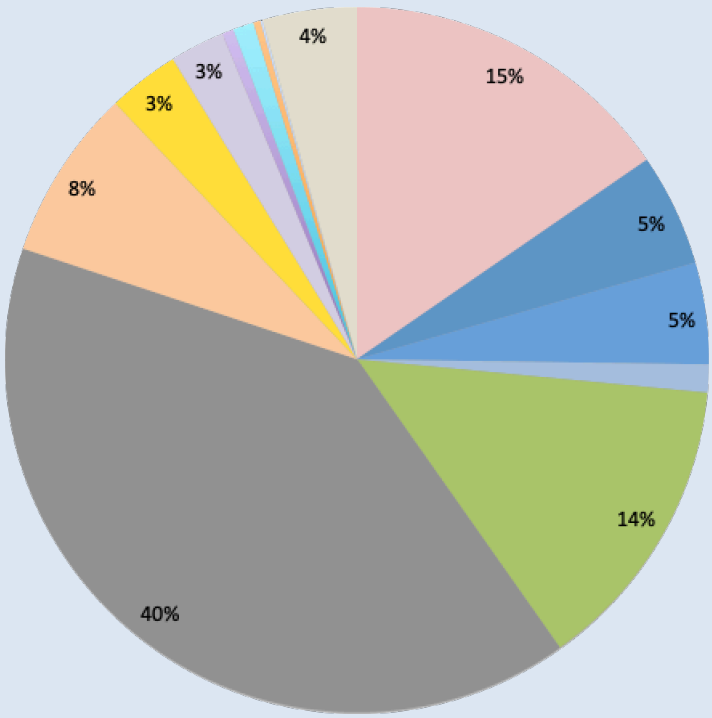
ECOSOUM

The Asia Foundation

# WASTE COMPOSITION STUDY

## DATA ANALYSIS REPORT

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# INTRODUCTION

Overall, data about waste composition in Mongolia is lacking, especially in rural soums like Khishig-Undur. As part of its waste management project, Ecosoum carried out in July 2019, with the support of The Asia Foundation, a domestic waste composition study among Khishig-Undur's households. The goal was to fill the gaps and provide detailed data on how much of each type of waste is produced by an average household in the soum.

Following this first study, The Asia Foundation supported Ecosoum to carry out a second one, in winter, to confirm the main trends identified in the previous study and to determine whether or not there is a significant difference in waste composition between summer and winter periods.

This report aims to present data analysis results.

# METHODOLOGY

For this study, Ecosoum partnered with Khishig-Undur's school to identify the households participating in the winter study. Pupils from age 16 to 18 were invited to take part in the study with their families.[1] After the informative meeting that was held at the school on January 16th, 2020, 50 households from the soum-center committed to participate.

However, only 35 households actually respected the main guidelines and provided Ecosoum with their sorted waste.[2] Therefore, this study is based on a representative sample of 10% of Khishig-Undur soum-center households (35 out of 367[3]).

Before the study began, all households were given precise instructions and sorting bags. They had to sort all the waste they produced over the course of seven days (from Friday 17th to Thursday 23rd of January 2020) into 15 categories:

1. Paper;
2. Plastic bottles (PET);
3. Hard plastic (HDPE, LDPE, PVC);
4. Plastic bags;
5. Tetra pack;
6. Glass;
7. Metal (e.g iron, aluminum, copper);
8. Food;
9. Fabric, woven items, leather;
10. E-waste;

[1] Relying on pupils as a way to identify participating households in this waste-management-related study incidentally followed the common will of Ecosoum and the school (which is part of an "Eco-school" international program) to involve the soum's young generation in environmental protection projects.

[2] The withdrawal of 15 households was mainly the consequence of the temporary closure of the school, due the flu epidemic that has been striking the whole country in the first months of 2020. As the school closed, many families left the soum-center for various personal reasons, including 15 of our participants.

[3] Mongolian Statistical Information Service (http://1212.mn), 2018.

11. Batteries;
12. Toilet and sanitary items;
13. Ash;
14. Livestock dungs;
15. Other.

At the end of the sorting week, they brought their sorted waste to a dedicated collection point where everything was weighed by Ecosoum's team. In some cases, waste was collected by Ecosoum's team directly from their homes and weighed there or back at Ecosoum's headquarter. When relevant, livestock dung and ash were estimated after weighing a representative sample directly at household's khashaa.

Each participating household was also given a questionnaire to fill. This questionnaire had 8 main questions related to topics that may have an impact on household's waste production and that could be useful to interpret data.

The questions were the following:

1. Does your household currently live in a house or in a ger?
2. Including yourself, how many people live at your home in Khishig-Undur soum-center?
3. Does anyone in your household perform a professional activity within your home/khashaa? If yes, please define what kind of activity.
4. What is the average annual income of your household?
5. How do you heat your home: electric, fire stove, other? If stove, what kind of fuel do you usually use in summer: coal, wood, livestock dung, other?
6. What heating system do you use to cook at your home: electric, fire stove, both electric and fire stove, other?
7. Do you have animals in your khashaa (dogs, livestock)?
8. If you have animals, do you usually feed them with your food waste?

Overall, except for the target households' selection process[4], the methodology was exactly the same for this winter study and the previous summer study.

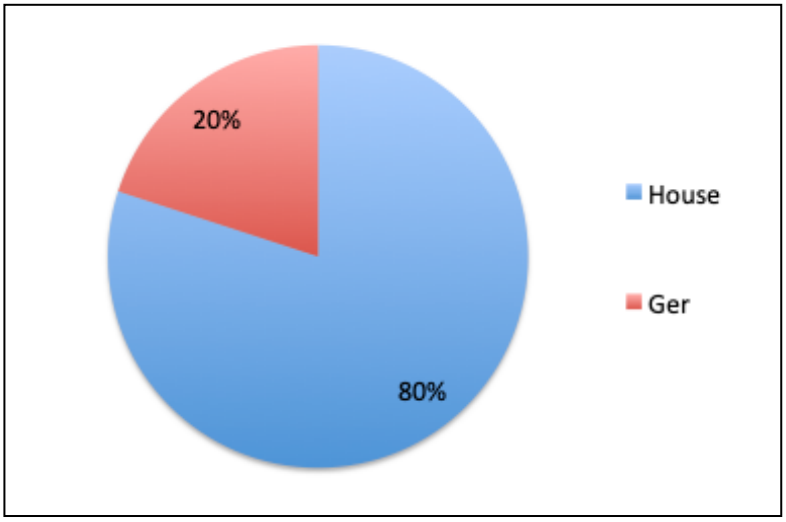
Data was processed and analysed in February 2020. Results are presented and discussed bellow.

[4] In the 2019 summer study, the selection process was initially supposed to be the same as in this winter study, through the local school. But as the study finally took place during summer holiday, the methodology had to be adapted and ended up not involving the school.

# CONTEXTUAL DATA FROM QUESTIONNAIRE

## 1. Type of housing

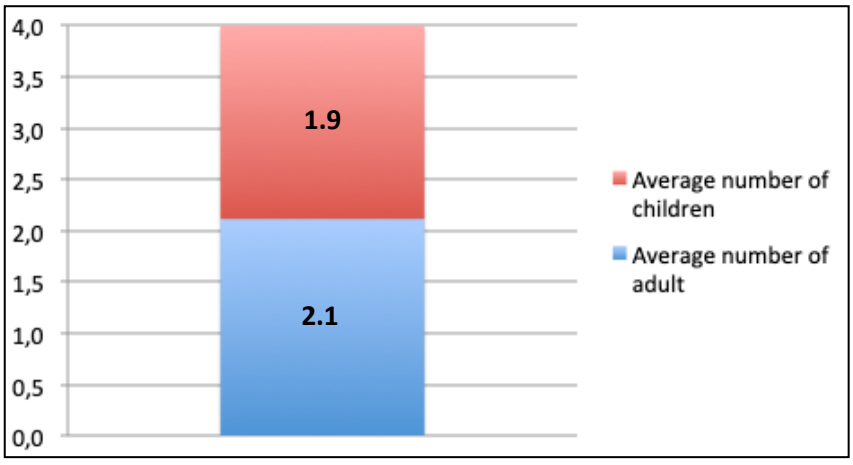
80% (28) of sample households live in houses, while only 20% (7) live in a ger.




*Percentage of sample households living in houses and gers*

## 2. Number of people per household

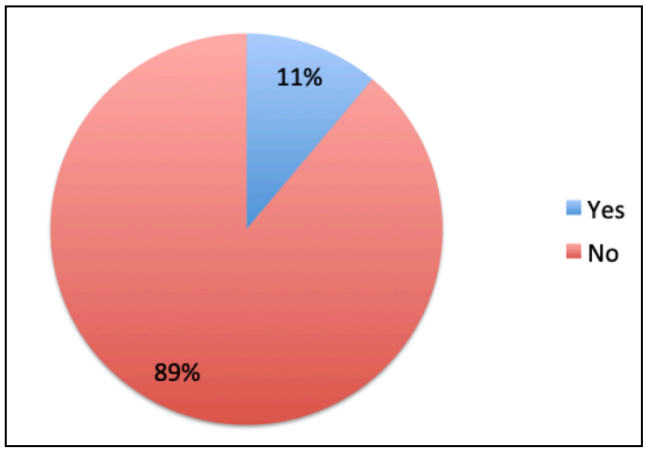
On average, sample households comprise 4.0 people, including 2.1 adults and 1.9 children.




*Average number of adults and children in sample households*

## 3. Professional activity within khashaa

Only 11% (4) of sample households carry out a professional activity within their personal khashaa: one is breeding cows, one has a construction shop, one is a blacksmith and one is a seamstress.



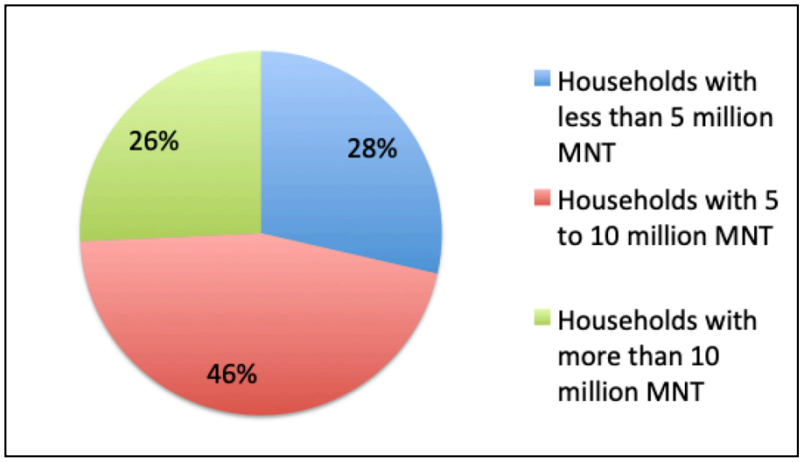

*Percentage of sample households who carry out a professional activity within their khashaa*

## 4. Average income

The average annual income among the sample households is 8.3 million MNT.

The average annual income per adult in each household is 4.2 million MNT.[5]

46% (16) of sample households have an income comprised between 5 and 10 million MNT. 28% (10) earn less than 5 million MNT per year, while remaining 26% (9) get over 10 million MNT.

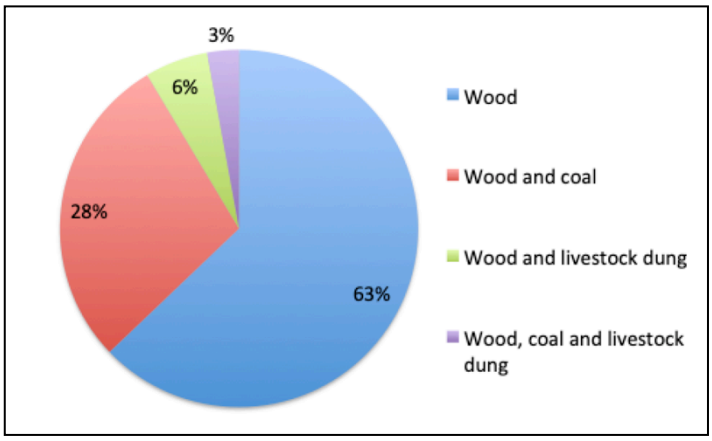



*Percentage of sample households depending on their average annual income*

## 5. Heating system

All 35 households usually heat their house or ger with a fire stove. Most households (63% - 22) use only wood and almost all the other households (29% - 10) use both wood and coal. 6% (2) use both wood and livestock dung while 3% (1) use all three kinds of fuel (wood, coal and livestock dung). During winter, none of the sample households fuel their stove with only coal or livestock dung.

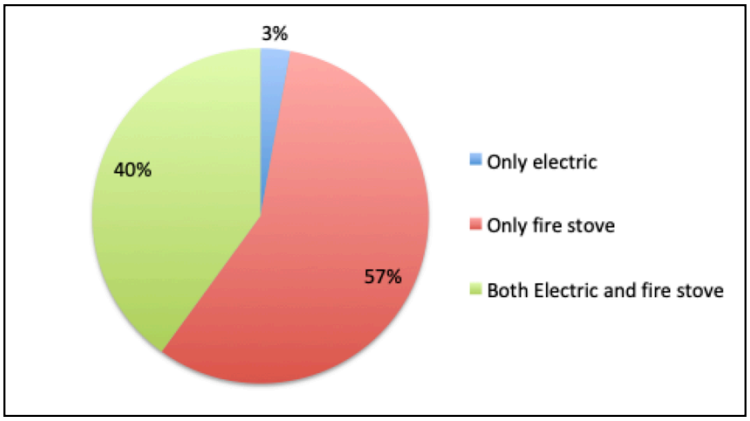
[5] Annual income per adult was calculated for each household before to be averaged for the whole sample. If we simply divided the average annual income in sample households by the average number of adults in sample households, we would find find an average income per adult of 3.9 million MNT.




*Percentage of sample households who use wood, coal and/or livestock dungs to fuel their stove*

## 6. Cooking system

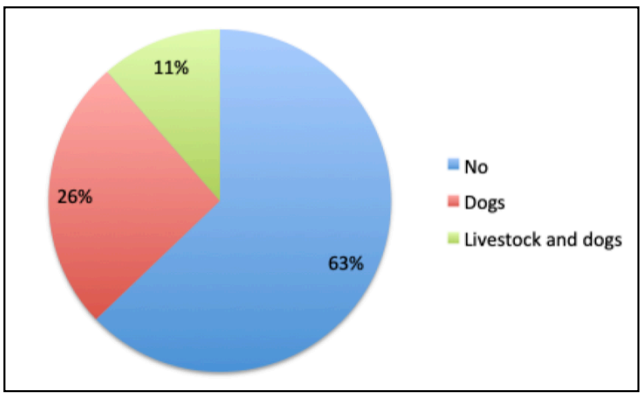
57% (20) of sample household usually cook only on fire stove. 40% (14) cook both on fire stove and electric hotplate. 3% (1) cooks exclusively on electric.




*Percentage of sample households who use electric hotplate, fire stove or both for cooking*

## 7. Animals within khashaa in winter

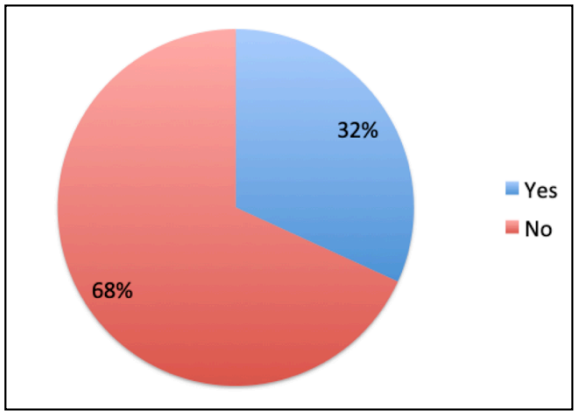
63% (22) of sample households claimed to have no animal at all within their khashaa. 26% (9) said they had only dogs, and remaining 11% (4) had not only dogs but also livestock.




*Percentage of sample households who have dogs, livestock or no animals within their khashaa during winter*

### 8. Feeding food waste to animals

74% (26) of sample households don't give their food waste to animals. On the contrary, 26% (9) do give their food leftover to animals (whether their own or other people's in the village).




*Percentage households who feed animals with their food waste*

## WASTE COMPOSITION: RESULTS AND DISCUSSION

### Livestock dung

4 households (11% of sample) claimed to have livestock, which produce dung. But like for summer domestic waste composition study, we considered that livestock dung should not been included in the results and the data analysis discussed below. The reasons remain the same as in summer study, mainly:

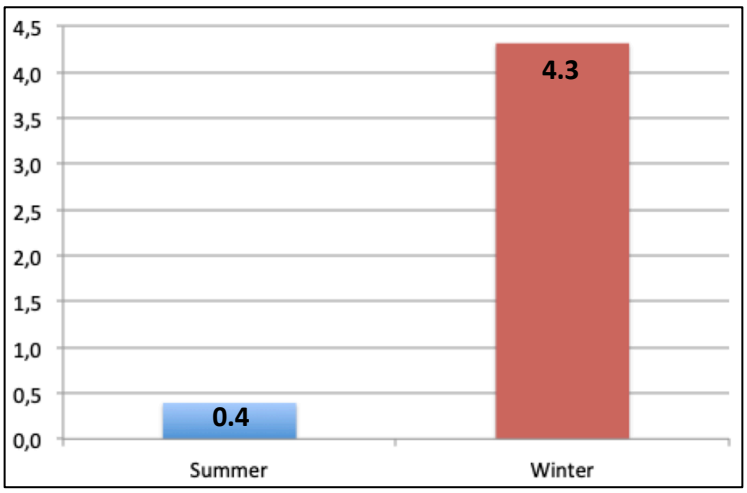
- Livestock dung is usually used to fuel stoves, which means it is technically not a *waste*, but a *resource*;
- Households with many animals, which may produce too much dung to burn in stove, are professional breeders.[6] As such, their potential excess dung may be considered as waste, but it would be *professional* waste, not *domestic* waste.
- Given the large amount of dung produced in a week by a single animal, including livestock dung in our statistics like all other 14 categories would make it totally impossible to analyze our data: for households with livestock, dungs would represent over 95% of all waste (in weight), which would make the remaining 14 categories futile in comparison.

In conclusion, like for summer domestic waste composition study, it seemed more relevant to exclude animal dung from data analysis results and discussion in the rest of this report.

[6] In this study's sample household, one was a professional cow breeder who produced about 800kg of dung each week. It was unclear whether or not this household used all their cow dung to fuel their stove. Remaining three households who claimed to have livestock claimed to produce about 100kg of dung per week and clearly stated that they use it all as fuel for their stove.

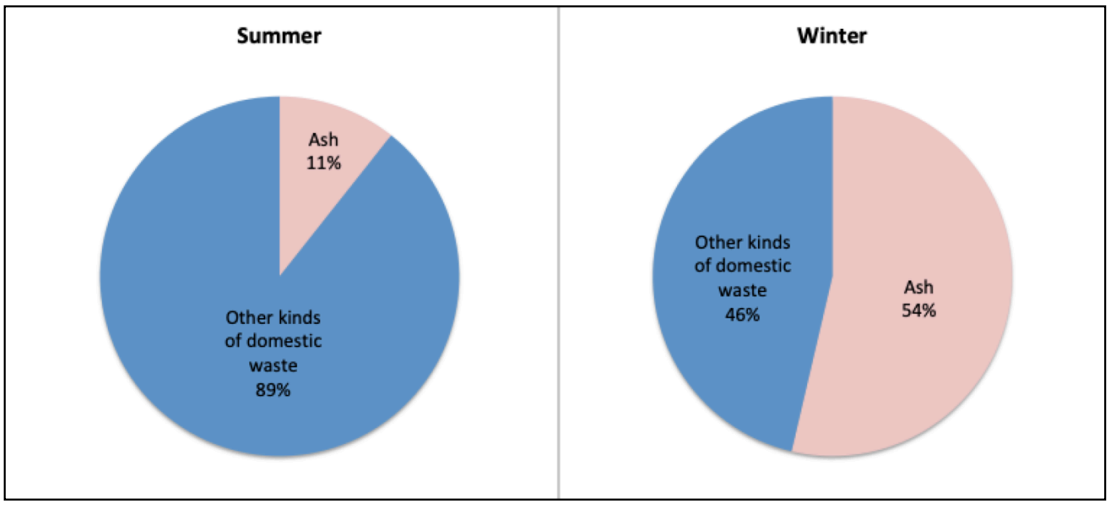
## Ash

In winter, since households need to heat their stoves much more than in summer to endure the cold weather, ash is produced in much higher amount. While in summer an average household produces less than 0.4kg of ash each week, over ten times more ash is produced in winter (4.3kg).




*Weekly amount of ash produced in summer and winter among domestic waste (kg)*

In relative terms, it means that while in summer ash represented only 11% of domestic waste, it accounts for more than half (54%) of it in winter.

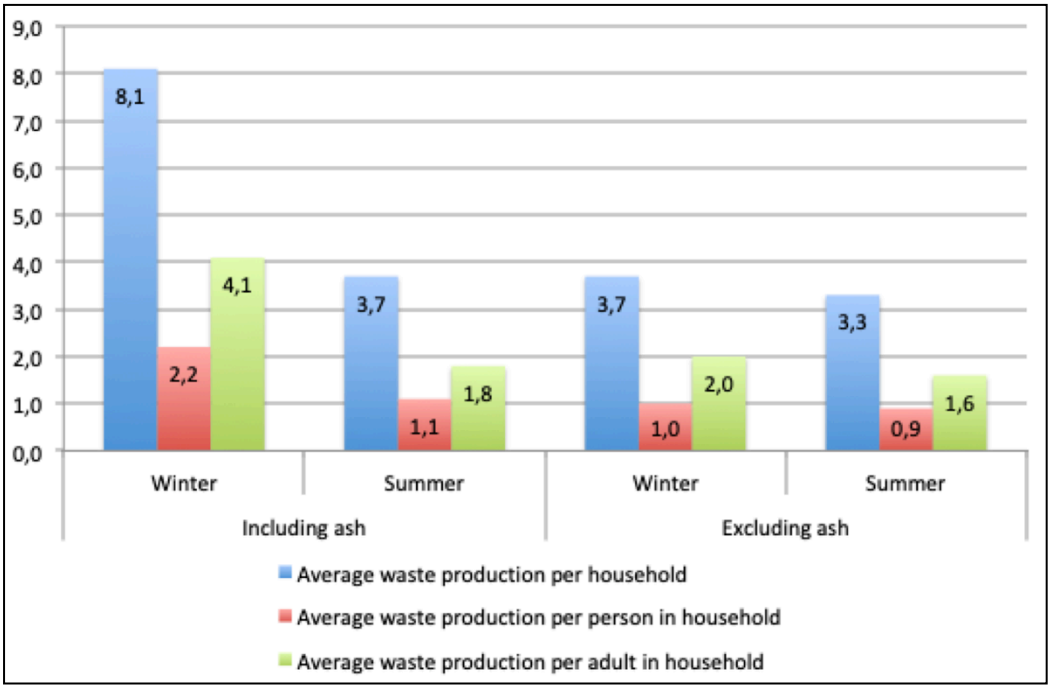



*Share of ash in total domestic waste in summer and winter*

As expected, the higher amount and proportion of ash within domestic waste represents a major difference between summer and winter. In fact, this significantly higher proportion of ash can become an issue if we want to compare relative shares of other types of waste between summer and winter, as it would mechanically tend to decrease the proportion of all other 13 categories in winter (although some may be higher in absolute terms). Therefore, in the rest of the report, ash will sometimes be excluded from the data, especially when comparing proportions of waste categories between summer and winter. In such cases, this exclusion of ash will be explicitly reminded to avoid confusion.

## Average weekly domestic waste weight

Excluding livestock dungs, average domestic waste reaches 8.1kg per household per week (against 3.7kg in summer). In light of household compositions, average weekly domestic waste production is 2.2kg per person in household (1.1kg in summer), or 4.1kg per adult in household (1.8kg in summer). If ash is also excluded, average winter domestic waste weight comes down to 3.7kg per household, which is much closer to what was found in summer (3.3kg). This represents 1.0kg per person in a household (0.9kg in summer), or 2.0kg per adult in a household (1.6kg in summer).




*Average weekly waste production per household, per person in household and per adult in household (kg)*

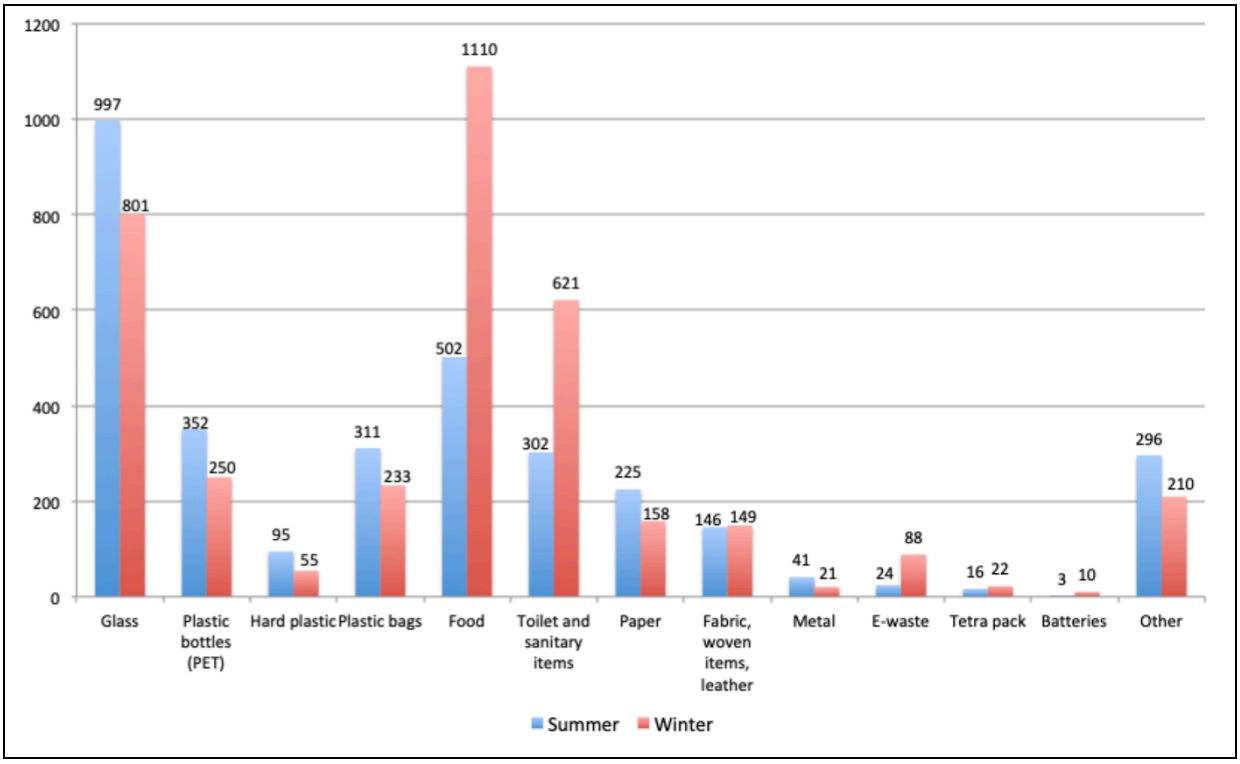
Even leaving the higher amount of ash aside, it thus may seem that households would tend to produce slightly more (+12%) waste in winter (3.7kg) than they do in summer (3.3kg). However, this increase may also be a simple artifact within margins of errors due to experimentation differences (different households, different sorting week, and so on). Therefore, while the increase in ash appears obvious and easily understandable, it seems dubious at this point to conclude to a real increase in the production of other kinds of household waste.

Nevertheless, a safer and yet no less interesting conclusion can be made from these results: the winter study clearly confirms that, ash aside, an average Khishig-Undur's sedentary household produces approximately 3.5kg of waste per week, not matter the time of the year. Since there are 367 households registered in the soum-center, we can conclude total annual domestic waste production (excluding ash) is approximately 70 tons in the village (excluding nomadic families).

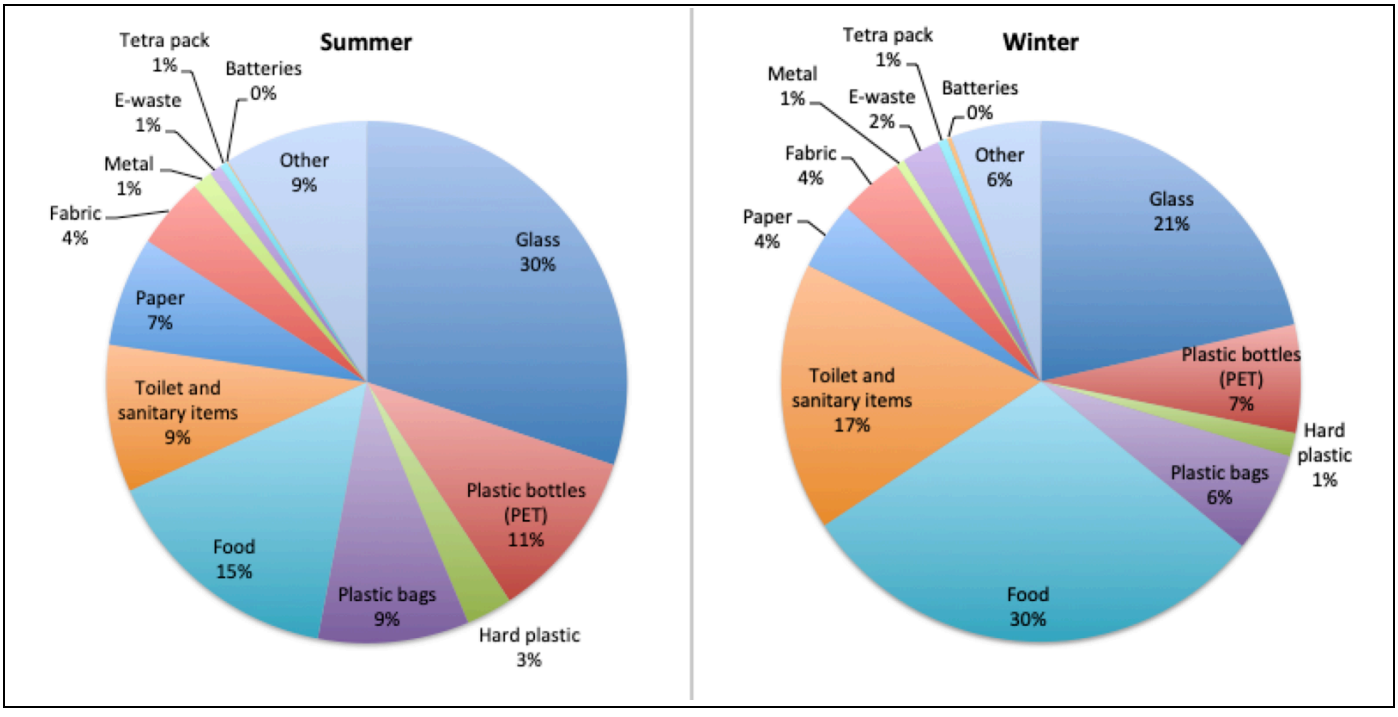
Nomadic households were not included in these studies so our results may not be representative of their waste production. In first approximation, however, in order to present an order of magnitude, it is still interesting to extrapolate the results to the whole soum: based on the same household waste production, we can estimate that total annual domestic waste production in all of Khishig-Undur soum could reach up to 200 tons.

## Domestic waste average composition

Production of each kind of domestic waste is presented for summer and winter in the two charts below, respectively in absolute (in grams) and relative (in %) terms. Ash has been excluded from both charts for the legibility reasons previously explained.




*Weight (in grams) of each waste category among sample households in summer and winter*




*Percentage of each waste category among sample households (excluding livestock dung and ash)*

The following comments can be made from these figures[7]:

- While glass represented 30% of domestic waste in summer (excluding ash) and was the number one category of waste with an average of 997g, we found only 801g, which corresponds to 21% of domestic waste during the winter study, Although we can't exclude that this 20% decrease in glass waste production is only (or partially) a study artifact, it could also reflect the fact that people may be consuming less alcohol[8] in winter than in summer (whether this is explained by personal habits and/or economic reasons).
- We also found 30% less plastic waste in winter (538g) than in summer (758g). While it represented 23% of domestic waste in summer, plastic waste accounts for only 14% in winter. This decrease is observed for all three subcategories of plastic (PET bottles, hard plastics and plastic bags) in similar proportion. As a result, we still find that PET bottles account for about half of all plastic waste.
- Food waste production appears over two times higher in winter (1,110g) than in summer (502g). With 30% of domestic waste (opposed to only 15% in summer), food waste is the number one category of domestic waste produced in winter. This observation reflects the fact that people apparently tend to consume more meat in winter: while summer food waste comprised more vegetable peels in summer, we observed that winter food waste comprised much more bones, which are heavier than peels.
- Sanitary items are also found in much higher amount: from an average of 302g in summer (9% of total domestic waste), they double to reach 621g in winter (17% of total). Like in summer, we observed that most households actually produce much less sanitary waste than this figure, but the average among total sample households is pulled up due to few families that have babies wearing diapers. These diapers are numerous and very heavy compared to toilet paper and other sanitary items. Since we can hardly imagine why babies would wear more diapers in winter, we can only assume that this increase is explained by an increase in households with babies in the winter study (in fact, five households brought diapers in winter, while there were only two in summer).
- Paper is found in slightly lower amount in winter (158g, or 4%) compared to summer (225g, or 7%). This 30% decrease could be explained by the fact that households light more fire in winter, and thus may require more paper waste as fire-starter.
- Fabric waste is found in similar amount in winter and summer and all other types of waste still represent a very low percentage of total domestic waste. For some of them, we can find dramatic increases (4 times more e-waste, 3 times more batteries) or decreases (two times less metal). But given the very low weight they represent in both studies, these differences should not be interpreted as significant trends but as simple artifacts.[9]

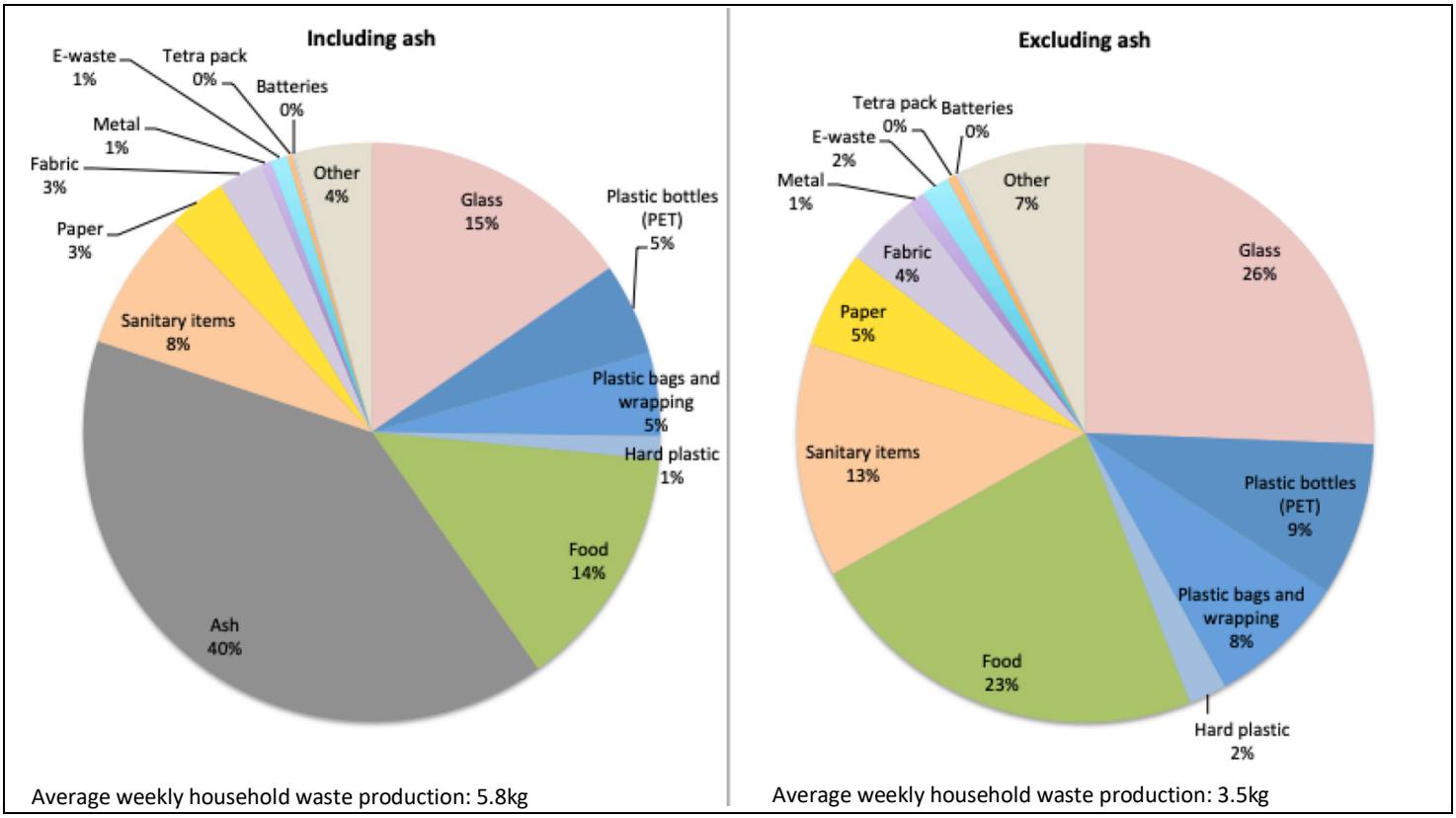
[7] The relative shares (%) of each category of waste in summer are slightly higher than the ones presented in the previous report. Although absolute weight remains the same, this difference is explained by the fact than ash was included in the previous report while it has been excluded for the current charts.

[8] Glass waste also comes from food jars and different kinds of drinks, but our observations show that vodka bottles remain the main source of glass waste.

[9] E-waste, batteries and metal wastes are usually not produced on a steady weekly basis. Should households suddenly decide to throw away an old keyboard or change batteries in a front light during our study's sorting week, results show a dramatic increase (which would most likely be smoothed if the study was conducted over a longer period of time).

Finally, rather than comparing summer and winter results, we can also join them together to produce a new average domestic waste composition. This process can have two interests. First, it would produce data that would be representative of yearly average waste production and composition, taking into account seasonal variations. Second, by increasing the number of households in the sample (71 in total), we would mechanically attenuate artifacts that can have had an impact on the results of both our summer and winter studies taken individually.

Results of such annual average waste composition are presented in the graphs below, both including and excluding ash.



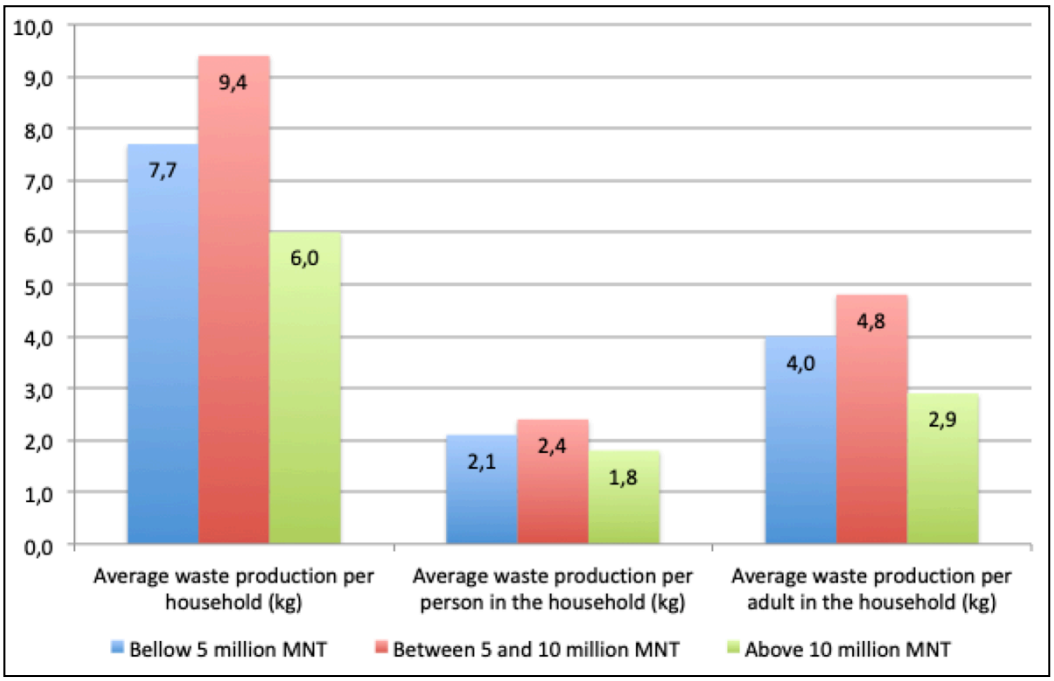

*Average yearly domestic waste composition (including and excluding ash)*

## Domestic waste production depending on income

Like during the summer study, in order to look for differences in waste production depending on households' income, we compared data for 3 categories of annual income: less than 5 million MNT, between 5 and 10 millions MNT, and above 10 millions MNT per year (see chart below).

Regarding overall waste production, results from summer study showed that waste amount tended to progressively decrease as income increased. However, the trend doesn't appear as clear in this winter study. Households with the highest income (over 10 million MNT per year) still tend to produce the lowest amount of waste. But in this study, contrarily to the previous one, the highest waste production doesn't come from the lowest income (below 5 million MNT per year), but from the intermediary category (5 to 10 million MNT). The same observation is made whether ash is included in

or excluded from the results. It is thus difficult to conclude to any clear trend regarding waste production depending on income.




*Average waste production (including ash) depending on household's annual income*

In the same way, while summer study seemed to show that higher incomes tended to produce less glass waste and more food waste, these trends are not found in the winter study anymore. In fact, for any waste category, no trend at all is found in this study when it comes to comparing households depending on their income.

This absence of trend in this winter study should lead us to be careful with the apparent trends that were drawn from the summer study. Since they are not confirmed here (except for the fact that the highest income may actually produce less waste), it is possible that the trends identified in the summer study may have been random artifacts.

## Domestic waste production depending on type of housing

Like in the summer study, we wondered if type of housing could have an impact on waste production and divided data regarding whether households lived in houses (8.2kg per household on average) or in ger (7.5kg per household on average). The main differences we can observe are that households living in houses seem to be producing more food waste while households living in gers seem to be producing more glass waste.

However, only 7 households (20% of the total sample) lived in a ger, which means that results may not be very representative of all Khishig-Undur's households living in gers. With such a small "ger sample", it appears too approximate to identify clear trends and draw conclusions. Results are presented in the table bellow for information, but they should be treated cautiously.

| Housing type | House | Ger |
|---|---|---|
| Paper | 2% | 1% |
| Plastic bottles (PET) | 3% | 4% |
| Hard plastic | 1% | 1% |
| Plastic bags | 3% | 2% |
| Tetra pack | 0% | 0% |
| Glass | 9% | 16% |
| Metal | 0% | 0% |
| Food | 15% | 8% |
| Fabric | 2% | 2% |
| E-waste | 1% | 0% |
| Batteries | 0% | 0% |
| Sanitary items | 7% | 10% |
| Ash | 53% | 55% |
| Other | 3% | 2% |

*Average percentage of each category of waste among households living in houses and in ger*

# CONCLUSIONS

Crossed with the previous summer study, this winter domestic waste composition study conducted in Khishig-Undur in January 2020, with a representative sample of 10% of soum-center's households, highlighted several interesting information:

- Average household ash production is over 10 times higher in winter (4.3kg per week) than it was in summer (0.4kg per week). While ash represents 54% of domestic waste in winter, it was only 11% in summer.
- Average weekly household waste production in this winter study is approximately 8.1kg including ash (3.7kg in summer) and 3.7kg excluding ash (3.3kg in summer). This new study thus confirms that an average sedentary household in Khishig-Undur produces approximately 3.5kg of waste (excluding ash) per week, regardless of the season.
- It leads us to estimate that Khishig-Undur's soum-center produces approximately 70 tons of domestic waste per year (excluding ash). If we include ash, this figure rises by 40% to reach approximately 115 tons per year.
- While glass and plastic represented more than half (53%) of total domestic waste in the summer study (excluding ash), they account for only one third (35%) of it in the winter study. This decrease is also observed in absolute weight (1.8kg in summer against 1.3kg in winter).
- PET bottles account for half of plastic waste (in weight) both in summer and winter studies.
- Food waste is two times higher in winter than in summer, both in absolute and relative terms. This observation is to be linked with a higher consumption of meat in winter, which produces more (heavy) bones than in summer.
- In households that have infants, diapers represent like in summer, a very high proportion of domestic waste (in weight), more or less equivalent to ash.

- Trends that were observed in our summer study regarding waste production depending on income are not confirmed in this study and may just have been a random artifact.

Overall, throughout the year, almost 90% of all domestic waste (in weight) is composed of only 5 main categories: glass (15%), plastic (11%), food (14%), ash (40%) and baby diapers (8%). In order to tend towards zero ultimate waste, a soum should thus primarily focus its effort on managing these 5 categories of waste.

From a waste management perspective, the following recommendations can be made:

- Although reducing the production of plastic waste at source is obviously recommended, affordable recycling technics can be a solution to most plastic waste. Our recyclable waste transportation analysis showed that selling some of them (starting with PET) to urban industry could be a viable solution, at least until more local recycling solutions are set up.[10]

- The same comment can be made for glass waste. Reusing bottles should be encouraged and could be economically sustainable under the right conditions, according to our study. If not, recycling/reusing solutions are possible both locally and/or with urban industry.

- Given its organic nature, food waste, although relatively important in weight, does not appear to be a real issue. Non-polluting, many solutions (from composting to animal feeding) can be set up relatively easily in rural soums.

- According to the US EPA, disposable baby diapers require hundreds of years to decompose in dumpsites and introduce pathogens into the environment, especially in ground water that may be used as drinking water.[11] Since they are impossible to recycle, it is necessary to reduce their production at source. This means replacing them by reusable diapers. Associated with proper sanitation systems (dry toilets with composter, for instance), this solution could sustainably remediate the issue of disposable diapers.

- Given the tremendous volume of ash that is produced by households, the issue of ash may be the trickiest of all. It raises questions much wider than simple waste management, as it is directly liked to major challenges such as sustainable energy and energy-efficient buildings. Reducing the amount of ash would definitely require working on these essential topics. In the meantime, improving ash's management is not necessarily an impossible task; especially since wood and livestock dung ash are virtually armless and can even be useful resources to some extend, especially for their agricultural potential applications. Coal ash, which usually contains toxic substances, may be more problematic, but fortunately our study shows that most people still rely on wood to heat their stove (no one uses coal in summer and only 31% of our sample households use coal in winter, in addition to wood). At this stage, chemical analyses should be conducted on wood and coal ash (as well as agricultural soils) to determine their exact properties and the best way to manage them in Khishig-Undur.

[10] https://www.ecosoum.org/en-resources-and-reports

[11] https://www.prnewswire.com/news-releases/disposable-diapers-add-millions-of-tons-of-waste-to-landfills-each-year-according-to-epa-report-300384344.html