ALETSEL DÖNEM DEPREM KATALOGU KULLANILARAK GUMBEL I ASİMTOTİK DAĞILIMI VE GUTENBERG-RICHTER İLİŞKİSİ İLE TÜRKİYE VE CİVARINDAKİ FARKLI BÖLGELER İÇİN NİCEL BİR DEPREMSELLİK ANALİZİ

A QUANTITATIVE *SEISMICITY ANALYSIS FOR DIFFERENT REGIONS IN TURKEY AND ITS SURROUNDINGS FROM GUMBEL FIRST ASYMPTOTIC DISTRIBUTION AND GUTENBERG-RICHTER RELATIONSHIP USING INSTRUMENTAL EARTHQUAKE CATALOGUE*

Yusuf Bayrak[1], Serkan Öztürk[1], George Ch. Koravos[2], Georgios A. Leventakis[2], Theodoros M. Tsapanos[2]

Posta Adresi: [1]Karadeniz Technical University, Department of Geophysics, Trabzon, Turkey

[2]Aristotle University of Thessaloniki, School of Geology, Geophysical Laboratory, Greece

E-posta: *bayrak@ktu.edu.tr*

Anahtar Kelimeler: Türkiye, Gutenberg-Richter ilişkisi, Gumbel dağılımı, modal değerler

ÖZ Bu çalışmada, Türkiye ve civarındaki farklı bölgeler için nicel bir depremsellik analizi yapılmıştır. Çalışmada kullanılan veri KOERI ve ISC kataloglarından derlenmiştir. Bu amaçla, Gutenberg-Richter yasası ve Gumbel I asimptotik dağılımı kullanılmıştır. *a* ve *b* parametreleri her iki yöntemle de hesaplanmıştır. Sonuçlar, Gumbel I dağılımından hesaplanan *b*-değerlerinin Türkiye ve civarındaki farklı bölgelerin tektonik yapısına Gutenberg-Richter ilişkisinden daha iyi bir uyum sağladığını ortaya koymuştur. Ayrıca, Türkiye'nin depremselliği her bir sismik bölge için modal değerlere (a_m/b) bağlı olarak ta değerlendirilmiştir. Kuzey Anadolu Fay Zonu ve Ege Arkında $a_m/b \geq 7.25$'tir ve bu bölgeler depremsellik açısından birinci derecededir. Sonuç olarak, modal değerler çalışılan alanda ki nicel bir depremsellik için yerel tektonik yapının detaylı bir görüntüsünü ortaya koyar.

Key words: Turkey, Gutenberg-Richter law, Gumbel's distribution, modal values

ABSTRACT *In this study, It is made a quantitative seismicity analysis for different regions in and around Turkey. The data used in this study is compiled from the catalogues of KOERI and ISC. For this purpose, the Gutenbeg-Richter law and the Gumbel's first asymptotic distribution of extreme values were used. The parameters a and b were estimated from both methods. The results show that the b-values calculated from Gumbel's first distribution reveal a better fit than Gutenbeg-Richter relationship to the tectonic environment of the different regions of Turkey and its surroundings. Also, the seismicity of Turkey has been estimated in terms of the modal values (a_m/b) for each one of the seismic regions. a_m/b is equal and greater than 7.25 in the North Anatolian Fault Zone and the Aegean Arc, and these regions are ranked to the first position according to seismicity. Consequently, the modal values provide a detail image of the local tectonics for a quantitative seismicity in the examined area.*

INTRODUCTION

A large number of quantitative methods have been applied over the years to evaluate the seismicity in various regions of the world. The most popular methods used are the

Gutenberg-Richter law and the Gumbel's asymptotic distributions. Also, many studies on *a* and *b* parameters have been made since Gutenberg and Richter (1944) introduced their law about the earthquake magnitudes distribution. Tsapanos (1990) observed that significantly different *b*-values in east and west Pacific and suggested that this is related to the difference in the mechanical structure of the material in each area, as well as to the tectonic evolution of them. Yılmaztürk et al. (1999), and Bayrak et al. (2002) shows that *a* and *b*-values do not always supply much information about the tectonics of an area. They suggested that the ratio a_m/b *(modal value)* is much better for understanding the seismic activity and the tectonic regime of a region. In this work, we aimed to analyse *b* and a_m/b values for different regions in Turkey and adjacent areas, and to find out which of them shows better correlation with complicated tectonics of studied area.

DATA USED and METHOD of ANALYSIS

The instrumental earthquake catalogue used in this study is taken from different sources such as the Boğaziçi University, Kandilli Observatory and Earthquake Research Institute (KOERI) and the International Seismological Center (ISC). Turkey earthquake catalogue has 2398 events between 1900 and 1974 and 68478 events between 1974 and 2005. The final catalogue between the time interval 1900 and 2005 and shallow earthquakes (depth<60 km) including 69339 events are used for the calculations. The catalogue is homogeneous for M_S. We carried out our analysis in a rectangular area limited by the co-ordinates 25°E and 45°E in longitude and by the co-ordinates 33°N and 43°N in latitude. The major fault systems and seismicity of Turkey as well as the studies and seismic source zones made by other authors (Erdik et. al., 1999; Bayrak et al., 2005) are considered for seismic source zonations in this study. Thus, Turkey was divided into 24 seismic regions. Figure 1 shows the seismic regions with tectonic structures and the epicenters of earthquakes in Turkey from 1900 to 2005.

There are generally two methods for the distribution of earthquake magnitudes in time and size. First of all uses whole available data and the other uses the extreme values. The latter is developed by Gumbel (1935, 1966) and based on the theory of extreme value statistics. The advantage of this method is that it is not required analysis of whole data set. In this study, we made an effort in order to analyze the seismicity parameters for different regions of Turkey and vicinity. The seismicity parameters of *a* and *b* are estimated from Gutenberg-Richter law and Gumbel first distribution. Also, seismicity has been analysed in terms of the modal values (a_m/b) for each one of the different regions. Figures 2 and 3 show the spatial variation maps of *b* and a_m/b values, respectively.

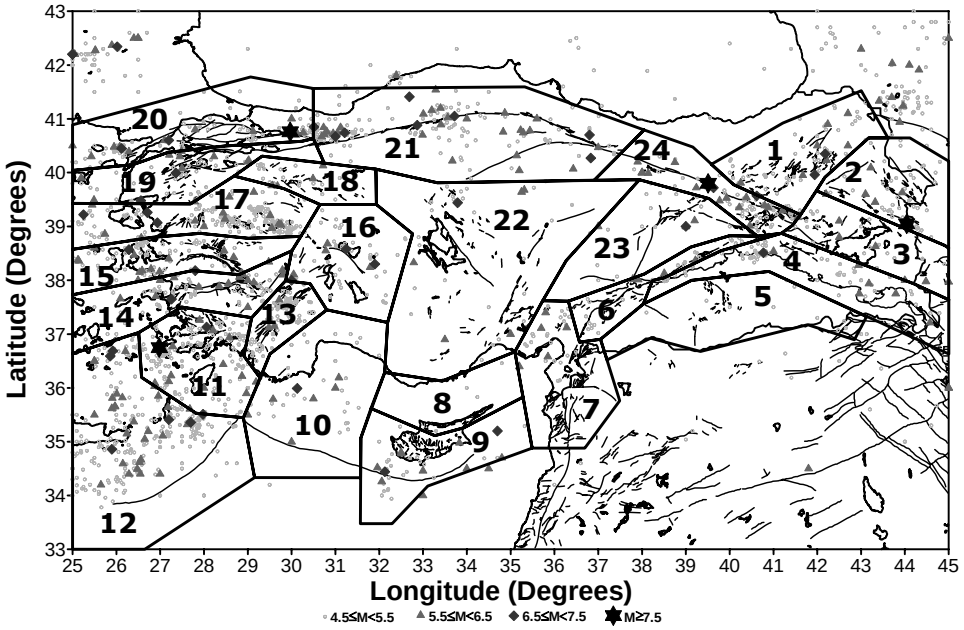

Figure-1. Different seismic source regions with the major tectonics. Epicenters of earthquakes for the time period 1900-2005 are also shown by different symbol.

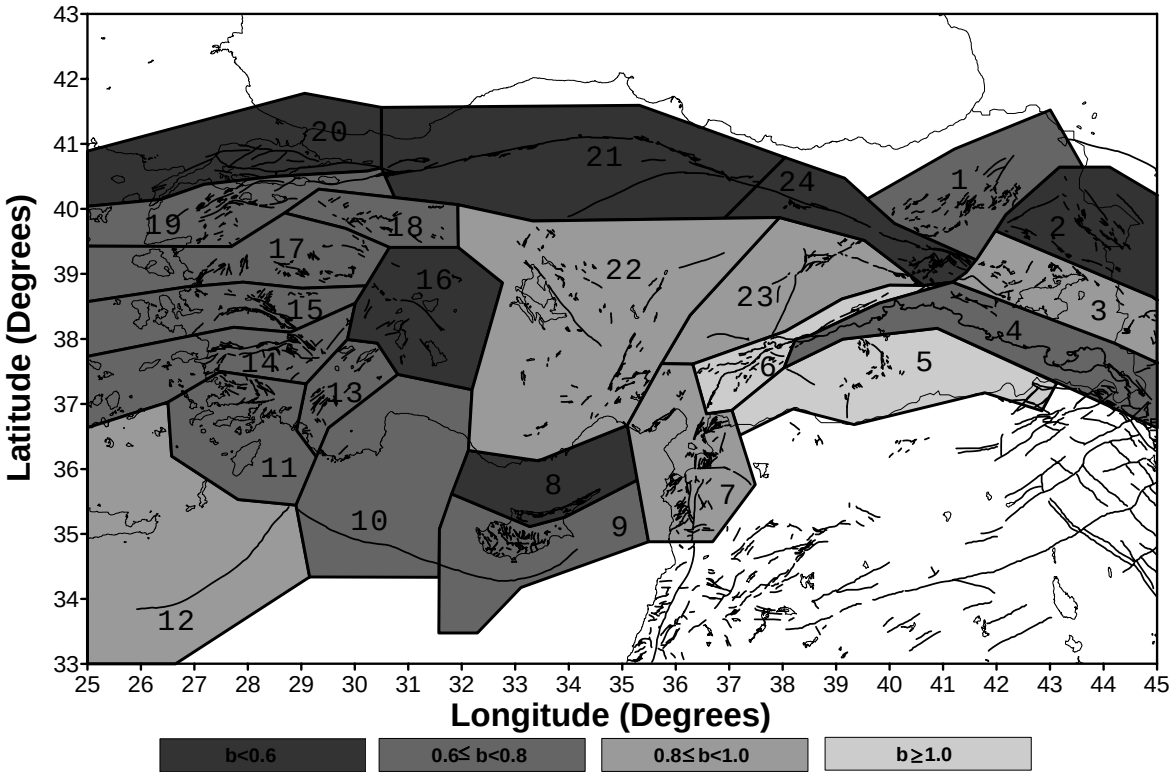

Figure-2. *b*-values computed from Gumbel I method for different seismic source regions in Turkey and surrounding areas.

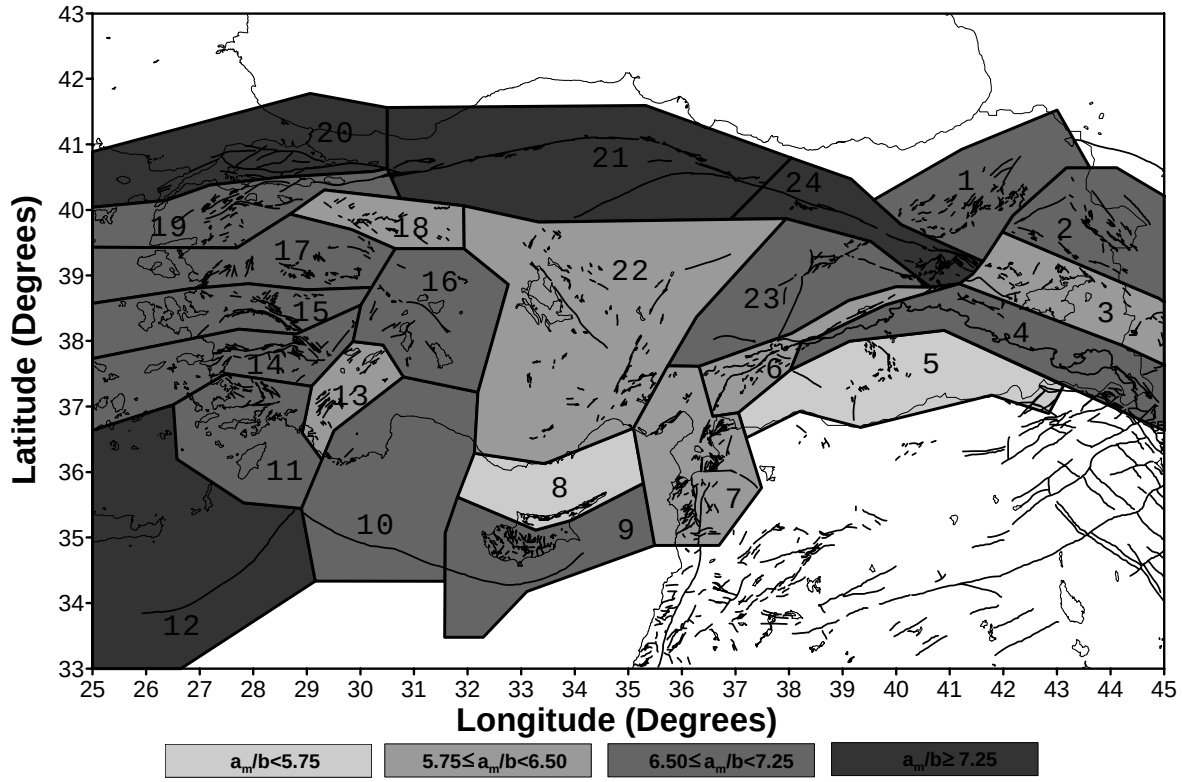

Figure-3. a_m/b values computed from Gutenberg-Richter method for different 24 seismic source regions in Turkey and surrounding areas.

CONCLUSIONS

The analysis of the seismicity for different seismic regions, in which Turkey and adjacent areas divided, is made in this work. For this purpose, two methods are adopted in order to find out which of them shows better correlation with the complicated tectonics of the studied area. The first is the "whole process" which follows the Gutenberg and Richter cumulative distribution frequency law, while the second is the "part process" which is well and wide known as theory of extreme values. An effort is then made to give an answer to the question, which is the most seismically active region of the investigated area. It is used the instrumental earthquake catalogue compiled from Boğaziçi University, Kandilli Observatory and Earthquake Research Institute and the International Seismological Center. Turkey earthquake catalogue has 2398 events between 1900 and 1974 and 68478 events between 1974 and 2005. We used a uniform catalogue of M_S between the time interval 1900 and 2005 and shallow earthquakes (depth<60 km) including 69339 events are selected for the calculations. The co-ordinates 25°E and 45°E in longitude and by the co-ordinates 33°N and 43°N in latitude were used in analysis. For the seismic source zonations in this study, the major fault systems and seismicity of Turkey as well as the studies and seismic source zones made by several authors were considered and Turkey was divided into different 24 seismic regions. It is resulted that the *b*-values calculated from Gumbel's first distribution show a better fit than Gutenbeg-Richter relationship to the tectonic environment of the different regions of Turkey and its surroundings. Also, the seismicity of Turkey has been analyzed according as the modal values (a_m/b) for each regions. The modal values equal and greater than 7.25 are found in the regions related to the Aegean Arc and the North Anatolian Fault Zone. It can be said that computed a_m/b values increase towards the areas in which large and destructive earthquakes have occurred. Finally, a_m/b values are better-fitted than *b*-values of G-R frequency law to the tectonics and seismicity in and around Turkey. The

results show that the Aegean Arc and North Anatolian Fault Zone are ranked to the first position according to their seismicity. Thus, the modal values provide a brief atlas which depicts variations of seismicity throughout the investigated area.

REFERENCES

Bayrak, Y., Yılmaztürk, A., and Öztürk, S., 2002, Lateral variations of the modal (*a*/*b*) values for the different regions of the world, **J. Geodynamics,** 34, 653–666

Bayrak, Y., Yılmaztürk, A. and Öztürk, S., 2005, Relationships between fundamental seismic hazard parameters for the different source regions in Turkey, **Natural Hazards**, 36, 445-462

Erdik, M., Alpay, B. Y., Onur, T., Sesetyan, K., and Birgoren, G., 1999, Assessment of earthquake hazard in Turkey and neighboring regions, **Annali di Geofisica**, 42, 1125-1138

Gumbel, L. J., 1935, Les valeurs extrèmes des distribution statistiques, **Ann. Inst. Henri Poincarè**, 5, 815-826

Gumbel, L. J., 1966, Statistics of Extemes, **Columbia University Press**, New York, N.Y., 375pp

Gutenberg, R., and Richter, C. F., 1944, Frequency of earthquakes in California, **Bull. Seismol. Soc. Am**., 34, 185-188

Tsapanos, T. M., 1990, b-values of two tectonic parts in the circum-pacific belt, **Pageoph.**, 134, 229-242p

Yılmaztürk, A., Bayrak, Y., and Çakır, Ö., 1999, Crustal seismicity in and around Turkey, **Natural Hazards**, 18, 253–267