Performance assessment method of urban waste management systems from Neamt County, Romania
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PERFORMANCE ASSESSMENT METHOD OF URBAN WASTE MANAGEMENT SYSTEMS FROM NEAMŢ COUNTY, ROMANIA

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Key words: P.A.M., waste management, urban areas, disparities

Abstract. This paper proposes a performance assessment method (PAM) at urban scale, based on five specific waste indicators such as: population access to waste collection services (%), separate collection (%), reuse & recycle (%), landfilling (%) and amounts of waste uncollected (Qwu-%). Values of each indicator are correlated to an assessment table for three different years (2004, 2007, 2010) highlighting the disparities between urban localities from Neamţ County. The paper also examines the changes and dysfunctions of urban waste management systems between pre-accession vs post-accession period. PAM should be a necessary tool for environmental authorities or decision-makers for monitoring process of municipal solid waste systems from various cities on regional scale particularly for new EU members.

Introduction

Urban waste management system from new EU countries is facing real challenges in providing proper waste management services according to waste hierarchy concept. Major disparities are reflected in current municipal waste management system between and within continents (Karak et. al., 2012; Mihai and Apostol, 2012). Each state develops waste indicators in order to assess the improvement of this sector at national or regional scale (Cifrian et al., 2012; Passsarini et al, 2011; Desmond, 2006).

These waste indicators should be chosen for a proper multi-scale analysis. Also an improvement of data from local authorities and waste operators should be constantly performed in order to reflect the real situation in the field.

The paper develops a performance assessment method (PAM) of municipal waste management based on such indicators which can be applied on local or regional scale providing a necessary tool for monitoring this sector at urban level.

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1. Materials and methods

The paper selected five waste indicators in order to assess the performance of a urban waste management system. This is a necessary tool for comparative analysis between several cities on local or regional scale. These indicators are:

✓ population access to waste collection services (%),

✓ separate collection (%) including five recyclable fractions such as paper/cardboard, plastic, metal, glass, wood and also the biodegradable fraction which may be used as compost.

✓ reuse & recycle (2R -%),

✓ landfilling (%) ,

✓ amounts of waste uncollected (Qwu-%).

These indicators are calculated for every urban locality based on information provided by EPA Neamţ, local authorities or waste operators. Also, these indicators are calculated for 2004 (pre-accession period when traditional waste management system prevailed for all cities), 2007 (year of EU accession), 2010 (post-accession period reflecting the transition from a traditional to an integrated waste management system). Each indicator according to its percentage values will get a score which will be added to the total amount of points accumulated by an urban waste management system.

Tab.1. Assessment table of household and similar waste indicators

WCS (%)		SC		2R		Landfilling		Q_{wu}	
%	Score	%	Score	%	Score	%	Score	%	Score
>90	10	>80	10	>60	10	>90	0	>20	0
80 -90	8	60-80	8	40-60	8	70-90	2	15-20	2
70-80	6	40-60	6	20-40	6	60-70	4	10-15	4
60-70	4	20-40	4	10-20	4	40-60	6	5-10	6
50-60	2	10-20	2	5-10	2	20-40	8	2-5	8
< 50	0	<10	0	< 5	0	< 20	10	< 2	10

These indicators are used according to the waste hierarchy principle, thus, high values of some indicators that promote these principle such as waste collection services, separate collection (SC), reuse & recycling (2R) correspond to a higher score. On the other side, high values of some indicators which correspond to a traditional waste management system such as landfilling or Q_{wu} will get fewer points. Also, these percentage values are specific to each indicator and cannot be uniform, these are selected in order to express more accurately the positive or negative implications for an urban waste management system.

Finally, based on total score, each municipal waste management system corresponds to a certain category such as: **excellent** (45-50 max.), **good or**

efficient (35-45), **moderate or proper** (25-35), **inefficient** (20-25), **poor** (10-20) **,
rudimentary or lacking** (<10).

2. Results and discussion

The share of urban waste collection services (WCS %) is a relevant indicator
for studying an urban waste management system in Romania because these
services still do not cover the entire population, favoring illegal dumping of
household waste. Furthermore, Mihai et al. (2012) and Mihai (2012) highlight the
major disparities between Romanian counties regarding the urban population
access to WCS. Also, these disparities are reflected at local scale between urban
localities from Neamţ County.

Tab.1 Population access to waste collection services (%)

WCS (%)	2004	2007	2010
Piatra Neamţ	60.8	62.91	64.72
Roman	70.79	78.54	81.83
Tirgu Neamţ	42.14	42.32	47.34
Bicaz	64.22	50.2	76.7

Data source: processing data from EPA Neamt, waste operators

According to table 1, no urban locality from the county has a higher value
than 85 % of WCS in the 2004-2010 period. Major differences between Roman and
others towns is due to rural localities included in administrative territorial units
(ATU) of urban areas which are not served by WCS. Also the private sector of
WCS has developed earlier in Roman and Piatra Neamţ (including significant
investments) than Bicaz or Târgu Neamţ. Roznov has no WCS until 2011, since a
separate collection is implemented and a transfer station is operational.

Tab. 2. Share of SC (%) from total amounts of household and similar waste (HSW)

SC (%)	2004	2007	2010
Piatra Neamţ	0.12	38.09	38.36
Roman	0.092	1.06	1.28
Tirgu Neamţ	0	0	0
Bicaz	0	0	0

Data source: processing data from EPA Neamt, waste operators

Mixed waste collection prevailed during 2004-2010 in Târgu Neamţ and Bicaz (SC = 0), separate collection being provided since 2011. Also, separate collection systems were in early stages in 2004 for Piatra Neamţ and Roman.

$SC = Q_{rw} * 100/Q_{HSW}$. SC- separate collection
Q_{HSW} = household and similar waste collected
Q_{rw} = recyclable waste collected 5+1, (t/yr), total sum of paper/cardboard, plastic, metal, glass, wood and biodegradable waste, these fraction are collected from special containers.

Separate collection is insignificant in Roman during 2004-2010 because there was no facility for recycling, treatment or composting municipal waste. On the other side, Piatra Neamţ has extended the separate collection systems in every collection point of the town since 2007, reflecting the higher values compared to 2004.

Tab. 3. Share of 2R (%) from total amounts of HSW collected

P% 2R	2004	2007	2010
Piatra Neamţ	0.037	9.33	3.86
Roman	0.085	0.088	0.248
Tirgu Neamţ	0	0	0
Bicaz	0	0	0

Data source: processing data from EPA Neamţ, waste operators

Piatra Neamţ has an operational sorting and composting stations (2007) which reflect higher values of 2R compared to 2004, yet the maximum values are still under 10%. This fact highlights the early stages of the integrated urban waste management system implemented through ISPA funds.

Most of the Romanian towns are facing the transition period from mixed waste collection and landfilling (traditional way) to reduce, reuse and recycling (3R policy) specific to an modern waste management system.

The poor values of the 2R indicator outline the fact the main current option in municipal waste management is still landfilling (over 90 % for every town of the county during 2007-2010). Thus, according to the assessment table (Tab. 1) the score of this indicator is 0 for all towns in every year.

Furthermore, municipal waste (beside HSW fraction is also included garden & street waste , construction & demolition waste) is disposed in non-compliant landfills which are often located on improper sites close to the residential areas (Mihai et al., 2012). Piatra Neamţ has a sanitary landfill (2 cells) which serves only this municipality until 2017.

The last indicator used for PAM refers to the uncollected waste (Q_{wu}). Mihai et al. (2011) outlined the vulnerability to illegal dumping of urban areas from Romanian counties using this indicator. In order to highlight this vulnerability at local scale it is calculated for every city applying the following formula:

Q_{wu} t/yr = P_u * I_g *365/1000, Pu - pop. unserved by WCS (nr. of inhab.)

 I_g –per capita generation of household waste (0.8 kg.inhab/day – an average value for 2003, adding an annual increase of 0.8%).

The next step is to calculate the share of Q_{wu} from total Q_{HSW} collected in the urban areas: **S (%) $Q_{wu} = Q_{wu*}$100/Q_{HSW}.**

Tab. 4. Share of Q_{wu} (%) from total amounts of HSW collected

S Q_{wu} (%)	2004[*]	2007	2010
Piatra Neamț	14	34.39	35.9
Roman	13.2	5.05	26.39
Tirgu Neamț	9.68	28.07	72.41
Bicaz	14.28	24.28	15.47
Roznov	**100**	**100**	**100**

*non reliable data

Urban population without access to WCS dispose the HSW on improper sites from surroundings, polluting the local environment and threatening human health. These situations prevailed in Roznov because of the lack of WCS during 2004-2010 and also in rural localities included in the administrative territorial units (ATU) of Piatra Neamt, Bicaz and Tg Neamt.

Tab. 5 PAM of municipal waste management system in 2004 (pre-accession period)

City	WCS	SC	2R	Landfilling	Q_{wu}	Total Score
Piatra Neamț	4	0	0	0	2	**6**
Roman	6	0	0	0	2	**8**
Tg Neamț	0	0	0	0	2	**2**
Bicaz	4	0	0	0	2	**6**
Roznov	0	0	0	0	0	**0**

On the other side, the data concerning waste flows is questionable because they are volumetrically estimated (m^3) and transformed in tons, and only Piatra Neamt has a weighting system since 2007. In this context, volumetric estimates of Q_{wu} are overestimated in most cities, reflecting the low share of $Q_{wu.}$ in 2004. The last data are more reliable and outline the high share of Q_{wu} (> 20%). In this case no

points will be added according to the assessment table. The extension of WCS is a basic condition for a sustainable waste management system.

Traditional municipal waste management purely based on mixed waste collection and landfilling prevailed for all towns in the county In this case, no urban locality has more than 10 points accumulated according to assessment grid.

Because the share of Q_{wu} varies considerably in relation to the amounts of HSW (whose values in 2004 were overestimated by waste operators) we could not compute the evaluation grid for this indicator. In any case, municipal waste management systems in 2004 were rudimentary and also partially served the urban population. Furthermore, Roznov had no WCS during 2004-2010, and this fact led to uncontrolled disposal of household waste on surroundings.

Tab. 6 PAM of municipal waste management system in 2007

City	WCS	SC	2R	Landfilling	Q_{wu}	Total score
Piatra Neamţ	4	4	2	2	0	12
Roman	6	0	0	0	2	8
Tg Neamţ	0	0	0	0	0	0
Bicaz	2	0	0	0	0	2
Roznov	0	0	0	0	0	0

Romania's EU accession year (2007) hasn't brought major changes to municipal waste management system, for Roman, Tg.Neamţ, Bicaz and Roznov prevailing the same rudimentary performance (under 10 points). Again, the last indicator (S % Q_{wu}) for Roman was not taken into account for the assessment grid due to overestimated volumetric data on HSW collected.

Piatra Neamţ has implemented since 2007 an integrated municipal solid waste management, providing separate collection points for waste streams (biodegradable, paper / cardboard, plastic / glass and residual), two bulky waste collection centers (furniture, WEEE, waste from construction and demolition) and also special containers for hazardous municipal waste. Near the sanitary landfill is also located the sorting and composting stations and the crush plant for C&D fraction. Following the first year, the new system led to a significant increase of separate collection waste and also a positive trend for recycling vs landfilling, but the performance is still poor (12 points).

After three years the same rudimentary performance of municipal waste management systems prevails in Roman, Tg. Neamt, Bicaz and Roznov. However, there are some infrastructure improvements for selective waste collection in Roman, but the efficiency is low. In terms of Q_{wu} indicator based on more reliable data of waste flows it could be achieved a weighting of this indicator from total

HSW collected (t/yr). Thus, high values of this indicator for most towns (> 20%) highlights that illegal dumping of waste is significant particularly in rural areas annexed to administrative territorial units of cities, these facts are also confirmed by field observations.

Tab. 7 PAM of municipal waste management system in 2010 (post-accession period)

City	WCS	SC	2R	Landfilling	Q_{wu}	Total
Piatra Neamţ	4	4	0	2	0	**10**
Roman	8	0	0	0	0	**8**
Tg Neamţ	0	0	0	0	0	**0**
Bicaz	6	0	0		2	**8**
Roznov	0	0	0	0	0	**0**

Although the results of PAM applied to Piatra Neamţ were promising in 2007, it is noted a slight decrease due to a stagnant trend in terms of people's access to WCS and secondly due to a poor recycling and recovery of household waste collected. Full access to WCS, good practices of inhabitants regarding the correct separate collection and development of waste market for recyclable fractions are three key factors beside a modern infrastructure necessary for results improvement of PAM. Also, new waste management facilities were operational since 2011 in Târgu Neamţ, Bicaz and Roznov, contributing to an upward trend on this sector.

Conclusions

The background of traditional waste management system based on mixed waste collection, waste disposal in non-compliant landfills and illegal dumping prevails in most urban localities of Neamt County during 2004-2010, threatening the urban environment and human health. Only Piatra Neamţ has an modern waste management infrastructure system since 2007, but it is outlined that the performance is poor so far.

The role of local authorities to prepare the people for the transition from a traditional to a sustainable waste management system in a short period of time is essential and cannot stagnate, otherwise Romania will not be able to comply the objectives assumed to the EU in this priority area of environmental policies.

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