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## **Spatial distribution of rural dumpsites parameters in Romania**

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1. Spatial distribution of rural dumpsites parameters in Romania
2. Distribuzione spaziale dei parametri di rurali discariche in Romania

#### 4. Abstract

Poor waste management facilities led to uncontrolled waste disposal on improper sites in the proximity of human settlements particularly in rural areas. This bad practice prevailed in all rural regions until 16 July 2009 when these garbage dumps should be closed and rehabilitated according to Government Decision number 345/2005 which comply the Landfill Directive 1999/31/EC. The paper aims a spatial analysis of waste indicators concerning the rural dumpsites at administrative territorial units on national, regional and local scale. These data are correlated to geographical conditions reflecting spatial patterns in their distribution across and within Romanian counties. The role of geographical conditions is revealed at local scales in these spatial patterns due to a low coverage rate of rural communities to waste collection services. Such analysis supported by field observations is necessary for a proper understanding of illegal waste disposal issue. Rural regions are still exposed to such bad practices polluting the local environment.

5. Key words: spatial analysis, waste indicators, rural areas, dumps, waste management,

6. Poveri spreco Impianti di gestione mal gestiti hanno portato allo smaltimento illegale dei rifiuti in siti localizzati in prossimità degli insediamenti umani, particolarmente nelle zone rurali. Questa cattiva pratica ha prevalso in tutte le regioni rurali fino al 16 luglio 2009, quando queste discariche devono essere chiuso e riabilite secondo la normativa del governo nr. 345/2005 che è conforme alla direttiva sulle discariche 1999/31/CE. La carta si propone un'analisi spaziale degli indicatori dei rifiuti riguardante discariche rurale presso unità amministrative territoriali su scala nazionale, regionale e locale. Questi dati sono correlati alle condizioni geografiche e riflettono I modelli spaziali nella loro distribuzione all'interno di contee rumene e tra le stesse. Il ruolo dei fattori geografici si rivela su scala locale in tali modelli spaziali a causa di un basso tasso di copertura delle comunità rurali da parte dei servizi di raccolta rifiuti. Tale analisi, supportate da osservazioni di campo, sono necessarie per una corretta comprensione del problema di smaltimento illegale di rifiuti. Le regioni rurali sono ancora esposte a tali pratiche che comportano un'inquinamento nell'ambiente locale.

7. analisi spaziale, indicatori di rifiuti , zone rurali, discariche, gestione dei rifiuti

#### 1. Introduction

Non suitable waste management systems are a serious environmental threat on a wide scale across the world (Karak et al., 2012). Noncompliant landfills and illegal dumping are the main options as a treatment solution of waste generated by urban and rural localities. Poor infrastructure and the lack of proper waste collection services led to the pollution of the local environment (rivers & streams, lakes, forests, agricultural land, roadsides etc.).

Rural regions are more predisposed to illegal dumping due to the lack of investments in this sector. Pollution derived from rural dumpsites in emerging economies such as China and India are complex and threatening the human health (Guan et al., 2012; Chunhui e Ping, 2008; Lakshmikantha, 2006). Furthermore, rivers are frequently exposed to waste dumping in the proximity of rural households (Obeta e Ochege, 2014; Breg et al., 2007;)

Illegal waste disposal sites are also encountered across rural EU countries, despite recent improvements in waste management infrastructure (Skoczko, 2003; Skourides, 2008; Mihai, 2012). GIS techniques and multi-criteria analysis are used in order to determine the rural areas predisposed to illegal dumping (Borrell et al., 2014; Mihai et al, 2013; De Feo et al., 2013). Waste management systems from rural areas of EU countries need to be better supported by central and local authorities in order to mitigate these bad practices (Căpățină e Simonescu, 2008, Passoti 2010; Gabršček e Išljamović, 2011; Benjamin, 2011).

This paper aims a spatial analysis of statistical parameters (number, surface – ha/sq.m) concerning the rural dumpsites at different geographical scales such as counties (Romania), communes (North-East Region) and the villages of Neamt County.

Regional and micro-scale analysis outline the role of geographical conditions in spatial patterns of rural dumpsites parameters. Poor data about the rural waste management system from Romania are available in environmental reports and quality of those provided are often questionable. There is no database concerning the rural waste indicators at the county or commune scale. In this context, this rural environmental issue is barely debated in the Romanian scientific literature and a geographical approach is absent.

## 2. Spatial analysis at national and regional scales

Romania has 8 development regions which correspond to NUTS 2 classifications, but these are not quite administrative borders with no executive attributions and a constitutional basis. These regions include 41 counties (NUTS 3) and the Bucharest municipality as a capital city. Each county is further divided into cities and communes (NUTS4). The commune is a lower administrative division specifically for rural areas which may include one or more villages. North-East Region is a part of the historical region of Moldavia and includes 6 counties as follows: Suceava, Botosani, Neamt, Iasi, Bacau and Vaslui. Each county has a County Council as a local authority of public administration, which coordinate the urban and communal councils within a county in order to provide public services. Regional development regions play an important role in accessing EU funds, including for the waste management sector. County councils supervise the new local integrated waste management systems supported through structural funds.

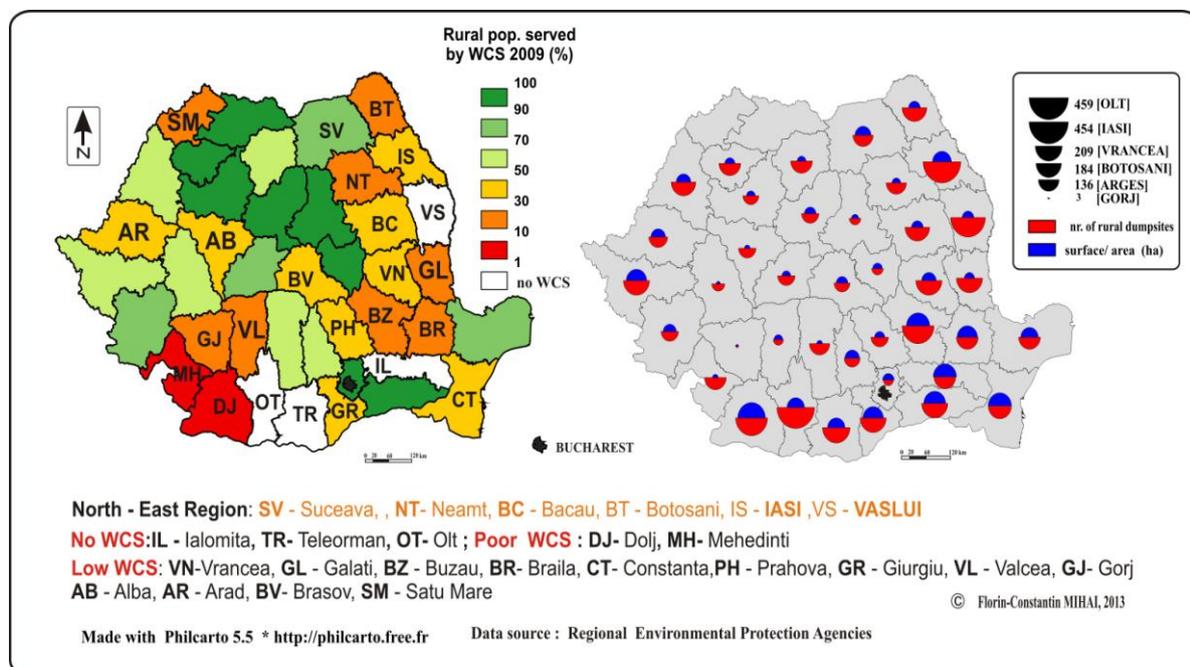
Regional authorities and waste operators often ignored rural areas concerning the waste management issue before EU accession. Poor waste management infrastructure led to the spread of dumpsites across rural regions. Every commune and village disposed their wastes on such improper sites (Mihai e Lămășanu, 2013). Almost every river or stream in the proximity of households were predisposed to illegal dumping particularly in mountain regions. Such dumpsites had a mixed composition, including household waste, agricultural

waste, sawdust, manure, demolition and construction waste, hazardous waste (tires, batteries, WEEE etc.) threatening the community health and local environment.

Development of waste collection services (WCS) in rural Romania was a lazy and lengthy process. Following the EU accession in 2007, eight Romanian counties still did not provide such services in rural areas in 2008 and in another 6 counties, the share of rural population with access to WCS was very low <10% (Apostol and Mihai, 2012).

Next year, the overall situation has partially improved, but following counties have no access to the WCS in rural areas such as Ialomița, Teleorman, Dolj. In case of Vaslui county, only 207 people (0.07%) were connected with such services from Zorleni village. Dolj and Mehedinți had a coverage of only 2%, and in 8 counties these rates are below 30% (including Neamț county). Lack of proper waste management facilities has increased the amounts of waste disposed in open dumps. Counties from North-East, South-East and South of Romania have the lower coverage rates as shown in Figure 1, being most vulnerable to waste dumping except following counties: Ilfov, Călărași (over 90%), Suceava & Tulcea (over 70%), Dâmbovița & Argeș (over 50 %). Larger open dumps are frequently found in the proximity of human settlements located in regions with a low risk of flooding (plateau areas, inter-fluvial hills, fluvial terraces) or on the plains where rural population density is higher and human settlements are more bundled in the absence of geographical constraints. Such dumpsites are more extensive and frequent in well populated counties with a significant share of rural population and poor access to the WCS (<10%) where plains and low hills dominate the landscape (Apostol and Mihai, 2012).

Figure 1 - Rural dumpsites parameters related to WCS rates at the county scale (NUTS3)



The North–East region has 3.302.217 inhabitants in 2011, according to the last population census data and include 6 counties, 46 cities, 506 communes and 2.414 villages.

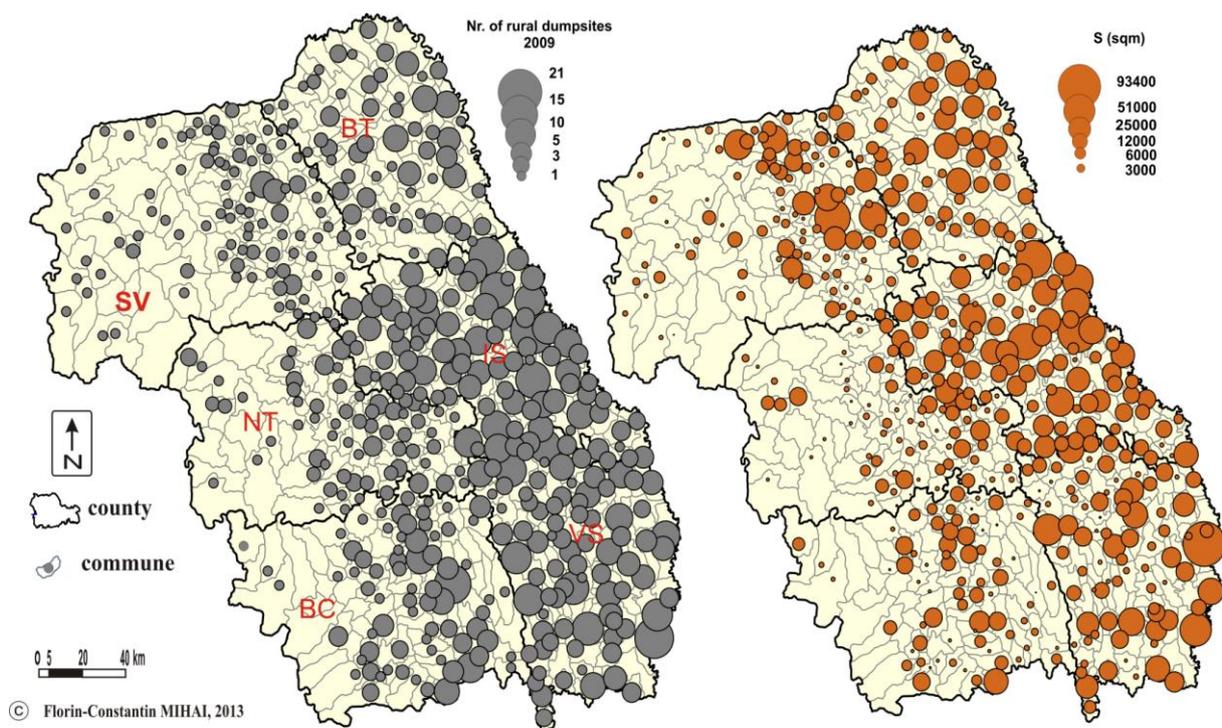
This region has a harmonious combination between various relief types as follows from West to East: mountains (Eastern Carpathians – 30 %, 2100 m max. altitude ), Moldavian Subcarpathians (30 %) which include several depressions and hills (higher altitudes around 700 - 800m), and 40% goes to the Moldavian plateau. This last form of relief occupies more than 70% of the surface in the counties of Botosani, Vaslui, Iasi .

Mihai et al., (2012b) outlined some spatial patterns concerning the ratio between the number of dumpsites at commune scale and number of villages that form a commune :

- ❖ in the mountainous western half of the counties Suceava, Neamț and Bacău the number of dumpsites is less than in the eastern half (dominant landscapes as Subcarpathian depressions and hills, plateau) as shown in figure 2.
- ❖ Botosani, Iași and Vaslui counties are overlapping the Moldavian Plateau, number of dumpsites are larger than the other three counties (particularly to mountainous western half). Frequently, each village from a commune reported the presence of a waste disposal site and sometimes number of these sites exceeds the number of villages that form the commune. This fact is due to the large rural population, especially in Iași County.

Physical-geographical transition of Suceava, Neamț (see figure 3) and Bacău counties influenced the distribution of rural dumpsites areas (ha) within the same county, while in eastern counties (Botoșani, Iași and Vaslui) this distribution is more uniform due to a more homogeneous landscape of Moldavian Plateau (Mihai et al., 2012b) as shown in Figure 2.

Figure 2. – Spatial patterns of rural dumpsites parameters in North-East Region



Counties of North-East Region: **SV** - Suceava, **NT**- Neamt, **BC** - Bacau, **BT**- Botosani, **IS** - Iasi, **VS** - Vaslui

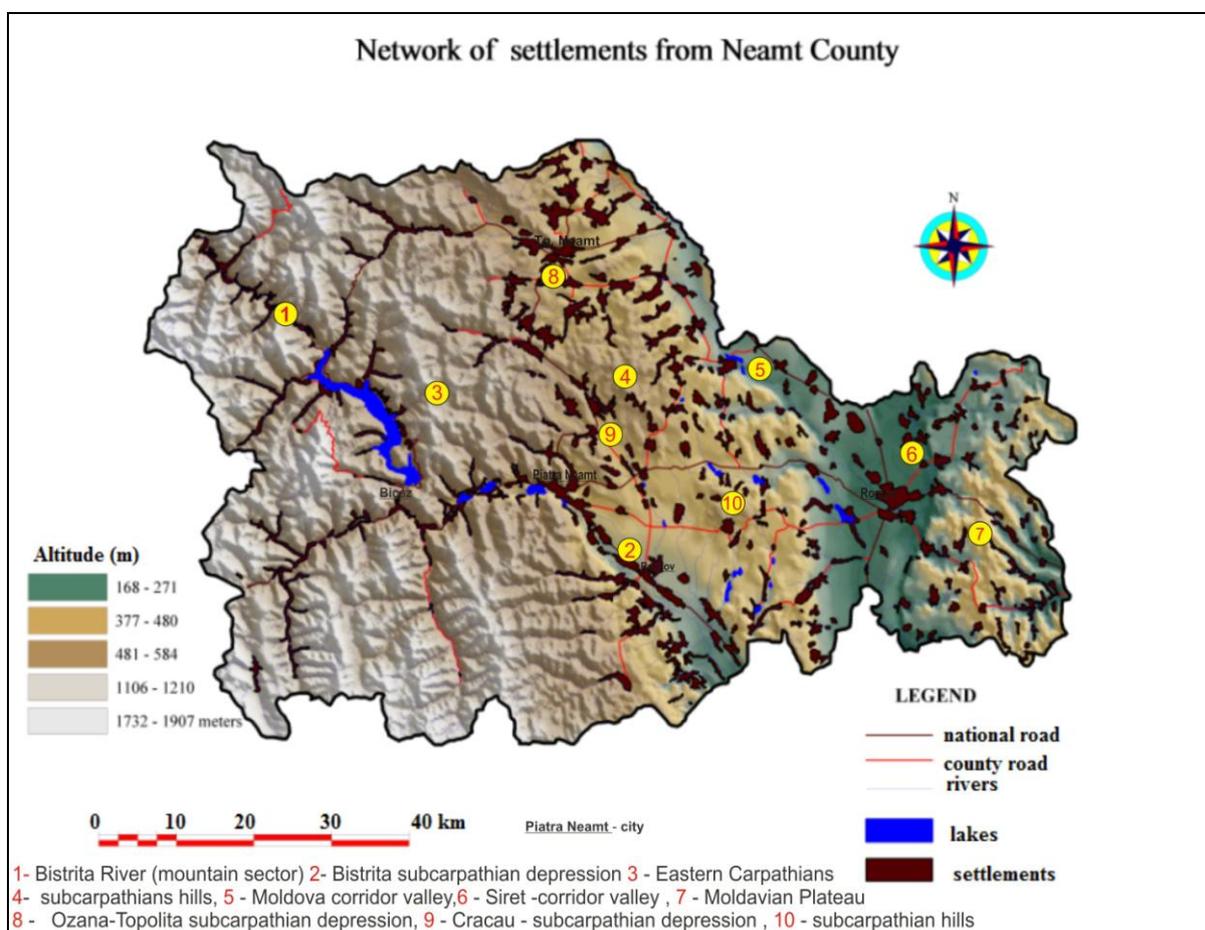
Made with Philcarto 5.5 \* <http://philcarto.free.fr> Data source : Regional Environmental Protection BACĂU

The North-East region is still facing the uncontrolled waste disposal (due to a partial coverage rate of rural population access to WCS) polluting local environmental factors such as the rivers and streams, ground waters, forested areas, agricultural lands in the proximity of built-up areas. Suceava, Botosani, Iași, Bacău and Neamț counties have made significant progress after 2009, regarding the development of waste management facilities in rural areas, unlike Vaslui where this sector was almost non-existent in 2010.

### 3. Spatial analysis of micro-scale (villages of Neamț County)

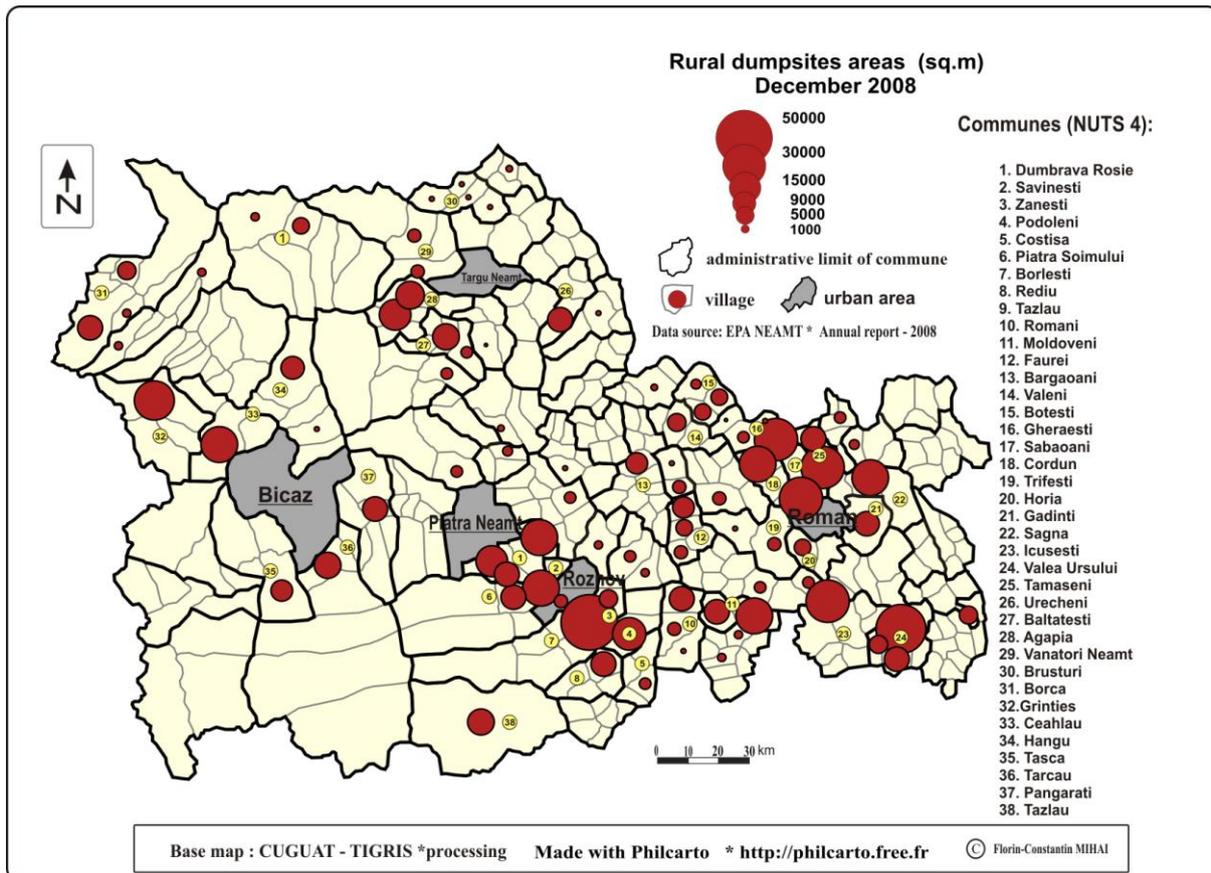
Following the multi-scale analysis of the geographical distribution of rural dumpsites at county & commune level, such an analysis is also performed at the micro - scale for villages of Neamț county. This has been possible due to inventory of these dumpsites made by EPA Neamț in partnership with local authorities in December 2008, data are provided on this scale in the annual environmental report (EPA Neamț, 2009). Nevertheless, it should be noted that these data differ from those used in the analysis at commune scale in the North-East Region as shown in Figure 2 (Neamț county data were provided by the National Environmental Guard, County Commissariat, September 2009 ).

Figure 3 - Geographical features of Neamț County



Statistical data representing the total amount of surfaces occupied by these sites within a village because there may be one or more such sites across a village. Comparing Figure 2 to Figure 4 it is noted that there are mostly the same geographical distribution of dumpsites surfaces, high values (> 1 ha or 10000 sq.m) focusing on the subcarpathian region of Bistrița river where wastes are often disposed on alluvial plains across several villages such as Cut (1.5 ha), Brășăuți (1ha), Săvinești (2ha), Zănești (5ha), Șovoiaia and Ruseni.

Figure 4 - Geographical distribution of dumpsites areas (sqm) at micro-scale (village)



These villages are vulnerable to flash floods in the warm season, local dumpsites are often temporary which may explain the differences regarding the surfaces at commune level between December 2008 and September 2009 or as open dumps located on older terraces of Bistrița river close to settlements such as Izvoare (2ha), Traian (0.55 ha), Podoleni (1.7ha) and Costișa (0.2 ha). Also, in densely populated localities located on terraces and floodplain of Moldova river larger open dumps prevail in following villages: Săbăoani (3ha), Cordun (3ha), Pildești (2ha), Horia (0.45 ha). In the same context enroll the villages which dispose the wastes on floodplain of Siret river as Tămășeni (3ha) and Adjudeni (1ha). Figure 3 & Figure 4 reveal the role of landscape in spatial analysis of rural dumpsites at local scale. Open dumps are common and usually occupy small areas (<0.5 ha) in the Moldavian Plateau with some exceptions, such as Valea Ursului (4ha) Bucium (1ha) or Recea (3ha).

Communes of this region have a large number of small villages in their administrative structure, these villages are sparsely populated and aging (<500 inhabitants) such as Oniceni, Icusești or with between 500-1000 people in villages Bozieni, or Valea Ursului and Stanița.

Subsistence agriculture and isolation from major traffic arteries & cities contribute to a poor economic situation that lead to a decrease of consumer goods which also imply a lower waste generation rate. Furthermore, waste recovery in own households (organic waste as a food source for livestock or compost, reuse of recyclable) mitigates the amounts of waste disposed on improper sites. This goes for hilly regions of central and south of the county and only in some cases rural dumpsites having larger areas such as Budești (0.7 ha) Moldoveni (2ha) Hociungi (1ha), Goșmani (2ha). In subcarpathian region, these sites are larger in case of tourist localities such as Agapia (1,2ha), Filioara (1,6ha), Bălțătești (1,07 ha). Development of waste collection services in such areas should be a priority in order to avoid the prejudice local tourism. In the same context fits the localities within the mountain region where wastes (household, agricultural and sawdust) were dumped on the banks of streams and rivers which are frequently flooded (Borca -1 ha, Madei- 0.5 ha, Grințies-2ha, Ceahlău-2 ha, Hangu -0.9 ha, Tașca 0.75 ha, Pângărați -1ha, Tazlău -1.075 ha, Pipirig -0.41 ha, Pietra Șoimului -1ha).

Differences between surfaces of dumpsites reported in December 2008 and September 2009 highlights the temporary nature of these sites in mountainous regions and on floodplains (extra-Carpathian region) which were frequently flooded. This comparison is made at commune scale, thus data at the village level is compiled for 2008. Such an analysis is relevant in the context of poor waste management services.

The significant decrease (Dec 2008/sept 2009 ha) in the mountainous region is found for following communes: Borca (1.5/0.27 ha), Ceahlău (2.04/0.81 ha), Pipirig (0.51 ha/-), Hangu (1.5/0.93 ha), Tazlău (1.075/0.15 ha), Grințies (2.4/0.85 ha), Tarcău (1.125 /0.05 ha), Pietra Șoimului (1/0.51 ha).

In the subcarpathian Bistrița valley, significant differences were recorded in case of Dumbrava Roșie (4.5 /0.12 ha), Săvinești (2/0.5 ha), Zănești (5 /0.14 ha) communes and the same patterns are encountered also for floodplain of Siret river in the proximity of the Tamaseni commune (4/0.28 ha) or floodplain of the Moldova river for Cordun commune (2/0.59 ha). Almost constant values were recorded in the villages located on the terraces of Moldova where such dumpsites are furthest from the river as Botești (1.03/1.3 ha) and Gherăești (0.28/0.29 ha). These major differences observed in the comparative analysis contributes also the closure of these sites (between the two inventories taken by the authorities, the legal term until 16 July 2009), on the other hand, depends on the accuracy of the data reported by local authorities. In any case, these aspects cannot minimize the potential role of flash floods on these sites where waste dumping still prevails in these areas (2010-2011) as confirmed by field observation. It should be noted that in both inventories there were several communes / villages who did not report such sites on their territory, although rural population access to WCS was only 15.14% in 2009.

#### 4. Conclusions

Statistic analysis of rural dumpsites parameters cannot claim to be exhaustive, but outlines the role of geographical conditions in their spatial distribution in a multi-scale context (counties –communes-villages). Rural dumpsites were the heritage of poor waste management facilities from pre-accession period until 16 July 2009 when these sites should be closed according to Government Decision nr. 345/2005. Nevertheless, these improper sites are also encountered in now days due to low coverage of WCS from several rural regions of Romania. Geographical implications at local and regional scale are outlined by thematic cartography and GIS techniques. These are useful tools in order to assess complex interactions between environmental- waste management- human settlements in a multi-scalar context, such as villages – communes – counties - development regions – countries – EU. Geography of waste is emerging under the multi and interdisciplinary approaches of waste management sector.

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