Evaluation of waste management and recycling systems in Addis- Adama economic corridor : Addis Ababa city

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Outlines

- Introduction
- Project Description
- Approaches and Methodology
- Waste generation- composition
- Solid waste collection and transportation system
- Waste recycling
- Waste disposal

Introduction

- Urban areas are particularly grappling with the issue of waste management.
- Urban waste management is a major environmental issue.
- Developing nations lack organized waste collection and recycling infrastructure.
- Sub-Saharan Africa faces significant population growth, leading to increased solid waste.
- Between 2010 and 2018, only 52% of municipal solid waste was collected, compared to 81% global

Waste Management in Sub-Saharan Africa

- Formally collected waste often ends up in landfills or burned.
- Only 7% gets recycled or reused, often handled by private businesses and the informal sector.
- Municipal solid waste management is a significant part of communal budgets, but recycling is often overlooked.
- High waste collection rates exist between cities and rural areas.
- Sub-Saharan Africa's waste mainly consists of organic and inert materials, increasing with economic wealth and consumption behavior.

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- The amount of municipal solid waste is expected to be 1.27 times higher in 2025 in comparison to 2012, while the collection rate is supposed to grow to 69% by 2025 .
- Ethiopia is facing rapid urbanization leading to overcrowding and development of informal settlements with poor waste management practices.
- Solid waste management is becoming a major public health and environmental concern in urban areas of Ethiopia.
- In 2018 Africa's first waste-to energy plant, was inaugurated at the Koshe landfill site, on the outskirts of Addis Ababa, Ethiopia.

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- With the construction of this incineration plant in Addis Ababa, the first approaches to a more differentiated circular economy have increasingly moved out of focus.
- However, the gradual introduction of a **circular economy is becoming more and more urgent**, especially for developing countries.
- In this context, the international collaboration research was proposed **"Sustainable Cities and Circular Economy in Sub-Sahara Africa 2024-SuCCESS24"**
- It has focused on **development of an SDG-based indicator set for Solid Waste Management in Sub-Saharan Africa**

Project area

For this particular task in Ethiopia, Addis Ababa – Adama economic corridor was selected.

The corridor consists of **logistic hubs** between Addis and Adama (in particular the so called "**Dry Port**" in **Mojo near Adama**), which are connected by two newly constructed arteries, the **Addis-Adama Express Highway** and the **railway line**, in addition to the old highway.


A2
YEKA
የካ ክፍለ ከተማ
Addis Abeba
አዲስ አበባ
Chefe Donsa
ጨፌ ዶንሳ
A1
B51
Boneya
Dukem
Ejere
Debre Zeyit
ቢሾፍቱ
A1
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Gedo
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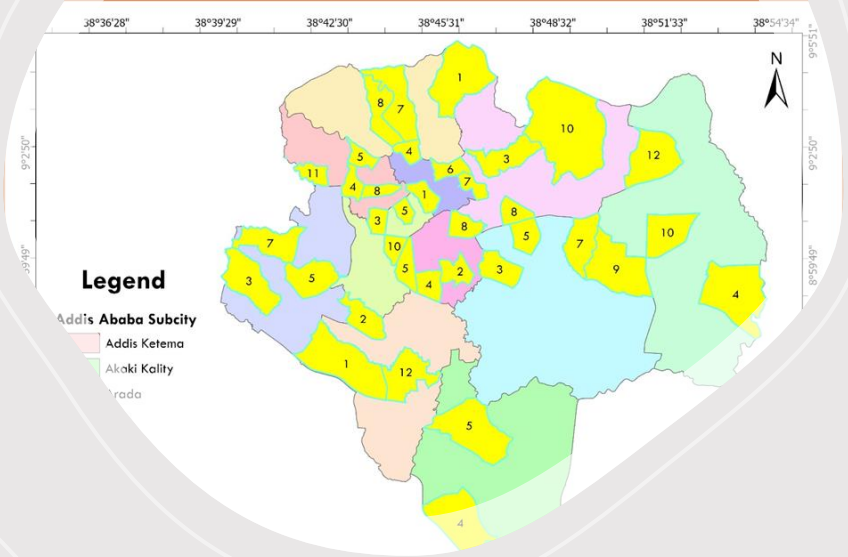
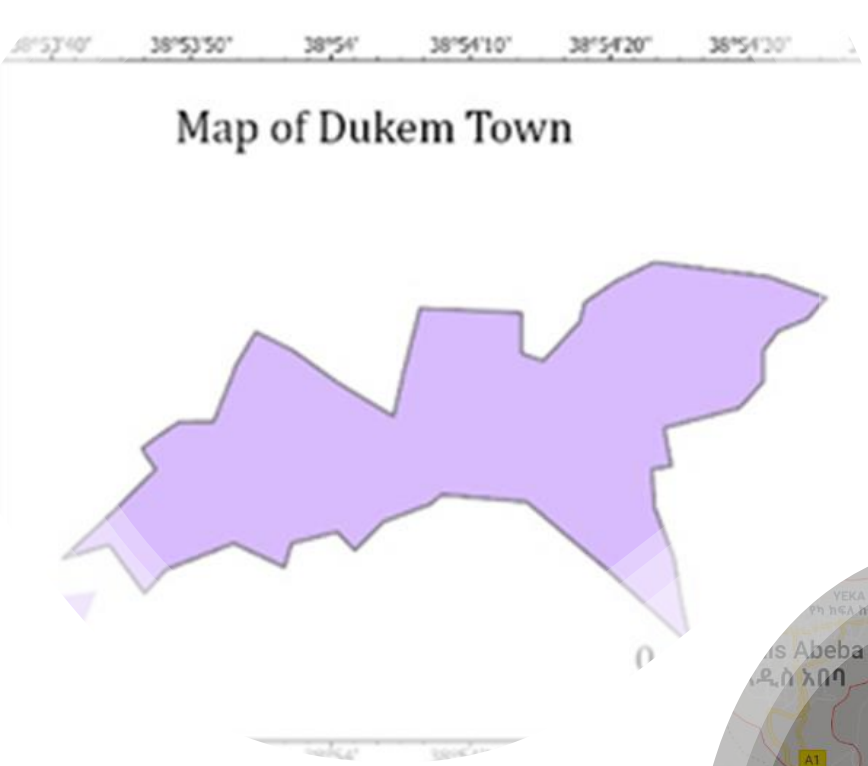
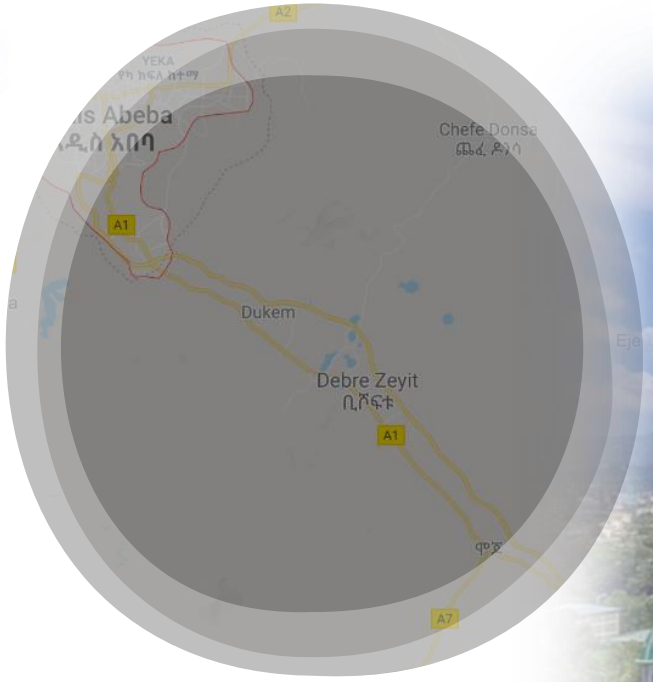
A7
B51

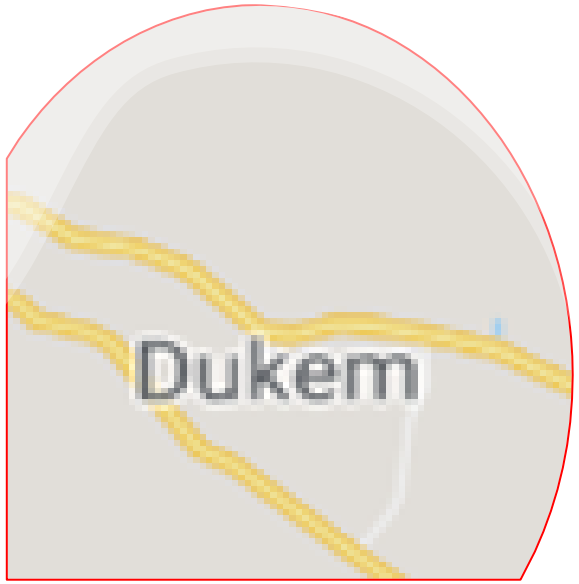


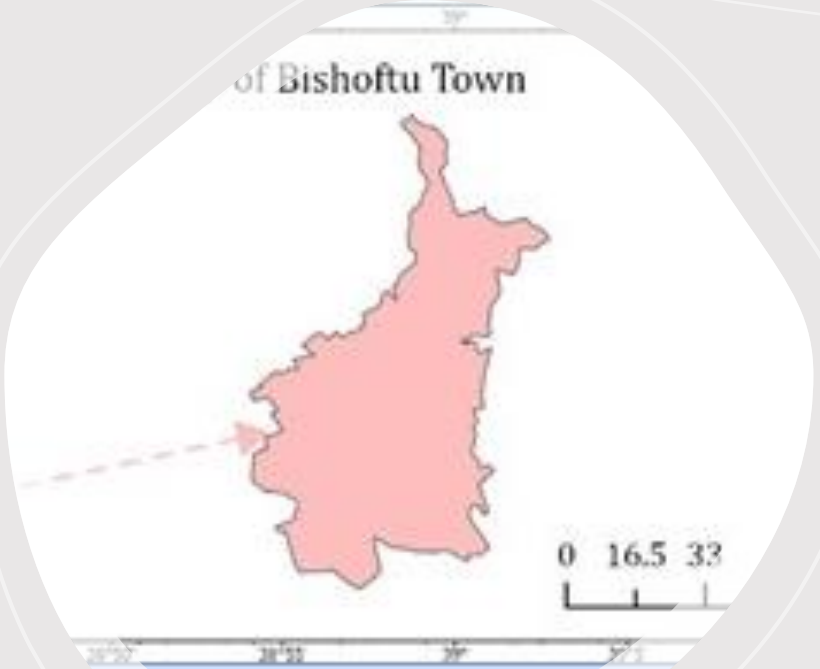
- ✓ Capital city
- ✓ 52,700 hectares and divided into eleven sub cities
- ✓ Estimated population of 3.94 million (703,571 households) as projected by the Central Statistics Agency (CSA) in 2013 and 5.46 million (975,000 households) as projected by United Nations World Population Prospects (2023)



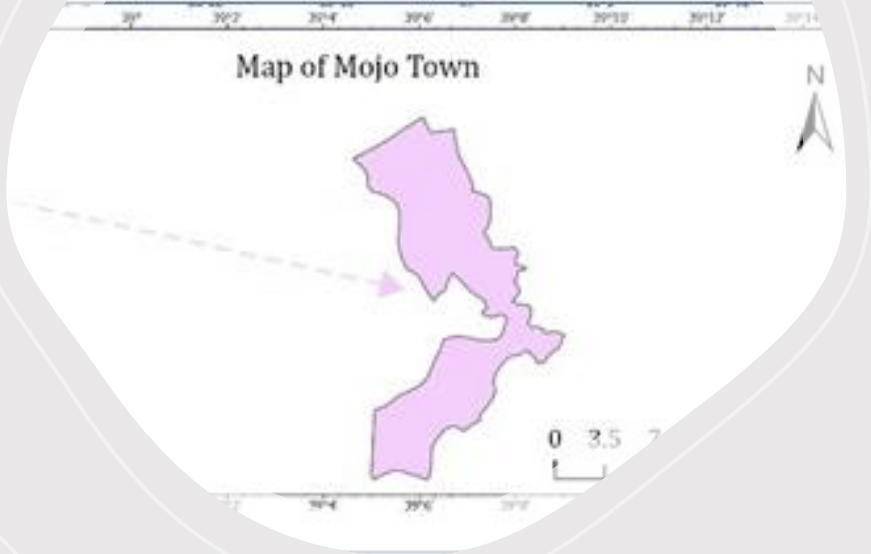
- ✓ 37 kilometers from Addis Ababa
- ✓ 9630.6 hectares and is divided into four kebeles
- ✓ The estimated population of the town is 85,839 with 23,884 number of households



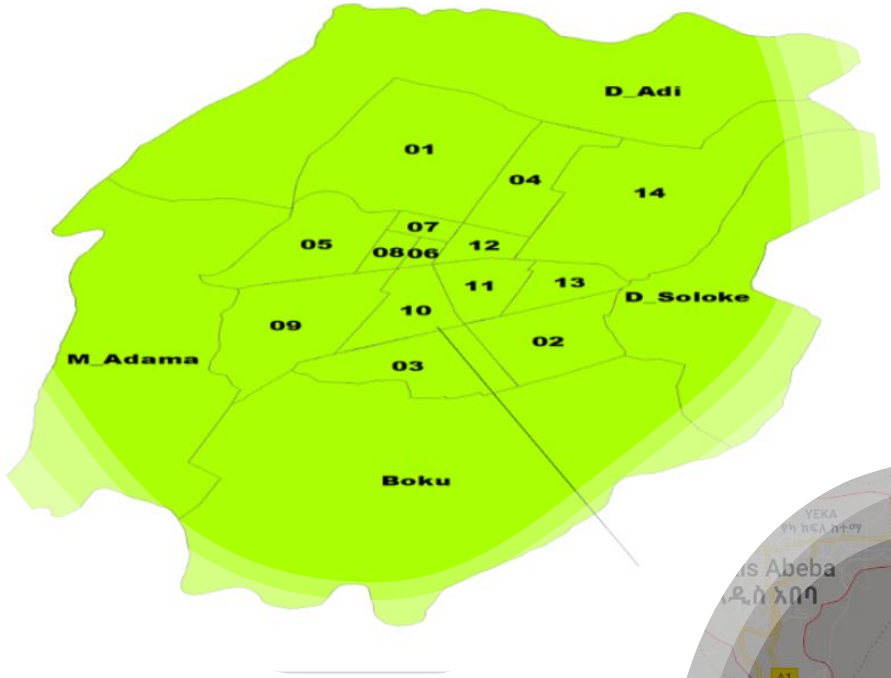


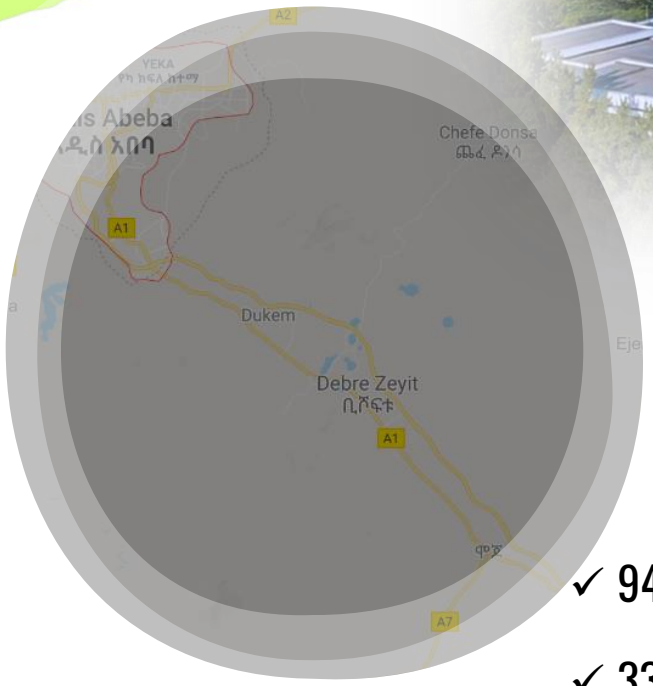


- ✓ 47 kilometers from Addis Ababa
- ✓ 20,574 hectares and is divided into nine urban Kebeles and five rural Kebeles
- ✓ The estimated population 225,000 with number of households 56,250



- ✓ 70 kilometers from Addis Ababa
- ✓ 4532 hectares and is divided into two kebeles
- ✓ The estimated population 93,264, with number of households 10,552





- ✓ 94 kilometers from Addis Ababa
- ✓ 33,000 hectares and is divided into 6 woreda, 14 urban and four rural kebeles
- ✓ The estimated population 857,148 with number of households 89,127

Approaches and Methodology

Household

Low Income

Middle Income

High Income

Commercial waste

- Cafeteria
- Bar & rest.
- Hotels
- Ret. Shops
- F&V

- Supermarkets
- Pub., print., & rec. media
- Furni. Mak.
- Garage
- Others…

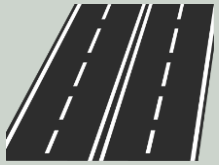
Institutional

- Educational institution
- Healthcare institution
- Governmental and no-gov.tal offices
- Religious center

Approaches and Methodology

Road

Ring Road

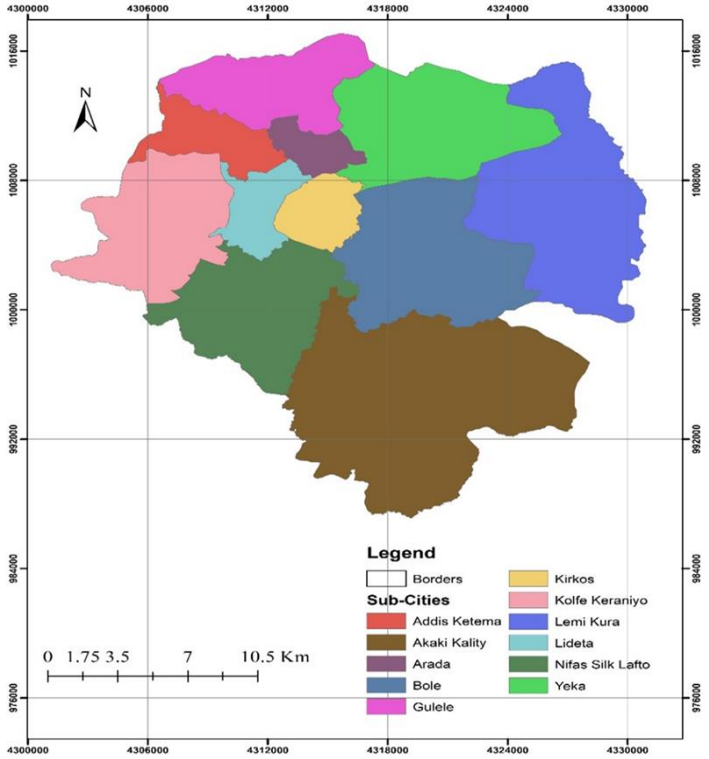


Arterial Street

Sub Arterial Street

Connecting Street

Sampling Sites



11 sub-cities

3 Woreda

Sampling size

Sampling categories	Wet Season		Dry Season		Total study sample
	Total Sample Size	Sample size for each woreda	Sampling Size	Sample size for each woreda	
Household	440 households (15% high income, 35% low Income, 50% low income)	13 household	858 households (15% high income, 35% low Income, 50% low income	26 household	1,298
Commercial	204	6/7	214	6/7	416
Institutional	100 (21 EC, 10 HI, 7 RI, and 62 GI&NGI)	9/11	120	10/11/12	220
Street	100 m of high, medium and lower traffic	7 HT, 8 MT and 7 HT	100 m of high, medium and lower traffic	7 HT, 8 MT and 7 HT	

Status: waste generation- household

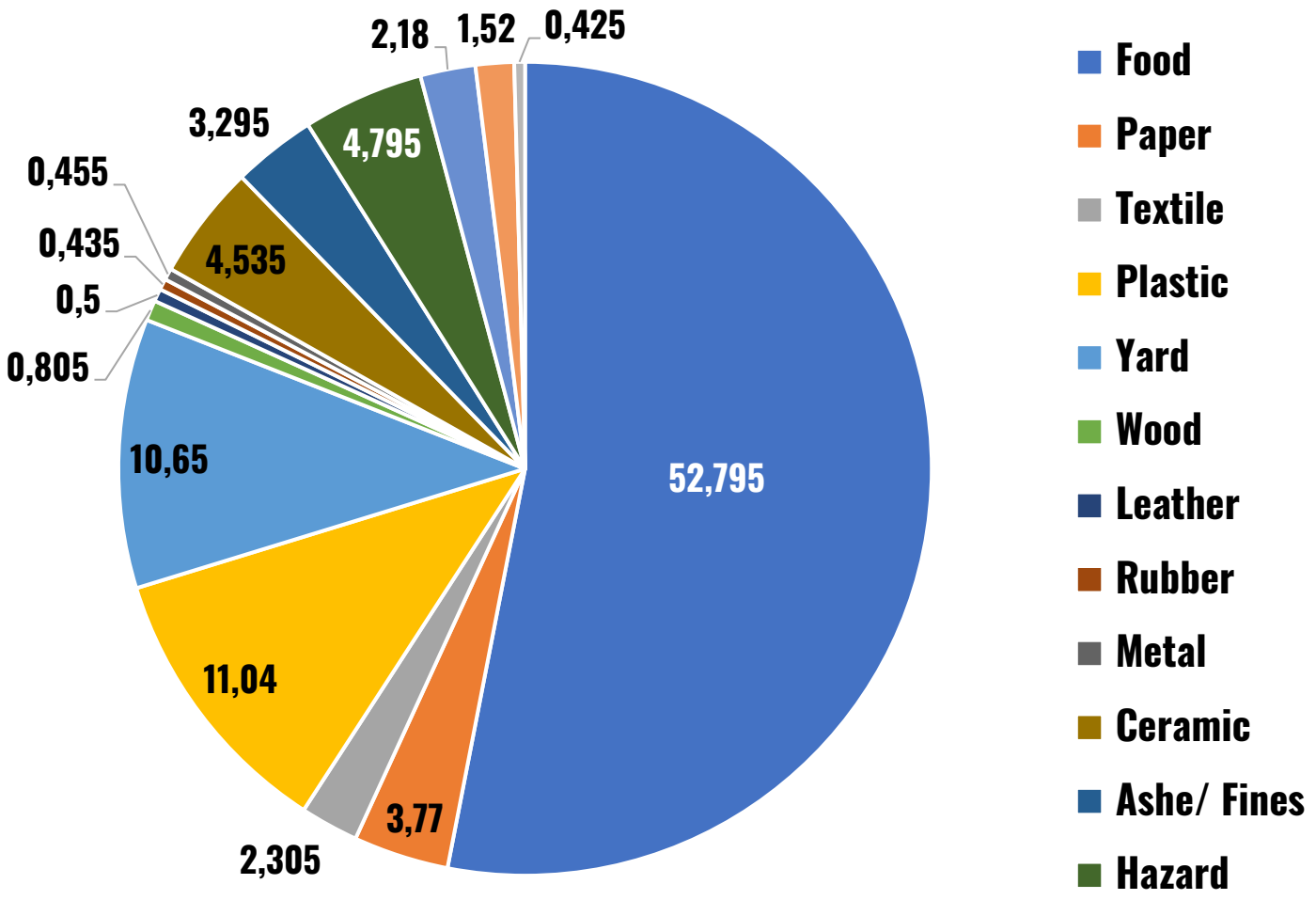
Sub City	Wet Season				Dry season				Annual Average SWG/Sub-city			
	HI	MI	LI	Mean SWG	HI	MI	LI	Mean SWG	HI	MI	LI	Mean SWG
Addis Ketema	0.464	0.352	0.354	0.39	0.41	0.33	0.2	0.41	0.43	0.34	0.25	0.40
Akaki Kality	0.177	0.531	0.248	0.32	0.34	0.3	0.4	0.34	0.29	0.38	0.35	0.33
Arada	0.401	0.483	0.236	0.37	0.61	0.31	0.28	0.34	0.54	0.37	0.26	0.35
Bole	0.423	0.42	0.197	0.35	0.5	0.4	0.28	0.35	0.47	0.41	0.25	0.35
Gulelle	0.658	0.298	0.45	0.47	0.54	0.38	0.27	0.35	0.58	0.35	0.33	0.39
Kirkos	0.799	0.413	0.387	0.53	0.51	0.43	0.32	0.39	0.61	0.42	0.34	0.44
Kolfe Keranyo	0.375	0.486	0.332	0.4	0.37	0.48	0.33	0.39	0.37	0.48	0.33	0.39
Lemi Kura	0.427	0.326	0.246	0.33	0.32	0.25	0.15	0.21	0.36	0.27	0.18	0.25
Lideta	0.292	0.241	0.208	0.25	0.4	0.27	0.17	0.24	0.36	0.26	0.18	0.24
Nifas Silk Lafto	0.486	0.347	0.44	0.42	0.64	0.42	0.34	0.41	0.59	0.4	0.38	0.41
Yeka	0.244	0.256	0.247	0.25	0.42	0.42	0.24	0.33	0.36	0.37	0.24	0.30

The wet season average per capita household solid waste generation rate was found about 0.37 kg/capita/day

The dry season mean average per capita household solid waste generation rate was found about 0.33 kg/capita/day

The daily mean average per capita household solid waste generation rate was 0.34 kg/capita/day

Status: waste composition-household



The average percentage weight composition household

Status: waste generation- Commercial sector

Business categories	N	Waste season (tons/day)		Dry season (tons/day)		Average (tons/day)	
		Using mean	Using median	Using mean	Using median	Using mean	Using median
Food and beverage service							
Bar and restaurants	13,296	130.70	86.69	88.68	66.48	109.43	73.13
Cafeterias	13,905	71.05	43.52	81.90	45.19	76.76	44.22
Fruit and vegetable vendors	2,259	30.79	22.39	30.18	22.03	30.47	22.03
Total	29,460	232.54	152.60	200.76	133.70	216.66	139.38
Hotel service							
Five-star hotels	8	6.46	6.55	7.02	7.08	6.74	7.00
Four-star hotels	21	3.49	3.76	3.79	3.71	3.64	3.73
Three-star hotels	34	1.41	1.09	0.96	0.87	1.18	0.87
One-star hotels	75	2.04	2.02	1.36	1.29	1.70	1.64
Uncategorized hotels	1,691	18.18	16.40	14.86	11.48	16.52	14.20
Pension and guesthouses	1,274	7.91	5.30	4.29	2.33	5.94	4.12
Total	3,103	39.49	35.12	32.28	26.76	35.72	31.56
Wholesale and retail trade service							
Household goods	107,380	196.51	64.43	158.92	65.50	178.25	64.43
Boutiques	36,897	50.18	19.56	40.96	25.83	45.38	21.77
Supermarkets	3,341	3.81	1.80	7.78	2.67	6.18	2.44
Beauty salons	10,114	12.34	5.87	9.61	4.65	10.82	4.96
Electronics	9,215	3.13	2.30	3.59	3.69	3.50	3.59
Pharmaceuticals	1,076	0.29	0.22	0.63	0.63	0.52	0.36
Machinery and equipment	10,598	5.62	5.09	18.23	5.62	13.99	5.09
Total	178,621	271.88	99.27	239.72	108.59	258.64	102.64

Status: waste generation- Commercial sector

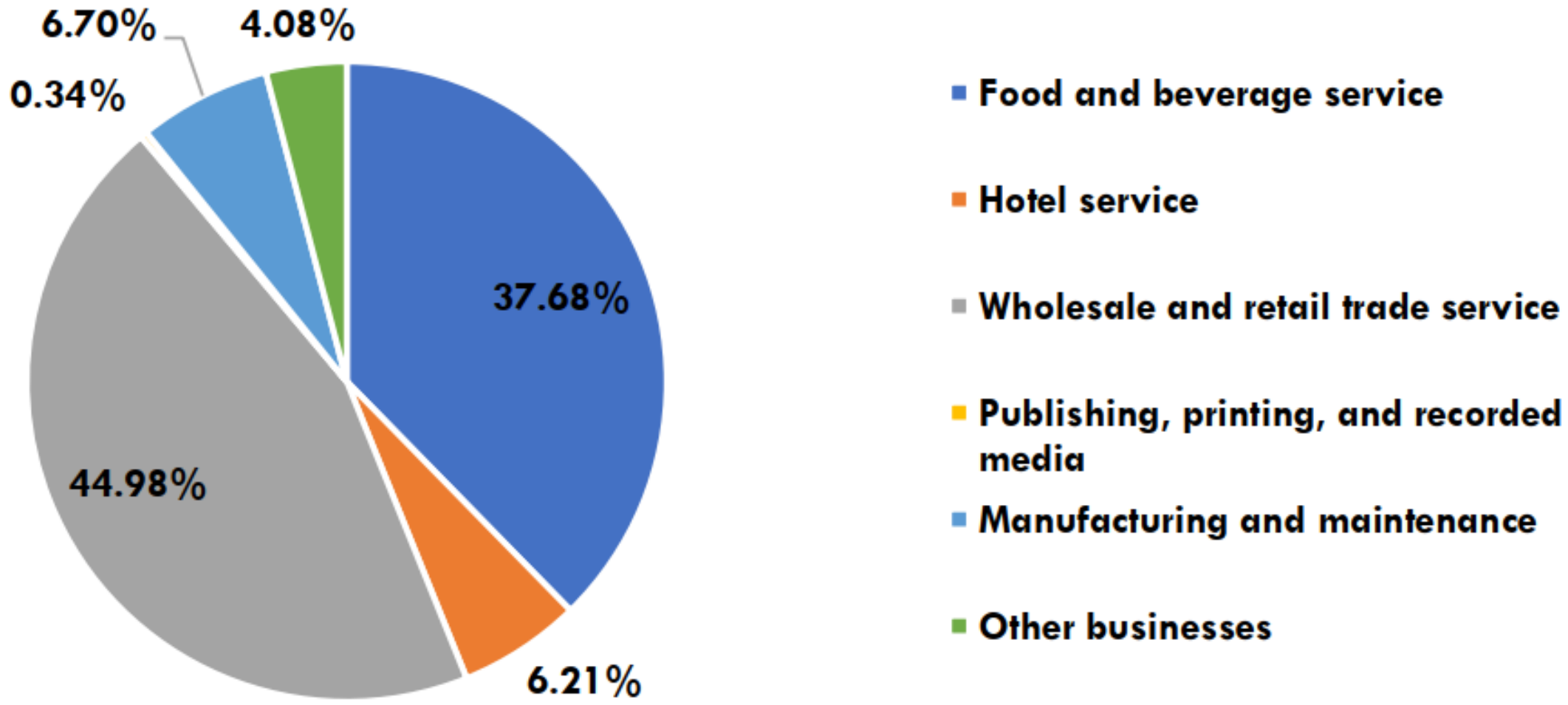
Business categories	N	Waste season (tons/day)		Dry season (tons/day)		Average (tons/day)	
		Using mean	Using median	Using mean	Using median	Using mean	Using median
Publishing, printing, and recorded media							
Internet, copy, and printing	5,382	1.35	1.24	1.99	1.18	1.67	1.24
Photography	315	0.12	0.17	0.13	0.06	0.12	0.06
Audio and visual arts	186	0.17	0.17	0.16	0.16	0.16	0.16
Total	5,883	1.64	1.58	2.28	1.40	1.95	1.46
Manufacturing and maintenance							
Furniture-makings	3,552	8.60	9.77	11.62	12.79	10.09	10.51
Garages	8,469	22.36	16.43	32.10	19.99	28.46	19.06
Total	12,021	30.96	26.20	43.72	32.78	38.55	29.57
Other businesses							
Grain mills	1,890	1.83	0.95	4.59	2.55	3.21	1.64
Tailor services	7,677	16.89	15.20	22.57	23.88	18.81	18.12
Sport & recreational center	3,725	2.53	0.00	0.41	0.00	1.45	0.00
Total	13,292	21.25	16.15	27.57	26.43	23.47	19.76

The total dry season waste generation amount of all commercial establishments in was estimated to be 546.3 tons/day

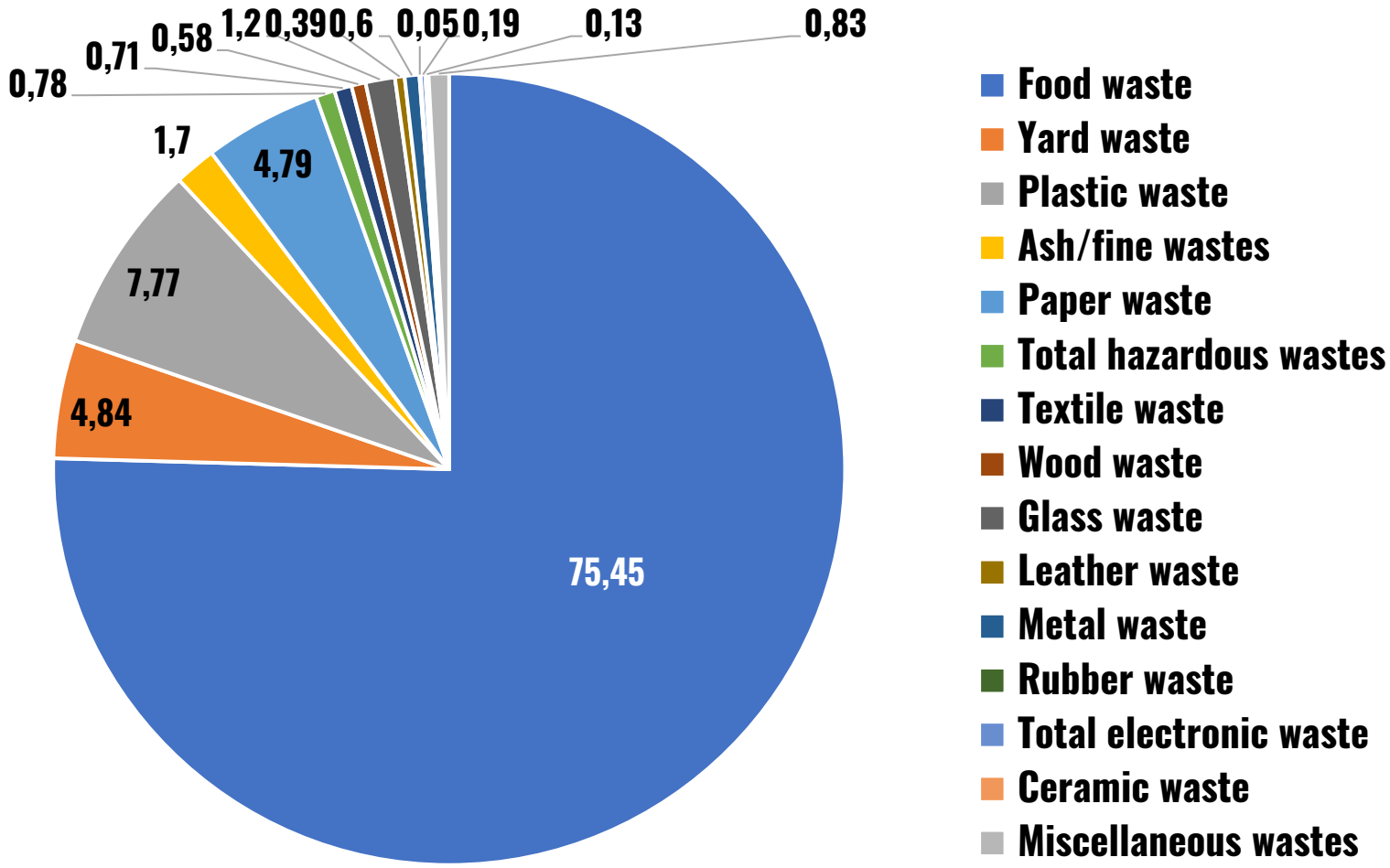
The total wet season waste generation amount of all commercial establishments was estimated to be 597.8 tons/day

The total average waste generation amount of all commercial establishments was estimated to be 575.0 tons/day

Contribution of business categories for commercial solid waste generation



Status: waste composition-Commercial sector



The average percentage weight composition of all commercial establishments including star-ranked hotels

Status: waste generation- Institutional

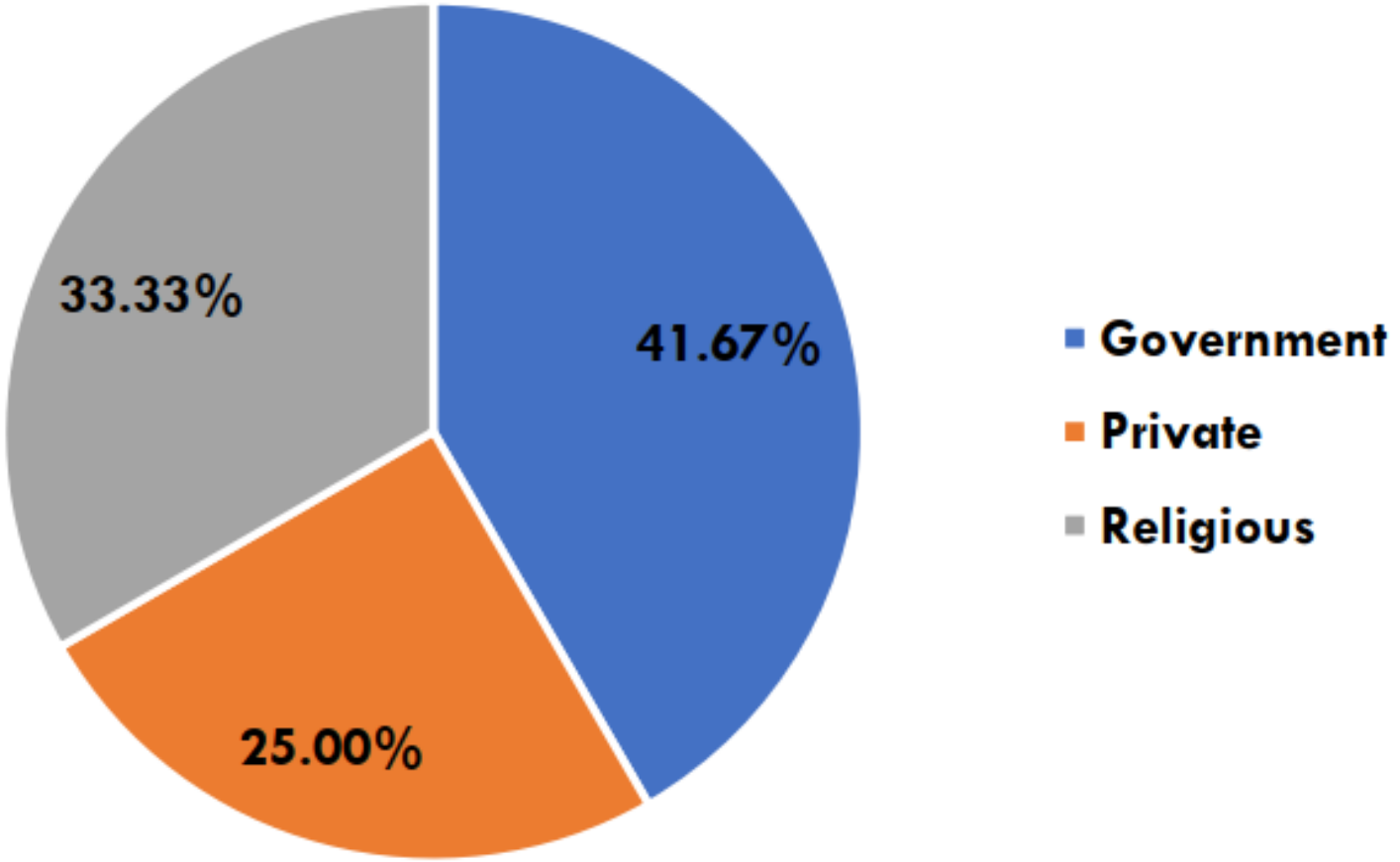
Types of institutions	Categories of institution	Dry season **TWG in Addis Ababa (kg/day)**	Wet season **TWG in Addis Ababa (kg/day)**	Average **TWG in Addis Ababa (kg/day)**
Educational*	Kindergarten	1902.32	-	-
	Primary School	899.1	2030	3104.64
	Secondary School	3286.8	810	910.2
	College/university	1,299.6	1440	9082.76
Healthcare	Clinic	1824	2020	1909.5
	Health center	257.74	250	251.86
	Private hospital	1558.96	1290	1492.4
	Government hospital	2043.47	9360	4737.2
Offices	Authority/bureau/commission	1750	3200	2700
	Bank/insurances	3973.2	6790	5297.6
	Ministry	203.7	690	366.66
	Police centers	495	680	580.5
	Woreda/sub-city	442	460	426.02
	SME/agencies/others	32605.2	52330.6	43473.6
Religious	Mosque	840	2660	1575
	Church	596.8	1044.4	820.6

The total dry season waste generation amount of all institution was estimated to be 53,977.89 kg/day

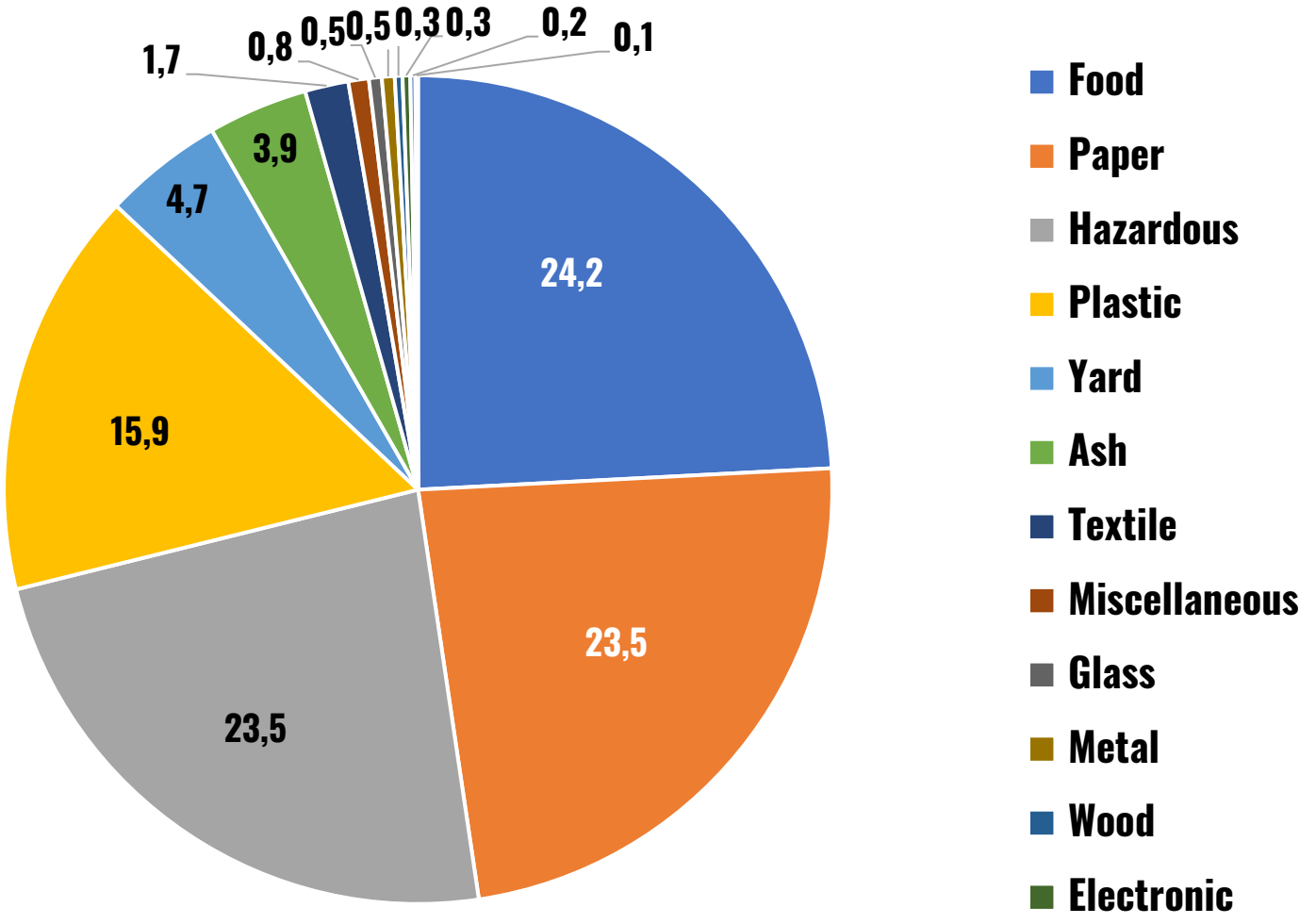
The total wet season waste generation amount of all institution was estimated to be 85,055 kg/day

The total average waste generation amount of all institution was estimated to be 76,729 kg/day

Contribution of solid waste generation by institutional type



Status: waste composition-Institutional



The average percentage weight composition of all institutions including hospitals

Status: waste generation- Street

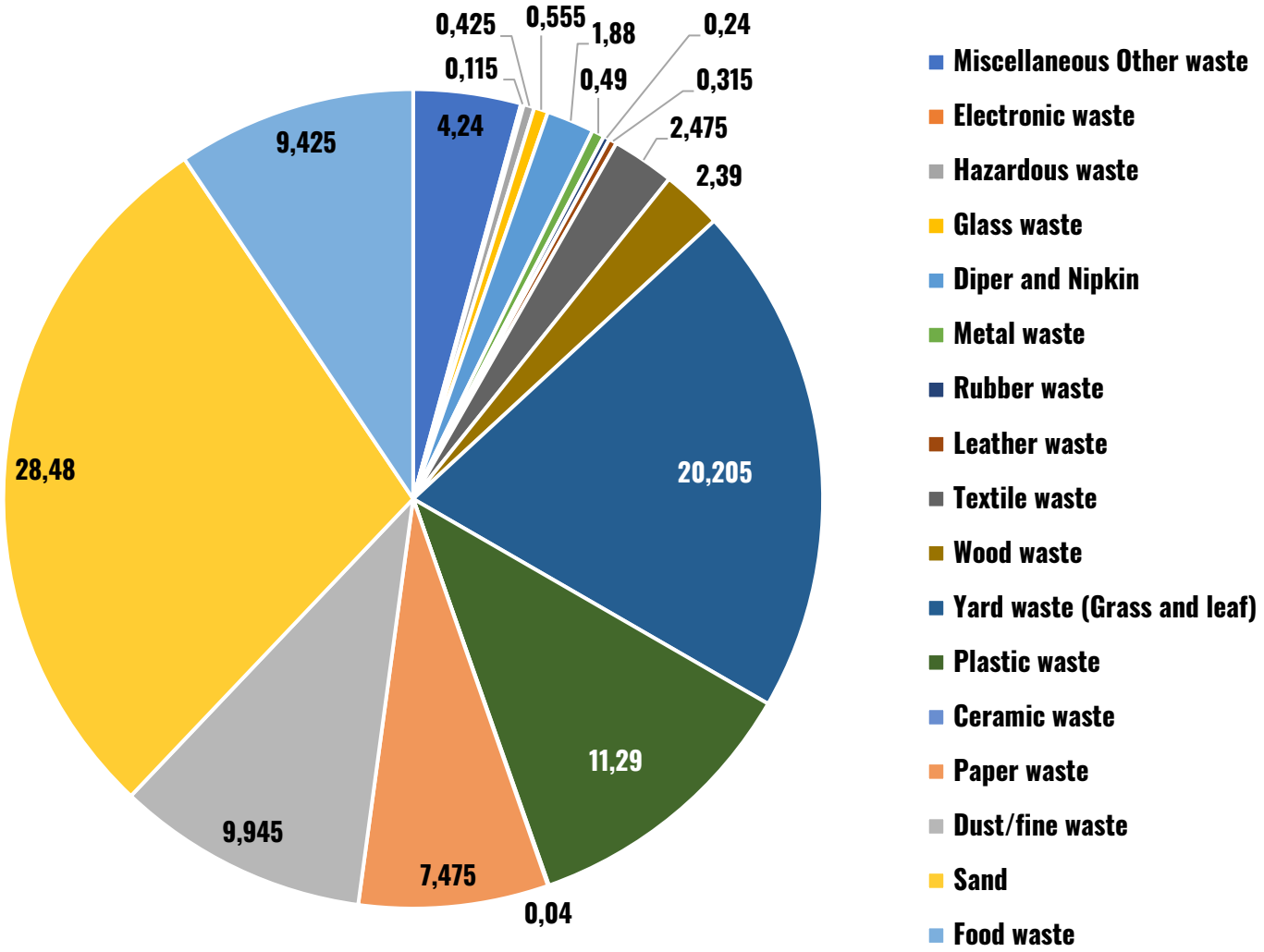
Road category	Street area name	Daily Solid waste generation rate in kg per 100m per day		
		Dry season	Wet season	Average
Arterial Road	High traffic load	7.07 ±5.30	9.92±7.63	8.50
	Low traffic load	1.44 ±0.42	6.59±1.48	4.02
	Medium traffic load	5.92 ±1.61	8.11±5.70	7.02
	Mean average	**4.81 ±2.44**	**8.99 ±6.74**	**6.90**
Sub-arterial road	High traffic load	9.44 ±3.80	6.49±3.64	7.97
	Low traffic load	4.70 ±1.45	9.62±5.39	7.16
	Medium traffic load	6.85 ±1.15	17.56±5.30	12.21
	Mean Average	**7.00 ±2.13**	**10.58 ±6.42**	**8.79**
Ring Road	High traffic load	8.15 ±2.47	6.53 ±2.13	7.34
	Low traffic load	2.10 ±0.77	1.66± 1.09	1.88
	Medium traffic load	2.46 ±0.60	3.56± 4.79	3.01
	Mean Average	**4.24 ±1.28**	**3.78 ±3.80**	**4.01**
Connecting road	High traffic load	28.69 ±4.02	4.7±0.00	16.70
	Low traffic load	6.40 ±3.73	21.41±7.4	13.91
	Medium traffic load	5.10 ±1.43	5.85±5.1	5.48
	Mean Average	**13.40 ±3.06**	**13.16±9.34**	**13.28**

The total dry season waste generation amount of all street was estimated to be 364,534.73 kg/day

The total wet season waste generation amount of all street was estimated to be 509,380.46 kg/day

The total average waste generation amount of all street was estimated to be 436,957.59 kg/day

Status: waste composition-Street



Average weight percentage of street solid waste composition

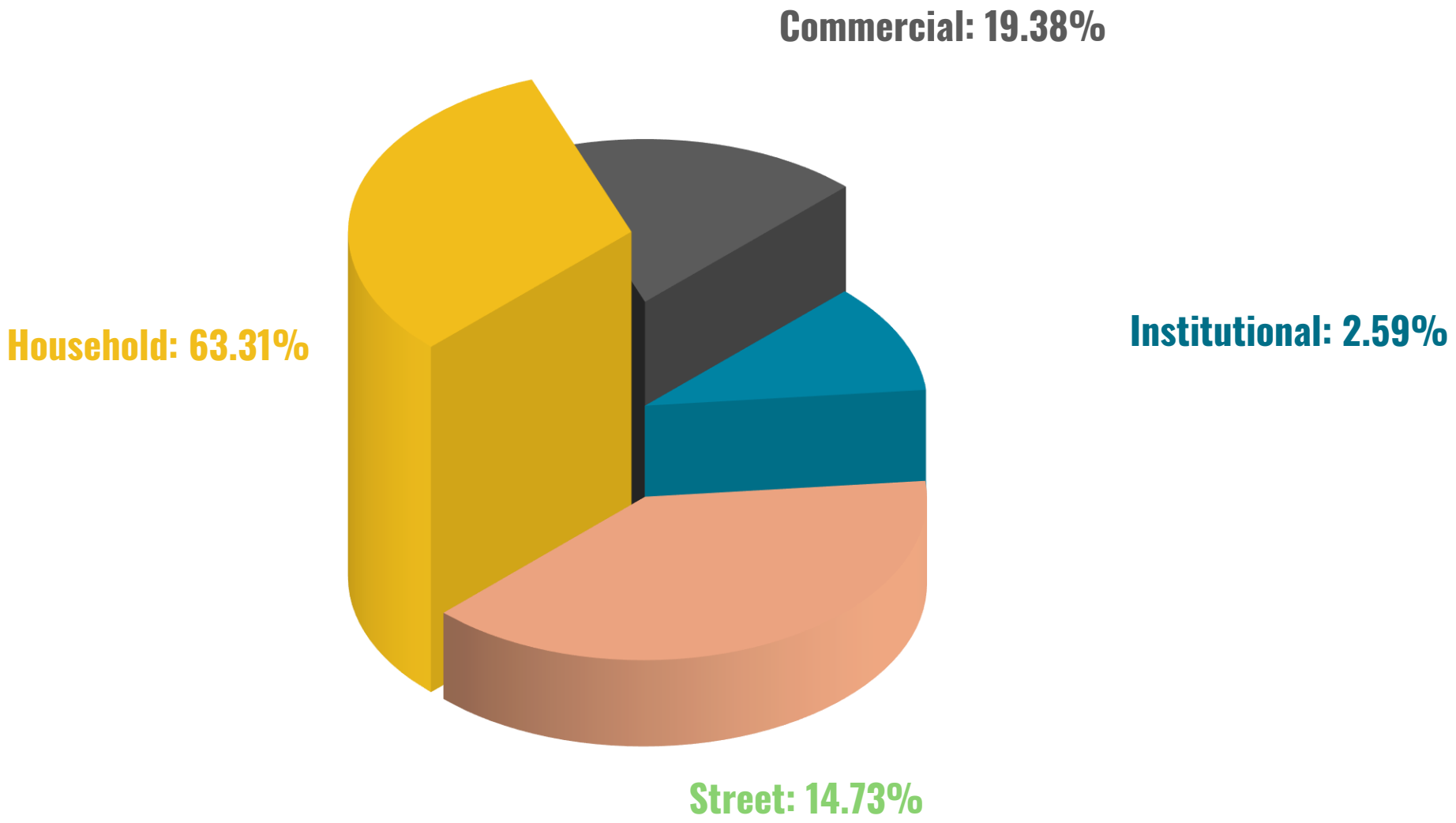
Municipal solid waste (MSW) generation

Source of waste (total) (tons/day)	Dry season	Wet season	Average
Household	1,802.13	2,020.57	1,878.58
Commercial	546.33	597.76	574.99
Institutional	53.98	85.06	76.73
Street waste	364.53	509.38	436.96
MSW	2,766.97	3,212.77	2,967.26
MSW (tons/year)	1,009,944	1,172,661	1,083,050
MSW (tons/day)	**2,767**	**3,213**	**2,967**
Total population	5,461,000	5,461,000	5,461,000
Per capita MSW kg/capita/day)	0.51	0.59	0.54

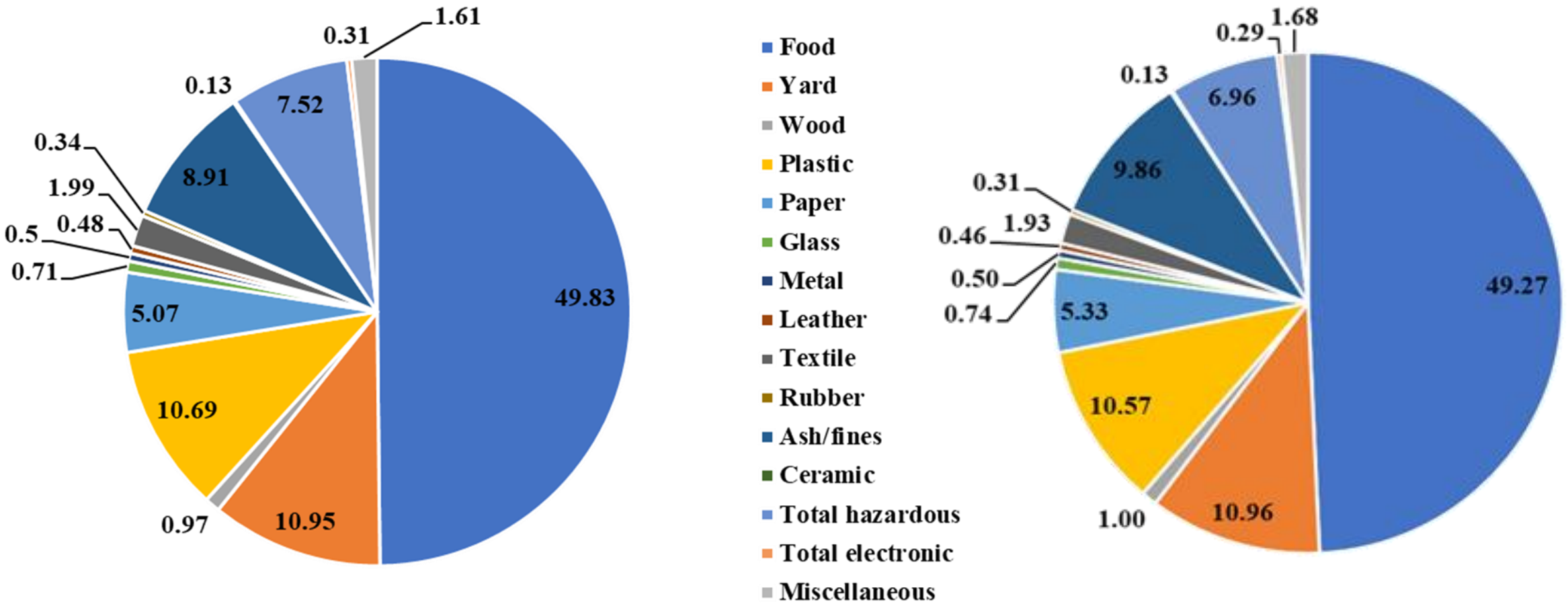
The average per capita Municipal solid waste generation rate was found about 0.54 kg/capita/day

The average per capita Municipal solid waste generation rate was found about 0.62 kg/capita/day

Municipal solid waste (MSW) generation sector contribution



Municipal solid waste (MSW) average composition



Average Municipal solid waste (MSW) composition (a) UN Projection, (b) CSA projection

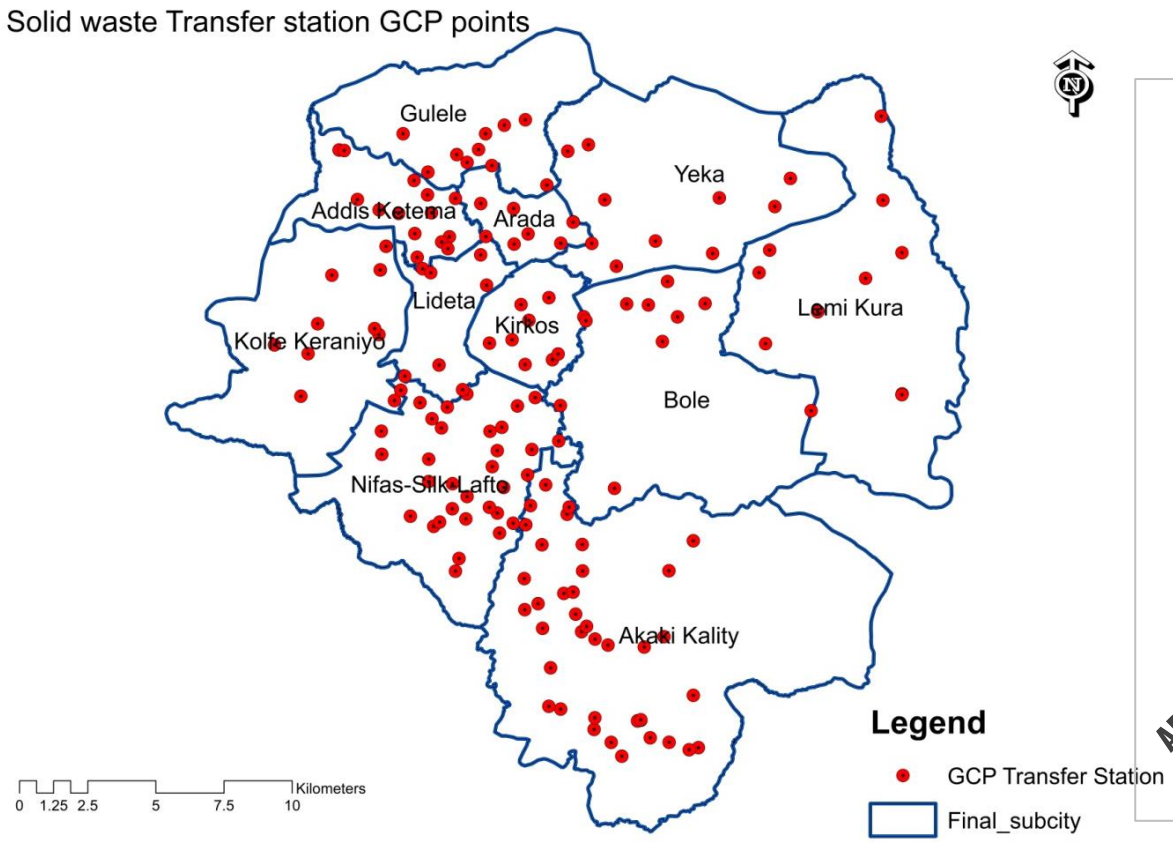
Solid waste collection and transportation system

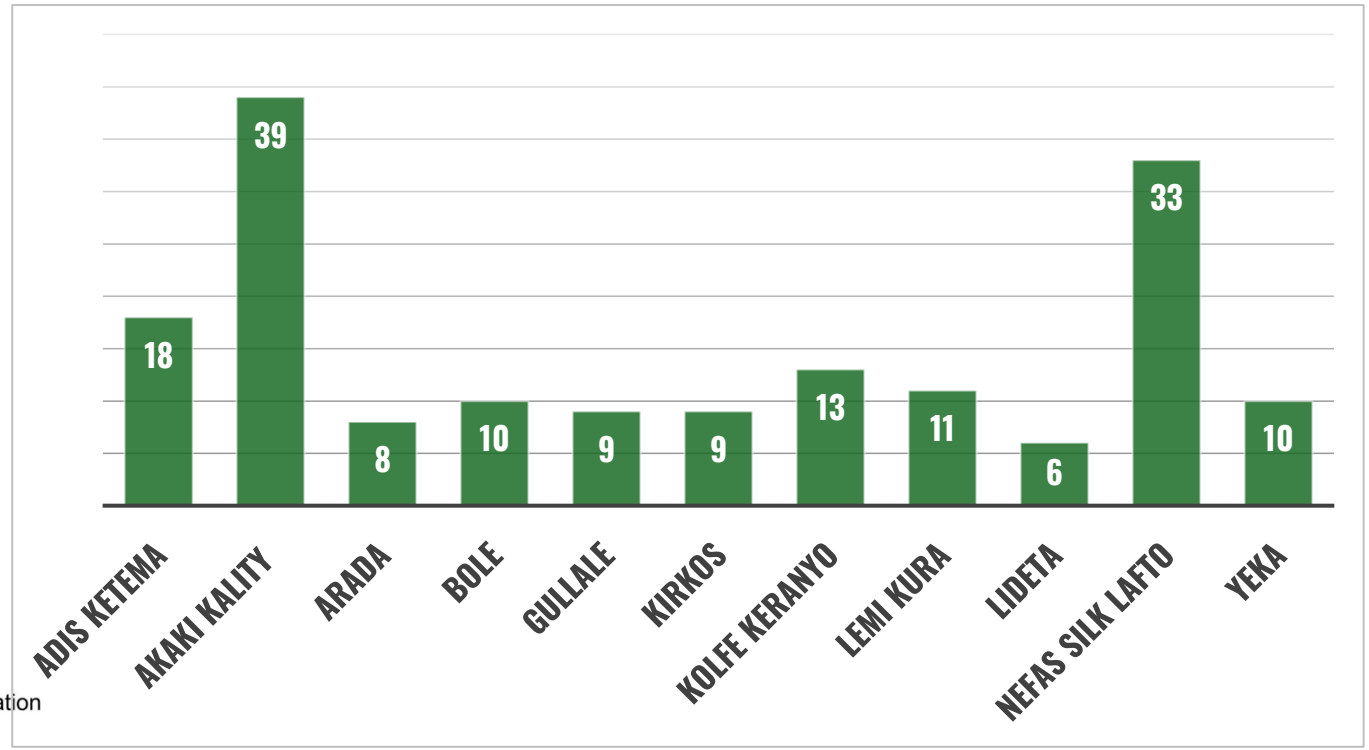
Two types of waste collection services : **primary** and **secondary** collection.

Primary collection involves transport of waste from the source to nearby communal storage sites (Several micro and small enterprises /MSEs/ organized and involved)

Secondary collection represents the transport of the collected solid waste from the transfer station to final disposal sites mainly done by government

EXISTING SITUATION ANALYSIS: City-wide existing skip points



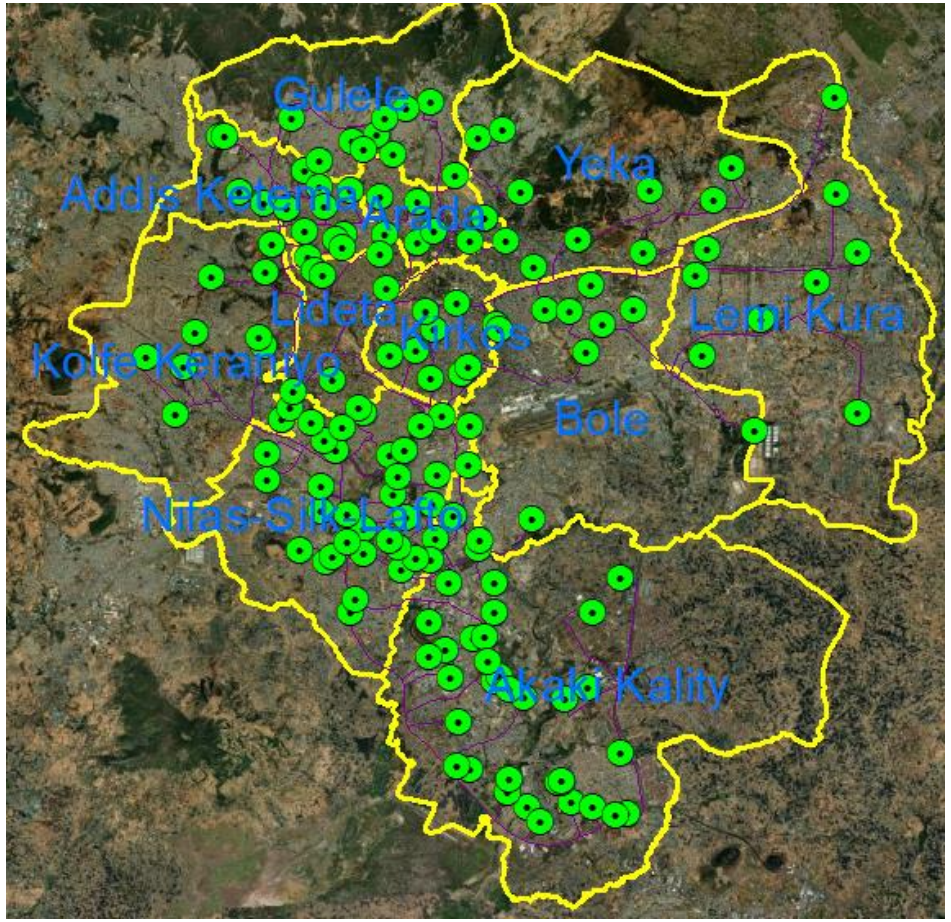


Total no of skip points – 166

Average per sub-city – 15

Average per woreda- 1.4

EXISTING SITUATION ANALYSIS: Area coverage



Subcity	total number	%	Area
Addis Ketema	18	10.84	741
Akaki Kality	39	23.49	11808
Arada	8	4.82	991
Bole	10	6.02	6371
Gullale	9	5.42	3018
Kirkos	9	5.42	1462
Kolfe Keranyo	13	7.83	6125
Lemi Kura	11	6.63	8758
Lideta	6	3.61	918
Nefas Silk Lafto	33	19.88	6830
Yeka	10	6.02	5679
total	166	100.00	52701

→ Average area coverage= **1 per 317ha**

→ Average population service coverage=**1 per 22,735 (CSA projection)** or **32,590 population(UN projection)**

→ containers should be placed no more than **200m from the residences**

EXISTING SITUATION ANALYSIS: Transportation

List of Government compactors & other vehicles

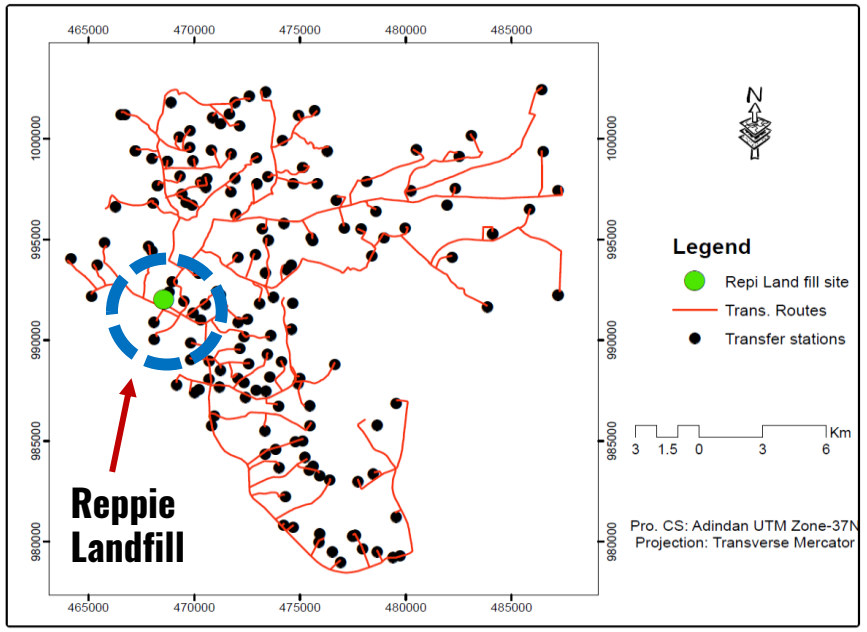
Current functional vehicles				
80 M³ compactors	40 M³ compactors	Container truck (loader)	Closed garbage truck (covered truck)	Road Sweeper
18	22	63	4	19

List of privet and outsource functional compactors & other vehicles

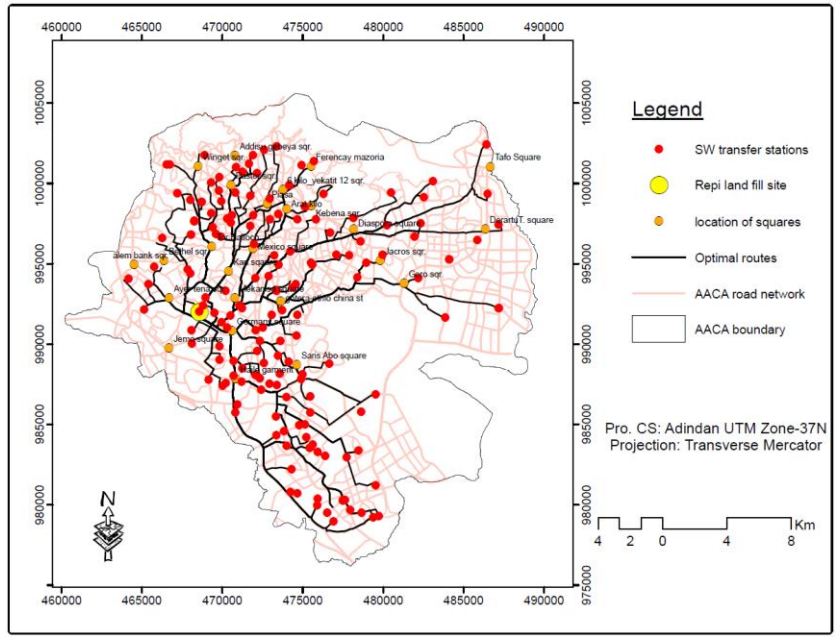
S/N	80 M³ compactors	Less than 80M³ compactors	Container truck (ገንዳ ተሸካሚ)	Closed garbage truck (ሽፍን መኪና)	Remark
1	38	51	7	-	privet
2	24	16	-	-	outsource
Total	62	67			

Total compactors & other vehicles 255

EXISTING SITUATION ANALYSIS: Transportation



Solid waste removed by type	Average in days	
	Frequency transportation	Total amount (tons)
Burning	163.5	911.67
Land fill	227.5	1250.24
Total	391	2166.91



Stakeholders	Average daily (tones)	Percentage
Government	839.0	38.4
Outsourced	680.2	31.1
Private	668.5	30.6
Total	2187.7	100.0

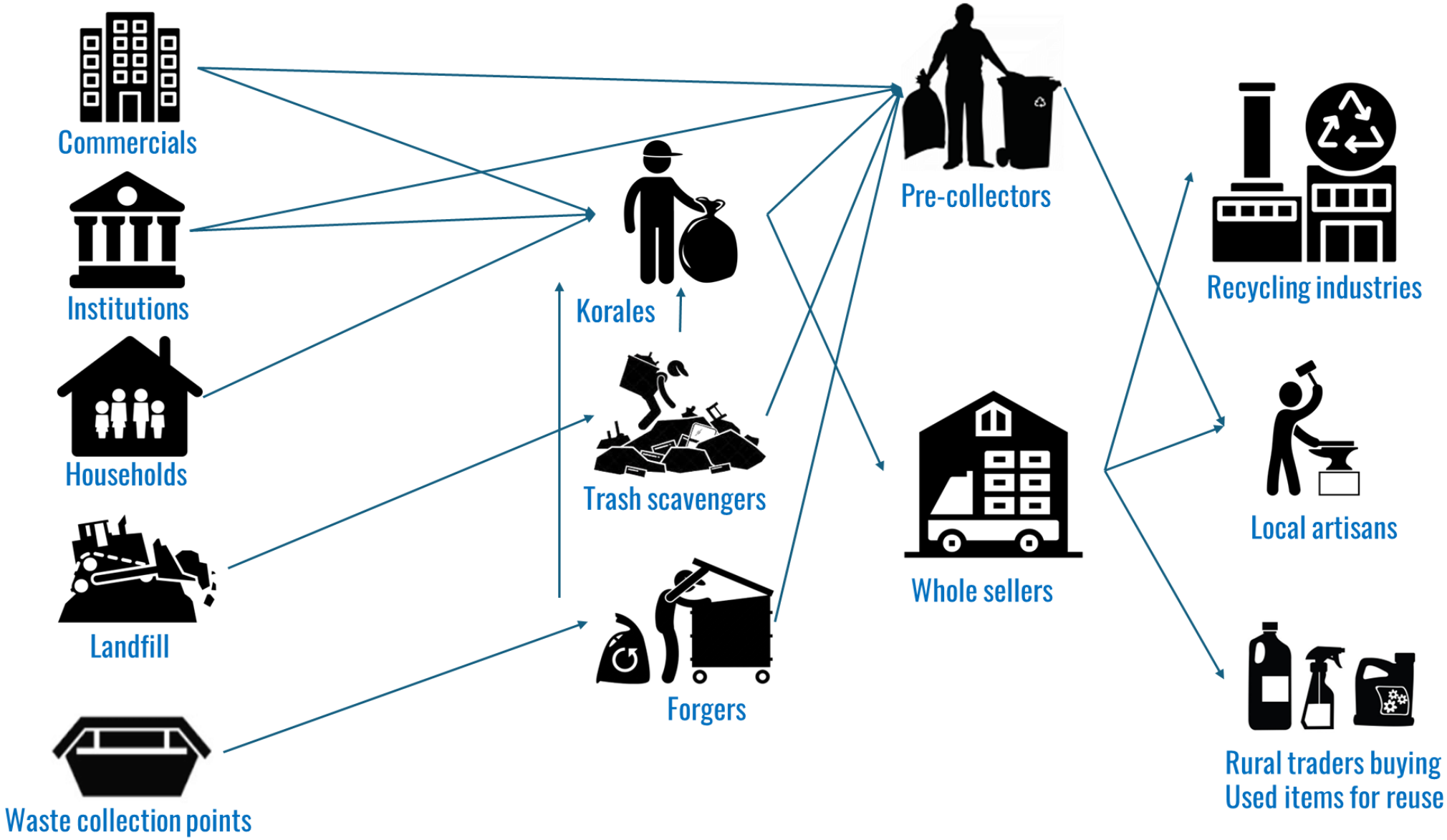
The average distance traveled using the optimal route based estimated 11.5 km.

Amount of solid waste recycled by formal sectors in Addis Ababa city in 2010-2015 E.C.

Year (E.C.)	Type of waste recycled							Total reused and recycled amount (tons)
	PET	HDPE	Metal	Paper	Glass	Electronics	Textile	
2010/ 2018	12,604	3,642	14,552	447	4,100	-	70	35,415
2011/ 2019	18,648	5,945	11,938	1,515	970	120	561	39,697
2012/ 2020	22,234	4,653	5,912	1,856	196	286	589	35,315
2013/ 2021	23,059	6,168	6,337	3,554	304	-	598	40,020
2014/ 2022	38,291	11,188	6,668	11,142	585	-	-	67,874
2015/ 2023	38,048	14,996	12,206	20,719	788	-	-	86,757

Source: Addis Ababa cleansing management agency

Type, source and purpose of wastes supplied and processed by informal actors

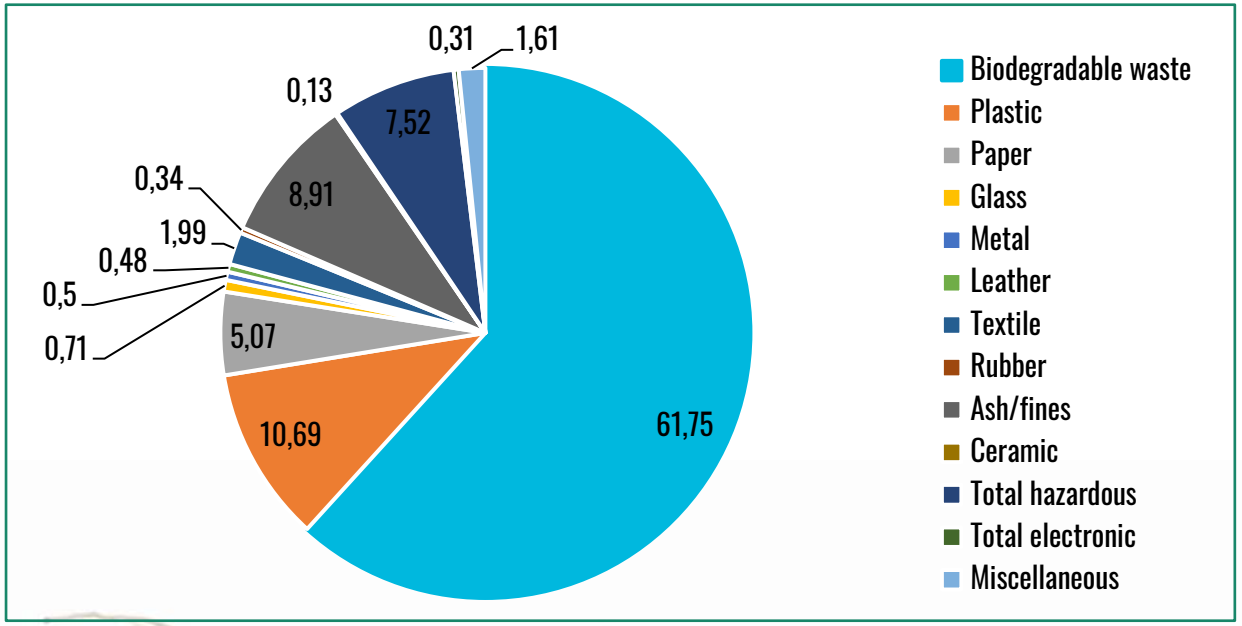


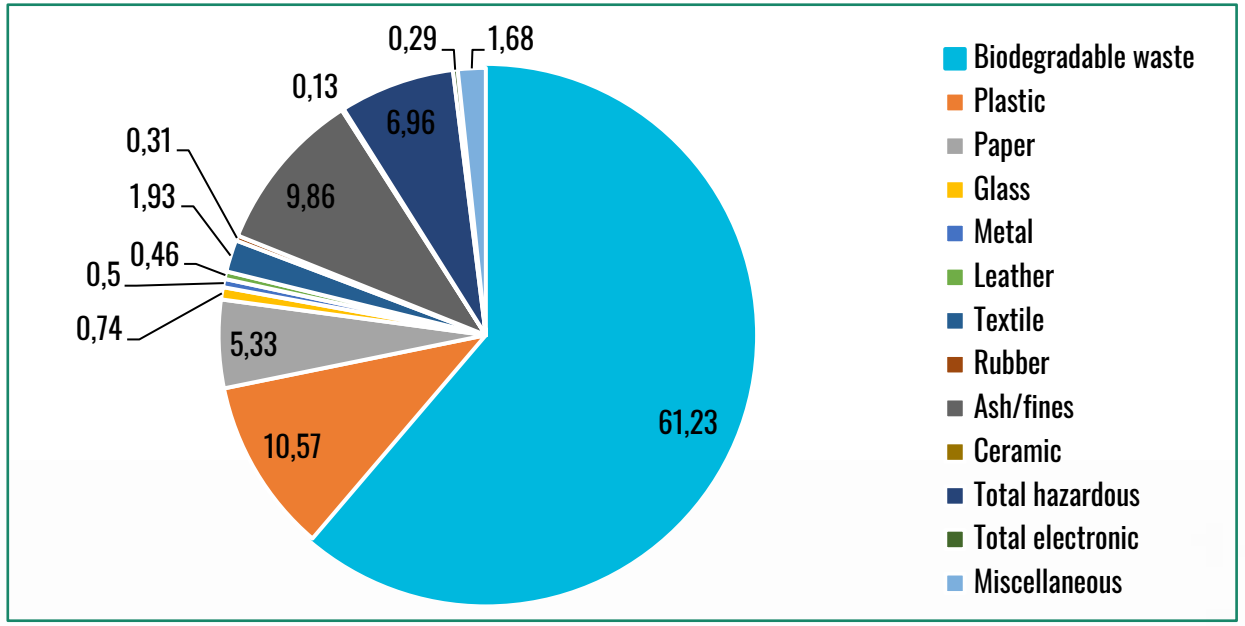
Paper and cardboard,
Plastic,
textile,
glass,
metal,
rubber,
cloth and shoes,
tin cans,
dry cells and batteries

Waste-to-energy plant

The Reppie waste-to-energy plant, inaugurated in 2018, is not only Ethiopia's but also Africa’s first of its kind facility. It is designed to process more than 1,400 tons of MSW daily.

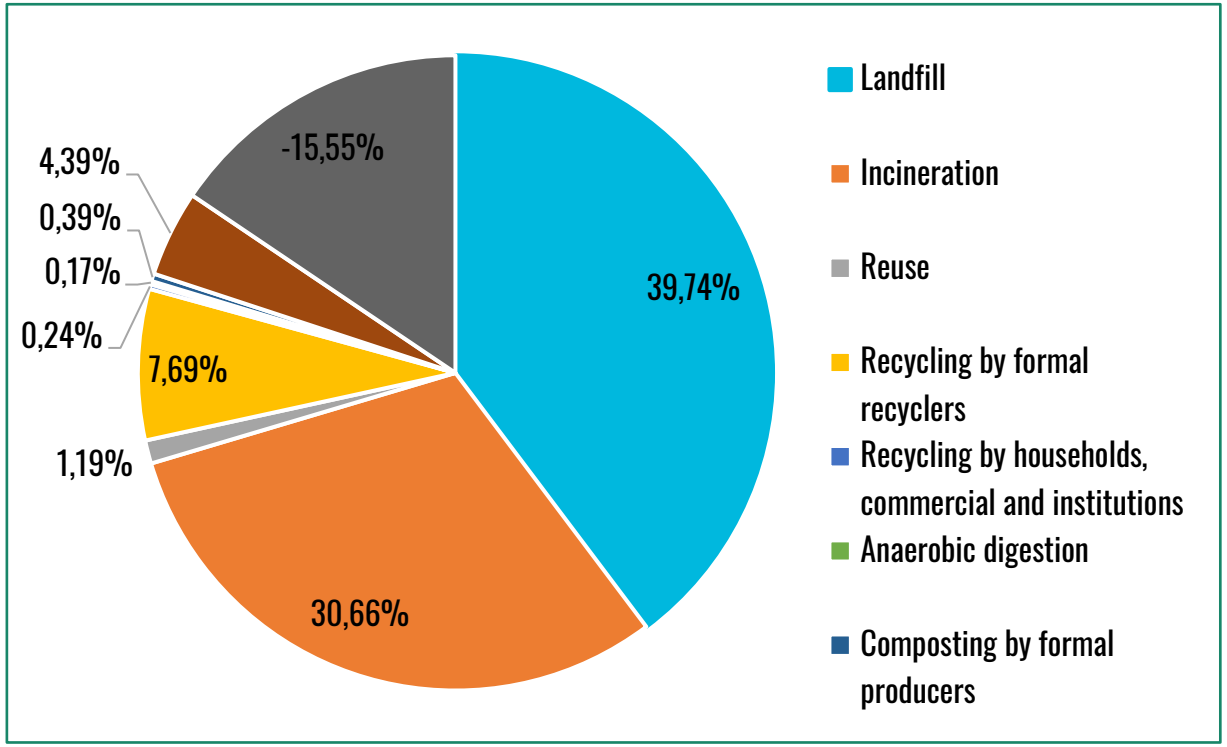
Waste compositions

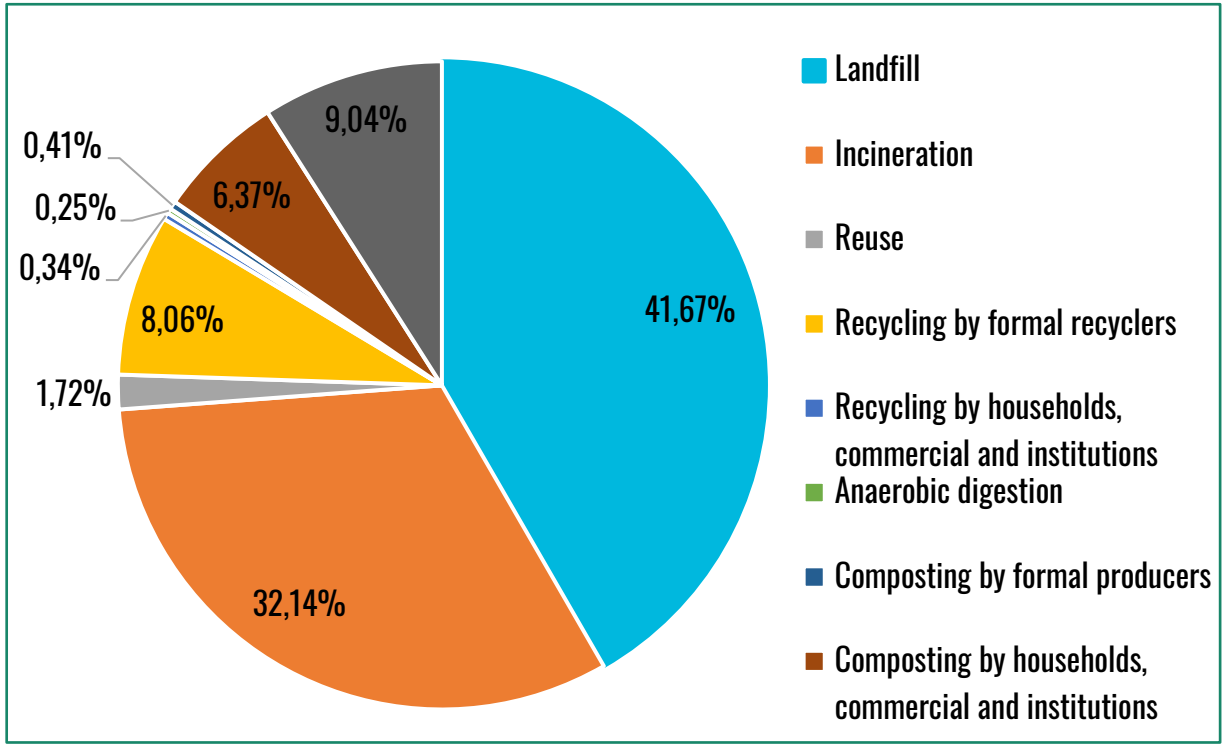




Percentage weight MSW composition based on CSA and UN projection

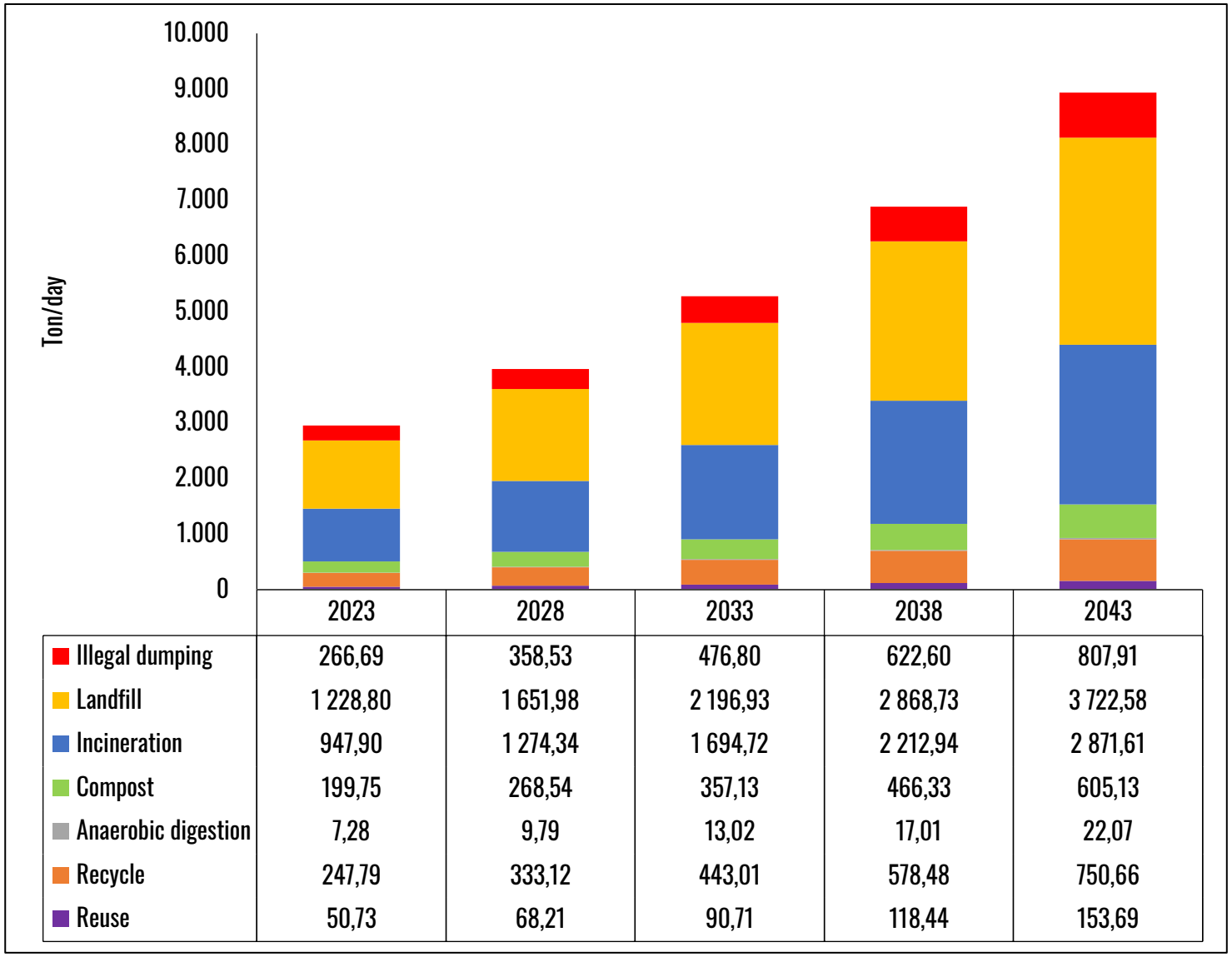
Waste flow analysis





Breakdown of the waste management and disposal strategies out of total MSW generation in CSA and UN projection

Existing solid waste flow



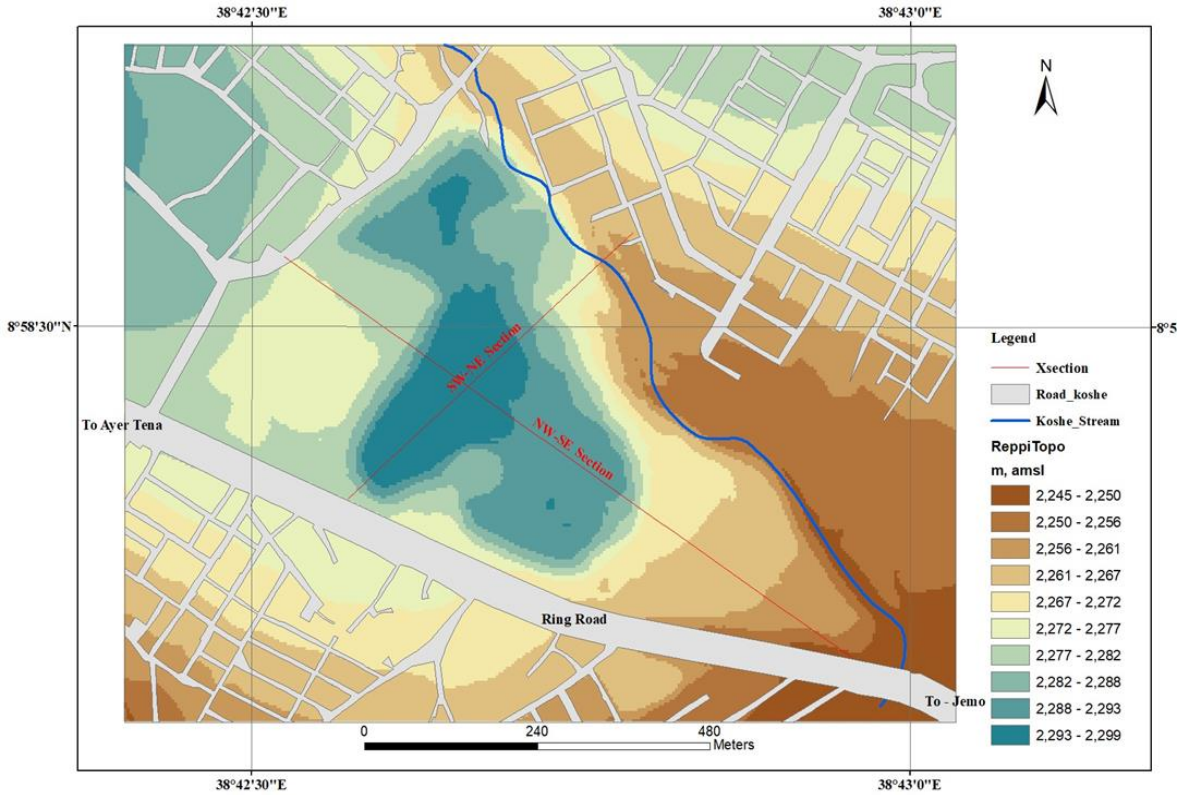
	2023	2028	2033	2038	2043
Illegal dumping	266,69	358,53	476,80	622,60	807,91
Landfill	1 228,80	1 651,98	2 196,93	2 868,73	3 722,58
Incineration	947,90	1 274,34	1 694,72	2 212,94	2 871,61
Compost	199,75	268,54	357,13	466,33	605,13
Anaerobic digestion	7,28	9,79	13,02	17,01	22,07
Recycle	247,79	333,12	443,01	578,48	750,66
Reuse	50,73	68,21	90,71	118,44	153,69

Solid Waste Disposal at Reppi

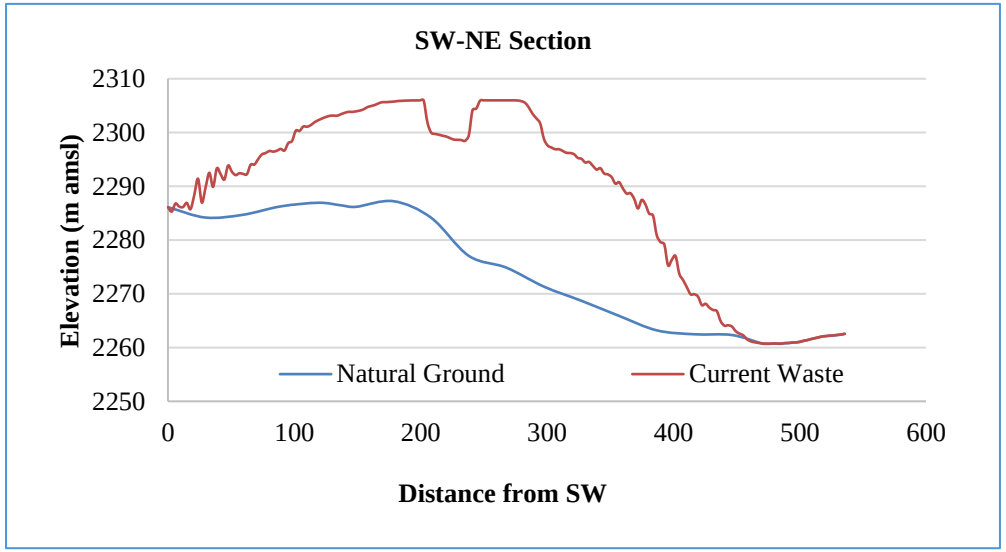
- The largest and oldest landfill site in Ethiopia is located in Addis Ababa.
- “Qoshee” also known as Koshe is a large open landfill which receives rubbish and waste from Addis Ababa city.
- The name means "dirty" in Amharic.
- The landfill site is in the south-western part of the city.
- The municipal administration of Addis Ababa started to use the site in 1971.

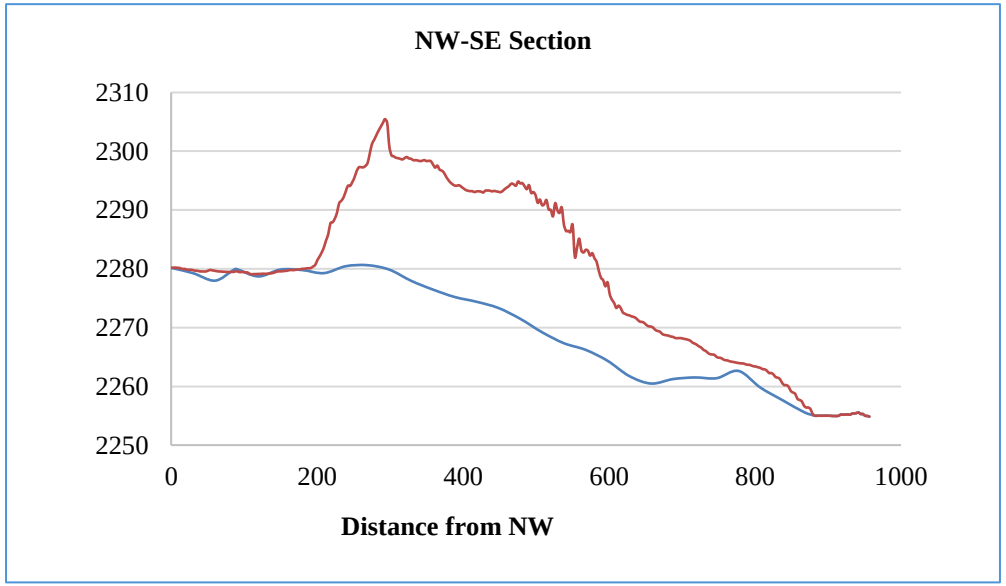
Solid Waste Disposal at Reppi

- Reppi Solid Waste disposal Site: Site Topography

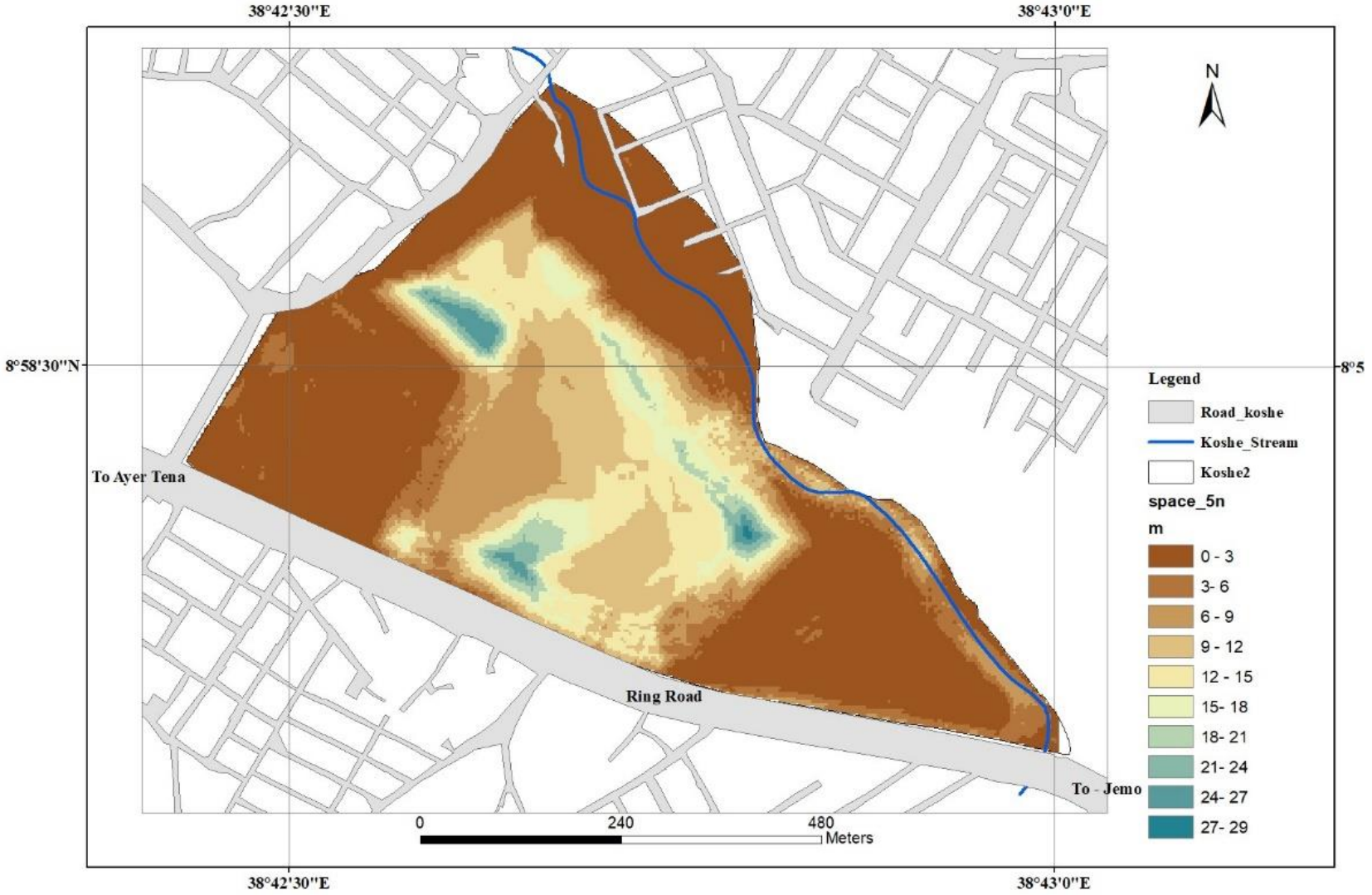


The natural landscape of the site exhibits a surface slope of approximately 2-5%, with a steeper slope leading towards the small stream on the eastern boundary.





Solid Waste Disposal at Reppi: Available volume



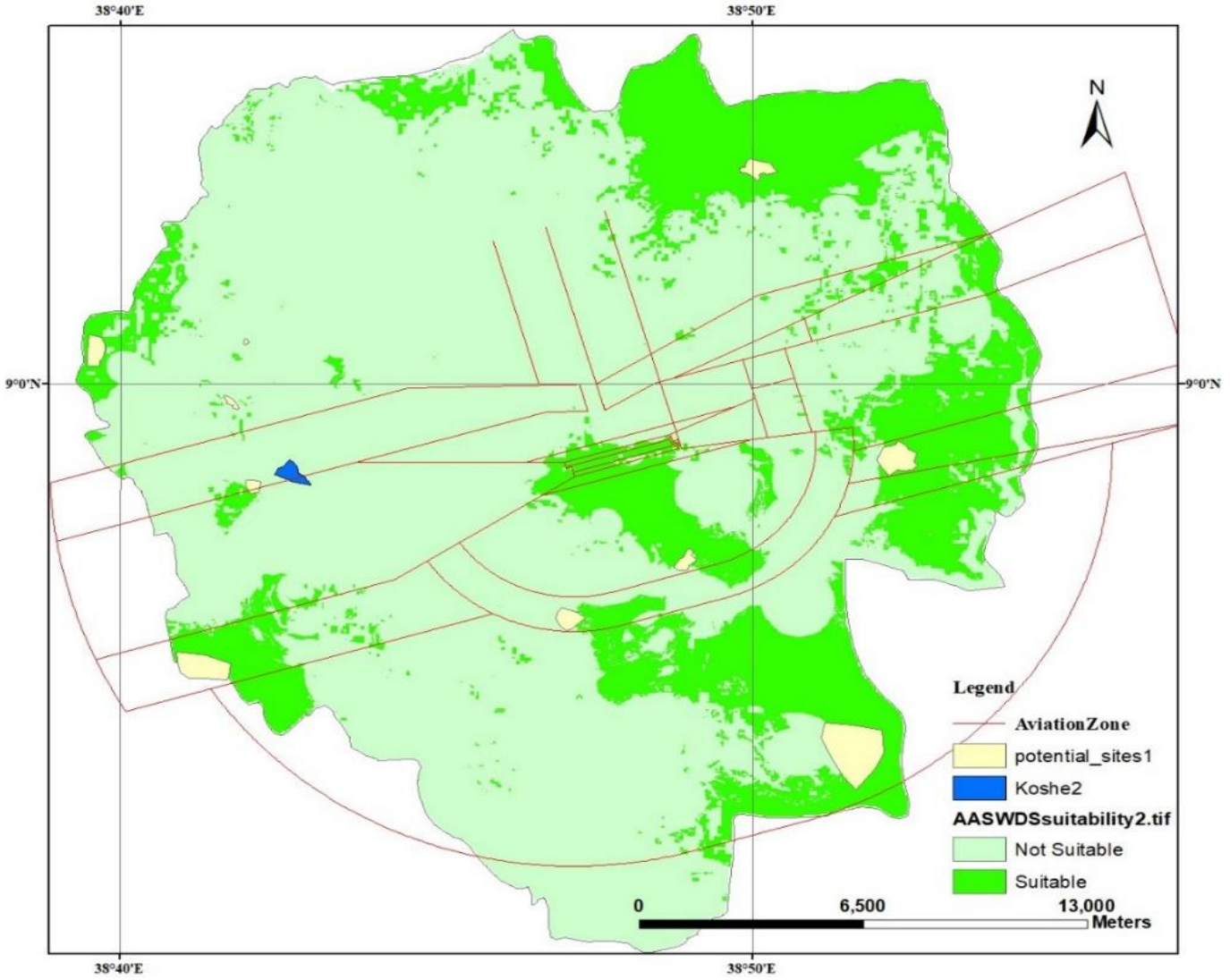
- 2,050,349 m^3 of space
- 1,463,042 tons (7 KN/m^3)
- Fills within (~12 to 18 m)

Potential Landfill Site in Addis Ababa: evaluation and prioritization

Landfill site selection criteria

- Natural land surface slope
- Proximity to surface water
- Proximity to main road
- Proximity to public institutions
- Proximity to residential areas
- Soil properties
- Groundwater table depth
- Geologic setting

Landfill site Suitability class distribution



Class	Rank	%
Not Suitable	1	1.6
Less Suitable	2	79.2
Suitable	3	19.3
Moderately S.	4	0
Highly Suitable	5	0

Features of identified landfill sites

Priority	Sub City	UTM N	UTME	Area (Ha)	Current Land cover	Planned Development	Distance (BI Airport, Km)
1	Lemi Kura	992394	485860	79.67	Crop Land, Quarry	High- and Low-Density Mixed Residence	6.186
2	Lemi Kura	989023	486036	36.79	Shrub and Grass Land	Solid Waste treatment and Management Site	7.346
3	Akaki Kality	987286	476343	38.22	Crop Land, Quarry	Manufacturing and Storage	4.565
4	Bole	989119	479736	22.13	Crop Land, Quarry	Environmental Protection Lake	3.748
5	Kolfe Keranyo	991511	467204	14.84	Shrub and Grass Land	Environmental Protection Forest	9.123
6	Kolfe Keranyo	994188	466572	8.35	Shrub and Grass Land	Low density mixed residence and forest	9.875
7	Yeka	1001650	481818	40.31	Crop Land, Quarry	Environmental Protection Forest	10.142
8	Kolfe Keranyo	996121	466998	1.99	Shrub Land	Environmental Protection Park	8.987

The top priority site in Lemi Kura sub-city, covering 79.67 hectares, will only be operational until 2034, but if improved solid waste management practices are implemented, it may serve until 2037.

The city development plan prioritizes a 36.79 hectares site for waste treatment and management, with potential landfill use until 2029 and 2030 under the best scenario.

Two prioritized sites, totaling 116.46 hectares, are set to operate until 2043, provided the best scenario is effectively implemented.

The three most suitable sites, covering 154 hectares, are capable of effectively managing waste beyond 2043 using best practices.


Thank
you