

Computerization of analogue data of earthquakes in Albania

Ariana BEJLERI¹, Flutura HAFIZI², Shpresa SHUBLEKA³

¹ Polytechnic University of Tirana, Faculty of Information Technology, Computer Engineering Department, Tirana, Albania, arianabejleri@yahoo.com.

² Polytechnic University of Tirana, Faculty of Geology and Mining, Earth Science Department, Tirana, Albania, hflutura@yahoo.com

³ Polytechnic University of Tirana, Faculty of Information Technology, Computer Engineering Department, Tirana, Albania, shubleka@yahoo.com

ABSTRACT

This paper deals with computerization of the analogue data on the seismicity in Albania by developing a database. Since ancient time Albania has been permanently affected by earthquakes, even though their magnitude has not been maximal. Albania is considered to be in the group of European countries with higher number of earthquakes per time unit. The release of the earthquake energy has mostly happened through micro-earthquakes ($M < 3.0$), weak earthquakes ($3.0 < M < 5.5$) and the ones of middle magnitude ($5.5 < M < 7.0$). Earthquakes with a magnitude of 7.0 have been very rare, the intensity at the epicentre being 10. The seismic hazard can be determined by applying both deterministic and probabilistic methods. This paper deals with the probabilistic method which uses the statistical distribution in a region based on the earthquakes having occurred in the past. Such a method provides evaluations of probabilities for various intensity levels. The database to be prepared will serve to digitize the parameters that describe the seismic activity in Albania. It will use the existing material which has been recorded by the analogue seismological network of Albania. The information which accompanies the earthquakes includes, date and exact time, geographic coordinates, depth to the focus/hypocenter, magnitude (Richter), intensity and epicentre. The database allows the data to be edited and searching in accordance with the user's needs. It will determine the earthquake characteristics for a certain administrative unit, characteristics according to the magnitude, classifying them as micro-earthquakes, weak and mid-intensity ones, or according to coordinates, focus depth, intensity etc. The database will be accompanied with reports which will reflect the seismicity for the entire Albania for a certain period of time, the earthquake distribution according to the magnitude, the earthquake frequency graphs etc. It will also serve as a basis for additional new information and its linkage with other software of the system. This database will contribute to have a better judgment on the seismic activity in Albania and expectations on future events.

Keywords: Earthquake, analogue data, computerization, magnitude, intensity, epicentre, seismic activity.

INTRODUCTION

The aim of this study is to digitalize the analogue information about earthquakes in Albania. Albania is divided in many Areas. These areas lie in different seismic belts in Albania [2, 3]. Our country has undergone several serious earthquakes over a period of several years. This is the reason why we have undertaken this study. A great deal of analogue seismic information in this area has been collected over years by the seismological network in Albania [1, 4].

The digitalization of all this abundant information allows us to proceed in two main directions: *first*, to understand the seismic activity for this region of Balkan, and, *second*, to assist in evaluating the expectation of eventual future seismic activity in this region.

This information consist in the: Event number, Date, Exact Time, Event Latitude, Event Longitude, Depth, Magnitude ML (Richter), Intensity (Ball), Epicentre, Area, Belts in which this Area lies [1, 4]. With this program the users can make an infinite number of searches and this data searched can also be viewed in graphical view in order to understand better the seismic situation. This program is very useful because it can be used for every Area in Albania.

Analyzing the database

We have analyzed the problem to be solved [6]. We have built the algorithm. We have determined which data must be digitalized and how they are related to each other. This program will be used by different users. So we planned a simple way to add and edit all this abundant data. We have also designed the form of the Search in order that users can search every data they need without any limit. We concluded that the best way was to include all the data in an infinite number of searches and to present them in a graphical view also.

Construction of the database

Design of tables and their relationships

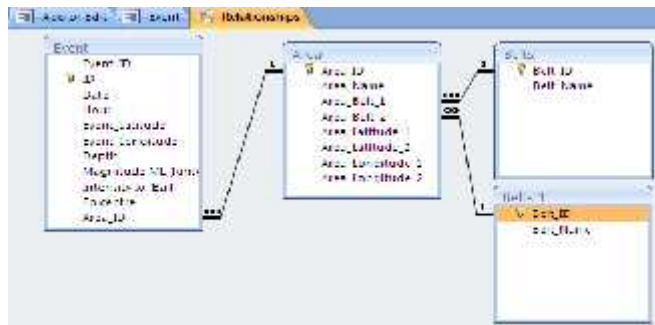


Figure 1 Relationship of the tables

We have designed four tables which contain all the data needed. These tables are related between them with one to many relationships (Figure 1). The basic table is the Event table, which contains all the information about the events in the Albania. One of this information, the Area_Id is related with the Area_Id in the table Area with a one to many relationship. So one Area_Id can be found many times in the Event table, because many events occur in one area. The table Area contains all the information about different Areas in Albania. This table contains also information about the belts in which this Areas lie. We have tables Belts and Belts_1. These are related with one to many relationship.

Design of queries



Figure 2 Queries

We have built many queries [5] (Figure 2). A lot of them are in SQL language [7].

First of all, we have built a query which gives us which Areas lie in two given Belts (Figure 3). This is done by using where condition with different operators such as And and Or. So if we give two belts, we find all areas that permeated by these two belts.

We have also built a query which gives us which Areas lie in one given Belt. In another search we find in which belts lies a given area. These are done by using the same operators such as And and Or.




Figure 3 Search Area by Belts

Then we design every data the user wants. One of these queries is the query Search Event (Figure 4). This query searches all

the events information occurred in a given date interval, latitude interval, longitude interval, depth interval, magnitude MI (Richter) interval and Intensity (Ball) interval. These data are ordered by date, then by hour and finally by ID.

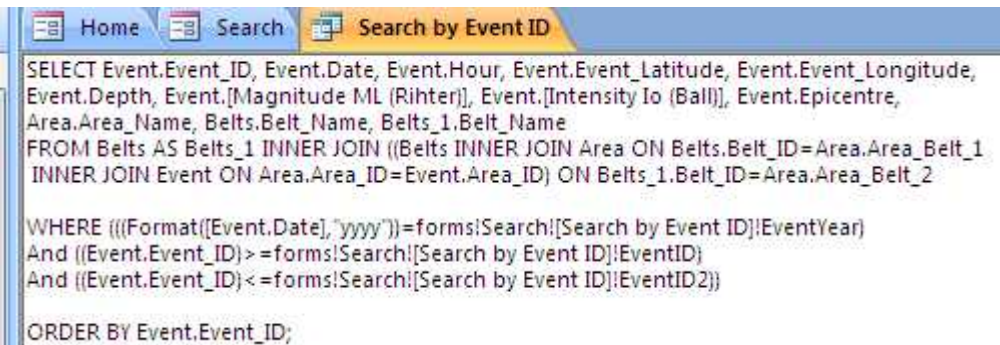
Another’s queries are the Search by two Belts , Search by One Belt, Search by Area and Search by Epicentre. Also in these queries data are ordered by date, then by hour and finally by ID



```
SELECT Event.Event_ID, Event.Date, Event.Hour, Event.Event_Latitude, Event.Event_Longitude,
Event.Depth, Event.[Magnitude MI (Richter)], Event.[Intensity Io (Ball)], Event.Epicentre,
Area.Area_Name, Belts.Belt_Name, Belts_1.Belt_Name
FROM Belts AS Belts_1 INNER JOIN ((Belts INNER JOIN Area ON Belts.Belt_ID=Area.Area_Belt_1
INNER JOIN Event ON Area.Area_ID=Event.Area_ID) ON Belts_1.Belt_ID=Area.Area_Belt_2
WHERE ((Event.Date)>=forms!Search!YearBelt) And ((Event.Date)<=forms!Search!YearBelt)
And ((Event.Event_Latitude)>=forms!Search!LatBelt) And ((Event.Event_Latitude)<=forms!Search!LatBelt)
And ((Event.Event_Longitude)>=forms!Search!LongBelt) And ((Event.Event_Longitude)<=forms!Search!LongBelt)
And ((Event.Depth)>=forms!Search!DepthBelt) And ((Event.Depth)<=forms!Search!DepthBelt)
And ((Event.[Magnitude MI (Richter)])>=forms!Search!MIBelt) And ((Event.[Magnitude MI (Richter)])<=forms!Search!MIBelt)
And ((Event.[Intensity Io (Ball)])>=forms!Search!Intensity) And ((Event.[Intensity Io (Ball)])<=forms!Search!Intensity)
ORDER BY Event.Date, Event.Hour, Event.Event_ID;
```

Figure 4 Search Event

The query Search by Event ID (Figure 5) finds all the events information for a given year and ID interval. In order to compare the given year with the Event Year in the database, we must use the formula (Format([Event.Date], "yyyy")) to take only the Year in the Event.Date. These data is ordered only by Event_ID.



```
SELECT Event.Event_ID, Event.Date, Event.Hour, Event.Event_Latitude, Event.Event_Longitude,
Event.Depth, Event.[Magnitude MI (Richter)], Event.[Intensity Io (Ball)], Event.Epicentre,
Area.Area_Name, Belts.Belt_Name, Belts_1.Belt_Name
FROM Belts AS Belts_1 INNER JOIN ((Belts INNER JOIN Area ON Belts.Belt_ID=Area.Area_Belt_1
INNER JOIN Event ON Area.Area_ID=Event.Area_ID) ON Belts_1.Belt_ID=Area.Area_Belt_2
WHERE (((Format([Event.Date], "yyyy"))=forms!Search![Search by Event ID]!EventYear)
And ((Event.Event_ID)>=forms!Search![Search by Event ID]!EventID)
And ((Event.Event_ID)<=forms!Search![Search by Event ID]!EventID2))
ORDER BY Event.Event_ID;
```

Figure 5 Search by Event ID

Design of Forms and Reports

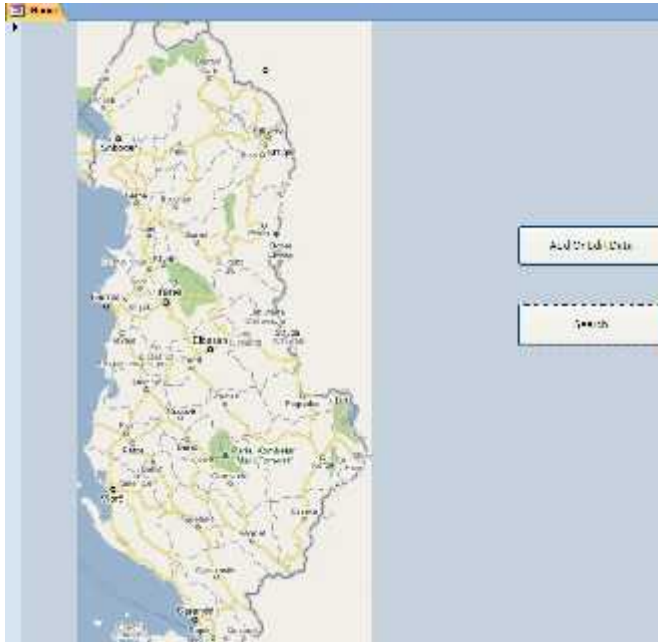


Figure 6 Form “Home”

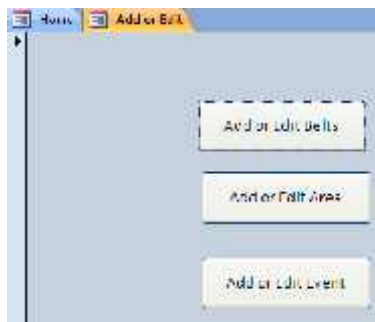


Figure 7 Form “Add or Edit”

We have designed the basic form called Home [5] (Figure 6) where we can see the map of Albania and two buttons. The button Add or Edit Data (Figure 6) is connected with the form “Add or Edit” (Figure 7) where are found three buttons. The button Add or Edit Belts is connected with the form “Belts” where all the Belts can be added or edited. The button Add or Edit Area is connected with the Area Form. We can add or edit the data about areas such as name and belts where these areas lie. The other button Add or Edit Event is connected with the Form Event where the data about the events are added or edited.

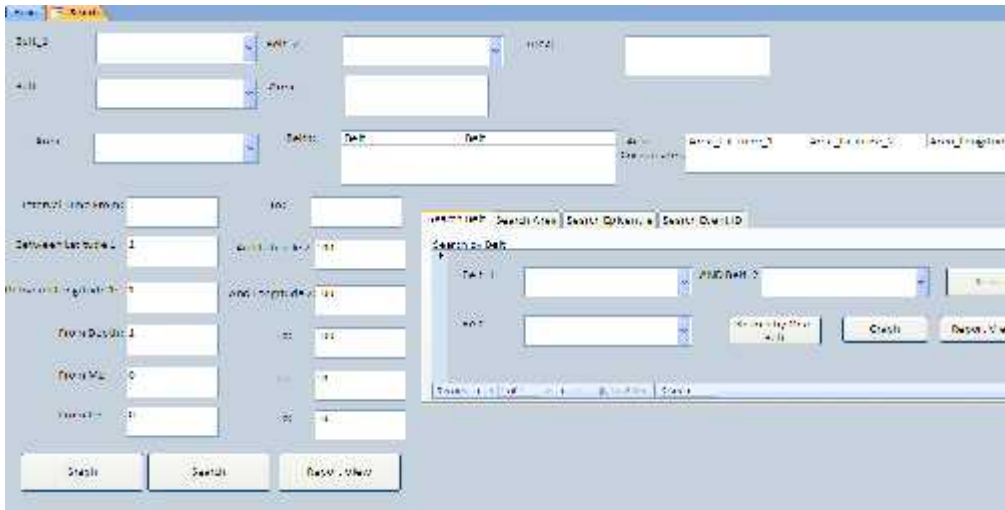


Figure 8 Form Search

The button Search in the Form Home(Figure 6) is connected with the Form Search (Figure 8), which contains all the different Searches. The first Search is the search by belts. In one search we give two belts in the combo boxes and we find all the Areas which lie in these two belts (Figure 9).

If one Area lies in only one Belt, in the first combo box we choose the belt and in the other combo box we choose “No Belt”. In the other search we give one belt and we find all the areas which lie in this belt (Figure 10). The second search is the search by Area (Figure 11). We choose in the combo box one area and we find belts permeated this area. Another

Search is the Search Event (Figure 12) where we can search all the events information occurred in a given date interval, latitude interval, longitude interval, depth interval, magnitude Ml (Richter) interval and intensity (Ball) interval. These data are ordered by date, then by hour and finally by ID. Latitude cannot exceed the interval 1-100. Longitude and depth also. Magnitude and Intensity cannot exceed the interval 0-10. So we put this numbers as default values for every search in order to find all information. If you need more detailed information you simply change this interval and you can find data exactly in this interval. You can change all the intervals for one search. In every Search form we have three buttons in order to view the searched information in a Form View, Graph View or Print Report View. In the Form view (Figure 13) of every Search we can find Event number, Date, Exact Time, Event Latitude, Event Longitude, Depth, Magnitude ML (Richter), Intensity (Ball), Epicentre, Area, Belts in which this Area lies.

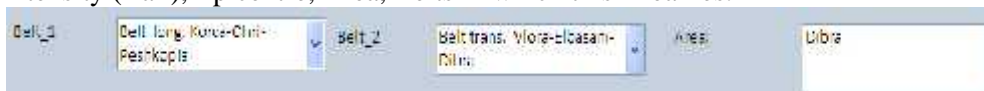
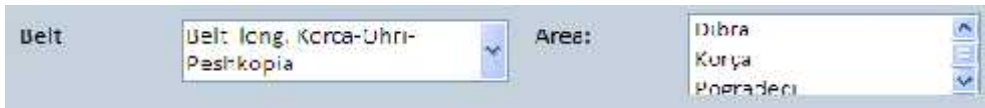


Figure 9 Search Area by belts



The screenshot shows a search interface with two dropdown menus. The 'Belt' menu is open, showing 'Uelt long, Korca-Uhri-Peshkopia' as the selected option. The 'Area' menu is also open, showing 'Dibra' as the selected option. Other options in the 'Area' menu include 'Kurça' and 'Pogradeci'.

Figure 10 Search Area by one



The screenshot shows a search interface with a list of search results. The 'Area' dropdown is set to 'Dibra'. The 'Belt' dropdown is open, showing a list of options: 'Belt', 'Uelt long, Korca-Uhri-Peshkopia', and 'Uelt Tirana, Vlora-Dibresë-Dibra'. The 'Uelt Tirana, Vlora-Dibresë-Dibra' option is highlighted.

Figure 11 Search Belts by



The screenshot shows a search event interface with various search criteria and buttons. The 'Interval Time From' and 'To' fields are set to '1/1/2011'. The 'Between Latitude 1' and 'And Latitude 2' fields are set to '1' and '100' respectively. The 'Between Longitude 1' field is set to '1'. The 'From Depth' field is set to '1' and the 'To' field is set to '100'. The 'From MI' field is set to '0' and the 'To' field is set to '10'. The 'From Io' field is set to '0' and the 'To' field is set to '10'. There are three buttons at the bottom: 'Graph', 'Search', and 'Report View'.

Figure 12 Search Event

Event ID	Date	Hour	Event Latitude	Event Longitude	Depth	Magnitude ML (Richter)	Intensity (Ball)	Epicentre	Area	Belts
1	17/05/1992	1:43:00 PM	41.41	20.25	14	3.3	3.3	Skrapar	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
2	17/05/1992	3:07:00 PM	41.45	20.22	16	3.3	3.5	Jallinështë	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
3	17/05/1994	2:01:00 PM	41.31	20.22	10	3.7	4.5	Lira	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
4	17/05/1995	3:01:00 PM	41.2	20.2	11	4	5	Kërçeqe	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
5	17/05/1995	3:11:00 PM	41.2	20.2	14	4*	5	Kërçeqe	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
6	17/05/1999	5:33:30 AM	41.24	20.22	9	2.9	3		Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
7	17/05/1999	2:12:20 PM	41.24	20.22	8	3.1	3	Shqipëri	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
8	17/05/1999	11:07:00 PM	41.23	20.22	17	3.2	3	Durrës	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
9	17/05/1999	2:07:28 PM	41.41	20.22	10	2.4	2	Okrahutit i Vogël	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
10	17/12/1999	6:01:00 PM	41.25	20.25	4	3	3	Shqipëri	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
11	2/12/1999	5:12:22 PM	41.2	20.25	12	4	4	Udhë-Bulqize	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi
12	7/12/1999	5:04:38 AM	40.42	20.42	40	3.1	3.5	Durrës	Ditë	Bel. Iorg. Kercë, Durrës, Peshkopi

Figure 13 Form View

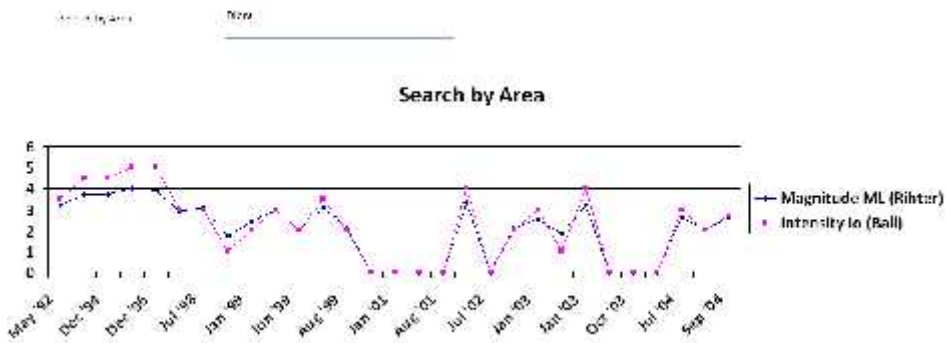


Figure 14 Graph View

In the graph view (Figure 14) of every search we can see the graph of Magnitude and Intensity by Month and Year for every data searched. All these graphs are updated at the moment of the data manipulation. In the Report View [5] (Figure 15) for every search we can view all the information: Event number, Date, Exact Time, Event Latitude, Event Longitude, Depth, Magnitude ML (Richter), Intensity (Ball), Epicentre, Area, Belts in which this Area lies in a Print Preview form, grouped by month. In the end of every month we can find the number of events and in the end of the report we can find the total of events for that search. All this information can be directly printed.

Event Name	Event ID	Date	Time	Event Location	Event Category	Event Type	Event Status	Event Description	Event Location	Event Status	Event Description
Mar 2011	1	01/03/2011	10:00:00	4	2011	24	50	00	Buzluca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	1	2011	15	50	00	Delishova	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	1	2011	11	4	00	Ure	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	4	2011	26	4	0	Blanca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	4	2011	28	50	0	Blanca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	1	2011	8	50	0	Ure	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	1	2011	1	1	0	Blanca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	4	2011	24	2	0	Blanca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	4	2011	20	50	0	Blanca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	1	2011	9	50	0	Blanca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	1	2011	15	50	0	Blanca	Open	Bull. Long. Kosovo (M. National)
Mar 2011	1	01/03/2011	10:00:00	4	2011	24	4	0	Blanca	Open	Bull. Long. Kosovo (M. National)

Figure 15 Report View

If we want more detailed information we use the Search Event plus the other Search, such as Search by Two Belts, Search by One Belt, Search by Area and Search by Epicentre.

To use these searches we must always fill the Search Event Form. Finally, you can use a more simple way to search data for a given area. In the Home Form, you just click in one area of the map (Figure 16) and all the events information for this area will appear in a Report View Form grouped by month. In the end of every month you will find the number of events for this month. In the end you will find the total number of events for this Area. These data can be easily printed.

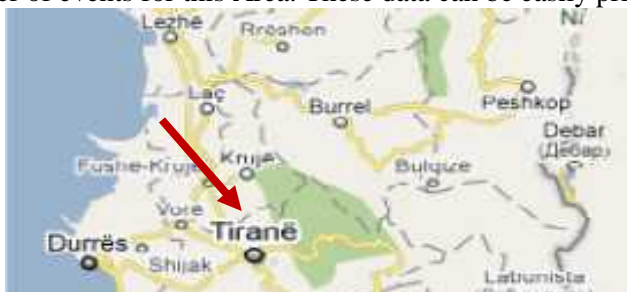


Figure 16 Map of Albania

CONCLUSION

This database:

- Helps to understand the seismic activity for one region
- Assist in evaluating the expectation of eventual future seismic activity in the region.
- Helps different users to add and edit data about events, simply and in a friendly way by using interactive forms
- Finds every needed information by the user in a very fast way, by using many different queries and forms
- Displays all the needed information in a graph view to see the frequency of events and their Magnitude and Intensity, and to make an expectation for the future seismic activity in the region
- Displays all the needed information in a form or report view
- Prints any information searched by users
- Finds every event information in one area by simply clicking one area in the map
- Can be used for every Area in Albania
- Is compatible with other software

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