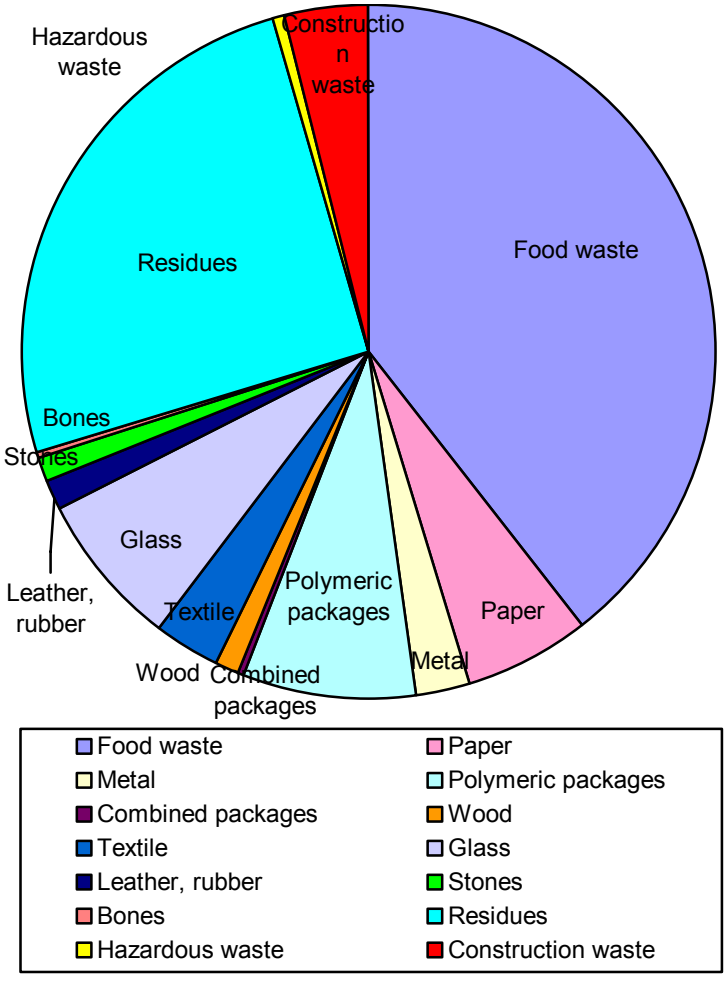
What's the Composition of our Waste?

A main question for the waste management is to know the composition of the waste. The type of disposal depends of it. In landfills the rate of organic matters is important for the production of biogas but plastics are not easily biodegradable. For incineration, the calorific power is important but some waste can produce toxic smoke. And naturally in aim to develop the recycling, it's a priority to know what are the quantities of recyclable matters, and moreover, how they can evolve.
When the co-operation programme joining Tacis and the state and regional administrations started, it quickly appeared that the available figures of the waste composition were old (dating from the 80s) or not very liable. So it has been decided to make a study of the waste composition.

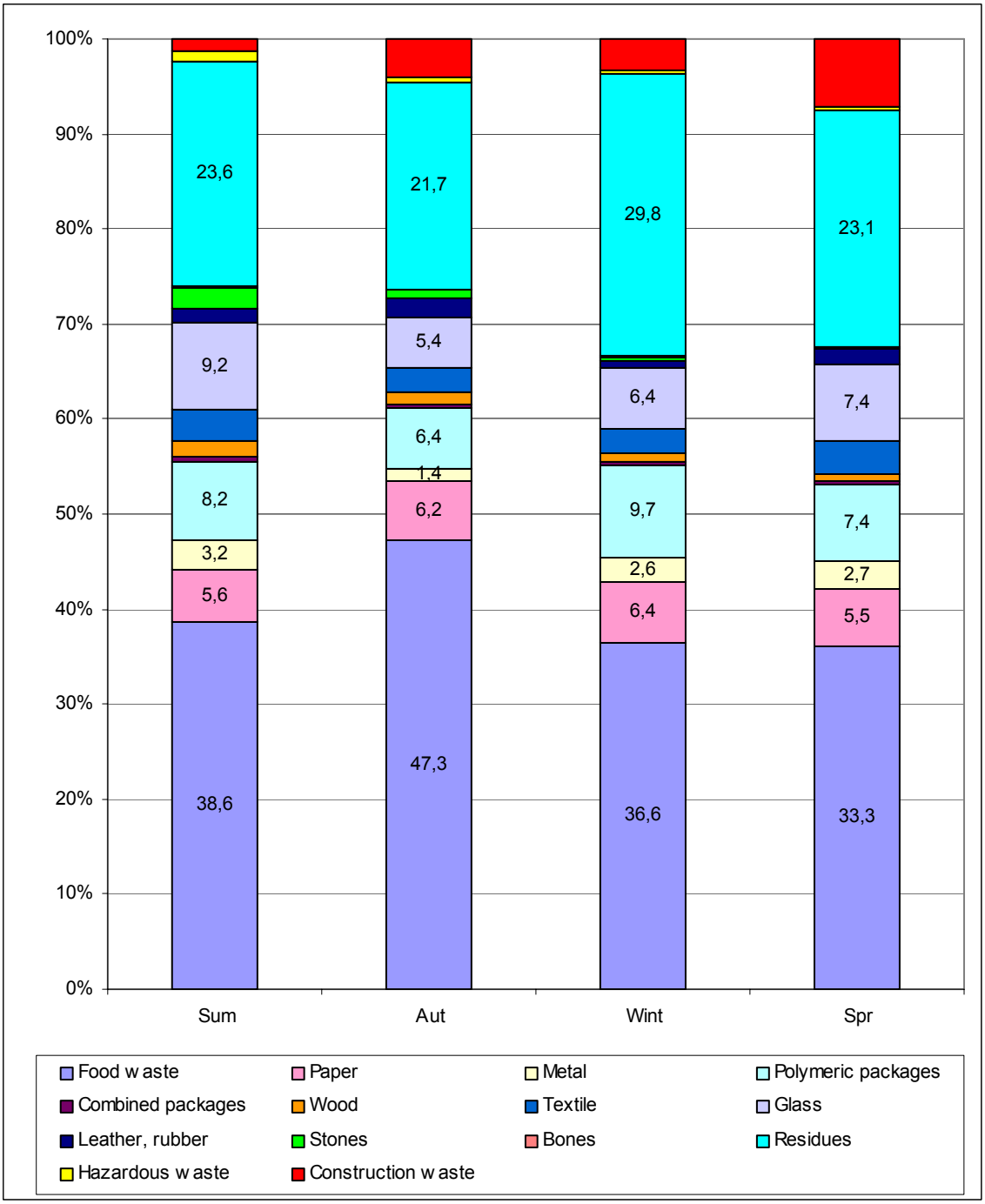
This study has been led on one year are the results are the following:



%	Fraction
39,5%	Food waste
5,9%	Paper
2,5%	Metal
7,9%	Polymeric packages
0,4%	Combined packages
1,1%	Wood
2,9%	Textile
7,4%	Glass
1,4%	Leather, rubber
1,1%	Stones
0,1%	Bones
25,3%	Residues
0,6%	Hazardous waste
3,9%	Construction waste
100,0%	

Variations

It was obvious that the composition of the household waste depends of the season. So we have measured the components with one campaign by season.

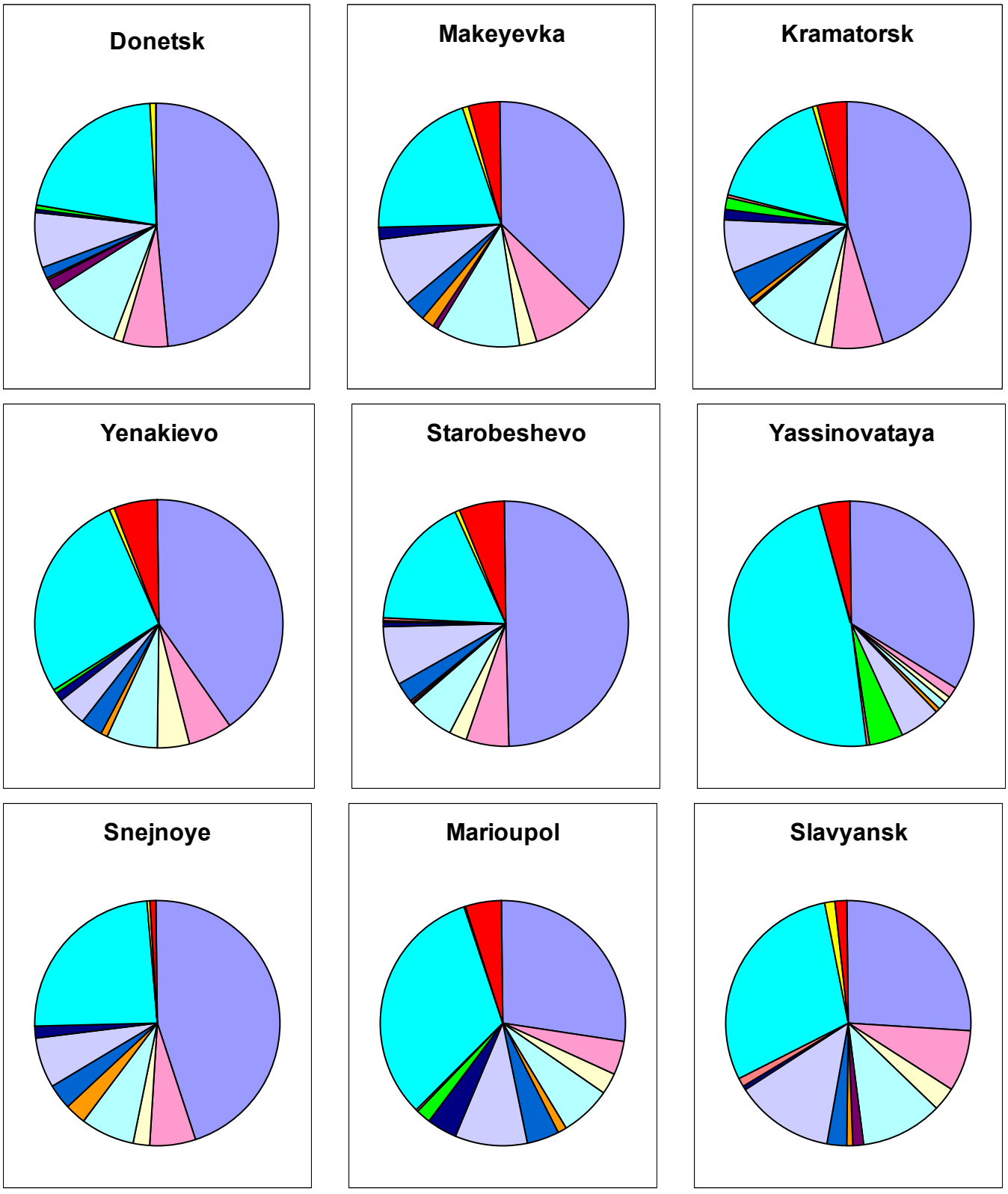


The composition of the waste of each inhabitant depends of his type of consumption (his lifestyle) and of his incomes (his life level). We have tried to classify these lifestyles and life levels and to choose 9 areas representative of these categories. As expected, the composition differs from one to other.

Improvement of Solid Household Waste Management in Donetsk Oblast (Ukraine)

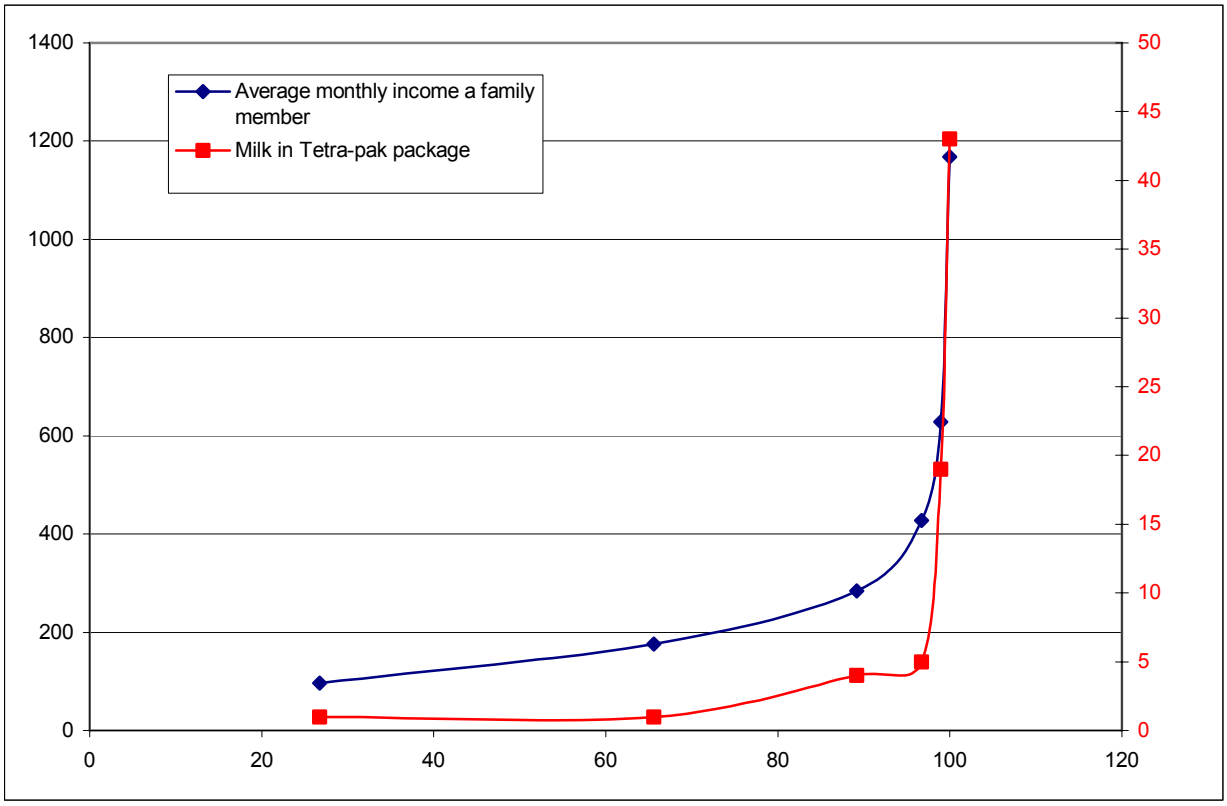
Solid Household Waste Composition

Household Waste composition (in weight)



A tool for decisions

We have said that the knowledge of the waste composition is fundamental for the decisions concerning the disposal of the waste. It's also necessary to anticipate the evolution of the waste composition. We have made a comparison between the life level and the type of milk package bought by the inhabitants.



This kind of graph shows that as it is expected a growth of the life level in the next years, the percentage of milk bought in Tetrapak will increase and this type of package will grow in the household waste.

It's also a reason why the waste composition study must be updated each year. It's necessary to optimise the waste disposal but the decisions in this field are long term decisions. The life length of a sorting plant or a landfill is more than 20 years. A good sizing of these facilities requires to preview the needs some years in advance.

Methodology

Preparation

The Waste Composition Study is based on the principle that the waste composition depends of the life level and of the lifestyle of the inhabitants, and of the type of dwelling. So it has been determined by an other study (opinion poll) that the population of the Donetsk Oblast could be shared in 8 socio-types, the 8th, as recreational areas, being itself shared in 2 subcategories for lake area (North) and coastal area (South).

For each type has been selected a city which is the most representative among all of the cities and which later on has represented the type in question during the study of waste composition. In a city selected there have been chosen 2 containers located in micro-regions and streets with the relevant type of dwelling.

Some trips have been organised to cities and settlements that represent a definite socio-economic type, in aim to identify the necessary sites with containers whose the waste were to be analysed and to do some preliminary examinations.

The containers have been watched for some time in order to define the frequency of the waste collection, the way they are used by the population, the time they get full, the presence of scavengers. The objective was to be sure that the contents of the container was representative of the production of the inhabitants.

Photos of containers have been prepared. The location of containers have been put on the map of each city. The objective was to be sure that any operator of the study should identify the container to be emptied from a season to the next. To register all necessary data about containers, a container card has been designed and filled in for each operation.

So nine collection points have been chosen as representative of these socio-types and the containers have been analysed successively in Summer, Autumn, Winter and Spring.

Operations

For the analysis of the SDW composition it was necessary to have some equipments (sorting table which is in fact a ping-pong table, balances, plastic basins for the different fractions, working suits, gloves, dust masks, etc.). A particular attention has been paid to the security of the operators because the sorting of the waste is hand made and it's often found glass pieces, needles, syringes, blades, and so. Convenient working premises, consisting of 3 rooms (for sorting, changing of clothes and rest, room with a water supply) have been rented, with an access for the truck. It was also nec-

essary to have some place where ultimate waste could be kept for some time before disposal. A truck has been put at disposal for the collection of the samples.

Prior to the day the waste was supposed to be retrieved for sorting, in each cities the containers were watched during two days preceding the arrival of the truck. After that the container was emptied on a plastic liner, then the waste were placed into special bags with labels marked with permanent ink felt-tips. The area was cleaned after the operations.

For the sorting, the contents of each bags unloaded on a plastic liner on the table. Then the operators sorted the waste which were placed in the plastic basins, whose the empty weight had been preliminarily measured. Then each of 14 fractions was weighted and put back into the bag with ultimate waste. The data of each bag were registered in a separate table. Each container consisted of 6-10 bags. After the waste of each bag was studied, the data were summarised and included into the data sheet of each container.

The 14 fractions have been defined on the base of the first sorting. It was not necessary to be too detailed and these categories have been chosen in the aim of the disposal of waste (recycling, composting, landfilling). The toxic waste gather all the problematic (on the point of view of the disposal) waste as batteries, electronics, remedies, aerosols, healthcare, etc.

Each socio-economic type was represented by 1 city and two containers, except for type 8 which was represented by two cities and four containers.

During the study of the SDW composition it was necessary to consider a seasonal factor. That's why the study have been carried out 4 times as a result of which each time 18 containers have been studied (2 for each socio and economic type).

Calculation of the results

Anomalies

As in all these kinds of studies appear anomalies in some containers as 88.8% of coal ash in one.
The first step has been to calculate an average ratio of each fraction, then to eliminate the aberrant figures (underlined in yellow in the Table 2).

Quantities

For each collection point, the total weight is different from a season to an other. So, the weight in kg has been converted in % of the total weight and the average of the 4 seasons has been calculated. When a figure has been eliminated (anomaly), the average has been calculated between the kept figures.

Weighting

For each socio-type, a geographical area has been determined, gathering the relevant administrative units. The population of these administrative units has been estimated. A percentage of the total population has been calculated for each socio-type and applied to the average quantities of each fraction in aim to calculate a weighted percentage of each fraction (Table 1).

Discussion

Uncertainties due to the size of the sample

The number of containers which has been measured is 72. The number of containers yearly collected within the territory of the Oblast is between 1.5 and 2 millions. In such conditions, the error margin is >10%.

Uncertainties due to the repartition of the population in socio-types

It has been supposed that the composition of SHW depended of socio-types of the population. The number of inhabitants of each socio-type has been evaluated with an uncertainty. If we compare the average composition applying or not applying the sharing of the population in socio-types, the results are:

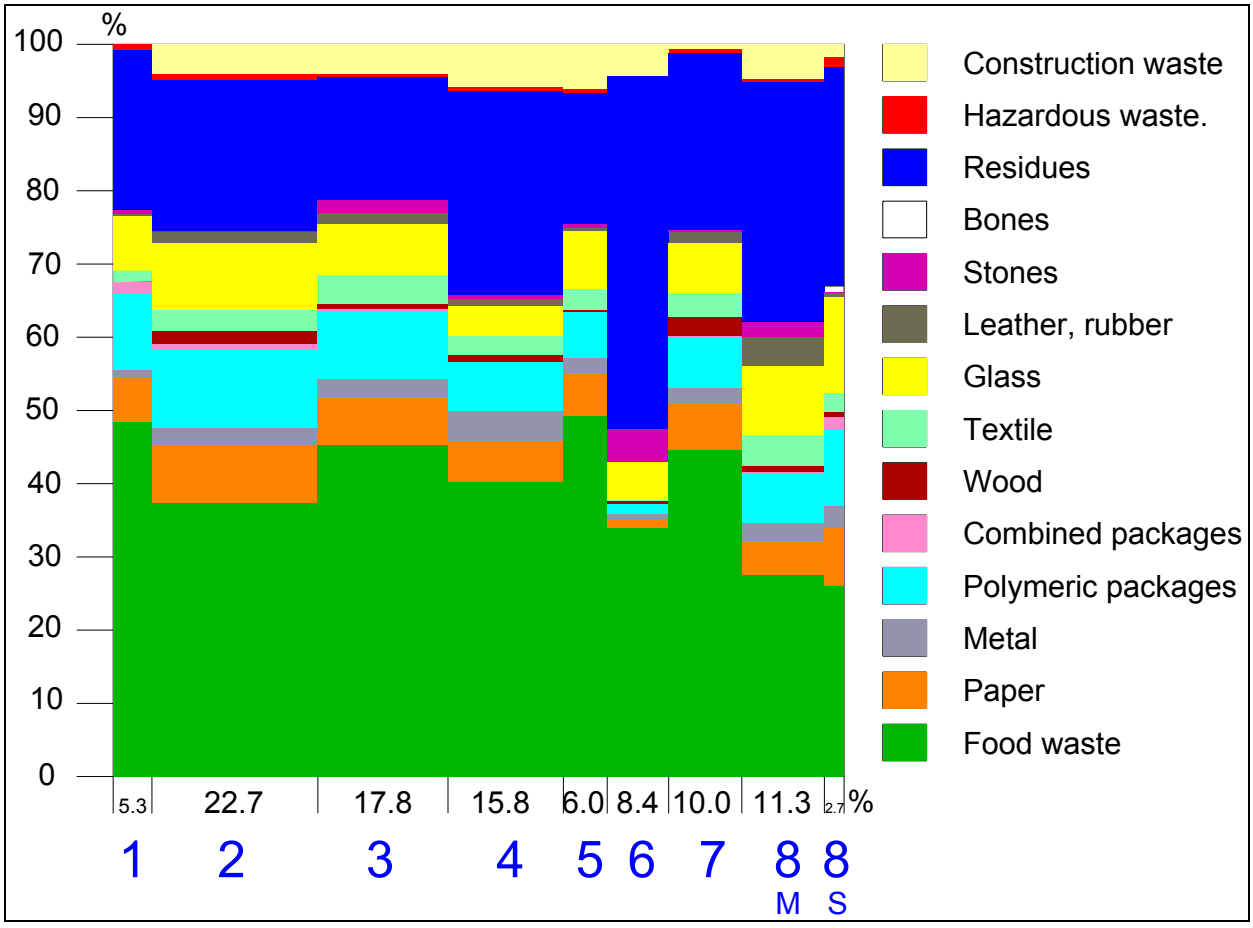
with	without		Error margin	Fraction
socio-types		#		
39,5%	39,9%	**0,4%**	**1%**	Food waste
5,9%	5,8%	**0,1%**	**2%**	Paper
2,5%	2,5%	**0**		Metal
7,9%	7,8%	**0,1%**	**1%**	Polymeric packages
0,4%	0,4%	**0**		Combined packages
1,1%	1,1%	**0**		Wood
2,9%	2,9%	**0**		Textile
7,4%	6,9%	0,5%	7%	Glass
1,4%	1,3%	**0,1%**	6%	Leather, rubber
1,1%	0,8%	**0,3%**	30%	Stones
0,1%	0,1%	**0**		Bones
25,3%	26,4%	1,1%	4%	Residues
0,6%	0,5%	**0,1%**	20%	Hazardous waste
3,9%	3,7%	**0,2%**	5%	Construction waste
100,0%	100,0%			

Solid Household Waste Composition

On the other hand, we knew that the residues are mainly constituted by the coal ash (domestic heating) produced by the inhabitants of the private sector (49.7% as yearly average in sector 6). So it's not unexpected to see that the main absolute difference appears on this fraction which is the most sensitive to the numbers of our socio-types. In parallel, we know that the selective collection of glass is more efficient in the urban sector and it can explain the difference we have.

On the contrary, the stability of the other figures shows that there is a common practice in the way of life whatever is the type of housing.

The waste composition can be shown in a graph highlighting the weight of each socio-type. On this graph, the width of the columns is proportional to the number of concerned inhabitants, so the area of each colour is proportional to the weighted average of the composition of the SHW.



Solid Household Waste Composition

Type 1	Type 2	Type 3	Type 4	Type 5	Type 6	Type 7	Type 8	
Central districts of Donetsk	1. Urban population of the central sub-districts of big cities 2. Outskirts of Donetsk	1. Urban population of the outskirts of large cities (except Donetsk) 2. Central parts of towns	Rural population of large cities	Urban population of districts (rayons)	Rural population of rayons	Population of depressive cities	Population residing in the resort area of Donetsk oblast	
240 000	1 020 000	800 000	710 000	270 000	380 000	450 000	510 000	120 000
❑ Voroshilovsky ❑ Kiyevsky	1. Central districts of the following cities: ❑ Makeyevka - Central-urban - Sovetsky ❑ Kramatorsk - Centre ❑ Gorlovka - Central-urban ❑ Yenakiyevo - Centre 2. Sub-districts of Donetsk: ❑ Kalininsky ❑ Leninsky ❑ Proletarsky ❑ Budyonovsky ❑ Kirovsky ❑ Kuibishevsky	1. Outskirts of the following cities: ❑ Makeyevka -Gornyatsky - Kirovsky - Chervonogvardeisky ❑ Gorlovka - Kalininsky - Nikitovsky ❑ Kramatorsk 2. Towns: ❑ Artiomovsk ❑ Debaltsevo ❑ Yasinovataya ❑ Khartsizask ❑ Dobropolye ❑ Druzhkovka ❑ Avdyeyevka ❑ Dokuchayevsk ❑ Dimitrovo ❑ Kirovskoye ❑ Krasnoarmeisk ❑ Krasny Liman ❑ Ugledar	Donetsk Makeyevka Gorlovka Yenakiyevo Kramatorsk	Aleksandrovka Amvrosiyevka Velikaya Novosyolka Volnovakha Volodarskoye Maryinka Starobeshevo Talmanovo	Aleksandrovsky Amvrosiyevsky Velikonovosyolkovsky Volnovakhsky + Volodarsky Maryinsky Starobeshevo Telmanovo	Konstantinovka Selidovo Sneahnoye Shakhtersk Torez Dzerzhinsk	1. Pervomaisky rayon 2. Novoazovsky rayon 3.Mariupol	1. Slavyansk 2. Slavyanogorsk
- High-comfort buildings - One-family cottages of the private sector	Multi-storied buildings (3 floors and higher)	Multi-storied buildings (3 floors and higher)	One-storied buildings + private sector with stove heating	Multi-storied buildings (2 floors and higher)	Private sector with stove heating	Multi-storied buildings + private sector with stove heating	Private residential sector in the coastal area	Private residential sector in the lakes area
29a Shchorska Str., 39 Universitetskaya Str.	41 Lenina Str. 42 Moskovskaya Str.	57 Bykova Str. 157 Belyaeva Str.	46 Chaikovskogo Str. 15 Polianskogo Str..	1 Schkolnaya Str. 8 micro-region Cheremushki	58 Lesnaya Str. 14 Lenina Str.	54 Octiabrskaya Str. 27 Donskaya Str.	115 Bolshaya Morskaya Str. 7 Kotovs-kogo Str.	16 Matveyeva Str. Sanatorium “Jubileyny””

Table 1 Geographical repartition of the socio-types

Improvement of Solid Household Waste Management in Donetsk Oblast (Ukraine)

Solid Household Waste Composition

Table for comparison of the share of SDW fractions by socio-economic types

Fraction	Share (%)																											
	1						2						3						4						5			
	Central districts of Donetsk						1. Urban population of central sub-districts of large cities 2. Outskirts of Donetsk						1. Urban population of outskirts of large cities (except Donetsk) 2. Central parts of towns						Rural population of large cities						Urban population of districts (rayons)			
Population	N	240 000					N	1 020 000					N	800 000					N	710 000					N	270 000		
	5,3%						22,7%						17,8%						15,8%						6,0%			
Fraction	S	A	W	Sp	T	**Share**	S	A	W	Sp	T	**Share**	S	A	W	Sp	T	**Share**	S	A	W	Sp	T	**Share**	S	A	W	Sp	T	**Share**
Food waste	34,0	54,3	52,5	53,1	48,4	**2,6**	33,1	41,5	33,4	41,5	37,4	**8,5**	45,8	52,4	45,2	37,9	45,3	**8,1**	56,7	52,5	28,2	23,3	40,2	**6,3**	60,4	55,6	44,3	37,0	49,3	**3,0**
Paper	11,0	5,5	4,9	3,1	6,1	**0,3**	5,9	13,0	6,2	6,7	7,9	**1,8**	5,9	6,4	8,2	5,5	6,5	**1,2**	3,4	3,4	9,1	6,6	5,6	**0,9**	5,9	4,8	9,5	2,5	5,7	**0,3**
Metal	0,4	1,9	0,8	1,3	1,1	**0,1**	3,3	1,0	3,3	1,5	2,3	**0,5**	2,0	1,4	2,0	4,3	2,5	**0,4**	7,1	1,3	2,3	6,3	4,2	**0,7**	2,1	1,0	3,8	2,0	2,2	**0,1**
Polymeric packages	10,2	10,8	11,5	8,6	10,3	**0,5**	13,2	8,0	13,9	7,8	10,7	**2,4**	8,2	8,0	10,4	10,8	9,3	**1,7**	5,1	4,6	9,4	7,3	6,6	**1,0**	7,5	4,3	5,9	7,0	6,2	**0,4**
Combined packages	1,8	1,6	2,2	0,8	1,6	**0,1**	0,9	1,0	0,8	0,7	0,8	**0,2**	0,2	0,2	0,5	0,3	0,3	**0,1**	0,0	0,0	0,0	0,3	0,1	**0,0**	0,1	0,1	0,1	0,2	0,1	**0,0**
Wood	0,2	0,0	0,0	0,1	0,1	**0,0**	4,1	1,5	0,1	1,4	1,8	**0,4**	1,7	0,1	0,2	0,5	0,6	**0,1**	0,6	0,5	1,0	1,4	0,9	**0,1**	0,5	0,1	0,0	0,5	0,3	**0,0**
Textile	1,4	1,5	1,4	1,7	1,5	**0,1**	2,0	1,3	3,5	4,4	2,8	**0,6**	5,4	4,1	2,9	4,0	4,1	**0,7**	2,1	3,0	3,7	1,7	2,6	**0,4**	2,8	3,0	1,9	3,9	2,9	**0,2**
Glass	11,0	6,8	7,2	4,7	7,4	**0,4**	13,5	4,1	6,2	13,0	9,2	**2,1**	7,9	7,3	5,1	7,1	6,9	**1,2**	2,4	3,7	6,3	3,9	4,1	**0,6**	7,1	3,2	9,9	10,8	7,8	**0,5**
Leather, rubber	0,1	0,0	0,2	1,2	0,4	**0,0**	1,4	2,8	0,5	1,3	1,5	**0,3**	3,2	0,3	0,5	2,0	1,5	**0,3**	0,3	1,4	0,7	1,5	1,0	**0,2**	1,0	0,1	0,4	0,4	0,5	**0,0**
Stones	1,9	0,0	0,0	0,0	0,5	**0,0**	0,2	0,0	0,0	0,0	0,1	**0,0**	6,4	0,3	0,0	0,0	1,7	**0,3**	0,9	1,0	0,0	0,1	0,5	**0,1**	0,8	1,1	0,0	0,0	0,5	**0,0**
Bones	0,0	0,2	0,0	0,1	0,1	**0,0**	0,3	0,0	0,0	0,0	0,1	**0,0**	0,0	0,0	0,4	0,0	0,1	**0,0**	0,0	0,0	0,0	0,0	0,0	**0,0**	0,0	0,0	0,1	0,1	0,0	**0,0**
Residues	26,3	16,7	18,8	24,9	21,7	**1,2**	19,7	18,2	25,2	18,9	20,5	**4,6**	8,4	19,1	22,0	17,7	16,8	**3,0**	16,4	28,4	33,7	32,7	27,8	**4,4**	10,9	13,9	20,4	26,2	17,9	**1,1**
Hazardous waste	1,8	0,6	0,4	0,4	0,8	**0,0**	2,4	0,4	0,4	0,2	0,9	**0,2**	0,6	0,2	0,4	0,5	0,4	**0,1**	1,6	0,2	0,5	0,2	0,6	**0,1**	1,0	0,2	0,3	0,4	0,5	**0,0**
Construction waste	0,0	0,0	0,0	0,0	0,0	**0,0**	0,0	7,3	6,6	2,7	4,1	**0,9**	4,2	0,1	2,4	9,2	4,0	**0,7**	3,4		5,0	14,7	5,8	**0,9**	0,0	12,6	3,3	9,1	6,2	**0,4**
Total	100,0	100,0	100,0	100,0	100,0	**5,3**	100,0	100,0	100,0	100,0	100,0	**22,7**	100,0	100,0	100,0	100,0	100,0	**17,8**	100,0	100,0	100,0	100,0	100,0	**15,8**	100,0	100,0	100,0	100,0	100,0	**6,0**

Solid Household Waste Composition

Table for comparison of the share of SDW fractions by socio-economic types

Share (%)

6						7						8 Marioupol						8 Slaviansk						Seasons				Weighted Total	
Rural population of rayons						Population of depressive cities						Population residing in the resort area of Donetsk oblast																	
N	380 000					N	450 000					N	510 000					N	120 000										
8,4%						10,0%						11,3%						2,7%						%					
S	A	W	Sp	T	**Share**	S	A	W	Sp	T	**Share**	S	A	W	Sp	T	**Share**	S	A	W	Sp	T	**Share**	**Sum**	**Aut**	**Wint**	**Spr**	**T**	**%**
26,4	37,1		41,4	35,0	**3,0**	40,5	70,2	22,3	45,9	44,7	**4,5**	17,2	28,8	43,6	22,2	27,9	**3,2**	12,0	23,6	35,5	40,8	28,0	**0,7**	**38,6**	**47,3**	**36,6**	**33,3**	**39,7**	**39,5%**
0,6	1,3		1,8	1,2	**0,1**	9,6	3,0	3,8	8,2	6,2	**0,6**	4,9	3,5	3,6	6,1	4,5	**0,5**	5,2	7,0	15,9	5,8	8,5	**0,2**	**5,6**	**6,2**	**6,4**	**5,5**	**6,0**	**5,9%**
1,6	0,6		0,5	0,9	**0,1**	2,4	1,2	2,4	2,5	2,1	**0,2**	3,4	2,0	3,8	1,2	2,6	**0,3**	1,3	5,3	3,7	2,7	3,3	**0,1**	**3,2**	**1,4**	**2,6**	**2,7**	**2,5**	**2,5%**
1,0	1,3		1,9	1,4	**0,1**	7,6	4,7	8,8	7,0	7,0	**0,7**	8,0	6,9	7,0	5,3	6,8	**0,8**	8,2	7,6	17,0	12,7	11,4	**0,3**	**8,2**	**6,4**	**9,7**	**7,4**	**7,9**	**7,9%**
0,0	0,0		0,0	0,0	**0,0**	0,2	0,1	0,0	0,2	0,1	**0,0**	0,4	0,1	0,0	0,2	0,2	**0,0**	1,5	1,0	2,8	1,0	1,6	**0,0**	**0,5**	**0,4**	**0,5**	**0,4**	**0,4**	**0,4%**
1,4	0,0		0,0	0,5	**0,0**	1,1	5,6	3,2	0,3	2,6	**0,3**	1,2	1,0	1,1	0,4	0,9	**0,1**	0,8	0,9	1,3	0,5	0,9	**0,0**	**1,7**	**1,1**	**0,8**	**0,7**	**1,1**	**1,1%**
0,3	0,1		0,0	0,1	**0,0**	3,1	1,9	3,5	4,6	3,3	**0,3**	7,6	4,9	1,1	3,2	4,2	**0,5**	1,7	2,2	4,0	2,8	2,7	**0,1**	**3,2**	**2,6**	**2,7**	**3,2**	**2,9**	**2,9%**
4,2	5,9		6,1	5,4	**0,5**	6,1	7,0	7,1	7,4	6,9	**0,7**	17,7	7,6	7,8	4,9	9,5	**1,1**	16,0			11,9	14,0	**0,4**	**9,2**	**5,4**	**6,4**	**7,4**	**7,4**	**7,4%**
0,1	0,0		0,0	0,0	**0,0**	1,6	0,5	0,5	3,3	1,5	**0,1**	1,7	9,3	3,1	2,1	4,1	**0,5**	0,3	0,3	0,2	1,1	0,5	**0,0**	**1,4**	**2,0**	**0,8**	**1,6**	**1,4**	**1,4%**
4,5				4,5	**0,4**		0,2	0,4	0,0	0,2	**0,0**	3,4	4,8	0,0	0,0	2,1	**0,2**		0,0	0,1	0,3	0,1	**0,0**	**2,2**	**0,8**	**0,4**	**0,1**	**1,1**	**1,1%**
0,4	0,0		0,0	0,1	**0,0**	0,1	0,1	0,0	0,0	0,0	**0,0**	0,4	0,1	0,0	0,0	0,1	**0,0**	1,2	2,6	0,1	0,1	1,0	**0,0**	**0,2**	**0,1**	**0,1**	**0,0**	**0,1**	**0,1%**
59,7	41,6		47,7	49,7	**4,2**	27,3	2,5	47,7	19,4	24,2	**2,4**	34,0	27,8	28,5	42,4	33,2	**3,8**	51,0	41,1	17,4	18,7	32,0	**0,9**	**23,6**	**21,7**	**29,8**	**23,1**	**25,5**	**25,3%**
0,0	0,1		0,0	0,0	**0,0**	0,5	1,1	0,1	0,4	0,5	**0,1**		0,7	0,4	0,1	0,4	**0,0**	0,7	2,9	2,0	0,1	1,4	**0,0**	**1,1**	**0,5**	**0,4**	**0,3**	**0,6**	**0,6%**
0,0	12,2		0,5	4,2	**0,4**	0,0	2,0	0,0	0,9	0,7	**0,1**		2,5	0,0	11,9	4,8	**0,5**	0,0	5,5	0,0	1,5	1,8	**0,0**	**1,3**	**4,1**	**3,3**	**6,6**	**3,9**	**3,9%**
100,0	100,0	0,0	100,0	103,0	**8,7**	100,0	100,0	100,0	100,0	100,1	**10,0**	100,0	100,0	100,0	100,0	101,3	**11,5**	100,0	100,0	100,0	100,0	107,0	**2,9**	**100,0**	**100,0**	**100,3**	**92,3**	**100,6**	**100,0%**

Table 2 Weighting of the measures