THE ASSESSMENT OF GIS USE IN WASTE MANAGEMENT

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ABSTRACT
Municipal waste is being produced in large quantities worldwide. If this large amount of waste is not being managed correctly it could lead to major deterioration of the environment and human population serious threats to health state. This paper presents how Geographical Information Systems can be used as a decision support tool for planning waste management. The municipal waste situation at the national level and at the development regions level was analysed. Thematic maps were developed to illustrate regional distribution of waste services along with a series of analyses that emphasise GIS efficiency in waste management.

Keywords: Solid waste management (SWM), waste management planning, municipal waste, Geographical information system (GIS), spatial data

INTRODUCTION
The European society produces a big quantity of waste reaching 2.61 billion tonnes in 2008, about 5 tonnes of waste per person. The biggest fraction of it has been disposed to landfills with negative effects on the environment and human life. Waste management consists of all the activities of collection, transport, non-harmful treatment, recovery, reuse and final disposal of waste, necessary for environment protection and public health safety. The development of new technologies for improving the waste management systems includes Geographic Information System (GIS), a technology that can provide spatial and non spatial information and which integrates and analyses maps for waste management databases. GIS is helping the public authorities to make the best decisions regarding waste management.

MATERIALS AND METHODS
1. Case-studies
In Romania about 97% of the collected municipal waste is eliminated by disposal in organised areas (landfills). Only 30 landfills out of total are in conformity with the European Community legislation in this field - the Waste Framework Directive 2008/98/EC, another 101 being in a transition phase (they are going to be closed until 2017) according to the Treaty of Accession of Romania. In distinction to other countries in EU, where has been observed a tendency towards diminishing the quantity of wastes being landfilled, in Romania has been detected a growth in the amount of waste in this category. But there must be taken into account that when a considerable development and preoccupation for a certain domain takes place in a country, as it happens to be the case of Romania in the waste management area, a growth in the total values of the tracked parameters showed by the statistical observation do not necessary point to a real growth but can rather intervene as a result of:
- A growth in the area of data collection.
- A growth in the quality of the collected data - the development of methodologies for data collection and quality control.
- A growth in the population number benefiting from waste services.
As a result of the Romanian Accession to the European Union and our entering in the obligation of annual collecting and publishing of statistical data in EUROSTAT, the degree of certainty of the analysed values is rising steadily. Thus Romanian waste management and the applied strategies have a rising probability of reaching their objectives.

An illustration of the possibilities of using the GIS technology was the development of a map of distribution for the existing landfills at the national level. Their size based classification can be visualised in fig.1 and contains the information available in 2008 but collected de facto in 2007.

![Fig.1. Waste landfills classification by size](image)

The GIS powerful tools of analyse were used in the following study based upon the data for the year 2009 [2]. Based on this new data we were able to elaborate a new map for the regional distribution of conform and nonconform landfills, as shown in fig. 2.

![Fig.2. Waste landfills distribution by area and conformity](image)

The quantity of municipal wastes collected by the specialised services pertaining to public city halls or waste services companies was of 6938715 tonnes. About 63.21% of the population had access to waste services, 83.88% of the people being in urban areas.
At the regional level the situation is very dissimilar. In Bucuresti – Ilfov Region, the population that benefitted from waste services has reached 86.21%, in North and North-Vest Regions has reached about 77%, conversely in the South-East Oltenia Region only 32.43% of the population had access to the waste services.

The disparities in the rural area are even bigger: in Bucuresti – Ilfov Region 75.8% from the population benefitted from waste services, in Center and North-Vest Regions about 65%, in South-East Oltenia Region 4.66%. This can be easily seen in fig. 3.

In the urban waste structure, domestic waste has the higher weight (75-80%), followed by the municipal services waste (10-12%), construction and demolition wastes having the lowest weight. Moreover, the C&D waste materials are usually dumped without being weighted as often they are simply discharged on free spaces [3]. Their repartition among the regions is shown in fig. 4.
Domestic waste composition has varied for the last couple of years, the highest weight being recorded for the biodegradable waste. In 2009, biodegradable waste represented 56% from the total quantity of collected domestic waste, paper-cardboard 12%, plastic 10%, glass 4.5%. Their distribution by region has been emphasised in fig.5.

The characteristics of MSW are important for evaluating infrastructure, technology and equipment needs, management program and planning, especially with respect to the implementation of disposal as well as resource and energy recovery options [4]. Other important factors to evaluate in waste management are the manpower need and the implementation of collection, transfer and landfill disposal.

In the case of Romania about 3% of the collected waste is recovered. The Vest Region has the highest recovery rate of 8%, as for the South-East and South Muntenia Regions they recover less than 1%, as shown in fig.6. Paper and plastic are among the most recovered waste in our country.
RESULTS AND DISCUSSIONS

The power of a GIS for the waste management database consisted in the easiness of understanding and interpreting a large quantity of information in a very short time, the extraordinary possibility of interpreting the same information at different scales having both the ability of seeing “the bigger picture” as the one of understanding local conditions.

We also used powerful tools that offered the availability of the database concept, the relationships that can be established between its elements conducting to different querying possibilities, most important being the ones based on the spatial location.

There are many queries that can be performed according to the usual syntax, with different degrees of complexity, to obtain the needed information in a very short time.

An illustration of this possibility for a waste management database is presented in fig. 7 to answer the question of “Which region has the recovery rate bigger than 3% and has more than 70% of the urban population covered by waste services?”

Formula for query was a typical one:

\[ [\text{ProcValorif}] > 3 \text{ OR } [\text{Procurb}] > 70 \]  (1)

where:

- [ProcValorif] is the field containing recovery rates and [ProcValorif] is the field containing the rates of urban population covered by waste services.

The use of GIS technology in waste management implies multiple advantages like the following:

- it ensures the quality criterion applicability by stating the well known principle of “garbage in – garbage out”,
- it makes possible the development of collecting methodologies and automation of data storage and validation,
- it allows an easy access to information, on multiple levels,
- it allows a fast correction of errors,
- it allows the development of thematic maps for different levels of interest and spatial analyses.

The existence of disadvantages can’t be ignored. The most important one is that the costs of GIS implementations are still high as it needs costly hardware, software and specialised personnel.

CONCLUSIONS

GIS can add value to waste management applications by providing outputs for decision support and analysis in a wide spectrum of projects: waste strategies, management plans and waste facility system flow modelling. Waste Local Plan, planning, policy and strategy documents, topographical, sensitive receptor, transport network and land use data are efficiently collected and quality assured prior to being imported and analysed in waste management GIS databases [5], [6], [7]. The analysis can be used for everyday management decisions, planning and waste strategies and site selection exercises.

REFERENCES