

# Investigating the Solid Waste Management Problems in Urban Area, Sudan

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**Abstract-** Rapid urbanization population growth and other factors such as drought and desertification, have increased rural urban migration in Sudan. This has caused population rise in major cities like Khartoum, leading to increased environmental resources usage, causing various environmental pollution. Accordingly, the quantity of solid waste (SW) increasing rapidly with high health related hazards. This study aimed to investigate the quantity, sources and impact of SW on outbreaks of diseases in seven main localities Khartoum state through well-designed questionnaire. The estimated value of per person generation rate of the SW was found to be 0.6 kg/day. The results revealed that SW in Khartoum was complex in composition and quantity. This indicates that local authorities lack the necessitate capacity to handle the immense problems of SW management. Diseases resulting from poor environmental sanitation constitute the bulk of the health problems in the study area, where communicable diseases were highly prevalent. Based on this study, the poor municipal SW management in Khartoum is posing high risks to human health and the environment. Therefore we recommend that, proper management of SW is required, while strict adherence to sustainable environmental practices would play a significant role in the control of related diseases.

**Keywords** Solid waste, Diseases, Environment, Public health.

## 1. INTRODUCTION

The city of Khartoum capital of Sudan has over the years experienced population rise as a result of urbanization, which had led to rapid expansion of the city along with recent economic development have been resulted in urban sprawl and a significant increase in SW generation in Khartoum state. This represents a huge challenge for environmental management in Khartoum and has exacerbated the problem of SW pollution. According to [1], the problems of SW management are compounded by the rapid urban population growth caused by rural to urban migration overstressing resources. Municipal wastes constitute one of the most crucial public health and environmental problems in African cities [2, 3]. Wastes can be generated by natural phenomena such as wind, erosion, precipitation, volcanic eruptions, flooding of river banks, atmospheric fallouts, among others and by human and animal activities including domestic, commercial, industrial and agricultural practices [4]. Waste

has been defined by [5], as any solid or semi-solid substance or object resulting from human or animal activities which the holder discards, intends or required to discard and represent a hazard for living.

The current municipal solid waste management practices especially collection, processing and disposing are considered to be inefficient in the developing countries [6]. The typical problems are low collection coverage and irregular collection services; crude open dumping and burning without air and water pollution control; The breeding of flies and vermin and the handling and control of informal waste picking or scavenging activities [7]. The inefficiencies in waste management practices in Sudan pose great challenges that need urgent attention. The improper management gravely affects the public health and degrades environment. These inefficiencies are largely due to the rapidly increasing waste generation in the major cities. The factors contributing to the increasing wastes generation in Khartoum include changes in food habitat and widespread use of disposable containers and packages. The magnitude of wastes generated from human activities alone may exceed 18,000 tons per year for a developing area [8]. As a result, the uncollected waste which is often mixed with human and animal excreta and dumped indiscriminately along the streets and in drains, becomes a health threat. Specifically, they serve as breeding sites for insect and rodent vectors resulting in the spread of various diseases [9], [10]. They may also contribute to flooding. Ref. [11] reported that more commonly noticed occupational health and injury issues in SW management include: back and joint injuries, respiratory illness, infections from direct contact with contaminated material, dog and rodent bites, or eating of waste-fed animals, puncture wounds leading to tetanus, hepatitis and HIV infection, injuries at dumps due to surface subsidence, underground fires and slides, headaches and nausea from anoxic conditions where disposal sites have high methane, carbon dioxide and carbon monoxide concentrations and lead poisoning from burning of materials with lead containing batteries, paints and solders. In Khartoum state in general and other administrative units in particular, the environmental health has drastically deteriorated because of lack of environmental health

programs, disorganized SW collection systems and the absence of improperly constructed drainage system.

Generally, waste management in Sudan presents a typical status of a developing country where no proper waste management systems exist, and nearly all waste generated is handled improperly. Therefore, this work aimed to estimate the amount of solid wastes generated by the current SW management practices in Khartoum state.

## 2. MATERIALS AND METHODS

### 2.1 Study area and conditions

Khartoum is the capital and largest city of the Republic of Sudan. The city located between  $15^{\circ}15' - 16^{\circ}45' N$  and  $31^{\circ}45' - 34^{\circ}15' E$ [12]. The city is the agglomeration of the three historic Sudan urban entities of Khartoum town, Omdurman, and Khartoum-Bahri (Khartoum North). The estimated overall population is 6.6 million[13]. Climate of the study area is semi-arid with relatively cool winter and hot summer, average rainfall of 190 mm between June and September.

### 2.2 Data collection

Data collected directly from the seven Localities in Khartoum state (Fig. 1) involving a combination of methods, namely interview using questionnaire and personal observations, documentaries, government reports, workshops and conferences.

### 2.3 Sampling

In order to investigate SW generation in Khartoum state, a randomized sample of 350 was taken as the most appropriate method of drawing up the sample size of the population under study. Firstly, the census data on the household population registered according to the residential areas was obtained from the statistics office and used as household sample size.

Visits were paid to the following sites: the three main dumping sites (25 km north of Khartoum, 30 km north of Omdurman town and 25 km north eastern Khartoum Bahri), the open markets and open-spaces, gutters, street-sides, stream banks, school premises, cemeteries, restaurants and open waste dumps. Data searching visits were made to places such as State Ministry of Health (MH) and the Higher Council for Environment and Natural Resources (HCENR) seeking health reports. The data collected were analyzed using Statistical package for the social sciences (SPSS).



Fig.1: The study area (7 localities)

## 3. RESULTS AND DISCUSSIONS

### 3.1 Source and Components of Solid Waste

From the observation and questionnaire investigations, there was very little food waste or garbage discarded in Khartoum. Much of the SW discarded were plastic bags, papers, grasses, rags, wooden pieces and automobile remnants. The sources of

these SW were mainly from the markets, houses, farms, abattoirs and public buildings. In the present research, it was found that the large quantities of waste were generated at the market place. The farms and the abattoirs recorded the least amount of SW generation (Fig. 2). The extremely high waste generation in these sensitive areas depicts that environmental awareness is completely missing in the study area. Figure 3

shows overall components of SW in Khartoum, these were mostly domestic SW; referred to as household or residential waste and sometimes termed as “refuse”.

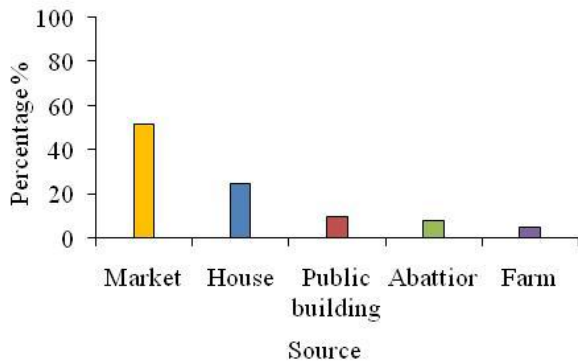


Fig.2: Main source categories of solid wastes in the study area

It includes food and vegetable waste (fruit waste such as lemon and orange peelings, banana peelings, pumpkin seeds), animal and bird waste (composed of bones, hoofs, horns, manure, feathers, skin and hides and intestinal waste), crockery (consists of glass, bottles, tin cans, old plates, charcoal stoves, dishes and cups), wood and grass waste (straw and twigs, dry leaves, ashes, charcoal, seed and grass), kitchen and house sweepings (dust, sand and gravels, clothes and leather waste, nylon bags, papers and textiles). Commercial and market waste were same as mentioned above. Local community waste comprise of street, open space and other municipal wastes, like fallen leaves, demolition debris, dead animals, and others. Office and institutional wastes are mainly papers, cartons, cigarette and matchboxes, packaging, cardboards and sweepings. Industrial solid wastes include waste from welding workshops, carpentry workshops cobblers' stall, like iron scraps, tin and barrel cuttings, wood and saw dust. Medical wastes comprise of clinical waste, such as the remnants of the laboratory, infectious wastes, pathological waste, sharp tools, drugs, poisons and chemical residues. Data from investigation and questionnaire revealed that most residents frequently disposed plastic wastes as their common solid wastes. Other frequently disposed materials included, paper, metal, vegetation, human and animal wastes (Fig. 4).

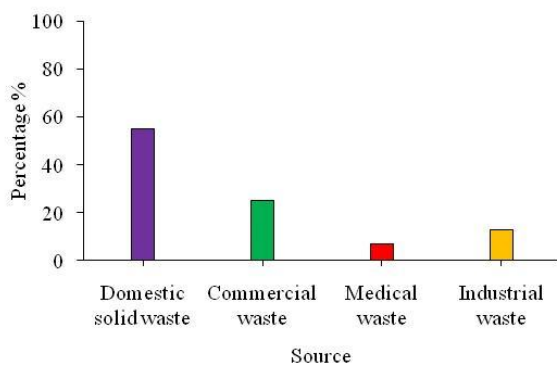


Fig.4: Overall of different waste generation categories

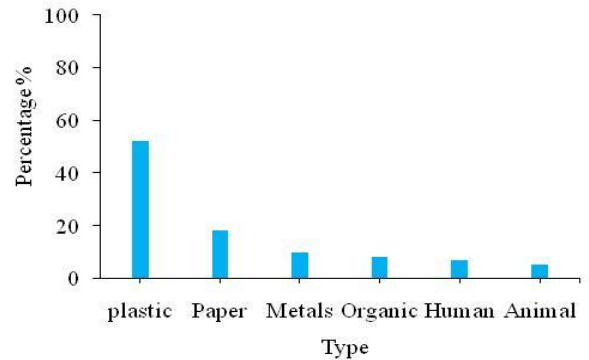


Fig.3: Components of solid waste

The present study revealed that 62% of the respondents dispose small amount of SW, 20% represented medium disposal while the remaining 18% is the large disposal. Table 1 shows the overall amount of SW, population size and houses in all seven Localities. Generally, the results revealed that the whole state disposes 4000 tons/day. The results in Table 2 also showed that the estimated average of SW generation and disposal per month was found to be 60.05 tons/month (63.4 %), which lies within the range for the low-income countries [14]. The amount and quality of waste including food consumed or generated by a household depends on the level of income and size of the household. A household with a higher income can afford better food quality.

A household with a large number tends to virtually consume all the food leaving very little waste that can no longer be utilized in any conceivable way. Countries with higher incomes produce more waste per capita and per employee, and their waste have higher portions of packaging materials and recyclable waste [11].

Table 1: Quantity of solid waste in seven localities in Khartoum State

Locality	No. of population	No. of homes	Quantity t/day
Khartoum	760.000	190,000	970
Gebel-Awlia	690.000	115,000	530
Omdurman	270.000	46.000	770
Umbada	1,998,000	148.589	450
Karary	850.000	117.164	340
Khartoum-Bahri	700.000	3111	590
Sharq-Elnil	800.000	95.000	350
Total	6.600	-	4000

Table 2: Total amount of waste collected in Khartoum state

Month	Quantity (t/month)	Percentage %
Jan	56.35	64.0
Feb	54.41	60.0
Mar	63.31	68.0
Apr	56.29	64.6
May	53.80	63.0
June	54.15	63.5
July	58.61	63.2
Aug	56.22	62.3
Sept	53.16	61.8
Oct	65.79	64.0
Nov	58.67	61.9
Dec	65.00	80.0
Total	720.6	-
Average	60.05	63.4

An observation of SW was made in commercial centers and open markets including food-marketing centers, restaurants, and slaughterhouse and meat markets. Local community waste was observed along the streets, open space and other municipal waste such as fallen trees, dry leaves, dead animals (dogs, rats, cats birds, etc.), construction and demolition debris, litter, trash and clippings and other throwaways. Municipal wastes were also found at in the immediate environment of government ministries and public institutions.

In the industrial area mostly around markets, waste from welding workshops, general workshops, blacksmith and junk-dealers workshops, and cobbler's stalls, were observed. Moreover, during the visit to Khartoum hospital, clinical waste, packaging, papers, cartons and sweepings were also seen. It was generally observed that the largest amount of disposable waste appeared to be ashes, fine charcoal, sand and gravel, leaves, milk and tomato-paste tins, bottles and crockery, nylon bags and papers. The greatest amount of animal waste was found in the slaughterhouses, meat markets, and restaurants and in the dumping site. Heaps of iron scraps, tin, plastic, barrel and leather cuttings, charcoal and wood, vegetable and fruit waste were observed in the open markets, whereas in the shopping centers, rags and other textiles, cartoons, papers, packaging, etc. were found.

### 3.3 Methods of solid waste management

There are several methods of SW management but the most commonly used in Khartoum were two. These included the disposal of waste in open space and the burning of solid wastes either on site within the residential areas or in the dumping site. The results obtained from questionnaire revealed that 76% households disposed their waste unburned in open space, which ultimately spreads randomly around the area. The remaining 24% claimed that they dumped and burned in open area within residential area. Despite the fact that landfill is seen as the least desirable option under the waste hierarchy there always remains a need for disposing waste, even after reuse and recycling [15]. The results reveal that, about 54% households disposed waste once per 3days, 32% 2 days and 14% once per day. With regards to the unburned dump and burnt waste, about 54% households said it gives bad smell and sight, 29% said it facilitates the propagation of flies and 17% said it attracted scavengers, stinging insects and provided breeding ground for mosquitoes and flies. Some of the problems arising from open burning that were observed in this study include; air pollution, health dangers to workers and residents, bad odor and fire hazards. Most of the residents complained about these effects. This method of SW management does not suit with the sanitary method of waste management because it poses health problems [16].

The waste management practices were inefficient in all seven study areas, because there was no sorting out of the wastes (Fig.5, Fig. 6). As a result of this failure to establish and follow segregation protocols and infrastructure, the waste, as a whole, is both potentially infectious and hazardous. The small waste parts that were segregated were not treated properly and finally disposed of with carelessness in most cases. Furthermore, waste has been observed to be the source of all types of pollution [17]. For instance, the open dumping of SW, without management, leads to soil and water contamination as for disposal of waste, the study revealed that 69% of the households interviewed discarded their waste randomly within the residential area while 17% temporary stores the waste in the house and 14% claimed that they dispose their waste in the dumping site within the residential area which is later transported to the three main dumping sites located in, northern, western and southern Khartoum state. There is an urgent need for relocating the main dumping site which should be done in accordance with the trend of physical horizontal expansion of the area and consideration should also



give to the topography of the new site, the direction of the prevailing wind, the possibilities of future expansion of the site and introduction of new disposal methods and accessibility to truck, and human resource.



Fig.5 Dumped and burned in open area within the residential plots



Fig.6: Waste pickers at the dumping site during the observation period

Most households lack public fixed containers. As results, waste is kept in the house compounds, or are immediately disposed indiscriminately off the house premises or at the nearest waste dumps on bare ground where it is left to rot or be burnt. Those areas where the waste is dumped are intensively used as sites for both disposal of waste and for day and night defecation. About 87% households said the waste management system was unsatisfactory while 13% households said it was satisfactory. Those who said the waste management system is satisfactory came from official quarters because these areas are better served by government laborers. All the public health efforts are directed towards proper maintenance of this area occupied by senior governmental and non-governmental officials.

The study also revealed that about 89% households do not pay for the services of waste management in the area and only 11% households admitted paying the fees for the services of waste management program. The results indicate that some households expressed their conditional willingness to pay if the services are adequately rendered to them whereas other households admitted that they would pay if they were asked to do. However, others could not simply pay because they cannot afford the fees. At the time of the study, observations revealed that the refuse in the main dump were spread all over by the

action of wind and other factors like scavenging animals (Fig. 7). Animal waste was seen rotting there and especially around the slaughterhouse areas. There is no house-to-house collection of SW covering all the residential area. The collection undertaken by the MH and Khartoum State Cleaning Project (KSCP) is mostly focused on heaps of accumulated residential SW within the residential areas and commercial areas. Every household and commercial areas generate SW and the city neither have standard refuse containers nor have public refuse containers provided by MH and KSCP. The marketplaces within the Khartoum state including Khartoum north (Khartoum Bahri), Omdurman and commercial areas like Al-Arabi market, Omdurman and Khartoum Bahri market suffer from problems of malodors, flies, mosquitoes, rats, cockroaches, scorpions, malaria, diarrhea, eye irritation and, respiratory diseases and many other diseases associated with SW. Residents attributed this situation to deficiency in SW management systems (Fig. 8).



Fig.7: Open dumping at the garbage pit and Burning of SW by the workers environment and attraction of waste to increasingly birds



Fig.8: The spread of waste in the markets of Khartoum State

### 3.4 Common Environmental diseases

The common diseases in the study area according to a survey carried out by the officials of MH in Khartoum state include: diarrhea, malaria, viral disease, eye diseases and skin diseases. The major causes of these diseases are improper disposal of refuse and human feces, inadequate water supply, poor housing and bad food hygiene. Accordingly, much of the

households suffer from diarrhea, malaria, viral disease, eye disease, skin disease and typhoid (Fig. 9). These results are in agreement with observations from previous studies. Ref. [18] reported that concerns have been raised that emissions from both landfills and incinerators may pose environmental health risks.

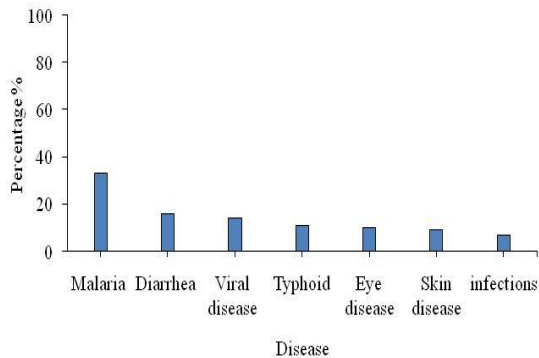


Fig.9: Common Environmental Diseases in Khartoum state

On observation, flies, mosquitoes and rats were found inside and outside houses, waste heaps around open markets, restaurants, abandoned latrines and open spaces that are covered with excreta and refuse. It was reported that at the onset of the wet season when all the refuse and feces are soaked with water, it becomes ideal for insect breeding and the population of flies increases tremendously and disease incidence increases correspondingly [19]. Observation reveals that the more waste an area produces, the more the prevalence of disease vectors, and the higher the disease incidence, provided that the waste remains uncollected long enough for breeding of disease vectors. According to the study observation, there are significant shortages of insecticide and disinfectants that are provided by the KSCP to sustain the elimination of environmentally transmitted diseases in the Localities.

### 3.5 Role of Ministry of Health and Khartoum State Cleaning Project to Solid Waste Management

Refuse excreta in open areas in every hot and dry desert climate does not pose a serious threat to human health as well as the surrounding environment provided that it is far from the community simply because the sunlight and heat quickly render the waste harmless. Lack of basic infrastructure particularly within the area where low income groups are concentrated leads directly to major environmental pollutions problems which affect water, land and air. These hazards in turn pose not only aesthetic hazards but also expose SW collectors to significant levels of physical, chemical and biological hazards.

The research revealed that most of the household do not receive health education from the MH. This was observed to be a major contributory factor to the poor sanitation practices in the Khartoum state. Only small fraction of households

receives health education (Fig. 10). This reflects the poor attitudes towards SW management in the study area.

The study also revealed that 38% of SW burns on-site by public health department (PHD), 29% collect domestic solid waste; 19% transport solid waste; 14% burn SW at the main dumps and no waste containers were provided to them. Also, the results revealed that 39% of the SW management is inefficient, 13% irregular, 17% unsatisfactory and overall 31% of the households accused the MH not maintaining hygienic conditions all over the state.

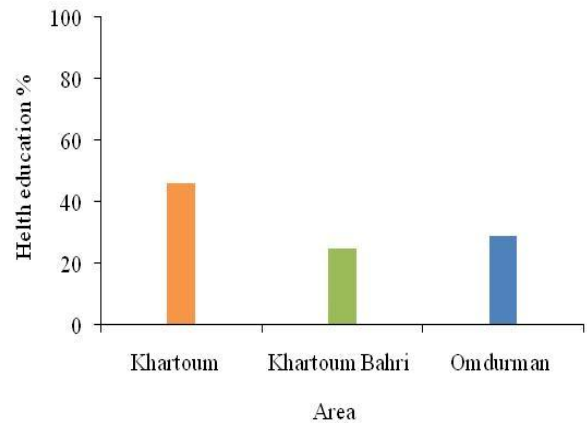


Fig.10: Role of the public health department in health education

Workers and waste pickers handling SW throughout the world are exposed to occupational health and accident risks related to the content of the materials they are handling, emissions from those materials and the equipment being used [11]. The research found that most of the waste pickers are young people of ages less than 20 years and old men and women whom were illiterates. The workers interviewed enumerated the following employment problems: The job is heavy, nasty and full of health risks especially in the wet season, the salaries are very low and irregular about 35 to 45US\$ per month, facilities and working implements are insufficient.

## 4. CONCLUSION AND RECOMMENDATIONS

The study revealed that the amount of SW generated varied from one locality to another. The quantity of SW tends to increase with the increase in the level of income, activity and geographic factors. Changes in food habits and the widespread use of disposable containers and packages resulted in huge amounts of waste generation. In contrast, working to change this attitude and habits would lead to lowering resources and hence decrease the quantity of food remains that forms the core of the waste. Also, the study revealed that SW management in the study area is inefficient and unsatisfactory. Moreover, environmental diseases and their mitigation are still weak due to the shortage of public health education and enlightenment. The prevalence of disease and disease-vectors in Khartoum is related to the amount of refuse produced and to insanitary management. The more waste an area produces and the more insanitary that area is, the more prevalent the disease and disease vectors are, and consequently the higher the incidences of environmental diseases. Accordingly, the

problem of SW management in Khartoum state will continue to magnify and urban environment will uncontrollably deteriorate unless proper management is taken and the public cooperate with the PHD in environmental sanitation of the state. Therefore, designing awareness program may play a vital role in this direction since cultural background of the residents in Khartoum state greatly influences their attitude to waste management. It is recommended that SW management policy should be developed and effectively implemented to curtail the numerous associated adverse effects revealed in the present study.

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