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CHARACTERISTICS OF THE POLLUTION BY SOLID MUNICIPAL WASTE IN TIMIȘOARA CITY AND ITS SURROUNDING AREA

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Abstract: Municipal solid waste collection is a serious environmental issue with various mitigation solutions, from technical to organizational ones, in view of an appropriate environmental behavior of the main actors. EU countries were early and dynamic at the heart of this issue, while Romania had to adopt and enforce such regulations after EU association and accession. The present article examines the recent evolutions in the municipal solid waste pollution in one of the greatest urban area of Romania - Timisoara city and its surroundings, defining of some environmental policies for a better collection and to reduce the general impact on population and economic activities. The analysis was based on the interviews applied to different representatives from the main institutions in the field and on 770 questionnaires applied to the population. The recent developments are positive: the overall amount of waste has decreased considerably, the amount of selectively collected waste has increased over 25 times (however, there is a high percentage of contaminated recyclable materials), a sorting station was built, the non-green landfill was closed, another European standards complying landfill was opened, a significant market for the recyclable materials has emerged. The analysis of questionnaires emphasizes that the indifference towards environmental values is high (25%) and awareness of the active role the public has to play is fairly low (31%). Attention should focus on cultivating an environmental behavior through mechanisms adapted to the social content of the studied area (involving mechanisms of financial rewarding for those who turn recyclables into uncontaminated form).

Keywords: Romania, Timișoara, municipal solid waste, environmental behavior.

1. INTRODUCTION

Cities are the largest generators of waste, given their capacity of maximum population concentration. Of the environmental impact types that are specific for cities, the one caused by the generation of solid waste is major on short, medium and long term (Assamoi & Lawryshyn, 2012).

Developed countries have experienced unprecedented growth in the quantities of municipal solid waste, due to intense urbanization and rising living and consumption standards of the population (Zaman & Lehmann, 2011). This has raised awareness of the acuteness this problem over the last decades of the 20-th century.

The experience of the last decades, characterized by great efforts to diminish the impact of solid waste, has highlighted the deficiencies of different technical solutions and has caused the recent interest reorientation in large conurbations towards a more sustainable and more efficient way called "zero waste " (Broitman et al., 2012, Zotos et al., 2009; Zaman & Lehmann, 2013). Zero waste cities would produce no harmful waste for our environment" (Broitman et al., 2012).

In the European Union, the response to the major issues of municipal solid waste was early initiated through a series of rules that came after the commitments taken at the World Conference in Rio de Janeiro in 1992 (Pires et al., 2011, Broitman et al., 2012). The comparative analysis of best practice examples highlights the fact that reducing environmental pollution by solid waste implies the synergy of the territorial actors, who have to implement the zero waste principle (Broitman et al., 2012; Suttibaku & Nitivattananon, 2008).

This study aims to investigate the way in which Romania's integration process into the

European Union succeeded in determining the synergy necessary for the reduction of pollution caused by municipal solid waste at the level of institutional actors, operators and the population of the city Timişoara. The studied area includes the city of Timisoara and 14 neighboring communes (Fig. 1).

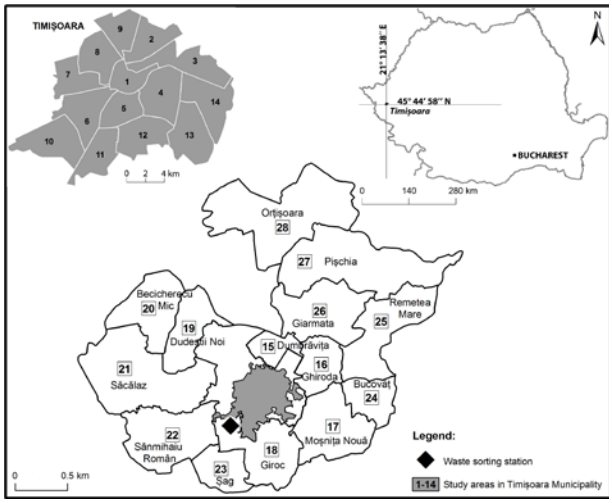

Figure 1. Timişoara and its surrounding area: location and structure

The Timisoara city and surrounding area have thus a total population of 360,000 inhabitants, in an area of 108,031 hectares and is dominated by the economic dynamism of the city of Timisoara, few activities being presently located outside its borders, with the rural area having mostly a residential function. Timişoara is accountable for 80% of the industrial production of the county, has a number of 18.364 production units and a number of 117,000 jobs, which determine the perpetuation of the pressure of population flux from other parts of the country. In this context, the problem of solid waste polution is one of great interest, especially since the Integrated Urban Development Plan of the Timisoara includes among its major objectives the creation of a comfortable and attractive green habitat, by ensuring urban comfort throughout the whole surrounding area.

2. METHODOLOGY

The following assumptions were the basis of this study: (a) in the post-1989 years, the evolution of the Romanian society increased the quantity of municipal solid waste, due to increasing consumption and modernization, (b) the obligation of alignment with the European standards, in the context of the country's accession to the EU, hastened the awareness of the impact of municipal solid waste issues, and forced authorities to define institutional factors, regulatory and monitoring instruments, (c) the effectiveness of the implemented measures is, however, dependent on the population, a rather inertial component of the territorial system in the difficult social and economic context of the past years, (d) one of the fastest growing municipalities in Romania, Timisoara, has taken the steps required and has made good progress regarding reducing pollution by solid waste.

The study uses the quantitative information provided by: the Department for Environment of the Timisoara City Hall, the RETIM Ecologic Service SA company, the Environment Protection Agency Timis, the Timis County Council. Also, the qualitative information was obtained through interviewing officials of the mentioned structures. In order to verify the assumptions concerning the effectiveness of institutional measures on waste management itself and on the behavior of the population, questionnaires were issued on a number of 770 individuals, uniformly distributed within the study area.

3. RESULTS AND DISCUSSIONS

3.1. Analysis of the reduction of the pollution caused by the solid waste

3.1.1 Evolution of the total amount of waste collected

Within the period 2003 - 2012, a steady increase in the total quantity of waste up to the year 2007 (at an annual rate of 6.8%) is noticeable, after which a gradual reduction occurs (Table 1, Fig. 2). These evolutions are explained in relation to the following factors:

- the introduction of the traders' obligation to have their own system of selective collection and selective management of waste (which has determined a reduction in the quantities processed by local operators);
- progress in the range of 2003 - 2007 concerning the evacuation of illegal waste disposals, respectively the regulation through the regime of waste, of sanctions and of their application, which discouraged the reactivation of illegal deposits;
- the increased monitoring of sanitation beneficiaries and a stricter regulation of pricing per quantity, which stimulated people to reduce at source the quantities they delivered to the operator; the population served by the health services has seen a steady growth primarily by inclusion of the city outskirts and, after 2008, by extension to the communities situated further in Timişoara surrounding area;

Table 1. Evolution of the total amount of waste in the Timişoara and its surrounding area (tons)

	2003	2005	2006	2007	2008	2009	2010	2011	2012
urban wastes	238,156	250,427	265,972	303,750	193,535.02	198,355.77	163,033.6	142,928.59	124,004.2
mixed waste collected from households	154,364	157,098	152,788	154,489	78,352	83,578	72,206	67,818	61,405
mixed waste collected from trade, industry, institutions	89,574	99,921	98,872	10,3242	52,211	40,695	24,610	18,707	16,652
separately collected waste	399.34	169.76	187.57	650.15	990.02	6526.17	1,2316.44	11,188.75	10,194.28
bulky waste	27,949	1,7441	21,477	2970	37,493	4,5030	3,6182	2,9814	2,0319
gardens and parks waste	509	519	522	523	9060.9	7982.7	6512	6216.2	5757.9
market waste	12.364	12,608	12,675	12,710	12,24.5	852.36	866.12	771.71	608.1
street waste	5,321	5,090	7,441	20,406	14,204	13,691	10,341	8,412.2	9,068.2
population served	273,107	286,330	290,790	293,949	294,665	281,603	303,845	304,585	298,695

source: RETIM Ecologic Services S.A.

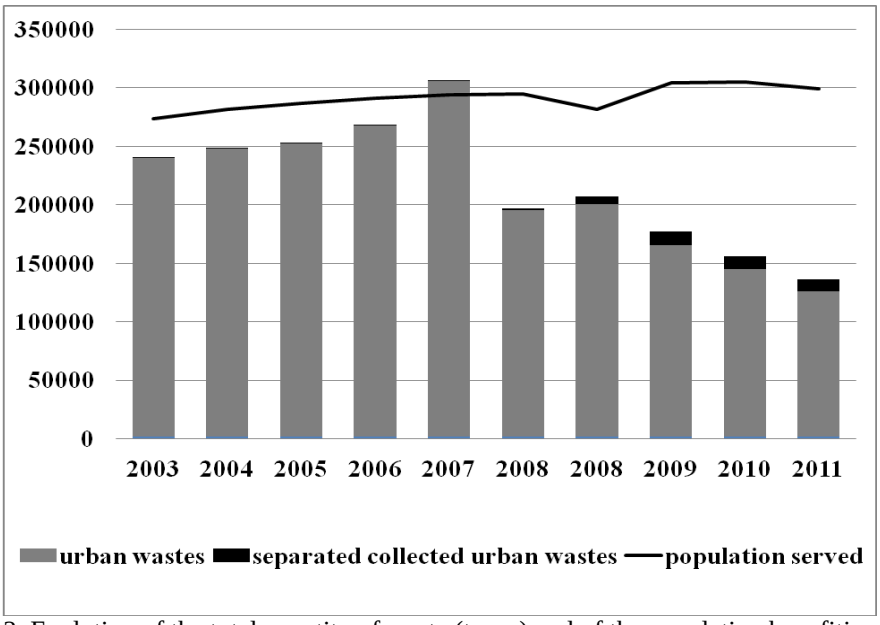

Figure 2. Evolution of the total quantity of waste (tones) and of the population benefiting from sanitation services at the level of Timişoara and its surrounding area

- the significant role played in the structure of Timisoara area by nuclei of the rural type, whose population reuses vegetal matter as fertilizer for their vegetable gardens, or by burning (not yet regulated);
- the effects of the economic crisis, which resulted in reducing the number of undertakers in the study area (647 only in the year 2009) (Hațegan. & Hotico, 2011, p. 115);
- the multiplication of undertakers specializing in collecting recyclable materials directly from the public, which led to the redirection of a portion of the waste flows.

In consequence, the amount of waste generated on the Timişoara and its surrounding area level, according to statistical records, has decreased to about half, which reduces pressure on the environment.

3.1.2 Reducing the pollution as a result of implementing of the selective waste collection and "Zero concept"

The selective collection of waste for recycling represents the second important link in ensuring the decrease in quantity of the definitively deposited waste. Over the studied period, a 25 times increase of the amount of selectively collected waste was observed, with its share increasing from 0.16% in 2003 to 8.22% in 2012 (Table 1, Fig. 2), which still represents to little of the total quantity (Fig. 3).

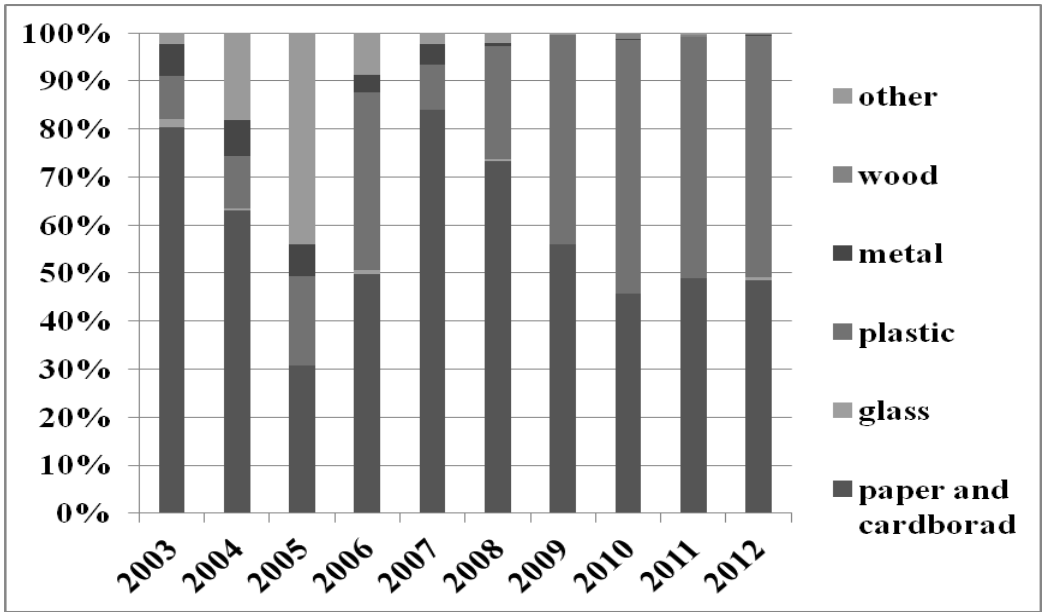

Figure 3. Evolution of the proportion of selectively collected waste in the Timișoara city and its surrounding area

Up to 2007, selective collection was possible only at the 4 collection points owned by the sanitation operator, unevenly distributed in the city areas: 3 in the eastern area and one in the western area. Nowadays, these points are used to collect bulky waste and constructions debris volumes (under 1 mc), while the selective collection is generalized at the level of the whole area. There are special recipients of different types and volumes distributed to the sanitation services beneficiaries: 17404 bags of 120 l, 486 bins of 120 l and 5417 bins of 240 l. 37 other independent operators buy recyclable materials from the populations and institutions.

The application by the authorities and the RETIM Ecological Service SA operator of a selective collection generalized at the level of the whole area was accompanied by a strong media campaign consisting of advertising, environmental education programs aired on local television stations, consistent thematic supplements of the local newspapers funded by the City of Timisoara, public information campaigns (Hațegan & Hotico, 2011), publication of informational materials destined for the public (also by the public-private partnership, i.e.a guide on the selective collection).In addition to selective waste collection through the dual system, the implementation of measures aimed at facilitating the collection of other categories of waste is noticeable:

- campaigns to collect WEEE (electrical and electronic waste) organized by the Timisoara City Hall in partnership with the Romanian Association for Recycling, RoRec;
- actions to green public space and green areas with the support of the Neighborhood Advisory Councils, respectively of the Seniors Council (Hațegan & Hotico, 2011);
- spring and autumn cleaning campaigns, which facilitate the evacuation of biodegradable materials, and of bulky waste from households.

The "Zero Waste" strategy provides the minimization of permanently deposited waste (Puri et al., 2011). A series of activities and infrastructures have been accomplished for the implementation of this concept.

Since 2010 Timişoara has been operating a waste sorting station built by the operator RETIM Service SA from mixed, own and European, funding. At that time, Timisoara was the only city in the country to own such a sorting station. The station allows both for the processing of pre-sorted material (selectively collected in the dry bins) and of the unsorted municipal waste. Secondary raw materials result from the sorted material, in a share of about 15% of the amount processed. These are subsequently capitalized by retailing to RETIM partners. Caloric materials are prelevated from what remains after the removal of all secondary raw materials, respectively after processing unsorted municipal waste, in a share of about 45-55% of the total processed material (Puri et al., 2011). These materials are produced constantly and are stored temporarily, until their delivery to beneficiaries (Aleşd, Chiscadaga, Hoghiz cement factories) (Hațegan & Hotico, 2011).

A composting facility is also in project, as the percentage of green waste is high in the composition of waste in the studied area: 48%.

3.2. Evaluation of ecologic behavior of the population

With the international acceptance of sustainability as a core priority, a series of events and documents of international organizations as well as scientific reports showed *sustainable practices* as an equally essential component of the sustainable development paradigm (Tudor et al., 2008, Ianoş et al., 2011).

The success of sustainable waste management strategies doesn't imply only synergistic action of institutional actors - responsible for creating the legal and organizational framework, and for monitoring the implementation of these tools - but also depends greatly on the responsible involvement of social actors, who must prove attitudes and specific behaviors (Sekito et al., 2013, Chakrabarti et al., 2009). The environmental policies of the last 25-30 years "have emphasized the need for greater environmental *responsibility* and the development of strategies that encourage more *sustainable practices*" (Tudor et al., 2008). The concept of *environmental citizenship* (Tudor et al., 2008) is, thus, central.

Following a methodology applied for the Bucharest metropolitan area (Ianoş et al., 2012), 28 study areas were established in the Timişoara City in order to apply the questionnaire: one for each of the 14 rural communities, respectively another 14 within the city. The sample included 770 people (an average of 25 - 30 people per each area), divided equally between the two environments. Most respondents are active adults: 49.16% are between 20 and 40 years, 42.08% are between 40 and 60 years, most (66.68%) have high-school education, a third (29.59%) have higher education, the rest are students. Based on the analysis elements of environmental behavior in general, the questions aimed at the following elements: values, attitudes, behavior.

- *Do you collect waste selectively?*

A percentage of 56.42% of the people collect waste selectively, but notable differences between the two areas were recorded. Thus, selective waste collection is performed by most of the population in urban areas (72.42%), but less than half of the rural population (42.75%).

Almost half of those who do not collect waste selectively *provided no explanation* for the fact that they, personally, do not collect waste selectively, which denotes *indifference to this issue, with lack of adherence to environmental values.*

The remaining approximately 46% of those who do not selectively collect waste, offered various explanations: the majority invoke management issues related to the sanitation operator: lack of separate containers (35.11% for urban, 36.6% in rural areas) and, respectively the insufficient number of collection points (15.96% in urban areas, 7.69% in rural areas).

Also, people in the urban areas cited lack of time (3.19%), (somewhat related to the remoteness of the collection points); - in rural areas lack of obligation accounts for 9.05% of the explanations. This *poor level of adherence to ecological values* is the consequence, for a large part of the respondents, of the absence of environmental concerns during their training and education age, both in their families and in the society in general, in the context of the communist regime.

- *Who do you think are the factors responsible for organizing waste collection? (the City Hall, the public, the Prefecture, others)*

Most respondents (63.45%) identify local authorities as responsible for the selective waste collection, thus demonstrating a low level of civic values (Table 3). Percentages higher than this average were recorded in rural areas or in farther outlying areas with a rural character within the city area. We consider this outlook to be a consequence of social functioning in the last half of the 20th century, during the communist regime, a time when the public was not involved in territorial decisions, having no role as a territorial actor. As a result, the people still perceive themselves as beneficiaries of the work of the authorities, not assuming an active role in general, respectively in waste management in particular.

31.1% of the responses indicate the public as a *factor responsible* for the selective waste collection, which highlights *a fairly low level of environmental consciousness* in the studied area. However, areas with higher weights than this average (41.07%, 51.4%) were recorded as well: these are predominantly urban areas, mostly including young families with children (area 12, area 9), respectively the rural communities which registered significant inflows of former urban dwellers, adults with higher education (areas 21, 22) (Table 2, Fig. 4).

- *To what proportion do you appreciate that waste is selectively collected in your neighborhood/ your community? (less than 10%, 10 to 30%, 30 to 60%, over 60%);*

The perception of most respondents is that 10 to 30% of the waste is collected selectively. More favorable perceptions (indicating a 30 to 60% share of collection) correspond to urban areas - neighborhoods of blocks included in the first stage of implementing the collection process, where 1m³ containers are currently implanted, in visible and accessible places. Here we can identify a consolidated environmental behavior.

Table 2. Who is responsible for the present day solid waste situation (%)

Area	The Municipality	The Population	The Prefecture	Others
1	56.57	35.62	3.12	4.69
2	55.19	37.93	3.44	3.44
3	62.5	34.38	0	3.12
4	56.25	31.25	6.25	6.25
5	54.50	45.50	0	0
6	42.87	46.42	10.71	0
7	55.82	44.18	0	0
8	63.04	32.49	2.65	1.82
9	53.20	46.10	0	0.7
10	69.69	27.28	3.03	0
11	81.82	18.18	0	0
12	53.66	41.07	0	5.27
13	65.10	27.85	1.25	5.80
14	93.33	6.67	0	0
15	65.85	26.82	0	7.33
16	60.00	28.57	11.43	0
17	86.66	10.00	0	3.34
18	55.00	32.50	5.00	7.50
19	62.85	31.43	2.86	2.86
20	90.00	3.33	0	6.67
21	37.10	51.40	0	11.50
22	55.55	44.45	0	0
23	51.40	37.14	5.73	5.73
24	100.00	0	0	0
25	54.54	36.36	0	9.10
26	60.55	36.00	0	3.45
27	59.45	37.83	2.72	0
28	74.29	20.00	0	5.71
Average	**63.45**	**31.10**	**2.07**	**3.38**

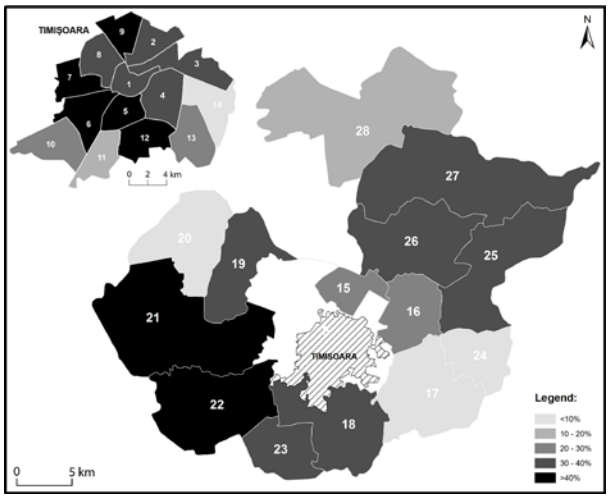

Figure 4. The share of respondents who consider the public as a factor responsible for selective waste collection

- *Why is selective waste collection achieved in such a poor degree?*

The respondents had to choose between *external factors (because it is not compulsory; there are few collection points)*, and *internal* ones *(lack of motivation; low education)*, conditioning this particular type of environmental behavior, represented by selective waste collection. We need to highlight the respondents' awareness of the prevalence of the internal factors. Thus, 48.09% of them pinpoint low environmental education (Table 4).

Table 4 Why is selective waste collection achieved this poorly?

Area	Because it is not compulsory	Few collection points	Long way to go	Lack of motivation	Low education
1	48.86	32.95	0	8.48	86.93
2	17.39	26.08	8.69	17.39	69.56
3	50.00	23.33	10.00	3.33	40.00
4	14.81	37.03	3.7	14.81	55.55
5	10.00	26.67	0	23.33	75.50
6	27.77	44.44	11.11	22.22	77.77
7	26.66	53.33	13.33	10.00	23.33
8	27.33	11.97	5.92	12.71	42.07
9	33.33	20.00	4.50	26.67	46.67
10	21.42	17.85	7.14	14.28	50.00
11	9.54	19.04	0	19.04	52.38
12	26.38	16.01	13.16	8.16	36.29
13	26.67	26.66	6.67	6.67	33.33
14	56.67	33.33	0	6.67	3.33
15	26.67	30.00	6.67	13.33	60.00
16	20.68	27.58	3.44	6.89	62.01
17	26.66	53.33	6.66	3.33	16.66
18	40.00	30.00	16.67	23.33	70.00
19	40.00	26.67	3.33	10.00	50.00
20	13.33	20.00	13.33	40.00	13.34
21	33.33	10.00	3.33	10.00	56.67
22	81.80	9.00	18.00	9.00	81.80
23	20.00	30.00	3.33	6.67	53.33
24	63.33	3.33	16.67	3.33	13.34
25	13.33	36.67	16.67	6.67	50.00
26	16.67	26.67	13.33	10.00	60.00
27	26.67	36.67	20.00	33.33	30.00
28	26.66	46.66	13.33	6.66	36.66
Average	**30.21**	**27.68**	**8.53**	**13.43**	**48.09**

Above average values were recorded in the areas that were also identified as pinpointing the public as a factor responsible for the selective collection: neighborhoods of blocks with the young adult population (area 12, area 9), respectively in the recorded inflows of former urban dwellers, adults with higher education (areas 21, 22) (Fig. 5). Operator responsibility, reflected in the small number of collection points is identified especially in peripheral rural areas (recently included, otherwise, in the selective collection program) (Fig. 6).

- *Is selective waste collection important? (yes, because....; no; I don't know; I won't answer this question)*

Possessing the necessary knowledge regarding the importance of selective waste collection is a

prerequisite for a positive attitude respectively for a positive behavior. 25.22% of the respondents alleged, however, that they do not have such knowledge, which may be real or may denote just an *indifference to the subject*. Considerably higher weights were recorded in several rural communes (areas 24, 20), not necessarily the most distant, and in some peripheral urban areas with a rural character, respectively with a significant share of Rroma population (areas 14, respectively 11). The other answers indicated an economic viewpoint in a proportion of 42.02% (wastes being considered as possible sources), respectively a green viewpoint (32.76%) (Table 5).

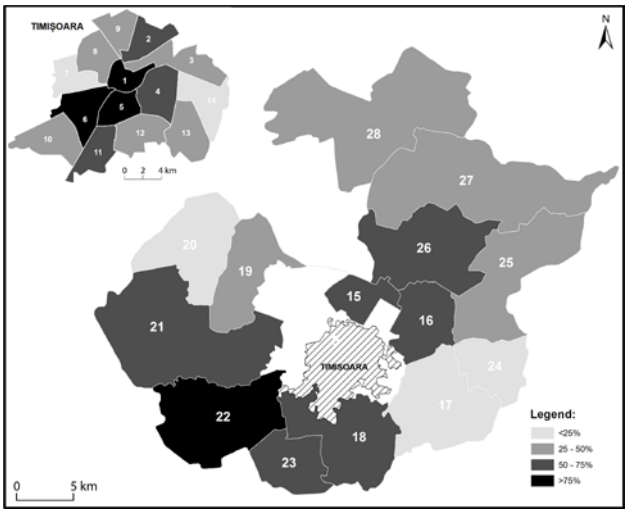

Figure 5. The proportion of respondents who explain the low level of selective waste collection in relation with poor environmental education

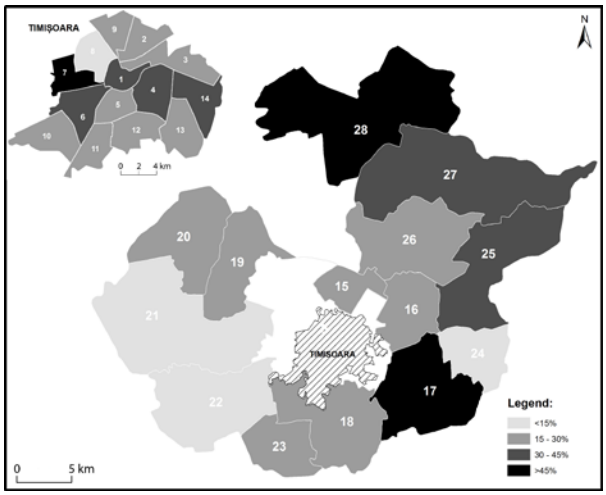

Figure 6. The proportion of respondents who consider the low number of collection points as responsible for the low level of waste collection

• *How did you learn about selective waste collection?*

The question was aimed at revealing the efficiency of the factors involved in the cultivation of an environmentalist behavior in relation to waste. The answers indicated *mass-media* as the most effective factor (45.66% of responses), followed by the main sanitation operator - RETIM Ecologic Service SA, with 39.09% of the responses.

Table 5. Why is selective waste collection important?

Area	environmental motivation	socio-economic motivation	do not know/ no answer
1	59.09	40.91	0
2	33.33	38.67	28.00
3	17.24	58.62	24.14
4	47.82	43.47	8.71
5	40.00	60.00	0
6	53.33	33.33	13.34
7	47.60	23.80	28.60
8	42.24	50.66	7.10
9	50.00	46.67	3.33
10	39.13	55.21	5.66
11	4.54	13.63	81.83
12	44.40	46.45	9.15
13	30.00	50.00	20.00
14	26.60	16.60	56.80
15	32.00	44.00	24.00
16	32.00	54.00	14.00
17	33.33	16.60	50.07
18	60.00	40.00	0
19	27.20	54.50	18.30
20	6.67	10.00	83.33
21	22.70	50.00	27.30
22	18.10	81.90	0
23	21.70	62.80	15.50
24	0	0	100.00
25	31.80	45.50	22.70
26	26.67	33.33	40.00
27	30.00	70.00	0
28	40.00	36.00	24.00
Average	**32.76**	**42.02**	**25.22**

4. CONCLUSIONS

The recent developments regarding the pollution caused by solid waste in the Timişoara and its surrounding area can be assessed as positive: the overall amount of waste has decreased considerably, the amount of selectively collected waste has increased over 25 times, a sorting station was built, the non-green landfill was closed, another European standards complying landfill was opened, a significant market for the recyclable materials has emerged. However, there is a high percentage of contaminated recyclable materials, which reduces the amount of waste that is actually changed into resources (10 - 15% of the amount collected), and results in significant increases in the costs of processing the selectively collected materials, given

that a further sorting is needed.

In conclusion, because the indifference to environmental values is high (25%) and awareness of the active role the public has to play is fairly low (31%), we conclude that the public was highlighted as the weakest link in the chain of ensuring the synergic action in respect with solid waste. Attention should focus on cultivating an environmentalist behavior, involving mechanisms of financial rewarding of those who return recyclables in uncontaminated form, stimulating the community spirit of good citizenship and of social responsibility.

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