Faculty of Management Science and Informatics
University of Zilina

GeoAccess

Final Report

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Contents

List of Figures

List of Tables

Abstract

This document was created under the scope of the subject *GIS Applications in the Management*, lectured in the school year of 2006/07 by Professor Ing. Peter Matis, in the Faculty of Management and Informatics, University of Zilina, and intends to present the project developed during the course.

1 Introduction

A *Geographic Information System (GIS)* it can be defined as a computer based tool for mapping and analyzing geographic information. It's possible to combine maps or "layers" of information and then analyze and manipulate them to generate results that can be maps or other type of information. These new maps are often used for making decisions about land use, resources, transportation, real estate, retailing, etc. Map making and geographic analysis is not new, but *GIS* makes it possible to do this type of work faster and more efficiently due to its power and ease of using automatic systems. It allows virtually anyone to create a map to help explain historic events, plan for the future, and predict outcomes. Taking this in consideration, the *GeoAccess* team always tried to generate results that anyone can use, as the application *GeoAccess*, with a simple *interface* capable of complex calculations, and in which or final results relies on.

The *GeoAccess* team was proposed with the challenge of creating an *Accessibility* application, which had as primary goal to calculate the *Accessibility* coefficient which indicates a relative level of efficiency. Also part of the project is the analysis of a geographical area with some characteristics and restrictions. Thus, it was adopted a planning oriented posture in order to complete all required goals within the time frame available.

Among several decisions to make, the ones most important are related with overall software application, area to analyse and which case to chose specifically. The main guidelines followed are:

- generate a simple yet effective application, so it can be widely used by people without deep knowledge about *GIS*;
- to chose a representative area and related data to it, part of the process of analysis;
- produce information analysis with collected data, using the developed application.

2 Problem analysis

The objective proposed was to analyse the accessibility to entertainment points in Slovakia. As starting point is necessary to define and understand what is Accessibility:

- *Term used to describe the relative ease or difficulty in reaching a destination.*

It measure the effort that one must make to access the the destination, in this particular case entertainment points.

In order to calculate accessibility is necessary to calculate at least the distance between points, and the possible travelling speed to get to the destination point. To do so it's necessary to use transportation infrastructures (roads), this roads can be used by private transports or by public transports (in our analysis only Bus were included).

The result value of our analysis is the effective travelling speed, by effective it's meant the travel speed including, private and public transports, along with the possibility of traffic jams.

Another problem that this kind of analysis creates is the qualitative classification to give to the final result, it's hard to make that process automatically processed by an application, because the average travelling speed can/is different according to the region that is the target of the analysis. So the scope of this project is to create the tools to perform the analysis, and to study and discuss the results.

3 Data Collection

All *GIS* data has to be in a digital format whether it's a report, a photo, a map, or information gathered in the field. In other words, the information or maps have to be put in a form, which the computer can use and display.

Part of the project consists of the accessibility analysis of general public interest points in a constrained territory. Thus, were picked, within the county of Zilina, and two of its neighbors, Martin and Dolný Kubín, as destinations points *Entertainment* places. These *Entertainment* places were chosen taken in consideration its diverse geographical location, season of usage, different classes of ages.

3.1 Territory

As stated above, the territory chosen to analyze consists of the county of Zilina, Martin and Dolný Kubín. These were selected primarily because are geographic related to the place were the project was proposed to the *GeoAccess* Team - University of Zilina - and due to its richness in destinations points useful to the project needs. Figure *Territory map.*

3.2 Destination points

Ski centers

Because in the nature of Slovakia are big mountains, there are a comfortable amount of ski centers. Much of them are also in the referred territory. The ski centers are sitting near of little mountain villages so the most visitors will be probably people from bigger cities during the Winter season.

Swimming pools

Almost each bigger city has a swimming pool. Very important for Slovak tourism are spas. Some of them are also in the selected territory like Rajecké Teplice or

Rajec. This kind of *entertainment* is largely used by general population mainly during the Summer season.

Cinemas

Also cinemas are sitting in bigger cities. Mainly because in the little villages are not enough people or there is low interest to build cinema which will be prosper. However, cinemas have the same amount of visitors during all year, and from cities and villages.

Ski centers	Swimming pools	Cinemas
Belá pri Ziline	Dolný Kubín	Dolný Kubin
Cicmany	Martin	Martin
Dolný Kubín	Rajec	Rajec
Fackov	Rajecké Teplice	Rajecké Teplice
Kubínska Hola	Stránavy	Socovce
Martin	Zilina	Vrútky
Párnica		Vysný Kubín
Strecno		Zilina
Terchová		
Valca		
Zázrivá		

Table 1: Entertainment points

3.3 Support Data

To the kind of data originally chosen to analyze, there were detected more needs so it could be possible to support and correctly relate it. One of the basics to explore accessibility it's transportation network, which in the specific case consists in two distinct types of transportation: *Public transportation* - bus network - and *Private transportation* - private transport mean using road network.

It's also required to have statistical data about each settlement existing in the chosen territory, such as advanced demographic information, and obviously its geographical location.

4 Data Process

4.1 Provided

Some of the basic required data was provided by the Project Supervisor itself, including counties boundaries, general settlements information and basic public road network. This information was provided in *shapefile* format, which stores no topological geometry and attributes information for the spatial features in a data set. The geometry for a feature is stored as a shape comprising a set of vector coordinates. An ESRI shape file consists of a main file, an index file, and a dBASE table. The main file is a direct access, variable-record-length file in which each record describes a shape with a list of its vertexes. In the index file, each record contains the offset of the corresponding main file record from the beginning of the main file. The dBASE table contains feature attributes with one record per feature. The one-to-one relationship between geometry and attributes is based on record number. Attribute records in the dBASE file must be in the same order as records in the main file. Figure *Territory map*.

4.2 Processed

However the most valuable data to be analyzed was collected by the team during the first stage of the project, which includes bus schedules within the area of study, *Entertainment* places according to the project requirements, and detailed demographic information adding statistical information about age and wage, as well as preferences for public or private transportation to reach a destination.

All information about *Ski centers*, *Cinemas* and *Swimming Pools* were achieved from the Internet, which contribute to generate *shapefile* files for each kind of entertainment, created in ArcView GIS application by extracting items which indicate entertainment points.

The entire model of accessibility try to measure it relating time and distance. Thus, and since the distance could be calculated from the provided transportation network data and consequently calculate travel time according to this and road category, to achieve it was needed to process time taken in *public transportation*. There are several companies providing this service, unfortunately in a non easy way to process automatically. It was extracted information about each bus line and how much time it takes to get between two points. It was decided not to process all this data, but a smaller part, since it would be a much more time consuming process with low effect on final results. Figure *Bus timetable*.

4.3 Generated

Unfortunately not all data was successfully acquired, and a small part of it was generated by the development team based on statistical data or common sense. Some of the demographic information was extended with statistical data on people expectations to use a kind of transportation to go to *Entertainment* places. Also the road capacity in cars per kilometer, needed to a component of the *Accessibility model* created. Due to the project characteristics, is not a problem to use generated data, since its just to educational purposes, however, it can easily changed to get more accurate results.

5 Accessibility Model

To obtain a number, which will represent accessibility there was a need to relate two different sets of input data - demographic information and information about the transportation infrastructure and transports. Transportation is represented by road information's and bus schedules, while the demographic information consists in distribution of people by age and wage.

Age	private transportation	public transportation
[0, 18]	0%	25%
]18, 25]	15%	30%
]25, 30]	30%	15%
]30, 45]	45%	10%
]45, 65]	10%	5%
]65, $+inf$[	2,5%	1,25%

Table 2: Model configuration values, related with age.

wage	private transportation	public transportation
minimum to medium	25%	17%
medium to medium/high	40%	10%
medium/high to high	60%	3%

Table 3: Model configuration values, related with wage.

Processing of transportation data consist from three parts :

1. Finding a shortest distance to get from begin point(settlement) to end point(entertainment). This is achieved by processing road network by LabelCorrect algorithm.
   Result: Distance, Capacity(minimal capacity of pathway)

2. Processing a private transport time to get from source to destination point(in our case the entertainment). This is calculated from shortest pathway(gained also as one of results of the previous point) in which each road segment has its own maximal speed and length. The time is calculated by:

   $$\sum \frac{RoadSegmentLenght}{RoadSegmentMaxSpeed} foreach\ Segment\ In\ Pathway$$

   .Result : Private Time (PrivTime)

3. Processing the public transport time to get from source to destination. Due to time shortage and problems with processing of bus schedules, it was decided to take the easiest way possible : ignoring the times of arrivals and departures of bus links, only taking existence of bus connection and time to get from one point to another. This way the transportation segments are similar to roads, having only time instead of length, so they can be processed also by LabelCorrect, result o this is directly the time.
Result: Public Time (PubTime)

Processing of demographic data consist from four parts :

- Calculating number of citizens according the age intervals(e.g. how many citizens of age from 19 to 25 are in that town). The percentages of population intervals(percent of people of that age represented in population) is acquired from Slovakia overall demographic situation. Attempts to obtain accurate information about each settlement (numbers of population in each class) failed due the unwillingness of Statistical Office of Slovak Republic to provide the data.
- Calculating number of citizens according the wage interval. This is done similarly to previous point, just instead of age intervals, the wage intervals are used. The percentage points were estimated according to recent social and economic situation of Slovakia.
- Next two points differ due to type of analysis - Statistical(making calculations for general population) or Personal(using just data of one person as input)

1. Calculating numbers of persons which will use private and public transport according to their age:
Statistical : Value is calculated as average of overall usage of private/ public transportation according the number of citizens in age interval and estimated percentage of people of each interval, which use the certain type of transport.
Personal : Value is calculated only from interval to which the certain person fits.
Result: Public Age (PubAge), Private Age (PrivAge).
2. Calculating numbers of people which will use private and public transportation according their wage:
Statistical : Value is calculated as average of overall usage of private/ public transportation according the number of citizens in wage interval and estimated percentage of people of each interval, which use the certain type of transport.
Personal : Value is calculated only from interval to which the certain person fits.
Result: Public Wage (PubWage), Private Wage (PrivWage).

Main part of accessibility calculation have this four parts :

- Calculating the private transport efficiency: this number represents real time to get to destination point by private transport. If the number of people trying to reach the destination via the certain road segment is higher than the roads maximal capacity, results are traffic jams. So if the number of peoples trying to reach certain entertainment point(calculated as average from PrivAge and PriWage) is lower than capacity of road, the time is equal to minimal time to get there, so :

  $$PrivEff = PrivTime$$

  If the number of people is higher than capacity, then:

  $$PrivEff = \frac{(\frac{(PriAge+PriWage)}{2})}{Capacity * Distance * PrivTime}$$

  Result: Private Efficiency (PrivEff).

- Calculating public transport efficiency: this number represents real time to get to destination point by public transport. The reason to do this is same as in private transport efficiency, but difference is, that public transport usually don't cause the traffic jams, they are caused by private transport users, therefore as friction constant, the private transport usage is used(same as in private transport eff.). If there is no traffic jam :

  $$PubEff = PubTime$$

  If capacity of road is not big enough, then:

  $$pubEff = \frac{(\frac{PubAge+PubWage}{2})}{Capacity * Distance * PubTime}$$

  Result: Public Efficiency (PubEff).

- Calculating time to get to the entertainment point :

  $$Time = \frac{(PubEff + PriEff}{2}$$

  Result: Time.

- Calculating the speed, with which we can reach the entertainment point :

  $$Speed = \frac{Distance}{Time}$$

  Result: Speed.

The result value (Speed) represents the accessibility to the desired destination, it's not in the scope of the model to decide if the result value represents a good or bad accessibility value, this decision as to be taken by the person who is realizing the analysis. This happens because the average travel speed depends on the target geographical area of analysis, it's influenced by cultural facts of the target area. Therefore the person that is creating the analysis is responsible for adequate the results to the target of it.

6 Software

This chapter contains the description of the software created, it will present the logical architecture of the system, it's features.

6.1 Architecture

The system architecture is composed by layers, by using this kind of construction it's intend to separate the logical functionalities of the system in different layers. This way the application is composed by tree layers, Core, Communication Module and Visualizer (Bottom-Up).

6.1.1 Core

This layer is responsible by the main processing of the all system, this means its responsible by all the business logic in the system. The Core is composed by several Java Packages, the objective of this packages is to allow a better organization of the classes, organizing them within logical functional groups.

The core can operate as a stand-alone application, this means it offers all the functionalities without the need of a graphical interface, to use the core it's only necessary to have the right configuration files set and it will function make all the processing available.

At the present date it's still necessary to hard-code some parameters within the core main method, future development can implement the capability to allow all the input of parameters from the console, this was not done for this version due to time restrictions.

6.1.2 Communication Module

This layer is responsible by the implementation of the methods necessary to allow the interaction between the Core and the Visualizer. It's not responsible by any processing at all, only serves as an "interface" between the Core and the Visualizer.

6.1.3 Visualizer

The main objective of the visualizer is to allow some simple interaction with the program. It uses as stated before the Communication Module to interact with the Core.

It allows the visualization of all the results, this includes shapefiles with the roads used and the model output values.

See figure *Logic architecture*.

6.2 Running Environment

The application was developed using the programming language Java, this allows this application to run under any operating system capable of running Java. The application was developed under Mac OS X, Linux Ubuntu and Window XP, it was also tested on developers version of Windows Vista.

So above the operation system there is a layer with Java Virtual Machine as normal and Java Advanced Imaging (JAI), the last is used on the visualizer to perform the renderization of the shapefiles. Sun defines JAI as:

- “The Java Advanced Imaging API (JAI) provides a set of object-oriented interfaces that supports a simple, high-level programming model which allows images to be manipulated easily in Java applications and applets. JAI goes beyond the functionality of traditional imaging APIs to provide a high-performance, platform-independent, extensible image processing framework.“

It was also used a library which provides compliant methods for manipulation of geospatial data, this library is of great use when developing a Geographic Information System as it provides useful methods either for the Core of the application as for the visualizer.

The top layer is composed by the application documented on this report, Geo Access.

See figure *Environment*.

6.3 Development

The project was developed having in consideration software development methodology and version control of code. There were also defined the tools to use to develop it.

6.3.1 Development Model

The original development model, as stated in the Project Development Plan as a mixture of Extreme Programming and Spiral model, both of them are classified as Agile Software Development Models. During the development of the project this model as evolved to a parallel method, both the visualizer and the core were implemented at the same time, this as necessary due to the small amount of human resources available, three programmers, and the tight schedule of the project. The part related to Extreme Programming was also abandoned due to the same reasons and to the lack of development infrastructures available for the project.

6.3.2 Version Control

Even with a small team the synchronization is a problem when developing in parallel, therefore the the team used Concurrent Version System (CVS), this allows a more simplified process of synchronization.

CVS implements a version control system: it keeps track of all work and all changes in a set of files, typically the implementation of a software project, and allows several (potentially widely separated) developers to collaborate. CVS has become popular in the free software and open-source worlds. CVS is released under the GNU General Public License.

6.3.3 Tools

The tools used during the project development:

- Integrated Development Environment (IDE) : Eclipse.
- CVS Client : Provided by Eclipse.
- CVS Server : Provided by SourceForge.net
- Debug Tool : Eclipse debugger.
- Mac OS X Tiger.
- Linux Ubuntu Edgy Eft.
- Windows XP Service Pack 2.

6.4 Features

The application developed contains the following features:

- Measurement accessibility.
- Statistical & Particular analysis.
- Able to store the user profile.
- Point to Point & Point to layer analysis.
- Simple graphical & text visualization of the results.
- Generation of files for external use, the files contain graphical information are in shapefile format.
- Area independent, it's only limited by the amount of input data available.
- Processing of public transports schedule in Comma-separated values (CSV).
- Abstract destination points.

- The Core of the application can run without any visualizer.
- Easy model configuration, it's easy to change the values of the model configuration files, as they are in a standard format (CSV).

7 Experiments and results

7.1 Inputs

In order to complete the task that the *GeoAccess Team* was originally proposed to, and fulfill all the primary objectives, a series of experimentations were carried on, with statistical data that can successfully represent all the area object of study - in the specific case Zilina, Dolny Kubin and Martin.

To the case study, were chosen about 20% of the total number of available collected settlements, in such a way that they can represent different kinds and amounts of population, as well as areas with different properties. Thus, there were analysed four areas:

- Area 1
  Located in the south boundaries of Martin county, includes the settlements Blatnica, Karlova, Valentova, Laskar, Socovce, Folkusova, Danova, Rakovo, Pribovce, and Leziachov.
- Area 2
  Located near the center of Dolny Kubin, includes the settlements Kriva, Chlebnice, Dlha Nad Oravou, Sedliacka Dubova, Horna Lehota, Malatina, Pucov, Pokryvac, Bziny and Velicna.
- Area 3
  Located near Zilina, includes the settlements Svedernik, Lysica, Varin, Bytcica and Pastina Zavada.
- Area 4
  Located in rajecka dolina valley in the southern part of Zilina county, includes the settlements Cicmany, Rajecka Lesna, Velka Cierna, Zbynov and Kunerad.

The destination points initially collected have entertainment characteristics. To this case study purposed were picked two kinds of entertainment points, once again to represent different kinds of destination points. Thus, was decided to analyse *Sky Centers*, due to its location be mainly in the boundaries of the city as its usage mainly concentrated during the *Winter* season, and *Swimming pools* for opposite reasons - located in or near centers, and having its top usage during *Summer* season. This kind of data allow a good quality level of an accessibility analysis, covering most of the aspects related to it.

To process the calculations between origin and destination points, were used two kinds of transportations - *Public* and *Private transportation* (see section *Data collecting* and *Data processing*).

7.2 Processing

All the inputs were easily processed using the software previously developed - *GeoAccess* -, which is capable of reading the given inputs, analyse them properly and generate all the required data to complete the analysis. This results were processed using the *Accessibility Model* created (see section *Accessibility Model*).

8 Results & Discussion

The results will be introduced in this section of the report, and some considerations about the same.

8.1 Ski centers

The results of this analysis are available in the appendix. See figure *Ski centers analysis* and related values tables.

8.1.1 Area 1

This area as good accessibility values to the ski centers more far from it, to the ones close to it the value of accessibility is worst. But the general accessibility for this area is not very good, because most of the ski centers are far from its location (four are close, but six are far from it), therefor even if the travel speed is acceptable for the far ski centers the distance is big, which leads to a bad overall accessibility. This study is only concerned with 3 counties so the fact that the area is located near the border of the county is not relevant, even if there are ski centers in the nearby counties. Another point that is not favorable to the accessibility of this area is that one of the nearby ski center (Fackov) doesn't have public transports to there, this limits the number of people who can go there (people that don't own a private transport).

8.1.2 Area 2

The situation on this area is very similar to the situation on the first area. Like it has good accessibility values to the ski centers more far from it, a bad value to the ski centers near it. To one of the nearest ski centers there are no available public transports. So the conclusion is the same taken for the first area.

8.1.3 Area 3

This area doesn't have any excellent value in the accessibility but in average it's the best areas of the four. To the most far ski centers it was the best accessibility values, the ones more close don't have such good values as the the far ones, mainly because that to nearby points the roads tend to be more slow and in most cases not in very good state of conservation. One problem of this area is that in comparison with the others areas its the one with more distance to the nearest ski center but this is not possible to solve, it's more easy to get better roads conditions than to move mountains, so this area compensates that fact with good overall accessibility values to the ski centers that are more far from it. Unfortunately this area also doesn't contain public transportation to all the ski centers.

8.1.4 Area 4

The situation on this area is the worst of all cases (keep in mind that the arrows in the image are relative to the others arrows in that area), so just by a first glance at the picture is possible to understand that all the accessibility values are not very good. Also it doesn't contain public transports connections to all the ski centers, which aggravates even more the situation on this area.

8.1.5 General picture

The general picture of accessibility to ski centers in this tree counties is between average and good. The accessibility value tends to be better in the urban areas, which can be explained by the fact that in average persons living in urban areas tend to have a better wage then the ones in rural environments, and also because the urban municipies tend to spend more money enhancing the accessibility's to their own city, but this of course also improves the accessibility to outside of the city. All this areas have problems with public transportation, maybe this problems are not entirely true, because of the small amount of data in this analysis, probably companies in other surrounding counties have public transport to those locations, but the objective given to this project only contained the three counties presented previously.

So as a solution to improve general accessibility it's proposed to enhance the public transports, bus, and to improve the roads Third class routes because as its possible to see they represent the biggest bottleneck in the roads infrastructure, this is seen in the accessibility values to the nearest ski centers of the areas selected in this study.

8.2 Swimming pools

The results of this analysis are available in the appendix. See figure *Swimming pools analysis* and related values tables.

8.2.1 Area 1

The situation in this area for swimming pools its bad. Despite of the good connections to swimming pools in the neighbours counties, it's possible to say that generally no one wants cross counties just to frequent a swimming pool. On the other hand, and taking in consideration the average accessibility of this area, it's possible to recognize a not so bad accessibility, which lead us to the point that an analysis has to be done taking all aspects in consideration, and not only the most obvious. Other reason for the not so good accessibility in this area is the lack of public transportation to one of its settlements.

8.2.2 Area 2

The case in this area is unusual, since it shows that it has a really bad accessibility to the swimming pool of its area, yet good connections to more far places. Once again, the time spent to travel too much to go to a place like a swimming pool will probably tell that this area has also a bad accessibility to swimming pools, even if it has a good ratio between distance and time.

8.2.3 Area 3

One of the best areas with connections to this kinds of *Entertainment* places, with a large number of swimming pools near, including one inside its area, and with good accessibility rates. There is a *concentration* of this kinds of places near this area, which is the main reason for this results. However, there is still a place without public transportation. In conclusion this is a good example of good accessibility where there are more than one choice with low costs in terms of distance and time.

8.2.4 Area 4

The fourth area to be analysed is similar to the third, not just because their location is near each other, but also because the called *swimming pool concentration* is situated approximately between both. Is possible to analyse that some of the results are even better than in the previous one, the problem with it is that is has no public transportation at all. However if it is a situation possible to solve quite easily in the previous case, it's not possible to say the same about this one. It requires infrastructures to cover all that area, and not only a part of it.

8.2.5 General picture

The overall picture of accessibility to swimming pools is not so good as it could. First of all there is a concentration of them in an area, what improves the accessibility in some areas, but makes it worse in other areas. One of other problem with it is the transportation network. The private transportation is not good in some cases, because is not possible to travel fast enough even if it for short distances, for example, to travel to the nearest swimming pool near the second area, the accessibility rate is very low, compared to cases where is possible to travel faster, but a too long distance. On the other hand public transportation is far to be perfect, existing some cases where they are inexistent or inefficient.

One of the proposed solutions to improve this situation is to invest some funds improving the transportation networks, as suggested in the *Ski centers* case. Other solution to solve this situation is to attract investment to this kind of entertainment places, making it more accessible.

9 Future Development

During the course of the project several new ideas were discussed by the team, some of them were implemented some, but some were left out, mainly because of the time restrictions, and the limited number of persons involved in the project.

9.1 Application

- Usability Aspects
  - Enhance error handling,provide better information to the end user, and implement a log system to store the errors.
  - Enhance user friendliness, the graphical interface and the console usage of the core to allow simpler and faster utilization of the system.
  - Enhance the presentation of the results, to allow better visual interpretation of the results.
- Implement new Features
  - Create a editor/viewer of shapefiles information integrated with the system.
  - Implement Socket based Communication Module.
  - Implement export functionality for the results in several formats.
  - Implement methods to store all the information in shapefiles, instead of only the usage of roads.
- Analysis Generalization
  - Generalize Model, instead of allowing only the editing of the model values, implement a interpreter for model defined in some format, for example in XML.

9.2 Model

- Introduce new Variables in the model, this means to make the model more complete that it's actual state.
- Improve path finder
  - Instead of using always the shortest path, thy to use another type of algorithm that make uses more effectively the road capacity.
- Improve the support for traffic jams, using the capacity by road and not by type of road.
- Study other type of final results, instead of using speed try to find others ways to calculate the accessibility.

- For this particular study, enhance the quality of the data collected.
- Introduce the support for the different hours of the day, this would be useful to improve the traffic jam simulator and to improve the public transports, allowing the different hours of the day.

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A Maps with important results and respective tables

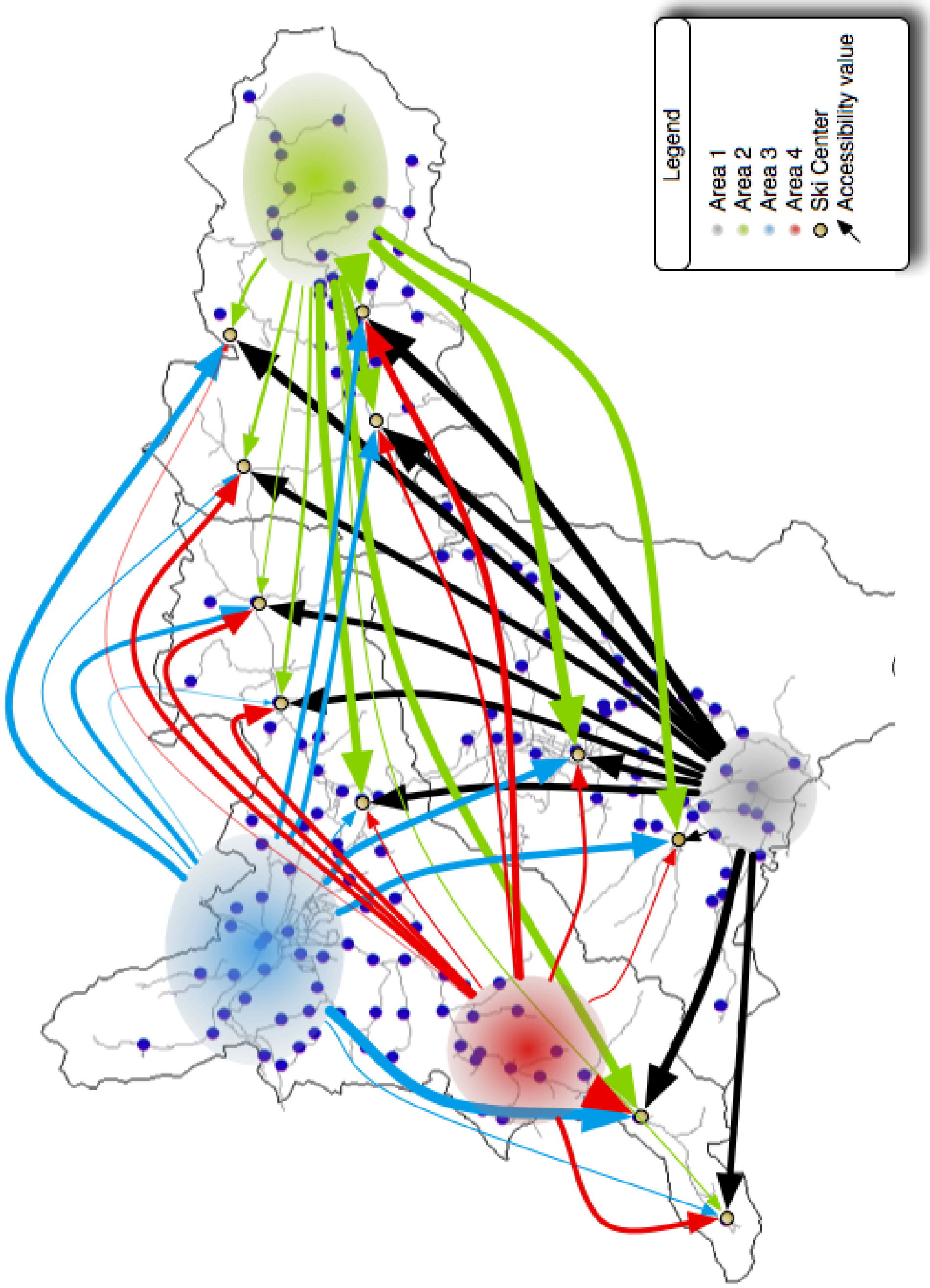

Figure 1: Ski centers analysis

Ski Center	Average Accessibility
Bela	62.4
Cicmany	72.87
Dolny kubin	78.04
Kubinska hola	70.2
Fackov	74.57
Martin	63.72
Parnica	79.83
Strecno	58.65
Terchova	59.89
Valca	28.04
Zazriva	64.84

Table 4: Ski centers analysis, area 1 results

Ski Center	Average Accessibility
Bela	48.24
Cicmany	71.85
Dolny kubin	71.47
Kubinska hola	54.72
Fackov	72.94
Martin	79.41
Parnica	70.68
Strecno	71.87
Terchova	39.19
Valca	70.77
Zazriva	54.68

Table 5: Ski centers analysis, area 2 results

Ski Center	Average Accessibility
Bela	29.46
Cicmany	72.54
Dolny kubin	57.22
Kubinska hola	64.78
Fackov	75.91
Martin	63.25
Parnica	54.62
Strecno	37.85
Terchova	57.69
Valca	61.11
Zazriva	40.48

Table 6: Ski centers analysis, area 3 results

Ski Center	Average Accessibility
Bela	71.12
Cicmany	72.96
Dolny kubin	71.31
Kubinska hola	67.26
Fackov	74.14
Martin	69.84
Parnica	70.73
Strecno	68.48
Terchova	70.98
Valca	70.7
Zazriva	70.66

Table 7: Ski centers analysis, area 4 results

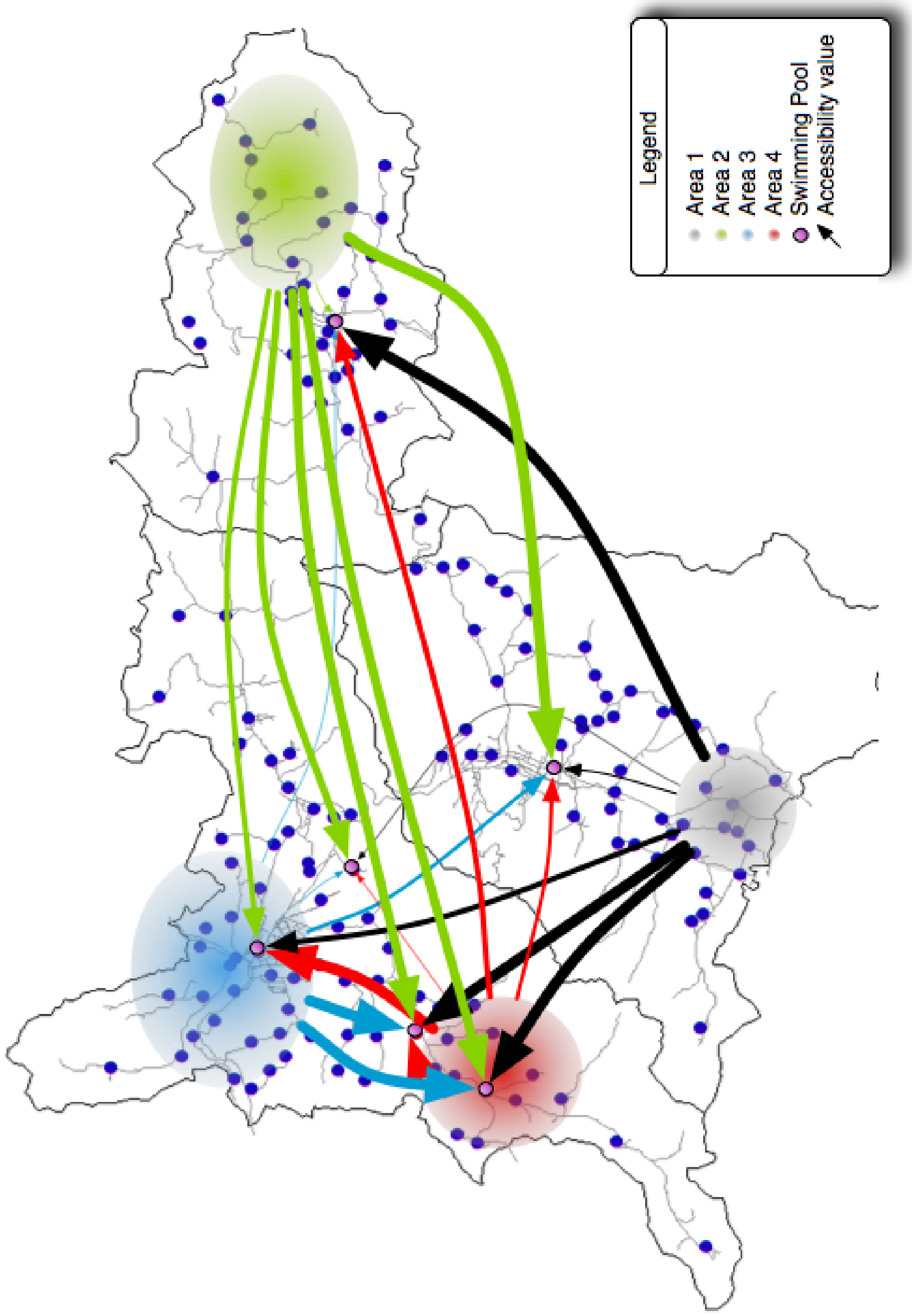

Figure 2: Swimming pools analysis

Cinemas	Average Accessibility
Dolny Kubin	78.04
Martin	63.72*
Rajec	73.77*
Rajecke Teplice	73.06
Stranavy	55.1
Zilina	60.82

Table 8: Swimming pools analysis, area 1 results

Cinemas	Average Accessibility
Dolny Kubin	60.72
Martin	68.01
Rajec	61.88
Rajecke Teplice	61.38
Stranavy	58.41
Zilina	55.08

Table 9: Swimming pools analysis, area 2 results

Cinemas	Average Accessibility
Dolny Kubin	57.22
Martin	63.25
Rajec	74.82
Rajecke Teplice	73.63
Stranavy	36.72
Zilina	19.01

Table 10: Swimming pools analysis, area 3 results

Cinemas	Average Accessibility
Dolny Kubin	71.31
Martin	69.84
Rajec	73.23
Rajecke Teplice	73.44
Stranavy	66.82
Zilina	74.49

Table 11: Swimming pools analysis, area 4 results

B General figures and tables

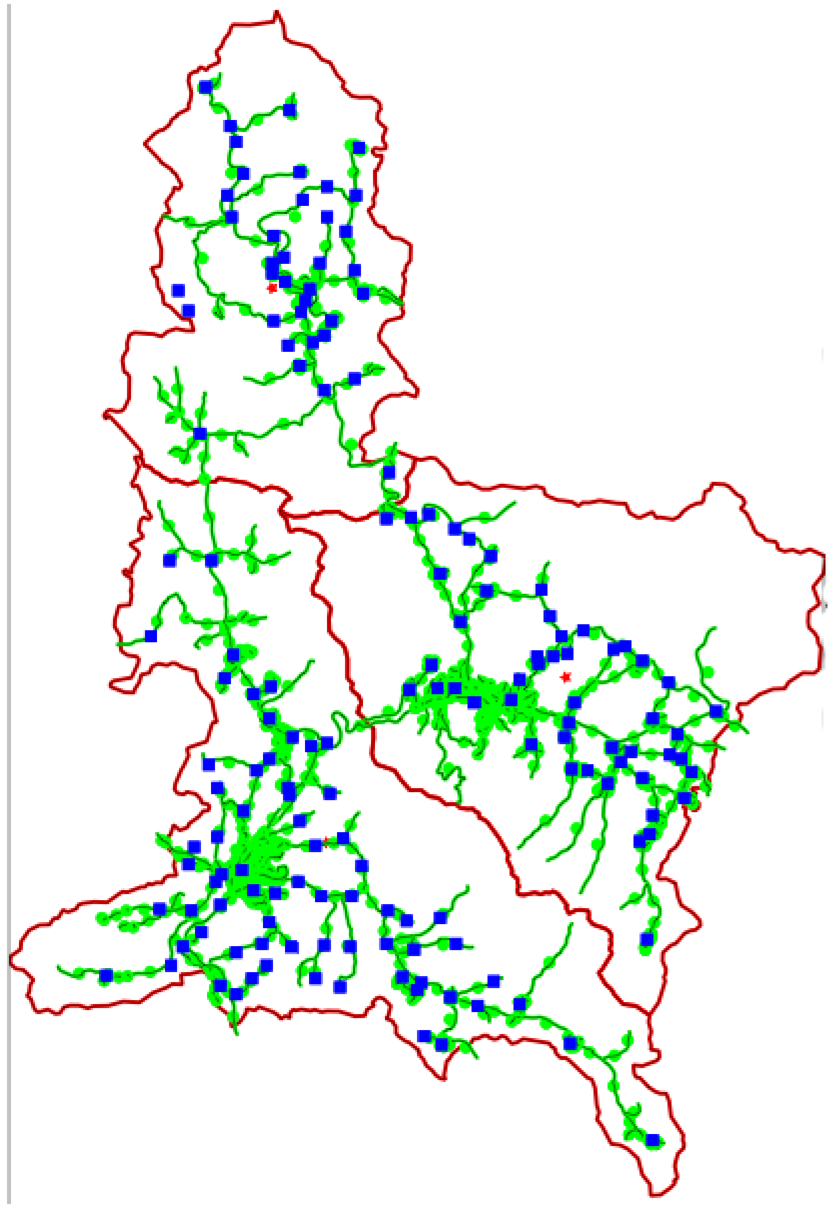

Figure 3: Territory map

503410 Dolný Kubín-Medzibrodie nad Oravou-Pucov-Pokryváč

Prepravu zabezpečuje: SAD Liptovský Mikuláš a.s., Bystrická cesta 62, 034 01 Ružomberok, prevádzka Dolný Kubín, tc

km				TČ				1		37	5		3	9		11		17	19
													✱						
			0	1	od	Dolný Kubín,,Matúškova	…	✱	…	✱	…	…	[illegible]	…	…	…	…	…	…
0	0		⟆	2		Dolný Kubín,,OÚ	…	[illegible]	…	[illegible]	⑥†	…	6 05	✱	…	✱	…	✱	…
1	⟆		1	3		Dolný Kubín,,Alej slobody	…	5 40	…	6 00	6 05	…	⟆	[illegible]	…	8 00	…	12 10	…
2	1		2	4		Dolný Kubín,,Žel.st.	…	5 42	…	6 03	6 07	…	6 08	7 00	…	8 02	…	12 12	…
3	2		3	5		Dolný Kubín,,SEZ	…	5 43	…	6 04	6 08	…	6 09	|	…	8 03	…	12 14	✱
4	3		4	6		Dolný Kubín,,SAD	…	5 44	…	6 05	6 09	…	6 10	7 03	…	8 05	…	12 16	[illegible]
⟆	⟆	0	⟆	7		Dolný Kubín,Kňazia,ZŠ	…	⟆	…	⟆	⟆	…	⟆	⟆	…	⟆	…	⟆	13 25
5	4	4	5	8		Dolný Kubín,Mokraď,rázc.	…	5 46	…	6 07	6 11	…	6 13	|	…	8 06	…	12 19	13 27
6	5	5	6	9		Bziny,,žel.zast.	…	5 48	…	6 10	6 14	…	6 14	|	…	8 09	…	12 23	13 28
8	⟆	7	8	10		Medzibrodie n.Oravou,,pri moste	…	5 51	…	6 13	6 16	…	⟆	|	…	8 12	…	12 29	13 31
9	⟆	8	9	11		Medzibrodie n.Oravou,,žel.st.rázc.	…	5 53	…	6 15	6 20	…	⟆	|	…	8 15	…	12 31	13 33
⟆	8	⟆	⟆	12		Medzibrodie n.Oravou,,Žel.st.	…	⟆	…	⟆	⟆	…	6 18	⟆	…	⟆	…	⟆	⟆
10	9	9	10	13		Medzibrodie n.Oravou,,Pod Benkovom	…	5 54	…	6 18	6 21	…	6 20	|	…	8 17	…	12 32	13 35
12	11	11	12	14		Pucov,,Jaseník	…	5 56	…	6 19	6 22	…	|	|	…	8 19	…	12 36	13 37
13	12	12	13	15		Pucov,,mlyn	…	5 58	…	6 20	6 25	…	6 22	7 15	…	8 21	…	12 37	13 39
14	13	13	14	16		Pucov,,OcÚ	…	6 00	…	6 22	6 25	…	6 24	7 16	…	8 23	…	12 39	13 41
14	13	13	14	17		Pucov,,Rokytník	…	6 01	…	6 23	6 26	…	6 25	|	…	8 24	…	12 41	13 42
15	14	14	15	18		Pucov,,RD	…	6 02	…	6 24	6 28	…	6 26	|	…	8 26	…	12 43	13 43
16	15	15	16	19		Pokryváč,,Tichaň	…	6 04	…	6 27	6 31	…	6 28	|	…	8 28	…	12 45	13 44
16	15	15	16	20	pr	Pokryváč,,pri moste	…	6 06	…	6 30	6 30	…	6 30	7 20	…	8 30	…	12 50	13 45

Figure 4: BUS schedules

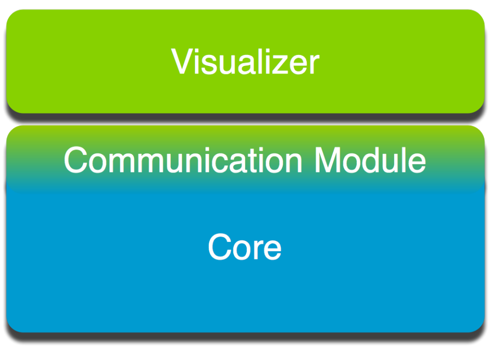

Figure 5: Logic architecture

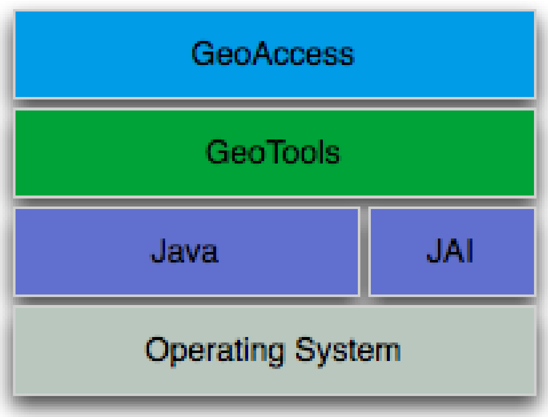

Figure 6: Environment

C Team and responsibilities

The team is composed by 4 elements:

- Michal Bors : Responsible for the collection of data.
- Pedro Maurício Costa : Responsible by the general management of the Project.
- Tiago Reis : Responsible by the technical management of the project.
- Vladimír Dobos : Responsible for the implementation of the project.

The responsability does't implie that it was the person only task, mainly all team members were involved in various parts of the project.

D GANTT chart

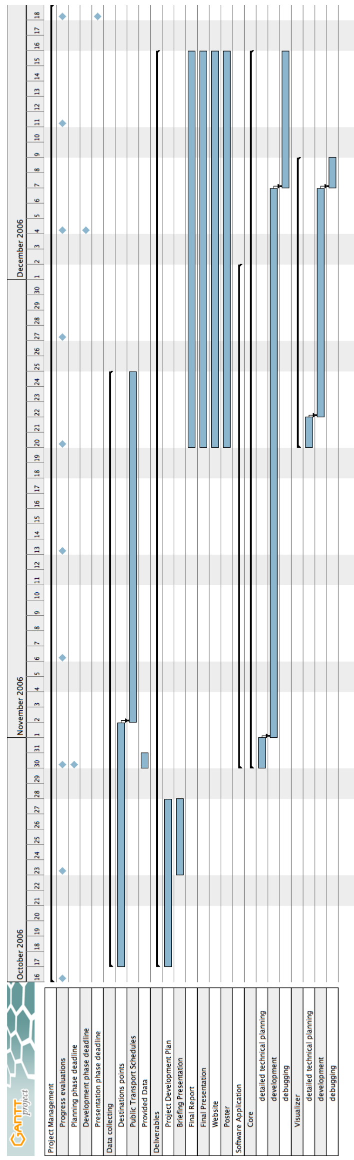

Figure 7: GANTT chart

E Presentation of project

Project website:

- http://gisampro.sourceforge.net

Presentation Poster:

- http://gisampro.sourceforge.net/files/poster_a3.jpg

Briefing Presentation of the project

- http://gisampro.sourceforge.net/files/briefing_presentation.pdf

Final Presentation of the project in slides:

- http://gisampro.sourceforge.net/files/final_presentation.pdf

Original Project development plan:

- http://gisampro.sourceforge.net/files/project_development_plan.pdf