



## Qualitative and Quantitative Analysis of Municipal Solid Waste (MSW) in Butwal Sub-metropolitan City, Nepal

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### Abstract

Urbanization and land use affect the quantity and characteristics of Municipal Solid Waste in a fast-growing municipality. Management of increasing amounts of solid waste has become a major challenge in many cities in developing countries. The present study was conducted for analysis of MSW in Butwal Sub-Metropolitan City. For quantitative analysis per capita waste generation was calculated by using digital weighing machine and for qualitative analysis, waste is categorized into mainly eight category i.e. Organic, Paper and paper product, Rubber and Leather, Plastic, Metals, Textile, Glass, and Others. Stratified random survey was conducted in three sub areas: Rural, semi-urban and core urban city using standard questionnaire and KII for qualitative analysis and to know about present status of waste management in Butwal. The per capita waste generation rate of Butwal Sub-metropolitan city is found to be 244.33 g/day. The quantity of waste generation is found to be 47.56 tons/day and 17359.4 tons/year which include wastes from household, commercial and institutional sector. The overall composition of solid waste is made up of 54% organic, 17% paper and paper products, 15% plastic, 5% glass, 2% metal, 1% rubber and leather, 1% textiles and 5% others. After the study the composition of organic waste was found dominant among household, institutional and commercial areas.

**Keywords:** Solid Waste Management; Landfill Site; Municipal Solid Waste; Waste Characterization; Waste Disposal; KII

### Abbreviation

SWMRC: Solid Waste Management and Resource Mobilization Centre; VDC: Village Development Committee; PPE: Personal Protective Equipment; KII: Key Informant Interview; MSW: Municipal Solid Waste; HH: Household; CBOs: Community Based Organizations; ADB: Asian Development Banks; SWM: Solid Waste Management

### Introduction

Solid Waste Management and Resource Mobilization Act, 2004 defines Solid Waste as materials which are in a state of disuse, or

which have been disposed of, or such other materials which are declared as solid waste by Solid Waste Management and Resource Mobilization Centre (SWMRC) time to time. People are having the attitude of throwing the waste hazardedly, old vehicles and heavy equipment's due to lack of training or need of well-equipped equipment's or lack of manpower, no appropriate laws and policies and lack of awareness among them [1]. Solid Waste generation within households, markets and communities is as a result of human activities [2]. According to Local self-Governance Act, 1999 municipalities in Nepal must be responsible for managing solid waste but are not actually responsible due to lack of necessary skill or resources

to manage the waste in proper manner (Solid waste management in Nepal: Current status and policy recommendations) [3]. One of the major problem faced by municipalities is SWM because it needs huge expenditure but gets only rare attention so, it has become critical issue for urban area [4]. Butwal Sub-Metropolitan is one of the twin cities of rapidly growing Butwal-Bhairahawa urban agglomeration in Nepal. It is bordered by Devdaha VDC in the east, Parroha VDC in the west, Dovan VDC in the north and Motipur VDC and Shankarnagar VDC in the south. It covers an area of 101.61 sq.km and is divided into 19 wards.

Because it is situated at the crossing of two major highways namely Mahendra Highway and Siddhartha Highway in the foothills of Churia Range it has developed as a major transportation and trading town as well as an administration Centre. As per 17 Jan, 2018 cabinet meeting, Butwal city has been declared as the interim state capital of Province No. 5. Butwal Sub-Metropolitan City dumps every day waste on the banks of the Tinau River that is at ward number 11, which is near the squatters' settlement [5]. Due to lack of proper urban waste management along with rapid urban environmental degradation local rivers are also being intensely polluted and are treated as temporary dumping site. Most of the people in rural wards are managing wastes on their own by digging, composting and incineration method. So, the quantification and composition along with current status of solid waste generation and management is necessary for proper sustainable waste management in the city.

## Materials and Methods

The study was conducted from March 15, 2019 to August 10, 2019 in Butwal Sub-Metropolitan city. To conduct the study we used digital weighing machine after the waste segregation process for the calculation of per capita waste generation during data collection. Waste characterization system is used to identifying the per capita waste generation for quantitative analysis. PPE like mask, gloves etc. were used while collecting and segregating waste. For analysis of data Microsoft Excel package was used. Stratified random sampling was used for choosing household, commercial and institutional sectors along with KII, on site observations as primary source of data collection. Total sub-metropolitan was divided in three sub areas: Rural, semi-urban and core urban city to represent the whole sub-metropolitan city. Ten wards were selected for survey on the basis of urban, semi-urban and urban to represent the whole sub-metropolitan city. For the stratified random sam-

pling we went to the center of the town and selected a direction in a random way. We spined a bottle on the ground and selected the direction on which bottle neck indicated. The household were chosen from the main way towards the ward i.e. the first house is one and the second house is in alternate leaving two houses in the row. Similarly, commercial and institutional houses were selected based on types to make sampling representative. The sample size was calculated using Slovin's formula [6]:

$$SS = N / 1 + N (e)^2$$

N = Population size

e = Margin of error/error tolerance

95% confidence level and p = 0.5 were assumed.

There were altogether 25 questions in questionnaire which include both closed and open-ended type questions. For the ease of receiving quick response from the respondents, we included more than 80% of the questionnaire to be of close-ended structured questions [5]. Interaction with municipal staff (KII) was also conducted to know the future plan and current status of Solid Waste.

Management in the city. The interaction was conducted among the executive officer, senior engineer and the other relevant staffs. These interactions helped a lot in the overall project plan and design.

## Research design

The study was carried out on the basis of primary data, secondary data, information from checklists and KII. The methodology for the study is as shown in figure (Figure 1).

## Results and Discussion

### Waste generation

The per capita waste generation rate of Butwal Sub-metropolitan city was found to be 244.33 g/day. The quantity of waste generation was found to be 47.56 tons/day which includes wastes from household 71.267% of total waste, commercial 26.786% of total waste and institutional sector 1.946% of total waste produced. It consists of organic waste, followed by plastics, paper and paper products, glasses, metals, textiles and other inert materials. Similar result was found that the major source of MSW that is generated in residential areas, which is 85.87% of total generation, whereas 11.60% in commercial areas, 1.02% in institutional areas, 0.55% in street sweeps and 0.96% in other areas [7] (Table 1).

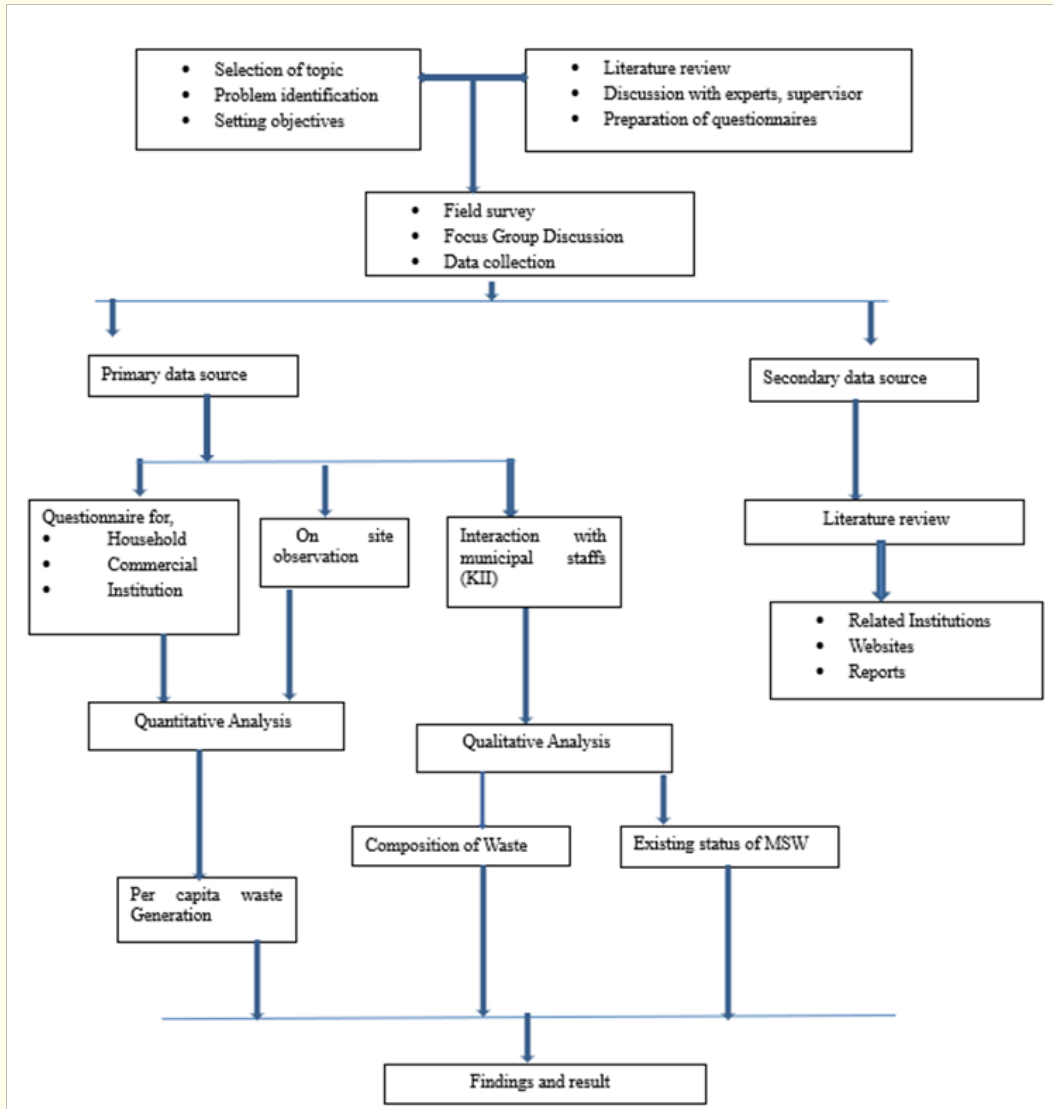


Figure 1: Hand held dynamometer.

Types	Total number	Per Capita Waste Generated (kg/day)	Total waste generated (kg/day)	Total waste generated (Tons/day)
Household	1,38,742	0.2443	33,894.67	33.89467
Commercial	6500	1.96	12,740	12.74
Institutional	150	6.1741	926.115	0.926115
Total	145392	8.3784	47560.115	47.56079

Table 1: Quantitative analysis of solid waste in Butwal Sub-Metropolitan city.

**Present status of waste management**

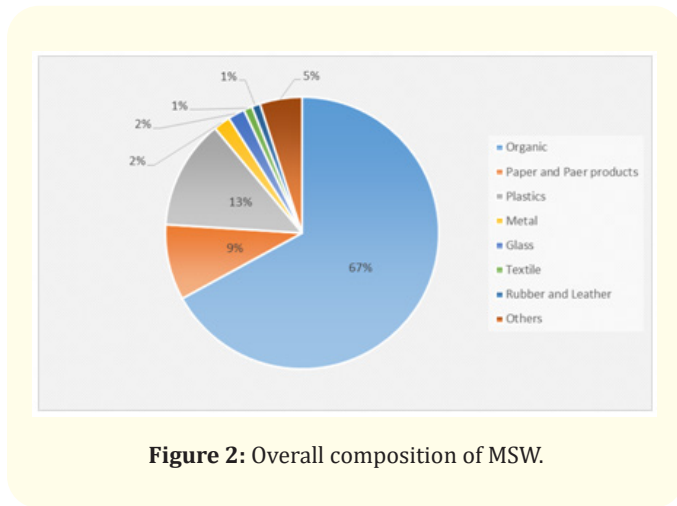
During the study, we found that at present solid waste is managed by the producer themselves highly by open burning, and also by open dumping, road-side and/or river-bank dumping practices on some extent. Similar type of result was found on the study done in Municipality of Huejutla, Mexico, where approximately 24% of the total waste generated was burned by households, of which 90% in rural areas, where there was not an MSW collection system [8]. Butwal Sub-Metropolitan city is facing a Solid Waste Management issue because it does not have a proper specified dumping site. There is no collection service for rural wards. They generally

have good network of informal recyclers such as scrap dealers who buy the recyclables from door to door. They collect dry waste such as cardboards, papers, newspaper, bottles, tin cans, metals, spare parts, plastics etc. Some scavengers visit on a regular basis to collect the recyclables materials; they basically pick roadside waste. The lack of a centralized waste segregation or recycling programs can be described as the main cause of indiscriminate dumping of waste by the people living in the rural wards. Only a certain section of the population has the incentive to segregate waste and use it, be it for use as manure after composting, to feed their livestock, or to sell certain items for recycling.

Wards No.	Collection Type	Collection Frequency	Transfer and Transportation vehicles	Treatment system	Final Disposal
Urban (1-7)	Road Pickup System	Regular	Handcart	No treatment system practiced.	Tinau River is Used as dumping Site since last 10-15 years
	Door to Door	Twice a week	Wheel barrows	Planning for Controlled dumping.	
	Road Sweeping (40 km)	Twice a day	Rickshaws Tractor trailers (20) Trucks (1) Tipper (1)	Recently approved plan for the waste management using 3R and Organic manure Production Centre in ward 9 with area 4.84 hector land.	
Sub – Urban (8-13)	Ward no 8, 9 and 10 collect HH waste from bucket distributed by municipality i.e. Door to Door.	Twice a week	Tractors (5)	Open burning (Highly followed)	
	Sanitation program by community & NGOs	Once a week (Saturday)		Compost bin	
	Door to Door	Twice a week CBOs		Vermicomposting Metals and Glass to Scrap Dealer	
Rural (14-19)	No collection, only public awareness program for proper waste management	—	No Transfer and Transportation vehicles	Open burning (Highly followed)	
	Sanitation program by local community	Twice a month		Compost manure Animal feeding Biogas Recyclable waste to Scrap Dealer or informal collector.	

**Table 2:** Present status of solid waste management of Butwal Municipality.

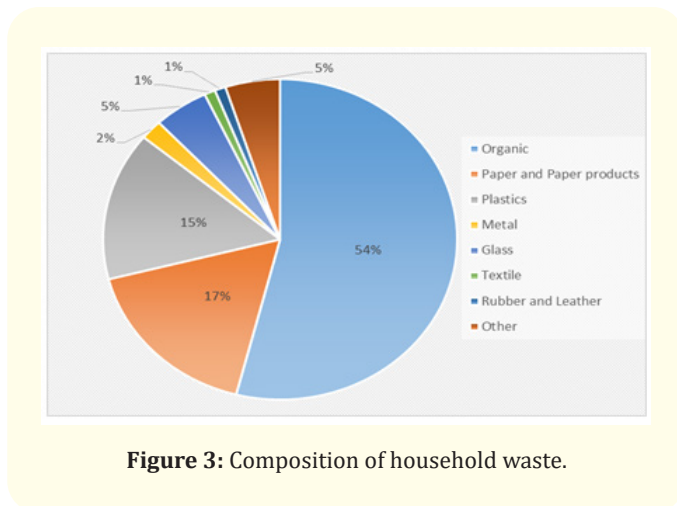
**Overall composition of MSW**



**Figure 2:** Overall composition of MSW.

Excluding organic waste other 40 - 46% of wastes are recyclable. Thus, the proper integrated waste management can significantly decrease the amount of total waste to be dumped/landfilled. This can lower the cost of waste collection and transportation, and also increase the lifespan of the dumping site.

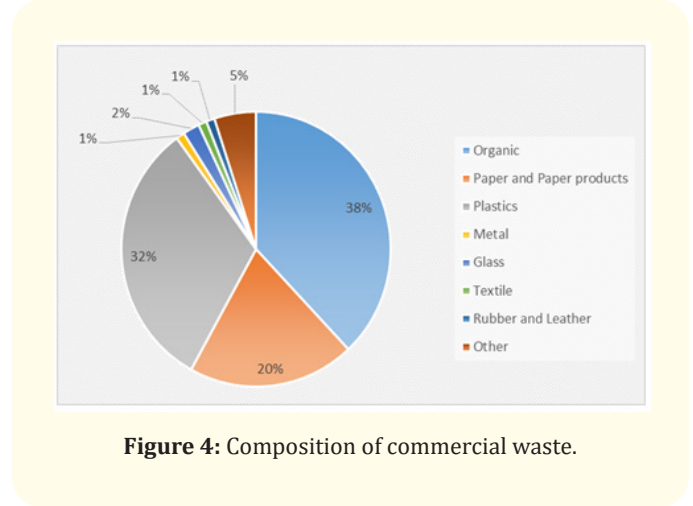
**Composition of household waste**



**Figure 3:** Composition of household waste.

The domestic waste comprises of 67% organic, 13% plastic, 2% glass, 9% paper and paper products, 2% metals, 1% rubber and leathers, 1% textile and 5% others. Rubber and leather waste was found in negligible amount.

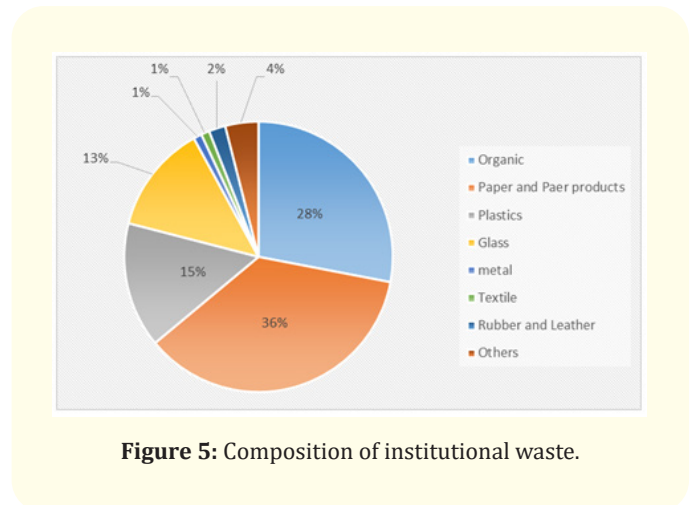
**Composition of commercial waste**



**Figure 4:** Composition of commercial waste.

Waste generated from commercial places like shops, hotels and restaurants varies according to their sizes and the flow of customers. Waste generated in vegetable and fruits shops are mostly organic whereas, in other shops like in stationery, fancy, grocery shops wastes are dominated by plastic, paper and paper products. The composition of commercial waste was made up of 38% organic waste, 32% plastics, 20% paper and paper products, 2% glass, 1% textile and 1% rubber and leather, 1% metal and 5% others.

**Composition of institutional waste**



**Figure 5:** Composition of institutional waste.

Organic and Paper waste contributes to the major part of commercial waste. School and office generate more paper waste. Most

of the plastic waste from school constitutes the wrappers of biscuit, noodles and other. Mud and dust also constitute the major weight of the waste generated from school. They are categorized under “other” waste.

Similar type of result was found in study done in Countries of medium low income in South East Asia shows the diversity composition of MSW where organic overburden dominates in most countries [9] and one can conclude that the biodegradable portion dominates the bulk of MSW. Generally, the biodegradable portion is mainly due to food and yard waste, typical of the developing countries whereas the developed regions have a higher paper and cardboard content [10].

### Conclusion

Currently Butwal Sub-Metropolitan city has so far done a remarkable job on solid waste management by effectively mobilizing local communities and initiating innovative programmes such as door-to-door waste collection, use of tractor trailers as bulk containers and waste transfer points, plastic recycling. The per capita waste generation rate of Butwal Sub-metropolitan city is found to be 244.33 g/day. The quantity of waste generation is found to be 47.56 tons/day and 17359.4 tons/year which include wastes from household, commercial and institutional sector. The overall composition of solid waste is made up of 54% organic, 17% paper and paper products, 15% plastic, 5% glass, 2% metal, 1% rubber and leather, 1% textiles and 5% others. After the study the composition of organic waste was found dominant among household, institutional and commercial areas. As the organic waste is dominant among household, institution and commercial areas it can be managed sustainably by composting at community and household level. The local staff seems to be committed to improving the waste management system and willing to learn new things. But they need additional resources to follow up on their programmes and improve the waste collection system. Butwal also needs support to materialize their plans for composting and landfilling facility.

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