GIS application with a Geospatial Database for improving the waste management in Sibiu Surrouding Area

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Abstract— This paper creates a role model to simplify and streamline how waste management is currently in Romania. This model can be further improved and extended to larger scale. To begin an analysis was made concrete in the Sibiu Surroundings on the current situation of waste management. Following tests have found new ways to improve the management process. One of them is to use GIS techniques to centralize and analyze data for a permanent significant improvements in this area. Also we present notions of geospatial databases. The work is highlighted in the use of GIS techniques in goal. Another method involves the implementation of specific rules from which all the inhabitants of studies should be encouraged to practice composting individual.

Keywords—composting, database, management, waste.

I. INTRODUCTION

The purpose of this paper is to create a model needed to streamline the management system of municipal solid waste which can then be extended more widely.

At first will be a reality check that will be taken into account all factors influencing waste management: environmental performance indicators for cost, service, process indicators-general, external factors affecting the performance so I can be influenced by the mayor or local council.

The data obtained will be centralized with the GeoMedia software for viewing spatial data obtained, the project will be more easily presented, to support, and will be much easier for people who will subsequently require information regarding the situation in the area (points selective waste collection, the amount collected in each island collection, the distance from one place to the nearest collection point, the area area it serves) to obtain in the relatively short and accessible through paper[1].

II. OBJECTIVES OF THE PAPERS

Regional objectives and targets presented in the paper are representative in following aspects:
1) Development of a geodatabase to manage waste in a particular geographical area;
2) Presentig the main characteristics of geospatial databases;
3) Stimulate the creation and development of a viable market of recyclable waste;

4) Promoting a system of information, awareness and motivation for all parties by Enhancing communication between all parties involved;
5) Organization and support programs for education and wareness population by all parties involved (public authorities and central local companies, public institutions, etc..);
6) Develop information materials;
7) Improved local and regional system for collecting, processing, analysis and validation of data and information related to the generation and management waste;
8) Establish a regional system for the collection, analysis and validation related to the generation and waste management.

III. GEOSPATIAL DATABASE

A Objectual Relational Database Management System (ORDBMS), also referred to simply as a database, is a complex suite of software applications that collectively controls the organisation, storage, and retrieval of data. Modern database systems provide support for data types other than numbers and strings. The type system may be extended allowing new types and operations to be introduced. All the major database vendors support extensions to the traditional type system to include spatial data types and associated functions.

The term *geospatial database* describes an ORDBMS that supports geographic information in the same way as any other data in the database. Vector data types such as points, lines, and polygons can be used and this data may make use of a Spatial Reference System (SRS) describing the coordinate system used. Raster, or gridded data, may also be supported in the form of an array structure where the cells contain information being modelled. Examples are satellite imagery or Digital Elevation Models (DEMs). A geospatial database may be used as the data repository for a Geographical Information System (GIS). The GIS supports an advanced user interface and incorporates specialised tools for the processing and presentation of spatial data.

Experienced few years ago, but already confirmed now, the approach is geometric entities that store recordings of relational databases or object-relational, not graphic files, it allows solving problems in GIS applications for data storage. This approach is also encouraged by the OGC (Open Geospatial Consortium) has issued several standards and

recommendations in this direction. Among the current solutions using this approach deserve mention Oracle Spatial suitable for large and very large Microsoft Access used by Arc / Gis and by Intergraph Geomedia. The solution presented in this paper is based on Geomedia Professional 6.1 software environment.

The advantages of a geodatabase are:

- linear referencing system;
- queries based on direct interaction of geometric entities;
- advanced geospatial functions;
- aggregation functions for spatial queries;
- SQL spatial extensions;
- coordinate transformation functions;
- ability to manage raster images.

A. Object approach to geospatial databases

Object-oriented approach to geospatial databases has advantages not only to the design / modeling and GIS applications, but the data collection phase. The main advantage is that data can be validated even as the data is entered or captured. Object approach allows all digitization, drawings, data input required by the model data to be supplied during data capture [8]. The process of capturing data in a GIS has three distinct phases:

- modeling to create the conceptual model for data to be collected based on the requirements / specifications of the GIS project;
- measurement data sources that meet the requirements / specifications are used to capture defined locations for the entities defined in the conceptual model
- Preparation according to sources, the data are passed through specific processing before being integrated into GIS

Because Object-Oriented concept and data collection can be assumed from the beginning, the entities and objects modeled in GIS, unified consideration of the geometry, attributes and behavior. It follows that since the introduction phase of GIS data relationships and constraints can be imposed only to require further interventions [8]. It thus appears that in all databases Object theory principle more realistic presentation of the environment, which is particularly important for GIS systems and geospatial databases serving them

In practice and considering a Geomedia GIS environment for entities that make up a network for example, require conditionings geometric shapes using topological facilities and creating the network connection. For specific conditions are imposed on entities with functions topological integrity of creation and network nodes. The media object topological features disappear they are replaced with methods on constraints, association, multiplicity and generalization [8].

To maintain compatibility of existing applications, and technology to exploit the relational and object-oriented technology motivated, major manufacturers in the field of GIS software, ESRI, Intergraph, created in recent years object-relational hybrid models such as Arc / Info, Arc View, Geomedia Professional. He was created as an extension of geodatabase technology database than a model of completely new database. This system can provide the properties of

objects with their behavior, resulting in a specific smart object database object [9]. Experience shows that such user is allowed to add data about geospatial entities conduct, rules and relationships.

Moreover, if data is imported into a geodatabase, then they automatically inherit the properties of the domain is already defined. Polymorphism is generally supported by the geospatial database, so that only the appropriate components will provide a response to a command / query. An important aspect is that in practice a geodatabase combined in a single file space and all the data nonspatiale project. In GIS products are now two possible approaches:

1. the file system data model GIS data sets include such classics Arc View
2. management systems of databases where information is stored in traditional geospatial database software, such as Geomedia.

It can be concluded that current geospatial databases are based on relational object model, built on the same concept of spatial data as shape files, files on its coverage grid, which were added to various advanced features.

B. Geospatial metadata

Acording with Wikipedia " **Geospatial metadata** (also **geographic metadata**, or simply **metadata** when used in a geographic context) is a type of metadata that is applicable to objects that have an explicit or implicit geographic extent, in other words, are associated with some position on the surface of the Globe. Such objects may be stored in a geographic information system (GIS) or may simply be documents, datasets, images or other objects, services, or related items that exist in some other native environment but whose features may be appropriate to describe in a (geographic) metadata catalogue (may also be known as a data directory, data inventory, etc.).

Geospatial metadata are necessary for:

- data can be difficult to find;
- data can be difficult to access;
- data can be difficult to query;
- data may not be current;
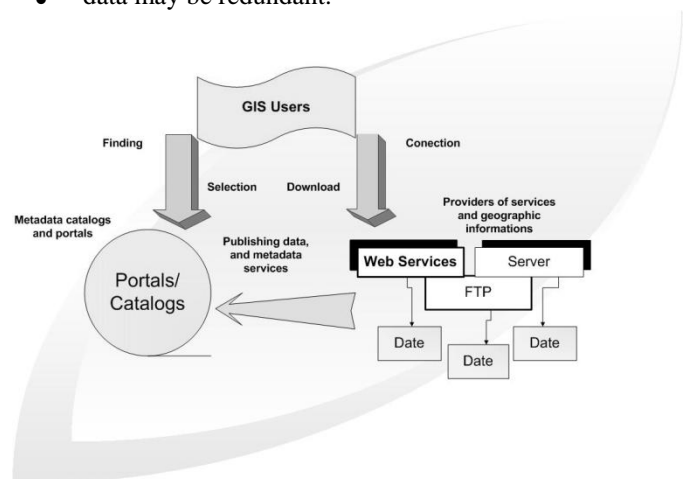- data may be incomplete;
- data may be redundant.

Fig 1 The role of metada in GIS

The creation and maintenance of metadata easily retrieved, one of the possible solutions is the computer network, with the advantage of decentralization and access information quickly. Disadvantages should be mentioned that the discrepancies in the definition of the differences in the search protocol, different storage formats and hardware and software incompatibilities. The basic idea in designing a metadata is to build systems that allow easy data entry or retrieval.

One approach in this field is the national data infrastructure, which are deposits large data including materials, technologies and personnel, the purchase, processing, storage and distribution of spatial data. This method has been adopted in several countries as a result of increased use of GIS production of spatial data sharing requirements of data in international projects and not least as a method of inducing or maintaining economic competitiveness at regional or national leve.

Of these existing systems can include: National systems of metadata: SNIG (Portugal), GEODAN (Netherlands), AFIGEO (France), Sines (UK), Geodata (Denmark), Info Space Directory (Belgium), ATKIS (Germany), FAD Geospatial Data Clearing House (USA), AUSLIG (Australia), NGDF (United Kingdom).

International systems of metadata: MEGRIN (Euro topographic) GEIXS (Euro Geological data), RCADE (Euro statistics and Some topo), ESMI (Future European clearing house), EWSE (Euro earth observation data). These systems must, however, have a common framework for communication, where it resides, as described above, the need for standards.

Spatial data, is the position and shape of objects or terrestrial phenomena using three entities:

- Points - GIS is too small to be described by lines or polygons, can be trees, islands of garbage collection. Therepresents the graphic symbols and may be accompanied by explanatory text.
- Lines - GIS is too narrow to be described by polygons, eg roads, streams or objects that have linear length but did not surface. It is characterized by length.
- Polygons - is closed surfaces representing the shape and position GIS homogeneous, eg administrative units, lakes, plots.

In Geomedia exists also entities composed - they contain all three.

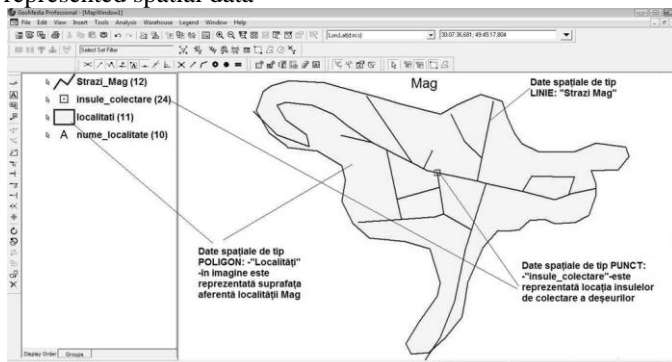In Figure 2 we illustrated the three entities that have represented spatial data

Fig. 2 Illustration of spatial data type: point, line and plygon

Descriptive data, is information about the objects located on a map they may be:

- an Attribute;
- a Values of attributes.

For the application presented in this paper has used GIS software, Geomedia who was attached to an Access database type . In Access database each instance of a class of objects of type point, line, area, compound corresponds to objects that have their own attributes. Data is stored in database tables. Each attribute has a data type and a value that can be string, numeric, date calendar, logic, etc. modeling object-oriented technologies, sometimes referred to by the acronym OO-GIS has the advantage of more natural representation of real entities and relationships between them

Fig. 3 The attributes of street class

GIS spatial analysis accounts for obtaining information with specific queries using SQL. These may be queries: Functional Attributes, Join Queries, Union Queries, Spatial, Queries, Attribute Queries. Geomedia software provides mechanisms to achieve all these types of queries.

Storing data in relational database systems object has a beneficial connection with that SQL query language has experienced in recent years a number of extensions and additions intended to define graphics conditionings. We have defined seven primary operations assessment spatial relationships: intersection, disjoint, Within, containers, touch, cross, overlap. An implementation of SQL commands in addition allows us to use conventional SQL commands and geographic elements: Intersects, Touches, Distance, Overlap attribute, query, spatial intersection, etc.

In the figure below is illustrates "Attribute Queries" query, that in a query with valente geospatial .
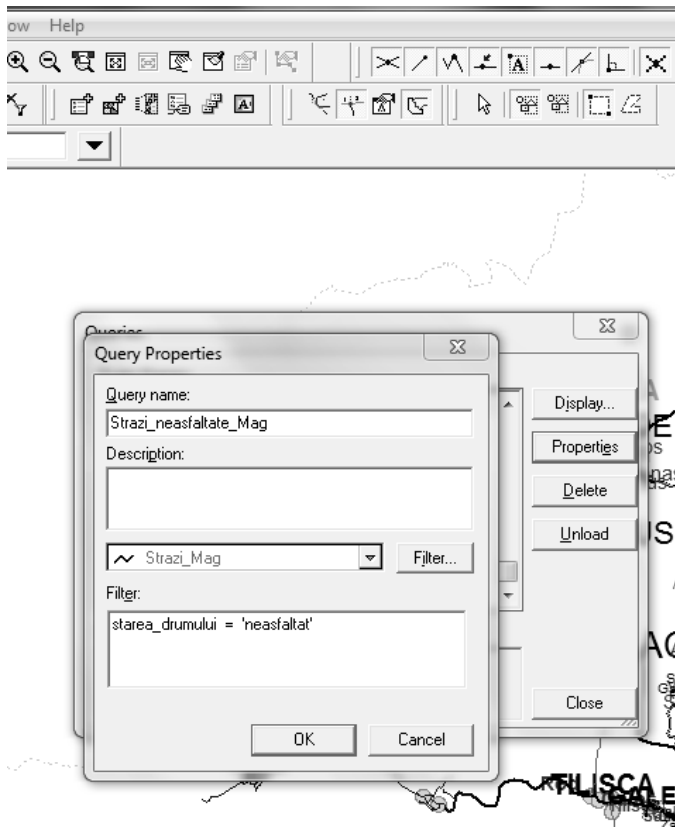
Fig. 4 Query type"Attribute Query"

IV. THE AREA WHERE THE STUDY PRESENTED IN THIS PAPER WAS DONE

The area is presented in the paper is in the South West of Sibiu county, in the mountainous hills Cibin Mountains, in the south of Transylvania. The map that we have developed using GeoMedia software location area can be seen, both within the country and in the county.
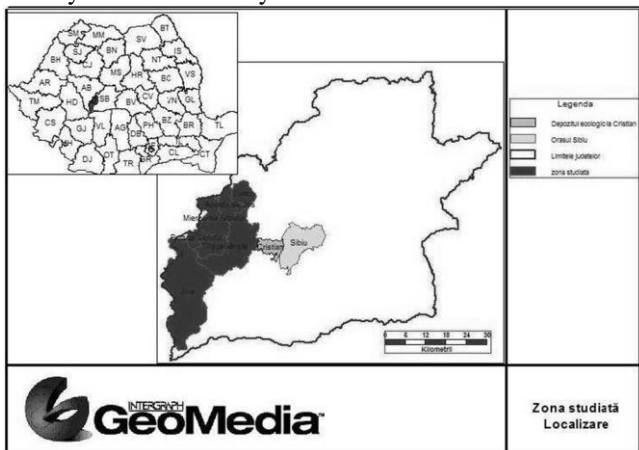

Fig. 5 Location in country and county area

The area in which to do research presented in the paper consists of:
- Saliste City and neighboring villages: Gales, Vale Sibiel Fântânele, Aciliu, Amnas, Sacel, Mag;

- Miercurea Sibiului city, with neighboring villages: Apoldul de sus, Dobârca;
- Tilisca village with village belonging Rod;
- Poiana Sibiului village, Jina village;
- Apoldul de sus village with village belonging Sîngatin;
- Ludos village with village belonging Gusu[5].

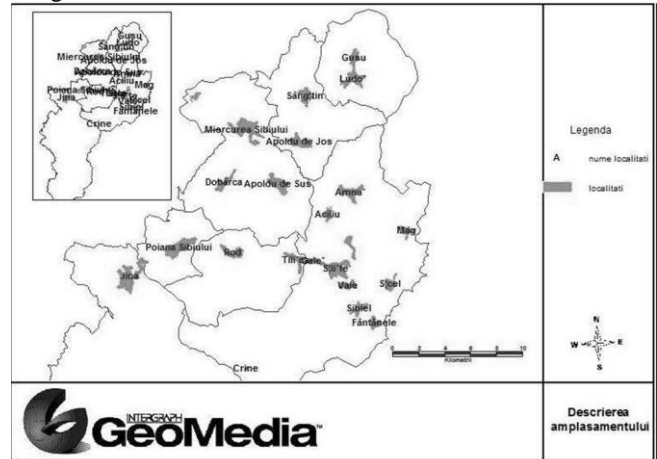All cities and villages of Sibiu Surrouding Area are seeing in figure 5.

Fig. 6 The cities and the village of the area

V. COMPOSTING

Composting is a process of decomposition and transformation of substances organic solids by microorganisms (mainly bacteria and fungi) in a material stable, which can be exploited in agriculture. Compost is a stable and hygienic material similar to humus in the forest, which can be used as natural fertilizer, thus avoiding the need to use chemical fertilizers. He is said to have relented on land and property. Adding compost to soil is considered as a natural way of increasing fertility and restore quality to them [2].

Waste suitable for composting:
a) Scraps from the kitchen: fruit and vegetable scraps, leftovers, Residues of coffee filter paper, etc..
b) Residues from animal manure, manure from poultry, rabbit manure, feathers and hair, etc..
c) Scrap garden: grass and dry leaves, twigs and bark, weeds, trimming hedges material resulted after, the vines, trees, etc.

Composting takes place in two phases:
- Mechanical treatment (grinding);
- Decomposition (fermentation) - occurs in conditions aerobic / anaerobic formation of CO_2, water and humic substances.

Factors affecting the composting process: air content of compost, humidity, waste composition, temperature, pH level, the grain waste subject to fermentation, homogeneity of the mixture, the settlement of waste ground in piles or containers of fermentation, the percentage of carbon and nitrogen.

It can be done in the simplest way, without significant cost, small scale in own yard, as far away from inhabited areas (the so-called back-yard composting). In this particular case will be composted in the green waste from the garden, orchard and waste biodegradable kitchen (potato peelings, cabbage

leaves, fruit and vegetable scraps, etc.). If higher courts (> 5000 m) can make compost from waste above that can be added and solid manure from animals (horses, cows, sheep, poultry, etc.). In all cases will be avoided meat, bones, the fetid smell and also attract rats and other rodents [4].

Stages of development:
a) collect, transport, reception, storage;
b) treatment of mechanical, manual (metal removal) and shredded (optional);
c) biological treatment - composting and finish - only with humidity control;
d) Final preparation of compost - Choppers, sieve (optional), and packaging.

If such waste compost obtained from the degree of safety can check simply by placing compost in a plastic bag, seal and open 48 hours. If after 48 hours compost smells bad, meant that the finishing stage is finished.

Location of green waste composting area must be evaluated in terms of construction impacts on the environment. Some development work is necessary but is preferred to minimize their investment to reduce and maintain a "buffer zone" natural (eg trees along the road and limit accces from adjacent living area, hilly, etc.). The site should not be in flooded areas (water and storm suprafa_a), do not allow the accumulation of water inside and be protected from erosion. It is considered optimum for composting suprafa_a land with a slope – 37. Minimum of 1% and the optimum 2-4% (drain rainwater and leachate from the chamber for pre-treatment facilities).

It is very important to have a water supply system. The average amount of water needed for composting leaves is a m^3 of approximately 80 liters of water.

Important elements in designing green waste composting area is:
a) pretreatment area;
b) the treatment (composting);
c) postratare area (finishing);
d) access roads and internal roads;
e) utilities and security of the entire site[6].

VI. ANALYSIS OF THE AMOUNT OF WASTE TO BE TREATED

The formula for calculating the amount of waste is:
Amount generated in a locality [tons / year] = (population* index generation * 365) / 1000

Table 1
FORECAST TOTAL AMOUNT OF HOUSEHOLD WASTE, HOUSEHOLD WASTE AND WASTE ASIMILABLE THE STREET ACCORDING TO THE INDICATIONS OF WASTE GENERATION (TONS / YEAR)

	2010	2011	2012	2013	2014	2015
Forecast the total domestic waste paper	4727	4748	4768	4788	4808	4828
Forecast total county household waste	5028	5050	5071	5093	5115	5136

View parallel to the total amount of household waste, household waste and assimilated waste street is presented in the graphic in figure 7.
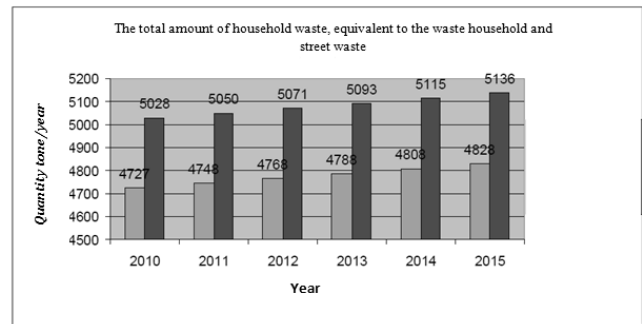

Fig. 7 The total amount of household waste, equivalent to the waste household and street waste

From the analysis we conclude that it takes an updated analysis of the areal amount of waste generated in each locality including the separate periods of the year. This will help to better waste management and of course to a decrease in transport expenditure[3].

The extent of waste recovery depends on factors such as:
a) education;
b) zonal development process;
a) efficient collection system and selection;
b) specific equipment;
c) population more interested

In setting targets for the percentage of recovery was held "Marginimea Sibiu" account the average percentage recovery target, set in the Regional Plan Waste Management (RPWM) with data corrections zonal situation[7].

Forecast recovery of waste fractions I did it from 2010 because it is the year that is being implemented in the selective collection area. Biodegradabilele compost is considered to be inividual each as part of the household in many cases will not be possible and much of that amount will go to waste disposal along with other household waste. From calculations carried out so far it follows that the biodegradable waste large share of the total waste that is intended to be recovered, it is therefore need to take more radical measures for this type of waste not may be stored or be burnt in the household.

Table 2
PROGNOSIS FOR RECOVERY OF WASTE FRACTIONS IN THE SIBIU SURROUNDINGS

Prognosis for recovery of waste fractions in the Sibiu Surroundings [tone/year]							
Assortment	2010	2011	2012	2013	2014	2015	2016
Paper	141.50	190,62	217,37	241,53	254,37	255,72	256,60
Glass	48.51	71,53	91,52	126,51	113,97	114,57	114,97
Metal	29.11	32,51	35,96	39,43	42,95	43,17	43,32
Plastic	116.43	143,06	156,90	170,88	178,39	179,33	179,95
Wood	29.11	45,52	57,20	67,36	71,03	71,40	71,65
Biodegradable	216.69	277,59	429,84	839,60	1.148,38	1.154,46	1.158,44
Total	581.36	760,84	988,79	1.485,31	1.809,08	1.818,66	1.824,92
Shelf	3461.45	3.303,48	3.097,13	2.622,71	2.320,71	2.333,00	2.341,03

VII. WASTE COLLECTION

Waste collection is as follows: first sorting is done at source on the islands of collection, the four types of recoverable wastes:paper, glass, metal, plastic.

Recoverable waste collection is done in three containers as follows:

- 1 x eurocontainer for recovered waste paper and cardboard;
- 1 x eurocontainer for recoverable waste metal and glass;
- 1 x eurocontainer to recover from plastic waste.

The 81 islands are set collection. Each area of the island having 25m². In total there are 243 euro containers with a capacity of 1.1 m^3 (of different colors and properly labeled for each type of material collected). Mixed waste is collected at home in a separate container. The 8800 bins are provided for 120 l (1 for each household in part). Recoverable waste is sorted by the sorting station will carry, where secondary sorting will be applied and mixed waste will be collected separately and will be transported directly from a warehouse that is emptied containers central. Frequency of empty containers is the type of waste and the period of filling dumpsters. The islands are located by mapping the collection made in Geomedia. These maps are used for spatial analysis project.
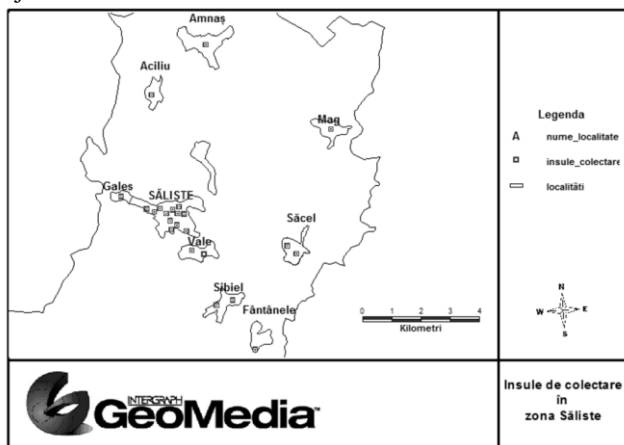

Fig. 8 Collection islands from Saliste area

In Figure 8 are illustrated the collection of islands from Saliste area and 150 m radius around them. I considered that 150m is the distance for which the island has an efficient collection best.
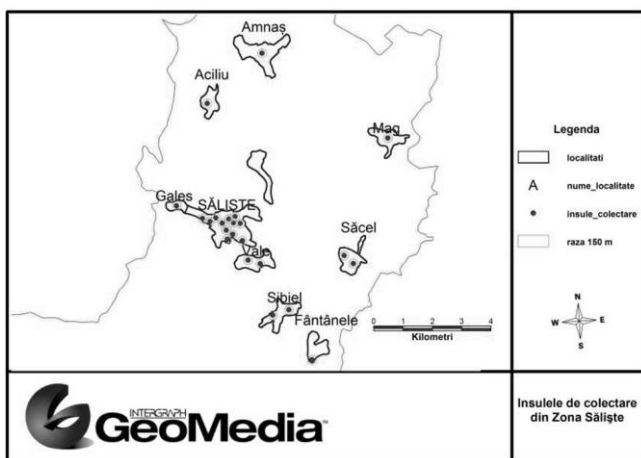

Fig. 9 Buffer zone arround the collection islands from Saliste area

For spatial analysis [1] of the area have used existing maps that were vectorize. Specific attributes were used for each instance of existing classes of objects in the map. An example is the map which shows the roads and the islands waste collection of area.

Fig. 10 The roads and the collection islands in Saliste town

Using data entered for each island may be part of collection perform spatial queries to be viewed as data that are needed at a particular time, eg during filling to view the fractions used to collect recyclable cans. In this way it can reduce the time needed to centralize and analyze data can be achieved and maps can be viewed as a drain for frequencies each locality and recyclable fraction.

In this paper we highlighted the use of GIS technology in managing waste, these include:

a) Data on existing access roads, road situation and the situation on waste are better organized. They are relatively easy highlighted by spatial analysis is performed directly on the paper;

b) Updating databases related to spatial information can be easily and quickly, they provide interactive and accurate data on waste management in the "Sibiu Surroundings";

c) Also by using GIS technology can avoid some mistakes due to ignorance of the area design.

perioada_de_umplere_fractii_reciclabile			
Perioada_de_umplere_hartie	Perioada_de_umplere_plastic	Perioada_de_umplere_metal_si_sticla	localitatea
31	33	147	vale
13	13	73	gales
22	22	147	sibiel
22	22	147	sibiel
26	33	110	amnas
22	26	147	sâcel
22	26	147	sâcel
26	33	110	mag
38	33	110	fântânele
38	33	220	aciliu
11	12	59	sâliste
77	82	367	ludos + gusu

Fig. 11 Filling period per day of recyclabe waste dumpsters

VIII. ESTABLISHING A DATABASE FOR THE RECYCLABLE WASTE FRACTIONS SALISTE

We positioned on map each locality islands for fraction collection recyclable waste - Zone location platforms Saliste I got from the Data Salitte sanitation service (SC Eco Marginime.SRL) and for other localities have taken information about the number of platforms is located in every locality of the project financed by PHARE

funds and we positioned according to images taken from Google Earth. As you can see city map Figura.12 Saliste islands and platforms acesteia. This maps related collection highlights:

- density collection of islands in a locality;
- coverage by selective collection services;
- efficient collection of islands location depending on the distance you need a citizen to go through to reach the nearest collection point in a very short time.

In Figure 11 we considered that the islands have a collection efficiency of a well approximately 200 m radius around it
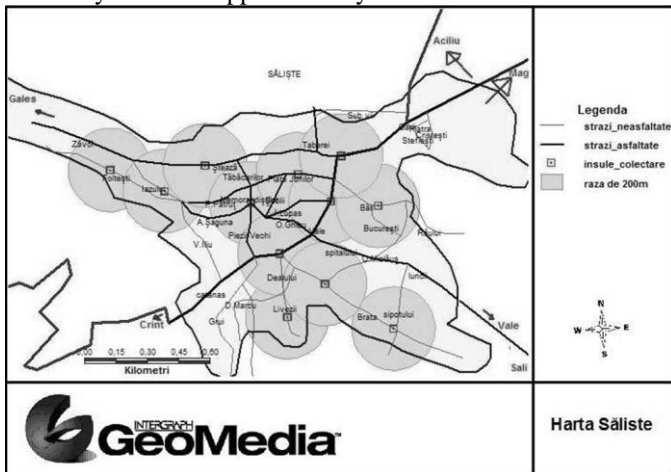

Fig. 12 Location City Saliste collection of islands

Papers such as those in Figure 13 are useful to have an overview collection of islands on the situation in the desired area, you can see in the image area Saliste the 23 selective collection platforms
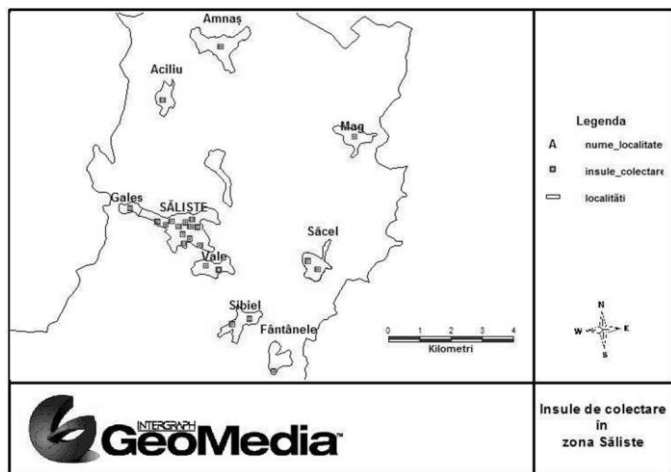

Fig. 13 Islands of collection in Saliste area

Using data entered for each island may be part of collection make tables to be viewed data are needed at a particular time, for example to view from filling fractions used to collect recyclable cans.

perioada_de_umplere_fractii_reciclabile			
Perioada_de_umplere_hartie	Perioada_de_umplere_plastic	Perioada_de_umplere_metal_si_sticla	localitatea
31	33	147	vale
13	13	73	gales
22	22	147	sibiel
22	22	147	sibiel
26	33	110	amnas
22	26	147	săcel
22	26	147	săcel
26	33	110	mag
38	33	110	fântânele
38	33	220	aciliu
11	12	59	săliste
77	82	367	ludos + gusu

Fig 14 Filling period of the recyclable waste dumpsters (days)

In this way it can reduce the time needed to centralize and analyze data and maps can be made that can be seen emptying frequencies for each locality and recyclable fraction, like the map in Figure 15
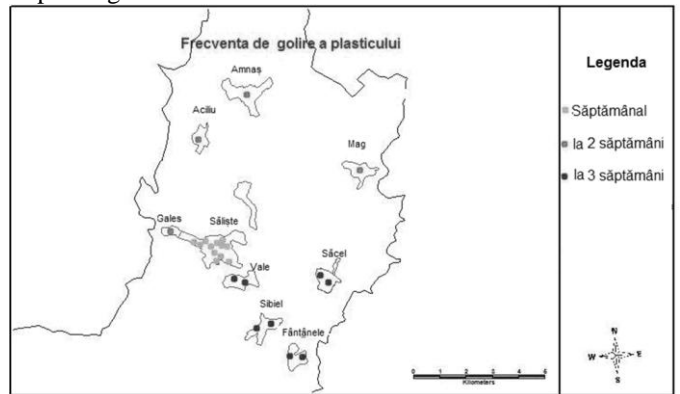

Fig 15 Frequency of emptying the plastic to Saliste area

IX.   CONCLUSION

Today the individual is not in the compost. It is being achieving only a pilot project to educate people on how composting. In Sibiel village in which 200 bins will be offered to those wishing compost. To achieve targets in terms of biodegradable waste plan Waste Management District - Reduction of biodegradable waste by 65% 2015 arriving at the warehouse, it is necessary that in all the villages in the area studied individual to practice composting.

After analyzing the existing situation in the moment we arrived at to conclude, that targets can be achieved in terms of RPWM.

Implementation of biodegradable waste is a need to introduce the project to individual composting throughout the area, it has the effect of lower taxes paid by residents for waste collection and transportation.

An area is also required for composting waste resulting from maintenance of green spaces.

What to do:
- Undertake a campaign to inform and educate citizens about individual composting include:
  - Informing and educating students in schools with both theoretical and practical making compost in the school and student involvement in this type shares. In the area are 21 schools and two high schools;
  - Informing the citizens in meetings with specialists who are appear to consist of composting
  - Brochures about composting;
- Setting at local council level differentiated fees for citizens composteaza than those who do not composteaza;

- Acquisition or construction dumpsters for their composting system composting

Among the statistical procedures used for instrument making strategic objectives national waste management can include the use of programs GIS computer to handle information in the geodatabase object-relational type, which helps to organize the most accessible and efficient of information related to waste management field. Smart maps that we presented in this paper allow Location in the country and county area Determination of infrastructure in the area studied Location of collection of islands in each locality Frequency of emptying recyclable fractions

REFERENCES

[1] S. Borza, "Introduction to Geomedia Professional", Eds University "Lucian Blaga"of Sibiu, ISBN-973-739-516-0, 2008.

[2] C. Bachert, W. Bidlingmaier, S. Wattanachira, „Open Windrow Composting Manual, Eds ORBIT e. V., Weimar, ISBN 3-935974-23-X, 2008

[3] R. V. Pascu "Waste management," Eds University "Lucian Blaga"of Sibiu, ISBN- 978-973-739-718-8, 2009.

[4] M. S. Castiñeira, "Manual to Obtain Composting in Household", Eds. Consellería de Medio Ambiente e Desenvolvemento Sostible da Xunta de Galicia e Sociedade Galega do Medio Ambiente (SOGAMA).

[5] County Waste Management Plan - Environmental Protection Agency Sibiu.

[6] National Waste Management Plan, Part 1 of 954bis, Gazette Official 10/18/2004;

[7] Regional Plan Waste Management (RPWM);

[8] N.Swan,"An Objectual Oriented Approach toSpatial Data Capture" Doctoral Thesis, University of California, Santa Barbara, 2002;

[9] Borza S., *Visual Fox Objectual Relational Databases Programming,* Eds University "Lucian Blaga"of Sibiu ISBN 973-651-683-0, 330 pag, 2003.

Sorin I. Borza (M'76–SM'81–F'87) and the other authors may include biographies at the end of regular papers. Biographies are often not included in conference-related papers. This author became a Member (M) of **NAUN** in 1976, a Senior Member (SM) in 1981, and a Fellow (F) in 1987. The first paragraph may contain a place and/or date of birth (list place, then date). Next, the author's educational background is listed. The degrees should be listed with type of degree in what field, which institution, city, state or country, and year degree was earned. The author's major field of study should be lower-cased.

The second paragraph uses the pronoun of the person (he or she) and not the author's last name. It lists military and work experience, including summer and fellowship jobs. Job titles are capitalized. The current job must have a location; previous positions may be listed without one. Information concerning previous publications may be included. Try not to list more than three books or published articles. The format for listing publishers of a book within the biography is: title of book (city, state: publisher name, year) similar to a reference. Current and previous research interests ends the paragraph.

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