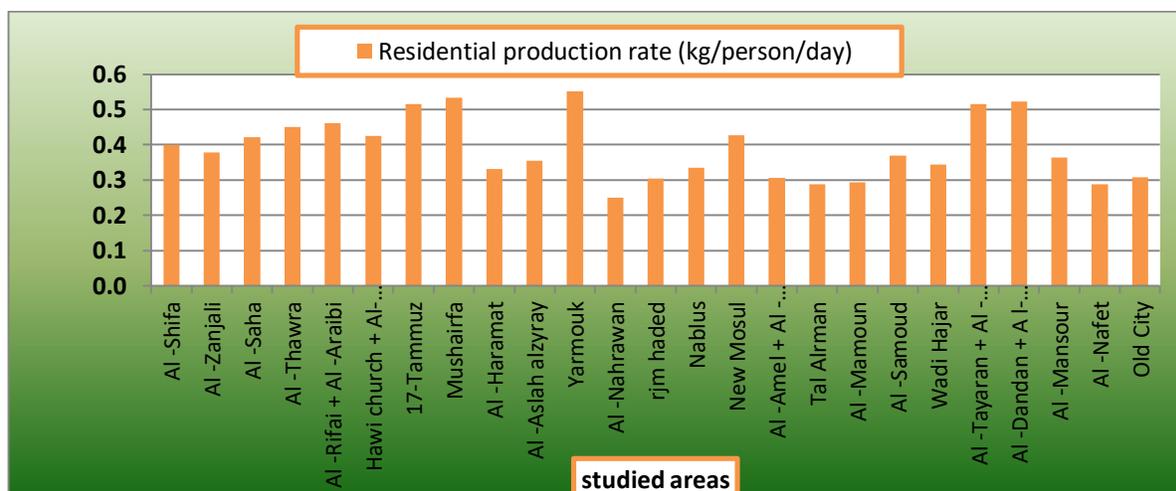


Figure No. (3) Average daily production of residential solid waste (kg/person) in most areas on the right side of the city of Mosul

4.2 The effect of the monthly variation in the rate of household solid waste production

As it is known, weather and climate have an impact on the rate of waste production, and Figure (4) illustrates this change during the months of the study, as a discrepancy is noted in the rate of domestic solid waste production during the study period, as climate change affects the quality and quantity of solid materials consumed by the individual, and it is evident from the results. The conclusion is that the highest rate of domestic waste production is in the month of October, and then begins to decrease slightly during the winter season. This is due to the decrease in the consumption of vegetables and fruits compared to the summer season, and the reason for this is due to the consumption of dry foods (legumes) and others.

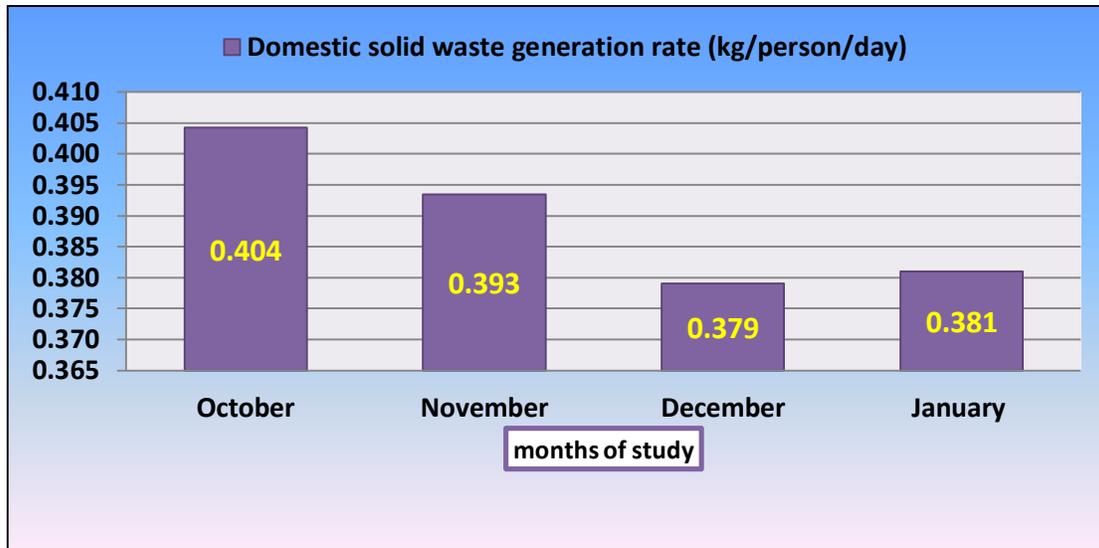


Figure No. (4) Monthly variation in the rate of residential solid waste production

Table No. (2) Estimates of the rate of solid waste generation according to studies conducted on the city of Mosul for the previous years

Estimation of household solid waste (according to)	Residential production rate (kg/person/day)	Total production rate (kg/person/day)
[11]	0.96	0.48
[12]	0.60	0.30
[7]	0.70	0.35
[4]	0.61	0.305

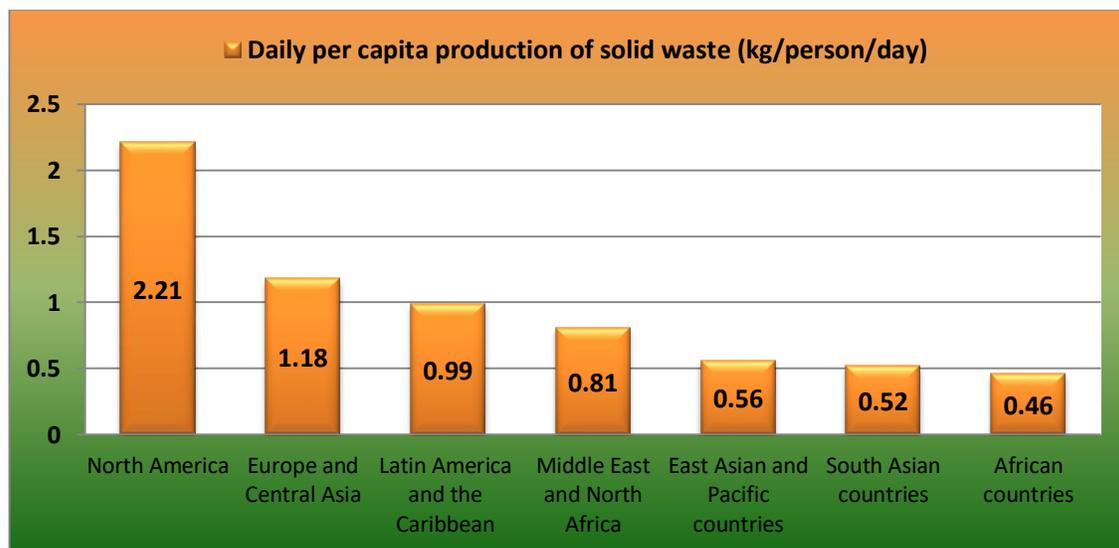


Figure No. (5) The percentage of solid waste generation distributed over the regions of the world in 2016 [13]

Table (3) shows the randomly scattered waste dumps inside residential neighborhoods and their associated serious environmental and health impacts, the most important of which is the increase in global warming as a result of the rise of fumes and gases, whether from the anaerobic decomposition process or from the combustion process, as well as their impact on sewage blockage, which causes Floods occur, especially in winter. And its impact on soil and groundwater pollution, in addition to its health effects by providing a

suitable environment for the spread of rodents, insects and germs, and ultimately the effect on the general appearance of the residential neighborhood.

Table No. (3) Landfill sites within the residential neighborhoods of the right side of the city of Mosul and its area

ID	Residential areas	The minimum number of landfills inside the neighborhood	The minimum area of landfills within the neighborhood in units (m ²)	Coordinates of some landfill sites		Are there containers inside the neighborhood
				Long	Lat	
1	Al -Shifa	5	38	43.121447	36.351399	Yes
2	Al -Zanjali	12	85	43.1114637	36.3499887	Yes
3	Al-Najjar	5	42	43.1022209	36.3600699	Yes
4	Al-Rifai	8	75	43.100208	36.356176	Yes
5	Hawi church	10	180	43.089897	36.375828	No
6	Al-Araibi	7	258	43.0865858	36.3630128	No
7	Al-Iqtisadya	6	60	43.0877961	36.3631917	Yes
8	17-Tammuz	10	86	43.085843	36.3656116	Yes
9	Mushairfa(1)	8	200	43.0793359	36.3766641	No
10	Mushairfa(2)	7	153	43.0708215	36.3883314	No
11	Al -Haramat	10	267	43.0753576	36.3609516	No
12	Al -Saha	6	68	43.1029168	36.3507561	Yes
13	Al -Thawra	0	0	0	0	Yes
14	Al -Aslah alzyray	10	98	43.0785516	36.3527733	Yes
15	Al-Warshan	3	16	43.0973794	36.3511325	Yes
16	Yarmouk (1)	4	22	43.087758	36.342529	Yes
17	Yarmouk (2)	16	170	43.067188	36.336277	a small percentage
18	Al-Matahan	7	155	43.090464	36.336684	Yes
19	Al -Nahrawan	10	114	43.05512	36.339167	No
20	Rajm Hadid	16	2023	43.073038	36.325001	No
21	Nablus	13	392	43.085344	36.328713	Yes
22	New Mosul	13	442	43.092771	36.32972	Yes
23	Al-Amel	15	2537	43.080347	36.32181	No
24	Al-Shuhada	6	186	43.101094	36.320211	a small percentage
25	Al-Moalemeen	10	949	43.097569	36.315227	No
26	Tal Alrman	9	720	43.095789	36.313885	No
27	Al -Mamoun	6	118	43.108336	36.314983	a small percentage
28	Al -Samoud	5	75	43.116506	36.314501	a small percentage
29	Wadi Hajar	12	333	43.129002	36.31921	Yes
30	Al-Ghazlani	5	54	43.136614	36.324693	Yes
31	Al-Tayaran	0	0	0	0	Yes
32	Al-Jawsaq	0	0	0	0	Yes
33	Al-Dandan	0	0	0	0	Yes
34	Al-Akeedat	11	88	43.131408	36.330437	Yes
35	Old City	79	666	43.12827	36.337897	Yes
36	Al -Nafet	10	256	43.106126	36.325761	Yes
37	Al -Mansour	6	346	43.118351	36.322658	a small percentage
38	Al-Abar	6	460	43.095271	36.338877	No
39	Sheikh Fathi	4	42	43.118727	36.346804	Yes
Total		More than 370 landfills	More than 11774m ²			

The results of the field survey showed a large spread of random dumps within the residential neighborhoods on the right side of the city, where the old city contained the largest number of dumps, and because of the large percentage of destruction that affected this area, where the demolished buildings turned into garbage dumps, as well as the inability of some mechanisms to connect to the interior due to Narrow alleys, followed by neighborhoods (Rajm Hadid and Hay al-Amel), which occupy an area of more than 2000, each with more than 15 dumpsites for each neighborhood. 13 landfills for each neighborhood, which occupy an area ranging from 16 m to more than 900 m for each of them. As for the neighborhoods of (Al-Thawra - Al-Dandan - Al-Tayaran Al-Jawsaq) they are characterized by the absence of random dumps inside them, where there is a container (barrel) in front of each house and thus they are used The direct transport system of waste from the house to the final or intermediate landfill, and Figures (6) and (7) show the area and numbers of random landfills.

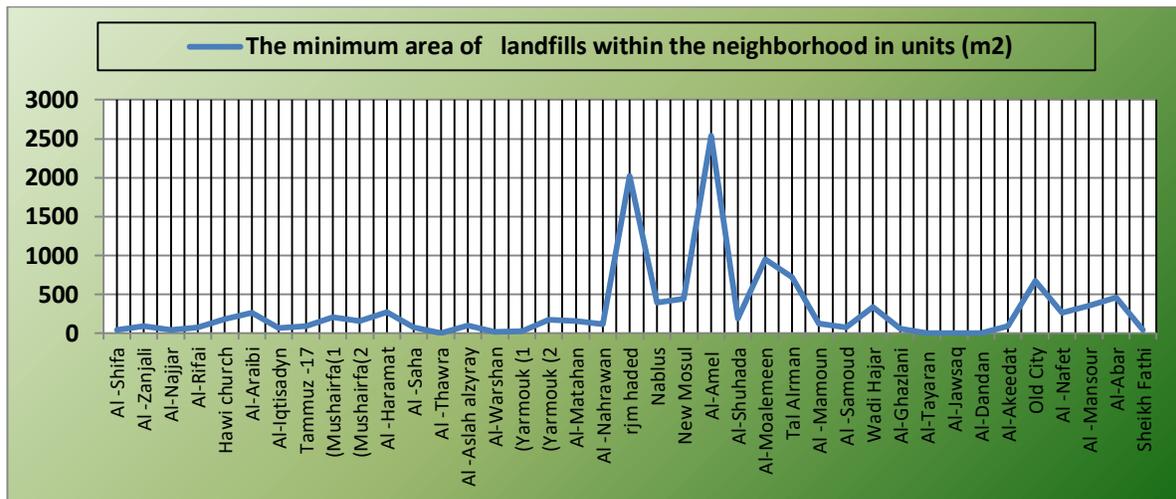


Figure No. (6) The area of random dumps inside residential neighborhoods on the right side of the city of Mosul

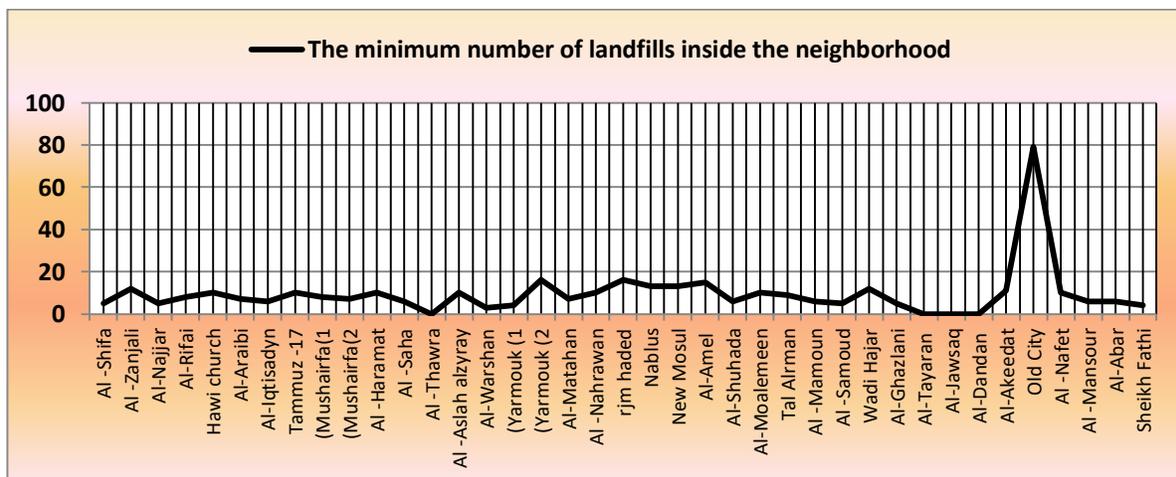


Figure No. (7) Number of random dumps inside residential neighborhoods on the right side of the city of Mosul

5. CONCLUSION

1- The lack of containers in most of the city’s neighborhoods, whether stationary containers (SC) or transported containers (Hauled Containers (HC), which led to the accumulation of waste in the form of

random dumps inside residential neighborhoods.

2- The use of large containers (transported containers) inside residential neighborhoods leads to the accumulation of waste around the container, due to the lack of commitment by most citizens to throw waste inside the containers.

3- Some residents throw waste into the public sewage network and valleys, which leads to flooding, especially in the winter season due to blockage of sewage.

6. RECOMMENDATIONS

1- It is preferable to use the Stationary Containers System (SCS) in residential neighborhoods because the dwellings are separate dwellings and thus the collection process is highly productive.

2- The horizontal expansion that the city is witnessing leads to depriving some dwellings of the service of removing the waste generated when using the movable container system; Some citizens who are far from the container are forced to throw their waste in any location near their homes or dispose of the waste by burning it, which leads to environmental problems.

3- Activating the direct transport system of waste from the source to the landfill.

4- Work to raise the level of environmental awareness for residents, workers and local bodies.

5- Work to create a development plan for solid waste management that takes into account the future population increase that will occur in the population.

6- Increasing the number of solid waste management elements, including workers, containers, compactor trucks, and street sweepers.

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