

## THE APPLICATION OF GIS AND ITS COMPONENTS IN TOURISM

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**Abstract:** Since the success of any tourism business is determined by tourism planning, development research and marketing, the first thing we review in this article is GIS application for tourism planning. Both tourism and IT increasingly provide strategic opportunities and powerful tools for economic growth, redistribution of wealth and development of equity around the globe. GIS technology offers great opportunities for the development of modern tourism applications using maps. This technology integrates common database operations such as query with the unique visualization and geographic analysis benefits offered by maps. GIS is used for bringing the georeferenced data (spatial and non spatial) of geographic location Zlatibor and Zlatar into digital maps. Each object is assigned to a thematic layer. Each layer combines related objects like roads, building, protected areas or watercourses. In this research the authors used GIS in three types of applications such as inventory, analysis and evaluation of plan based on tourism development.

**Keywords:** Tourism, information technologies, GIS, maps, geographic analysis.

### 1. INTRODUCTION

Tourism is one of the world's largest and most rapidly expanding industries, contributing with over ten per cent to global GDP and generating employment for 200

million people, according to annual research by the World Travel & Tourism Council (WTTC), Ake (2001). Technology plays a vital enabling role in tourism and is crucial to the expansion of the industry.

Information technologies and tourism are two of the most dynamic motivators of the emerging global economy. Both tourism and IT increasingly provide strategic opportunities and powerful tools for economic growth, redistribution of wealth and development of equity around the globe.

With the tremendous growth of the Web, a broad spectrum of tourism information is already distributed over various Web sites. To fulfill the tourists request for an extensive data collection it is inevitable to make accumulated data from different sources accessible. Beside this problem, tourists are also confronted with differences regarding information presented on various Web sites. The solution of these problems is using maps to present information in an effective way. Maps are a natural means of indexing and presenting tourism related information. Travelers are using maps to navigate during their travels and for preparing their routes. Moreover, maps exploit the two dimensional capabilities of human vision and present the information in a compact and “easy to read” way.

## 2. GIS IN TOURISM PLANNING

Since the success of any tourism business is determined by tourism planning, tourism development and research and tourism marketing, the first thing we review in this article is GIS application for tourism planning.

Geographic Information Systems (GIS) is a rapidly expanding field enabling the development of applications that manage and use geographic information in combination with other media. In the tourism industry, GIS is used to provide:

- A digital map base for printed maps
- Digital files for Internet mapping
- Digital files for mobile mapping
- Attractions map
- Website with interactive mapping

GIS technology offers great opportunities for the development of modern tourism applications using maps. This technology integrates common database operations such as query with the unique visualization and geographic analysis benefits offered by maps. The integration of tourism data and GIS data is a big challenge for the tourism industry, today.

**Table 1:** Definitions of GIS [2]

Properties of GIS		GIS Analytical Functions
A process	A system for capturing, storing, checking, manipulating, analyzing and displaying data, which are spatially referenced to the earth.	Presentation and thematic mapping Data query
A toolbox	Containing tools for collecting, storing, retrieving, transforming and displaying spatial data.	Spatial query Database integration Route finding
A database	Spatially referenced entities	Point in polygon analysis
An application	Cadastral information system, marketing information system, planning information system, etc.	Overlays Buffering
A decision support system	Integrating spatial data within a problem-solving environment	Visualisation and 3-D modelling

GIS operates on two data elements: spatial and attribute data. Spatial or geographical data refers to a known location on the Earth's surface. Usually this is expressed as a grid coordinate or in degrees of latitude and longitude. Most organizations make use of implicit geographical references as place names, addresses, postcodes, road numbers and so on; implicit spatial references can usually be geocoded into explicit spatial references. Technological advance, particularly in software and hardware, has resulted in the development of systems which provide a range of searching, querying, presentation and analytical functions in a more user-friendly manner.

**Table 2:** GIS data elements

GIS data elements	Description
Geographical or spatial data	Location aspects: <ul style="list-style-type: none"> <li>▪ Explicitly - using a standard geographical frame of reference such as latitude and longitude</li> <li>▪ Implicitly – using surrogate spatial references such as addresses/postcode</li> </ul>
The attribute data	Statistical and non-location data associated with a spatial entity

Tourism planning refers to the integrated planning of attraction (i.e., natural, cultural, man-made), service (e.g., accommodation, restaurants, shops, visitor information, tour and travel operations, money exchange, medical facilities, postal services etc.), and transportation facilities (i.e., both material infrastructure and transportation services), here also referred to as „tourism infrastructure“.

Tourism planning requires more spatial data collecting and processing, as all locations and their interrelations should be defined and analyzed within a spatial context. For this purpose, GIS can describe and identify tourism infrastructure elements geometrically, thematically and topologically. Moreover, GIS can deal with both object data (e.g., visitor centres, trails) as well as field data (e.g., humidity, altitude) of which both types can be represented in either grid or vector data format.

### 2.1. Creation of Spatial Database

Tourism industry is rapidly becoming a leading destination for tourists. Government efforts are already under way through the institutions of tourism to develop and maintain this sector to become a major source of revenue for development in the country. It is evident that the country's tourism potential has not been fully explored and marketed. The procedure followed in the development of the spatial database included the following:

- Acquisition of graphical maps covering the Region;
- Converting the paper maps into digital maps by digitizing;
- Creation of topology to establish relationships between the map features;
- Transformation into real world coordinates.

To build tourist maps, vector graphic shapes (e.g., paths consisting of straight lines and curves), textual information, and images must be integrated. Each object is assigned to a thematic layer. Each layer combines related objects like roads, building, or watercourses. To integrate tourism data the traditional layer model [4] with layers like roads, buildings, vegetation, watercourses, etc., must be widened with additional tourism layers like hotels, restaurants, sights and further infrastructure layers (Fig.1).

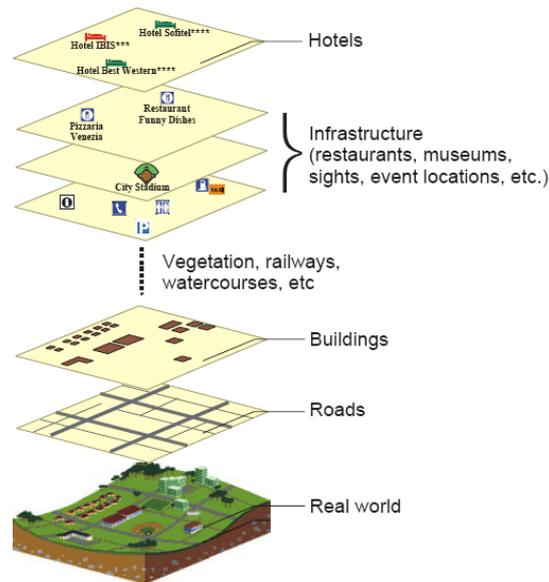


Figure 1: Extended Layer Model [5]

## 2.2. Attribute data creation and multimedia development

Attribute information on the various tourism facilities collected from different sources can be linked to their respective spatial features. This involves the following steps:

- Compilation and addition of text information to feature locations in tables
- Development and editing of pictures and images to text labels
- Hot linking of images to their respective feature locations
- Audio narrations on some selected features recorded digitally were also linked to their respective feature locations.

A link to a feature on the map would display an image combined with text in addition to audio description of that particular feature. The audio narrations would generally include a brief history of the feature, available facilities and what a potential visitor could expect to experience from a visit.

## 2.3. Application scenarios

In regards to its function, the application uses a geographic search to perform complex geographic queries in geographic context. It allows the combination of touristic attributes, like object type (e.g., hotel, restaurant, event location, etc.), object name, category of hotels, etc., with geographic criteria like nearness, distance, location (city or province) or objects located inside a selected rectangular map region. The user defines a query by selecting tourist criteria and choosing a geographic area (e.g., map area).

A thematic mapper is used to integrate tourism information (e.g., object symbol to identify the object type, object name, category (stars) of hotels, a link to the object homepage for further navigation, etc.) and GIS data to build tourist maps. A hotel search can be a time-based search which extends the map with available information of rooms (e.g., the color of the hotel symbol emphasizes the availability). To guarantee a sensible use, the user will have the possibility to zoom in/out to change the scale of the map, scroll on the map and print as well. When returning the map to the Web-client, only queried layers are set to be visible (Fig.2) to give the user a more detailed impression of where things are, how they can be reached, and which things are located nearby. SVG offers the possibility to turn layers on or off to create the representation which fits to the requirements of the user. All layers can be combined without restrictions to achieve the goal of the user.

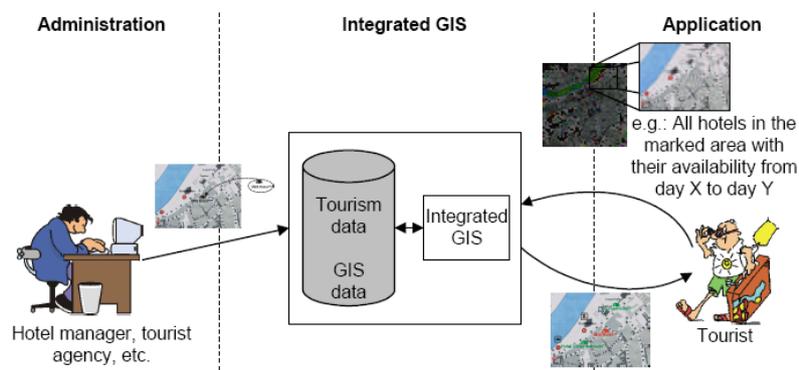


Figure 2: Integrated GIS system [5]

### 3. GIS AND NETWORK ANALYSIS

The heart of GIS is the analytical capabilities of the system. What distinguishes the GIS system from other information systems are its spatial analysis functions. Spatial Analysis helps in identifying trends on the data, creating new relationships from the data, viewing complex relationships between data sets, and making better decisions. Although the data input is, in general, the most time-consuming part, it is for the data analysis that GIS is used. The analysis functions use the spatial and non-spatial attributes in the database to answer questions about the real world. Geographic analysis facilitates the study of real-world processes by developing and applying models. Such models illuminate the underlying trends in geographic data and thus make new information available.

The objective of geographic analysis is to transform data into useful information to satisfy the requirements or objectives of decision-makers at all levels in terms of detail. An important use of the analysis is the possibility of predicting events in another location or at another point in time. Geographic Analysis is an analysis of problems with some Geographic Aspects:

- Alternatives are geographic locations or areas
- Decisions would affect locations or areas
- Geographic relationships are important in decision-making or modelling.

Some difficulties of Geographic Analysis are: plenty of data; spatial relationships are important but difficult to measure; inherent uncertainty due to scale; difficult to make data sources compatible; difficult mathematics; quantity vs. quality questions; multiple objectives etc.

Before commencing geographic analysis, one needs to assess the problem and establish an objective. The analysis requires step-by-step procedures to arrive to conclusions. The range of geographical analysis procedures can be subdivided into the following categories:

- Database Query
- Overlay
- Proximity analysis
- Network analysis
- Digital Terrain Model
- Statistical and Tabular Analysis

The selective display and retrieval of information from a database are among the fundamental requirements of GIS. The ability to selectively retrieve information from GIS is an important facility. Database query simply asks to see already stored information. Basically there are two types of query most general GIS allow query by attribute and query by geometry

Map features can be retrieved on the basis of attributes. For example, they can show all the urban areas having the population density greater than 1,000 per square kilometer. Many GIS include a sophisticated function of Relational database management system known as Standard Query Language (SQL), to search a GIS database. The attribute database, in general, is stored in a table (relational database mode) with a unique code linked to the geometric data. This database can be searched with specific characteristics. However, more complex queries can be made with the help of SQL.

GIS can carry out a number of geometric queries. The simplest application, for example, is to show the attributes of displayed objects by identifying them with a graphical cursor. There are five forms of primitive geometric query: query by point, by rectangle, by circle, by line and query by polygon.

A more complex query still is one that uses both geometric and attributes search criteria together. Many GIS force the separation of the two different types of query. However, some GIS, using databases to store both geometric and attribute data, allow true hybrid spatial queries.

Network models are based on interconnecting logical components, of which the most important are:

- "Nodes" define start, end, and intersections
- "Chains" are line features joining nodes
- "Links" join together points making up a chain.

This network can be analyzed using GIS. A network is a set of linear features that are interconnected in GIS. Common examples of networks include highways, railways, city streets, rivers, transportation routes (e.g., transit, school buses, garbage collection, and mail delivery), and utility distribution systems (e.g., electricity, telephone,

water supply, and sewage). Collectively, these networks form the infrastructure of modern society. They provide the means for the movement of people and goods, the delivery of services, the flow of resources and energy, as well as the communication of information, Thomas and Ospina (2004),

The simplest and the most apparent network application analyses are: street network analysis, traffic flow modelling, telephone cable networking, pipelines etc. The other obvious applications would be service centre locations based on travel distance.

Basic forms of network analysis simply extract information from a network. More complex analyses process information in the network model to derive new information. One example of this is the classic shortest-path between two points. The vector mode is more suited to network analysis than the raster model.

Network Analysis is closely related to spatial interaction modelling. A set of geographic locations is interconnected in a system by a number of routes. A network refers to a system of lines topologically structured. Networks may be reduced to topological graphs, which are arrays of points connected or not connected to one another by lines. This simplification facilitates the revelation of common topological structures of the networks. The following elements may be identified: nodes, links, and regions. The number of edges (links) in the network, the number of vertices (nodes) in the network, and the number of isolated (i.e., no connecting) networks (sub graphs) are employed to develop a series of topological measures to characterize the network structure. It should be noted that an edge is defined by two nodes. There are two main groups of measures: (1) those based on gross characteristics and (2) those based on shortest-path characteristics. These measures allow a quantitative description of the network and a comparison of one network with another.

#### **4. CASE STUDY - TOURIST DESTINATION ZLATIBOR AND ZLATAR**

The success of tourism in any country depends on the ability of that country to sufficiently develop, manage and market the tourism facilities and activities in that country. Most developing countries depend mainly on tourism for economic growth and diversity. In Serbia, tourism authorities are continuously collecting data on tourist facilities. With the information in different place, some in paper files, some on the computer, it usually takes a long time to respond to a client's query. An information system that is capable of answering questions about where facilities and resources are located represents enormous benefits. An application of GIS in this case study provides tourism information in an integrated manner and will be of immense benefit not only to the region but Serbia as a whole.

This study was carried out in tourist destination Zlatibor (Čajetina) and Zlatar (Nova Varos), which have a lot of tourist resources, facilities, products and offers. Some of the hotels in destination Zlatibor and Zlatar and most important tourist places were considered and transferred to the system. Furthermore, hardware and software used in this study are written below.

In the study of the tourist potential of Čajetina and Nova Varos municipalities, GIS was consistently used in the sense of concept and technology. It directly relates to the creation of cartographic layers and filing data about space and anthropogenic objects, use of land and zones with various levels of environmental protection (Fig.1, 2.....7). At

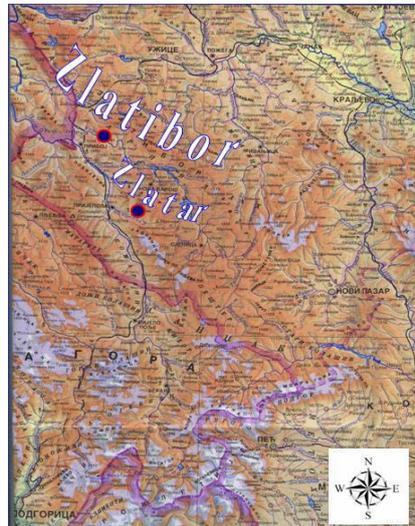
the same time, GIS was used as an analytical tool for establishing arrangement and density of tourist objects in that area, as well as their characteristics, such as type, category, name, quality, etc (Tab.3 and 4).

**Table 3:** Hardware and software used in this study

Hardware	Software
Celeron R CPU 2.66 GHz 512 MB RAM 74.5 GB HDD 17" Monitor DVD+RW	Arc GIS 9.1, Arc MAP Arc Catalog

These results can be achieved by queries in GIS Design and Application for Tourism [3]:

- Determination of tourist destination Zlatibor and Zlatar (Figure 3 - raster map)



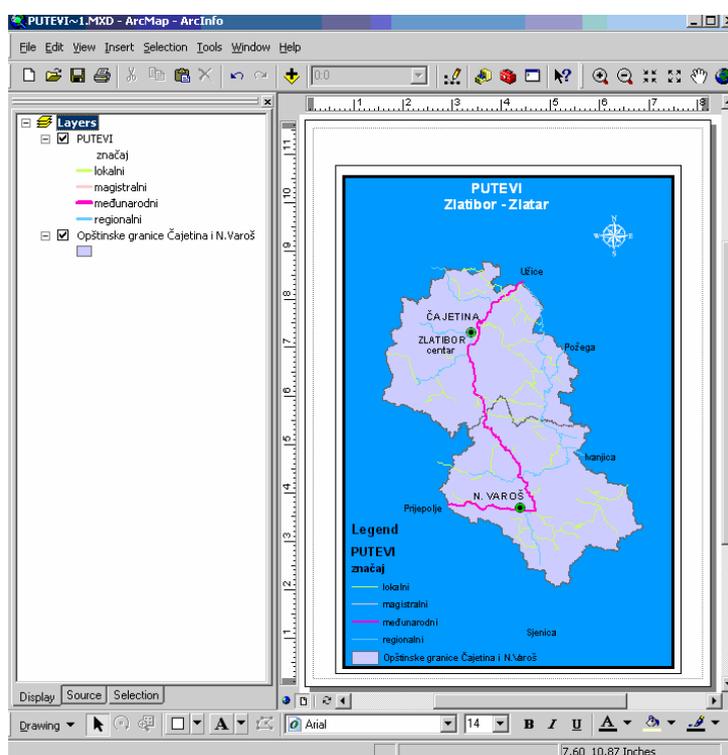
**Figure 3:** Tourist Destination Zlatibor and Zlatar

- Creation of attribute data (Table 4.)

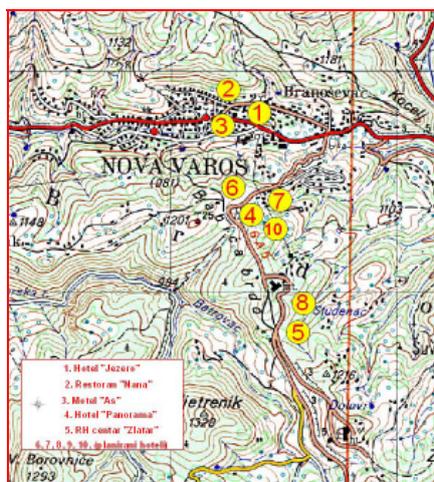
**Table 4:** Layers and attributes

Name of Layer	Attributes
Location (Destination)	Name (Zlatibor, Zlatar)
Road	ID, Type
River	ID, Name
Lake	ID, Name
Railway	ID, Name
Boundary of District (Čajetina, Nova Varoš)	ID, Name, Area
Nature park	ID, Area
Settlement	ID, Name
Hotel	ID, Name, Category, Number of Rooms, Property
Resting house	ID, Name
Restaurant	ID, Name, Property

Determination of important and necessary places for tourism (Figure 5. - vector map)



**Figure 4:** Destination boundary and roads on destination Zlatibor and Zlatar (Čajetina and Nova Varoš municipalities)

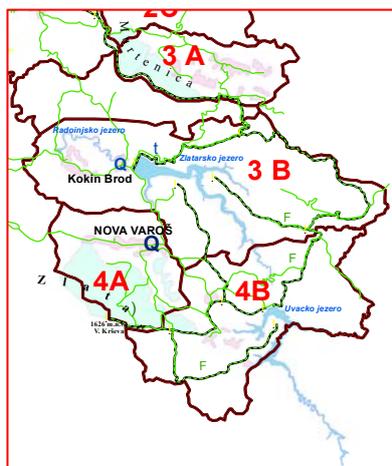


**Figure 5:** The hotels and restaurants in Zlatar tourist destination

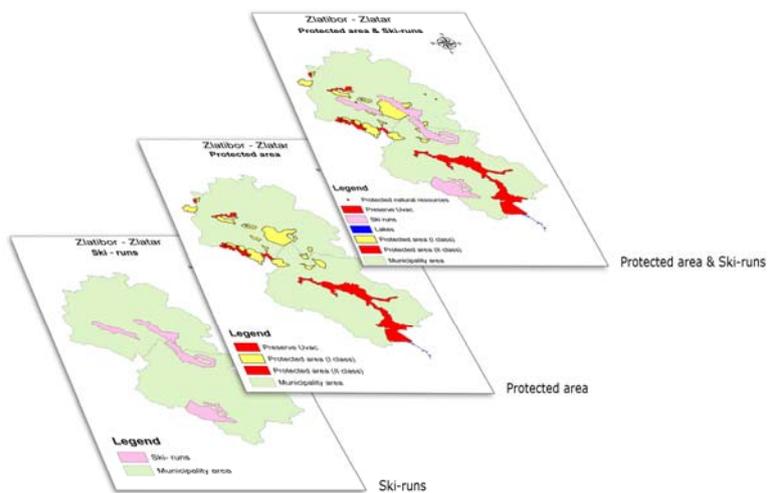
- Creation of thematic maps (Fig.6,7,...)



**Figure 6:** Zlatibor and Zlatar tourist subdestination (daily and planned tourist products: lakes, visit sites, ski paths ...)



**Figure 7:** Tourist attractive areas (3A, 3B, 4A, 4B) in the Zlatar region  
 Overlapping the layers of thematic maps (Figure 8.)



**Figure 8:** Determination of the location for ski-runs

GIS is especially convenient for planning and positioning of locations for ski-runs, which have to be outside of the protected areas. It should also serve in choosing the location of the ski-runs (Zlatibor (2), Zlatar (2)). The result was obtained by overlapping the layers of thematic maps, planning and defining of the locations planned to be used for the development of tourist industry (Fig.8).

## 5. CONCLUSION

GIS use has so far provided successful results which promote importance of information over technology. The reality is that geographic data in actual world come in many different formats. In this paper GIS has been established as a tool for collecting, analyzing, modelling and visual presentation of tourist data. Also, GIS is used for bringing the georeferenced data (spatial and non spatial) of geographic location Zlatibor and Zlatar into digital maps. Each object is assigned to a thematic layer. Each layer combines related objects like roads, building, or watercourses. To integrate tourism data the traditional layer model with layers like roads, buildings, vegetation, watercourses, etc., must be enlarged with additional tourism layers like hotels, restaurants, sights and further infrastructure layers.

Geographical information system is a rapidly expanding field enabling the development of applications that manage and use geographic information in combination with other media. In the tourism industry, government strategy, decision making, GIS is used to provide: digital basic map, digital files for analyzing and mapping, digital files for mobile mapping and modelling, digital multimedia.

In the case study "Tourist destination Zlatibor and Zlatar", GIS has three type of applications *in inventory* of zoning areas, land uses, protected areas; *in analysis application* (number and density of hotels, resting-houses, clubs, sport facilities such as swimming pools, playgrounds, football pitch, tennis courts; *in management/making application*, e.g. evaluation of land use plan based on demographic and natural characteristic and planning for capital investment in tourism.

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