
Municipal Solid Waste Generation Rate and Characterization in Tepi Town, Southwest Ethiopia

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Abstract: The study was focused on municipal solid waste generation rate and characterization in Tepi town southwest Ethiopia. In this study random sampling was used in all the three kebeles. 100 households from each kebele were taken. All the samples were collected characterized and weighted. The municipal solid wastes were classified into biodegradable recyclable and non-recyclable. The study was categorized into four seasons. In the summer season 116213 kg solid waste was generated. From this 111882 kg biodegradable 979 kg recyclable and 3352 kg non-recyclable. In the spring season 118881 kg solid waste was generated. Out of this 115240 kg biodegradable 1161 kg recyclable and 2480 kg non-recyclable. In the winter season 118874 kg solid waste was generated. From this 115234 kg biodegradable 1175 kg recyclable and 2465 kg non-recyclable. In the outman season 117265 kg solid waste was generated. Out of this 112872 kg biodegradable 1017 kg recyclable and 3376 kg non-recyclable. The municipal solid waste of Tepi town composed of 455228 kg (96.6%) biodegradable 4337 kg (0.93%) recyclable and 11673 kg (2.49%) non-recyclable. On average from June/2015 – May/2016 9817.35 kg of solid waste was generated per week from Tepi town. From this 9483.92 kg biodegradable 90.25 kg recyclable and 243.19 kg non-recyclable.

Keywords: Municipal Solid Waste, Biodegradable, Recyclable, Non-Recyclable, Generation Rate

1. Introduction

All creatures including human being constantly make decisions about what to use and what to throw away therefore waste is a consequence of everyday life of all creatures [1]. Municipal solid waste (MSW) is a term usually applied to a heterogeneous collection of wastes produced in urban areas the nature of which varies from region to region. The characteristics and quantity of the solid waste generated in a region is not only a function of the living standard and lifestyle of the regions inhabitants but also of the abundance and type of the regions natural resources. Solid waste is defined as the unwanted remains residues and discarded materials or byproducts which are no longer required for the initial use [2, 3].

Over the last three decades there has been increasing global concern over the public health impacts attributed to environmental pollution. World Health Organization estimates that about a quarter of the diseases facing mankind today occur due to prolonged exposure to environmental pollution. Most of these environment related diseases are

however not easily detected and may be acquired during childhood and manifested later in adulthood. Improper MSW disposal and management causes all types of pollution air and water [4-6].

In developing countries where waste management systems are insufficient and inefficient coupled with the expanding urban population the problem of refuse disposal is reaching proportions that are causes for concern. Also the operation and management of municipal solid waste collection services are rudimentary. This is reflected in the lack of information about the quantities and types of municipal solid waste [7, 8]. For planned solid waste management it is important to know the waste generation rate and it is also important to characterize these solid wastes in different components.

2. Materials and Methods

2.1. Study Area

The study was conducted in Tepi town. Tepi is located in Sheka Zone Southern Nations Nationalities and Peoples

Region (SNNPR). Tepi is located at about 610 kilometers south west of Addis Ababa (capital city of Ethiopia). Tepi is located at 7°12'N latitude and 35°27'E longitude with 1500 meters above sea level elevation. The average temperature and average rainfall of Tepi is 21°C 1800 mm per annum respectively [9].

2.2. Sampling and Data Collection Methods

According to the statistical abstract of the Federal Democratic Republic of Ethiopia Central statistical Agency (FDRECSA) 2013 Tepi town has the population of 36128. The population of the town expected to grow at the rate of 3.1% per annum. There are three kebeles in Tepi (Selam, Hibret and Andinet). According to the administration of the town there are 3289 households in Hibret kebele 4341 households in Selam kebele and 3561 households in Andinet kebele [10].

In this study for the purpose of sampling households were grouped according to the town administration. Households were randomly selected from the three kebeles. In this study sample size was determined according to Glenn D. Israel (2013). 100 households from each kebele were taken as a sample [11].

The assessment was conducted through a household survey to determine the amount of waste being generated and its composition in the town. Data collection was on weight

and type of solid waste generated by household in a week and constituents of solid waste were taken. All the data were recorded analyzed interpreted and presented in statistical forms.

2.3. Methods of Solid Waste Characterization

House to house collection mixing the collected samples characterization and weight analysis method was used to determine the generation rate of solid waste in the town. The municipal solid wastes were characterized as biodegradable recyclable and non-recyclable. A labor intensive manual process of sorting classifying and weighing all items in each sampling unit and a detailed recording of the data was implemented. The total wet weight of each waste category was determined and expressed in kilogram and the percentage of each constituent was calculated. The whole process of sorting and weighing was carried out one times a week categorized in four seasons for one year.

3. Results and Discussion

The municipal solid waste collected in the study area was determined in terms of biodegradable recyclable and non-recyclable components [11]. As it is shown in the tables below the study was categorized in to four seasons.

Table 1. Weekly municipal solid waste generation per kebele of season 1 (summer).

No	Time	Biodegradable (Kg)			Recyclable (Kg)			Non-recyclable (Kg)			
		Andinet	Selam	Hibret	Andinet	Selam	Hibret	Andinet	Selam	Hibret	
1	June/2015	Week 1	3026	3118	3242	23	29	21	80	96	97
		Week 2	3133	3643	3341	30	37	17	93	93	91
		Week 3	3308	2980	3152	26	32	19	79	99	95
		Week 4	2912	3097	3098	20	35	20	57	97	99
2	July/2015	Week 1	3096	3086	3079	22	31	25	96	96	96
		Week 2	2982	3182	3102	25	29	23	96	99	105
		Week 3	3112	3212	3012	29	33	30	80	90	98
		Week 4	2997	3097	2990	31	30	28	90	97	96
3	August/2015	Week 1	2950	3050	3085	27	32	26	82	92	110
		Week 2	3201	3112	3001	32	30	27	95	95	107
		Week 3	3105	2985	3108	26	29	29	76	96	102
		Week 4	3095	3159	3034	21	27	28	87	97	98

In summer season 38240 kg 39242 kg and 38731 kg municipal solid waste was generated from Andinet, Selam and Hibret kebeles respectively. The weight of municipal solid waste materials between the kebeles is not significantly different (at $p = 0.05$). In this season 116213 kg municipal solid waste was generated from Tepi town out of this 111882 kg was biodegradable 979 kg was recyclable and 3352 were non-recyclable the weight of biodegradable > non-recyclable > recyclable solid wastes with a significant difference (at $p = 0.05$).

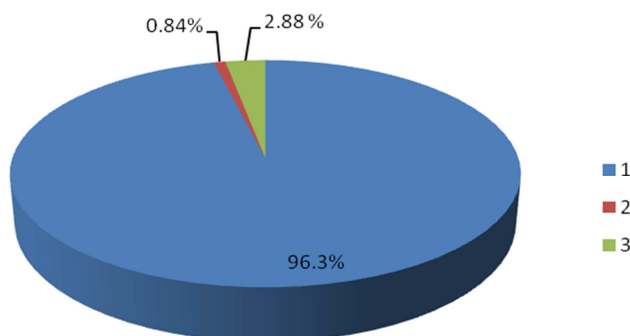


Figure 1. % composition of municipal solid waste in season 1.

As it is shown from figure 4 in summer season from the

total municipal solid waste 96.3% was biodegradable 0.84% was recyclable and 2.88% was non-recyclable.

Table 2. Weekly municipal solid waste generation per kebele of season 2 (spring).

No	Time		Biodegradable (Kg)			Recyclable (Kg)			Non-recyclable (Kg)		
			Andinet	Selam	Hibret	Andinet	Selam	Hibret	Andinet	Selam	Hibret
1	September/015	Week 1	3613	3400	2995	34	33	25	74	59	80
		Week 2	3002	3520	3065	25	52	27	46	60	106
		Week 3	3132	3230	2996	28	49	23	56	56	100
		Week 4	2995	3067	3097	30	37	26	65	52	109
2	October/2015	Week 1	3523	3309	3095	30	33	26	70	56	98
		Week 2	3032	3429	3764	27	42	26	49	50	96
		Week 3	3231	3310	2987	28	45	29	57	53	90
		Week 4	3095	3095	3187	31	39	24	55	52	109
3	November/2015	Week 1	3410	3408	3005	33	37	25	54	51	90
		Week 2	3091	3420	3068	29	42	22	46	50	96
		Week 3	3052	3320	2959	28	48	24	50	54	93
		Week 4	3097	3134	3107	31	47	26	45	52	101

In spring season 39294 kg 40791 kg and 38796 kg municipal solid wastes were generated from Andinet, Selam and Hibret kebeles respectively the weight of the municipal solid waste materials between the kebeles was not significantly different (at $p = 0.05$). In this season 118881 kg municipal solid waste was generated from this 115240 kg was biodegradable 1161 kg was recyclable and 2480 kg was non-recyclable the weight of biodegradable > non-recyclable > recyclable solid wastes with a significant difference (at $p = 0.05$).

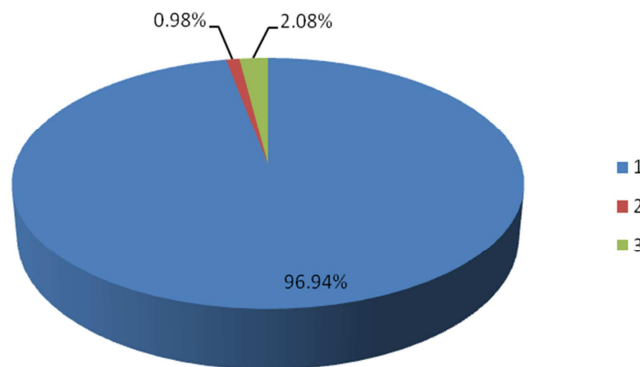


Figure 2. % composition of municipal solid waste in season 2.

As it was shown from figure 5 in spring season from the total municipal solid waste 96.94% was biodegradable 0.98% was recyclable and 2.08% was non-recyclable.

Table 3. Weekly municipal solid waste generation per kebele of season 3 (winter).

No	Time		Biodegradable (Kg)			Recyclable (Kg)			Non-recyclable (Kg)		
			Andinet	Selam	Hibret	Andinet	Selam	Hibret	Andinet	Selam	Hibret
1	December/2015	Week 1	3014	3296	3098	38	33	25	64	60	90
		Week 2	3402	3420	3085	27	42	29	47	53	101
		Week 3	3132	3310	3006	28	49	25	59	57	103
		Week 4	3095	3207	3090	32	47	29	64	50	107
2	January/2016	Week 1	3423	3314	3005	30	39	26	60	57	99
		Week 2	3133	3408	3562	25	42	25	50	50	97
		Week 3	3131	3210	3187	27	40	28	58	55	95
		Week 4	3195	3185	3180	31	39	23	55	51	99
3	February/2016	Week 1	3325	3400	3055	32	38	25	50	50	97
		Week 2	3181	3390	3083	29	40	24	46	50	96
		Week 3	3002	3360	2975	29	46	29	49	53	98
		Week 4	3070	3204	3100	30	45	29	46	50	99

In winter season 39109 kg 40840 kg and 38924 kg municipal solid waste was generated from Andinet, Selam and Hibret kebeles respectively the weight of municipal solid waste materials between the kebeles is not significantly different (at $p = 0.05$). In this season 118874 kg municipal solid waste was generated from this 115234 kg was biodegradable 1175 kg was

recyclable and 2465 kg was non-recyclable the weight of biodegradable > non-recyclable > recyclable solid wastes with a significant difference (at p = 0.05)

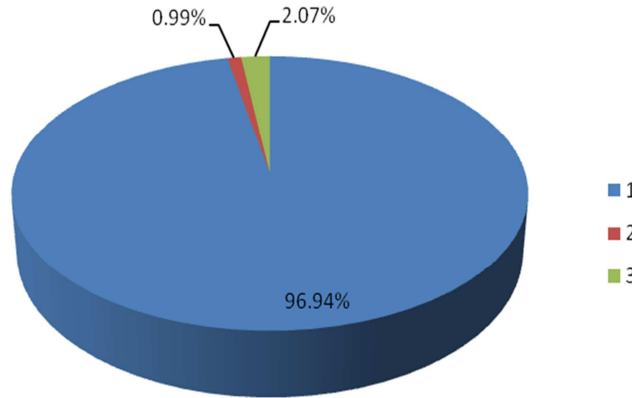


Figure 3. % composition of municipal solid wastes in season 3.

As it was shown from figure 6 in winter season from the total municipal solid waste 96.94% was biodegradable 0.99% was recyclable and 2.07% was non-recyclable.

Table 4. Weekly municipal solid waste generation per kebele of season 4 (outman).

No	Time		Biodegradable (Kg)			Recyclable (Kg)			Non-recyclable (Kg)		
			Andinet	Selam	Hibret	Andinet	Selam	Hibret	Andinet	Selam	Hibret
1	March/2016	Week 1	3126	3238	3207	26	30	22	85	99	98
		Week 2	3033	3473	3291	29	36	19	91	95	96
		Week 3	3098	2996	3108	28	31	21	89	97	98
		Week 4	3112	3157	3188	25	36	21	67	98	97
2	April/2016	Week 1	3196	3206	3099	24	32	28	90	99	102
		Week 2	3182	3132	3156	28	28	27	93	96	96
		Week 3	3112	3142	3102	30	32	33	82	91	99
		Week 4	3097	3089	2986	31	31	27	91	96	97
3	May/2016	Week 1	3150	3158	3095	29	35	25	83	95	107
		Week 2	3101	3032	3092	30	29	26	85	94	105
		Week 3	3112	3185	3110	27	29	29	79	99	100
		Week 4	3135	3169	3007	23	31	29	88	98	101

In outman season 38815 kg 39514 kg and 38944 kg municipal solid waste was generated from Andinet, Selam and Hibret kebeles respectively the weight of the solid waste materials between the kebeles was not significantly different (at p = 0.05). In this season 117265 kg municipal solid waste was generated out of this 112872 kg was biodegradable 1017 kg was recyclable and 3376 kg was non-recyclable the weight of biodegradable > non-recyclable > recyclable solid wastes with a significant difference (at p = 0.05).

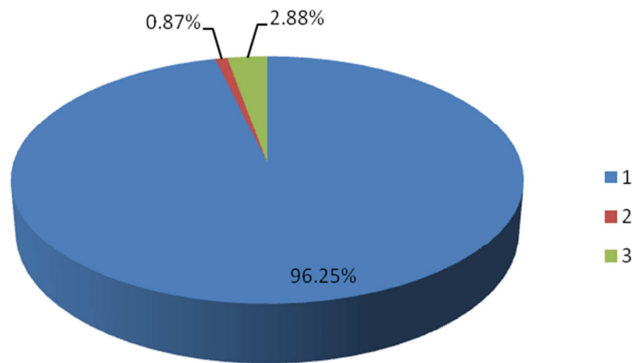


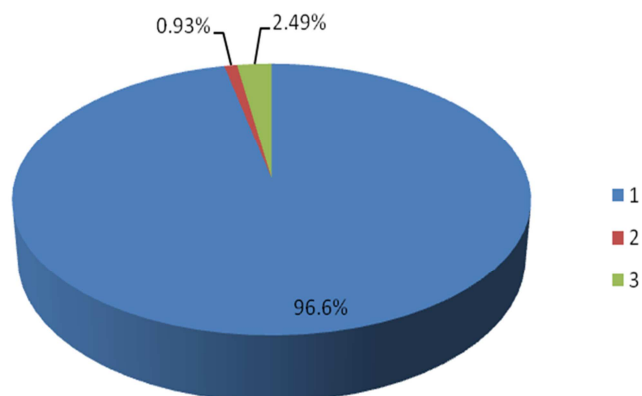
Figure 4. % composition of solid wastes in season 4.

As it was shown from figure 7 in outman season from the total municipal solid waste 96.25% was biodegradable 0.87% was recyclable and 2.88% was non-recyclable.

Table 5. Municipal solid waste generation per month.

No	Time	Biodegradable (Kg)	Recyclable (Kg)	Non-recyclable (Kg)	Total	
1	Summer/2015	June	38050	309	1076	116213
		July	36947	336	1139	
		August	36885	334	1137	
		September	38112	389	863	
2	Spring/ 2015	October	39057	380	835	118881
		November	38071	392	782	
		December	38155	404	855	
3	Winter/ 2015-2016	January	38933	375	826	118879
		February	38145	396	784	
		March	38027	324	1110	
4	Outman/ 2016	April	37499	351	1132	117265
		May	37346	342	1134	
Total		455228	4337	11673	471238	

As it is shown from the above table 471238 kg of municipal solid waste was generated from Tepi town in one year (June 2015 – May 2016) which was 455228 kg (96.6%) biodegradable 4337 kg (0.93%) recyclable and 11673 kg (2.49%) non-recyclable.

**Figure 5.** % composition of Tepi town municipal solid waste.

According to this study weight of biodegradable > non-recyclable > recyclable municipal solid wastes with a significant difference (at $p = 0.05$). The weight of municipal solid waste was not significantly different in between the seasons (at $p = 0.05$). In average from June/ 2015 – May/ 2016 9817.35 kg of municipal solid waste was generated per a week from Tepi town accordingly 1402.48 kg of solid waste was generated per day from this town. This study is in line with [12, 13] stating that largest stream of municipal SW in developing countries is from food wastes. Most of the developing countries have high percentage (40-70%) of organic matter with high moisture content. Waste composition generated in studied countries was normally dominated by biodegradable waste [14, 15].

4. Conclusion

The study was conducted for one year categorized in to four seasons. Accordingly in the summer season 116213 kg municipal solid waste was generated which contains 111882 kg biodegradable 979 kg recyclable and 3352 kg non-

recyclable. In the spring season 118881 kg municipal solid waste was generated that contains 115240 kg biodegradable 1161 kg recyclable and 2480 kg non-recyclable. In the winter season 118874 kg municipal solid waste was generated contains 115234 kg biodegradable 1175 kg recyclable and 2465 kg non-recyclable. In the outman season 117265 kg solid waste was generated that contains 112872 kg biodegradable 1017 kg recyclable and 3376 kg non-recyclable. The municipal solid waste generated from Tepi town was composed of 455228 kg (96.6%) biodegradable 4337 kg (0.93%) recyclable and 11673 kg (2.49%) non-recyclable. Weight of biodegradable > non-recyclable > recyclable of municipal solid waste with a significant difference (at $p = 0.05$). The weight of municipal solid waste was not significantly difference in between the seasons and in between kebeles (at $p = 0.05$).

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