

## Research Article

### Assessment of the Municipal Solid Waste Pollution Problem in the Newest Country: Case Study of Juba, South Sudan

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**Abstract:** Many cities and towns of the developing countries face serious municipal solid waste pollution resulting from the indiscriminate waste disposal. The situation is even more critical and pervasive in the Least Developed Countries (LDCs). This study highlights the current pollution situation in Juba, with specific focus on waste management system. Brief investigation of some causative factors is also discussed. The study was purely quantitatively descriptive, including various data collection techniques (interviews, field observation and systematic literature reviews). The study revealed that average household municipal solid waste generated was 2.88 kg/day and the/capita/day was 0.38 kg. Thus, the entire city, with a population of about 231,776, generates approximately 667.5 tons/day. Plastic dominates the composition making up 72.75%, wood 19.98%, worn out textile 2.36%, metal 1.84% and organic (mostly food waste) 3.13%. Illegal dumping was also observed as well as open air burning. The wastes were disposed of in river bank/streambeds, especially at night and burnt on the road sides, open spaces and near the houses. All these malpractices pose a serious health and environmental hazard to the water bodies. The same water being used for household purposes by the majority of the city's residents. The study also noticed that 69% of the wastes were disposed of randomly by the householders themselves, 22% by Juba city respective waste management units and 9% by private companies. The conclusion of this assessment showed that the municipal solid waste pollution poses high risk to human health and the environment.

**Keywords:** Environment, household, human health, municipal solid waste, pollution

## INTRODUCTION

Management of solid waste is currently one of the major global concerns. Thus, solid waste has become a major consequence of development and modernization, yet some of the greatest challenges to its management are felt mostly in the developing countries (Thomas-Hope, 1998). Industrialization, rapid population growth, urbanization and the changing consumption patterns have resulted in the generation of increasing amounts of solid waste and diversification of the types (Visvanathan and Glawe, 2006; Zurbrügg, 2002a). The generation of municipal solid wastes and their amount vary from place to place to a great extent; the people's standard of living, cultural practices and also climate and season can influence their waste generation pattern (Visvanathan and Glawe, 2006; UNEP, 2003).

Municipal solid waste management continues to be a major challenge for local governments in both urban and rural areas across the world (Wang *et al.*, 2011). This situation is more alarming especially in the cities of developing countries. In addition to polluting the environment; inadequate collection, recycling or treatment and uncontrolled disposal of waste in dumps pose risks to human health and the environment (Collivignarelli *et al.*, 2004; Medina, 2010; Sharholy *et al.*, 2008; Suez, 1998). In many cities of the developing countries and especially the most underdeveloped, there is insufficient collection of the municipal solid wastes being generated (Firdaus and Ahmad, 2010; Senkoro, 2003). As a result, the uncollected wastes, which are often also mixed with human and animal excreta, are dumped indiscriminately beside the streets and in drains, so contributing to

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Fig. 1: Map of south Sudan showing the location of Juba

stagnant water, water pollution, breeding of insect and rodent vectors and the spreading of diseases (Cointreau, 1982; Zurbrugg, 2002b). Most wastes are disposed of in open dumps, deposited on vacant land, or burned by residents in their backyards (Medina, 2010; Visvanathan and Glawe, 2006). The current practices of collecting, processing and disposing of municipal solid wastes are also considered to be insufficient in the developing countries. 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 (Bartone, 2000).

Although some cities do spend significant portions of their municipal revenues on waste management (Cointreau, 1982; Thomas-Hope, 1998; Schübeler, 1996; Bartone, 2000), they are often unable to keep pace with the scope of the problem. Senkoro (2003) indicated that “for many African countries, only less than 30% of the urban population has access to proper and regular garbage removal”. The poor municipal solid waste management in the developing countries consists of a major threat to public health and environmental quality and reduces the quality of life, particularly for the poorer residents in both urban and rural areas (Wang *et al.*, 2011). According to USAID (2006), “absence of waste management activities can increase diseases transmission. Public health and hygienic conditions are considered very important aspects to preserve; and they make it necessary to have a proper waste management system in the developing countries in which most of them are still characterized by high

mortality rate due to poor hygiene conditions”. This study aims at assessing the municipal solid waste problem in the city of Juba.

## METHODOLOGY

**Study area:** Juba is the capital city of the Republic of South Sudan (the world’s newest country) in North East Africa. The city is located in Central Equatoria State, South Sudan along the western bank of the River Nile. Its geographical coordinates are 4° 51' 0" North and 31° 37' 0" East. Juba is a county made up of three districts (*payams*) which include Juba, Kator and Munuki and is directly administered by the city mayor. It is one of the most undeveloped places in the world: although slow to moderate developmental progress is being made in many physical, social, political and economic sectors. It was reported that Juba is perhaps currently among the fastest developing places in the world (UNEP, 2012). More specifically, growth in its population is noticeable. In 2011, the population of the city of Juba was estimated at approximately more than 500,000 people (Global Water Intelligence, 2011). The location of Juba city is clearly shown in Fig. 1.

Juba is characterized by rapid population growth due to the influx of returnees (both refugees and internally displaced people) and also investors and business men from the neighboring countries, rapid development, urban sprawl and inadequate services provision. This very development in turn yields its own odd reciprocals among which the non existence of a proper waste management infrastructure seems to be at the lead.

The municipal solid waste pollution problem in Juba city is real, serious and pervasive that needs a very urgent solution. Juba's huge piles of wastes always amaze many visitors. Trash seems to be everywhere-dumped along streets, clogging streams, bobbing down into the River Nile, littered around buildings, even strewn across the graves in the municipal cemetery. The pervasive plastic half-liter empty water bottles seem almost like raindrops from the clouds and lie almost everywhere-some still new, fat and even sparkling a bit; others already old, squashed and dusty. According to Bruce *et al.* (2009), "it is hard to believe that Juba is inundated-not with water, but with millions and millions of empty plastic water bottles". In Juba, municipal solid wastes sometimes block water channels, thereby creating pools of stagnant water, which provide good breeding and development habitats for many diseases' vectors for example, the mosquitoes that transmit malaria, which is an endemic disease in Juba. In Juba, there are certainly high health risks from vectors' transmitted diseases due to the open dumping and the poor drainage caused by improper disposal of wastes.

**Data collection procedure:** In this study, the three districts (*Payams*) of Juba County were targeted basically because since 2011 after the independence of the Republic of South Sudan, the entire responsibility of the municipal solid waste management was handed to the Juba city council authority by the government. This study involved three different phases:

**Phase 1:** This stage involved a thorough review of documents and records relating to municipal solid waste management in Juba. The goal was to obtain background information to gain a deeper understanding of the municipal solid waste pollution situation and the management system.

**Phase 2:** Stage 2 involved formulation of a questionnaire, semi-structured and verbal interviews with department heads from the city council main office, the three districts (*Payams*) offices and the Ministry of Environmental Affairs. Also convenient individual interviews were conducted especially on the streets and market places. The questions asked in the interviews were geared towards obtaining information on:

- The amount of municipal solid waste being generated
- Municipal solid waste collection and disposal status and problems
- Environmental impact from uncollected and randomly dumped waste
- Ways to mitigate municipal solid waste management problems. Information obtained was used to backup the data collected during the desk study

Table 1: Household municipal solid waste (kg) generated: house/day and per capita/day

Payam	Population	SW (kg) /house/day	SW (kg) /capita/day
Kator	64,000	2.29	0.33
Juba	52,776	3.30	0.36
Munuki	115,000	3.05	0.44
Total	231,776	-	-
Average	-	2.88	0.37

**Phase 3:** Phase 3 involved a visit to the open dumping site which is about 16 km West of Juba; along the Juba-Yei road. The dumping site is a home to a good number of people who are involved in scavenging. Few convenient individuals among them were interviewed on specifically concerning their general feeling of life in such a place. Local residents and a private municipal solid waste handling company's drivers were also interviewed. The questions asked during the interviews were focused towards obtaining information on: how satisfied they are with the municipal solid waste management in Juba.

## RESULTS

People's standard of living, consumption pattern, cultural practices and also climate and seasons variation of an area can significantly influence the generation rate of municipal solid wastes hence, the amount vary from place to place to a great extent (Visvanathan and Glawe, 2006; UNEP, 2003). The municipal solid waste generated per-capita (kg/day) in Juba is relatively low when compared with some South Asian countries. Its per-capita ranges between 0.33 to 0.44 kg/person/day unlike that of the South Asian countries which vary in a range from 0.3 to 0.9 kg/person/day (WWF-Pakistan, 2001). Table 1 shows the household municipal solid waste (kg) generated in Juba city.

From Table 1, it is clear that the highest household municipal solid waste generator was Juba district (*Payam*) with a population of about 52,776, generating about 3.3 kg/house/day; which are about 0.36 kg/capita/day. This is because most of the business activities of the city take place here. The second district (*Payam*) was Munuki; with a population of about 115,000 people, has a household generation rate of about 3.05 kg/day and this is about 0.44 kg/capita/day. Kator (*Payam*) was the least in waste generation. With a population of about 64,000, it has a household generation rate of 2.29 kg/day an equivalent of 0.33 kg/capita/day. The average household municipal solid waste generation per house was found to be 2.88 kg/day which gives 0.33 kg/capita/day in Juba as a whole.

**Agents responsible for household municipal solid waste disposal in Juba districts (*Payams*):** In Juba city, there are three main agents responsible for the municipal solid waste disposal namely; random or indiscriminate disposal by the householders themselves, the district (*Payam*) waste management unit and the private companies. Table 2 shows the percentages disposed of by each one of them:

Table 2: The agents for household municipal solid waste collection and disposal in Juba

Agent	Kator district (payam) (%)	Juba district (payam) (%)	Munuki district (payam) (%)	Avg. (%)
Random (householders) disposal	54	75.58	77.78	69.12
Through the district (payam) unit	40	19.77	5.55	21.57
Private companies	6	4.65	16.67	9.11

Table 3: Shows household municipal solid waste generated (tons) /payam/month and /year

Districts (payams)	Tons/month	Tons/year
Munuki district (payam)	1,518 tons/month	18,216 tons/year
Kator district (payam)	633.60 tons/month	7,603.02 tons/month
Juba district (payam)	569.98 tons/month	6,839.77 tons/year

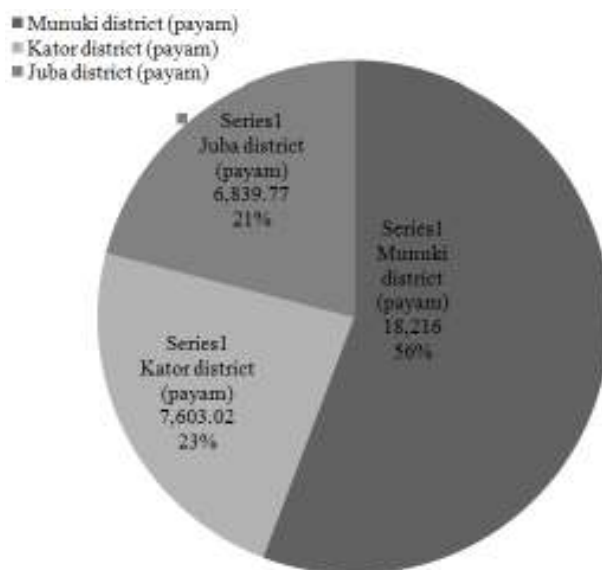


Fig. 2: The percentages of municipal solid waste generated in tons/year

The Table 2 highlights that 54% of the household municipal solid wastes in Kator district (*Payam*) was being disposed of randomly by the householders themselves. Whereas 40% were disposed of through the district (*Payam*) waste management unit and 6% through private companies. In Juba district (*Payam*), 75.58% were being disposed of randomly by the householders; 19.77% through the district's (*Payam*'s) waste management unit and 4.65% by private companies. While in Munuki district (*Payam*), 77.78% were being disposed of randomly by the householders; 5.55% by the district's (*Payam*'s) waste management unit and 16.67% by the private companies.

**Household municipal solid waste generated (in tons) /payam/month and per year:** In the study, it was found out that the three districts (*Payams*) generate quite a huge amount of municipal solid waste as shown in Table 3.

The Table 3 shows that Munuki payam was at the lead with a generation rate of about 1,518 tons/month which is about 18,216 tons/year. Kator payam followed; by about 633.6 tons/month which is equivalent to 7,603.02 tons/year. Juba payam produces the least; with a generation rate of about 569.98 tons/month which is about 6,839.77 tons/year. This is because Juba payam is a commercial center hence; it

has fewer residents than the other two payams. The amounts in the table above when converted into percentages, they can be 56, 23 and 21%, respectively. Figure 2 shows the percentages of municipal solid wastes generated in tons/year as indicated in Table 3.

**Types of household municipal solid wastes generated by the three payams of Juba city:** In Juba, there are a number of municipal solid waste types being generated. Table 4 clearly shows these:

Table 4 shows the different types of municipal solid wastes being generated in Juba city. From the table it is clear that 80.65% of the total household municipal solid waste generated in Juba payam is plastic; 11.87% wood; 1.35% worn out cloth (textile); metals 2.06 and 4.26% organic. Whereas in Kator payam, plastic forms 73.42%; wood 21.34%; worn out cloth (textile) 1.26%; metals make up 1.98% and organic wastes constitute 2.00%. In Munuki payam, plastic makes up 64.18%; wood 26.73%; worn out cloth 4.48%; metals form 1.49% and organic 3.12%.

## DISCUSSION

The findings of the study highlighted that, municipal solid waste management system in Juba is

Table 4: The types of household municipal solid wastes being generated

Type of solid waste	Juba payam (%)	Kator payam (%)	Munuki payam (%)	Avg. (%)
Plastic	80.65	73.42	64.18	72.75
Wood	11.87	21.34	26.73	19.98
Worn out cloth (textile)	1.35	1.26	4.48	2.36
Metals	2.06	1.98	1.49	1.84
Organic (food waste inclusive)	4.26	2.00	3.12	3.13

seriously flawed. Thus, in this section, a closer look at the municipal solid waste management system's functional elements (waste generation, waste handling and separation, storage and processing, collection and final disposal), associated challenges and possible solutions will be discussed:

#### **Municipal solid waste generation and its composition in Juba:**

The study clearly showed that in Juba's three districts (payams), Munuki district (*payam*) was the leading municipal solid wastes generator 56% followed by Juba district (*payam*) 23% and finally Kator district (*payam*) 21%. The municipal solid waste stream is dominated by plastic (especially empty plastic water bottles) and they constituted the highest percentage (72.75%) of all the other types of municipal solid waste being generated. This is mainly due to the poor sanitary conditions whereby most people tend to drink distilled bottled water as a way of minimizing bacterial infections. The waste situation in Juba is contrary to findings of other researchers concerning municipal solid wastes composition in other developing countries whereby food waste is the dominant. For example, in Nigeria the food waste was 52-65% (Imam *et al.*, 2008); in India it was 40-60% (Sharholy *et al.*, 2008) and in Jordan it was 54-78% (Abu, 2007). Here, the standard of living could have been a major factor; in Juba, the living standard is very low for most of the population, thus, food waste is almost the lowest (3.13%) a clear indication that food is not in abundance. Figure 3 shows how dominant plastic wastes are and how people try to get rid of by burning.

**Municipal solid waste collection in Juba:** In Juba, the collection of the waste is a kind of a joint venture which includes the Juba city council authorities and a private company applying the door-to-door system. In this system waste pickers collect garbage from shops and streets and load it on a lorry (usually a tipper truck) as there are still no waste compactors trucks. Unfortunately, these pickers lack all the necessary appropriate equipment except having only rakes, spades and bags. Their working conditions are generally unhygienic; implying that there is high health risk. The famous and the only company involved is the Southern Express Company. This company is only responsible for the collection of waste of Juba district (*payam*) whereas the other two districts (*payams*) (Kator and Munuki) are the responsibility of the city council. One big problem with this company is that, it is very



Fig. 3: Municipal solid waste management practices in Juba University's campus (photo by the author during the observation period)



Fig. 4: The municipal solid waste collection process (photo by the author during the observation period)

selective in providing the services. For example, the areas that it regularly serves are Juba Market, Riverside (where most of the hotels are), Hai Malakal, custom Street, Juba na Bari and some other areas where NGOs, UN agencies and Ministries are located. The residents of these areas are mostly the upper class citizens. Surprisingly, all the mentioned areas comprise only 10% of the entire Juba district (*payam*). One can imagine how the 90% of the payam manages its waste.

For the other two districts (*payams*), the city council is trying its best to render services to the citizens but lacks the capacity to cater for the huge and ever increasing population. The city council mostly cater for the big markets like Konyo Konyo, Malakia, Suk Jebel, Makata Yei and Suk Sita and some few residential areas. A common complaint from the residents was that the waste collecting vehicles can delay even for weeks hence, making the waste to get rotten and produces bad odor. As a counteraction, the truck drivers also complaint of poor access into the residential areas. Figure 4 shows the municipal solid wastes collection process in Juba.

**Municipal solid waste disposal in Juba:** In many cities of the developing countries and especially the most underdeveloped, one to two thirds of the municipal solid wastes generated are not collected (Firdaus and Ahmad, 2010). As a result, the uncollected wastes, which are often also mixed with human and

animal excreta, are dumped indiscriminately in the streets and in drains, so contributing to stagnant water, breeding of insect and rodent vectors and the spreading of diseases (Cointreau, 1982; Zurbrügg, 2002b). It is very unfortunate that in the developing countries most wastes are disposed of in open dumps, deposited on vacant land, or burned by residents in their backyards (Medina, 2010; Visvanathan and Glawe, 2006). Insufficient collection and inadequate disposal generate significant pollution problems and risks to human health and the environment (Medina, 2010). The situation in Juba totally and practically is in accordance with those authors findings. In Juba, there is no sanitary land fill available for municipal solid waste disposal: Juba's municipal solid wastes are being dumped indiscriminately on the land and partially outside of the city at the designated open dumping site 16 km away from the city.

Most governments in the developing countries are aware of the seriousness of the municipal solid waste pollution problem, but the rapid population growth hinders their capacity to provide even the most deserved services to the citizens (Asnani, 2006). This is the case in Juba: the government is unable to render the services to all. Thus, there is that tendency to direct the services to the high profile residential areas. Hence, it becomes obvious that the low-income residential areas are neglected. Therefore, left with no any other option, residents tend either to dump their garbage at the nearest vacant land, public space, river/streambeds, or simply burn it in their backyards. Uncollected waste can accumulate on the streets and clog drains which might cause water stagnation. When it rains, waste can also be carried away by run-off water to streams and rivers and this has a negative effect on the water sources in and around the city. One of the worse practice of all the above mentioned with regards to municipal solid waste disposal in Juba city is the illegal dumping in Streambeds.

#### **The direct impact of illegal dumping in streambeds:**

The majority of local inhabitants of Juba do not have any garbage service and many used the dry stream beds that traverse the city as dumping areas. Once the rain comes, these masses of wastes are washed into the adjacent River Nile. Surprisingly and regrettably, most residents of Juba still depend on these surface water bodies for water supply and especially for bathing; this explains in part the high incidence of persistent typhoid, diarrhea and cholera at certain times of the year. This is a clear indication that there exists a strong link between rainy season, municipal solid waste pollution and some water born diseases. However, a more detailed scientific research needs to be done so that this can be proved.

**The dumping site:** The dumping site is located about 16 km away from the city along the Juba-Yei road. It is



Fig. 5: People scavenging at the dumping site (photo by the author during the observation period)

a kind of a small valley; this could have been the reason for its choice so as to reduce the excavation cost. The site (Fig. 5) lacks all the necessary sanitary land fill practices. There are no any pollution control measures and it is not fenced. There is no waste separation practice; wastes are just dumped like that and when the heap is mounting, a shovel loader is hired by the city council in order to flatten and compact it. Disposal operations are usually disrupted during the rainy season due to heavy rains and also by the frequent breakdown of the Lorries; all these can lead to the delay of waste disposal.

Due to the lack of environmental protection measures, small ponds of highly polluted water can be seen in the site; and these in turn provide a good breeding place for mosquitoes and flies. This is also another health risk to the people scavenging as the site is a home to most of them. Thus, in order to reduce the number of mosquitoes and flies and also the volume of the waste, the scavengers practice frequent burning. Another scenario is that, at times offal from the slaughterhouses is dumped at the site. This site is soon expected to begin producing leachate; and this is already a risk to the underground water and even to the River Nile as it is not very far from the site. The scene at the dumping site is clearly shown in Fig. 5.

#### **The impact of the municipal solid waste pollution on the human health**

**Waterborne diseases:** Municipal solid waste pollution is believed to be a major source of surface water pollution in Juba: thus couple up with the poor sanitation poses a direct effect on the water quality. The poor water quality and sanitation can be directly reflected in the high rate incidence of waterborne diseases, which is currently a serious health problem in Juba city. The incidence of these diseases is highly seasonal: the greatest problems usually occur at the start of the rainy season as the rains and run-off washes the wastes and fecal matter that have accumulated during the dry season into the streams and the River Nile.

Waterborne illnesses such as typhoid, cholera, dysentery, diarrhea, hepatitis A and a number of tropical diseases including malaria are a real threat to the public health of the city. For example, according to UNEP (2007), "in 2005 and 2006, Southern Sudan experienced a major cholera outbreak in several towns

including Yei, Juba, Bor and Malakal. The total number of victims recorded by WHO were over 16,000, with over 470 deaths. Cholera is a waterborne disease linked to fecal pollution of drinking water". The logical connection here is that municipal solid waste pollution provides favorable breeding sites for such diseases vectors and especially during the rainy season.

Also Pielou (1998), pointed out that "human and animal fecal waste contain disease-carrying organisms such as the bacterium *Escherichia coli* (*E. coli*) and pathogens that causes cholera, typhoid and cryptosporidiosis". According to Todar (2007), "virulent strains of *E. coli* can cause gastroenteritis, urinary tract infection and neonatal meningitis. In rare cases, virulent strains are also responsible for hemolytic-uremic syndrome, peritonitis, mastitis, septicaemia and Gram-negative pneumonia". Someone who has *E. coli* infection may have these symptoms: bad stomach cramps and belly pain, vomiting, diarrhea, which is sometimes bloody; all these are very common in Juba.

**Factors that encourage the municipal solid waste pollution in Juba:** The major factor is the financial constraint: and this is of course a typical characteristic of most of the developing countries and specifically the most underdeveloped. Some of the other factors are the below:

- **Rapid population growth:** The rapid population growth in Juba makes it so difficult if not impossible for the government to provide even the most basic services adequately to all
- **Negligence of municipal solid waste management by the policy makers:** Municipal solid waste management in developing countries has received less attention from policymakers and academics than that paid to other urban environmental problems (Medina, 2010). This is the situation in Juba: the responsible authorities pay much attention to other matters other than municipal solid waste management
- **Lack of awareness:** This is obvious to happen because the authorities are even unconcern about the social well-fare of the citizens
- **Access to waste for collection:** This is a real big problem due to a number of factors:
  - Most residential areas are unplanned
  - **Poor infrastructure:** No good access routes to most residents
  - Inadequacy of the authorities to render services to all
- **The "nobody cares" or "it's none of my business" attitude:** This is the most critical factor behind the entire municipal solid waste pollution problem in Juba. It starts right from the top government officials till to the street boys/girls: everybody is unconcern of what is happening in his/her surrounding. In Juba, it is not a surprise to

see an empty plastic water bottle being thrown out of the latest Land Cruiser model (V8) while being driven by very important people. Also in Suk Custom (Custom Market) one will be surprised to find people running their businesses normally besides the what can be termed as "nobody cares' hill" (a very huge garbage in the market)

## CONCLUSION

Municipal Solid Waste Pollution is a real, pervasive and serious problem in Juba that needs a very urgent solution. The implication of the pollution is that it has become a threat to both the human health and the environment. Municipal solid waste management is so inadequate that it becomes limited only to organized collection from the more well off residential areas and dumping is just in the open land near the city. In the majority of cases, garbage of all types accumulates close to its point of origin and is periodically burnt so as to reduce the volume. The most unacceptable thing that is happening is that, even from the small scale somehow managed waste, there is no waste separation at source, all kinds of waste including even medical wastes, human and animal excretes can be seen within the normal waste stream. Waste is also commonly dumped directly into seasonal watercourses or streams, thereby contributing to water pollution and waterborne diseases. Open air burning seems to be the only and most common method of waste disposal for the majority of the city residents. The study also found out that the municipal solid waste composition in Juba is contrary to other developing countries. In Juba, the waste stream is dominated by plastic waste while in other developing countries it is organic (food waste) that dominates.

For Juba authorities or rather the entire Government of South Sudan (GoSS) to tackle this rampant municipal solid waste pollution problem, it must develop and smoothly implement good municipal solid waste management strategies. But firstly and foremost: GoSS has to invest heavily in urban planning and capacity building for all its ten states; This will entail a process of importing expertise and 'learning by doing' through improved master planning for each state capital. And secondly, it has to increase investment in environmental health-related infrastructure and services. And finally, it must also invest in training its human resources in issues pertaining to environmental management.

## Recommendations for improving the current municipal solid waste management system in Juba:

- The Juba city council authority must develop comprehensive municipal solid waste management plan and strategy.

- The Ministry of Environmental Affairs, the Juba city council authorities and the NGOs (especially UN agencies like UNEP and WHO) should embark on public awareness programs pertaining to municipal solid waste management.
- Construction of a sanitary land fill must be one of the top priorities of the government's programs so as to improve the situation.
- The waste sector should be given priority in the government (political) agenda.
- Waste management legal frameworks (policy, law and regulation) should be developed.
- There must be an adequate annual government budgetary allocation to the waste management sector.
- More studies should be carried out by the young scholars in Juba; for example, a study that looks at the correlation between the municipal solid waste pollution, water pollution and some of the water borne diseases could be a good one.

#### ACKNOWLEDGMENT

The authors acknowledge and highly appreciate the support offered by China University of Geosciences (Wuhan) and particularly the School of Environmental Studies and the College of Natural Resources and Environmental Studies, University of Juba, Republic of South Sudan.

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