

GIS Management Tool on the 26th of November 2019 Earthquake in Tirana

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Abstract: On the 26th of November 2019, an earthquake of moment magnitude 6.4 struck the northwest region of Albania. This paper summarizes the development of a Geographic Information System "GIS" for the management and analysis of information on damaged facilities in Tirana during survey. The application of GIS techniques allowed us to store, extract, modify and analyze data on earthquake-damaged buildings. The final product consists of information converted as maps, as well as numerical tables associated with the maps. The study was conducted using QGIS and ArcGIS software and was structured in thematic vector and Raster. The damaged sites are placed on a map, with all the information on the earthquake (number of dead, number of houses collapsed, economic losses.) Accompanied by relevant data. GIS is structured in such a way as to be able to integrate with other geospatial data from other local and central institutions. Furthermore, the GIS system enables various spatial and statistical analyzes, can provide support both for damage assessment, its geographical distribution determination, identification of regions repeatedly affected by seismic events, quantify the level of seismic and extends the assessment to other natural hazards. These applications were a GIS portal site for quickly sharing disaster-related GIS data, an efficient method of accessing and recording damage in the field throughout the city.

Keywords: Albania earthquake · GIS, Field survey · Post-earthquake · Building's damage assessment

1. Introduction

On Saturday 21st September 2019 at 15:15 CET, an earthquake of moment magnitude (Mw) 5.6 and shallow focal depth (~ 10 km) (Bilgin and Hysenlliu 2020; USGS 2020) hit the northwest region of Albania. The epicenter of the earthquake was estimated 5km northwest Durrës city (35km west of Tirana). Despite the proximity to the city, the event had relatively small consequences with no fatalities, i.e., ~110 injured people and ~120 damaged buildings without structural failures. This was the first event of the seismic sequence and, on the 26th of November, at 03:54 CET, central and north-west Albania was struck by the main shock of the sequence with Mw 6.4 and shallow focal depth (~ 20 km) (USGS 2020). The epicenter was 16 km west-southwest of the town of Mamurras in Kurbin municipality. The earthquake was felt strongly in Albania's capital Tirana where the significant duration (bracketed between the 5% and 95% of Arias intensity) of the strong motion was 24 s. The earthquake was also felt in places as far away as Taranto (Italy) and Belgrade (Serbia). A total of 51 people were killed in the earthquake, with about 3,000 injured. The first estimates revealed that the total effect of the disaster in the 11 municipalities amounts to 985 million euro, including direct and indirect losses (Republic of Albania Council of Ministers 2020). In Figure 1 are shown the epicenters of earthquakes sequences and the location of Tirana Municipality.

We had several damaged buildings to inspect, and many field surveyor's groups. This brought a lot of information in a very short time.

We chose to develop a GIS Application to the disaster response on the damage caused by the Earthquake in the Municipality of Tirana, which, in terms of quantity and quality of known data, can be used as an effective tool for

creating an integrated information system which allows a comparison of data from different sources of information in a quick time. An indirect analysis of these data allows us to access the damage, to determine its geographical distribution, to identify areas repeatedly affected by seismic events, and to quantify the level of seismic damage in the area.

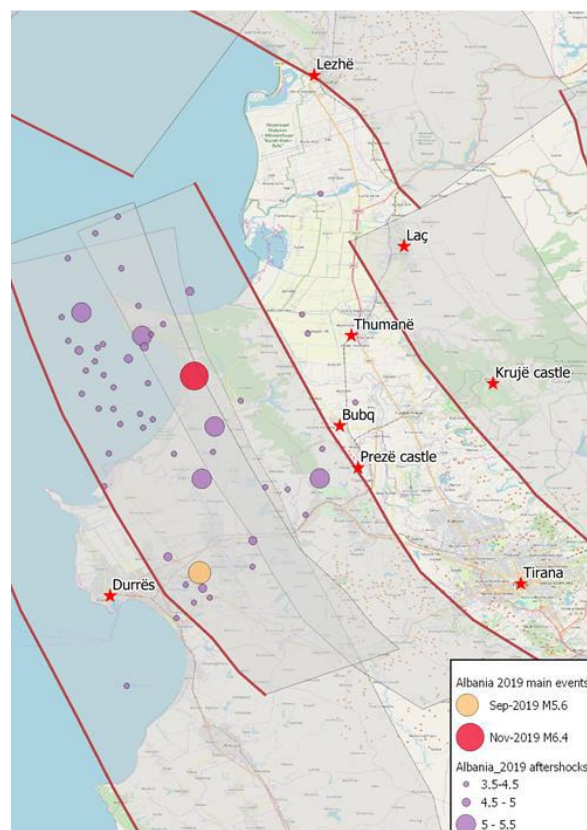


Figure 1: Durrës earthquakes sequence and distance from Tirana (Adapted from EEFIT).

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Data Formatting in GIS

Since we need to store the data for each Building as a Basic Layer, we used the geo-data from address system. During the on-site inspections it was noticed that the data information was not accurate two or more buildings were digitized as one and in some cases the buildings were missing. To add the missing buildings, some additional data were used such as Orthophoto of 2018, Orthophoto of 2015, Satellite Imaging, etc. A Database was created which would store the Field Reported data, as shown in Table 1.

Table 1: Preliminary Database

Inspection Group
Date of Inspection
Object Address
Object Contact Person
Telephone Number of the Contact Person in the Facility
Coordinates N - (Latitude)
Coordinates E - (Longitude)
Object Typology
Structure Typology
The height of the building on the floors
Field Typology
Year of Construction
Structural Damage
Details on structural damages as well as other damages
Advice on Further Actions to Take to Secure the Facility
Forced evacuation of the Facility
Typology of Foundations / Basement

For each of the Fields there were categorizes and subcategories. In the first week of the damage assessment survey there was no Standard format from the Government for determining damage assessment. Caused by the Earthquake. We had problem determine the location of the building as there were no addresses sign in the building in some cases even in the street sign in the field, so to determine the position of the building the coordinates of the building were find via Mobile Phones in the WGS84 Geographic System. These data were regularly discarded by

the operators then in the Municipality of Tirana. The operators in the Municipality, reading the damage assessment, made categorizations by interpreting the Findings Act in 3 Categories: Safe; Review; Evacuation.

Figure 2: The first model of the damage assessment

It was soon noticed by the Government that through this format it was very difficult to determine the damages and to build a database which would show us the buildings which needed to be evacuated immediately or which required immediate intervention.

On 8 December 2019, The Inter-ministerial COMMISSION ON CIVIL EMERGENCY after several discussions on collaboration with UNDP and other agencies drafted the new Standard for damage assessment shown in Figure 3.

Figure 3: The second model of the damage assessment

Through this model was made Standard damage assessment which considered the damage states:

- DS0 (No Damage)
- DS1 (Light Damage)
- DS2 (Medium-Serios Damage)
- DS3 (Medium-Serios Damage)
- DS4 (Heavy Damage)
- DS5 (Heavy Dagate)

GIS Project and Structure

GIS is used as data storage. GIS includes maps for the entire Municipality of Tirana. Spatial database built into the

KRRGJSH system EPSG: 6870 is the basis for all data to be in a single georeferenced coordinate system. Earthquake damages were stored as points with fixed coordinates, each point above is placed with a building which shows damage level also features of the building.

Orthophoto is a useful reference to show the actual condition of the territory. The data captured from the damage assessment on the field were completed in an excel spreadsheet and then dumped into GIS. Each data had Coordinates N, E. This methodology is shown in the Diagram below.

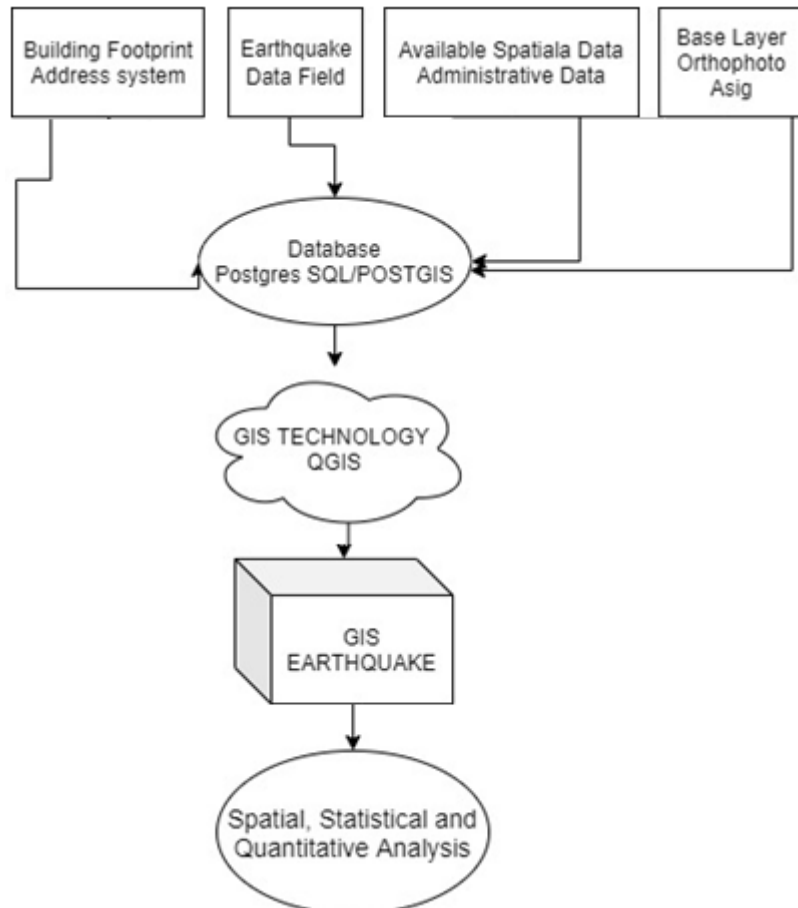


Figure 4: Methodology

Through this spatial database created we can store any data on buildings damaged by the earthquake with location as well as geographical reference with other elements such as Cadaster, Building Permits, Geology, etc.

Through the software QGIS we can do the management of this data, the presentation of this data and their statistical analysis based on different geographical divisions. helps us to build interpretive summary, can provide support for damage assessment, its geographical determination, distribution, identification of regions continuously affected by seismic events.

Earthquake maps and tables will be used for government intervention in the areas most affected by the earthquake as well as policies for Allocation of Funds needed for their Reconstruction.

2. Data Consultation and Submission

The main advantages of GIS software consist in its ease use and instant access to real-time information. Damaged places were automatically digitized on the map by entering the coordinates of points N, E, each point constitutes and represents a damaged object. Using a UNIQUE identification code which was later used for reference as the GIS CODE Object Address, the damage data was linked to individual points, displaying a one-to-one correspondence on the map.

Linking the data to the map allows thematic maps to be generated within the initial GIS processing. In the specific case, linking the dots to the damage data. The structure and operation of GIS allows many automated operations to be performed for the integrated representation of different types of data, such as the overlap of several thematic maps,

namely geological and tectonic maps Elevation Maps DEM and Orthophoto, which can show the contribution of geology and tectonic structures up to the intensity of the earthquake.

Distributions of earthquake damage by Administrative Units is shown in Figure 5.

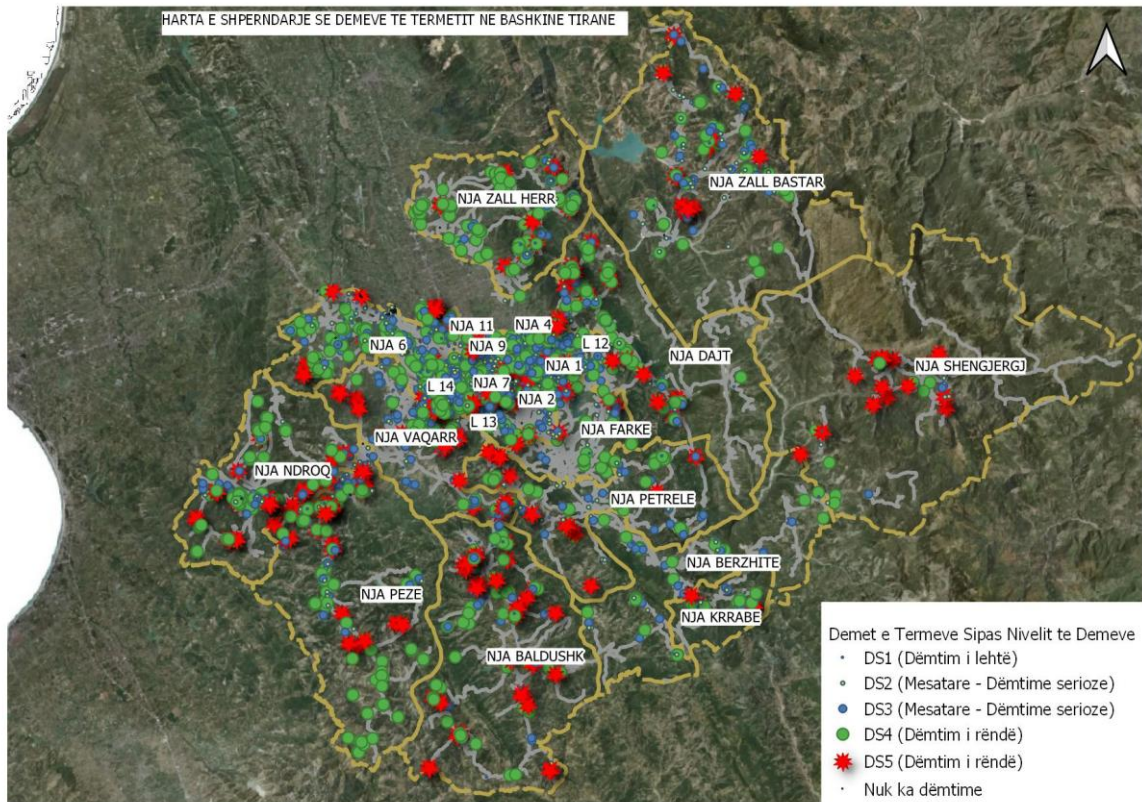


Figure 5: Distribution of damages in Administrative Units of Tirana

Another interesting map is the Heat map according to the geographical distribution shows the accumulative distribution of damages as a weight for the generation is

used the parameter if the building is habitable or NO. It can be noticed from Figure 6 that the Administrative Unit (NJ) 6 and 10 have experienced the biggest damages.

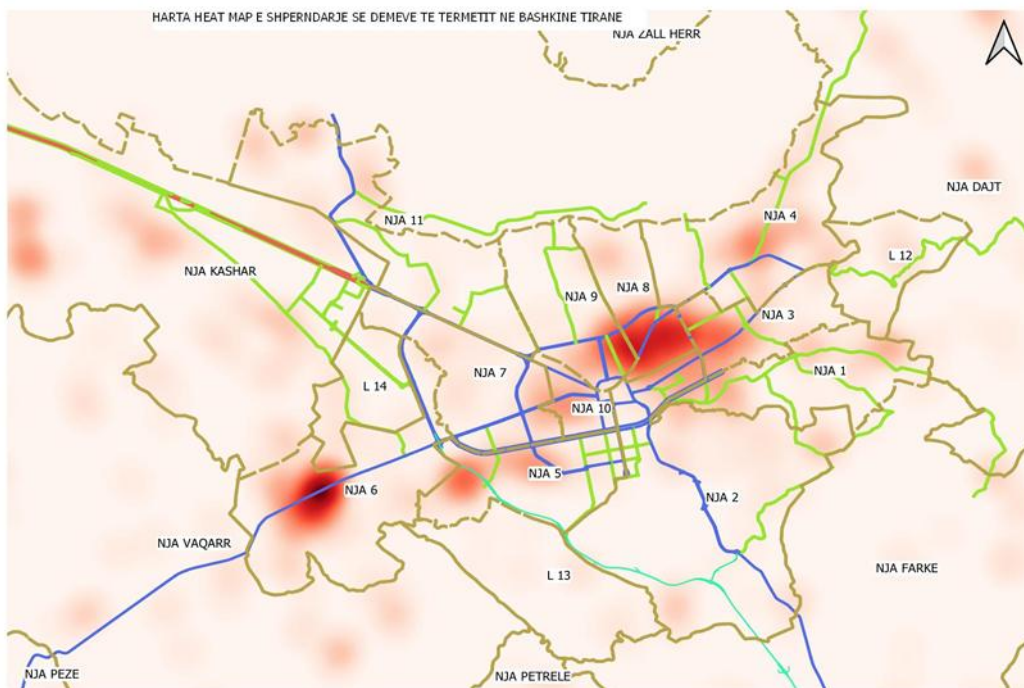


Figure 6: HeatMap of Administrative Units of Tirana Municipality

Another interesting map is the map distribution of damage within the territory of Tirana municipality as shown in

Figure 7. We see that the terrain has not had any clear effect on the damages of the buildings.

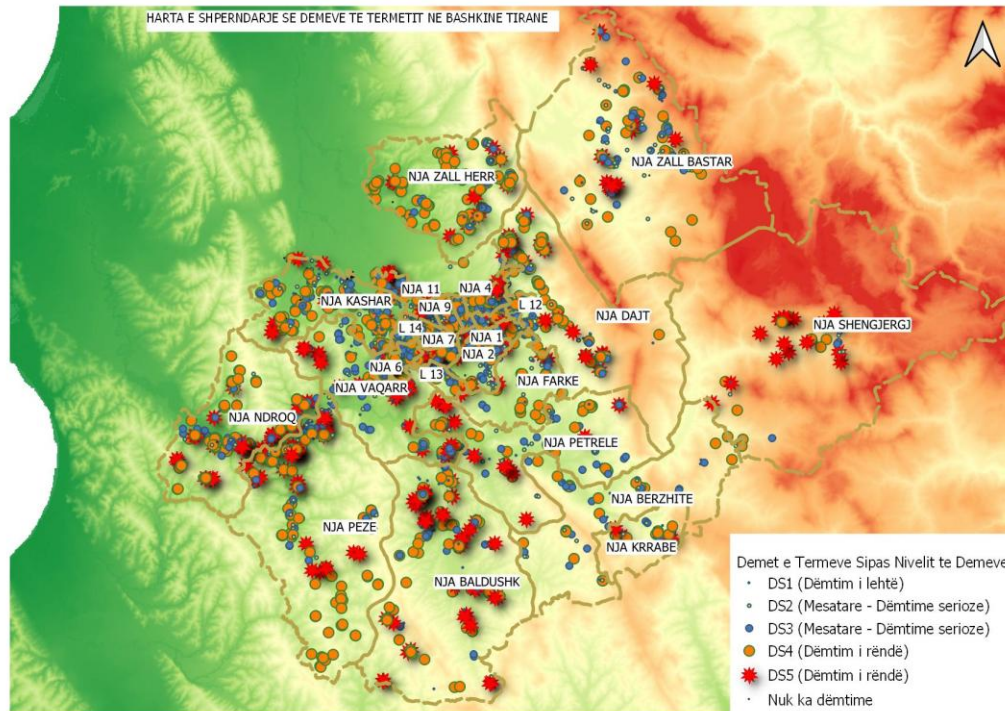


Figure 7: Damage map as per different DS based on terrain digital model.

3. Results and Discussions

From the verifications the biggest damages are concentrated in the Administrative Unit 6, Administrative Unit 8, Administrative Unit 9, Administrative unit 5 and Administrative Unit 3 which also show a large concentration of damages. To make an analysis of the castings it is necessary for the Structural Engineers to look at the data of the buildings such as the types of damages, the materials, the geological map. From the results in the Database, it appears that over 5185 Inspections of Buildings in Tirana with Damage have been performed. From the Statistics it appears that the approximate data are summarized in Table 2.

Table 2: Statistical data of the damaged buildings

Statistic Data		
FID *	niveli_dem	FREQUENCY
1	Te Pa Inspektuara	78542
2	DS1 (Dëmtim i lehtë)	1295
3	DS2 (Mesatare - Dëmtime serioze)	1197
4	DS3 (Mesatare - Dëmtime serioze)	971
5	DS4 (Dëmtim i rëndë)	1145
6	DS5 (Dëmtim i rëndë)	277
7	Nuk ka dëmtime	300

It should be quoted that these have been the first data from the Field. Based on these data then for buildings with damage DS4-DS5 In-depth structural assessment with damage DS4-DS5 In-depth structural assessment was conducted by the Institute of Construction or Private Structural Design Companies.

4. Conclusions

GIS is a useful tool in natural disaster management.

It serves for the clear identification of damages in a more accurate and efficient way, it serves for the advance planning of the Objects for expertise, for informing the multilateral actors for the evacuation of the inhabitants in an immediate manner in case of need, for the planning of the budget in advance precisely. By making the combinations of Earthquake and Civil Status data, ACA has also made it possible to create preliminary reports on the funds needed for the Rebuilding.

In the process of Reconstruction GIS has been the tool used to calculate the bill of damages for EU funding, with a tool Transparent which can be accessed from any country at the Micro or Macro level.

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