Seismicity of Eastern Alps and North Western Dinaric Alps

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CE³RN

At the end of 2014 Seismic Network of the Republic of Slovenia, Friuli VG accelerometric network, NE Italy BB Network and Seismic Network of Austria agree to formally establish the cross border seismological network and to name it Central and East European Earthquake Research Network, in order to locate it geographically since cross-border networks can be established in other areas of the world. University of the Trieste is also joined the CE^{3}RN project. The main goal of the project is the creation of a trans frontier network for the common seismic monitoring of the region for scientific and civil defense purposes. Furthermore, one of the main goals of the CE^{3}RN is to intensify the cooperation between these institutions through common research activities and preparation of common international projects. Today there are more than 30 seismic stations running by several institutes, universities and civil defense services.

Seismicity

Historical and instrumental catalogues show that north eastern Italy and western Slovenia are affected by a fairly high seismicity, with the most intense seismic activity concentrated along the foothills of the Eastern Southern Alps (ESC) in the Friuli Region. [2] [4]. Instrumental seismicity started from 1931, when the seismological station of Trieste was installed. The most important instrumental earthquakes in this region occurred during the 1976 Friuli sequence that was widely studied thanks to the abundance of collected seismometric data [6]. In the eastern Alps, the shallow crustal seismicity is located on several south-verging ramps developed within the Adriatic Mesozoic cover. Subparallel faults broad the active region at the intersection between the Alpine and Dinaric structures. The southernmost active thrust is located at the foothill. Large thrust earthquakes are caused by a NS trending compression [7] [1]. Along the Adriatic thrust fault system, regions with scarce background seismicity define possible seismic gaps. To the east, the seismicity clusters on NNW trending faults in the northern part of the Dinarides. Strike slip mechanisms, such as the ML 5.6 Bovec earthquake, accommodate a transpression of Adria.

Data

In this project, we used several databases to construct the earthquake catalog. 27725 earthquakes are collected from Istituto Nazionale di Geofisica e Vulcanologia, United States Geological Survey, European-Mediterranean Seismological Centre and our local network at the rectangular area at 10.0 - 16.5 North and 44.0 - 51.0 East. Our catalog has earthquakes between 1960 and 2017. We choose 1960 as a starting date since the seismic array around the region was not good coverage (Figure 1).

Method

Gutenberg and Richter law is used as a method [5]. Earthquake catalog is processed by well known ZMAP and MapSeis software [8] [3]

$$\log N(M) = a - bM. \tag{1}$$

Parameter 'a' is called observation period and it is depended on the observation area and observation time. Parameter 'b' is depended on many factors. Heterogeneity in the ground, porosity of the soil and cracks can change the parameter. Normally it varies between 0.9 and 1.2. This value can be lower than 0.9 if the area produces earthquakes frequently.

Furthermore, we look for periodicity of earthquake occurrence for some magnitudes. Even though, this method is not very accurate for seismic risk calculations, it can give first impression about region's seismic hazard.

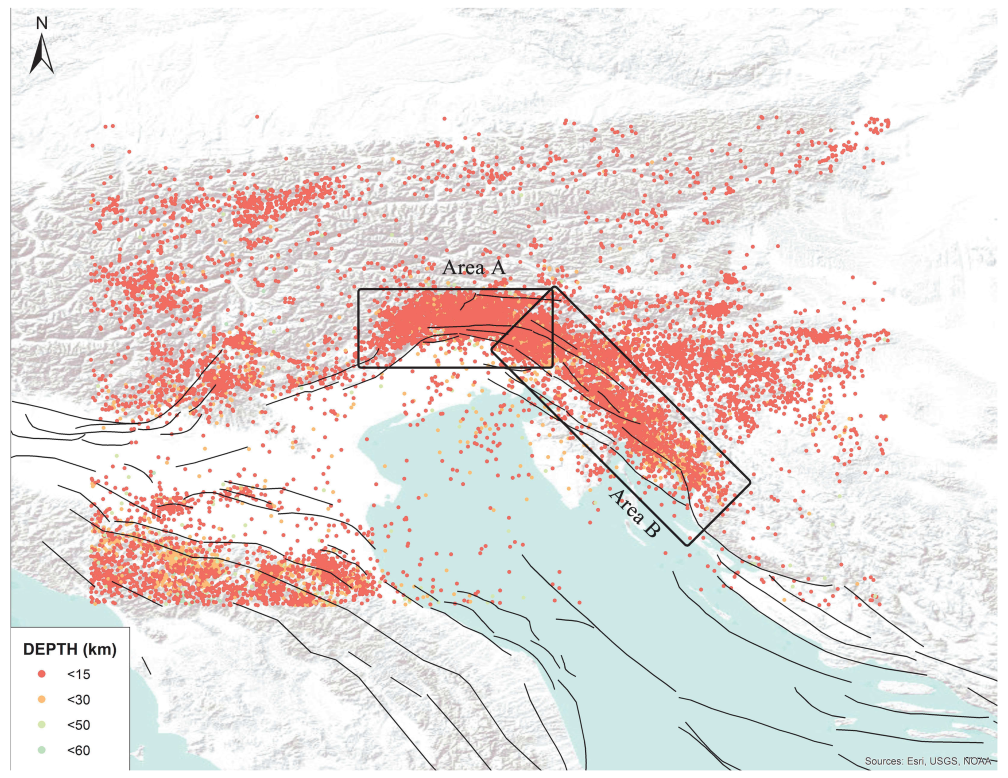

Figure 1: Earthquake, occurred between 1960 and 2017, locations at the region. Solid black lines indicate the tectonic features, faults, subduction zones etc., at the region. Red, orange, light green and green circles are correspond earthquakes depth at less than 15km, less than 30km, less than 50km and less than 60km, respectively. Area A and Area B are the areas inside the rectangles.

Results

We calculate the b value of whole region (Figure 2). Resolution of b values at Figure 2 decrease at the northern part due to lack of earthquakes. Area with high b value (Figure 2) is the area that we have dense seismic station coverage. We can detect many earthquakes magnitude less than 1. These earthquakes increase the b values since there is no almost no big earthquake except 1976 Friuli earthquake.

We also calculate the b value of each area in depth (Figure 3 and Figure 4). Earthquakes are focused at two areas (Area A and B in Figure 1) .

Then we calculate the earthquake occurrence period for magnitude 6 and 6.5 for both Area A (Figure 5 and Figure 6) and Area B (Figure 7. Magnitudes are selected, related to regions' historical and instrumental seismicity.

There are certain places for area A with short time periods for such big magnitudes which are unreliable. These areas are not be able to produces big earthquakes yet according to ZMAP software these areas can be very 'productive'.

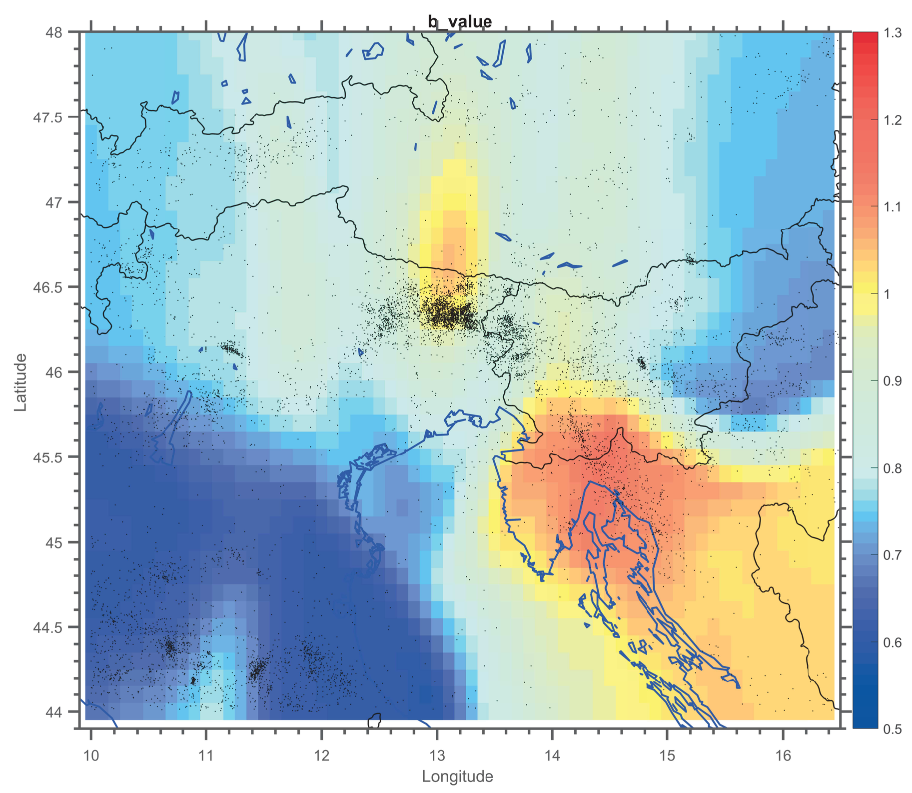

Figure 2: b value of the region. b values are vary between 0.5 to 1.3.

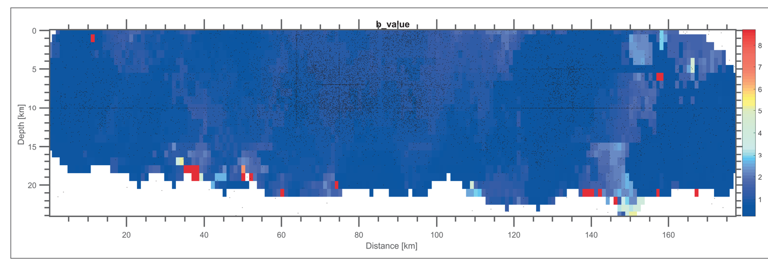

Figure 3: b value of Area A in depth

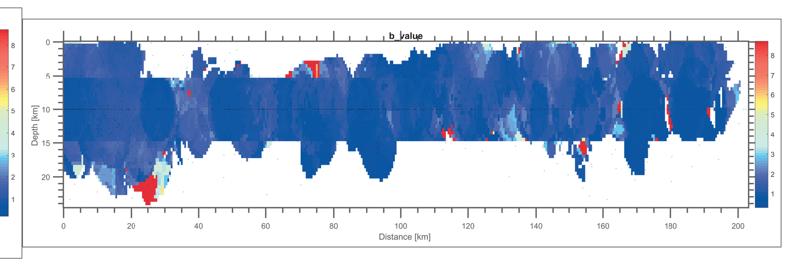

Figure 4: b value of Area B in depth

b value maps of areas A and B at depth. Area A's b values is in the left and Area B's b values is in the right of the figure. b values are vary between 0.2 to 2.6.

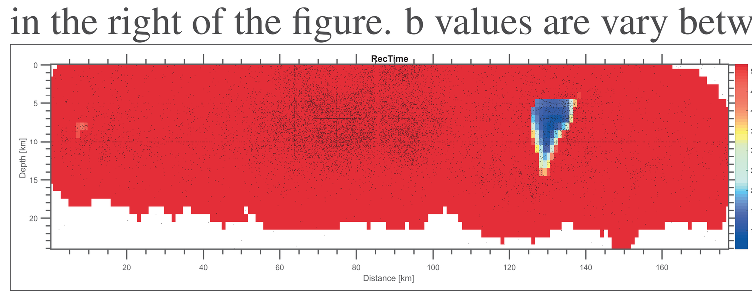

Figure 5: Reoccurrence of M6 earthquake in years.

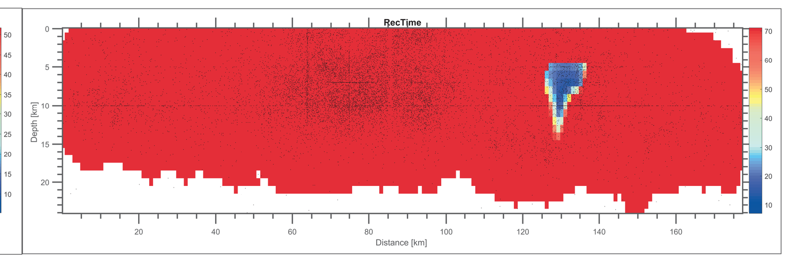

Figure 6: Reoccurrence of M6.5 earthquake in years.

Earthquake occurrence periods of magnitude 6 (left) and magnitude 6.5 (right) earthquakes for area A.

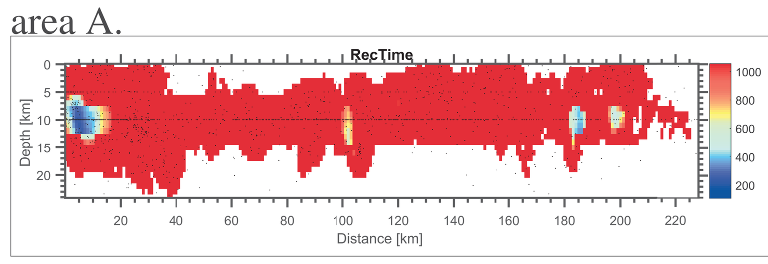

Figure 7: Reoccurrence of M6 earthquake in years.

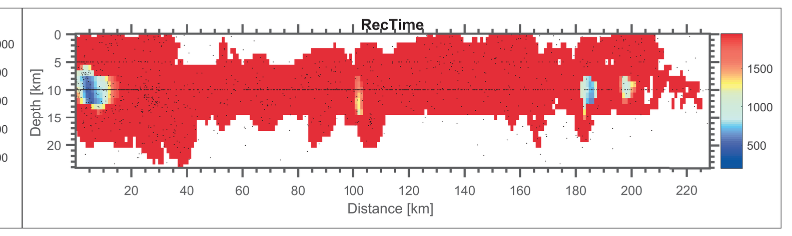

Figure 8: Reoccurrence of M6.5 earthquake in years.

Earthquake occurrence periods of magnitude 6 (left) and magnitude 6.5 (right) earthquakes for area B.

Conclusions

- Eastern Alps and North western Dinaric Alps are seismically active regions. There was magnitude 6.5 magnitude earthquake in 1976 and magnitude 6.8 eartquake in 1511 in the region.
- In Area A and Area B earthquake depth is located between 5 - 20 km
- Low b values are indicating that this region can accumulate energy which can generate magnitude 6+ earthquake.
- Earthquake repetition results show that we can expect magnitude 6+ earthquakes around the region in between 70-1000+ years depends on the area.

Acknowledgement

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