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Experience of Geographical Information Systems (GIS) application in regional planning of economic development

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Abstract. The aim of this paper is to analyze the experience of applying the geoinformation system for the purpose of quality management and sustainable development. Enterprises from all fields of activity, including maintenance, use geoinformation systems in their strategic planning. At the very beginning of the work are described the terms of geoinformation systems, their application and capabilities, and the software for making GIS is described. Through examples of good practice, an overview of the application of GIS in the fields of agriculture, transport and ecology will be presented on case study of Croatia.

1. Introduction

The information system as a support to business activities is critically important for successful business processes of business entities. The application of modern information technologies contributes to the improvement of business operations in interdisciplinary maintenance activities. It should be stressed that technological progress is a key factor in the contemporary world economy. The Internet, as the most significant technological phenomenon of today, provides the entities with some completely new competitive opportunities.

The introduction of Geographic Information System (GIS) and the mode of presentation it offers offers new opportunities in terms of expanding geographic solutions in space, cost reductions and increasing service quality. By introducing new guidelines in planning and building geographic information systems to support the maintenance process and by analyzing business process maintenance, GIS develops for the first time with specific business needs.

There are several developmental lines that should provide a solution to the GIS problem on the technological and organizational side. First of all, it refers to technologies that make it easier to use existing capacities as well as to simplify the upgrading of existing infrastructure and services that GIS supports. After the theoretical discussion will be a day of experience of GIS application in the field of maintenance in agriculture, transport and renewable energy.

2. Theoretical considerations of geographic information system (GIS)

GIS is an abbreviation of a "geographic information system", a system that collects, stores, analyzes, manages and displays spatial data. The simplest explanation is that GIS is merging cartography and technology into databases. GIS systems are used in cartography, remote research, geodesy, communal management, photogrammetry, geography, urban planning, emergency management, navigation etc. [1]

When we say for some system of data, analysis and representation of their dependence on space in space that it is a GIS system, then under that name we mean that it is a system that basically works with data representing an object (appearance, technical means, building and etc.) that is related to some coordinate position in space and in geographical interdependence with other objects in that area. Different symbols, colors, shapes, and display styles allow us to visualize three-dimensional objects from the real world on two-dimensional maps in a visually acceptable way.
Information in the GIS system consists of large amounts of data collected in different ways and more specifically describe each of the geographic objects in the observed system. Only the data collected for each of the objects (from the interest of the observed analysis and the actual state of view) are linked to one entity when we add them, along with the other, and the geographical attributes (for each object individually). [2]
The application of these systems is multifaceted in maintenance activities, among which we can highlight the following:
• economy (planning, supply, traffic management, geomarketing)
• maintenance of the environment (air, water, vegetation, agriculture, waste disposal)
• research (, climatology, archeology, medicine, criminology)
• management (cadastre, surveying, geodesy, spatial planning, army).

Figure 1. GIS functions

However, in order for the system to function, certain preconditions for GIS development in practice need to be met. Although somewhat different interpretations of the GIS definition are identical in defining the basic GIS components, namely:
• educated and well-motivated experts (for computers, for various scientific disciplines, GIS operators, GIS experts, software engineers, etc.)
• data (spatial, temporary, attributes, etc.)
• programs and methods (programs for collecting, processing, analyzing and displaying data etc.)
• hardware (IT and IT equipment - computers, measuring devices, communication devices, printers, drawers, scanners, etc.). [3]

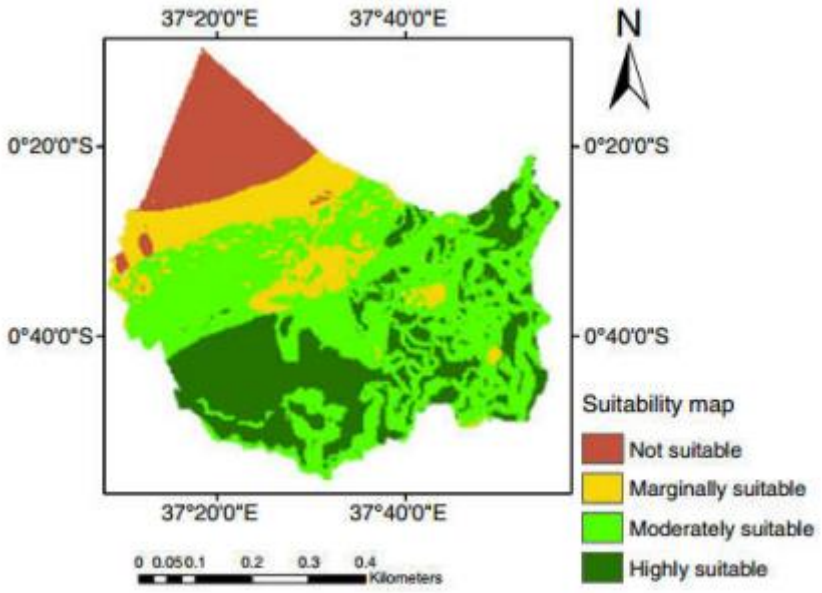
These prerequisites should be accepted and implemented in the practice of economic entities in order to improve the maintenance activity in these sectors through the GIS system.

3. Spatial data types in GIS

In the theory and practice of geographic information systems we encounter specific forms of data and can be classified into the following categories:
• graphic data
• textual data
• animation
• pictures
• videos
• audio tracks.

Although we can simplify this division and say that GIS generally consists of graphical and attribute data, it is apparent that geoinformation systems increasingly become multimedia technologies. The graphic data is in vector or raster format. The most commonly used vector structure is represented by a mathematical description, a complex, more efficient topology, allowing direct access to the object as well as storing data with greater accuracy than that of a raster structure. [4] Specifically, in the raster structure, the data is represented by a pictorial element (pixel) whereby the position of the object is defined by the position of the image element (row and column number) in the image matrix, and each image element can occupy one value. The advantage of raster structure is simplicity, which is also its flaw, because the individual object is difficult to present with sufficient accuracy. Most of today's programming systems enable work with both vector and raster data.

Figure 2. Data models in maintenance of agricultural land

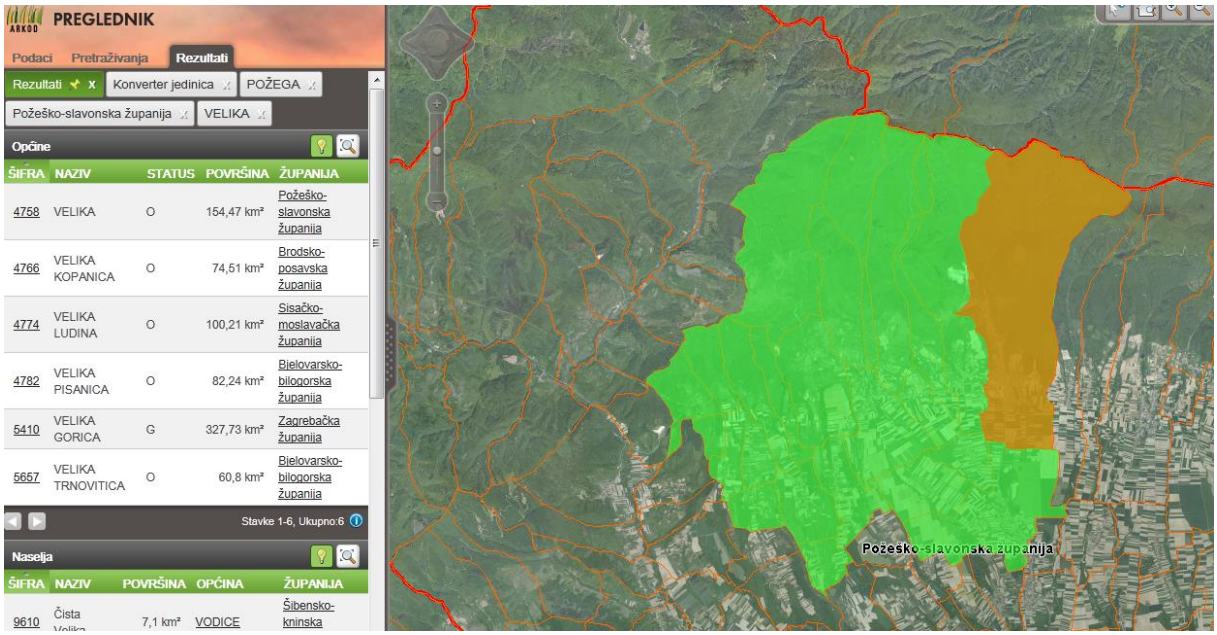


An example of an application of spatial data in GIS in agriculture is shown in the figure 2 where it is necessary to classify the areas by type of land. By displaying any information on the raster data model, all details of the cell or pixel variations are lost, and each cell / pixel contains only one value. Thus, in a simple structure of raster data, every pixel has either no or no entity, while the complex structure of raster data is recorded by different entity codes (eg, different functions of the soil). Generally speaking, basic spatial data elements that are processed in the analyzes are location, attribute data and topology. Location refers to the determination of coordinates (X, Y); attributive data describes the non-spatial features of certain locations while the topology describes the geoobject interactions.

4. GIS application in agriculture: Case study of Croatia

Council Regulation (EC) No. 1290/2005 stipulates that the EU may only finance grants paid in the Member States through an accredited Paying Agency. The Republic of Croatia is obliged to use funds from the Structural Funds (IPARD) as well as to make the establishment and national accreditation of the Paying Agency as well as accreditation by the European Commission, prior to joining the European Union. All EU Member States need to set up an Integrated Administrative and Control System (IACS). This Integrated System needs to be applied primarily to support models.
The Identification System for Agricultural Plots (LPIS) should be established on the basis of maps or documents of the land register or other cartographic sources. The use is provided by the computer geographic information system (GIS), including primarily spatial orthophotos, as shown in Figure 3.

Figure 3. Environment maintenance using the ARKOD system

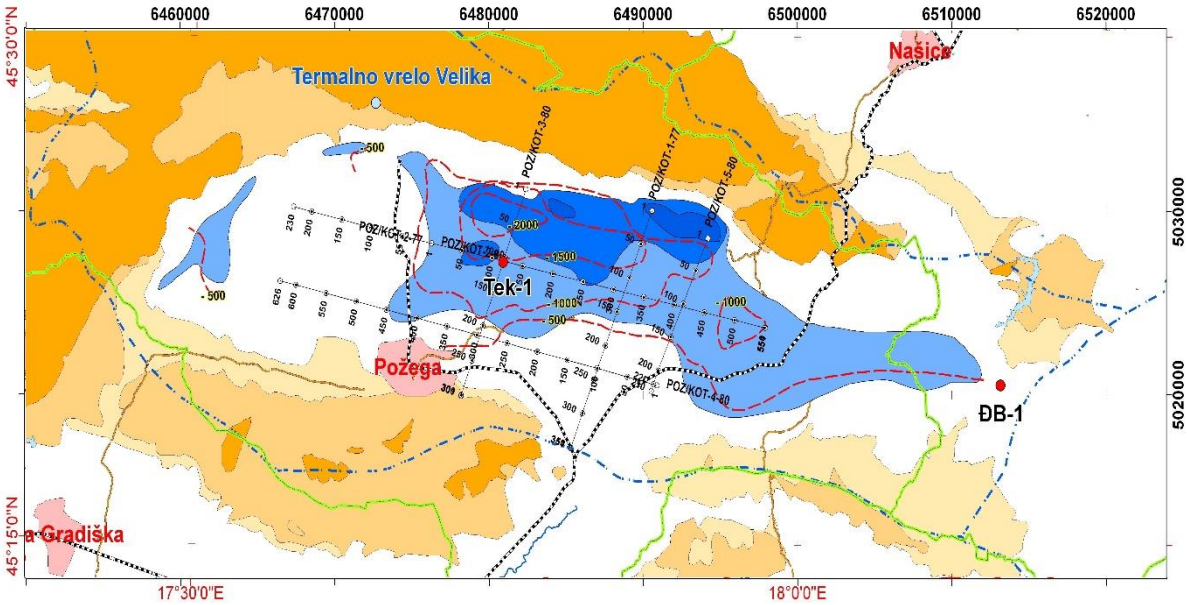


It is a centralized system in which process power and data storage concentrate in the center, so communication links of appropriate permeability are ensured from each branch office to the center. Also educated and trained by a number of specialists, starting from administrators as advanced users and end-users, to work with GlS (ARKOD is the Croatian version for LPIS). According to Council Regulation 796/2004, the agricultural land identification system should operate on the basis of reference parcels such as cadastral parcels or production blocks, which will ensure a unique identification of each reference parcel.

5. Application of GIS systems in maintenance of geospatial thermal springs in Croatia

The next area of application of the GIS system is the planning and maintenance of the space where the thermal springs are located. An example is presented in the field of analysis of experience in the field of Eastern Slavonia. In order to have geothermal reservoirs besides suitable temperatures, they are also necessary for deep reservoirs or water-bearing geothermal water. Most importantly, we find the surface of the tertiary rocks of the Pannonian Basin. There, among the various broken rocks, the most significant Mesozoic massive rocky rocky rock masses are. One in the geothermal fields of Lunjkovac - Kutnjak, Velika Ciglena, the Zagreb geothermal field and many other places form massive, over one thousand meters of thick waterfowl. Most of the spa of Croatia is connected with this most significant geothermal aquifer, and also this local spa near Lipik, Daruvar and Velika.

Figure 4. Interpretation based on 2D seismic profile and deep well Tek-1, potential favorable distribution of potential geothermal aquifers in carbonate rock mosses (lighter shrubs) and bottom bridge sand (dark shrubs)



Although the tertiary deposits have a cover or isolator character, for the geothermal tributary on the surface and the preservation of geothermal deposits, and within them there are geothermal waterborne, as in the carbonate sequences of myocene age, in the Požeška valley found by the deep Tekić-1 (Tek-1) borehole well-permeable sandy bodies of Pannonian and Pontic Age, registered with the same borehole. The possibility of their widespread use is presented, thanks to the interpretation of existing geophysical measurements, specifically 2D seismic profiles, in the Golden Valley. Terme Đakovo Breznice on natural springs and wells Đakovačka Breznica-1 (ĐB-1) are linked to the Miocene carbonate age.

Experiences on geothermal and mineral water exploration and production in the Pannonian basin of the Republic of Croatia enabled the indication of its untapped potential in the Vallis Aurea area. The presence of all these types of rocks has been established and their favorable position for the formation of the reservoir is indicated by the interpretation of geological geophysical observations and measurements, including 2D seismic profiles by drilling and hydrodynamic examination and the geothermal production of these deep wells, which provides a solid basis for detailed research and use geothermal water using the GIS system.

6. Application of GIS systems in traffic infrastructure

The application of GIS at airports goes from planning and designing the development of airports to support day-to-day operations at the airport. Several applications of GIS will be mentioned in the example of Split Airport. Below are classified as[6]:

• 3D GIS analysis of the barrier-determining the size of obstacles on the Split airport space and classifying the larger area in the area with the same permissible height for buildings.
• Business application Aircraft Parking-planning, organization and coordination of air traffic on the airport station.
• The WEB GIS Business Application - The Emergency Planning Plan for Emergency Airport Intervention is available to everyone, providing more information on the shortest route to a selected vehicle type (eg fire brigade, police).
•WEB GIS Business Application-Birds- Automated Event Records and Reporting of Birds by Email and SMS, stored in a database.

Figure 5. Visualization of GIS results on the example of Split Airport

Classification and visualization of the results shows the obtained distances of protective surfaces from the terrain classified in 13 classes. Scanned and geo-referenced state maps of scale 1: 5000 are overlaid with vector data classification. The obtained map represents the visualization of 3D GIS analysis results and serves in the process of designing and harmonizing spatial development solutions for the surrounding settlements, hence the further development of the Split Airport.

7. Proposed use of GIS tools in maintenance area

The development of Internet technology has a great impact in all branches of human activity, as well as in the explanation of maintenance activities. Data is increasingly available in digital format, providing a new and faster way of processing and analyzing spatial data. So there are currently a number of GIS tools available that can be applied in practice. The following are the most significant:

- gvSIG -prepared for Java, Linux, Unix, Mac OS X and Windows platforms.
- JUMP GIS / OpenJUMP ((Open) Java Unified Mapping Platform)
- MapWindow GIS - a free desktop application
- Quantum GIS (QGIS) - runs on Linux, Unix, Mac OS X and Windows platforms.
- SAGA GIS (System for Automated Geoscientific Analysis)
- uDig
- Capaware - A C ++ 3D GIS application for geographic visualization
- The FalconView - mapping system develops on the Georgia Institute of Science, an open source tool.
- Kalypso uses Java platform and is used in visualization of water surfaces
- TerraView.

8. Conclusion

Using GIS technology, it is possible to collect, create, maintain, and analyze spatial data and perform different tasks from planning and design to deployment and relay of operational tasks, and thereby establish a quality platform for management to make the right decisions in maintenance activities. GIS

technology allows the use of georeferenced spatial data, which gives the maintenance system in economic development an additional dimension and raises the overall system quality by linking users, projects, addresses, financial, cadastral and geographic data to all other sources of information.

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