Solid Waste Situation in Thi-Qar Governorate

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Abstract. This study aims to provide an overview of the current status of solid waste in Thi-Qar governorate by a case study of five cities in this governorate. The five cities are namely: Al-Nassriya, Al-Shatra, Al-Rifai, Suk Al-Shoyokh, and Al-Chibayish. In general, the results revealed that the average generation rate of domestic solid waste was 0.85 Kg/capita/day in the study area. The organic waste was found the major components of municipal waste and it exceeded 60% of waste composition. All dumping sites in the aforementioned cities are uncontrolled dumpsite, their design not suitable, and do not work according to proper operating standards. There are no landfills or dumping sites specified for disposal the non-municipal waste. The investigations showed the presence of potential health risks and negative environmental aspects of solid waste handling in Thi-Qar governorate due to improper handling of collection, transfer, and disposal of solid waste. Thus, developing a master plan for integrated solid waste management is prerequisite to overcome the difficulties solid waste management sector in Thi-Qar governorate.

1. Introduction

Solid waste research has gained more attention in last decades; meanwhile solid waste management was one of the main concerns in developed countries particularly affected due to ineffective waste management systems [1]. The residential, commercial, industrial and institutional activities are the main sources of solid waste in urban areas [2, 3]. The generated solid waste from a community that requires collection and transport to a processing or disposal site is named municipal solid waste or refuse [2, 3]. Compared with medical waste, industrial solid waste, and construction waste, municipal solid waste has the characteristics of non-point source pollution [4]. In addition, the production of municipal solid waste widely varies depending on different parameters. For example, Abdulredha, et al. [3] found that the municipal solid waste produced by hotels, in Karbala city-Iraq, varies from 830 to 1220 g/guest-day, depending on different parameters, such as the hotels’ rate. Additionally, Abdulredha, et al. [3] stated that the relationship between production of municipal solid waste and hotel features could be statistically model with a good correlation factor value (R² of 0.799) [5]. Poor management of solid waste has negative effects on public health and the environment due to spread vector-borne disease and increase pollution levels [6,7]. Moreover, the important physical components of municipal solid waste, such as plastics and chemical fibers, may be harmful in some contexts [8] and are suspected of being carcinogenic to humans [9]. Solid waste has become one of the global environmental issues [10]. Around the world, with rapid population growth and urbanization, 120-130 billion tons of natural resources are annually consumed and produce around 3.4-4 billion tons of municipal solid waste [11]. Iraq is one of the most populous Arab countries with population exceeding 35 million. Iraq is administratively divided into eighteen governorates. The high population growth rates, the rapid economic growth, the increase in individual income, and improper waste management practices have led to worsening solid waste management problem in the country. As well as, Iraqi waste processing and disposal infrastructure was heavily damaged after decades of conflict. A number of serious concerns
for both human health and the environment associated with the mismanagement of solid waste and lack of controls, inadequate legislation. Therefore, this country needs comprehensive plans for solid waste management.

The solid waste management is complex tasks and technical challenges [12]. Managing waste properly is essential factor to protect health of the population, promote environmental quality, for building sustainable and livable cities, but it remains a challenge for many developing countries and cities [13, 14]. Regardless of the origin, content or hazard potential, solid waste must be managed systematically to ensure environmental best practices. Thus, this study aims to identify the current solid waste situation in Thi-Qar governorate.

2. Methodology

2.1 Description of the Study Area

Thi-Qar governorate is one of the 18th Iraqi governorates and located in the south. Al-Nassriya city is the capital of Thi-Qar governorate lies on the Euphrates River about 370 km southeast of Baghdad, near the ruins of the ancient Ur city. The area of this governorate is 12900 Km$^2$. The population number is about 2 million people and they are live in urban and rural areas. Euphrates River passes through the governorate and supplying the water for southern cities. Meanwhile, the northern cities are supplied by steams of Tigris River. Thus, the governorate takes the advantage of these two rivers; both rivers contribute to create marsh areas. The administrative structure of Thi-Qar governorate consists of 20 units. These units were divided into 5 districts which represent main cities and 15 sub districts as shown in Figure. 1 shows the administrative map of Thi-Qar governorate. This study attempted to focus on the main five cities, Al-Nassriya, Al-Shatra, Al-Rifai, Suk Al-Shoyokh, and Al-Chibayish to identify the solid waste management process in these cities. Table 1 shows number of population and areas of these districts.

![Figure 1. Administrative map of Thi-Qar governorate including selected cities (Source: Thi-Qar urban planning directorate).](image)

| City            | Number of population (2015) |
|-----------------|-----------------------------|
| Al-Nassriya     | 523237                      |
| Al-Shatra       | 170689                      |
| Al-Rifai        | 65905                       |
| Suk Al-Shoyokh  | 123381                      |
| Al-Chibayish    | 34922                       |

2.2 Data collection

The information and data were collected based on published reports, questionnaire, and interviews with municipal officials and other directive authorities. This was achieved through questionnaire application, live interviews with municipal officials and other directive authorities, literature review and physical inspection. The study was accomplished during 2017.
3. Results and Discussion

3.1. Solid waste generation and composition

The interviews with solid waste management officialdoms revealed that municipal solid waste showed that the average generation rate of domestic solid waste was 0.85 Kg/capita/day in urban areas of Thi-Qar governorate. It is worth mention that the generation rate varies in one municipality, neighborhood based on standard living. It was around 1 kg/capita/day in high standard living neighborhoods; meanwhile, it was around 0.7 kg/capita/day in low living neighborhoods. These results are still relatively small compared to 2.1 kg/day/capita in the USA. Meanwhile is higher the production of solid waste per capita in India (less than 0.5 kg/day/capita and close to China generation rate (less than 0.9 kg/day/capita) [15]. Meanwhile, solid waste can be categorized into three types’ domestic solid waste (73%), commercial and non-hazard industrial solid waste (16%), and street and green waste (11%). The average of solid waste quantities that was monthly collected by municipality cleaning departments of the five cities are Al-Nassriya, Al-Shatra, Al-Rifai, Suk Al-Shoyokh, and Al-Chibayish are depicted in Figure 2. The highest amount of solid waste was 17146 ton/month, it was found in Al-Nassriya city due to large number of population in that city.

![Figure 2. Monthly estimated solid waste quantities in Thi-Qar governorate.](image)

One significant aspect of solid waste from the solid waste management that the results showed the main portion of the solid waste stream in Thi-Qar governorate was an organic material. Based on Directorate of Environmental Affairs of Thi-Qar data, the composition of municipal solid waste is presented in Table 2. In general, the organic waste forms 61.3% (an average) which is biodegradable is remarkably high. Moreover, it can transform into organic fertilizer and compost materials. The rest of the solid waste stream contains considerable amounts of paper and plastic and reasonable quantities of glass and metals, and textiles that can be recovered or recycled. The other materials included inert materials (bricks, stones, dirt, etc.), wood, and electric waste. In spite of the absence of actual and real data about the amount recycled materials, it is expected that some non-organic waste are recycled or recovered by individuals and then the collected reusable materials are sold to private sector. However, there no official data about the quantity of recycled waste or the number of people who work in the sector. Waste characteristics of each community must be studied carefully before any treatment or disposal facility is designed and built.
Table 2. The composition of municipal waste in Thi Qar governorate

| City            | Paper (%) | Plastic (%) | Glass (%) | Metals (%) | Organic (%) | Textiles (%) | Other materials (%) |
|-----------------|-----------|-------------|-----------|------------|-------------|--------------|---------------------|
| Al-Nassriya     | 12        | 13.2        | 1.6       | 2.2        | 65.8        | 2.8          | 2.8                 |
| Al-Shatra       | 10.1      | 12.3        | 2.1       | 2.8        | 60.5        | 2.3          | 8.9                 |
| Al-Rifai        | 9.2       | 13.2        | 2.6       | 3.7        | 56.4        | 1.8          | 7.3                 |
| Suk Al-Shoyokh  | 11.2      | 14.8        | 1.9       | 2.7        | 59.9        | 2.9          | 6.7                 |
| Al-Chibayish    | 10.2      | 14.3        | 2.4       | 3.9        | 63.8        | 1.5          | 6.4                 |

3.2. Disposal Sites of Thi-Qar governorate

The five cities under this case study, Al-Nassriya, Al-Shatra, Al-Rifai, Suk Al-Shoyokh, and Al-Chibayish have dumping sites. Table 3 summarizes the physical and environmental conditions of the dumping sites in these cities. These sites have a negative impact on public health and the environment and do not meet the US Environmental Protection Agency (EPA) standards for landfill sites [16]. These sites located adjacent of residential area except Al-Nassriya dumping site as well as some of these sites are close to watercourses especially in Al-Shatra, Suk Al-Shoyokh, and Al-Chibayish. All dumping sites in the five cities are uncontrolled dumpsite, their design are not suitable, and doesn't work according to proper operating standards. In each location, the waste is burned and the practice is widely spread to reduce the volume of waste. Only a few equipment was employed at each site to handle waste in these sites. There is no data about the thickness of cover layer and the wastes covered without spreading and compacting. Moreover, some of these sites have shallow water table below ground surface. Therefore, the contaminated water, heavy metals and toxic elements present in the wastes contaminate the soil and ultimately seep into underground water after rainfall [17,18]. However, it is necessary to implement groundwater monitor plan, especially for the sites that have a shallow level of groundwater table.

Tables 3. The physical and environmental conditions of the dumping sites

| City            | Total area (m²) | Used area (m²) | Vacant area (m²) | Ground water table (m) | Soil type | Equipment | Number |
|-----------------|-----------------|----------------|------------------|------------------------|-----------|-----------|--------|
| Al-Nassriya     | 960000          | 480000         | 480000           | 8                      | clay      | Loader Bulldozer | 1 1    |
| Al-Shatra       | 20000           | 12000          | 8000             | 7                      | clay      | Loader Bulldozer | 1 1    |
| Al-Rifai        | 25000           | 10000          | 15000            | 5                      | clay      | Loader           | 1      |
| Suk Al-Shoyokh  | 20000           | 7000           | 13000            | 1.5                    | clay      | Loader           | 2      |
| Al-Chibayish    | 150000          | 6500           | 8500             | 1                      | clay      | Loader           | 2      |

3.3. Non-municipal solid waste

Non-municipal solid waste includes construction and demolition waste, medical waste, non-hazardous industrial waste, and agricultural waste.

3.3.1 Construction and demolition waste

Identification construction and demolition waste quantities are an essential requirement for the implementation of successful solid waste management [19]. Construction and demolition waste is waste that generated from construction and restoration works and building demolition. This includes building materials such as wood, bricks, concrete, insulation, electrical wiring, nails, aggregate, and etc. that are damaged or unused for various reasons during construction or generated after demolition. Construction and demolition waste may contain hazardous substances such as lead, and asbestos. On the other hand, there is the potential to recycle many components of construction and demolition waste.
Generally, these wastes in the study area are collected and disposed in open areas or near municipal dumping sites or mixed with other wastes and disposed in the landfill sites. It is worthy to mention that, sometimes, of these wastes are recycled and used in filling and dumping swamps in city area or reused in another construction project. Figure 3 presents the monthly estimated quantities of construction and demolition waste in Thi-Qar governorate.

[Figure 3: Estimated construction and demolition waste.]

### 3.3.2 Medical waste

Medical waste disposal is one of the biggest day-to-day challenges faced by healthcare providers. Medical waste is a by-product of health care facilities that includes sharps, non-sharps, blood, body parts, chemicals, pharmaceutical products, medical instruments, and radioactive materials. Poor management of medical waste may expose the health care personnel, waste handlers, and the community of infectious agents, toxic materials, and increase risk of injuries. Information of concerning estimated medical waste quantities, sources, and current management practices in the main hospitals in the five cities, Al-Nassriya, Al-Shatra, Al-Rifai, Suk Al-Shoyokh, and Al-Chibayish are tabulated in Table 4. The medical wastes in these cities are processed by separation based on type, for example, the sharp materials are collected in special yellow plastic containers. Meanwhile, other wastes collected in other plastic bags and containers.

In general, the medical waste in the health care facilities in aforementioned sites are treated by incineration, the most popular method, which is still the only method used for pathological waste, such as body parts and recognizable tissues. The results revealed that the highest generation of medical waste was found in Al-Nassriya city because it has the three main hospitals. In general, the practice of treating medical wastes in the medical health facilities is meeting the environmental legislation except Alshatra hospital, whereas these wastes burned inside the incineration of hospital. The Environmental affairs office of Thi-Qar governorate closed the incinerator in Alshatra hospital due non-compliance with conditions and specifications. However, the hospital management daily sends the medical waste for burning in another hospital incinerator. After burning the medical waste, the residual material is transferred to the landfill sites by municipality cleaning staff.
Table 4. The estimated medical waste quantities and current management practices in the main hospitals of Thi-Qar governorate.

| City          | Hospital name                          | Capacity (bed) | Waste quantity (ton/month) | Action                                                      | Disposal method               |
|---------------|----------------------------------------|----------------|---------------------------|-------------------------------------------------------------|-------------------------------|
| Al-Nassriya   | Alhussian hospital                     | 424            | 14.2                      | Separation of waste based on degree of hazard in special plastic bags | Burned inside hospital incineration |
|               | BintAlhuda hospital                    | 285            | 9.33                      |                                                             |                               |
|               | Alhaboby hospital                      | 200            | 8.51                      |                                                             |                               |
|               | Nassiriya heart center                 | 120            | 7.911                     |                                                             |                               |
| Al-Shatra     | Al-Shatra public hospital              | 168            | 5.66                      | Separation of waste based on degree of hazard in special plastic bags | Send the waste materials to burn out side hospital. |
| Al-Rifai      | Al-Rifai public hospital               | 154            | 5.1                       | Separation of waste based on degree of hazard in special plastic bags | Burned inside hospital incineration |
| Suk Al-Shoyokh| Suk Al-Shoyokh public hospital         | 180            | 6.21                      | Separation of waste based on degree of hazard in special plastic bags | Burned inside hospital incineration |
| Al-Chibayish  | Al-Chibayish public hospital           | 50             | 3.74                      | Separation of waste based on degree of hazard in special plastic bags | Burned inside hospital incineration |

3.3.3 Non-hazardous industrial wastes
Non-hazardous industrial wastes refer to the waste that generated from industries and cannot be potentially threatening to the health of labors and work environment. These industries include brick factories, textile, blacksmith workshop, automotive maintenance workshops and etc. The non-hazardous industrial wastes in the five cities that over mentioned are together collected with municipal wastes and disposed in the dumping sites. Table 5 shows the results of some collected data about the quantity of these wastes form some industrial activities within municipality boundaries in Al-Nassriya, Al-Shatra, Al-Rifai, Suk Al-Shoyokh, and Al-Chibayish cities.

Table 5. Estimated non-industrial waste quantities.

| City          | Industrial activity                  | Number | Estimated non-industrial waste (ton/month) |
|---------------|-------------------------------------|--------|---------------------------------------------|
| Al-Nassriya   | Maintenance and blacksmith workshops | 1365   | 661                                         |
| Al-Shatra     | Maintenance and blacksmith workshops | 256    | 120                                         |
| Al-Rifai      | Maintenance and blacksmith workshops | 101    | 56                                          |
| Suk Al-Shoyokh| Maintenance and blacksmith workshops | 150    | 90                                          |
| Al-Chibayish  | Maintenance and blacksmith workshops | 20     | 13                                          |

3.3.4 Agriculture wastes
Agriculture waste includes garden waste, waste of poultry and livestock breeding farms, and waste from agriculture crops and trees. Figure 4 presents summary of the results of the estimated quantities of agriculture wastes in the study area. There is no special practice to handle these wastes and almost these wastes are collected and disposed with municipal solid wastes.
3.4. Environmental aspects of solid waste handling in Thi-Qar governorate

Improper handling in the storage, collection and transfer of solid waste could lead to negative impacts on human health and the environment. During investigation and physical inspection, it was noted several points. In general, the waste collection crews are specifically facing occupational hazards such as injuries from sharp objects, airborne disease, spills of polluted materials, and traffic accidents due to a lack of health and safety facilities. Illegal burning of waste in the dumping sites in the study area is forming serious health and environmental hazards such as causing illness, changing outdoor air quality and reducing visibility.

Uncollected solid waste and spreading waste in some locations in the study area is dispiriting efforts to keep open spaces and streets clean, degrading these wastes the urban environment and emitting nuisance odor. Furthermore, presence of fraction of food waste in these locations provided an attractive shelter for flies breeding and rats which are very effective vectors that spread disease in the study area. In case, open body vehicles are being utilized for the collection and transferring of solid wastes in the study area without cover. This practice is unhygienic and spreading dust and filth, dirt from these trucks. Unsatisfied treatment of wastes in dumping sites could cause leachate and contaminating ground water resources. Iraqi Environment Law No. 27 of 2009 was issued to conserve natural resources, preserve the health of human being, support sustainable development, and increase the environmental awareness.

However, the waste management problem in Iraq suffers from the lack of governmental legislation and instructions that arrange the responsibilities of recovering process between the local people and municipality administrations. As well as, the lack of legislations that regulate the investment process in Iraq caused low or absence of private sector participation in solid waste management field. Finally, due the dramatic changes in climate [20-23] which in turn could influences the production of solid wastes. Therefore, it is recommended carrying out future investigations about the relationship between the climate change and production of municipal solid wastes. Additionally, using of facilities that produce less volumes of wastes is recommended, for instance using electrocoagulation water and wastewater treatment method significantly decreases the production of sludge (solid waste) [24], which in turn enhances the management of municipal wastes.

4. Conclusions

The study showed that huge quantities of solid wastes that include more than 60 percent organic materials are generated in Thi-Qar governorate. A poor disposal infrastructure in the study area, which increases the concerns about human health and the environment due to spontaneous fires, large-scale greenhouse gas emissions and groundwater contamination probability. Based on the study results and to manage the solid waste properly in the future, the study recommended that all dumpsites that incompliant with the EPA standards should be closed. Waste separation at source should be taken place, covering at least organic and inorganic wastes. Develop suitable plan for recovery, processing, and
reuse of the majority of non-hazardous industrial wastes. Establish sanitary landfill sites meets with EPA criteria’s at adequate capacity to receive residual unusable wastes.

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