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REALIZATION OF SPATIAL DATABASE FOR CATALOGUING ROAD NETWORK OF THE RACIECHOWICE COMMUNE

Summary

In the 21st century, at constant economic and industrial development, the efficient and fast management of technical infrastructure is a key element. Its quality and technical condition considerably influence rural development, possibilities to acquire capital, create new jobs, etc. One of the key issues is the road infrastructure, i.e., network of commune roads, and its condition, while the possibility of management and promptness of decision making determine and are of key importance for planning further development of the commune.

In order to manage the road network efficiently and fast, the commune needs all available relevant information. Data describing road technical parameters are the spatial data. Accumulation of the data in geographical database gives a general spatial picture of the commune road network. All data describing roads are recorded in so called road books. The obligation is imposed on the communes by the Minister of Infrastructure Regulation in the method of numbering and registration of public roads [Journal of Laws, No. 67, Items 582 and 583 of 25 April, 2005].

The main objective of the presented paper was the realization of a geographical database of the parameters of road network for the Raciechowice Commune Authorities using GPS receiver and the MapSource and ArcView specialist computer packages. For this purpose geocoding of road sections and their spatial inventory in the Raciechowice commune was made by means of a GPS device. The results of measurements obtained by means of GPS were then read immediately to MapSource. The data obtained in this way allowed to create a database in which technical parameters of individual sections of the Raciechowice commune roads were recorded. The ArcView software was used for management of the spatial database and visualization of road technical parameters in form of maps and diagram maps.

Key words: GIS, DGPS, Raciechowice, road book, road inventory

INTRODUCTION

GIS (Geographic Information System) is a system of collecting, accumulation and processing information, its analysis and sharing. The system may be divided into 5 basic parts (referring to spatial data and their attributes) whose tasks involve: data loading, data processing, storing and data updating, data analysis, data acquisition (final information) [Rybiński et al., 2002].

Initially data bases served mainly for descriptive data management. At present both descriptive and geometric data are stored in a database. In this way, we may freely manage data, edit necessary information (descriptive and geometric) or identify sub-bases with the data we need [Litwin et al, 2005]. The form of available data changes with development of various media serving data sharing. GIS systems allow systematizing the possessed data, quick search and fast updating. They enable fast edition of digital maps, which greatly facilitates current data analysis [Litwin et al, 2005].

The main advantages which may be ascribed to GIS applications in local self-government refer to: more effective planning of self-government development through better spatial and strategic planning, more efficient environmental monitoring, decision making concerning the future of the self-government on the basis of full, reliable and up-to-date information, improvement of the efficiency of city resources management, including spatial management, supporting self-government promotion.

AIM AND SCOPE OF WORK

The aim of the work was realization of a spatial database for road network in the Raciechowice commune. The data for the base creating were acquired during travelling the roads. Measurements taken by appropriately configured GPS receiver and subsequently processed by MapSource were used for realization of the database providing the basis for data visualization in ArcView.

The created database consisted of attribute data, data on spatial location (vector layer covering the area of the Raciechowice commune with the road network managed by this administrative unit).

Raciechowice is a rural commune situated in the southern part of the Małopolskie voivodeship, 40 km from Krakow, 60 km from the Balice Airport, in the Myślenice district (*poviat*). Its area is 61 km^2; it covers 9.06% of the Myślenice district area. Raciechowice is the main locality and the seat of the local government. The area of Raciechowice is situated beyond the range of strong air or soil pollution and is counted among the areas which do not belong to so called “areas of serious ecological hazard”.

SOFTWARE

In Poland, professional applications of GIS are prepared by inter alia: Esri Polska, Autodesk and Intergraph. Various software offered by these firms allow for ordering, unification and systematizing of data. They provide the opportunity for visualization of the processed information on the map. Using various system of commands we may easily manage the data, process and analyze of them.

ArcGIS is a whole line of various products created by ESRI Enterprise, which together form a basis for Geographic Information System software with three basic configurations: ArcView, ArcEditor and ArcInfo.

ArcView makes possible creating maps by means of simple creators and symbol libraries containing initially defined map templates. It simplifies and greatly facilitates creating coherent styles on a map. Created map may be saved, printed, exported or used for other documents and applications. A rich set of tools and functions for integration with the map in ArcView makes possible easy navigation and posing questions to the map, acquisition of additional information, such as hyperlinks, which integrate the map with external information. The programme possesses tools for high quality map printouts comprising integrated drivers rasterizing the map during the printout [Sikora et al, 2007].

Various database may be managed using special programme or package of programmes of the Relational Database Management Systems (DBMS) or Database Management system (DBMS). These programmes together with a set of functions are designed to data loading, access control, data edition, archiving and ordering. They allow to change spatial relations, manipulate the relationships between spatial, non-spatial and topological data irrespective of the scale, resolution and degree of aggregation [http://www.gisplay.pl].

DBMS is an element of Geographic Information System allowing for the use of database. Multimedia databases may contain various kinds of data: digital, sign, textual or attribute data referring to e.g. charts or maps. Databases make possible fast search for information, according to determined criterion, even in a large set [Widacki, 1997].

TECHNICAL PARAMETERS OF COMMUNE ROADS

The following method of road numbering is used, pursuant to the Minister of Infrastructure Regulation in the method of numbering and registration of public roads [Journal of Laws, No. 67 Item 582 of 25 April, 2005]: for national road one or two-digit number is used, sometimes preceded by letter A for the sections of road with motorway parameters or by letter S for the sections of road with expressway parameters. For a provincial road a three-digit number is applied, a commune road is marked with four-digit number with abbreviation of

the province (voivodeship). Road numbers should be unique on the whole territory of Poland.

The register of numbers is kept by General Directorate of National Roads and Motorways, separately for national and provincial roads, by voivodeship authorities separately for district and commune roads.

The data entered into the road book must contain determined information describing individual road sections, such as: dimensions (the length, width and area), kind of road surface, pavements, cycle path, entrances, parking lots, quantitative and qualitative data describing the presence and characteristics of road signs, informers, signalers, single trees, engineering objects, etc., and data characterizing technical approach and determining the range of occurrence of road elements, such as road utilities or road lighting [Błażejowski et al, 2000].

The file is being updated constantly, no later than by the end of the first quarter of each calendar year for the preceding calendar year. The file is kept either in electronic or paper form. The file kept in electronic form requires adequate protection against data loss. The register of assigned road numbers is kept by the General Directorate of National Roads and Motorways, separately for national and provincial roads, and by voivodeship authorities separately for district (*poviat)* and commune roads. The register of assigned road numbers should contain the road number and the road course. The road number register is updated on request of the appropriate road operator.

Road operators within the boundaries of cities with the *poviat* status, other provincial, district (*poviat*) and commune roads, concessionaires of toll motorways and companies which signed contracts for construction and operation or exclusively operation of toll motorway, prepare information for statistical purposes by filling in an appropriate data form concerning public road network, which they submit to General Directorate of National Roads and Motorways.

Table 1. Symbols of road surfaces

Item	Symbol	Name
1.	MB	bitumen surface
2.	BT	concrete surface
3.	KP	surface of prefabricated cobblestone
4.	KK	surface of cobblestone
5.	KL	clinker surface
6.	PB	surface of prefabricated concrete materials
7.	BR	cobble surface
8.	TŁ	broken stone surface
9.	ŻW	gravel surface
10.	GŻ	ground surface reinforced with gravel, slag, etc.
11.	GR	natural ground surface (of native soil)
12.	IN	other

Source: own elaboration on the basis of [Journal of Laws, No.67, Item 582, dated 25 April, 2005].

Data on the kinds of kerbs use the following symbols:

KK – stone kerb,
KB – concrete kerb.

Data concerning the kinds of intersections:

DJ – level crossing,
DR – a roundabout with central island,
DD – two-level crossing,
DW – two level crossing in the form of a junction.

Engineering structures and ferries including:

M – bridge, viaduct, trestle, footbridge,
T – tunnel,
PD – underground passage,
P – culvert,
KO – retaining structure,
PR – ferry.

Natural objects: the information about the objects is given respectively for the right or left side:

P – parking area,
H – hotel,
SP – fuel station,
I – other.

Barriers: data applies to the barriers and fences situated along the road and used to protect the road users, respectively on the right and left side:

BB – concrete barriers,
BS – steel barriers,
W – fences (e.g. segment, chain or made of nets, steel sections or rods),
I – other.

Exits – information about exits from roads, situated respectively on the right or left road side;

ZP – exit to the field,
ZL – exist to the forest,
ZD – exit to a building,
ZO – exit to a roadside object.

Ground road technical facilities – provided information concerns technical facilities, respectively for the right or left side:

G – gas grid,
W – water ,
T – telecommunication,
E – power line, contact line (railway, tramway or trolleybus),
I – other.

RESEARCH METHODS

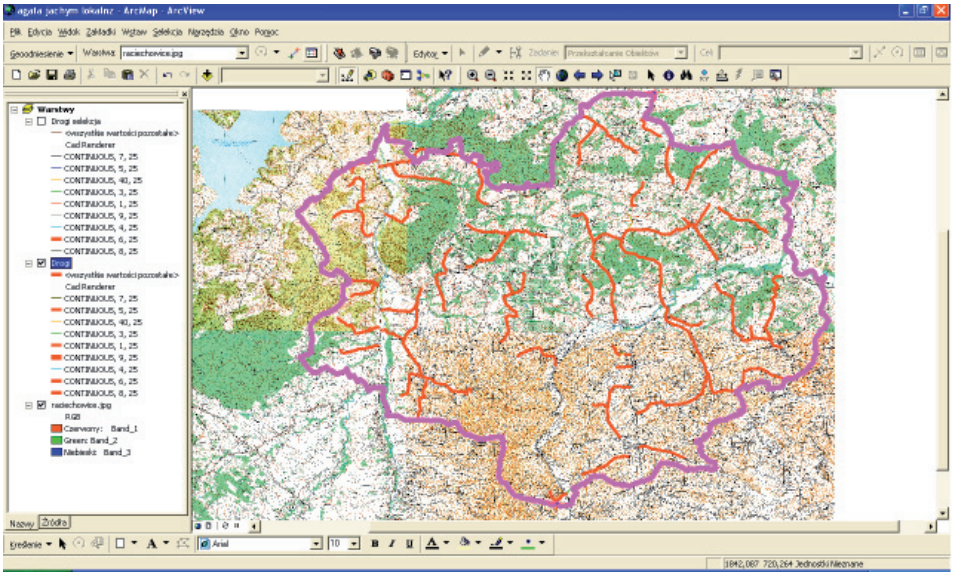
The starting point for spatial data acquisition were land register maps in 1:2000 scale and a land register of road parcels. Subsequently, due to the size of the sheets and therefore impossibility of their use on site, the course of road parcels was transferred onto a map in 1: 10 000 scale. The transfer concerned only roads managed by the commune (commune roads marked with "G" symbol, because the district and provincial roads have been mostly catalogued by the higher administrative units (Directorates of District Roads and Regional Departments of General Directorate of National Roads and Motorways). Because all the details listed in Road Books, one of the most labour-consuming but crucial stages of the starting, conducting and practical application of the record is collecting data on road technical parameters. The key issue is setting a point where the object is situated, i.e. the exact distance from the beginning of the road or assumed reference point to a given object marked along the road axis at which the object is situated. Each section of the road in field conditions was ascribed its corresponding parameters: the width, length, kind of surface, etc. The data will be used to create a road book. The data was read from GPS receiver to a *.dbf file by means of MapSource. The file contains the list of attributes of individual road sections collected during the travel by the commune roads. This recording allowed to analyze them in the ArcView programme. Once the data describing the investigated areas have been saved in the database, they can be visualized using AcrView Programme and the researched area may be presented as maps linked with the database. The linear layers in the programme were prepared in the way enabling to insert attribute data as descriptions of spatial data. The spatial database created in this way is constantly updated and developed with changes of road network.

RESULTS

Total length of the Raciechowice commune roads is 68.3km, of which bitumen surface constitutes 86.5%, gravel 9.9%, broken stone 2.0% and concrete 1.6%. The highest road density is in the area of the Czasław, Raciechowice, Gruszów and Poznachowice Górne localities. The highest number of asphalt roads is noted near Gruszów and Raciechowice localities, while the Krzesławice area has the higher number of roads with gravel surface.

Boundary lines of the Raciechowice commune were delineated from the maps in 1:2000 scale. The maps were acquired from the map collections owned by the Raciechowice commune and Land Register of the Raciechowice commune. The route was marked by GPS device. Subsequently obtained results of the previous measurement were put on the Raciechowice Commune map in the 1:10 000 scale. The kind of road surface distinguishable on the roads in the Racie-

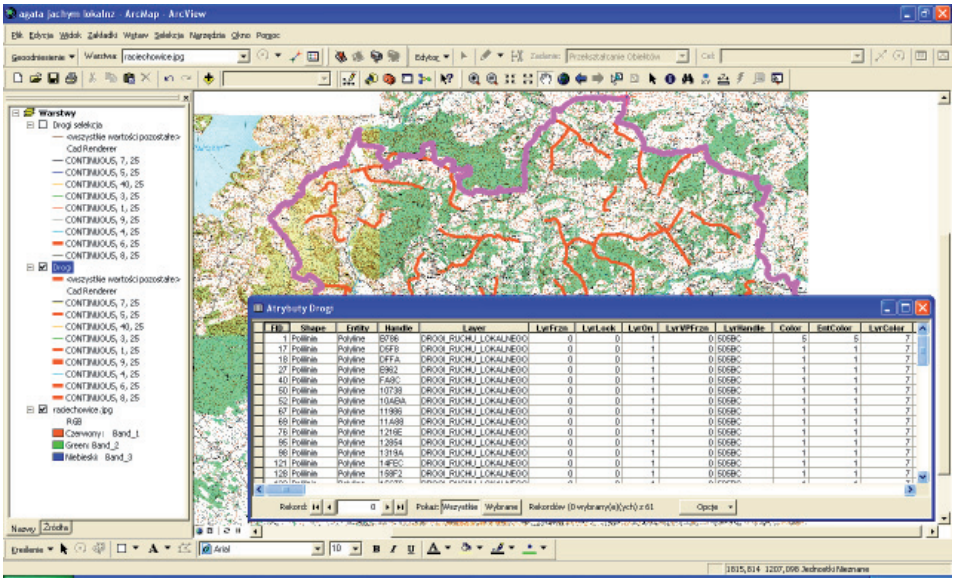
chowice Commune are paved surfaces, which may divided into improved and non-improved ones. The improved ones comprise bitumen and concrete surfaces, whereas non-improved are gravel and broken stone surfaces. The total length of travelled roads on which measurements were made is 68.3km, in which gravel surface constituted 6.8km, broken stone 1.3km, bitumen 59.1 and concrete surface 1.1km.



Source: own elaboration 2011

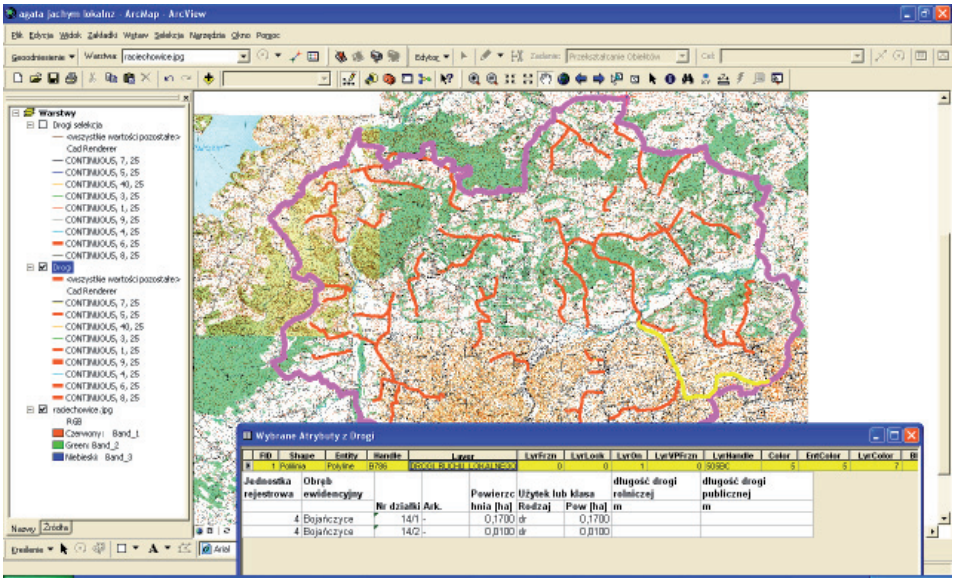
Figure 1. Visualization of the course of commune roads in Raciechowice

Figure 2 presents supplementing parameters for individual roads as attributes for the course of the route. Technical parameters concerning the kind of surface, the length and width of the road and side of exit were introduced during study works for each stretch of road. The technical parameters were acquired during travels along the stretches of road in the Raciechowice commune and then entered into appropriate forms of the road books. The data acquired in this way were then introduced into the database. Database line in the *.dbf file has been linked to the given road section visible on the map and contains the attributes describing it. The study work was done in two stages. A computer database was created at the first stage, to which subsequently technical attributes of individual road stretches were introduced. The second stage concerned linking attribute information with the course of the routes.



Source: own elaboration 2011

Figure 2. Attributes describing the course of roads in spatial database



Source: own elaboration 2011

Figure 3. Marked stretch of road on thematic layer with attributes induced from dbf file

The database presented in Fig. 3 is linked with the map of the Raciechowice commune. It allows to search for information in the database and to get answers in a tabular form or as thematic maps. In the database we may search for individual stretches of roads through their attributes from the numbers, names of roads and finally subsequent exits. Once the SQL question is asked about a road stretch or its marking on the map, we obtain information and list of attributes of a given road saved in the file with the *.dbf extension. The database may be constantly updated by adding next attributes for individual road sections, such as: road repair, road surface changes, construction of new roadside objects.

Geographic database provides also an opportunity to search for a given road section on the spatial map after introducing the attribute or attributes describing it.

CONCLUSIONS

The result of the research is a spatial database allowing for automatic search for information about the course and technical parameters of the road network in the Raciechowice commune, compatible with the parameters obligatory for public road operator, pursuant to the Decree of the Minister of Infrastructure dated 16 February 2005 on the method of numbering and cataloguing of public roads, bridge objects, tunnels, culverts and ferries and the register of numbers assigned to roads, bridge objects and tunnels [Journal of Laws, No. 67, Item 582 of 25 April 2005]. The database was created in such a way that each stretch is a linear element on the thematic layer presenting the road network layout. The stretches were described with numbers composed of 14 signs: road class, 6-digit road number assigned by the road operator, two-digit number of the voivodeship, two-digit number of the district (*poviat*) and three-digit number of the commune [Journal of Laws, No 157, Items 1031 of 22 December 1998]. Due to this fact we are able to analyze individual road sections, their technical parameters, we may make their visualization in a suitable form, update them and prepare all kinds of reports and compilations.

The realized spatial database is primarily a set of facts necessary for road register of territorial units shown on an example of the Raciechowice commune. On the basis of the conducted analyses and acquired information we are able to create new thematic layers described by appropriate attributes: the length and width of the road and number of exits. We may also use thematic layers referring to actual locations, e.g., the course of roads in the selected region of the commune.

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Rozporządzenie Ministra Infrastruktury z dnia 16 lutego 2005 r. w sprawie sposobu numeracji i ewidencji dróg publicznych, obiektów mostowych, tuneli, przepustów i promów oraz rejestru numerów nadanych drogom, obiektom mostowym i tunelom [Journal of Laws, No. 67, Items 582 of 25 April, 2005]

Rozporządzenie Ministra Infrastruktury z dnia 16 lutego 2005 r. w sprawie trybu sporządzania informacji oraz gromadzenia i udostępniania danych o sieci dróg publicznych, obiektach mostowych, tunelach oraz promach [Journal of Laws, No. 67, Items 583 of 25 April, 2005]

Rozporządzenie Rady Ministrów z dnia 15 grudnia 1998 r. w sprawie szczegółowych zasad prowadzenia, stosowania i udostępniania krajowego rejestru urzędowego podziału terytorialnego kraju oraz związanych z tym obowiązków organów administracji rządowej i jednostek samorządu terytorialnego [Journal of Laws, No 157, Items 1031 of 22 December 1998]

http://www.gisplay.pl/gis/funkcje-gis.html -29.03.2011

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