

Solid Waste Pollution and the Importance of Environmental Planning in Managing and Preserving the Public Environment in Benghazi City and Its Surrounding Areas

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Abstract—Pollution and solid waste are the most important environmental problems plaguing the city of Benghazi as well as other cities and towns in Libya. These problems are caused by the lack of environmental planning and sound environmental management. Environmental planning is very important at present for the development of projects that preserve the environment; therefore, the planning process should be prioritized over the management process. Pollution caused by poor planning and environmental management exists not only in Benghazi but also in all other Libyan cities. This study was conducted through various field visits to several neighborhoods and areas within Benghazi as well as its neighboring regions. Follow-ups in these areas were conducted from March 2013 to October 2013 as documented by photographs. The existing methods of waste collection and means of transportation were investigated. Interviews were conducted with relevant authorities, including the Environment Public Authority in Benghazi and the Public Service Company of Benghazi. The objective of this study is to determine the causes of solid waste pollution in Benghazi City and its surrounding areas. Results show that solid waste pollution in Benghazi and its surrounding areas is the result of poor planning and environmental management, population growth, and the lack of hardware and equipment for the collection and transport of waste from the city to the landfill site. One of the most important recommendations in this study is the development of a complete and comprehensive plan that includes environmental planning and environmental management to reduce solid waste pollution.

Keywords—Solid waste, pollution, environmental planning, management, Benghazi, Libya.

I. INTRODUCTION

MUNICIPAL solid waste management (MSWM) is an integral part of urban environmental planning. The characteristics and amount of MSW arising from domestic, commercial, and industrial activities in a region is not only the result of a growing population and increasing standards of living and technology development, but is also the result of the abundance and type of natural resources of the region [1]. Environmental pollution is one of the most important problems facing humanity today.

This phenomenon arises with the evolution of modern humans through improvements in the industrial, agricultural,

and urban society coupled with the emergence of multiple residues, such as solid, liquid, and gas waste.

Solid waste, including household, commercial, and industrial waste, is the most important type of waste. Solid waste contributes significantly to the pollution of the environment by polluting the main elements (soil, water, and air) with the different formulations, concentrations, and quantities of its materials and components as well as its physical, chemical and possibly antibiotic properties [2]. Waste from food scraps, sewage, and animal body parts have been generated since the inception of creatures on Earth. The quantity of this waste was minimal in the past; thus, the environment was able to absorb it, causing only a few environmental problems. In modern times, waste has become one of the most important social problems; it poses a constant threat to humans and the environment because some types of waste are toxic and dangerous [3].

Solid waste problems are very critical issues in many urban areas in Libya, including Benghazi City. The development in this city continues to increase as infrastructures, public service offices, industries, and entertainment areas increase in number. Moreover, the Benghazi population continues to grow as a result of births and migration of citizens from small cities and rural areas. Rapid development, industrialization, and the increasing population contribute to the increase in the amount of solid waste in the city [4]. The generation of solid waste is a natural consequence of human life, and the disposal of such waste should be consistent with improved quality of life.

The initial aim of solid waste management (SWM) techniques was to eliminate waste from the vicinity of habitable areas as a means of maintaining public health. After realizing the hazards of uncontrolled disposal, measures were devised and implemented mainly through the use of sanitary landfills. Various material and energy recovery technologies have been devised in recent years and are now included in modern systems. Global efforts are being implemented to reorient SWM systems toward sustainability [5]. Pollution and solid waste environmental problems plague Benghazi and all cities and towns in Libya; these problems are caused by the lack of environmental planning and sound environmental management. Environmental planning is very important for the development of projects aimed at preserving the environment. Therefore, the planning process should be prioritized over the management process. The objectives of

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this study are to determine the causes of solid waste pollution in Benghazi and its surrounding areas and establish several recommendations that would improve SWM and highlight environmental planning and environmental management to address the problem of solid waste pollution.

II. LITERATURE REVIEW

In this section, studies on pollution by solid waste throughout the world, particularly in Libya, are reviewed. Reference [6] studied pollution caused by household solid waste in Al Abyar. Results show that pollution caused by solid waste has serious effects on the environment and human health. The size and amount of household solid waste produced by the city, the knowledge sources and components, the influencing factors, and the means to improve waste treatment and disposal were analyzed. The study concluded that population growth, urbanization, increased income level, and lack of resources available to the Environmental Protection Agency have a significant impact on the increase in the amount of household solid waste in Al Abyar. The study also showed that general cleaning services differ from one district to another. The study recommended the application of the administration-integrated waste principle to address this problem.

Reference [7] studied the effect of human activities on different types of environments, such as agricultural and pastoral areas, and found that pollution caused by household solid waste has spread to agricultural and pastoral lands. The absence of healthy spoils in the region and the lack of interest in preserving the environment result from the lack of environmental awareness by the local population. Heaps of household waste was found in large areas and on both sides of agricultural roads. These heaps of waste not only pollute the environment but also diminish the aesthetic value of the area. To address this problem, the study recommended that the population be educated and a specific date be set as to when to dispose waste. Another recommendation was to impose deterrent penalties for those who dispose of waste improperly. The study recommended that specific areas, such as the area near Al Abyar, Suluq, and the valley farms of Ghoat Alsultan Project, be dedicated to waste disposal.

Reference [8] studied environmental pollution by solid waste in Benghazi. The study analyzed the sources and components of solid waste and the methods of waste collection and disposal in the area. Results show that 94.4% of solid waste is disposed through traditional methods, and only 5.6% is processed and converted into fertilizer (modern method). The study highlighted the importance of environmental awareness and the implementation of the law. SWM is becoming a problem in major cities worldwide, especially in cities in developing countries, as a result of the rapid increase in solid waste generation caused by rapid population growth, urbanization, rapid industrialization, and economic development [9]. Reference [10], in their study on the status of SWM in Benghazi explained that pollution involves the issue of age and affects the health of all individuals. Environmental pollution is an issue that affects

the future because it affects resources, such as land, natural soil fertility, water purity, and the abundance of aquatic resources. No attention has been devoted to the preservation of the beauty around us; only the preservation of purity, the survival and health of human resources, and production based on natural resources have been highlighted. The failure to control environmental pollution will result in dire consequences that cannot be predicted. As such, the solid waste problem is highly important. The pollution generated by construction activities has become difficult to control because environmental protection has not been sufficiently emphasized. Reuse, recycling, and reducing the quantity of construction materials are encouraged in Hong Kong to control waste generation by construction activities [11].

Reference [12] studied environmental pollution and solid waste in Derna and found that the high rate of population growth in the city and the requirements of urban development resulted in an increase in the amount of human activities and human services. This increase in activities and services increased in the amount of solid waste, particularly household and construction waste. The method of waste disposal also differed among households. The study showed that the relevant authorities failed in SWM. The shortage of labor, equipment, and mechanisms for hygiene because of the lack of funds caused such failure, which in turn led to the lack of interest among citizens and improper waste disposal practices. In addition, a discrepancy was observed in the cleanliness of service equipment among the different neighborhoods of the city. The service vehicles experienced difficulty maneuvering the streets and rarely arrived on time, resulting in the lack of interest among citizens as to the importance of hygiene. Thus, the severity of the problem increased. The daily amount of household solid waste produced by the city reached approximately 70 tones (approximately 713 grams per capita). This significant amount of solid waste resulted in the accumulation of such waste as well as the accumulation of numerous environmental effects, including the spread of foul odor, distortion of the landscape of the city, and breeding of pathogenic insects and rodents.

Reference [13] studied environmental pollution caused by solid waste at El-Gubba City. The study examined the components and amounts of waste, the factors that affect the accumulation and proliferation of such waste, and the resulting effects. The study concluded that the disposal of solid waste in places other than those dedicated for such purpose is due to lack of environmental awareness among the population; the study also revealed the relation between the increase in the standards of living and the increase in the diversity of the amount of household solid waste. Several recommendations were proposed in the study, including auto provisioning, acquisition of hardware and equipment for waste collection, and increasing the environmental awareness of the population to introduce them to the effects of improper SWM. Reference [14] reported that solid waste is an important issue in Nigeria. Piles of waste are often found on roads, rivers, and many other open spaces in Nigerian cities, causing significant health and environmental problems. Reference [15] studied urban

pollution by household solid waste in Al Bayda. The components of solid waste, the factors that affect the accumulation and proliferation of such waste, the resulting effects, and the treatment and disposal of household solid waste were analyzed in the study. The results of the study revealed the cause of the accumulation of solid waste in the city, the lack of mechanisms and skilled labor in the field of hygiene, and the lack of funding for SWM programs. The improper disposal of solid waste was found to be a result of the lack of environmental awareness among the population of the city. The study emphasized the importance of education and its impact on behavior modification in dealing with household solid waste as well as the link between the increase in the standards of living and the increase in the diversity of household solid waste.

Similarly, [16] stated that the continuous poor collection and inadequate transportation of waste result in the accumulation of waste throughout the city. The lack of suitable facilities (equipment and infrastructure), underestimation of waste generation rates, shortage in labor, management deficiencies, and improper route planning are responsible for the poor collection and inadequate transportation of solid waste. Moreover, the unscientific disposal methods employed in the city not only cause adverse effects on the environment and human health, but also decrease land availability for waste disposal and other uses.

III. THE STUDY AREA

Benghazi is the second largest city in Libya. It lies on the Mediterranean Sea in northeastern Libya, approximately 621 miles (1000 km) east of Tripoli (Fig. 1). Benghazi is the industrial, and transportation center for a region producing grains, fruits, and livestock. Its port, although overshadowed by that of Tripoli, handles a considerable amount of foreign trade. Food processing, as well as sponge and tuna fishing are the city's chief industries. Benghazi has an international airport, and a highway links directly the city with Tripoli [17].



Fig. 1 The study area indicated on the Map of Libya by a red square

IV. METHODOLOGY

The present study was conducted through various field visits to several neighborhoods and areas within the city of Benghazi as well as its neighboring regions. Follow-up was conducted in these areas from March 2013 to October 2013 as documented in photographs. The methods of waste collection and means of transport were examined, and interviews with relevant authorities, including the Environment Public Authority in Benghazi and the Public Service Company of Benghazi, were conducted.

V. RESULTS AND DISCUSSION

A. Solid Waste Generation

The Secretary of Health and Environment of the City of Benghazi, through the Public Company of General Services, is responsible for managing the municipal solid wastes, while the Cleaning Department is responsible for handling these wastes. The department is responsible for the clean-up of the entire city, including the streets, public places, and gardens, among others, and the transfer of garbage to the disposal site located in the southeast of Benghazi City. The amount of waste generated, which must be disposed in Benghazi City, has increased as a result of inadequate investment in collection, transport, and treatment facilities. These problems are made complicated by political, economic, and social factors in the city. The average generation in Benghazi is around 0.70 – 0.95 kg per person per day, which is almost equal to the national average (1.1 kg per person per day) [18].

B. Waste Collection and Transportation

The MSW collection and transportation are not efficient enough. Extra efforts are required to improve it as well as the current situation of the city streets. Three collection systems are available in the study area:

- Private sweepers collect the wastes stored outside or inside the houses or shops with their trucks and dump them into the storage bins.
- Wastes are transferred to the storage points by households or shop keepers themselves.
- Private companies collect wastes from one house to another using their own vehicles.

The EGA plays the biggest part in the MSW collection in Benghazi since it is the agency responsible for managing these wastes in the city. The EGA transfers about 87.34% of the total MSW to its final disposal site, with the private sector relying on several companies and agencies and transferring about 5.56%. There are various local and foreign agencies showing initiative in transferring these wastes, which account for about 7.10% of the total solid wastes transferred to the disposal site.

C. Collection Vehicles

Different types of vehicles from compactors to ordinary trucks, tractor-trailers, dumper-placers, and tippers, are used for waste transportation. Open-body trucks of 5-15-tonne capacity are commonly-used. Tractor-trailers are used in

smaller areas in the city even if they are noisy and inefficient. Many of the vehicles are older than their normal operating lives, resulting in high fuel consumption and low efficiency. Municipal corporations employ staff and vehicles for clearing community bins. The corporate staff loads the wastes from the community bins into the vehicles. Then, the wastes are transferred to the disposal site. Metallic containers are directly carried by the dumper-placer for unloading at the disposal site. The wastes are transported mostly by municipal vehicles, although in some large areas, private vehicles are also hired to augment the fleet. Vehicle maintenance is carried out in a general municipal workshop along with other municipal vehicles, wherein refused vehicles receive the lowest priority. Most of these workshops have facilities for only minor repairs. Although preventive maintenance is necessary to maintain the collection fleet in proper operating condition, this maintenance is commonly neglected. Regarding applicable services in public places, such as streets, gardens, and parking, among others, these areas have been equipped with special boxes for garbage collection (capacity =1.1m³); around 1,063 of these boxes were distributed by the General Company for Cleaning and Services. These boxes are transferred by 15-tonne compacter trucks. There are around 12 compacter trucks available for the purpose, but since these trucks usually breakdown, the actual number of trucks properly working on any given day is estimated to be only seven. Each truck goes out for collection with a driver and two workers from 7 am to 6 pm. Each truck could make two trips to the disposal site with the said period. If the trucks and crew are available, the working hours could be extended until 12 midnight. During our journey around the city, we noticed many boxes in poor condition, and some can no longer be used. The boxes are not washed after collection. Some residents do not place their garbage into these boxes; they rather place them beside the boxes, Figs. 2 (a) and (b). Such attitude is attributed to the residents' lack of awareness and knowledge on the MSWM. In Benghazi, more than 30% of the primary collection and storage of waste is done using open storage enclosures, and these result in unhygienic conditions, foul odor, and the proliferation of flies and other disease vectors. Since open storage enclosures cannot be eliminated, these should be cleaned completely after waste collection. The volume of storage enclosures should also be designed by overestimating the generation of waste, not underestimating it as presently done [18].

The objective of the study is to determine the causes of pollution and solid waste in Benghazi and its surrounding areas. The results reveal the proliferation of solid waste in all neighborhoods within Benghazi and its surrounding areas. Waste was found on streets and sidewalks, roadsides, and in front of shops. The solid waste problem is a result of poor planning and environmental management; no specific plan for private waste collection exists. The increase in the population of Benghazi, the spread of haphazard construction, and the presence of unpaved roads contribute to pollution. Waste is placed in black plastic bags (the color differs by population) and placed in front of houses, Figs. 2 (a) and (b). Owing to the

lack of containers in some neighborhoods, several individuals transport waste directly to the landfill. However, the methods of waste collection and transport remain traditional. Ill-equipped vehicles that are not intended for waste transport are utilized. The transport vehicles are light, open, and covered with waste. After filling the vehicles with waste, a cloth or a blanket is used to cover and protect the waste as it is transported to the landfill, Figs. 3 (a) and (b). This method is uncivilized and unsafe. The slots in the vehicles drip waste on the roads during transport from the city to the landfill site.



Fig. 2 (a) The bad plan for waste collection



Fig. 2 (b) Specific plan for private waste collection exists



Fig. 3 (a) The methods of waste collection and transport remain traditional



Fig. 3 (b) The other methods of waste collection and transport remain traditional

The results show that pollution by solid waste in Benghazi and its surrounding areas is caused by poor planning and environmental management. The spread of waste on streets, roads, and sidewalks is a result of the lack of equipment and resources necessary for SWM, Figs. 4 (a) and (b). These results are similar to those in previous studies ([7], [12], [6], [8], [15], [19]). The utilized method of waste disposal and the behavior of the population are the result of the lack of awareness of environmental hazards and problems caused by the accumulation of waste and their damaging effects on human health and the environment. These findings are consistent with those obtained by ([10], [7], [12], [6], [8], [15], [14], [16], [4], [13], [18]).



Fig. 4 (a) The spread of waste on the roads



Fig. 4 (b) The spread of waste on streets and sidewalks

The results obtained also indicate that the high standard of living of the population results in the increased amount of waste; high standard of living is one of the important factors that increase the amount of solid waste. A similar finding was obtained in previous studies ([7], [12], [6], [15], [4], [13]). Moreover, the method of transporting waste from the city and its neighboring areas to the landfill site is uncivilized; private cars have been customized for waste transport because of the lack or inadequacy of financial support for the proper and safe transport of waste. This finding is consistent with those obtained by ([7], [12], [8], [15]). In addition, the rapid increase in the population of the city, especially after 2011 when people migrated from several Libyan towns and cities to Benghazi, is the cause of the increase in waste generation. This result is similar to those obtained in previous studies ([9], [18]).

VI. CONCLUSION AND RECOMMENDATIONS

The lack of interest in environmental planning, the mismanagement of pollution and solid waste, the proliferation and scattering of waste in the streets and on sidewalks and roadsides in Benghazi and its neighboring regions negatively affect human health. Solid waste emits foul odors and facilitates the spread of diseases caused by mosquitoes and flies as well as rodents. To avoid the damage to the environment, solid waste should be recycled and converted into an economic asset.

The following recommendations are thus established for the development and implementation of a more effective and efficient solid waste management and planning program in Benghazi and its surrounding areas.

- 1) The Libyan government should develop a general strategy that will reduce solid waste pollution in Benghazi, its surrounding areas, and other similar areas in Libya.
- 2) The administration should focus on environmental planning for the improvement and development of solid waste management in Benghazi and its surrounding areas.
- 3) Environmental awareness should be promoted by utilizing all types of media.
- 4) The collection and transfer of solid waste by the state should be supported and funded by private companies; these companies could also provide advanced equipment for the collection of solid waste.
- 5) Small factories should be established to recycle and utilize solid waste from households.

APPENDIX A

Key Definitions:

Waste is defined as a left-over redundant product or material of no marginal value to the owner and which the owner wants to discard [20].

Solid waste is defined as a non-liquid material that no longer has any value to the person responsible for it. The words rubbish, garbage, trash, or refuse are often used as synonyms of solid waste [21].

Municipal solid waste is defined as any household waste or garbage, street litter, or solid waste produced by businesses, institutions, and schools. It does not include materials segregated for recycling, infectious or hazardous waste, waste from industrial processes, demolition or disaster debris, mining or agricultural waste, ashes, or sewage sludge [22].

Solid waste management is defined as the discipline associated with the control of the generation, storage, collection, transfer and transport, processing, and disposing of solid waste in a manner that is in accordance with the best principles of public health, economics, engineering, conservation, aesthetics, and environmental considerations [23].

Environmental planning is governed primarily by environmental considerations and directly or indirectly yields the expected environmental projects proposed by development plans for the foreseeable future [24].

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