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DESIGN, DEVELOPMENT AND TESTING OF A SYSTEM THAT REFLECTS THE EVOLUTION OF THE COASTLINE - CASE STUDY LALZI BAY, ALBANIA

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Abstract. The study of the coastal area constitutes one of the basic scientific problems in all countries of the world, who have direct contact with the sea. Considering that the coastal area represents a complex natural and socio-economic environment, where processes are continuous and dynamic, rational decisions about the uses of resources need to be made. These decisions should be based on scientific studies that require long amount of time, endurance and fatigue. Our goal as geoinformatics engineers is to reduce the factors that affect the progress of these studies. For this purpose we will have to define the problems a researcher encounters in these kinds of studies, such as: the long amount of time needed for carrying out the study, the difficulty in image georeferencing, the need for a central database and the implementation of analytical formulas for concerned analysis.

Keywords: Coastline Evolution, Geographic coordinates conversion, Programming, Server-Client Architecture.

Rezumat. Proiectarea, dezvoltarea si testarea unui sistem care reflectă evoluția liniei de coastă - Studiu de caz golful Lalzi, Albania. Studiul zonei de coastă constituie una dintre problemele ştiințifice fundamentale din toate țările lumii care au contact direct cu marea. Având în vedere că zona costieră reprezintă un mediu natural şi socio-economic complex, unde procesele sunt continue şi dinamice, trebuie luate decizii raționale cu privire la utilizarea resurselor. Aceste decizii ar trebui să se bazeze pe studii ştiințifice care necesită mult timp, rezistență şi oboseală. Scopul nostru ca inginer geoinformatician este de a reduce factorii care afectează progresul acestor studii. În acest scop, va trebui să definim problemele pe care un cercetător le întâlneşte în astfel de studii, cum ar fi: timpul necesar pentru realizarea studiului, dificultatea în georeferențierea imaginii, necesitatea unei baze de date centrale şi implementarea formulelor analitice pentru analiza în cauză.

Cuvinte cheie: Evoluția coastei, conversia coordonatelor geografice, programare, arhitectura server-client.

INTRODUCTION

After we have determined the problems, we will perform an overview of the current solution where we will explain their positive and negative sides. By "solution" we understand the existing system which may serve to study the coastline dynamics. We will introduce our solution and perform a confrontation with the current solutions where we explain the reasons why the system that we propose may be the most appropriate for studying the coastline evolution. After that we will make a presentation of the system construction where we will support the use of a client-server structure and we will explain the reason why we chose to use this type of structure.

To conclude we will perform various tests to evaluate the achievements where, as a case of study we picked the Lalzi Bay area, then we will submit a draft of conclusions and introduce further developments and modifications that are needed to fully complete the system.

MATERIAL AND METHODS

One of the first problems posed is the conversion of coordinates from one system to another. After the conversion is performed, the problem of georeferencing the map with the study area arises. This kind of problem in itself contains another problem which occurs when the researcher doesn't have sufficient knowledge of georeferencing the image with a software. In this kind of situation a third party is included in the process. This new player does the georeferencing and carried out the coordinates laying. The involvement of the third party increase the studies cost.

Another problem shows up when the researcher obtains the map, now he should define the changes that the coast line has undergone. A particular problem arises when the researcher must make comparisons between different data. In this case, a database it is very necessary. The lack of a database complicates and delays the analytical processes that characterize the study.

The major problem is the lack of primary data and historical data. In order to possess the first type of data the researcher must go to the field and acquire the ones with a GPS which is long and tiring process. The second type of data can be retrieved from old maps - this process is boring and takes a long time.

In summary, the problems that must be solved are: converting coordinates, avoiding third party involvement, using analytical algorithms to help with the analysis, provide a database and create facilities in obtaining data. The main goal is the automation of study processes for saving researchers time, money and effort.

The best current solutions to study coastline dynamics are: ArcGIS, QGIS and AutoCAD. ArcGIS is a comprehensive system that allows people to collect, organize, manage, analyze, communicate, and distribute geographic information. AutoCAD is a programme used to create high-precision drawings or technical illustrations. This type of programme can be used to create 2D or 3D models.

The difference between these two software programmes is that ArcGIS is a programme that works with a database while AutoCAD is more a graphic program. In AutoCAD, lines are much more important than in ArcGIS where lines are just a representation of the data.

Even though these programs are quite powerful and helpful for researchers, they are not at all easy to use and cost too much. In this situation, the researcher faces two sources of dissatisfaction: the involvement of third parties in research and high costs for conducting the study.

On the other hand, QGIS is an open source solution that supports most of the GIS features and spatially graphical rapresentation of the geographical problems. Although the QGIS system offers a number of tools for coastline evolution, this system is deficient from the point of view of the unification of geographical coordinates expressed in different systems such as Gauss-Krueger, UTM, Geographic and Geodecimal. Another problem observed in QGIS is the fact that the QGIS Server system does not offer any graphical interface and no control over the data that a system user can launch for the seaside coast line. Also QGIS Server has no control on the user rights over the system itself.

The solution we propose is a programme which uses the client-server architecture. A programme that uses this type of architecture is built in such a way that the database is placed in a central computer known as a server and can be used by many users. In this case users use an application that is installed locally on a personal computer. This application is known as a client and connects to the server through the network. The client is used to display the results to the user, it requests information from the server. To deal with multiple users the server use multithread. When the server received a request it connect to the database retrieve the information needed and pass those to the client.

The proposed programme will have the ability to convert coordinates and storing them in two forms of coordinates initial and final. The map will be georeferenced and the coast line will appear automatically with just one click. If the users will need to add new coordinates, they will have the opportunity to choose between 4 coordinative systems: Geographic, UTM, Gauss-Krueger and Geodecimal. UTM is used as a based system for the programme. The reasons why this system was chosen are:

- It presents little deformation and provides normal constant interactions distance across the map.
- The coordinates are expressed in meters.
- It is used in many countries of the world.
- There is no need to use fake north and east because negative values aren't present

The analysis of the coast line dynamics will be done using analytical algorithms that will enable researchers take results in a short time and in a simple way. The users of this programme will have the opportunity to extract coordinates directly from the system and save them into the database.

As shown in Fig. 1 the steps to get the server up and running are as below :

1. Create a server socket
2. Name the socket
3. Prepare the socket to listen
4. Wait for a request to connect, a new client socket is create here.
5. Read data sent from client
6. Close client socket.
7. Loop back
8. Close server if problem

```
      socket( )
      bind( )
+---->listen( )
|     accept( )
|     (block until connection from client )
|     read( )
|     write( )
+-----close( )
      close( )
```

Figure 1. Socket server flow.

By following the steps above we can create a simple server that manages a customer for time. In my case the server is not sufficient because we want the server to offer the possibility of managing more than one client at the same time. To attain it this server must use multithreading.

Multithreading is the ability of a programme or an operating system process to manage its use by more than one user at a time and to even manage multiple requests by the same user without having to have multiple copies of the programming running in the computer.

As a relational database management system we choose to use MySQL for this reason:

1. Scalability and Flexibility
2. High Performance
3. High Availability
4. Strong Data Protection

5. Open Source Freedom and 24 x 7 Support

The database will be created based on the model rapresented in Fig. 2.

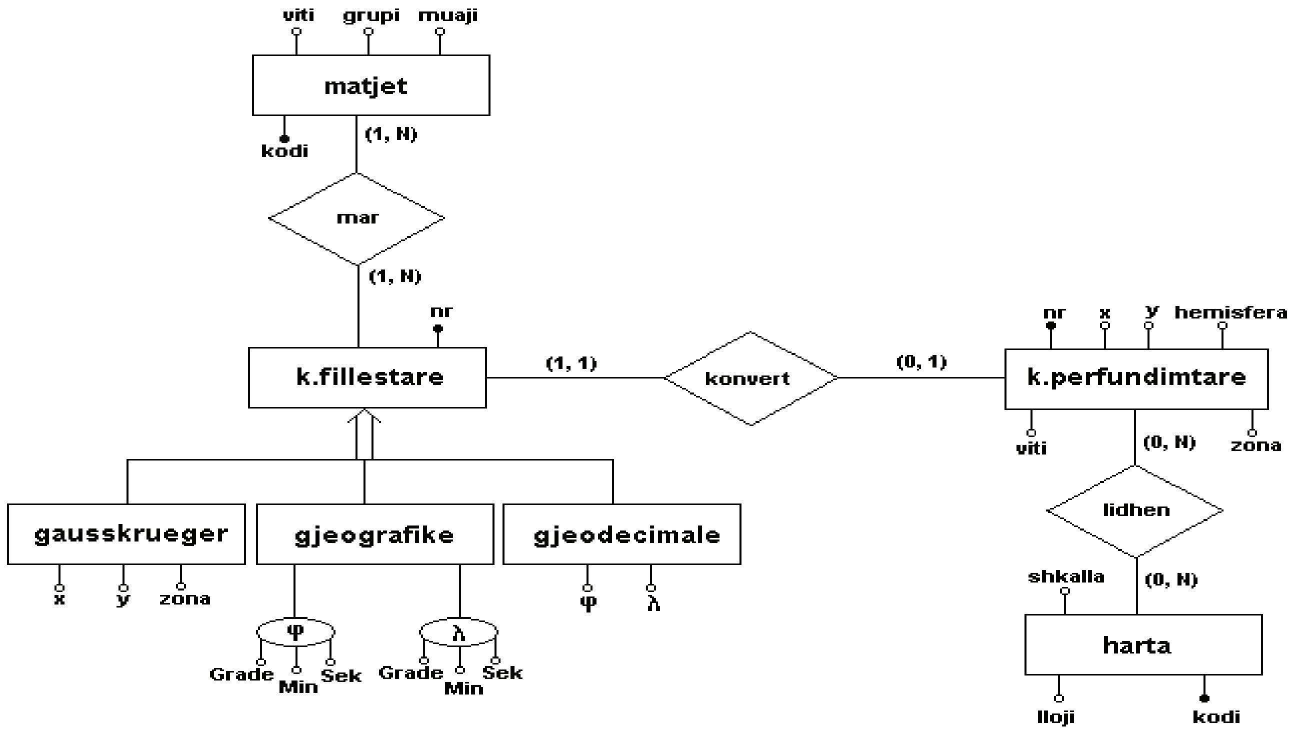

Figure 2. Entity-Relationship model.

In order to communicate with the server the client needs this steps:

1. Create a socket with the server IP address.
2. Connect to the server, this step also names the socket.
3. Send data to the server.
4. Read data returned back from the server.
5. Close the socket.

The methods that make possible the comunication of the client with the server are rapresented in Fig. 3.

```
socket( )
connect( )
write( )
read( )
close( )
```

Figure 3. Socket client flow.

Communication channels are used to create a connection between the client and the server are used, they are network protocols such as: NetBIOS, RPC (Remote Procedure Call), DCOM, Pipe, IPC (Inter - Communication process, etc.). But in this case we will only use TCP / IP and IPv4 in particular because it is the current version and is supported by more modern networks.

To build the graphical user interface we decided to use wxWidget because:

- It gives a nice look and feel to the application.
- It is very complete. There are many utility classes like: wxRegEx, wxFTP, wxSplashScreen, wxZipInputStream, etc.
- Many compilers and platforms are supported: Windows, Linux, Mac, Unix.
- It's free for personal and commercial use, and is more flexible than the LGPL license.
- It can be supported by different platforms like: Windows, Linux, Mac.
- A lot of ready to use classes are available.

We choose to use the client-server structure because offers the following advantages:

- Any given information is stored in a central system all users can work with. This way of storing data gives user the option to use other data that has been extracted from another user, thus resulting in a

reduction of working time.
- Maintenance is simplified because data is focused on a central server.
- The cost of the physical parts of the computer is minimized because the data is not stored on the client.

When the data are sent to the server, a client window appears to ensures that the data was successfully sent.

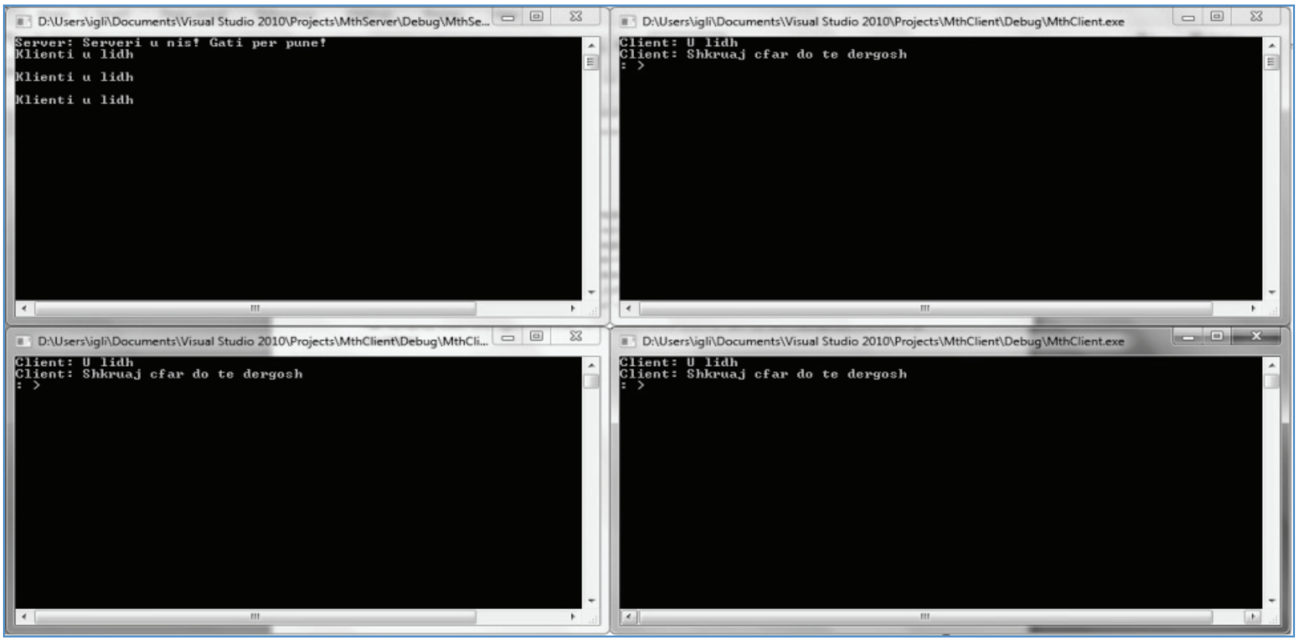

Figure 4. Opening socket connection and wating for client request.

As shown in Fig. 4 the server is wating for a client connection. In the moment that a client is connected, the server creates some welcome message and notifies the client that it is waiting for orders from him.

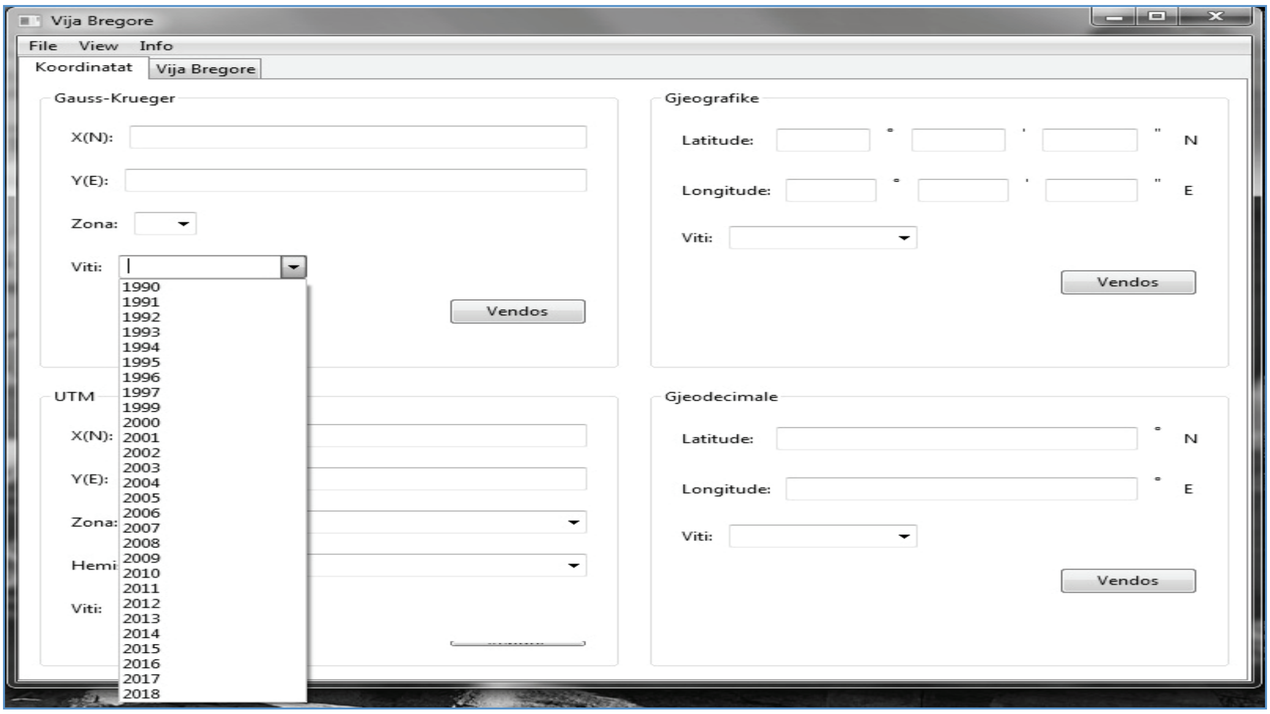

Figure 5. Sending data from the client.

An example is shown in Fig. 5 of how the client throws the GUI (Graphical User Interface) sends messages to the server.

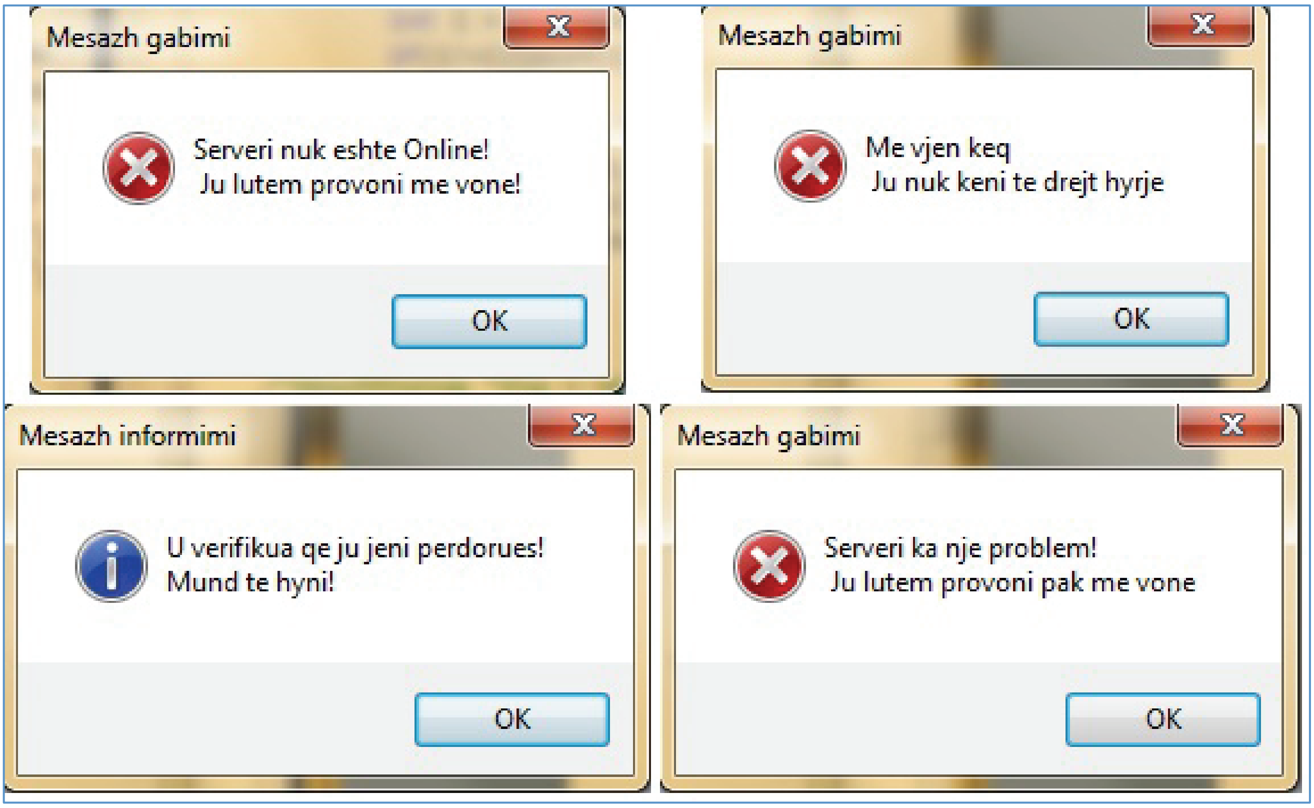

Figure 6. Possible answer from the server throught socket.

On the other hand, the server sends information messages, through the sockets, which are displayed in the client as shown in the Fig. 6.

RESULTS

In order to carry out system testing, some measurements of the litoral line in the Gulf of Lalzi were carried out over a number of years. It should be mentioned that the coordinates placed in the system had different coordinating systems each year. The measurements that were made refer to the years: 1867, 1939, 1984, 1990, 2002, 2003, 2005 and 2014.

When a year is chosen from the column the coast line corresponding to that year will be automatically created. In this case we have chosen two years to carry out system testing and analyse the coastline evolution over the years.

As shown in Fig. 7, when the user selects two years of collected data, the system will build a blue line that represents the year 1984 and a yellow line that represents the year 1990. The system uses diferent colours to represent the coast line of each year. This way, the user has a clear idea of the evolution of the coast line as represented in Fig. 8.

The system that we propose has in the first place a high level of usability since the coordinates a user can place are in different coordinating systems and is the server that unifies all these coordinates in a unique coordinate system. The proposed graphics interface is very simple as it consists of only two panels: a panel where the user puts the data and a panel where the results are graphically visualized. Both of these panels are managed by the server according to the rights a user has. The presentation of the results is graphical where the user has the ability to perform visual analysis of the coastline shift in two or more years. For each year the system provides a different color of the coastline.

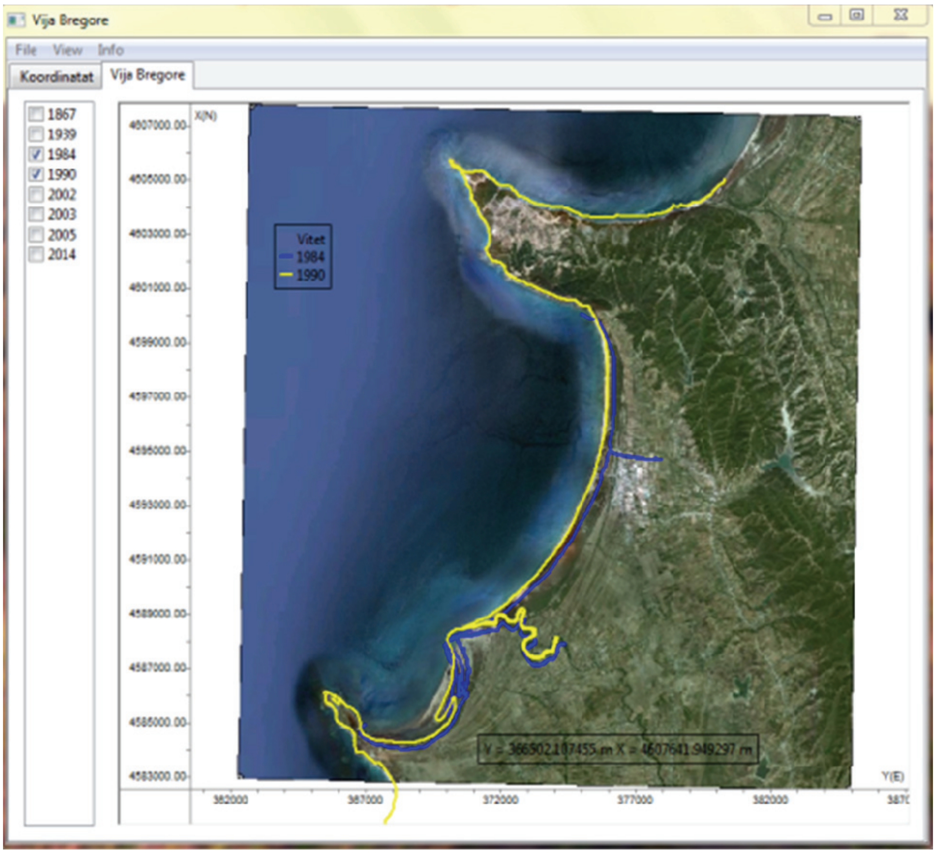

Figure 7. Choosing the years to build the coastline.

Figure 8. Image produced from the system with two coast lines, 1984 the blue and 1990 the yellow.

CONCLUSIONS

After a long work a functional programme is created. It is based on a central database, provides information protection and gives the possibility to use it at any time and moment. The possibility to convert coordinates with minimal error allows researchers to save time and gain highest security in studies.

The creation of the coast line in a simple and quick way, as well as the presence of a georeferenced environment for the Lalzi Bay Area helps researchers save up time, money and avoid third party involvement in studies. The construction of the graphical interface in a simple way makes it accessible and usable by persons who do not have high informatics knowledge. Preservation of data in a central system all users can work with helps different researchers to have information without necessarily going on the field.

The use of UTM as a basic coordinative system shows little deformations and provides normal distance interactions across the map, the use of fake north and east is not needed in this projection because negative values aren't present. Despite the good results achieved by the system, modifications will still be needed to achieve perfection.

In the current situation we recommend some improvement of the system. The new developments that are expected to be added to the software are:

- The involvement of analytical algorithms in the system which will allow carrying out the analysis of the dynamics of the coast line.
- The ability to add other maps and the ability to georeference them in a simple and understandable manner.
- The ability to create lines and to store data in the system, thus reducing the time of extracting coordinates from old maps.
- Improved client / server architecture, bringing a better data transmission.

REFERENCES

SEVERANCE CH. 2015. *Introduction to Networking.* Creative Commons Attribution-NonCommercial 4.0 International License. 119 pp.

JONES A. 2002. *Network Programming for Microsoft.* Microsoft Press. Redmond. 712 pp.

MORIN R. CH. 2002. *C++ And Threads.* KBCaffe. http://bitcnc.com/sabertecnico/Programacao/Advanced/HowTo.Thread.pdf. 7 pp. Accessed January 12, 2018.

SMART J. & HOCK K. 2006. *Cross-Platform GUI Programming with wxWidgets.* Prentice Hall PTR. Upper Saddle River. 744 pp.

DEAKIN R. E., HUNTER M. N., KARNEY C. F. F. 2010. *The Gauss–Kruger Projection*. Proceedings of the Victorian Regional Survey Conference, Warrnambool. 10-12 September, 2010. 20 pp.

BUGAYEVSKIY L. M. & SNYDER J. P. 1995. *Projections: A reference manual*. Taylor & Francis. Rutledge. 428 pp.

LI S., ZHANG L., CUI Y., YIN X. 2003. *Relationship and applications of utm projection and Gauss-Kruger projection*. Proceedings of the 21st International Cartographic Conference (ICC). Durban, South Africa, 10 -16 August, 2003: 1153-1157.

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