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Household Solid Waste Generation Rate and Physical Composition Analysis in Case of Assosa Town, Benishangul Gumuz Regional State, Ethiopia

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Abstract:

Mismanagement of solid waste has been the main problem facing society around the globe today, and especially in developing countries. This study aims on the household solid waste generation rate and analyses the physical composition analysis in Assosa town of Ethiopia. Assosa is one of the fastest-growing cities in Ethiopia that has largest population growth rate and urbanization. Due to the abysmal solid waste management practice, its residents suffer from severe health problems. The problem relies upon a lack of awareness on the impact on human health and the lack of adequate solid waste disposal nearby. This study was conducted based on a survey questionnaire distributed to 373 randomly selected families and an in-depth interview with the responsible body. The main findings are that daily household solid waste generation is directly related to household income and household size. The low, middle and high income households rate of daily waste generation per capita per day were 0.22, 0.31 and 0.41kg, respectively. The physical composition of solid waste mainly *consists of 87.4% organic. The study also found that most of the solid waste in Assosa town can easily be decomposed and recycled*. Therefore, awareness of the creation of safe disposal sustainable solid waste management practices (resource reduction, reusing, recycling, and composting) is crucial for the environment and human health.

Keywords: Solid waste; Household; Composition; Waste management; generation rate.

1. Introduction

The last two decades in developed countries, per capital the over increased waste generation nearly three-fold, which is reaching a level five to six times higher than that in developing countries (UNEP, 2005). Waste generation in developing countries is increasing rapidly, with increases in populations and living standards and may double in volume in the current decade. The world may be seen a five-fold increase in waste generation by the year 2025 if current trends continues (Endalkachew Abrhame, 2018). Solid waste is not only rising in quantity but also changing in composition (from less organic matter to more paper, plastics, packing materials, metal, glass, and other substances), which is posed by low collection rates (Solomon,2011). In Africa at approximately 0.5 kg per person per day a survey by the United States Agency for International Development (USAID) in 2009 cleaned the rate of solid waste generation. From this waste only a small amount of these solid wastes is properly disposed of in designated landfills. The rest are dumped openly without recourse treatment systems otherwise left in public dumpsters with no one to

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properly dispose of them (Pradhan, 2009). In a modern city or town, huge volumes of solid waste are generated every day that need regular collection, transportation and disposal. These operations have to be carried out rapidly and efficiently without controversy a bit much cost or degrade to the environment. Unfortunately, in many developing countries, the system for managing waste is primitive and cannot cope with the volumes of waste being generated (Ahmed and Ali, 2004). An alarming rate of solid waste generation rate trends can be observed parallel to industrialization, urbanization and economic development. The environmental load continues to be a major pressing issue threatening the environment and health of the people. The problems related to solid waste intensified with the gradual increase in solid waste generation and its poor management issue. In developing countries solid waste management is becoming a big concern for cities administration task. This is mainly due to increasing population growth, magnitude of rapid urbanization and which in turn has greatly accelerated municipal solid waste generation rate in the urban environment (Hayal Desta et al., 2014). According to World Bank (2012), every year developing nations spend nearly $46 billion on managing their municipal solid waste. In developing countries, with an over-increasing population, municipal solid waste management is emerging to be one of the serious problems. The improper household solid waste management exposes a potential risk to air, water, and land pollution poses risk to human health (Solomon Fantaw and Sharma, 2016). In Ethiopia like other developing countries municipal solid waste generation rate becomes increasing. This is because urban expansion and increasing population that is why most of the dwellers in most urban areas of Ethiopia used illegal disposing of their waste in the areas that are not permitted for waste disposal (Melaku and Degnet, 2008). In Ethiopia, like other developing countries, the increase of solid waste generation resulted from rapid urbanization and population booming. The amount of solid waste in Addis Ababa and other fast-growing areas in the country has been increasing over time, largely attributed to rapid population growth rate (Dawit and Alebel, 2008). The studies indicated that from the total solid waste released by the population in the city, about 50-60% was collected and another one was unattended (Zebenay, 2010). Different approaches are used by countries to manage solid waste in order to prevent its impact on the environment and health. Until recently, solid waste management (SWM) services in Ethiopia were mainly the responsibilities of municipalities, which results in inadequate service provision reflected by lack of proper waste collection, poor co-ordination, improper planning and poor sanitary facilities (Tadesse Kuma, 2004 & Edmealem Bewuket, 2013). Assosa, is a town like other Ethiopian towns have many sanitary problems of which the bigger one is highly waste generation rate and poor waste management practice. This is because of urban expansion and increasing population, do to this most of the dwellers in the area used illegally disposing of their waste that are not permitted for waste disposal. Moreover, solid waste management is a challenging problem because lack of society awareness and Municipality do not give attention to the problem so far. It is very common to dispose masses of waste on the streets, river banks, residential areas, Religious areas, available open areas and market areas. In addition to this households throw and dispose of waste illegally, it is observed that flies and rodent's bread and also goats and dogs, sheep scatter the wastes.

2. Materials and Methods

Description of the Study Area

Asosa is a town in western Ethiopia and the capital city of Benishangul-Gumuz Regional state of Ethiopia. Which is located in Assosa Zone, and this town has a latitude 10°03′48″N and longitude of 34°32′50″E, (figure.1). The town is 670Km far from Addis Ababa west of Ethiopia, with an elevation of 1570 meters above sea level. Furthermore, the area of this town is 19.20km2 and is served by an airport with a 6398 × 152 ft. (1950 × 46 m) paved runway.

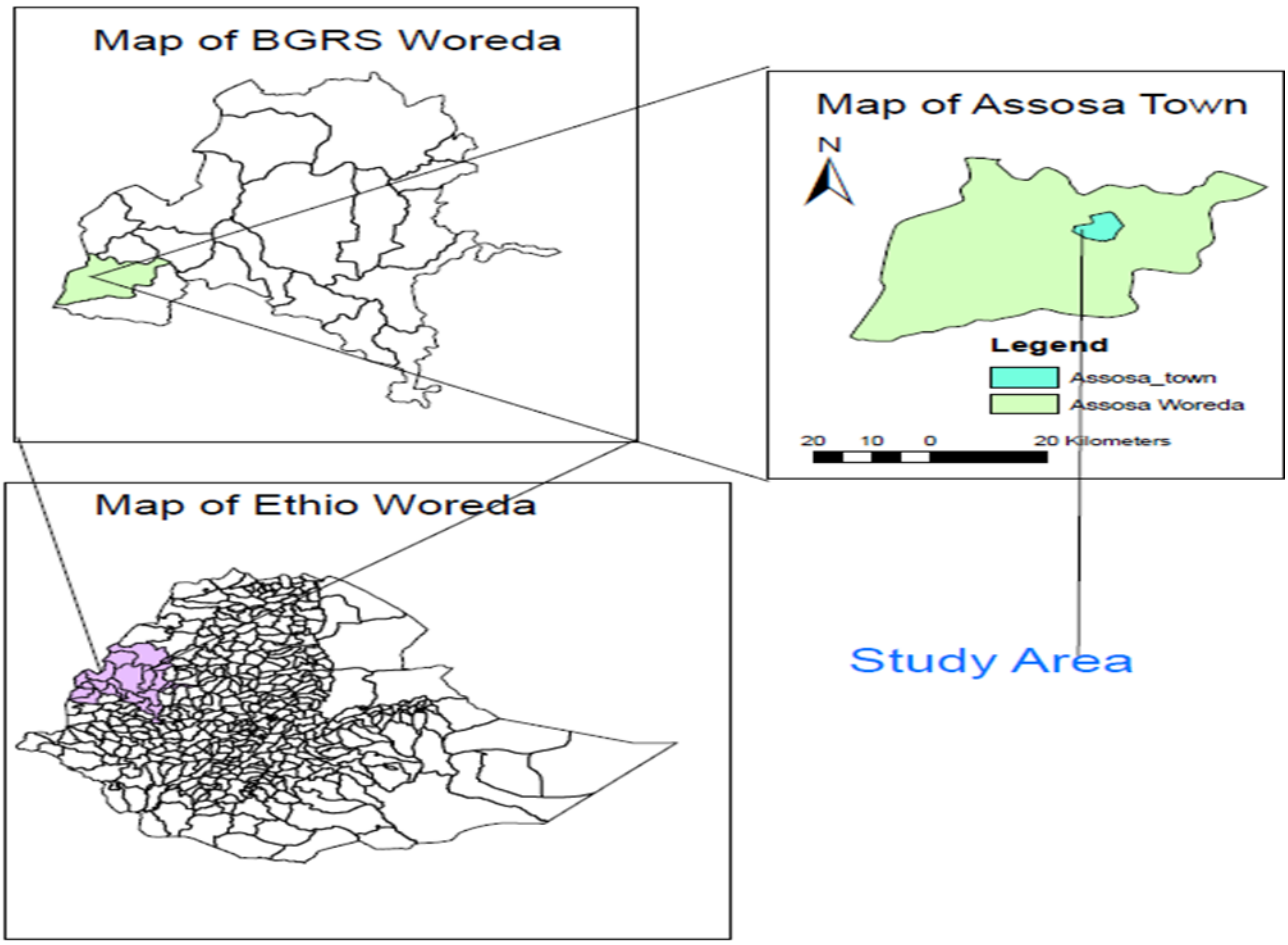

Figure 1. Map of the study area

Research Design

The researcher was used a descriptive research design which would to assess the current situation of solid waste generation rate, physical composition and the management practices of the town. This descriptive research design is helpful to describe and obtain relevant information from various forms of data concerning the existing or current status of the problems of the study.

Household solid waste sample collection and sorting

Considering variations between day`s household solid waste generation rate and physical composition a week round (7 day) sampling for each socio-economic zone (King & Murphy, 1996). Sorting of waste is distributing plastic bag to the household and collect after 24 hours to measure the weight on a black thick plastic sheet. Actual collection and sorting of wastes from the participating 40 households was conducted for seven consecutive days.

Figure 2: Partial view of household solid waste generation measurement.

Sources of Data

In order to achieve the objective of this study the important data was collected through both primary and secondary sources. Primary data was collected through household's surveys, field measurement and field observation. Moreover, secondary data provide relevant information of this study obtained from different source include different Reports from sanitation and beatification desk, photo from municipality and the health institutions from the town.

Data Collection methods and Instruments

Relevant data collected from primary sources of data through questionnaires, interviews, field observation, Field Measurement of solid waste, photograph and searching related topics.

Questionnaire

The questionnaire is mainly preparing for 373 selected households to assess the physical composition of solid waste of households, to identify the types of waste they produce and waste generation rate. Questions were prepared in English language and translated to local language (Amharic).

Interview method

Interview has purposely prepared to municipality officials, ketena leaders, environmental protection agency and health experts on waste generation of the town and management practices at individual household. It has been designed to assess the current SWM system of the individual household in the town, and to know the history of SWM service, collection, transfer and transport system in the study area.

Observation method

In order to understand the management practice solid waste field observation was employed by households solid waste handling practices, illegal dumping, solid waste collection, transportation systems and disposal

site facilities of the town. The necessary instruments such as photographs was taken during field observation for 'hotspot' waste dumping sites, and illegal waste disposal practice of the community across the town.

Field Measurements

Do determine the generation rate of solid wastes, out of 373 households 40 households were selected purposely depending on their income level. In order to have an average result in cases of differences in waste generation between days, collection and sorting of solid waste from the participating households has been conducted for seven (7) consecutive days.

Data Analysis technique

The daily, weekly, monthly and annually solid waste generation rate (DSWGR) of the town as well as per capita per day solid waste generation rate at household level can be calculated according to equation 1 (Fobil, 2000) per capita per day solid waste generation rate (PCPDSWGR)

$$PCPDSWGR = \frac{Total\ solid\ waste\ Generation\ rate\ within\ 7day}{7\ days\ x\ total\ family\ size\ of\ 40\ households} \quad \text{Eq(1)}$$

The relationship between variables was conducted by correlation test for observing the relationship between family size with generation rate and income with generation rate of household's solid waste.

3. Results and Discussion

Determination of per capita total solid waste Generation Rate

Daily Solid waste generation rate (DSWGR) of the town as well as per capita per day solid waste generation Rate at household level can be calculated as follows.

Per capita per day solid waste generation rate (PCPDSWGR) is given by the following formula

The researcher used a descriptive research design which would assess the current situation of solid waste generation rate, physical composition and the management practices of the town. This descriptive research design is helpful to describe and obtain relevant information from various forms of data concerning the existing or current status of the problems of the study.

$$PCPDSWGR = \frac{Total\ solid\ waste\ Generation\ rate\ within\ 7day}{7\ days\ x\ total\ family\ size\ of\ 40\ households}$$

$$PCPDSWGR = \frac{281.6kg}{7 * 138} = 281.6/966$$

$$= 0.292\ Kg/capital/day$$

Solid Waste Generation Rate of the town per capita per day at household level was 0.292 Kg/capital/day. Based on this result the daily total solid waste generation rate of the town was calculated as total population of the town (49,145) times per capita household solid waste generation rate. Based on these the daily total solid waste generation of the town is 14350.34 kg. The weekly, monthly and annual total generation of solid waste is also 14350.34 kg times 7, 30 and 365 days i.e. 100452.38 kg, 430510.2 kg and 5237874.1 kg respectively.

Income level of householder Solid waste generation rate

In order to examine the association between income levels and rate of solid waste generation at the households also stratified into three categories as high, middle and low income group.

Table 1. Solid waste generation rate of households in each income level in 2020 [Source: Field survey data, 2020]

Level of Income	No of HHs	Family size	Qt/Week(kg)	Qt /day(kg)	Solid wastes Kg/person/day
Lower income	18	51	77.2kg	11.03	0.22
Middle income	17	65	141.2kg	20.17	0.31
Higher income	5	22	63.2kg	9.03	0.41
Total	40	138	281.6kg	40.23	0.292

The amount of solid waste generation is (0.292 kg/person/day). But each income level of solid waste generation rate were 0.22 kg/cap/day for high income households while for low- and medium-income households were generated 0.31 and 0.41 kg/cap/day respectively. Since income and family size are the most important factors influencing the generation rate of solid waste in a particular area (George, 2015); their relationship was tested using correlation and linear regression model analysis technique.

Table 2. Correlations between household income and solid waste generation rate

		Qt /HH /day (Kg)	income of HHs (Birr)
Qt /HH/day (Kg)	Pearson correlation	1	.436**
	Sig. (2-tailed)	-	.005
	N	40	40
Income of HHs (Kg)	Pearson correlation	.436**	1
	Sig. (2-tailed)	.005	-
	N	40	40
**Correlation is significant at the level of 0.01 (2-tailed).			

The daily household solid waste generation was positively correlated with the monthly household income (i.e.0.436). This result indicates that, as the household's monthly income increases, the quantity (Qt) of waste generated per day also increases. George (2015) observed that an increase in income leads to an increase in the amount of waste generated per day. He also confirmed that increase in income affects life style of households as well as the consumption habit. Therefore, this as a result of higher income leads to a greater purchasing habit. The more income level of households generates high solid waste than who earns low income inhabitants. The same study was conducted also confirmed that the income of the household is strongly correlated with the solid waste generation rate (Mengie, 2015).

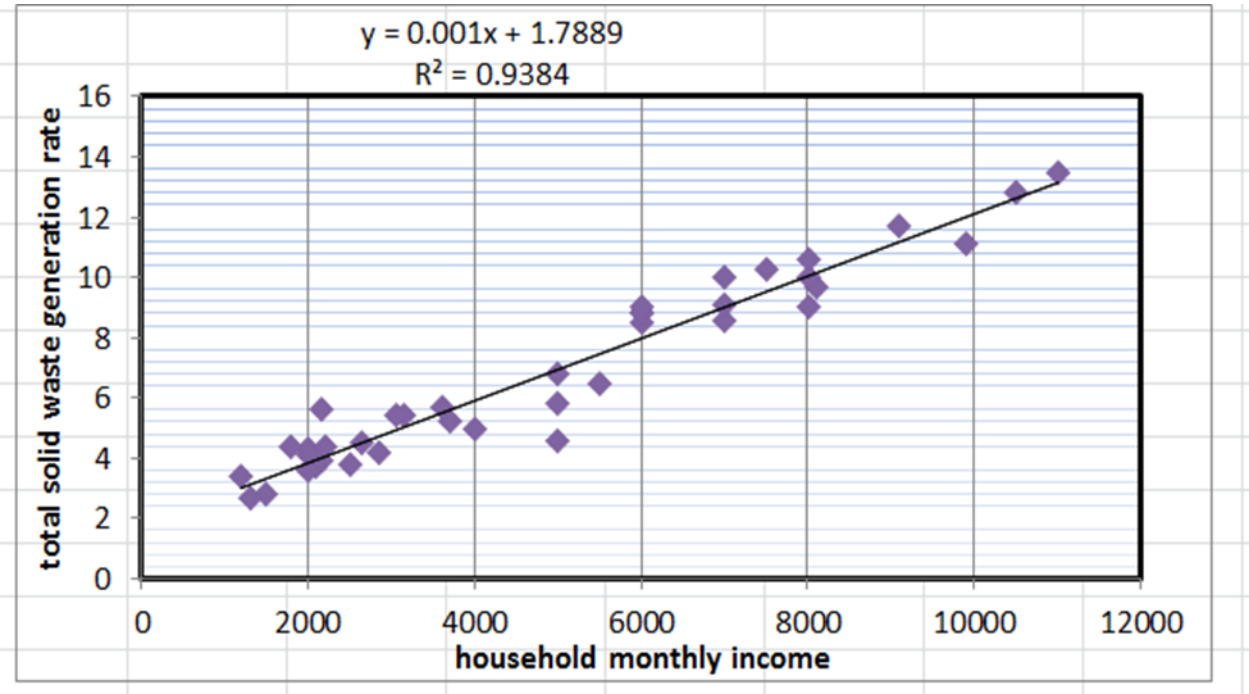

Figure 3. Linear regression analyses of solid waste generation rate and household monthly income

		Qt /HH /day (Kg)	income of HHs (Birr)
Qt /HH/day (Kg)	Pearson correlation	1	.635**
	Sig. (2-tailed)	-	0
	N	40	40
Famile Size	Pearson correlation	.635**	1
	Sig. (2-tailed)	.005	-
	N	40	40
**Correlation is significant at the level of 0.01 (2-tailed).			

Furthermore, there was similar correlation with family size was also positively correlated with waste generation at the household level in the present study (i.e. 0.635). This indicates that, when family size increases in member of household leads to increases in resource consumption resulting in increase in waste generation at their household level. According to the study conducted in Cameroon also indicated that, the family size is positively correlated to the amount of waste generated in the household (George, 2015). Households get more money they will tend to generate a larger quantity of solid waste i.e. depending on their income.

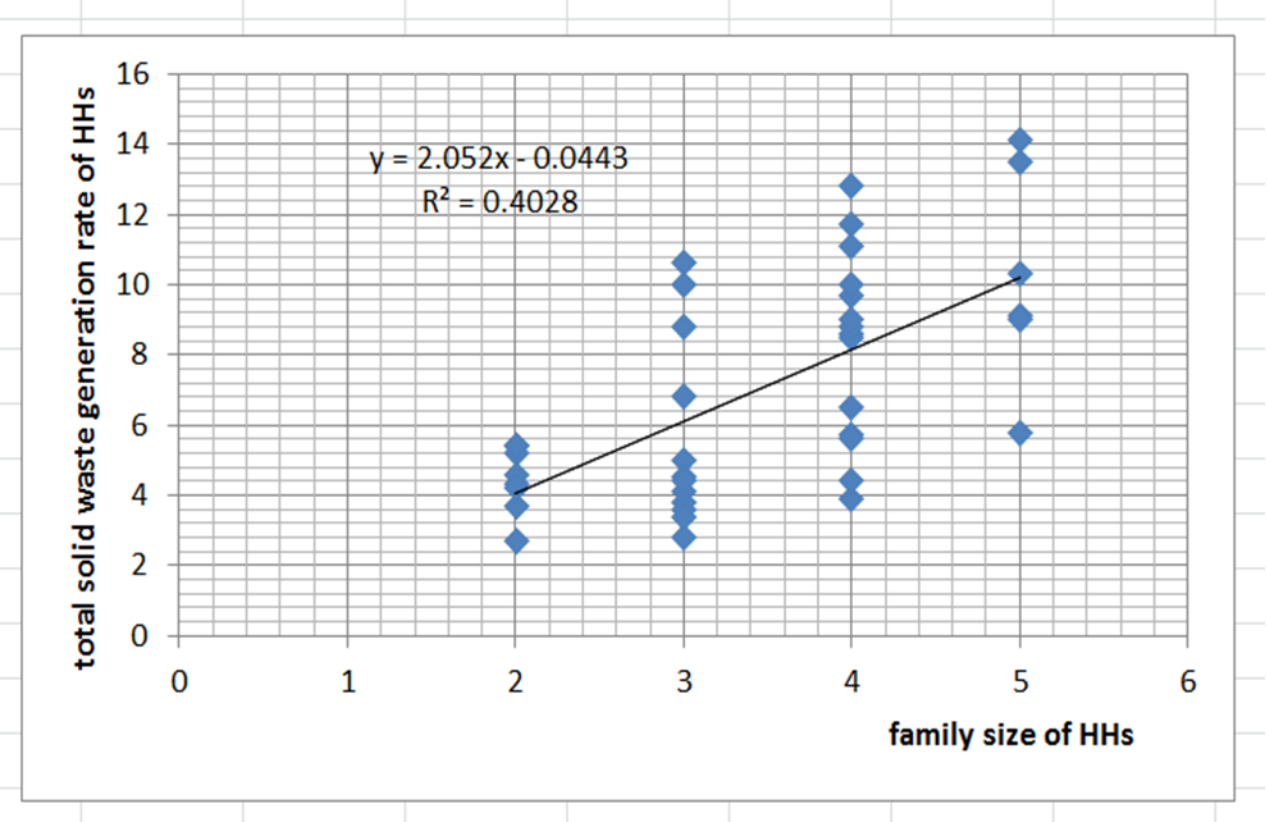

Figure 4. Linear regressions of solid waste generation rate and household family size

The relationship between solid waste generation and socio-economic factors

Depending on this study monthly income per capita households were categorized in to three income groups population projection made by Assosa Town plan and Economic development office (2020). According to (Wells, 1996) the study Per capita income level and solid waste generation rates have direct relationship. Households that have more income needs better life standard more earn use more consumption materials than low income households do, and hence the former group generates higher wastes.

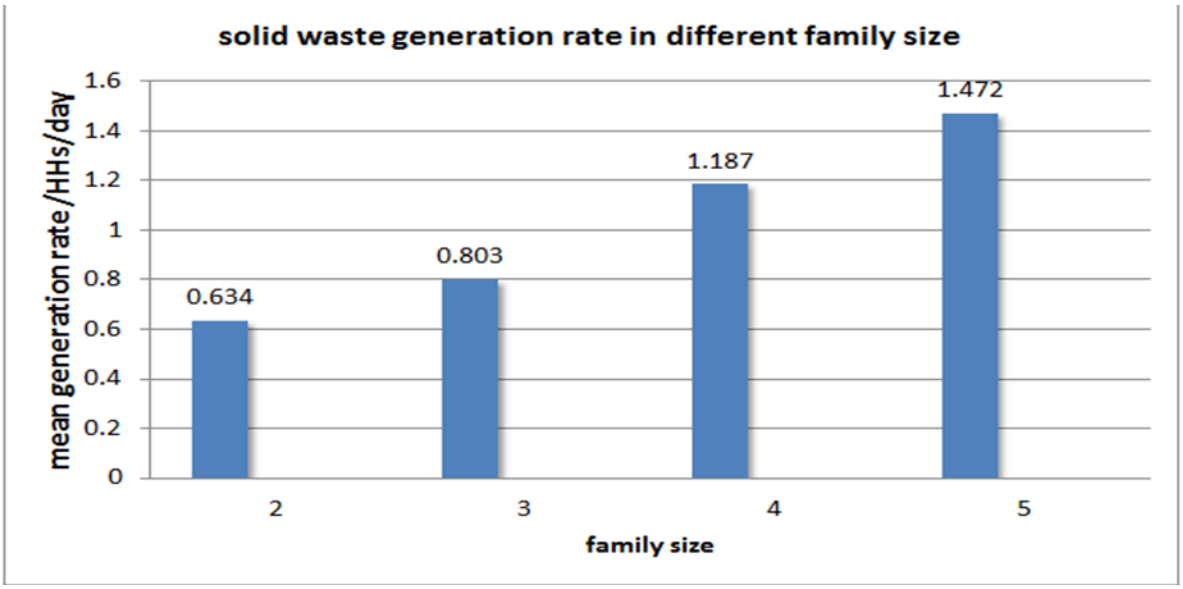

Figure 5. Generation of HHs solid waste based on family size.

The results of the study indicated that the mean generation rate of low level income generates 0.613 kg of solid waste per HH per day, medium and high income of the HH generate 1.187 and 1.472 kg of solid waste per HHs per day respectively and the overall average household solid waste generation is 1.024kg. This indicates that the daily HHSW generation per person increases with increased economic status of living standard of households.

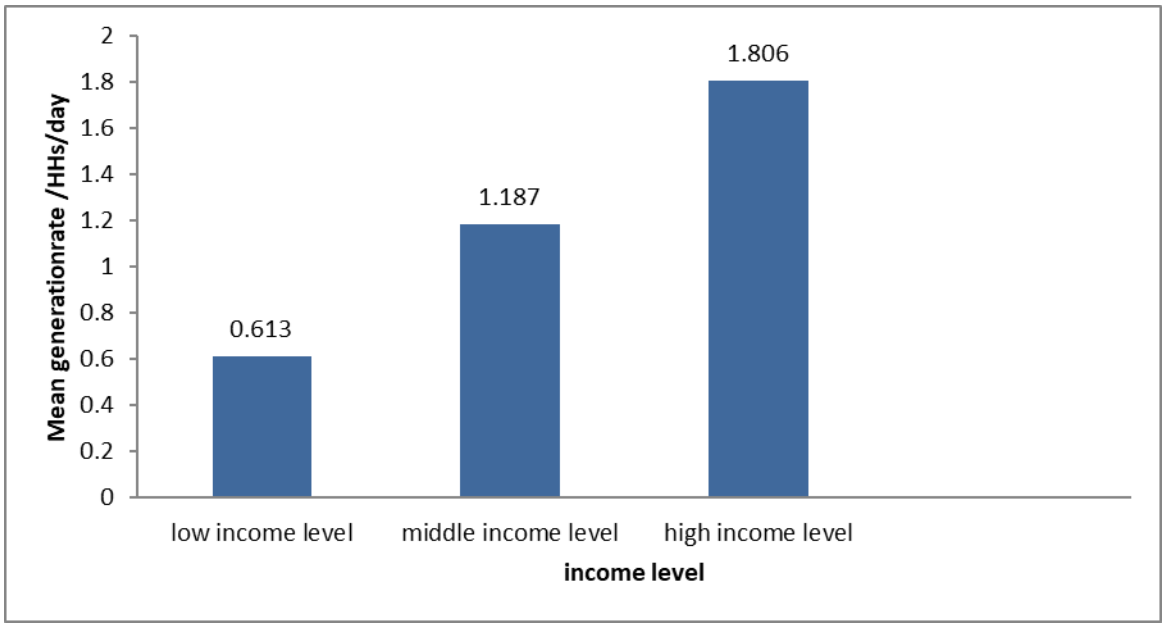

Figure 6. Generation rate of HHs solid waste based on income level

Household Solid Waste Storage Facility and its Handling Method

Primary Solid Waste Storage Facility and its Handling

From the total sample respondents about 173(i.e.46.4%) used trash bags for their temporary waste storage materials. This storage bag was preferable because it is long lasting than plastic bags because it is made up of strong fiber. Furthermore, it is convenient to handle when waste is transported by carts from the residential area to the disposal site. Some households, especially those who dispose of or transfer their own waste used plastic bags this accounted for 40 (i.e.10.7%), 61(16.4%) were used basket 16(4.3 %) of metal container and 83(22.3 %) were used sack as a temporary solid waste storage. On the other hand, the type of storage materials used by households show that high variation. This is mainly because of the nature of storage material of households is needed depending on characteristics of solid waste, collection frequency and types of collection material, space available placement of the storage materials, and by considering economic power of solid waste generators (Gtsadkan, 2002).

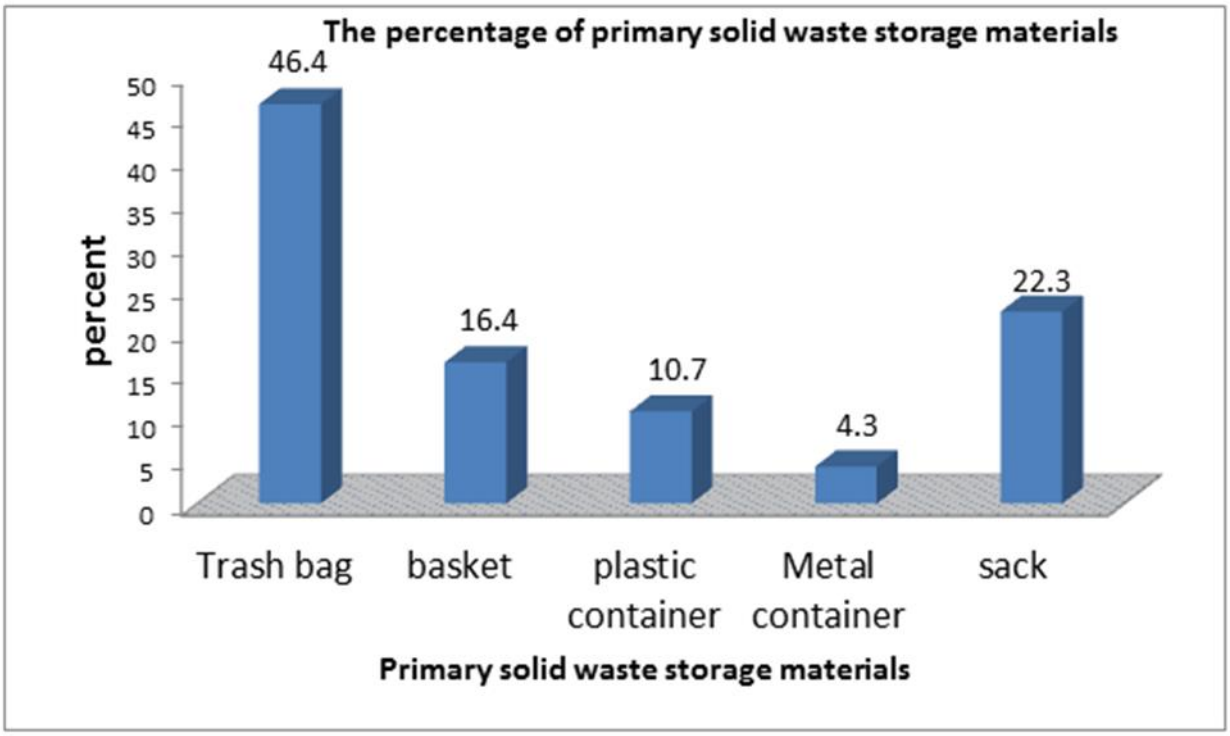

Figure 7. Types of primary solid waste storage materials at the household level

It is also observed that most of the households who used the „Festal", as a storage material for their solid waste at home throw away together with the waste it contains. This experience of the households shows that storage materials are meant use and through i.e. one-time use only. This means that no storage materials become part of the waste that increases the quantity of non-decomposable solid waste that is increasingly littering most parts of the city in general. However, the most preferable one way to manage solid waste is to reduce the source of the waste to generate at the source and hence storage materials have to be purposely designed for long times use, so that these types of materials do not wear out, therefore quickly and become part of waste instead.

Secondary household solid waste storage facility and its handling

It was the most preferable waste storage facilities that may be either stationary or portable units. According to (Zebenay,2010) the secondary storage facilities indicates that the variety types of solid waste containers which comprises keeping solid waste generated from different households at common designed areas from where collection vehicles can easily pick it and transport to final disposal site. In order to manage the waste of the town the municipality must be responsible for providing the facility. Until this research conduction, the Assosa town municipality put only eight (8) common solid waste containers in different sites in different ketena of the town. Different responsible bodies such as hotel owners put public solid waste containers without any need of facilitators considering frequent illegal dumping sites and high population density. And give priority to the households that are found close to main roads, but these types of collection cause odor and dust problems that attacks the residents who settled around the containers. This is mainly due to the absence of frequent collection of those solid public waste containers and misuse of the society.

Households' solid waste disposal practices

As indicated the figure below the existing solid waste disposal practices in Assosa town were observed from door to door. The solid waste collection of the town was very insignificant both in spatial coverage and efficiency. As a result, quit large numbers of households 213(57.1%) preferred improper and unauthorized solid waste management practices. This confirmed that the destination of the majority of uncollected solid wastes of households were in roads, sewers, river banks, valleys, gullies, bridges, and open areas. This improperly the solid waste disposal of the town solid waste exposed communities to different respiratory and water borne diseases. 62(16.6% of the respondent practice their waste disposal practices along the road side and an open area 60 (16.1%) of the respondent burn their waste in their compound while only 38(10.2%) of the respondent wait until waste collector come back similar result was observed in Debre markos town (Zebenay, 2010) In order to assess the routine method of solid waste disposal practices of households and to know the destination of uncollected solid wastes, the sample respondents were asked about their common disposal system.as the research field observation this illegal disposal of household solid waste was the result of lack awareness about the impact of solid waste on health issue and other related health problem. I think this illegal disposal practice comes from the area which is free from any construction and lack of wariness about the negative impact.

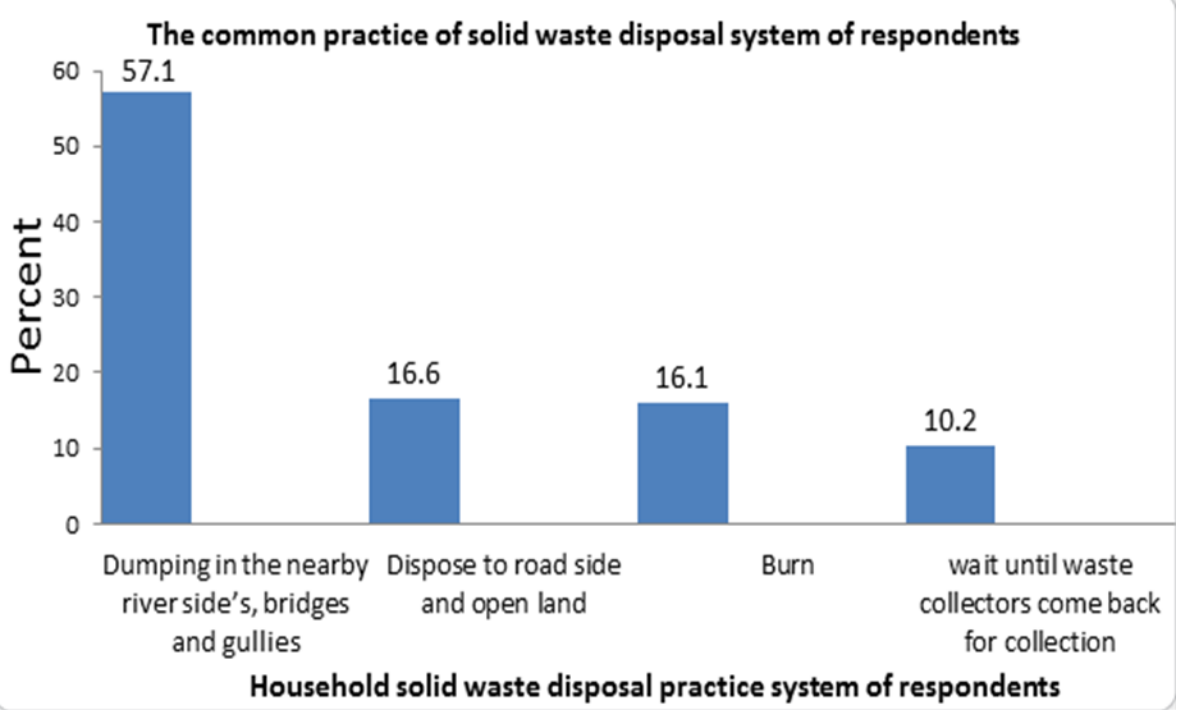

Figure 8: Household's solid waste disposal practices in the study area

According to the investigator common problem in some of the households, their income was very low i.e. their monthly income is hand to mouth. Some householders expect that it is the mandate of the municipality, the government and therefore they are not willing to pay charges. just they are dumping their waste either in roads, sewers ,river banks, valleys, gullies, bridges or nearby open spaces; from there the government bodies like municipalities roads, sewers ,river banks, valleys, gullies, bridges or open spaces the same result was observed in Desie town (Solomon, 2011).

Existing Situation of Solid Waste Disposal Site in the study area

The collection and transportation of solid waste is not an end to solid waste management practice. In addition to this proper solid waste management also requires proper disposal site of waste in a proper place. In sight of this the investigator field observation Assosa town solid waste disposal site and its management is inadequate and below the standard. The waste collected is disposed of an open field which is far from 1.50 km away from the center of the town.

Figure 9. Current disposal site [Source: Direct field observation]

When the windblown waste is scattered all over the site and some light plastics and paper might travel back all the way to the city. The major problems associated with the disposal site are the site being crop field and grazing ground where children and farmers frequently stay, has no fence, no soil cover, it is surrounded by housing areas and health hazard for people living nearby, and situated in a seasonal flood plain land. Furthermore, this disposal area is now in a day between Assosa University and the place where people live near the surrounding of the disposal site and gets into the map of towns. Due to this reason the surrounding society was exposed to different health problems.

4. Conclusions

The residents of Assosa town have low awareness about solid waste management, it is very common to see masses of waste on the streets, river banks, in residential areas and market areas. The investigator used descriptive statistical research methods of both qualitative and quantitative methods was designed random sampling techniques were adopted to select 373 household heads. In order to collect valid data field measurement, questionnaire, field observation and interview were employed. The study was conducted randomly selected 373 households; and 40 key informants were purposely interviewed. Moreover, the gathered data from different samples was analyzed based on the adopted quantitative and qualitative methods of descriptive statistical techniques using the percentiles, frequencies, correlation between the two variables by using statistical package for social sciences (SPSS, Version21.0). The household solid waste generation rate in the town is 0.292 kg/cap/day. The total daily, weekly, monthly and annual generation rate is 14350.34 kg, 100452.38 kg, 430510.2 kg and 5237874.1 kg respectively. The physical composition of solid waste is mainly organic, which constitutes 87.04%.The rates of daily waste generation per capita per day low, middle and high incomes is 0.22kg/cap/day, 0.31 and 0.41kg/cap/day respectively. The town was found not exercising waste management practice, like the reduction of waste at the sources, recycling of wastes and energy recovery. In this study 87.04 % of waste

generated in town is decomposable that can be re-used through different methods. Therefore, adaptation of sustainable solid waste management practices like (source reduction, reuse, recycling and composting) through awareness creation about the importance of safe disposal of solid waste for their healthy environment should be encouraged.

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8.Conflict of Interest

The authors declare that there are no conflicts of interest regarding the publication of this article.

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