# THE ANALYSIS OF THE VECTOR SYSTEM OF THE CADASTRAL MAPS FOR THE CREATION OF A GIS PROJECT

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***Abstract:*** *The output of a remote sensing system is usually an image representing the scene being observed. A further necessary step of image analysis and interpretation is required in order to extract useful information for the GIS from the image. Remote sensing is technology of acquiring information about material objects, area, or phenomenon, without coming into physical contact with them. The value of a GIS is directly related to the quality and currency of its internal data. Remote sensing offers a suite of tools for quickly creating current, consistent datasets for input to a GIS. We can say that remote sensing is a young branch of terrestrial measurements. In the past years, remote sensing has made great progress, given that the first remote studying and recording methods were mentioned four or five decades ago. The research work on the land surface performed in air and outer space with remote sensing methods provides most valuable information for various fields of activity such as agriculture, silviculture, geology, pedology, hydrology, cartography, natural resource prospection and valuation, environment (soil, water and air) monitorisation etc. The chief objective of the thesis is to create the methodological framework for the use of satellite data in creating a GIS of soil, farmland and cadastre resources for a better management of agricultural, cadastre and pedological activities. Of special value are the results obtained by the recording, transmitting, processing and interpreting of remote sensing data. They provide new ways of investigation in terrestrial measurements and other fields as well. Remote sensing and GIS allows permanent direct access to ped logic and agriculture information at different times, without altering the state of the surface.*

***Key words*****:** *GIS, remote sensing, vectorisation*

## INTRODUCTION

The vector system is based on graphic primitives. A graphic primitive is the smallest nondivisible element used in creating and storing vector images and recognised as such by the system. The vector system is based on five graphic primitives: the POINT, the ARC (the line that unites the points); the NODE (the point that marks the ends of and arc or is within the contact of the arcs); the POLYGON (an arc-delimited area); the SOLID (the area-determined solid).

## MATERIAL AND METHOD

Simple cartographic objects are made of primitives. More complex cartographic objects, as well as geographic objects are obtained by combining simple objects.

1. The POINT is the basic unit in geometry or photogrammetric capture. It must not be confused with the cell in the raster representation, because it has neither area nor dimensions. It is a positioning in space with 2 or 3 dimensions. The records on magnetic support will contain numbers. Each point will be recorded in a file under the form of a table with two columns. The first column includes an identification number (which is unique), and

the second gives the coordinates of the point in the chosen reference system. In the GIS products, the programmes are embedded in a larger structure (GIS software) that is called by commands represented either by menus or icons.

2. The ARC is a succession of junctions between a sequence of points. It is a double entity, as it is formed by one or two junctions that unite two or several points. Most of the times, the junction is a straight line. Generally, an arc is a broken line that unites two points of the path. A broken line can approximate any curve by reducing segments. An arc is oriented in the direction of the path from the first to the last point. As with points, disk records contain tables. The first column contains the identification number and the second gives the coordinates of the segments forming the arc.

3. The NODE is an arc extremity that should not be confused with a point. An arc always has an origin and a destination node. The nodes indicate the path of the arc.

4. The Polygon is delimited by arcs that are connected to nodes in a planar graph. A polygon contains an isolated node called centroid.

5. As primitive graphics, SOLIDS are not the primary concern of software products and we shall no treat them in detail. Certain software packages offer the possibility to consider, calculate and represent prisms or simple solids. They approximate solids represented on three-dimensional maps.

Image-data uploading, the analog-to-digital conversion, is done by scanning and vectorisation. It should be mentioned that these operations may alter the quality, the geometry of the elements retrieved by superficial vectorisation, In order to check the quality of the information resulted after the analog-to-digital conversion, the information is printed and overlapped on the checking plate. The numerical information will be structured on information layers as components of a cartographic database. GIS products allow various analyses and the creation of new updated products.

The analysis of the RESURS and SPOT photomaps has revealed the following characteristics of retrieving certain cartographic details:

- the following elements can be retrieved easily: the limits of the built area; the structure of the transport network (agricultural service roads, national and county roads, motorways); forestry areas, irrigation and drainage networks, hydrography (rivers and lakes) and wetlands;
- areas covered with growing crops (various shades of red) and areas where crops have been harvested (grey-blue shades);
- ambiguity occurred:
- when delimiting grasslands from wetlands;
- when delimiting vineyards and fruit tree plantations;
- when delimiting irrigated arable plots.

In conclusion, RESURS and SPOT images provide an impressive amount of quality spatial information for the research, development and update of a GIS project for regional or national analysis.

A nomenclature is required that should specify interpretation levels, the themes of interest and the associated codes, as established in the Corine Land Cover project (Table 1).

Georeference is the process through which a digital map is associated with real geographical coordinates. There are applications that do not require geographic coordinates; a Cartesian coordinate system is sufficient. In the case of vector maps that already contain a local (Cartesian) coordinate system, the conversion to geographical coordinates is done through coordinate transformation. Georeference is the process of establishing the geographical coordinates of certain points with great accuracy and their location on a digital map, while the remaining points are calculated automatically, based on transformation formulas. This operation is called continuous georeference. The new coordinates must be associated with a certain cartographic projection.

*Table 1*

Interpretation nomenclature

| Level 1 | Level 2 | Level 3 |
|---|---|---|
| 1. Artificial surfaces | 1.1.Urban areas | 1.1.1. Continuous urban areas<br>1.1.2. Discontinuous urban areas |
| | 1.2. Industrial or commercial units | 1.2.1. Industrial or commercial units<br>1.2.2. Road and rail networks and associated land<br>1.2.3. Port areas 1.2.4. Airports |
| | 1.3. Mine, dump and construction sites | 1.3.1. Mineral extraction sites<br>1.3.2. Dump sites 1.3.3. Construction sites |
| | 1.4. Artificial, non-agricultural vegetated areas | 1.4.1. Green urban areas<br>1.4.2. Sport and leisure facilities |
| 2. Agricultural areas | 2.1. Arable land | 2.1.1. Non-irrigated arable land<br>2.1.2. Irrigated land; 2.1.3. Rice fields |
| | 2.2. Permanent crops | 2.2.1. Vineyards<br>2.2.2. Fruit trees and berry plantations;2.2.3. Olive groves |
| | 2.3. Pastures | 2.3.1. Pastures |
| | 2.4. Heterogeneous agricultural areas | 2.4.1. Annual crops associated with permanent crops<br>2.4.2. Complex cultivation patterns<br>2.4.3. Land principally occupied by agriculture<br>2.4.4. Agro-forestry areas |
| 3. Forest and seminatural areas | 3.1. Forests | 3.1.1. Broad-leaved forests<br>3.1.2. Coniferous forests<br>3.1.3. Mixed forests |
| | 3.2. Scrub and/or herbaceous vegetation | 3.2.1. Natural grasslands<br>3.2.2. Moors and heathland<br>3.2.3. Sclerophyllous vegetation<br>3.2.4. Transitional woodland-scrub |
| | 3.3. Open spaces with little or no vegetation | 3.3.1. Beaches, dunes, sands; 3.3.2. Bare rocks<br>3.3.3. Sparsely vegetated areas (steppe); 3.3.4. Burnt areas<br>3.3.5. Glaciers and perpetual snow |
| 4. Wetlands | 4.1. Inland wetlands | 4.1.1. Marshes<br>4.1.2. Peat bogs |
| | 4.2. Maritime wetlands | 4.2.1. Salt marshes<br>4.2.2. Salines<br>4.2.3. Intertidal flats |
| 5. Waterbodies | 5.1. Inland waters | 5.1.1. Water courses<br>5.1.2. Lakes |
| | 5.2. Marine waters | 5.2.1. Coastal lagoons 5.2.2. Estuaries<br>5.2.3. Seas and oceans |

In raster systems, there is no coordinate system established in the image. Georeference is the precise location of dispersed pixels to which the previously known coordinates are associated. The geographical coordinates of the remaining pixels are calculated with the transformation formulas. As a pixel has size, it corresponds to an area on Earth. Consequently, the image resolution is very important when coordinates are determined. The resolution of a digital image is the maximum dimension on the Earth surface to which a pixel is assigned. The precision of the location of the pixel to which the geographical coordinates are assigned matches the image resolution. In raster systems, georeference is called discrete georeference. Discrete georeference also associates new coordinates with a projection system. Georeference becomes a problem in disseminated digital maps, which are maps from various sources that must be used together.

Digital information is obtained by scanning the originals of the cadastre map. The recommended resolution is -600 dpi in tiff format. A series of geometrical transformations are applied to the raster file for the removal of scanning errors and the information is changed to the desired system of coordinates. The vectorisation of the scanned image has the following stages:

- a set of characteristics for details is created: geometric (line, dot, text), layer, colour, size;
- the vectorisation parameters are set;
- the vectorisation method is chosen (manually or semiautomatically);
- qualitative information (attributes) may be introduced as well.

In the case of the studied areas, the digital map at 1:50 000 scale obtained by vectorisation contains planimetry details as shown in table 2. The table can be improved by adding more layers and information.

Table 2 shows a project model based on information layers under the form of *byte image*. The number is stored as a unit of 8 bits, allowing a range of values from 0 to 255. Zero is for black and 255 is for white. The intermediary values are the different shades of grey.

*Table 2*

Planimetry

| | **Characteristics** | **Layer** | **Colour** |
|---|---|---|---|
| 1 | Hydrography | 1 | 1 |
| 2 | Hydro names | 1 | 1 |
| 3 | Railways | 2 | 100 |
| 4 | National road | 3 | 30 |
| 5 | County road | 4 | 50 |
| 6 | Communal road | 5 | 4 |
| 7 | Service road | 6 | 150 |
| 8 | Name of county seat | 7 | 3 |
| 9 | Municipality border | 8 | 3 |
| 10 | Name of municipality | 8 | 3 |
| 11 | Town border | 9 | 3 |
| 12 | Town name | 9 | 3 |
| 13 | Commune border | 10 | 3 |
| 14 | Commune name | 10 | 3 |
| 15 | Village border | 11 | 3 |
| 16 | Village name | 11 | 3 |
| 17 | County border | 12 | 110 |
| 18 | County name | 12 | 110 |

***Creating the cartographic database***

Information obtained by vectorisation is stored on informational layers and creates a cartographic database.

The digital maps used in GIS data processing form the *spatial data base – SDB*. A map is decomposed in several information layers and viceversa, several layers make a map. This is the basic idea of SDB organisation. It is the most effective way of map storing. The layers can combine to make maps that do no exist in traditional form. When a layer is created, it must be known that it is used as a whole and the geographical entities cannot be separated. In other words, if we have a layer containing the rivers with the limits of the hydrographic basins, when the map is called, both entities will be displayed, even if we need only one. If the two types of geographical entities need to be processed separately, they must be stored on different layers. In most processing cases, a simple layer structure and several layers are preferred.

A layer in the vector system requires a set of graphic primitives that separate the same topological properties. Some software products restrict the common use of graphic primitives. It is recommended that each type of graphic primitive should be on a separate layer. Also, depending on the theme of the map, several layers can contain the same primitives. For instance, a layer of lakes (polygons) must be separated from the vegetation layer (also made of polygons). Another example is the administrative country and commune limit. At first sight, the decision can be made to represent both limits on the same layer. Each layer has its own attribute table. From the user's perspective, a layer is a theme map. Layer distribution is indispensable because surface topological restrictions require the knowledge and identification of all arc and surface segments generated by increased amounts of information, which would make the map hard to read.

In the raster system, a layer is a theme image. The layers can be used with the vector layers or separately, depending on the purpose. Obviously, the programmes in the GIS product allow this possibility.

Small scale layers are administrative limits, geology, cadastre properties, land use, altimetry, hidrography, road network, railway network, power supply network. Large scale layers are the street plan of a city, the water supply network, the gas supply network, the telephone line network, the aerial or underground power supply network.

Layer manipulation and operations depend on the spatial analysis module. One of the most frequent operations is layer overlapping. When overlapping maps, it is very important to take into account the scale and the cartographic projection of the map. Overlapping maps of different scales and projections is pointless.

*Attribute data*

Data in tabular form associated to digital maps have different formats: ASCII, dbf or special formats. The format type is determined by each GIS product. For example, ArcView uses dbf tabular data that can be created with dBase or Fox. Excel exports files in dbf format, on condition only one sheet with a database-type structure is used (each column is a field and each line an article; no comments or other forms of writing are admitted). This is a great advantage, Excel being a strong and popular product on the market. It performs many operations that are also executed by ArcView.

The attribute data form the *Attribute Database (ADB)*.

Most GIS products import tabular data files created with Spreadsheet, like Microsoft Excel or Lotus 1 – 2 – 3 or database files created with Microsoft Access. The tabular format accepted by GID products are CSV (Comma Separated Variable) and DBF (dBase Format). CSV is a text file (ASCII) in which every text line is one record. All variables are separated by commas. DBF is a very common database format and is also used by ESRI products like ArcView and PC Arc / Info.

*Geocoding – Geographic database (GDB)*

Associating tabular data with spatial data is a special operations and it is what distinguishes GIS software products for digital cartography (that create digital maps and reproduce them on paper) from a traditional DBMS, from CAD products or graphic applications like CorelDraw or Freehand. The process of associating the two data categories is called *geocoding*. The operation differs with every system. In the vector system, each graphic primitive is associated with a table which is called attribute table and contains alpha-numerical data concerning the characteristics of the primitive. For example, if a polyline or an arc (see topological models) is associated with a road section, then the attribute table will contain a polyline identification code (found in the file representing the vectorial map) and some characteristics like name, quality and length. If a polygon is associated with a forest area, its attribute table must include elements such as covered surface and type of trees besides its unique identification code.

When the map is digitized with a different product, for instance, AUTOCAD, there is no attribute table and it must be created when it is converted into a GIS product. The attribute identification codes must be typed.

In the raster system, in the attribute table, the code is the pixel number. A peculiarity of this system is that the attribute can be contained in the image. For instance, one raster map can include the soil type and another one the pH values. Such a map contains the attribute in itself. This is a frequent situation, but not very efficient. It does not cause difficulties in smaller databases, but if the number of images is very high, their management and the disk space may become a problem. Having the same outlines, the two images can make a simple soil map associated with an attribute table that provides all non-spatial information.

The two databases - SDB and ADB form the geographical database (GDB). This is an established term and should not be given other meanings. O geographical data is a GDB element and has a dual aspect: spatial (field location) and attribute (what it represents).

## RESULTS AND DISCUSSIONS

Vector models of data representation

The model is a conventional representation of data structures in a given context that identifies the nature of the data, the operators using the data structures and the restrictions imposed to maintain correctness of data.

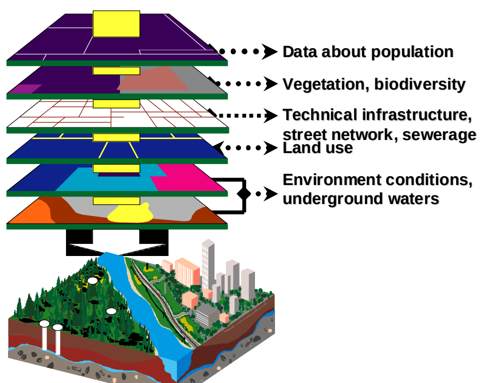


Figure1. Overlapping of vector models on separate layers

The vector presentation system has generated several models:

A. the spaghetti model uses only points and arcs primitives;

B. the network topological model (a linear topological model that adds the node to the spaghetti model;

C. the surface topological model (two-dimensional topological model) that adds the polygon to the previous model.

Figure 1 shows a suggestive mix of several layers that combine these models in order to obtain the desired information.

## CONCLUSIONS

The use of vector models in GIS projects has a number of advantages in agriculture and other fields:

- spatial image of decision fundamentals
- procedure visualisation
- transparency in decision-making
- transparency for the affected citizens
- successful cooperation
- space-related decision control
- improved organisational integration
- strategic planning and superior decisional support
- successful communication
- reduced costs
- efficient operability in administration
- reduced database redundancy
- automation and introduction of new processes
- effective work management and control

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