CYCLETOURIST GIS
OF MORAVIAN WINE TRAILS

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Abstract. The paper deals with the creation of a geographic information system (GIS) with the main emphasis of its use in cycling. The data collection on the trail, obtaining of the maps data and their processing and transformation into the System – Uniform Cadastral Trigonometric Network (S-UCTN) are described. The import of geodata, geodatabase creation and a graphic representation design of cycle tracks and infrastructure are explained. The conclusion is devoted to a real use of GIS – tasks of searching and querying, creating of outputs, and are also the possibilities to export to other formats (ArcReader, ArcPad, ArcScene and GeoPDF) and platforms (PDA, tablet, web map server) have been explored.

Key words: Geographic Information System, ArcGIS, database, analysis, Moravian wine trails, cycletourism

INTRODUCTION

South Moravia is becoming an increasingly popular tourist destination not only for domestic but for foreign tourists as well. An integral part of the stay in South Moravia is the visits to wine cellars, vineyards, and various wine events. A very important place in wine tourism is obtained by the Moravian wine trails which were chosen for the years 2014–2019 by CzechTourism Agency as one of three top products of the Czech Republic in the field of active tourism. In 2013 the renowned travel guide Lonely Planet indicated South Moravia and its wine trails in the list of 10 most interesting regions of Europe.

It should be noted that tourism development should not be just an economic benefit to the region's development, but should also contribute to the protection of natural and cultural heritage, which in South Moravia is double truth.

Tourists who plan to stay in South Moravia should have a valuable source of information from which he could draw not only about the route information and interesting places of the stay, but also the information about possible refreshments, accommodation

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and related services. Currently, it is expected that the Internet could be the main source of information, especially the specialized mapping portal. Furthermore, it can be assumed that a large proportion of tourists already has a qualitive mobile device or tablet with an internet connection available, so it is possible to have the necessary data in a suitable form and on-line right on the cycle tracks.

The following contribution deals with the problems of creating an information system specializing in wine cycling tourism.

MORAVIAN WINE TRAILS

The Partnership Foundation is inextricably linked to Moravian wine trails since 1997, which became the main implementer and guarantor of a very successful project, as can be said nowadays. It would not happen, however, in the case if small vintners and self-sufficient vintners did not have the opportunity to join the wine tourism, which was excluded by legislative restrictions. The magic of Moravian wine landscape is mostly in small cellars and small vineyards and followed-up folklore, which are the things that cannot be found in most European wine countries nowadays.

Fortunately, a lot of problems in this area are currently solved, trails are marked in the field, a lot of services of wine tourism which are still expanding, function, many events with wine theme are organized and small winemakers and large wine companies coexist.

Currently, there are 10 wine trails in South Moravia; their names are derived from the names of wine regions. These 10 trails are then connected to the backbone Moravian Wine Trail, which is 280 km long. The total length of trails reaches 1200 km. The trails are marked with different colors and the logo of Moravian Wine Trails on each direction and information board. The color of the logo determines the location of a tourist on one of the trails. Routes are marked separately and in combination with other cycle tracks.

The summary of the trails is in Table 1.

Table 1.   Summary of Moravian Vine Trails

Name of the trail	Length [km]	Name of the trail	Length [km]
Brněnská	90	Mutěnická	60
Znojemská	163	Bzenecká	24k
Mikulovská	82	Kyjovská	84k
Velkopavlovická	109	Strážnická	101k
Podluži	113	Uherskohradišťská	74k

Along the route of Moravian wine trails there are currently 14 small local wine trails. Some of them are forming separate wine villages or wine companies, to make the viniculture and winemaking traditions of the region closer.

GIS DATA COLLECTION IN THE FIELD

Topcon GRS-1

GIS data collection just in the field (i.e. the coordinates of database values and photographs) is made with the Topcon GRS-1, which is a receiver GPS + GLONASS L1, L2 and a controller located in a small resilient case. The integrated GPS chip supports the satellite systems WAAS and EGNOS and reduces the multipath spreading of the signal. The device allows the dual frequency static, kinematic and real time kinematic measurement modes (with the external GNSS antenna) and single frequency static, kinematic and differential GPS measurement modes.

Additionally, it includes some built-in features such as a digital camera or integrated magnetic compass, which in addition to geodetics makes this device suitable for GIS data collection.

The device for measuring was totally proved, battery life is sufficient for one day measurements. Among the shortcomings mainly a weaker camera can be mentioned, which meant that the photographs were carried out by an external camera and the individual images were then put manually into the database.

The device Topcon GRS-1 runs on the operating system Microsoft Mobile 6.1, which allows the use of ArcPad software for data collection.

ArcPAD

To collect data in the field the software ArcPad from ESRI Company is used, its basic features are:

- *Visualization – depiction, zooming and scrolling of the map, measuring of distances, areas and the direction of movement, displaying of descriptive information and photographs of elements in the map, describing elements.*
- *Work with data – data editing, querying and searching in data, navigation with the help of selected or searched elements.*
- *Connection with a GPS receiver – if connected, the display constantly shows the current position, it is possible to target the exact coordinates of interesting objects and, if necessary, to record the passed track.*

ArcPad allows creating and editing geographic data by a mouse, pen and a GPS receiver. It also allows to process data from the built-in or attached to the equipment cameras and range-finder.

ArcPad supports an open shapefile vector format. ArcPad AXF format allows a data exchange between a mobile device and a central database through check-out and check-in operations. During the reverse synchronization (check-in) only the changes made by the user are then transmitted to a central database.

ArcPad also supports the following raster data formats: MrSID (with a geo-referenced file SDW), Windows bitmap (with a geo-referenced BPW file), JPEG, JPEG2000 (with a geo-referenced file JGW), TIFF (with a geo-referenced file TFW) and then PNG, GIF and CADRG.

The programme also has a desktop version for a personal computer in which data can be additionally edited. For collection the new project was found in WGS84 coordinate system and inside it new shapefiles for individual elements were created. For each element the filling form of individual attributes is prepared. Primary data (collected in the

field) are then supplemented by secondary data from existing sources, mostly from the internet.

As a base map for GIS data collection the Open Street Map was chosen, whose goal is to create freely available geographic data. The project is based on the collective cooperation and the concept of Open Source. Data are provided under the license from Open Database License.

The advantage of this base is the availability, sufficient accuracy and a vector form, which enables faster displaying in Topcon GRS-1.

Database of point and linear elements

For collecting data and creating your own GIS, a database of point and linear elements was designed. Its diagram which shows a connection of each table is as follows:
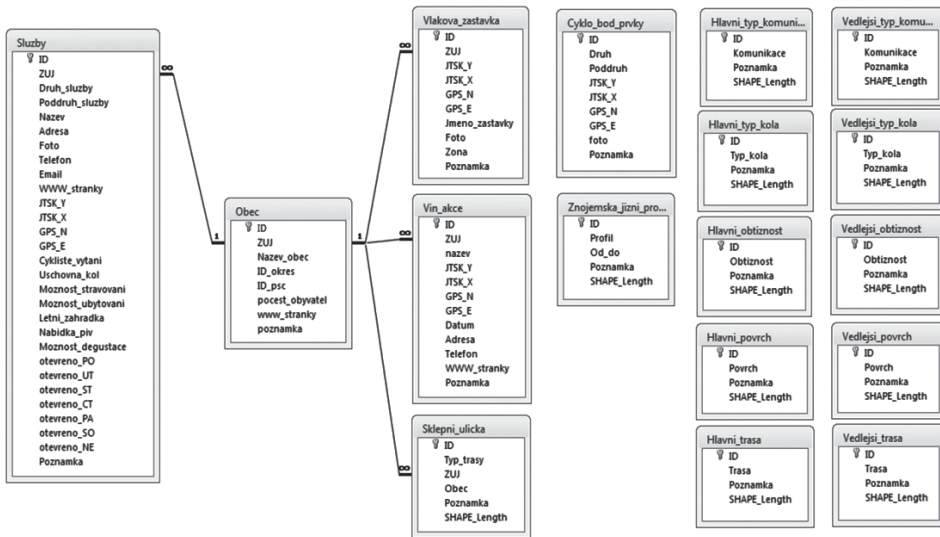

Fig. 1.   Database diagram

Line elements of the cycle tracks are primarily divided into two types: Main and Secondary (alternative trails). For both variants the data on the type of roads, type of the appropriate bicycle, difficulty and surface are collected. The main trail is then divided into sections of about 10 km, which contain information about the route profile. Each category of the trail is distinguished by the colour, thickness and the type of lines, so that the user in any combination of layers turned on got clear and well arranged information.

According to the type of road line elements are divided into roads of the categories I, II, III, local and tertiary roads, cycle tracks and lanes.

According to the type of bicycle they are devided into road, mountain and trekking ones.

According to the difficulty the trails are divided into the easiest, medium and the most difficult ones.

According to the surface type asphalt, paving, clay, gravel and other surfaces are distinguished.

As a special linear element the lines of cellar lanes are kept, which form the complementary information to the point element of cellar lanes and only show the spatial configuration of the streets' network.

Point elements include the elements on its own cycle track, and in particular the elements included into the category Services, which is a large database divided into other types and subtypes (see Tab. 2). Special types of elements are then Localities, Train stations, Cellar lanes and Events. Symbols from the database of the offered symbols ESRI with possible slight modifications were assigned to each point element.

Table 2.   View of the second point elements

Category	Types (shapefile)	Subtypes
Cycle track Point elements	Cycle point elements	natural rest areas, rest areas, signage, information boards, prospects, panoramic photos, other
	Locality	
Services	Refreshments	Pub, restaurant, pizzeria, fastfood, confectionary (cafe), canteen, others
	Accomodation	Hotel, guest house, camping, hostel, others
	Institutions	Municipal/city authority, library, town hall, post office, information office, police, hospitals, ...
	Shops	Food stores, groceries, pharmacy, ...
	Wine	Wine bar, wineshop, wine growing, wine cellar, cultivating station
	Places of interest	Church, chapel, museum, castles, towers, observation tower, others
	Swimming	Indoor, outdoor, pond, lake, swimming pool, reservoir / dam
	Other services	ATMs, …
	Repairing services/bike rentals	
	Wine events	
	Train station	

Database information for the general element may be then a combination of these items (see Tab. 3).

Table 3.   Database information for common element

Database information for common element		
Coordinates JTSK	Catering possibilities	Name
Coordinates WGS84	Outside seating	Type of accomodation
Address	Cyclists welcoming	Bicycle storage rooml
Phone	Beer offer	
WWW pages	Type of wine	Name of the station
Opening hours		Zone
Foto		

Map data

For the creation of GIS diverse map dat were used, some of them are the basis for the outputs of GIS, some have a helping function and are not used for outputs. Summary of data is in the following table.

Table 4.   Map data

Map	Source	Format
Shocart cycling maps 1:60 000	Shocart s.r.o.	JPG
Data200	COSMC (Czech Office for Survey-ing, Mapping and Cadastre)	SHP
State map 1:5 000	COSMC	TIFF
Basic map of the Czech Republic 1:10 000	COSMC	TIF
Basic map of the Czech Republic 1:25 000	COSMC	TIF
Basic map of the Czech Republic 1:50 000	COSMC	TIF
Basic map of the Czech Republic 1:200 000	COSMC	TIF
Ortofoto of the Czech Republic	COSMC	JPG
ZABAGED (Basic Geographic Data Base)	COSMC	SHP
Geonames	COSMC	SHP
Cycle routes of South Moravia	Informatics Department	SHP
DTM (Digital Technical Map) of South Moravia 2012	Informatics Department	ADF
Specialized Cadastral Map (SCM) of South Moravia 2013	Informatics Department	SHP, DGN, RDL
Categorization of vineyards	Informatics Department	SHP
Wine trails – Partnership	Partnership Foundation	SHP, GPX, KML

The basic idea is that a cyclist for orientation in different situations needs a map of different scale - for crossing a longer distance they need the scale of 1: 50 000, for orientation in complicated terrain – the scale of 1: 10 000 and for locating the point elements (e.g. individual cellars, refreshments, shops, accommodation, etc.) – a map at the scale of 1: 5000 and larger.

Therefore, the basis for the data export is a series of basic maps of the Czech Republic, which is complemented by a network of cycle routes and by linear and point elements acquired within the collection of data. It is a flexible system in which while zooming relevant scale maps gradually appear and turn off the maps of an inadequate scale. Another important layer is an orthophoto layer. Local orientation maps are created from the map at the scale of 1: 5000 and SCM of South Moravia for some settlements and cellar lanes.

In certain cases the connection of mapping services was used, e.g. WMS service of Road and Motorway Directorate for categorization according to the type of the road.

CREATION OF GIS IN SOFTWARE ARCGIS

The actual project GIS is created in software ArcGIS 10.1. The so-called *Group Layers* are created for better recording out of all the underlying data, these can then be used in the future for connecting additional data, which guarantees the preservation of configu-

red symbology. Since most of the underlying data is in the system S-UCTN, the data in WGS84 are transformed by means of ArcGIS.

Measured point and linear elements are then imported into the established personal geodatabase in ArcGIS, which among other things will allow to create database queries and perform analytical tasks over the data.

Outputs of GIS

GIS is further used to create an output for a variety of users, whether sitting at home at their PC or sitting in the saddle of their bike, or users who need a simple printed output.

Overview of possible outputs is given in Table 5.

Table 5. Data output from GIS

Overview of outputs from GIS	
Map outputs	ArcScene ouput
Outputs in GeoPDF format	GIS output in ArcReader format
Routes profileand itineraries	GIS output in format ArcGIS Explorer format
Passport for cyclists	GIS output in ArcGIS Online format
Database queries	GIS output in Google Earth online format
Analyses	GIS output in Marushka online format

Map outputs

Map outputs through the possibilities of contemporary technique have their advantages – the possibility of using larger formats, unequalled readability in the sun and independence of the energy source or an Internet connection.

GeoPDF

GeoPDF output can be well used especially for the users without an internet connection. After opening the GeoPDF in Acrobat Reader browser with the appropriate plug-in module makes it possible to turn off individual layers, to find out information about objects, insert the lines, place the notes, use the measurement tools, import and export the objects, etc.

For creating a GeoPDF file it is necessary to have purchased a software license from TerraGo Company, otherwise the output is devalued by the text on the trial version of the application.

Routes profiles and itineraries

Routes profiles and itineraries are connected to the main route of wine trails of about 10 km sections. This data was created with the permission of the administrator of the server www.cyklo-jizni-morava.cz.

Passport for cyclists

As another example of the possible use of the system, the so-called passports are created – printed outputs brochures in A5 formate which process a day trip. The content is usually a mapping output, route profile and itinerary, the outputs from the elements database, photographs, etc.

Database queries

In the GIS a variety of database queries or spatial queries can be performed. Templates of basic questions are created; the problem is the distribution of results to the end user, or the possibility to create queries by the users themselves. However, it is possible to assume that there would be a minimal percentage of such erudite users.

Analyses

ArcGIS environment with ArcToolbox application lets to create various analyses in connection with the operation of the network of wine trails or analyses of basic general research in various fields.

ArcScene output

The ArcScene application is a part of the 3D Analyst extension for ArcGIS Desktop. ArcScene is an application designed for viewing and analyzing small data sets, it displays data as a 3D scene. ArcScene for GIS Moravian wine trails purposes was used mainly for creating animations and flybys over the area of interest.

Making videos is demanding on computer hardware, mainly on insufficient memory and high-quality graphics card. For animation flybys creation it was necessary to solve the problem with the impossibility to define the precise trajectory of the camera, so currently weare testing other alternative applications. Created videos should be placed on the site of Moravian Wine Trails Partnership Foundation.

GIS output in ArcReader format

ArcReader is a free downloadable application that allows viewing maps created with ArcGIS Publisher extension and thus there is no need to have an ArcGIS license. It allows viewing GIS data to a wide range of users. ArcReader offers the fuction of length measurements, finding information about objects, turning on and off layers and others. The prerequisite is that the user has available source data, which in most cases is not possibleto provide.

GIS output in ArcGIS Explorer format

ArcGIS Explorer is a new browser of geospatial data. It offers an easy way to quickly access and view geographic information in both 2D and 3D, and also includes the ability to perform queries over the displayed data and analytical tasks. ArcGIS Explorer allows the access to applications for spatial data processing (geoprocessing) based on the server with GIS data sets and gives the access to all the possibilities offered by ArcGIS for Server, including geoprocessing and 3D services. ArcGIS Explorer is an open and interoperable application – it can work with both local data layers, as well as the services made available through ArcIMS, ArcWeb Services, and WMS consortia of OGC or KML.

In order to support the same formats (KML, KMZ), for an ArcGIS Explorer application the same export as for the Google Earth application is used, but in the same way as with ArcReader it is necessary to distribute the source data.

GIS output in Google Earth format

Google Earth is a free application that allows viewing satellite photos, maps, terrain, 3D buildings and others. One of the possibilities that the application provides is the view of your own data. The basic supported formats include * .kml, * .kmz * .gpx, * .loc and others. It is possible to add images to objects in * .jpg, * .tif, * .bmp formates, etc.

Google Earth does not support the vector format * .shp, therefore it is necessary first of all to convert the data into a * .kml format through ArcGIS. The application displays symbols of point elements as well as in ArcMap application, but in lines most of styles were not preserved, only a full line style is supported. This application allows you to turn on and off layers, display information about the object, and measure distances.

Google Earth application allows also starting an animation of a flyby over a certain line. But there is a very limited control of the animation and the inability to save the video file.

GIS output in ArcGIS Online format

ArcGIS Online is a tool for viewing, publishing, data sharing, interactive maps and applications using the Internet creation. For a full work in ArcGIS environment it is necessary to register free on the website www.arcgis.com. An important feature is the ability to upload your own data and to create map services from them.

The great advantage of maps on ArcGIS Online is their use in different environments. It is possible to work with them in ArcGIS for Desktop, in a web browser, on mobile devices, and in the self-developed applications. The advantage is that all of these clients have the map displayed in the same way without depending on the client, with the help of which you connect to ArcGIS Online.

The application allows to record data in formats * .shp, * .csv, * .txt or GPS records in the format * .gpx, also it allows an extensive editing of inserted data, such as the change of point elements and lines symbols. It is also possible to insert new points or move the existing points, to change the attributes of individual elements and many other functions.

For the Czech Republic it is possible to use a very high quality detailed base map at a scale of 1: 10 000. This is a topographic map, which has been updated based on the data from ZABAGED (Basic Geographic Data Base).

Among the negatives it currently includes the problems with diacritics, so it is necessary to modify some of the characters in attribute tables of each SHP before uploading. It is also necessary to re-assign symbology to the recorded data, which because of differences in applicable symbols differs from that in the ArcGIS 10.1 programme.

To view geographic data used in the field, the mobile application ArcGIS for Android platforms, iOS and Windows Phone is used. Sample environment in a mobile phone is shown in Figure 2. Data of the currently processed part of the Mor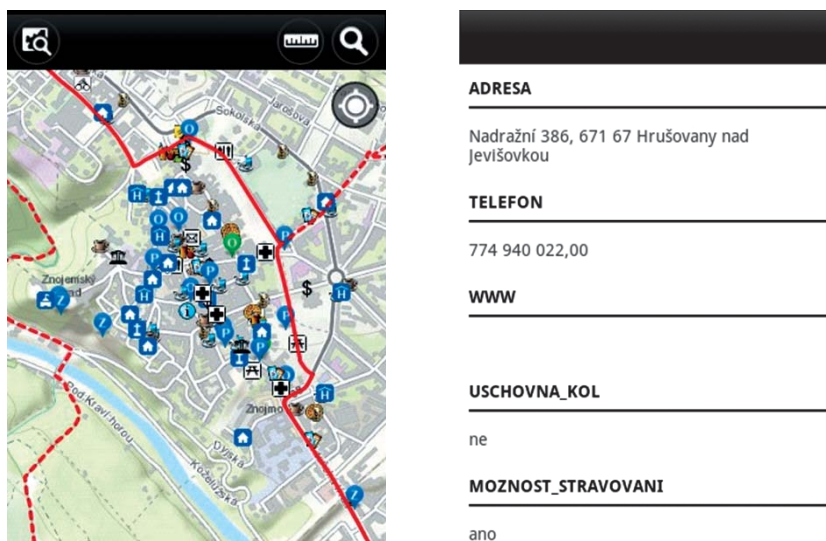avian Wine Trails can be viewed at the following addresses http://bit.ly/1juRn6t http://bit.ly/1ssH7kz and http://bit.ly/SNjUyC.

Fig. 2.   Screen mobile phone

GIS output in Marushka online format

Map application server Marushka® represents the new generation for publication and use of GIS data in the Internet and Intranet. It is based on component technology in the "DOT NET" environment. The aim of the development was to overcome the limits of common map servers, especially when it comes to publishing performance and cartographic data presentation possibility. The important role that the application offers is the editor of plotting order of layers and displaying at a certain scale, so that the map does not contain unnecessary elements and does not lose the informative value. To edit vector and raster symbols, legends, user styles, queries, and other objects the set of integrated visual editors is used.

The formats, with which the Marushka® application works, include the vector format WKB (Well Known Binary). The application also supports * .shp, * .gml, * .dgn and * .gpx formats.

Marushka® application should be soon available at the Geodesy Department of the Faculty of Civil Engineering, BUT and we suppose that the publication of Moravian Wine Trails project will get even on a higher level.

CONCLUSIONS

This paper describes the many years of experience in the creation of a specific GIS of Moravian wine trails. Nowadays the standardized technology was created which includes data collection in the field, GIS creating with a unified database, symbology and underlying data. Individual data sets can thus be easily combined into a larger whole. Outputs from the GIS are possible, besides other things, to get on-line to the end user, the current data are available on the above mentioned web links.

It can be assumed that with the hardware and software development, this GIS will continuously get on a higher level.

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**GIS MORAWSKICH SZLAKÓW WINA
DLA TURYSTYKI ROWEROWEJ**

Streszczenie. Praca traktuje o utworzeniu Systemu Informacji Geograficznej (GIS) z głównym naciskiem na jego wykorzystania w turystyce rowerowej. Przedstawiono w niej gromadzenie danych o szlakach na podstawie map, przetwarzanie tych danych i transformację do Zunifikowanego Systemu Trygonometrycznej Sieci Katastralnej (S-UCTN). Wyjaśniono import danych geograficznych, tworzenie geo-bazy, projektowanie graficznej reprezentacji ścieżek rowerowych i infrastruktury. Ostatecznie poruszono problemy praktycznego wykorzystania GIS: przeszukiwanie bazy i zapytania do bazy, generowanie odpowiedzi. Opracowany system GIS ma możliwość eksportu do innych formatów, takich jak ArcRead, ArcPad, ArcScene czy GeoPDF. Istnieje również możliwość eksportu na urządzenia mobilne typu PDA, tablet i sieciowy serwer map.

Słowa kluczowe: GIS, ArcGIS, baza danych, analiza, morawski szlak wina, szlak rowerowy