GOVERNMENT OF MONGOLIA

MINISTRY OF ENVIRONMENT AND TOURISM

ULAANBAATAR CITY MAYOR'S OFFICE

ULAANBAATAR HOUSEHOLD WASTE COMPOSITION STUDY

REPORT 2019

Supported by:

Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

based on a decision of the German Bundestag

UN environment programme

Technology for Environment

The Asia Foundation

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THE WASTE AND CLIMATE CHANGE PROJECT
ULAANBAATAR HOUSEHOLD WASTE COMPOSITION STUDY 2019

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INTERNATIONAL IMPLEMENTING ORGANIZATION:

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MINISTRY OF ENVIRONMENT AND TOURISM

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NATIONAL TECHNICAL IMPLEMENTING ORGANIZATION:

The Asia Foundation

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The views expressed in this report are not necessarily those of the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, United Nations Environment Programme (UNEP), International Environmental Technology Centre (IETC) or the Asia Foundation.

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FOREWORD

T.GANTUMUR

Ulaanbaatar City General Manager and Head of the Mayor's Office

The Ulaanbaatar City Mayor's Office and The Waste and Climate Change Project of The Asia Foundation, funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety as well as the International Environmental Technology Center (IETC) of the United Nations Environment Programme (UNEP) successfully conducted the household waste composition study in Ulaanbaatar. The study will update the current waste composition data in Ulaanbaatar, while also providing a research framework for the development of future local and international projects.

A similar study was conducted in 2007 with the support from Japan International Cooperation Agency (JICA), which was the last time that household waste composition study was organized in Ulaanbaatar. After 11 years, we have updated our data which can inform more effective municipal solid waste management, improving resident's wellbeing and health.

I would like to express my gratitude to the IETC, UNEP, The Asia Foundation, project consultants, non-governmental organizations, the waste management departments at districts, khoroo Governors, students, residents and all other partners that provided their support to conduct the study.

Waste management is a key challenge for countries and cities around the world. According to the recent World Bank publication "What a Waste 2.0: A Global Snapshot of Solid Waste Management to 2050", the world generates 2.01 billion tonnes of municipal solid waste annually. When looking forward, global waste is expected to grow to 3.40 billion tonnes by 2050, more than double population growth over the same period. Poorly managed waste threatens humans and ecosystems health and depletes resources. It also contributes to climate change. According to the Intergovernmental Panel on Climate Change, GHG emissions from the waste and wastewater sector accounts for about 2.8 per cent of global anthropogenic GHG emissions (IPCC 2007).

Having more accurate information about the increasing amount of waste, especially in developing countries where there is constant lack of reliable waste data, is extremely important in order to improve the decision making towards better waste management. This report provides the recent data on household waste generation by the residents of Ulaanbaatar city. The findings will help inform future waste management improvements and policy decisions, as well as identify opportunities for further research.

We hope that this publication will inspire policymakers, businesses, communities and all other stakeholders to recognize the importance and urgency of the waste problem, and create opportunities to raise awareness to reduce waste at source and encourage better waste management in the future.

Keith Alverson
Director,
International Environmental Technology Centre (IETC),
United Nations Environment Programme

The Asia Foundation

For the last decade, the Asia Foundation has been an active partner and collaborator with the Ministry of Environment and Tourism of Mongolia as well as the Municipality of Ulaanbaatar, more specifically the City Mayor's office, on the issue of waste management. This waste composition study conducted as part of the Waste and Climate Change project, is one of the latest important outputs this collaboration has produced.

Ulaanbaatar, the capital city, has been rapidly urbanizing since early 2000s and consequently, the amount of waste transported to dump sites increased 7 times since 2009. The findings of the study indicate that waste composition has been changing as well, and waste generation per person has been increasing in relation with the population and income growth. These trends point us towards the need to not only manage waste better, but also start working to fundamentally transform consumer behavior and the actions that cause us to generate more waste per person every year.

On behalf of the Asia Foundation, I would like to extend my sincere gratitude to all our partners who supported the successful completion of the study, especially the field team who worked tirelessly to collect, segregate and analyze the waste samples collected. Special thanks to the Ulaanbaatar City Mayor's office and the General Manager for excellent technical guidance and moral support throughout the study period, and to our partners at the UNEP IETC.

Mark Koenig
Country Representative, Mongolia
The Asia Foundation

ACKNOWLEDGEMENT

Special thanks are given to the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, the funder of the Waste and Climate Change project, also the International Environmental Technology Centre of the UNEP, the international project implementer. Also sincere thanks for effective collaboration and strategic guidance to the Ministry of Environment and Tourism of Mongolia, the Ulaanbaatar City Mayor's Office, the Waste Management Department.

Thanks to all other partners that provided their support to conduct the field research, collect information and organize consultation workshops for this report.

Project funder:

- The German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety

International implementing organization:

- The International Environmental Technology Centre of the United Nations Environment Programme

Project partners:

- The Ministry of Environment and Tourism of Mongolia
- Ulaanbaatar City Mayor's Office

Project implementer in Mongolia:

- The Asia Foundation

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- Katrina Mattingley, Project Support Officer, Waste and Climate Change Project
- Zach Conn, Environment Project Officer, Waste and Climate Change Project

Working group to provide strategic guidance and support throughout the study

- A.Oyun, Environment and Natural Resources Management Department, Ministry of Environment and Tourism
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- G.Uuganbayar, Former Head of Waste Management and City Utility Department
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- B.Erdenechimeg, Officer of the Food and Commerce Department, Ulaanbaatar City Mayor's office
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- B.Odgerel, Head of Waste and Landscaping Department of Bayangol district
- N.Mungun-Erdene, Head of Waste and Landscaping

Department of Songinokhairkhan district
- T.Edmon, Head of Waste and Landscaping Department of Sukhbaatar district
- A.Gerelt-Od, Head of Waste and Landscaping Department of Chingeltei district
- Ts.Bat-Erdene Head of Waste and Landscaping Department of Khan-Uul district
- A.Nyamdorj, Head of the Health and Social Policy Institute of Mongolia
- B.Jargal, New Village NGO
- A.Myagmardoljin, Institute of Women's Rights Protection and Development NGO

The organizations, universities and individuals that supported and assisted the study:

- Capital City Landscaping Office state owned company
- Bayangol district Governor's office
- Bayanzurkh district Governor's office
- Songinokhairkhan district Governor's office
- Chingeltei district Governor's office
- Khan-Uul district Governor's office
- Sukhbaatar district Governor's office
- Khoroos (subdistricts):
  - 21st khoroo of Songinokhairkhan district
  - 14th khoroo of Sukhbaatar district
  - 8th khoroo of Chingeltei district
  - 11th and 15th khoroos of Khan-Uul district
  - 26th khoroo of Bayanzurkh district
  - 14th khoroo of Bayangol district
- Khoroo Governors, kheseg leaders and officials
- Institute of Women's Rights Protection and Development NGO
- Health and Social Policy Institute of Mongolia
- New Village NGO
- School of Civil Engineering and Architecture, Mongolian University of Science and Technology:
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  - Sh.Bilguun
  - N.Erdenebaatar
  - G.Tuguldur
  - B.Gantsooj
  - E.Munkhgerel
  - P.Bilguun
  - M.Bilguun
  - B.Sodnomjamts
  - G.Erdenebayar
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Representatives of organizations and universities that supported the study

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DEFINITIONS OF KEY TERMS

An apartment district is another common form of residential district in Mongolia. It includes small and big sized apartments and separate houses (also called townhouses) which are fully connected with integrated water, heat, electricity and sewage system.

Circular economy is a theory that the economy should not waste resources, but should continue to reuse them and repurpose what is often thought of as waste.

Environmentally sound technologies (ESTs) are improved technologies or methods that when compared to standard methods, have a less negative impact or can even have positive environmental impacts.

A ger district (Mongolian: ger khoroolol) is a form of traditional residential district in Mongolia. Most ger areas have not been fully provided by engineering infrastructure (such as integrated water, heat supply, sewage system etc.). They usually consist of parcels with one or more detached houses or gers (hence the name), surrounded by wooden fences.

Greenhouse gas (GHG) refers to gas, such as carbon dioxide, that trap heat from the sun in the Earth's atmosphere.

An Intended Nationally Determined Contribution (INDC) is a voluntary goal a country selects to reduce the impact it has on climate change as part of the Paris Agreement to prevent global average temperatures rising by more than two degrees Celsius.

Climate change mitigation refers to activities and actions that reduce the impact that communities have on global climate. An example of a mitigation action would be composting, an activity that reduces methane (a SLPC) being released from rotting food at dump sites and yields a product that can enhance farm production.

A sample refers to waste collected from a ger or apartment. In this study, a sample is all of the waste generated by the household since the previous sample was collected.

A source refers to the place where waste is being generated, for example a household or ger.

Short lived climate pollutants (SLPCs) are gases that cause rapid short term changes to the atmosphere that are often significantly worse than standard greenhouse gases. For example a kilogram of methane, a gas which is released by livestock and rotting food waste, has the warming impact of 25 kilograms of carbon dioxide.

Waste composition defines types of waste generated and their respective percentage of the total waste generated.

Waste quantity defines the amount of waste, measured by weight for this study, generated by a resident, a household, or a business entity in a given duration of time.

Summer study refers to a study conducted between April and October.

Winter study refers to a study conducted between October to the end of March.

The Asia Foundation and the IETC, UNEP in collaboration with the Ministry of Environment and Tourism as well as the Municipality of Ulaanbaatar, are implementing the Waste and Climate Change Project in Mongolia since August 2017 (funded by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety and IETC, UNEP.

The project aims to strengthen the capacity of policy makers and practitioners in Mongolia, Bhutan and Nepal to reduce greenhouse-gases (GHG) and short-lived climate pollutants (SLCP) from the waste sector, drawing on the concept of a circular economy to plan and deliver sector improvements. The key outcome of the project is defined as follows:

OUTCOME:

Key actors (policy makers and key waste sector stakeholders) in Bhutan, Mongolia and Nepal implement enhanced legislative formworks, creating enabling conditions for the introduction and uptake of suitable environmentally sound technologies in the waste sector, while contributing to the achievement of the pledged intended nationally determined contribution (INDC) to contribute to the global challenge of climate change mitigation.

The project has four outputs:

OUTPUT I:

National and city level strategies for waste management with explicit links to GHG and SLCPs mitigation opportunities are developed and implemented.

OUTPUT II:

Environmentally Sound Technologies (ESTs) for the waste sector of each country are identified based on the United Nations Environment Programme (UNEP) methodology 'Sustainability Assessment of Technologies.'

OUTPUT III:

Capacity of policy makers of target countries is strengthened to access green financing for larger-scale investments to apply environmentally sound technologies mitigating GHGs and SLCPs in the waste sector.

OUTPUT IV:

Governmental officials, waste sector operators and the general public are aware of mitigation potentials including the benefits of the waste sector. Knowledge and best practices on mitigation potentials are disseminated.

1. STUDY OBJECTIVES AND IMPORTANCE

The household waste composition study was conducted to update and improve the existing data on household waste generation by the residents of Ulaanbaatar city. The findings will help inform future waste management improvements and policy decisions, as well as identify opportunities for further research. The research methodology applied was designed to be simple and low cost, so that it can be adapted and replicated in other provinces to support similar studies in the future.

The study will be essential to set a waste fee for households and for further studies to identify best possible technologies to help reduce the impact of specific types of waste. Furthermore, the study will provide information that can be used to update estimated emissions of greenhouse gases (GHG) and other short-lived climate pollutants (SLCP) from the waste sector.

This study is distinctive by collecting waste from source for analysis, allowing for greater insight into waste habits at the individual household level. This sampling method is more suitable to determine the amount and composition of waste generated by households because it highlights specific waste habits and how they change depending on the season and settlement type.

This waste composition study included surveys and sampling of municipal solid waste from households in the 6 central districts of Ulaanbaatar city, which were selected to represent a range of demographic factors during the summer and winter of 2018.

Volunteer students at the waste sample segregation site

2. CURRENT CONDITIONS OF WASTE MANAGEMENT IN ULAANBAATAR CITY

Total amount of waste delivered to the waste dump sites in Ulaanbaatar and provinces: The amount of waste delivered to dump sites is increasing year by year due to population growth and shifting consumer habits. There is no specific and reliable data on the total amount of waste generated in Mongolia, the only available data is the total amount of waste delivered to dump sites. This does not include illegal dumping, which in Ulaanbaatar can account for up to 15% of waste disposal (Byamba & Ishikawa 2017[1]). Legal waste dumping across Mongolia reached 3,353,548 tonnes in 2018, increasing 4 times over since 2008 (Figure 1[2]). This rapid increase is likely caused by both increases in actual waste production, combined an increasing percentage of total waste generated that is reaching designated dump sites.

Figure 1: Waste generation of last 10 years in Mongolia, tonnes (amount of waste delivered to waste dump sites[3])

41.6% or 1,393,753 tonnes of waste delivered to waste dump sites in 2018 was generated in Ulaanbaatar, while the remaining 58.4% or 1,959,795 tonnes were generated in other provinces[3].

Figure 2: Waste generation ratio of Ulaanbaatar and other provinces

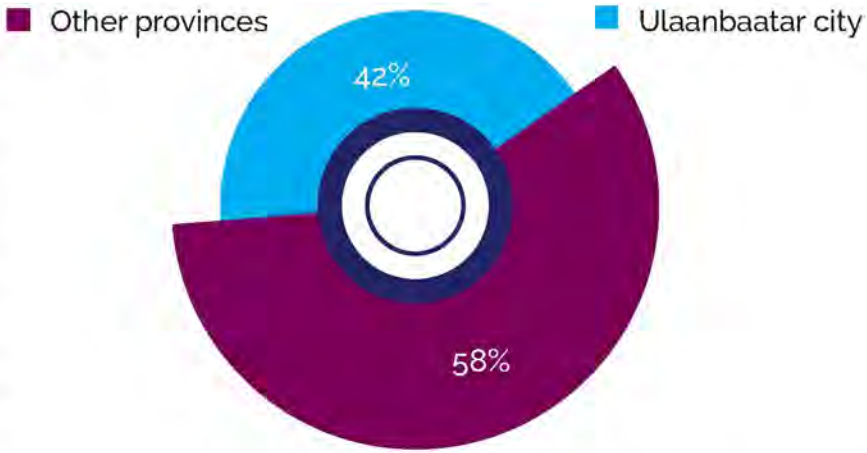
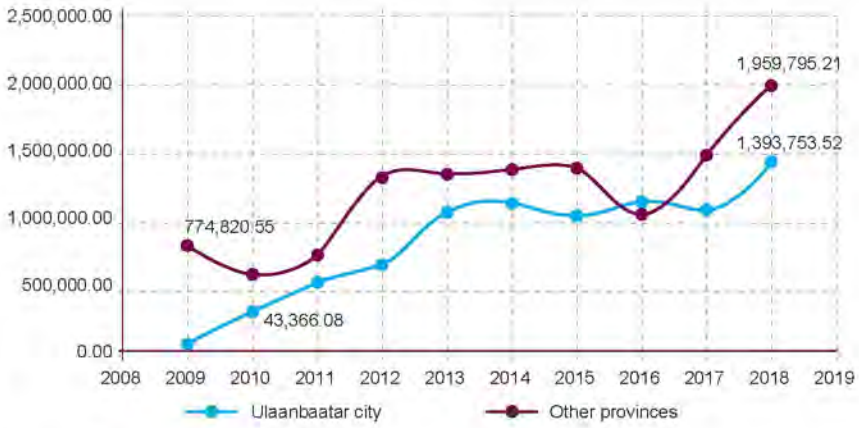


Figure 3: Total amount of household and industrial waste delivered to waste dump sites in Ulaanbaatar city and other provinces, tonnes[3]



1 Byamba, B., and Ishikawa, M. (2017). "Municipal solid waste management in Ulaanbaatar, Mongolia: systems analysis", Sustainability, vol. 9, doi:10.3390/su9060896
2 Enkhbat, A., Tsogtsaikhan, P., and Dr.Nyamdavaa, G. (2019). Report on the Current Status of the Environment of Mongolia (2017-2018)
3 Environmental database of Ministry of Environment and Tourism of Mongolia: https://eic.mn/

Annually, the transported waste amount increased by 281,706 tonnes on average in the other provinces, while it increased by 150,043 tonnes on average in Ulaanbaatar city[3].

As a result of weighing and recording waste on weigh bridges since 2010 in Ulaanbaatar city, the amount of waste received at waste dump sites has increased 7 times since 2009.

The majority of waste (2.8 million tonnes[3]) generated in urban and rural areas is disposed and buried at dump sites. Currently, there are no landfill sites available in Mongolia which meet all the environmental requirements of landfills as set forth in the Law on Waste of Mongolia 2017[4].

There is no integrated statistics on recycled waste, the statistics for the amount of waste being recycled in Mongolia vary widely depending on if the data is from government, non-government organizations and the private sector. The Report on the Current Status of the Environment of Mongolia (2017-2018) published by the Ministry of Environment and Tourism of Mongolia, states that recycled waste accounts for less than 10% of total waste. According to the statistics obtained from the environmental database[3] recycled waste accounts for 7.31% of the total waste collected, transported and disposed of at dump sites in 2018, if we compare recycling rate by city and other provinces, it would indicate that 17.5% of waste generated in Ulaanbaatar is recycled, while it is just 0.06% in provinces. According to the Mongolian National Waste Recycling Association, 300,000 tonnes of waste is sorted and recycled per year and mostly exported to China, which would be 8.9% of total collected waste. To eliminate this variation, a comprehensive study should be conducted.

4 For specific requirements for landfills please refer to Articles 17.2 – 17.6 of the Law on Waste of Mongolia.

3. PREVIOUS STUDIES ON WASTE COMPOSITION

A nationwide waste composition study has not been conducted yet, however a few studies have been undertaken in Ulaanbaatar commissioned by international donors. One of these studies was conducted under Japan International Cooperation Agency (JICA)'s Master Plan for Ulaanbaatar City Waste Management and Technical Cooperation Project for Improving Waste Management of Ulaanbaatar City in 2005-2012[5], which found the daily waste generated per person varies depending on housing district and is summarized in the table below.

Table 1: Waste generation rate per person, per day in 2007[5]

Classification	Unit	Waste generation
Apartment	g/person/day	312
Ger (household waste)	g/person/day	164
Ger (ash)	g/person/day	870
Ger (total)	g/person/day	1,034

Waste composition of households is identified as follows:

Table 2: Waste composition, percentage 2007[5]

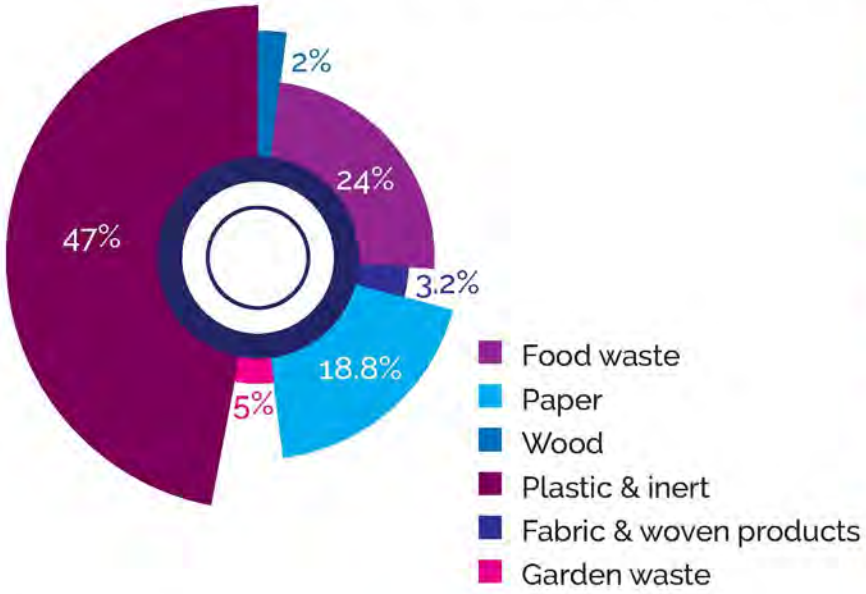
Solid waste physical composition	Percentage
Food waste	20.7
Paper	8.5
Textile	2.9
Grass, wood	0.6
Plastic	12.8
Leather, rubber	0.3
Combustible waste total	**45.8**
Metal	2.5

5 Japan International Cooperation Agency (JICA) (2007). Master Plan for Ulaanbaatar City Waste Management and Technical Cooperation Project for Improving Waste Management of Ulaanbaatar City

Glass bottles	9.3
Ceramic & stone	2.3
Miscellaneous	3.3
Incombustible waste (without ash) total	**17.4**
Other (%)	63.2
Ash (%)	36.8
Total	**100.0**

The pie-chart below shows the results of the 2014 waste composition study conducted by Namkhainyam et al. in 'Studies on country specific GHG emission and removal factors for Mongolia'[6].

Figure 4: Namkhainyam's study result[6]



6 Namkhainyam B.et al. (2014). Studies on country-specific GHG emission and removal factors for Mongolia, technical report

4. STUDY METHODOLOGY

This study is the first waste composition study conducted in winter and summer for both apartment and ger area households in Ulaanbaatar.

A general methodology for conducting waste composition studies in Mongolia was developed in order to provide a framework for future studies that can be applied in other provinces and Ulaanbaatar city. This methodology was developed based on the "Methodology to Determine the Waste Norm"[7] approved under Order A/368 dated December 25, 2017 by the Minister of Environment and Tourism and other relevant international guidelines.

The study included the following four stages as shown in graph below:

STAGE 1: Preparation for the study
from May 2018 to Aug 2018
Selecting households, agreeing on the number of samples in consultation with city officials, developing brochures and handouts for households, purchasing of required equipment, etc.

STAGE 2: Summer waste composition study
from Sep 10 to 17, 2018
Collection of samples of households, on site segregation and weighing of samples, recording results, data analysis, report writing

STAGE 3: Winter waste composition study
from Nov 26 to Dec 03, 2018
Collection of samples of households, on site segregation and weighing of samples, recording results, data analysis, report writing

STAGE 4: Analysis of the results, preparation of reports for publication:
1st and 2nd quarter of 2019
Data analysis and verification, translation, report writing

7 Ministry of Environment and Tourism (2017). Methodology to determine the waste norm, Government of Mongolia, December 25 2017, available online at https://www.legalinfo.mn/annex/details/8165?lawid=13068

4.1 Source and number of samples

The selection of sample sources and the decision on the number of samples for inclusion in the study was undertaken in collaboration with the Waste Management Department at the Ulaanbaatar City Mayor's Office and project consultants.

The study sampled municipal solid waste from 132 households in the six central districts of Ulaanbaatar city. Sampling occurred over two weeks during summer and winter of 2018 to assess potential seasonal variation. Participating households were selected to generally represent the population of Ulaanbaatar city, considering variables likely to influence waste generation and composition. This included factors such as

- Geographical location of households: district, khoroo;
- Settlement area: apartment and ger area;
- Dwelling type: apartments, townhouses, detached houses and traditional gers etc.;
- Heating type: whether households are connected to the central heating supply or use indoor combustion stoves;
- Household income level; and
- Number of family members.

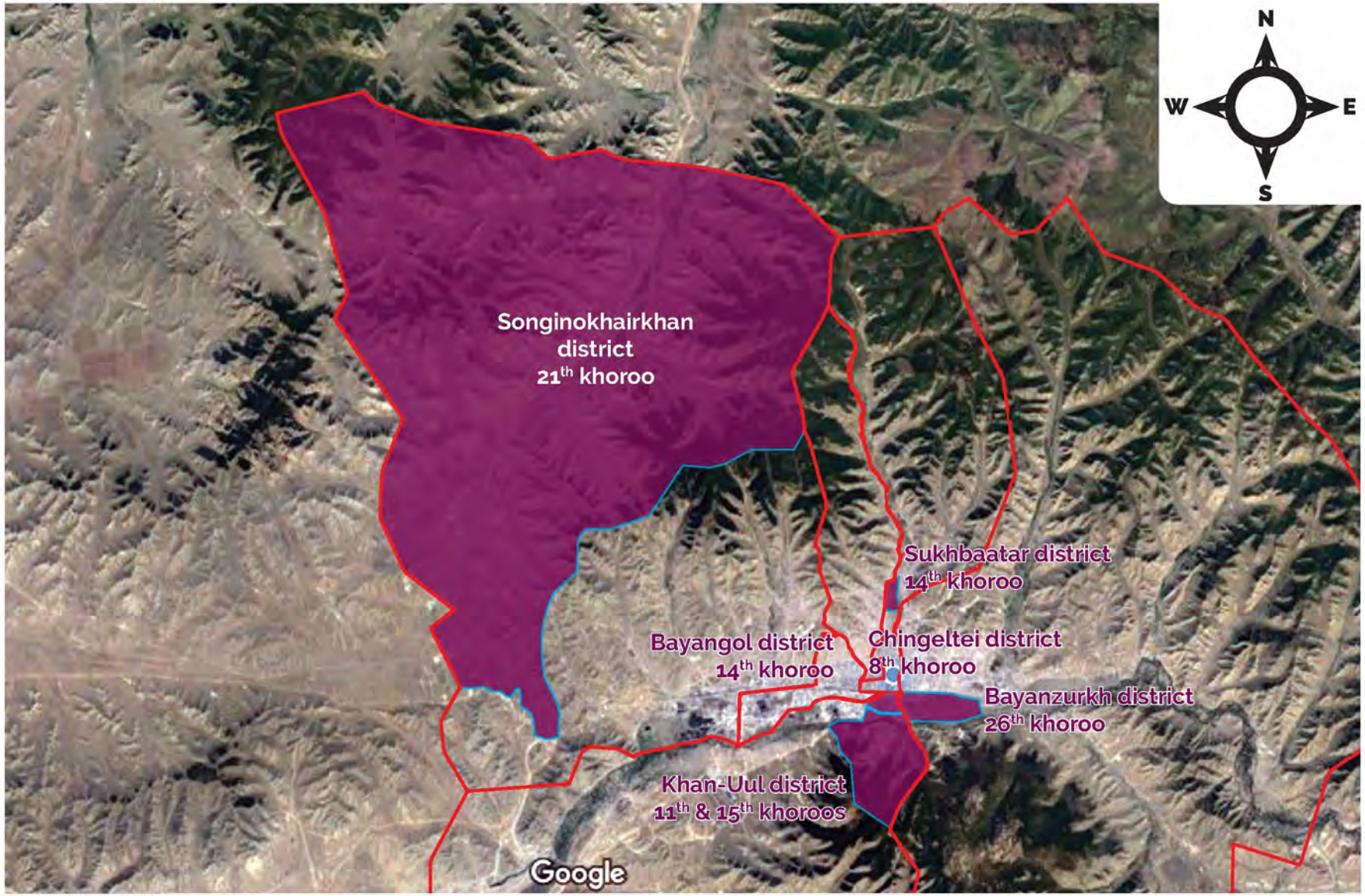
While a total of 132 households were targeted to be included in the study, the actual participation rates were 131 households (72 from ger areas, 59 from apartment areas) in the summer study and 130 households (72 from ger areas, 58 from apartment areas) in the winter study. The study team tried to include the exact same households in both summer and winter study, but 22 households needed to be replaced due to either inactive participation in summer study or unwillingness to be included in the winter study.

Ulaanbaatar ger and apartment districts

Table 3: Summary of the households which participated in the study and number of samples collected

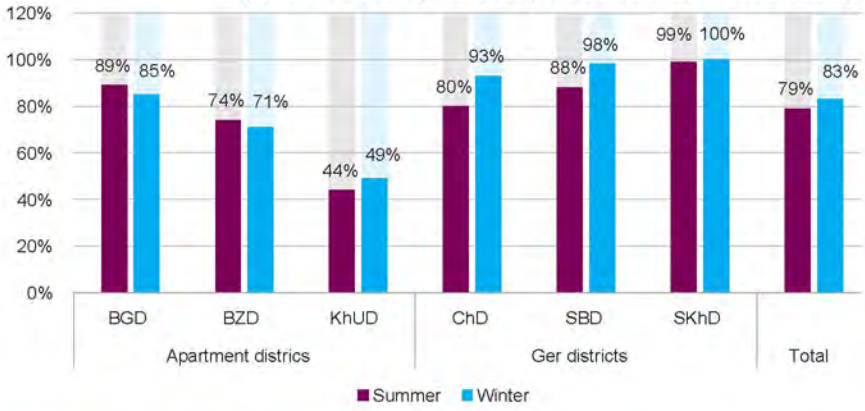
District and khoroo, dwelling type	Household income level	Number of family members	Summer		Winter	
			No. households	Total no. samples	No. households	Total no. samples
APARTMENT DISTRICTS						
Apartment	>1mill MNT/month	<4	2	10	-	-
		4+	9	59	9	48
	<1mill MNT/month	<4	6	38	3	20
		4+	3	17	8	51
Bayangol (BGD) -14: Belongs to zone 1 of the city. Microdistrict of apartments.		District subtotal	***20***	***124***	***20***	***119***
Apartment	>1mill MNT/month	<4	6	32	5	26
		4+	5	29	5	22
	<1mill MNT/month	<4	2	11	5	20
		4+	7	32	5	32
Bayanzurkh (BZD) -26: Belongs to zone 2 of the city. Microdistrict of newly constructed apartment complexes.		District subtotal	***20***	***104***	***20***	***100***
Apartment	>1mill MNT/month	<4	7	31	6	23
		4+	9	27	5	21
Town house	>1mill MNT/month	<4	-	-	2	8
		4+	3	4	5	16
Khan-Uul (KHUD) -11: Belongs to zone 1 in the city. Microdistrist of townhouses.		District subtotal	***19***	***62***	***18***	***68***

District and khoroo, dwelling type	Household income level	Number of family members	Summer		Winter	
			No. households	Total no. samples	No. households	Total no. samples
GER DISTRICTS						
Detached house	>1mill MNT/month	4+	2	12	2	13
	<1mill MNT/month	<4	11	64	10	59
		4+	5	27	6	31
Ger	<1mill MNT/month	<4	3	16	2	12
		4+	3	16	4	18
Chingeltei (CHD) -8: Belongs to zone 3 in the city. Closer to the city center.		District subtotal	***24***	***135***	***24***	***133***
Detached house	>1mill MNT/month	<4	1	7	2	12
		4+	2	14	4	27
	<1mill MNT/month	<4	1	6	1	7
		4+	12	74	9	61
Ger	>1mill MNT/month	4+	1	5	1	7
	<1mill MNT/month	<4	1	6	-	-
		4+	6	35	7	46
Sukhbaatar (SBD) -14: Belongs to zone 3 in the city. Isolated from the city center		District subtotal	***24***	***147***	***24***	***160***
Detached house	>1mill MNT/month	<4	4	27	4	28
		4+	4	28	4	28
	<1mill MNT/month	<4	2	14	2	14
		4+	1	7	1	7
Ger	>1mill MNT/month	<4	2	14	2	14
		4+	3	21	3	21
	<1mill MNT/month	<4	2	14	2	14
		4+	6	42	6	42
Songino Khairkhan (SKHD) -21: Belongs to zones 4 and 5 in the city. Isolated from city center, livestock and animal husbandry primary occupation.		District subtotal	***24***	***167***	***24***	***168***
TOTAL			**131**	**739**	**130**	**748**


N
W
E
S
Songinokhairkhan district 21th khoroo
Sukhbaatar district 14th khoroo
Bayangol district 14th khoroo
Chingeltei district 8th khoroo
Bayanzurkh district 26th khoroo
Khan-Uul district 11th & 15th khoroos
Google
District boundary
Khoroo boundary

Participation level of households living in Songinokhairkhan district was very high in both summer and winter with 99-100%. Other districts that participated actively were Bayangol and Sukhbaatar districts, ranging from 85-98%. The least participation registered in Khan-Uul district reaching just 44%-49%.

Figure 5: Participation of households in the study



4.2 Sample collection

The household waste composition study was conducted over two weeks, with a week in summer (September 10 to 16, 2018)[8], and a week in winter (26 November to 3 December 2018)[9]

- Information brochures and training were provided to target households and kheseg leaders regarding how to segregate waste into different categories
- Households were asked to segregate the waste samples into 7 categories at household level as shown below:

8 Average temperature was 15C during the day and 2C at night. Source: https://www.accuweather.com/en/mn/ulan-bator/246421/september-weather/246421?year=2018
9 Average temperature was -8C during the day and -19.5C at night. Source: https://www.accuweather.com/en/mn/ulan-bator/246421/december-weather/246421?year=2018

Waste samples from households

Plastics and tetra pak cartons: plastic bottles from drinks, juice, milk, yogurt, water, shampoo, detergent, domestic cleaning products and all types of plastic bags

Glass and metal cans: metal and glass bottles from vodka, beer, juice, pickles, jam etc.

Food waste

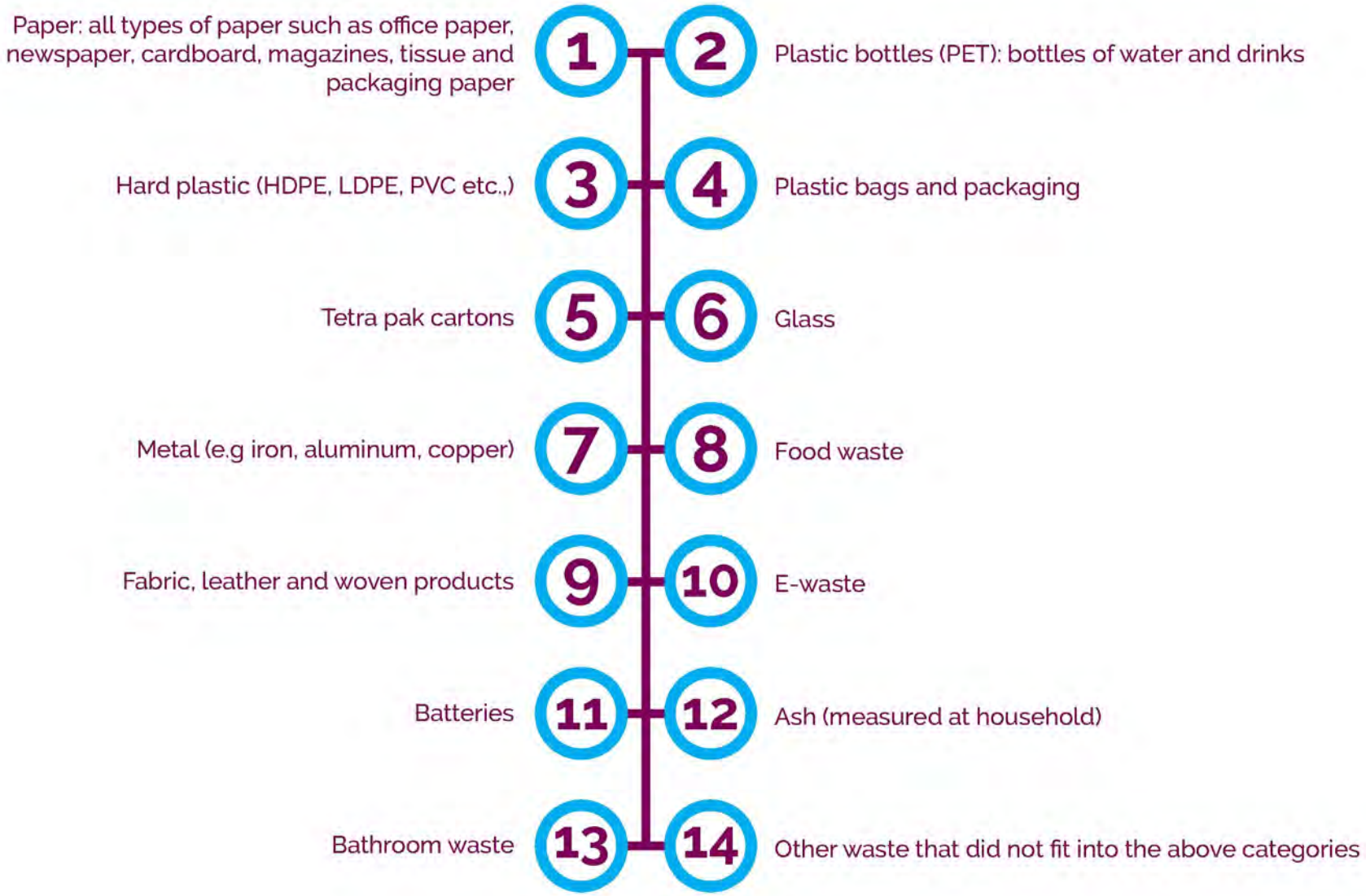
Everything comes out of the bathroom/toilet area

All types of paper such as printing paper, newspaper, cardboard, magazines, box board, tissue and packaging paper

Ash

All other miscellaneous waste

- Segregated waste samples were collected from households every day for a week
- The segregated waste samples were then delivered to segregation point where samples were further segregated into below 14 categories by segregation team, detailed below.



- At households where livestock is kept, the weight of animal dung waste was estimated based on information provided by the household and observation.
- The weighing of ash in winter composition study occurred twice in two of the ger khoroos (khoroo 8 of Chingeltei district and khoroo 14 of Sukhbaatar district) due to doubt that the portable weighing equipment used during the summer study could be used for the large quantities of ash generated in winter. To eliminate this doubt during the first ash measurement, the study team changed its methodology from daily based weighing to weekly based weighing by providing a large ash container to all 48 households. The households were requested to deposit their ash to that container only for the full week and at the end of the week the study team visited on the field and measured ash at each household.

Ash collection and weighing at Ger area households

4.3 Surveys and interviews

As part of the waste composition study, a questionnaire survey was conducted at the same 131 households that participated in the summer composition study. The questionnaire was based on their personal observation which and had a total of 16 questions including their perception of the amount of waste they generate and the composition.

4.4 Study limitations and assumptions

- Sampling locations were selected to be representative of households across the six central districts of Ulaanbaatar, based on assumptions made as a result of previous studies and the experience of project consultants. This included households representing a broad range of demographic factors which would potentially influence waste composition and generation, but does not constitute a statistically representative sample.

- Not all demographic factors were considered and assessed, for example the age of household residents or employment status. Data therefore is not necessarily applicable to other districts or locations, or where household characteristics vary from those included in the study.

- The sampling occurred over a one week period in summer and a one week period in winter. Variation based on holidays and other seasonal influences therefore has not been considered and might affect the overall waste generate figures for a household annually.

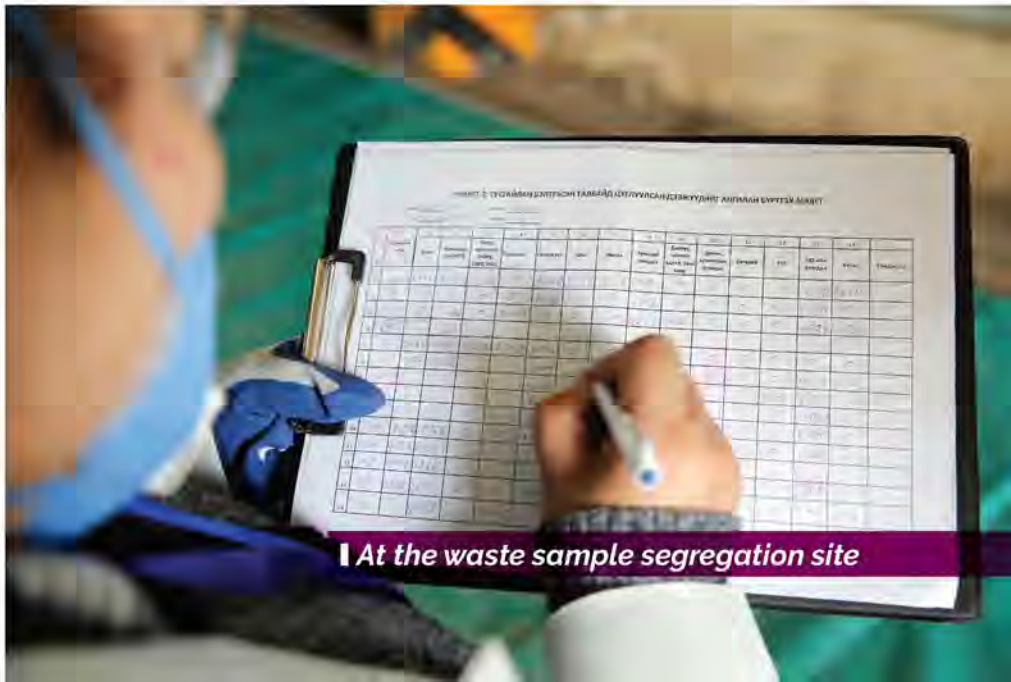
- Households did not all participate in the study for the entire two week period. In some districts, households that participated in the summer and winter sampling were different, however an attempt was made to maintain diversity in household characteristics by replacing each household that drops out with a "like" household that had similar demographics.

5. FINDINGS OF THE STUDY

5.1 Total weight of samples

A total of 1,487 waste samples were collected from households during the study over the summer and winter periods. During summer, approximately 1,258 kg of waste was measured and characterized across 739 samples collected from the 131 households who participated. During the winter study 748 samples were collected from 130 households for a total of 2,624 kg of waste measured and characterized.

Table 4 and Figure 6 below presents a summary of the number of samples and quantity of waste measured by district as part of the study.

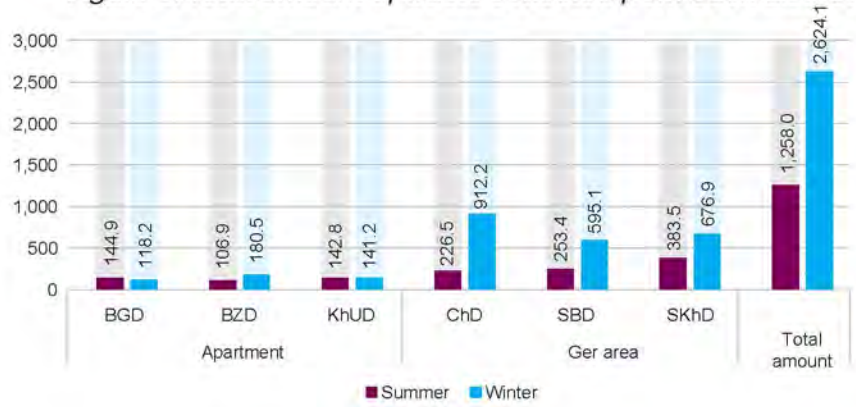


At the waste sample segregation site

Table 4: Summary of waste sampled

District and khoroo		Summer study					Winter study				
		No. Households	No. residents	Total no. samples	Total waste sampled (incl. ash) (kg)	Total waste sampled (excl. ash) (kg)	No. households	No. residents	Total no. samples	Total waste sampled (incl. ash) (kg)	Total waste sampled (excl. ash) (kg)
Apartment areas	BGD-14	20	89	124	-	145	20	89	119	-	118
	BZD-26	20	86	104	-	107	20	86	100	-	181
	KHUD-15/11	19	73	62	-	143	18	68	68	-	141
Ger areas	CHD-8	24	86	135	227	201	24	86	133	912	215
	SBD-14	24	118	147	253	212	24	118	160	595	180
	SKHD-21	24	96	167	384	221	24	96	168	677	147
Total		**131**	**548**	**739**	**1,258**	**1,029**	**130**	**543**	**748**	**2,624**	**982**

Figure 6. Total amount of waste collected from each district



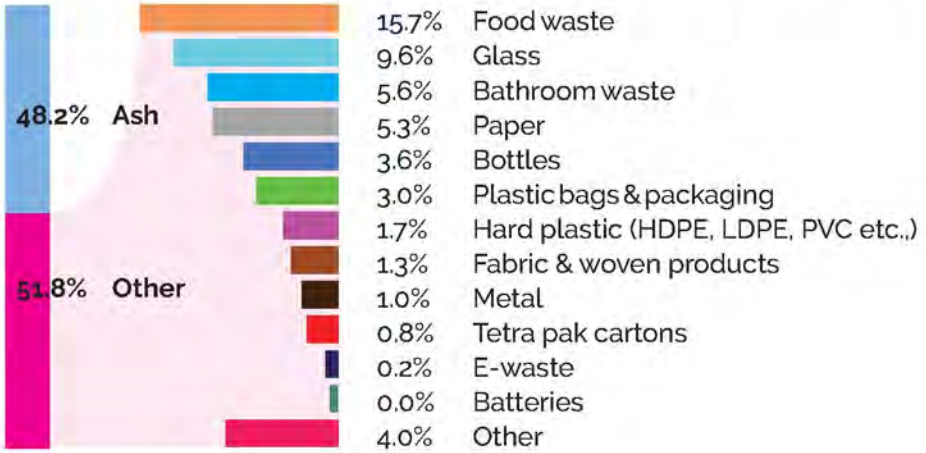
5.2 Composition of waste

The composition of waste as a percentage by weight[10] for the samples collected is summarized in Table 5. On average across all samples, the top three components of waste measured by weight were ash (48.2%), food waste (15.7%) and glass (9.6%).

10 The results of the study are presented as a percentage by weight. Data does not take into account different densities of materials (for example glass is heavier than fabric). This was based on international methods and previous studies for conducting waste characterization and composition studies, however it should be noted when interpreting the results.

At the waste sample segregation site

Figure 7: Average annual composition across all samples in both summer and winter (% by weight)



5.3 Waste composition by area

Figures 7-11 show the composition of waste generated in summer and winter by the households in ger and apartment areas.

The composition of waste generated by the households in ger and apartment areas are different. The majority of waste from ger area households during winter was ash, in contrast to apartment areas where it was mainly food waste throughout the year.

26.5% of total waste generated by ger area households is ash during summer, which significantly increases to 75.2% in winter. 41.0% of total summer waste generated by apartment area households was food waste, which is relatively high compared to the 16% food waste measured in the ger area households.

Figure 8: Waste composition in ger area households (summer)

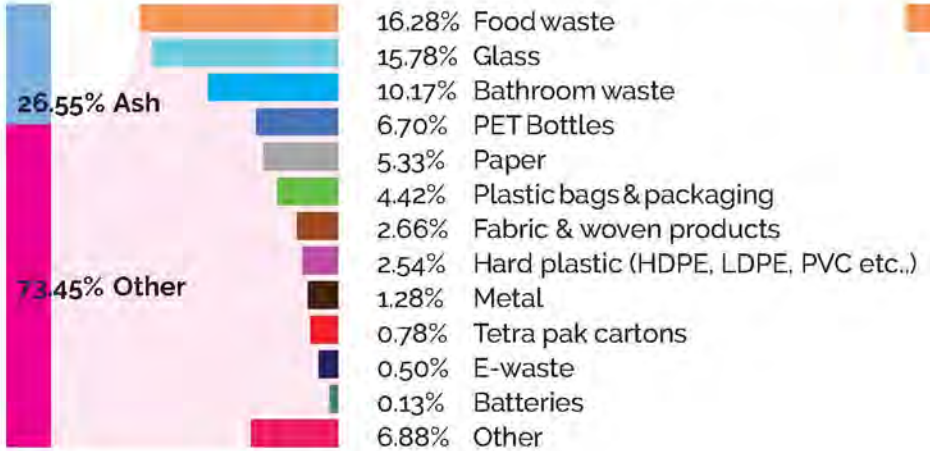


Figure 9: Waste composition in ger area households (winter)

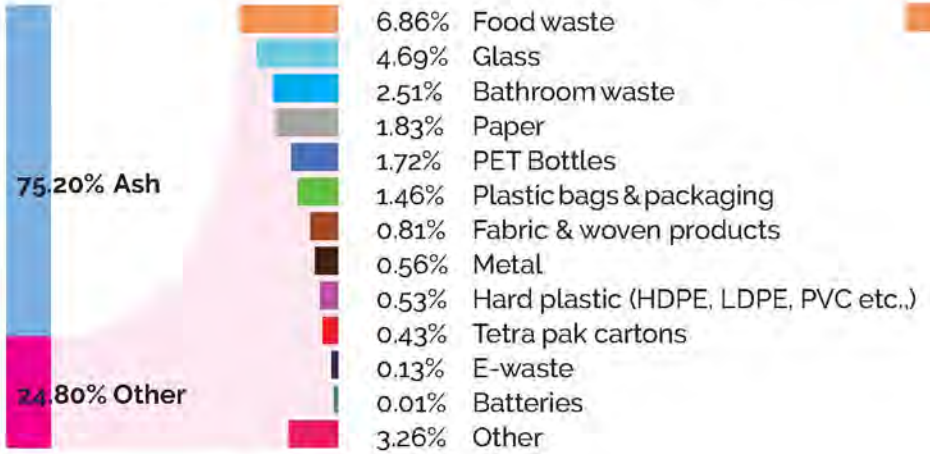


Figure 10: Waste composition in apartment households (summer)

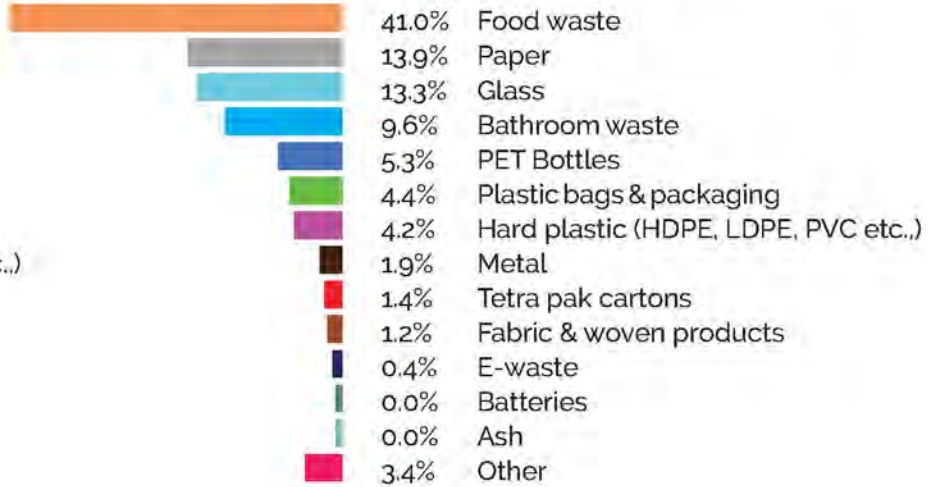
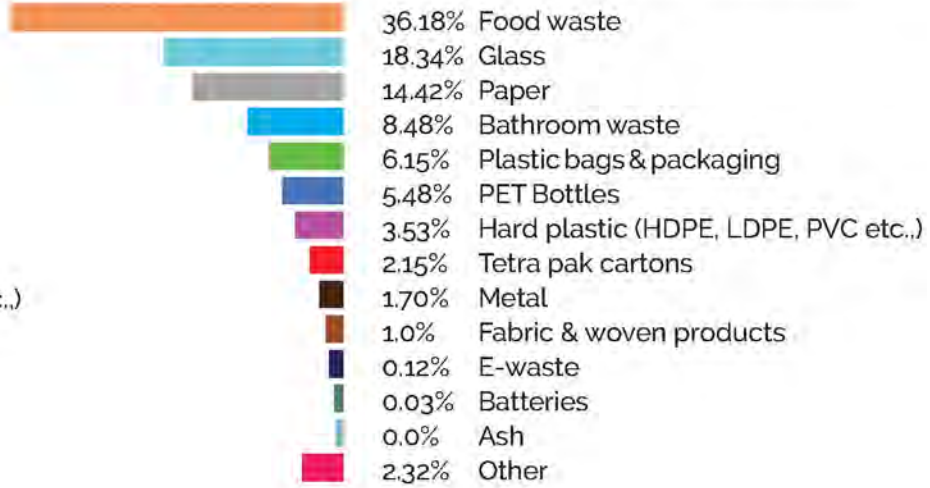


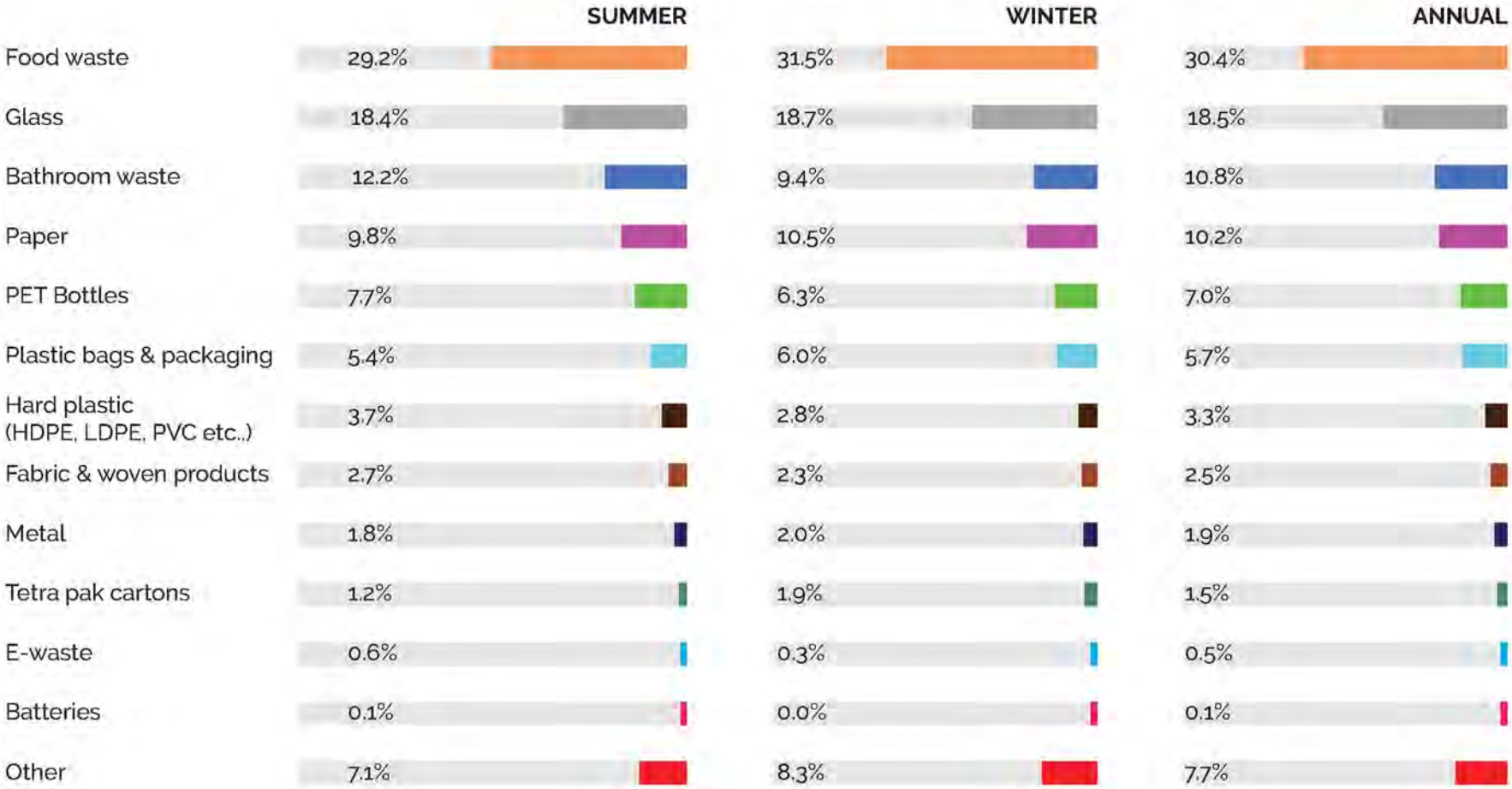
Figure 11: Waste composition in apartment households (winter)



5.4 Seasonal variation of waste composition

There was significant seasonal variation in the composition of waste from ger area households due to the significant amount of ash generated during winter. When we excluded ash from the ger area waste composition to observe seasonal variation of other types of waste, we found that the summer and winter ger area waste composition did not vary significantly, as shown in Figure 12 below.

Figure 12: Seasonal waste composition (excluding ash, percentage by weight)



5.5 Waste composition by dwelling type

3 highest contributions to waste by dwelling type:

- Waste composition of **households living in a ger in the ger areas was found to be:** 39% ash, 11% food waste, and 9% glass in summer. In winter, it was 71% ash, 7% food waste, and 5% glass;
- Waste composition of **households living in detached houses in ger areas was found to be:** 20% ash, 19% glass, and 19% food waste in summer. In winter it was 77% ash, 7% food waste and 5% glass;
- Waste composition of **households living in the apartments was found to be:** 41% food waste, 14% paper, and 14% glass in summer. In winter, it was 36% food waste, 18% glass, and 14% paper; and
- Waste composition of **households living in townhouses was found to be:** 48% food waste, 16% paper, and 10% bathroom waste in summer. In winter, it was 35% food waste, 19% glass, and 16% paper.

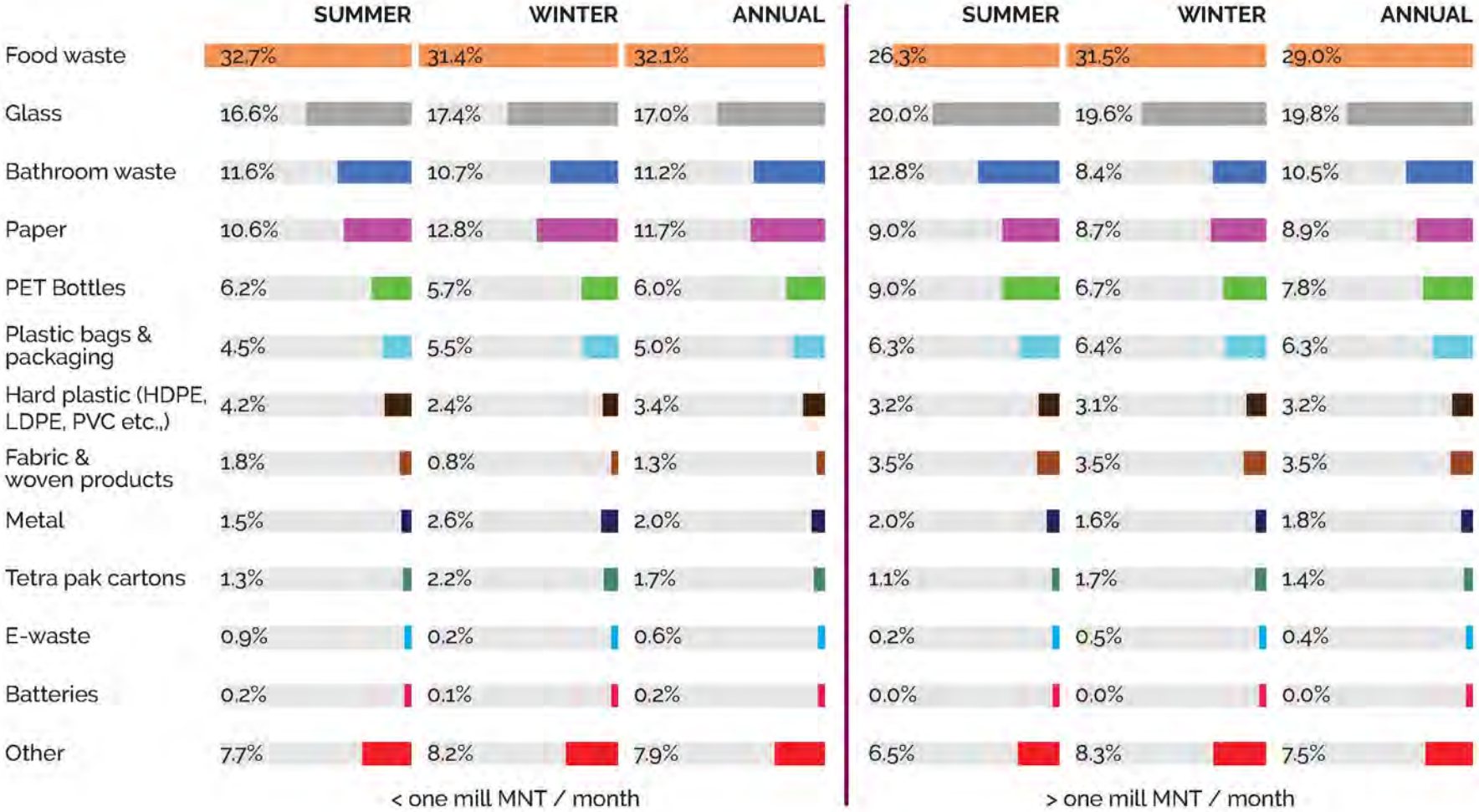
Table 5: Waste composition by dwelling type

Area	Dwelling type	Season	Number of samples	Paper	PET bottles	Hard plastic (HDPE, LDPE, PVC etc.,)	Tetra pak cartons	Plastic bags & packaging	Glass	Metal	Food waste	Fabric & woven products	E-waste	Batteries	Bathroom waste	Ash	Other
Ger areas	Gers	Winter	174	3%	2%	1%	0%	2%	5%	0%	7%	1%	0%	0%	4%	71%	4%
		Summer	169	5%	7%	2%	1%	5%	9%	1%	11%	2%	1%	0%	9%	39%	7%
	Detached houses	Winter	287	2%	2%	1%	0%	1%	5%	1%	7%	1%	0%	0%	2%	77%	3%
		Summer	280	6%	7%	3%	1%	4%	19%	1%	19%	3%	0%	0%	11%	20%	7%
	Average	Winter	461	2%	2%	1%	0%	1%	5%	1%	7%	1%	0%	0%	3%	75%	3%
		Summer	449	5%	7%	3%	1%	4%	16%	1%	16%	3%	0%	0%	10%	27%	7%
		Annual	910	3%	3%	1%	1%	2%	8%	1%	10%	1%	0%	0%	5%	61%	4%
Apartment areas	Apartments	Winter	263	14%	5%	4%	2%	7%	18%	1%	36%	1%	0%	0%	9%	n/a	2%
		Summer	286	14%	5%	4%	1%	4%	14%	2%	41%	1%	0%	0%	10%	n/a	3%
	Town houses	Winter	24	16%	7%	3%	4%	3%	19%	3%	35%	1%	0%	0%	7%	n/a	3%
		Summer	4	16%	6%	7%	1%	5%	3%	1%	48%	0%	0%	0%	10%	n/a	2%
	Average	Winter	287	14%	5%	4%	2%	6%	18%	2%	36%	1%	0%	0%	8%	n/a	2%
		Summer	290	14%	5%	4%	1%	4%	13%	2%	41%	1%	0%	0%	10%	n/a	3%
		Annual	557	14%	5%	4%	2%	5%	16%	2%	38%	1%	0%	0%	9%	n/a	3%
All areas Summer Annual		Winter	748	4%	2%	1%	1%	2%	7%	1%	12%	1%	0%	0%	4%	63%	3%
		Summer	739	8%	6%	3%	1%	4%	15%	1%	24%	2%	0%	0%	10%	18%	6%
		Annual	1,487	5%	4%	2%	1%	3%	10%	1%	16%	1%	0%	0%	6%	48%	4%

5.6 Waste composition by income level

Out of total households surveyed, 46% of the households had a combined monthly income over MNT 1 million and 54% were less than MNT 1 million. However, the composition of waste between households that had an income above versus below MNT 1 million did not vary significantly. Waste composition based on income level is shown below in Figure 13 (excluding ash).

Figure 13: Waste composition based on income level (percentage by weight, excluding ash)



5.7 Waste generation rate per person

As for the daily waste generation rate per person, ger area residents were found to be producing 609.3 g of waste on average during summer whereas this number increases to 1,530.1 g (2.5 fold increase) during winter due to excessive amount of ash. As for the residents of apartments, each person was found to be generating 414.2 g waste per day during summer and 427 g per day in winter.

If the dwelling type is not considered, the average daily waste generation of those who participated in the study was found 1,038.0 g per person during winter compared to 521.3 g in summer. If ash is excluded, the daily generation rate decreased to 440 g per person in summer and 424.3 g in winter (see Figure 14).

Figure 14: Waste generation rate per person per day

	SUMMER	WINTER
 APARTMENT	**414** g/person/day	**427** g/person/day
 GER AREA	**609** g/person/day **460** g/person/day excluding ash	**1,530** g/person/day **422** g/person/day excluding ash
 AVERAGE	**521** g/person/day **440** g/person/day excluding ash	**1,038** g/person/day **424** g/person/day excluding ash

Table 6: Waste generation rate per person, per day (g) (Min, Max, Average scenarios)

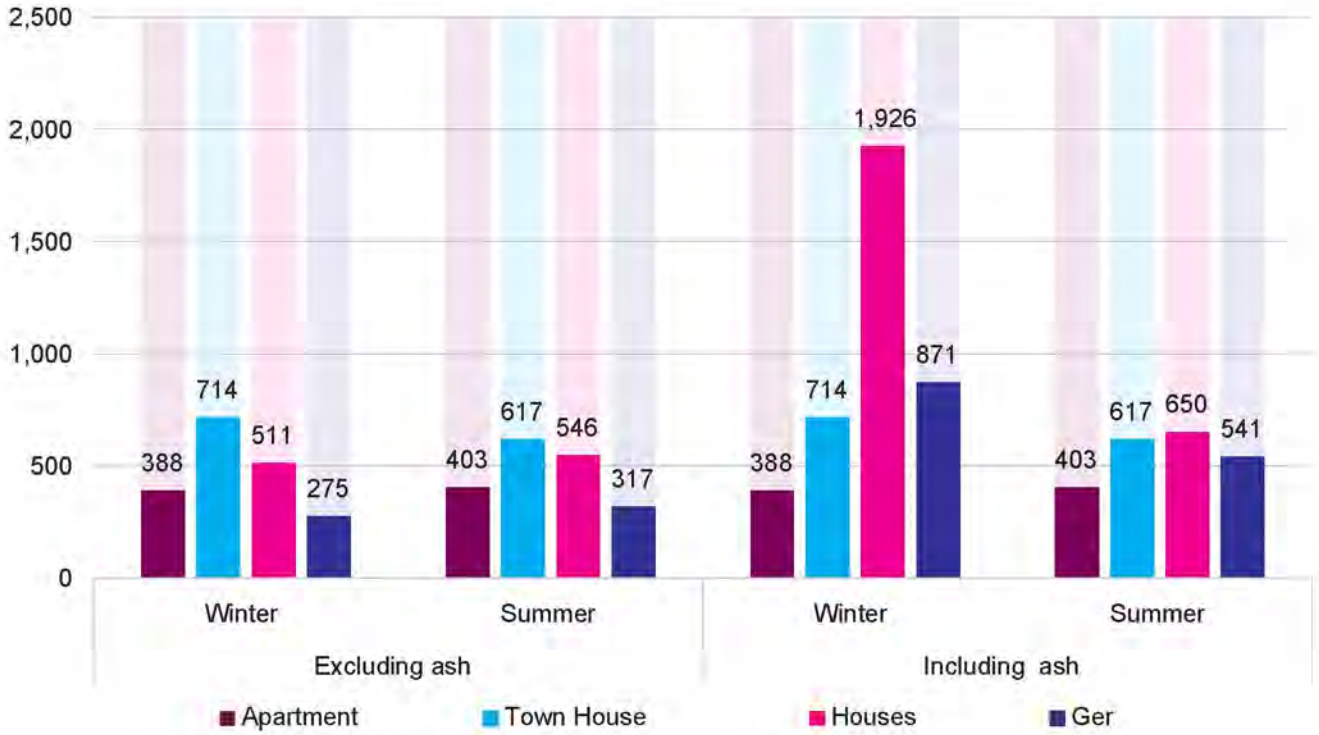
No.	Participating Household District	Season	Waste generation rate (excluding ash) (g)			Waste generation rate (including ash) (g)		
			Average	Minimum	Maximum	Average	Minimum	Maximum
APARTMENT		winter	427	25	1,558	427	25	1,558
		summer	414	85	1,575	414	85	1,575
1	Households participated from BGD	winter	226.1	24.6	976.5	226.1	24.6	976.5
		summer	306.6	94.1	817.3	306.6	94.1	817.3
2	Households participated from BZD	winter	477.3	26.7	1,281.9	477.3	26.7	1,281.9
		summer	293.4	85.1	1,262.7	293.4	85.1	1,262.7
3	Households participated from KHUD	winter	594.5	112.6	1,557.6	594.5	112.6	1,557.6
		summer	654.7	85.0	1,574.5	654.7	85.0	1,574.5
GER AREA		winter	422	84	3,502	1,530	92	10,693
		summer	460	48	2,543	609	98	2,600
4	Households participated from CHD	winter	733.4	83.8	3,502.0	2,455.9	397.4	10,692.9
		summer	625.6	98.4	2,543.2	692.0	130.8	2,599.5
5	Households participated from SBD	winter	234.6	92.1	519.3	737.2	92.1	1,997.9
		summer	317.6	47.5	757.4	367.2	98.0	757.4
6	Households participated from SKHD	winter	298.1	97.6	991.1	1,397.2	333.1	5,462.6
		summer	438.0	100.6	1,405.7	767.8	154.9	1,821.4
AVERAGE		winter	424	25	3,502	1,038	25	10,693
		summer	440	48	2,543	521	85	2,600

5.8 Waste generation per person based on dwelling type

When waste amount generated by a person in different dwellings is calculated, a resident living in an apartment generates 388 g waste on average per day in winter and 403 g waste on average per day in summer. In townhouses, the average was 714 g per day in winter and 617 g waste on average per day in summer.

When waste amount, including ash, generated by a person in ger area is calculated, a resident living in a detached house generates 1,926 g waste per day in winter and 650 g waste per day in summer. As for the residents who are living in the ger, it is 541 g per day in summer and 871 g per day in winter. If ash is excluded, a resident living in a detached house generates 511 g waste per day in winter and 546 g waste per day in summer. As for the residents living in a ger it is 275 g per day in winter and 317 g per day in summer. Further details can be found in Figure 15.

Figure 15: Average waste amount per person per day by dwelling type (grams)

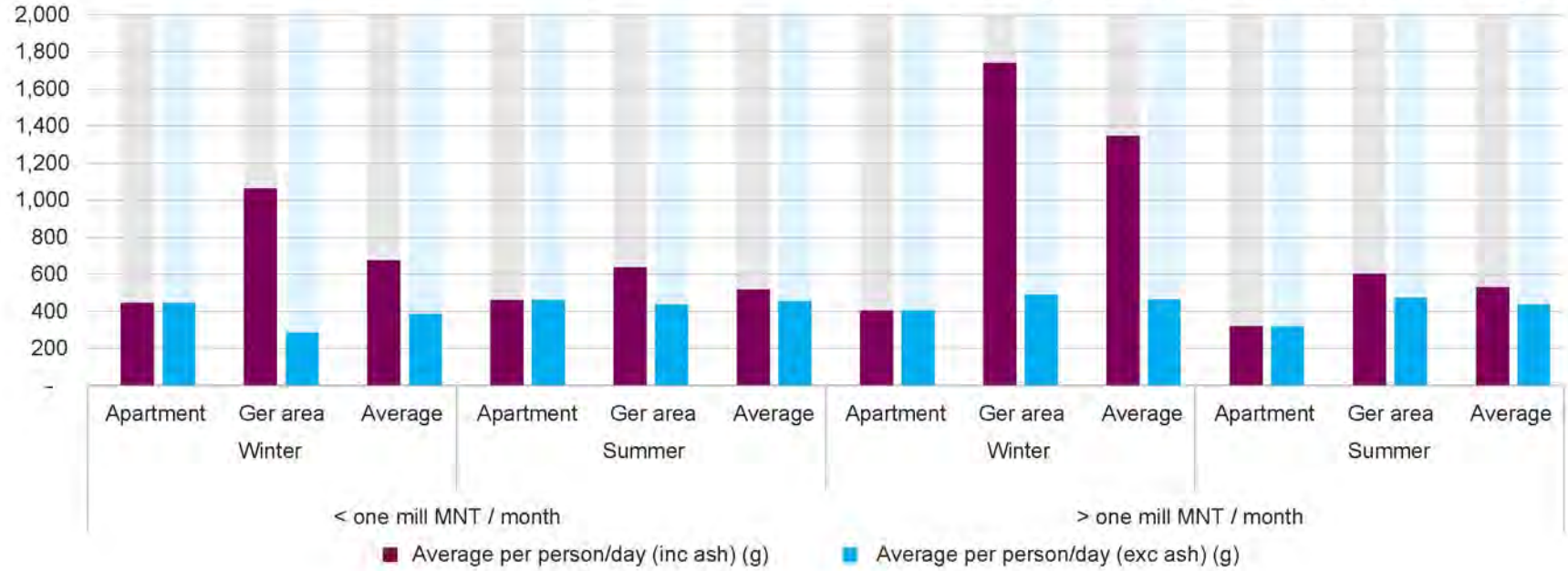


5.9 Waste generation per person dependent on household income

While this study could not draw clear causal linkages between waste generation rate and income level of families, there were broad trends that could inform future studies. One of the linkages found is that higher income families in ger districts present significant seasonal variation and tend to produce more waste during summer, even when excluding ash from results. This trend is especially visible in summer when higher income ger households produce almost twice as much waste when ash is excluded and match the waste quantity within apartments of high income earners. This was an unexpected finding as a common assumption is that lower income ger households burn combustible waste in winter for added warmth, which would have been displayed as lower income ger households having less waste in winter. What was actually observed that was waste excluding ash in the lower income ger households showing little seasonal variation.

Another interesting finding was that high income households in apartments did not exhibit seasonal changes in waste generation, the only group that has this feature. They generally created more waste regardless of season compared to low income apartment households, which created the least amount of waste except when compared to high income ger households excluding ash weight. The low income apartments also displayed seasonal variation, generating slightly less waste in winter. Further study needs to investigate the correlation between waste generation rate and income level to improve the understanding of the forces driving the trends observed.

Figure 16: Waste generation rate based on income level (grams)



5.10 Special waste

88-94.6% of total waste generated by livestock raising households in Khoroo 21 of Songinokhairkhan district is animal manure waste, summarized in Table 7.

Table 7: Waste composition of livestock raising households

No.	Types of waste	Amount of waste, kg			
		Summer		Winter	
		kg	%	kg	%
1	Paper	15.84	0.2%	9.7	0%
2	Plastic bottles (PET)	17.59	0.2%	10.9	0%
3	Hard plastic (HDPE, LDPE, PVC etc.,)	10.06	0.1%	3.9	0%
4	Tetra pak cartons	3.20	0.0%	3.0	0%
5	Plastic bags & packaging	10.26	0.1%	5.5	0%
6	Glass	56.56	0.8%	35.2	1%
7	Metal	3.29	0.0%	5.7	0%
8	Food waste	34.18	0.5%	24.0	0%
9	Fabric & woven products	5.82	0.1%	0.8	0%
10	E-waste	1.70	0.0%	0.0	0%
11	Batteries	1.09	0.0%	0.2	0%
12	Ash	162.20	2.3%	530.2	9%
13	Bathroom waste	26.27	0.4%	18.7	0%
14	Other	35.40	0.5%	29.1	1%
15	Special waste	6,695.00	94.6%	5,065.0	88%
TOTAL		**7,078.48**	**100%**	**5,741.9**	**100%**

While animal manure was excluded from the survey, the statistics are provided in order to highlight the sheer volume.

Livestock raising households live in the remote Khoroo 21 of Songinokhairkhan district. The study included 24 households of this Khoroo and all of them have livestock, however the exact number of livestock per household is unknown. Animal manure can be used as fuel, but if the household generates an excessive amount of manure that can't be solved by using it as a fuel then sometimes it is dumped straight into the public places, roads and valleys. Waste transportation companies refuse to transport the animal manure either separately or mixed in with household waste.

Cow dung, Songinokhairkhan district, khoroo 21

5.11 Household questionnaire survey findings

Survey findings show that households in ger areas varied widely in their description of the quantity of waste generated. 51% of ger area households assumed that they generally produces one regular-sized (shopping bags) plastic bag of waste per day and 16% of households assumed 500 g of waste per day. Whereas 92% of apartment area households assumed that they were generating one regular-sized plastic bag of waste per day, while the remaining 8% estimated that they usually generate two regular sized plastic bags of waste per day.

One regular-sized plastic bag of waste weighs around 2 kg. If this is divided by the average number of household members which is 3.8 people, the waste generation rate per person will be approximately 500 g, which is close to the findings of waste composition study.

When asked about the types of waste that are mostly generated, 28% of ger area households answered that they thought food waste was the most generated waste whereas 27% thought paper was the most common and 16% answered ash. When the same question was asked from the residents from apartment area majority of the households (57%) answered as food waste followed by paper (22%). These results are again similar to those measured in the waste composition study.

At the waste sample segregation site

6. CONCLUSION

The major findings and conclusions of the study include the following:

- **Waste generation rate per person is increasing, while its composition is also changing.** While the outcomes of previous composition studies cannot be compared directly to this study due to differences in the methodology, overall the study findings show that the waste composition has been changing and waste generation per person has been increasing in relation with the population and income growth.

- **Waste amount in apartment districts is seasonally stable.** The difference in waste generation per person per day in apartment areas in summer and winter is approx. 13 g which indicates very small seasonal variation. In terms of composition, there is also very little difference irrespective of season.

- **Ash plays a major role in defining the overall waste composition and waste generation per person in ger area households.** In ger district households ash formed between 26-75% of waste weight in summer and winter respectively. More studies should be conducted to understand the characteristics of the ash generated in ger districts, and to identify proper ways of segregation, transportation, disposal and recycling of ash. Only by finding viable solutions for ash would it be possible to resolve the waste issue in ger areas, especially during winter time when ash prevails in the household waste composition.

- **More than 60% of household waste generated can potentially be recycled or pre-processed for recycling.** Even though there is limited recycling happening in country, there is a possibility to export certain recyclables to China after pre-processing in country. Also there are upcoming projects to support and expand recycling in country in accordance with green development plans of the Government of Mongolia, which aims for 40% of total waste to be recycled by 2030. This presents a strong case for developing waste recycling and processing plants in country and creating a legal framework for integrating waste into the economy. This would also be a crucial step towards actualization of the circular economy.

Mr.Gantumur, the Ulaanbaatar City General Manager and the Head of the Mayor's office visiting the waste sample segregation site

- **Inert waste is usually high in the household composition due to significant amount of ash.** Inert waste[11], waste that does not undergo any significant physical, chemical or biological transformations, is usually high in the household composition when ash is included, approx. 57.8% since ash itself is considered to be inert. However, when ash is excluded, non – inert waste[12] prevails at 73.8% because of high volume of food waste in the household composition

- **The majority of the waste generated by apartment area households is food waste (36%- 41%).** In Ulaanbaatar, apartment area households are middle or upper-middle level of income, and income growth is linked to increased use of goods and products which results in food waste, such as left-overs, as well as vegetable and fruit peels. Whereas in ger area households food waste is much less than that of the apartment area. Income level in ger areas is generally lower, variety of food consumed might be less and leftovers are fed to domestic animals.

- **The high volume of food waste, contributes to the increasing greenhouse gas (GHG) emissions from the waste sector.** Since there is no official segregation of food waste happening at source, food waste is mixed with other household waste and transported directly to dump sites where currently there is no proper capture of methane. The Waste law 2017 requires the Ulaanbaatar dump sites to be upgraded by introducing technologies for methane capture and use, and the Ulaanbaatar City Municipality aims to introduce at source segregation of waste starting from 2020. Going forward proper food segregation should happen at source, and relevant technologies should be in place to divert food waste from dump sites and to reduce GHG from waste.

11 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/296422/geho1110btew-e-e.pdf Inert waste will not dissolve, burn or otherwise physically or chemically react.
12 https://www.epd.gov.hk/epd/misc/cdm/introduction.htm Non-inert waste includes other wastes such as food waste, bamboo, timber, vegetation, packaging waste and other organic materials.

- **Non-combustible waste[13], the inorganic content of solid waste, is quite high in household waste composition, when ash is included and makes approx.** 58.8% in the household composition. However, when ash is excluded, the volume of combustible waste[14] considerably increases and reaches 71.4%. Segregation of waste should happen at source prior to transporting waste to incineration facilities if such projects are in discussion in the near future. The amount of combustible waste such as paper, plastic bottles, plastic bags, cotton or woven fabric materials, sanitary napkins reduced substantially in winter (26.4% in winter and 59.0% in summer respectively), that might suggest that ger area households might be burning some waste materials in household stoves or out in the open.

13 https://www.codepublishing.com/CA/SantaCruz/html/SantaCruz06/SantaCruz0612.html#6.12.090 Non-combustible waste (inorganic content of solid waste, including glass, metal, tin, cans, foils, dirt, gravel, brick, ceramics, crockery and ashes)
14 https://www.codepublishing.com/CA/SantaCruz/html/SantaCruz06/SantaCruz0612.html#6.12.090 Combustible waste (organic content of solid waste, including paper, cardboard, cartons, wood, boxes, excelsior, textiles, bedding, leather, rubber, paints, yard trimmings, leaves, and household waste all of which will burn).

At the waste sample segregation site

- **Income doesn't play important role in household waste composition.** A comparison of waste composition by income level identified that with the exception of ash, the proportion of waste was not significantly different between households earning above or below the average income of 1 million tugrugs per month. For more detailed analysis, variety of income ranges should be considered to explore the link between waste composition and income level.

- **The waste composition by dwelling type was similar to the waste composition by settlement area.** Households living in ger areas irrespective of the dwelling type – whether it was a ger or a detached house – generated similar types of waste. In households who lived in apartments and town houses the composition and quantity of waste were roughly the same.

Waste samples collected








Different waste categories

- **It is recommended to conduct waste composition studies periodically, ideally every few years to reflect the changes in the composition and amount of waste generated per person per day.** It is also recommended to build the capacity of government officials at both national and sub national levels to conduct such studies and to encourage them to use the findings to improve decision making in the waste sector.
- **Methodology should be further improved to consider local specifics and the volume of waste:** Over time the methodology should be improved and customized to local needs especially in the rural context so that specifics of rural waste composition are well reflected. Also while improving the methodology it would be important to consider volume of waste which is equally important as the weight of waste.
- **Proper actions should be taken to address the increasing amount of ash:** It is recommended to test, pilot and implement adequate treatment (collection, transportation, disposal, reuse and recycling) of ash, especially in ger areas where there is substantial amount of ash in the household waste in winter time.
- **Adequate treatment of food waste is essential:** The same recommendation applies to food waste which makes up a majority of waste produced at apartment households - to test, pilot and implement adequate treatment (collection, transportation, disposal, reuse and recycling) of food waste. More detailed composition study of food waste should be carried out to understand and explore opportunities for food waste treatment and recycling in order to divert as much food waste as possible from dumpsites.
- **Livestock waste should be handled properly:** Innovative solutions for adequate treatment (collection, transportation, disposal, reuse and recycle) of livestock waste (e.g cow dung) should be developed and implemented in areas where there is accumulation of herder families (e.g Songinokhairkhan district, khoroo 21).
- **Waste segregation at source is required to enhance recycling:** In order to advance recycling in country, it is of paramount importance to introduce segregation of waste at source, and to organize separate collection and transportation of recyclables to recycling facilities to reduce waste at source.
- **More categories of segregation will result in more accurate data:** Adding more detailed categories for waste segregation while conducting composition studies would allow for better understanding and waste characterization at source.
- **Use of waste composition data should be encouraged for improved decision making:** Encouraging the use of updated waste composition data in the planning of landfills in the city, especially the analysis of landfill lifetime is important. Moreover, the data can be used in effectively planning and calculating the required capacity of waste collection, transportation and disposal companies (e.g. number and the capacity of trucks required) to meet the minimum service standards given these estimates for waste being produced.
- **Awareness raising by sharing data:** Publicly sharing the main findings of the waste composition study would create awareness around the issue of increasing waste, and will inform the residents of trends in waste generation, and would trigger to think through consumer behavior.
- **Every household waste matters:** Active participation of households should be ensured throughout the study for more accurate results.

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Dump sites in various locations in Mongolia

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