

# Solid waste Characterization and Recycling Potential in Hawassa University, Ethiopia

Hunachew B. Mengesha, Biruck Y. Dessalegn

**Abstract**—Owing to the dramatic expansion of universities in Ethiopia, understanding the composition and nature of solid waste at the source of generation plays an important role in designing a program for an integrated waste management program. In this study, we report the quantity, quality and recycling potential of the waste generated in the three campuses of the Hawassa University, Southern Ethiopia. A total of 3.5 tons of waste was generated per day in the three campuses of the university. More than 95% of the waste constituents were with potential to be recovered. It was a lesson from the study that there was no source reduction, recycling, composting, proper land filling or incineration practices in-place. The considerably high waste generation associated with the expansion of educational programs in the university appears worthwhile requiring implementation of programs for an integrated solid waste management to minimize health risk to humans and reduce environmental implications as a result of improper handling and disposal of wastes.

**Keywords**—Hawassa University, integrated solid waste management, solid waste generation.

## I. INTRODUCTION

UNCONTROLLED dumping and improper waste handling causes a variety of public health and environmental problems, including contaminating nearby water bodies, attracting insects and rodents, and increasing flooding due to blocked drainage canals or gullies [1], [2]. Few reports indicated that the average organic content for urban municipal solid waste in Africa is more than half of the total waste generated [3]-[5]. Wastes from institutions such as educational institutes are characterized by considerable volumes of organic waste from the kitchen and gardens, recyclable wastes such as plastics, paper, cans, non-recyclable and hazardous wastes. Armijo et al reported the generation of one ton of solid waste per day in the Mexicali campus, Mexico where the portion with recycling potential was more than 65% [6]. From the study, larger proportion of waste is found in the recyclable and potentially recyclable categories. Owing to the dramatic expansion of universities in Ethiopia, understanding the composition and nature of solid waste at the source of generation plays an important role in integrated waste management program. Application of the integrated waste management hierarchy is useful in terms of resource recovery,

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protecting human health and environment, and for the reduction of greenhouse gases (GHGs). This approach within the educational institutions will create an opportunity to communities in university campus and nearby to effect sustainable programs [7]. Moreover, universities can be a platform to educate and increase awareness, implement technologies, and develop working guidelines and tools to create an environmentally sustainable future. To our knowledge, there is no study or information on the solid waste generation for universities in Ethiopia. In this study, we report the quantity, quality and recycling potential of the waste generated in the three campuses of the Hawassa University, Southern Ethiopia.

## II. MATERIAL AND METHODS

### A. Description of the Study Area

The study was conducted in three campuses of Hawassa University (The university main campus (MC), the College of Agriculture (CA), and the College of Health Science and Referral Hospital (CMHS)). The three campuses were selected based on their proximity to the ecologically sensitive environment such as Hawassa Lake, source of livelihood for over five million people [8]. According to the recorded information from the university registrar office the students in undergraduate and postgraduate programs were 17,187 and 1272, respectively. There were also 11986 students in the continuing and distance education program. The total number of workers was 2963. Significant number of patients and patient relatives visit the hospital every day. The current solid waste management practice includes collection of wastes at their point of generation, transportation to specific locations, and burning or burying.

### B. Study Design

The study was a cross-sectional study involving collection, identification and measurement of wastes in all the three campuses.

### C. Study Methodology

All the activities and potential waste generation sites in all the three campuses were identified; and all categories of wastes generated in each campus were brought to predetermined and convenient locations. Separation of wastes in specific categories and subsequent measurement were made onsite. The weight of containers was determined prior to measurement of each waste. Characterization and weighing of wastes were carried out every morning and afternoon. This study assumed that the academic and administrative activities

in the campus are the same all year round (except during vacations). The weighing scales were calibrated before each measurement.

#### D. Data Analysis

The weight of each category of waste was recorded in the format prepared for these specific activities, which is structured with the categories and sub-categories. The weight percentage for each subcategory was calculated using the following equation:

$$\text{Sub-category (SC) \%} = (\text{weight of SC} / \text{Total weight}) \times 100 \%$$

After obtaining the weight and, in order to find out the recycling potential of the waste, each sub-category were classified according to: waste for which there exists a recycling market, recyclable waste for which there does not exist a local market, and non-recyclable waste. The data was registered in excel sheet and all calculation was made possible.

### III. RESULT

A total of 3557.8 kg (more than three tons) of waste was generated per day in the three campuses of the university. Of which 53.73% is produced in the main campus, and followed by 32.69% and 13.58% from CMHS and CA campuses respectively (Fig. 1).

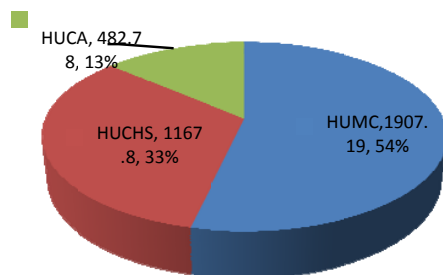


Fig. 1 Daily solid waste generation rate in each campus, kg/day

The findings of the study revealed that 90% of the waste categories generated are putrescible. There has also been significant amount of waste that can be reused or recycled.

TABLE I  
CHARACTERISTICS OF WASTES GENERATED WITH THEIR RESPECTIVE DAILY QUANTITY IN KG

S.N	Waste category in the 3 campuses	Weight (kg/day)	%
1	onion, potato, cabbage, fruit scraps	1467.6	41.25
2	food leftover	1175.6	33.04
3	paper	339.54	9.54
4	hazardous	216.2	6.05
5	leaves and grasses	153.92	4.33
6	carton	69.65	1.97
7	others (plastic bag, bottles, cans, batteries)	135.28	3.8
<b>Total</b>		<b>3557.8</b>	<b>100</b>

### IV. DISCUSSION

Various approaches can be used to quantify solid waste generation depending on the setup and the number of activities performed in the area of generation. In higher institutions the generation rate can be expressed in terms of the number of employees involved, the number of students present during the study period, the number of buildings among other things. In the present study area we quantified the generation rate of the wastes in the College of Health Science Campus based on the number of beds of the Hospital and accordingly the daily generation rate of all categories of wastes was 3.83 kg/bed/day. The solid waste generation rate of the Hawassa University College of Agriculture campus was calculated per the number of students. Accordingly, it was determined to be 0.46 kg/student/day (482.78 kg/1052 students). For the university main campus, the generation rate was calculated using the total employees involved in it, and it was determined to be 0.64 kg/p/day (1902 kg/2965 staff). During the study period, it was learned that no source reduction, recycling, composting, proper land filling or incineration practices in place. In the study, it was estimated that more than 95% of the waste constituents can be converted in one or more useful forms. The amount of putrescible wastes including paper generated per day was 3172.92 kg, which is 90% of the total amount. The solid waste generation in all the three campuses was 1158.1 tons per year. With the imminent increment of the number of students and staff in each category with consequent diversified activities of the university, the amount of waste generated could be high. In the college of health sciences campus, significant amount of hazardous waste is generated each day. The lack of proper collection, segregation and recycling-reuse program of hospital wastes could possibly put, patients, workers, students or nearby communities at risk of infections, injury or fire hazards. The vast economic potential from the waste demands the application of the Integrated Solid Waste Management (ISWM) hierarchy in terms of resource, protecting human health, environment, and reduction of GHGs from the improper SWM practices

The current study revealed that there has been a daily generation rate of 27.35 and 25.29kg reusable plastic bags and plastic bottles, respectively. Recycling involves collecting, reprocessing, and/or recovering waste of potentially useful materials such as glass, paper, metal, plastic, textiles, and

electronics. The study revealed that there has been a generation rate of potentially recyclable 409.19 kg/day paper and carton, 27.35 kg/day plastic bags, 25.29 kg/day plastic bottles and 6 kg/day cans. The amount of putrescible (compostable) wastes including paper generated per day is 3172.92 kg which is 90% of the total waste generated per day in the university. The annual generation of compostable solid waste is 1158.1 tons of waste. Recycling of these valuable materials from the generated waste reduce greenhouse gas emissions and the number of combustion facilities. Moreover, recycling has economic benefits via job creation and as raw materials to industrial consumption [9]-[11].

#### V. CONCLUSION

The daily generation rate of solid waste in the three campuses was 3557.8 kg. Lack of source reduction, recycling, composting, proper land filling or incineration practices in place to reduce the impact of solid waste by the university suggesting the need for creating awareness of proper waste management practices among concerned university communities. More than 95% of the waste constituents were with potential to be recovered. It was a lesson from the study that there was no source reduction, recycling, composting, proper land filling or incineration practices in-place. The considerably high waste generation associated with the expansion of educational programs in the university appears worthwhile requiring the university to initiate the implementation of ISWM system to protect public health, environment, and reduce GHGs. The university needs to allocate its own specific budget for the management of solid wastes; continuous awareness creation to the community of the university and the nearby community need to be made using the existing media; collaborate with the city administration to implement viable management options for long-term solution. Moreover, encouraging entrepreneurs to use the wastes as raw materials for setting up business opportunity is an alternative approach to minimize health risk to humans and reduce environmental implications as a result of improper handling and disposal of wastes.

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