Investigation of Seismicity Risk Analysis in Konya with GIS

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Key words: Geographic Information Systems (GIS), Seismicity Risk Analysis, Open Source Software, Closed Source Software

SUMMARY

Earthquakes, floods, landslides, rockfalls, drought, snow avalances are leading natural hazards. Since the beginning of the 20th. century about 87.000 people has lost their lives and a further 210.000 people have been injured due to natural disaster. Natural hazards and disasters can have significant impacts on the economic and social development of Turkey .Turkey is one of the countries on the world with high seismic risk.. When Turkey's statistics on natural disasters are examined earthquakes are cause many casualties than the other natural hazards.

There are many methods developed for the identification of such disasters. Among these Geographic Information Systems (GIS), is an effective tool for natural hazard management. GIS is a systematic means of geographically referencing a number of "layers" of information to facilitate the overlaying, quantification, and synthesis of data in order to orient decisions.

The studies about earthquakes are only limited by settlements areas in Turkey but earthquakes occurrences are not only the city center, it also affects the towns and villages. Earthquake hazard and seismic risk studies should contain the remaining places in the whole province. Therefore, in this study, between the years 1900-2015 seismicity risk analysis performed in boundaries of the Konya province examining the earthquake epicenter point with GIS. In addition, the analysis performed with open and closed source software separately, it has been revealed comparison and differences between software**.**

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1. INTRODUCTION

Hazard means the probability of occurrence within a specified period of time and within a given area of a potentially damaging phenomenon (Varnes 1984).Natural hazards have always been associated with disasters and can be understood as unpredictable acts of nature, characterized by extremes in physical processes. Natural disasters are divided into geologic (earthquakes, tsunamis, volcanic eruptions…), atmospheric (tropical cyclones, tornadoes…) hydrologic (floods, droughts…) and biologic (epidemic diseases) categories (Smith 1996).Geological disasters like earthquakes and tsunamis often leave a devastating impact on human life and cause a high degree of damage particularly in developing countries. In the first decade of the 21st century, a large number of devastating earthquakes attacked highly populated urban areas in the world, and a huge amount of human, structural, and socioeconomic losses were reported due to the earthquakes (Table 1).

Table 1. Statistics of Recent Deathly Earthquakes (Source: USGS)

	1980-1989	1990-1999	2000-2009
Earthquakes with 1000 or more death	**11**	**14**	**9**
Estimated death toll	**58,880**	**114,646**	**465,357**

In recent years, growing population and urbanization have largely increased the impact of natural hazards both in industrialized and developing countries such Turkey. Turkey is situated on an active earthquake zone with shortest return periods and earthquakes caused loss of lives in the history. In the last century, over than twelve major earthquakes with minimum magnitudes 7 (Ms) caused significant casualties and extensive structural damage in Turkey (Arslan, 2007). Therefore, it becomes necessary to prepare landslide susceptibility, and hazard or risk maps. Many different methods and techniques have been suggested and used. Before and after natural disasters has attracted significant attentions among researchers and practitioners of disaster management. In this regard, advanced technologies, GIS, have become important new tools in disaster management. Using Geographic Information System (GIS) as the basic analysis tool for landslide hazard mapping can be effective for spatial data management and manipulation. There are many study which GIS is used in current literature such as Ghajari., (2016) Fernandez.(2016), Zhang, (2015), Hashemi and Alesheikh (2011), Sassa (2009), Alexander (2008), Corominas and Moya (2008), Carrara and Pike (2008), van Westen (2008, 2006), Keefer and Larsen (2007), Chacon (2006), Brenning (2005), Saha (2005), Wang (2005), van Westen (2004), Guzzetti (2003), Begueria and Lorente (2002), Dai and Lee (2002a), Guzzetti (1999), Aleotti and Chowdhury (1999), Dikau (1996), and Carrara (1999). Geographic Information Systems (GIS) have had a significant impact, and are currently being used in a variety of ways during all phases of disaster management.

In this study, between the years 1900-2015 seismicity risk analysis performed in boundaries of the Konya province examining the earthquake epicenter point with GIS. In addition, the analysis performed with open and closed source software separately, it has been revealed comparison and differences between software**.**

2. MATERIALS AND METHODS

Konya was chosen as the study site. It is the seventh most populous city in Turkey. By area it is the largest province of Turkey. 76.2 % of the population in Konya Province lives in the city, while the remaining 23.79 % lives in the villages, sub-districts and districts (Figure 1)

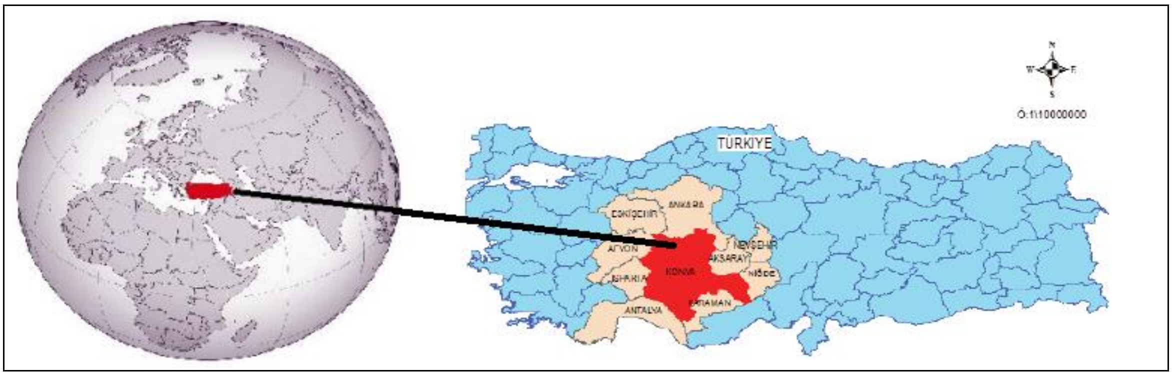


Figure 1. Study Area

The gathering of data is one of the most important and most costly aspects of Geographic Information System applications. In this phase, it is necessary to ensure regular data flow to the system in order to be able to operate the system to be created in an appropriate manner. It is also important to integrate these data into the system. Earthquake center points between 1900 and 2015 from the AFAD database were freely downloaded in CSV and KML format (Figure 2). Figure 2: Earthquake center points between 1900 and 2015 from the AFAD database The CSV file was recorded for years in the Excel environment (Table 2).

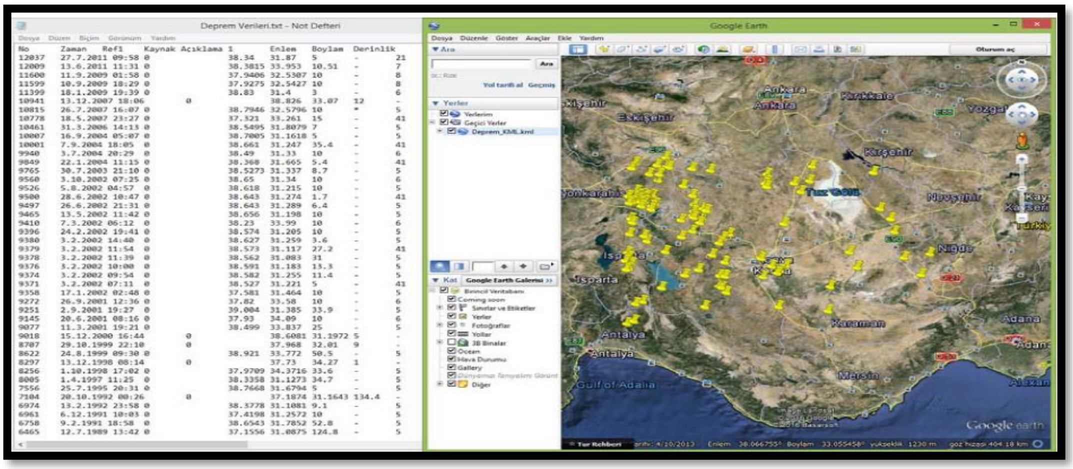


Figure 2. The CSV and KML File

Table 2. Earthquake Center Points Between 1900 and 2015

N	Zaman	Latitu	Longitu	Buyukl	T	YIL	No	Zaman	Latitu	Longitu	Buyukl	T	YIL
6	6.2.1900	38.1	31.29	5	M	190	579	22.2.1986	38.99	31.491	4	m	198
8	26.5.1902	37.7	31.07	5	M	190	578	17.1.1986	38.55	31.373	4	m	198
1	6.7.1903	38.1	31.26	4	M	190	614	27.11.1987	37.98	31.081	4	m	198
4	21.8.1914	38	31.5	4	M	191	614	26.11.1987	37.93	31.098	4	m	198
5	16.1.1918	38.8	32.9	5	M	191	634	22.12.1988	37.59	32.111	4	m	198
6	26.9.1921	38.4	31.79	5	M	192	634	24.12.1988	37.60	32.086	4	m	198
5	13.4.1921	38.4	31.8	5	M	192	634	24.12.1988	37.53	32.16	4	m	198
5	16.1.1921	38.3	32.79	5	M	192	634	1.1.1989	37.72	32.152	4	m	198
6	29.8.1922	37.3	32.73	4	M	192	646	12.7.1989	37.15	31.087	4	m	198
6	13.12.1924	38	33.5	4	M	192	696	6.12.1991	37.41	31.257	4	M	199
8	11.9.1930	37.3	31.18	5	M	193	675	9.2.1991	38.65	31.785	4	m	199
9	12.1.1931	38.5	31.9	5	M	193	697	13.2.1992	38.37	31.108	4	M	199
9	12.1.1931	38.4	31.8	5	M	193	710	20.10.1992	37.18	31.164	4	m	199
10	19.6.1934	37.8	31.13	5	M	193	755	25.7.1995	38.76	31.679	4	m	199
12	16.7.1946	38.6	31.15	5	M	194	800	1.4.1997	38.33	31.127	4	m	199
12	21.2.1946	38.2	31.79	5	M	194	829	13.12.1998	37.7	34.27	4	m	199
15	22.6.1956	38.4	31.94	4	M	195	825	1.10.1998	37.97	34.371	4	m	199
22	3.11.1966	38.9	31.1	4	m	196	862	24.8.1999	38.92	33.77	4	m	199
23	13.6.1967	39.0	31.14	4	m	196	870	29.10.1999	37.96	32.01	4	m	199
24	9.3.1968	38.2	31.1	4	m	196	901	15.12.2000	38.60	31.197	6	M	200
26	26.9.1968	38.7	32.6	4	m	196	927	26.9.2001	37.8	33.58	4	m	200
26	6.10.1968	38.81	32.60	4	m	196	914	20.6.2001	37.9	34.09	4	m	200
27	24.4.1969	38.4	31.9	4.4	m	196	907	11.3.2001	38.49	33.83	4	m	200
27	23.4.1969	38.4	31.9	4	m	196	925	2.9.2001	39.00	31.38	4	m	200
26	8.1.1969	37.8	31.1	4	m	196	950	28.6.2002	38.64	31.27	4	m	200
30	6.5.1970	38.9	31.3	4	M	197	938	3.2.2002	38.62	31.25	4	m	200
35	3.8.1972	37.88	32.147	4	M	197	937	3.2.2002	38.52	31.22	6	M	200
35	2.8.1972	37.71	32.563	4	m	197	949	26.6.2002	38.64	31.28	4	m	200
34	6.3.1972	39.09	31.476	4	M	197	956	3.10.2002	38.6	31.34	4	m	200
35	3.8.1972	37.84	32.809	4	m	197	952	5.8.2002	38.61	31.21	4	m	200
35	4.8.1972	37.78	32.743	4	m	197	946	13.5.2002	38.65	31.19	4	m	200
35	3.8.1972	37.76	32.715	4	m	197	941	7.3.2002	38.2	33.99	4	m	200
34	7.3.1972	38.10	32.086	4	M	197	939	24.2.2002	38.57	31.20	4	m	200
36	23.7.1973	38.17	31.672	4	M	197	935	17.1.2002	37.58	31.46	4	m	200
36	10.11.1973	37.88	31.060	4	m	197	937	3.2.2002	38.58	31.25	4	m	200
35	27.4.1973	38.7	32.97	4	m	197	937	3.2.2002	38.59	31.18	4	m	200
37	23.11.1974	37.79	31.865	4	m	197	937	3.2.2002	38.57	31.11	4	m	200
41	14.10.1977	37.36	31.934	4	m	197	937	3.2.2002	38.56	31.08	5	M	200
41	25.9.1977	38.63	31.08	4	m	197	976	30.7.2003	38.52	31.33	4	m	200
42	27.11.1977	37.72	32.09	4	m	197	1000	16.9.2004	38.70	31.161	4.2	m	200
42	10.3.1978	38.20	32.195	4	m	197	984	22.1.2004	38.36	31.66	4.2	m	200
42	24.2.1978	37.84	32.655	4	m	197	994	3.7.2004	38.4	31.33	4	m	200
45	26.5.1980	38.96	31.773	4	m	198	1000	7.9.2004	38.66	31.24	4	m	200
45	9.5.1980	38.90	32.600	4	m	198	1046	31.3.2006	38.54	31.807	4	m	200
47	10.4.1981	38.99	33.098	4	m	198	1081	26.7.2007	38.79	32.579	4	m	200
47	25.3.1981	37.73	31.716	4	m	198	1094	13.12.2007	38.82	33.07	4	M	200
50	14.3.1982	38.64	31.064	4	m	198	1077	18.5.2007	37.32	33.26	4	m	200
50	17.4.1982	38.16	32.128	4	m	198	1139	18.1.2009	38.8	31.4	4	M	200
55	23.6.1984	38.94	31.978	4	m	198	1160	11.9.2009	37.94	32.530	4	M	200
54	27.4.1984	38.89	31.410	4	m	198	1159	10.9.2009	37.92	32.542	4.8	M	200
57	17.11.1985	37.60	33.286	4	m	198	1203	27.7.2011	38.3	31.87	4	M	201
58	26.2.1986	38.98	31.51	4	m	198	1200	13.6.2011	38.38	33.95	4	M	201

The saved files have been converted to KML format online from maps data site. These files converted into KML format are opened in Global Mapper 16 program and converted into shapefile format. As a basemap, Konya region from the geofabric data of Open Street Map has been downloaded free in .shp format. In this study, ArcGIS and Quantum GIS software were used for Kernel Density Analysis. ArcGIS is commercial software and QGIS is open source software. Kernel Analysis is a nonparametric statistical method for estimating probability densities from a set of points. Kernel probability density estimation is well understood by statisticians, having been well explored since the 1950 (Warton 1989). In the programs, the radius must be determined for Kernel Analysis. The radius for the study area is 300 km.

3. RESULTS AND DISCUSSION

Earthquake external central data obtained from AFAD database between 1900 and 2015 were analyzed with open and closed source code software. Data with point features such as earthquake external center data can be analyzed according to density distributions. When the intensity of the earthquake center points between 1900 and 1950 is examined, it is difficult to interpret it due to the lack of data. There are only 16 earthquake data records in this time interval. It is observed that earthquake activity is more intense only on the western sides of Konya (Figure 3).

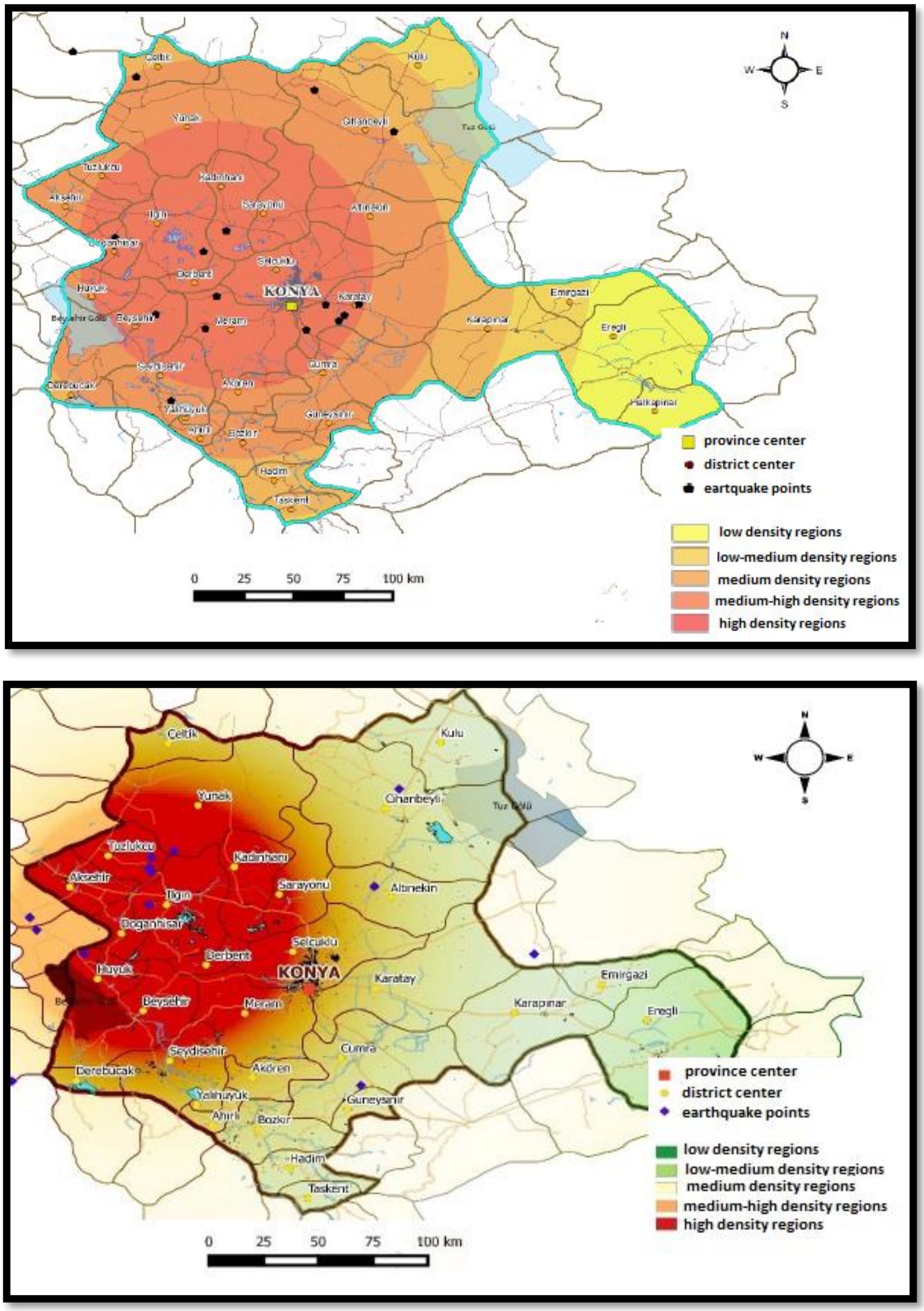


Figure 3. ArcGIS Quantum GIS - Konya 1900-1950 Seismicity Map

Between 1950 and 1970, there were 10 earthquake data recordings. In the analysis of the intensity of the earthquake out center points, it is observed that earthquake activities are more intense on the northwest side of Konya (Figure 4).

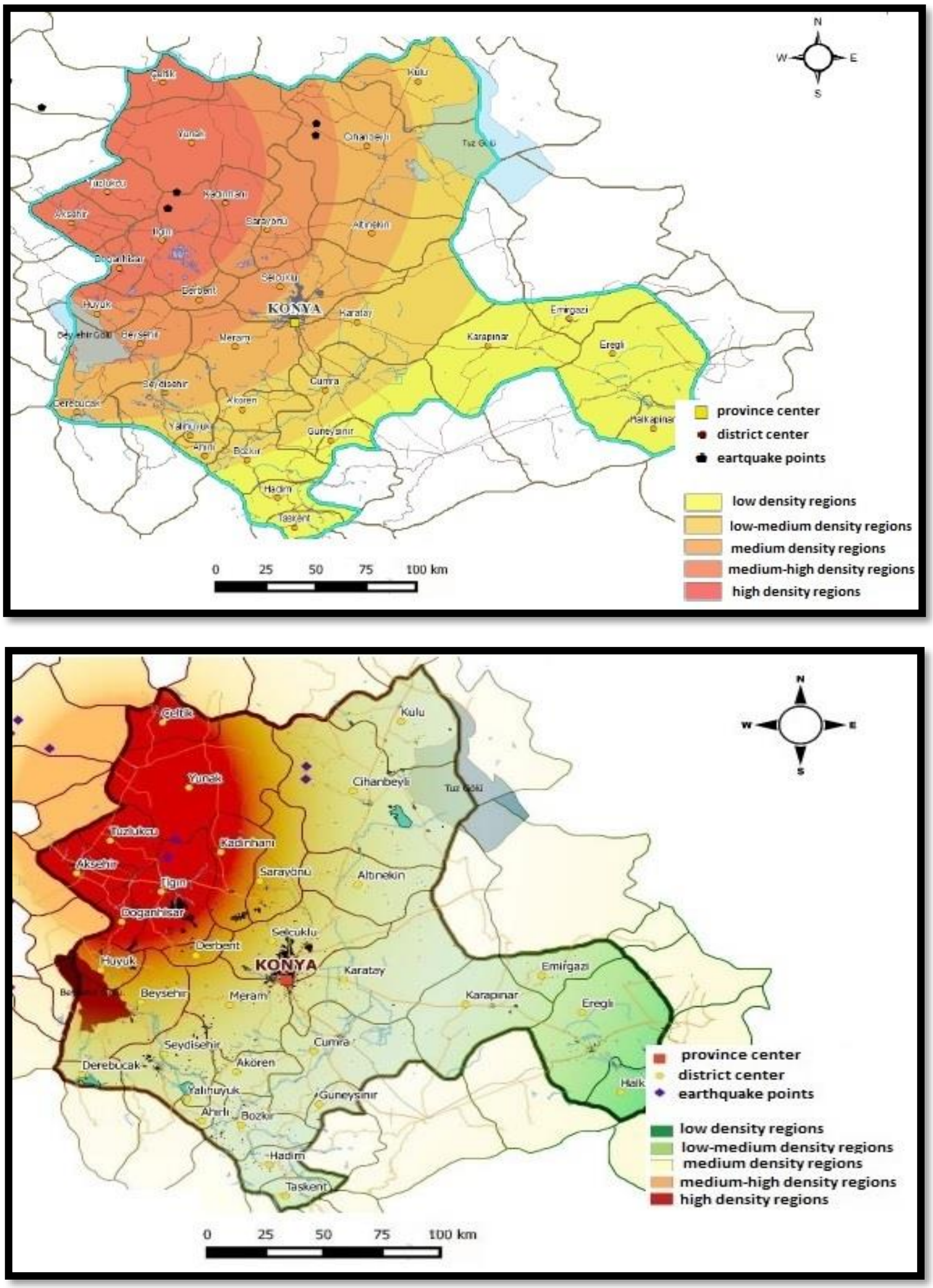
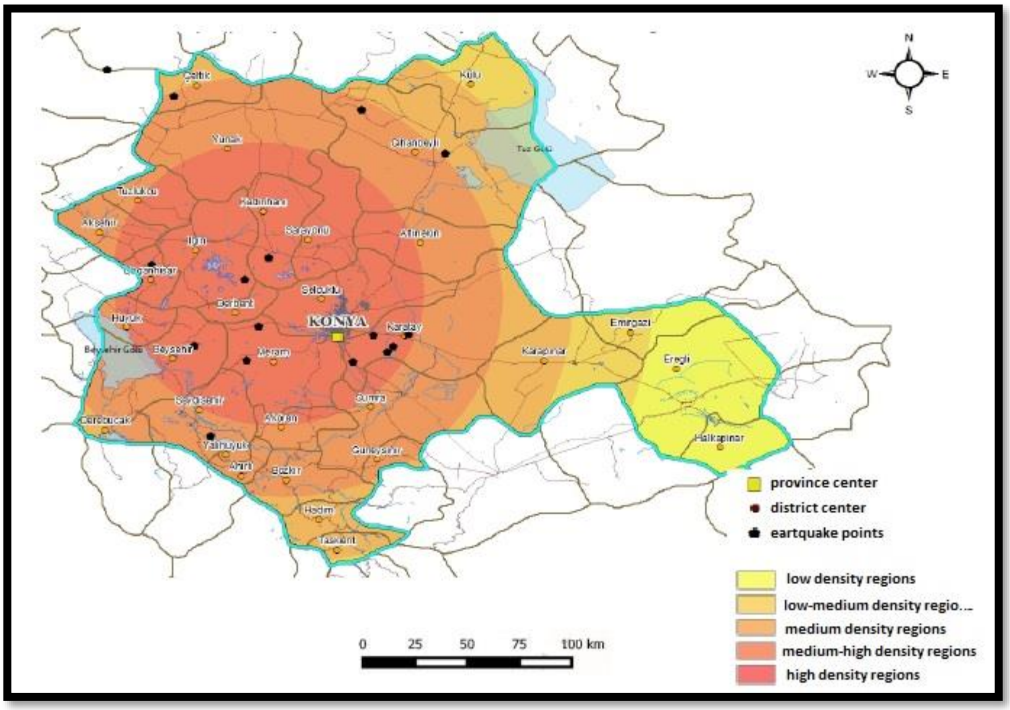


Figure 4. ArcGIS Quantum GIS - Konya 1950-1970 Seismicity Map

Between 1970 and 1980, earthquake outcrops were observed to converge from the Konya Fault Zone to the East, in the city center on the west side (figure 5). There are 18 earthquakes recorded in this time interval (Figure 5).



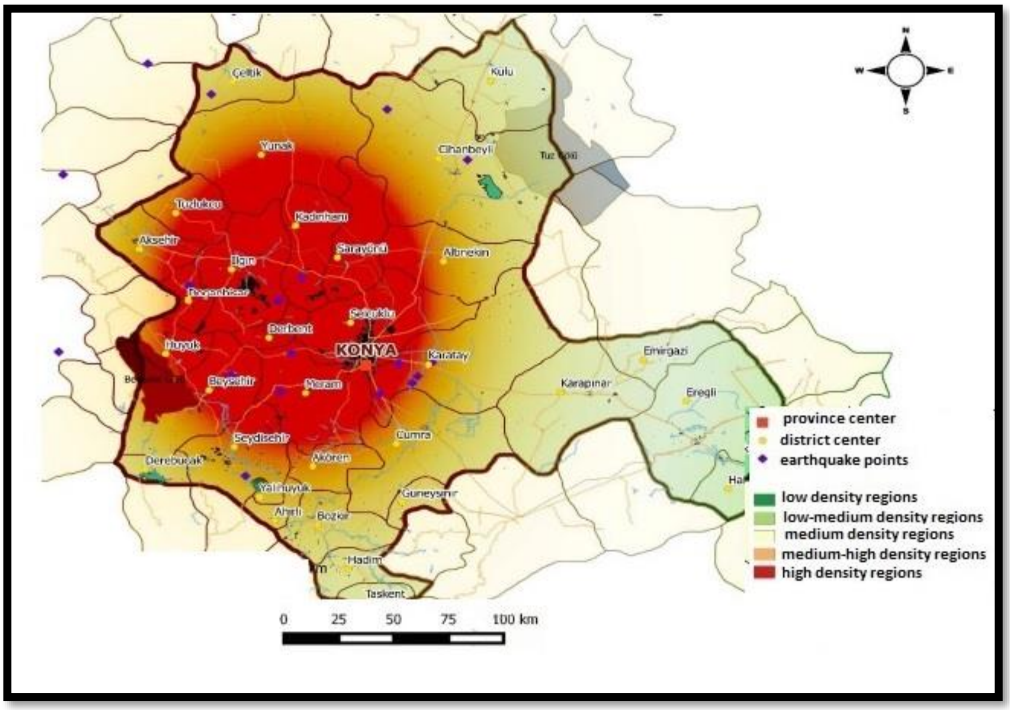


Figure 5. ArcGIS Quantum GIS - Konya 1970-1980 Seismicity Map

Between 1980 and 1990, there were 17 earthquakes. It was observed that the external center density of the earthquake advanced westward along the Konya Fault (Figure 6).

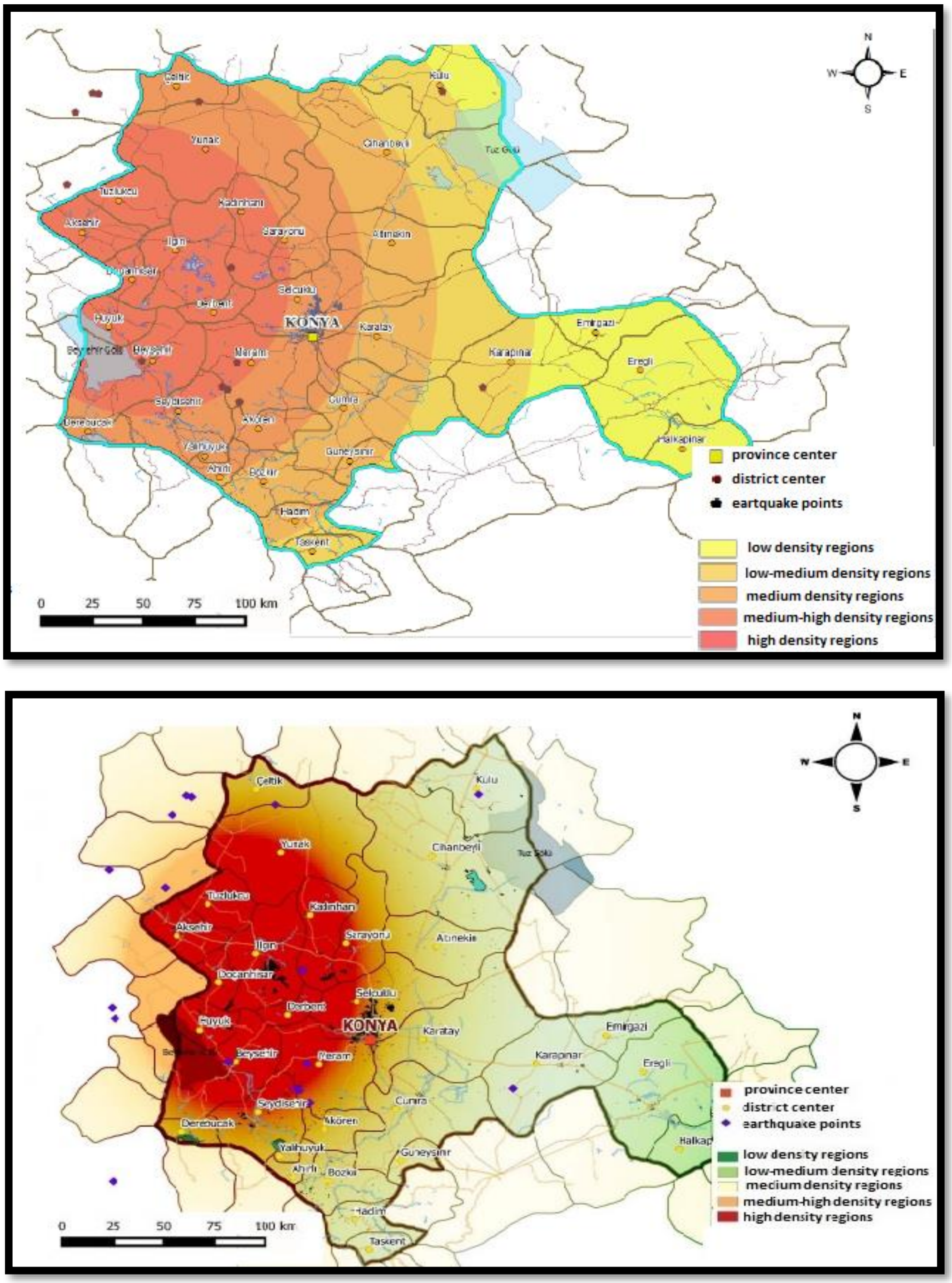


Figure 6. ArcGIS Quantum GIS - Konya 1980-1990 Seismicity Map

Between 1990 and 2000, earthquake activity is generally seen to be concentrated on the western side of the provincial border. During this period of time, 11 earthquakes occurred and it was understood that the intensity was not seen around the city center of Konya, but on the west side of the city (Figure 7).

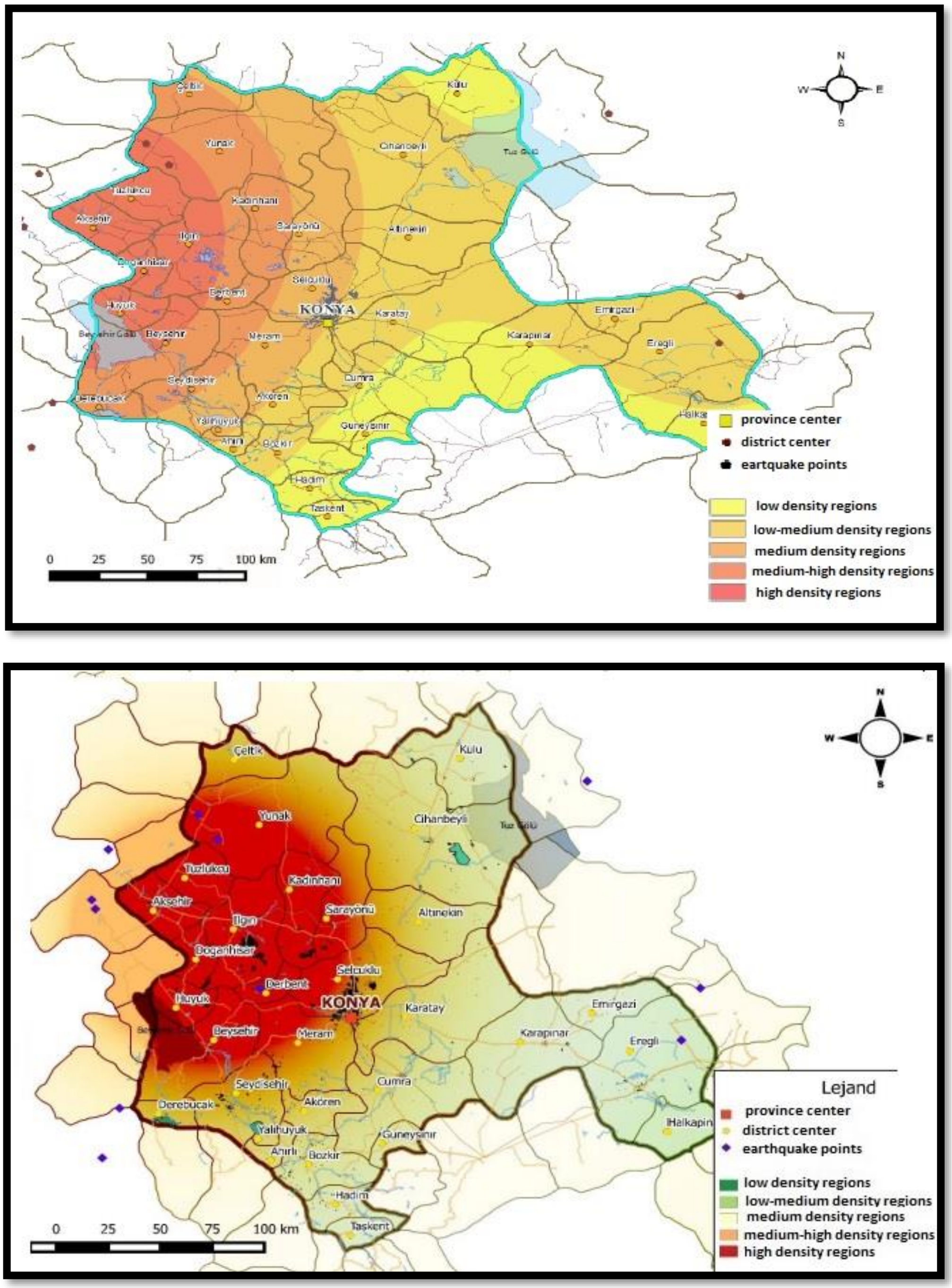


Figure 7. ArcGIS Quantum GIS - Konya 1990-2000 Seismicity Map

The period from 2000 to 2015 is the period when earthquakes are the most popular. During this time, there are 32 records of earthquake data. It was observed that the density distribution of these earthquakes also extended west-northwest along the Konya Fault Zone (Figure 8).

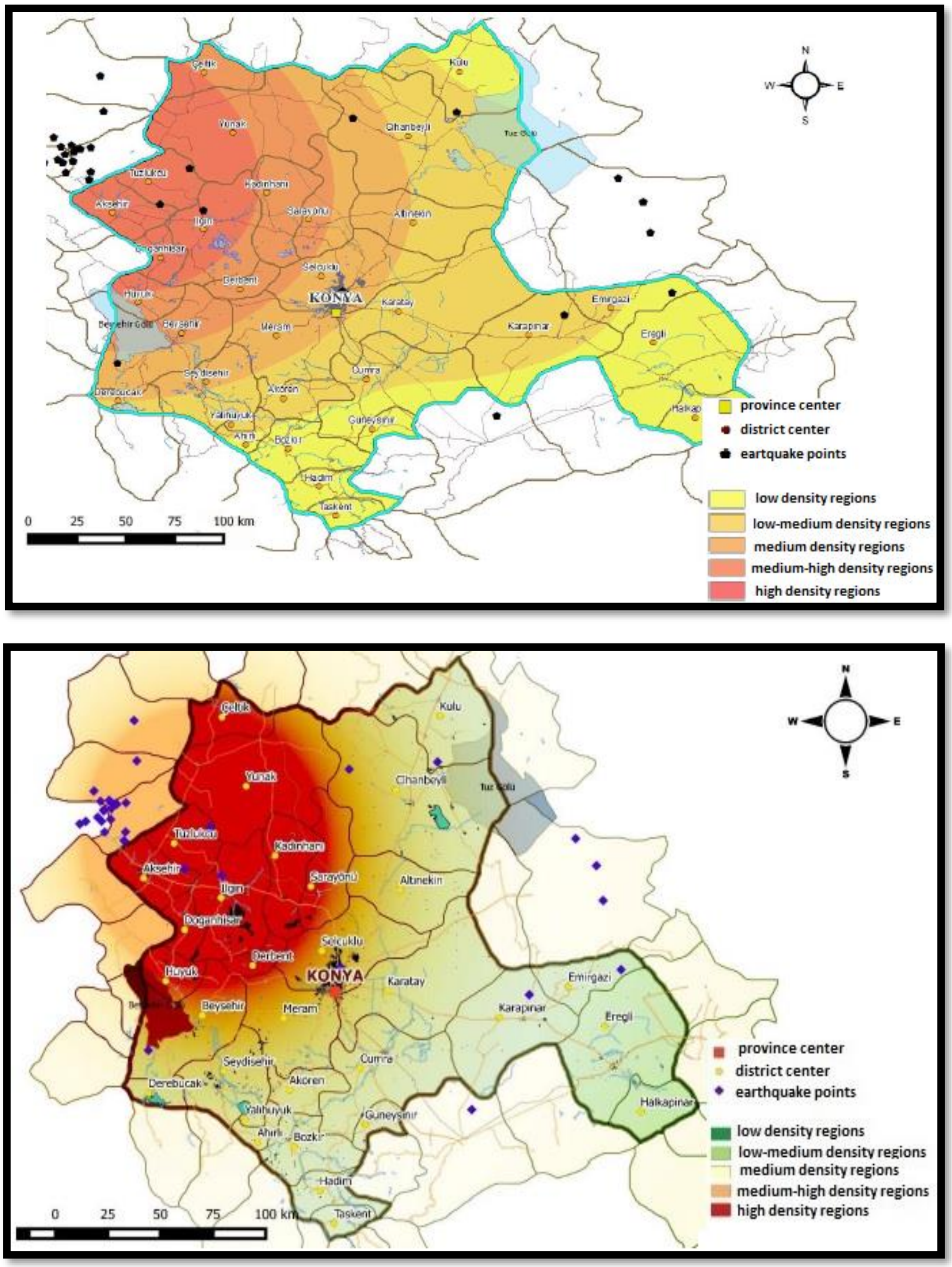


Figure 8. ArcGIS Quantum GIS - Konya 2000-2015 Seismicity Map

Earthquakes between 1900 and 2015 were analyzed as a whole in the central data (figure 9).According to the density analysis of the earthquake centers in Konya province, it is understood that the density of Konya extends in the west-northwest direction.

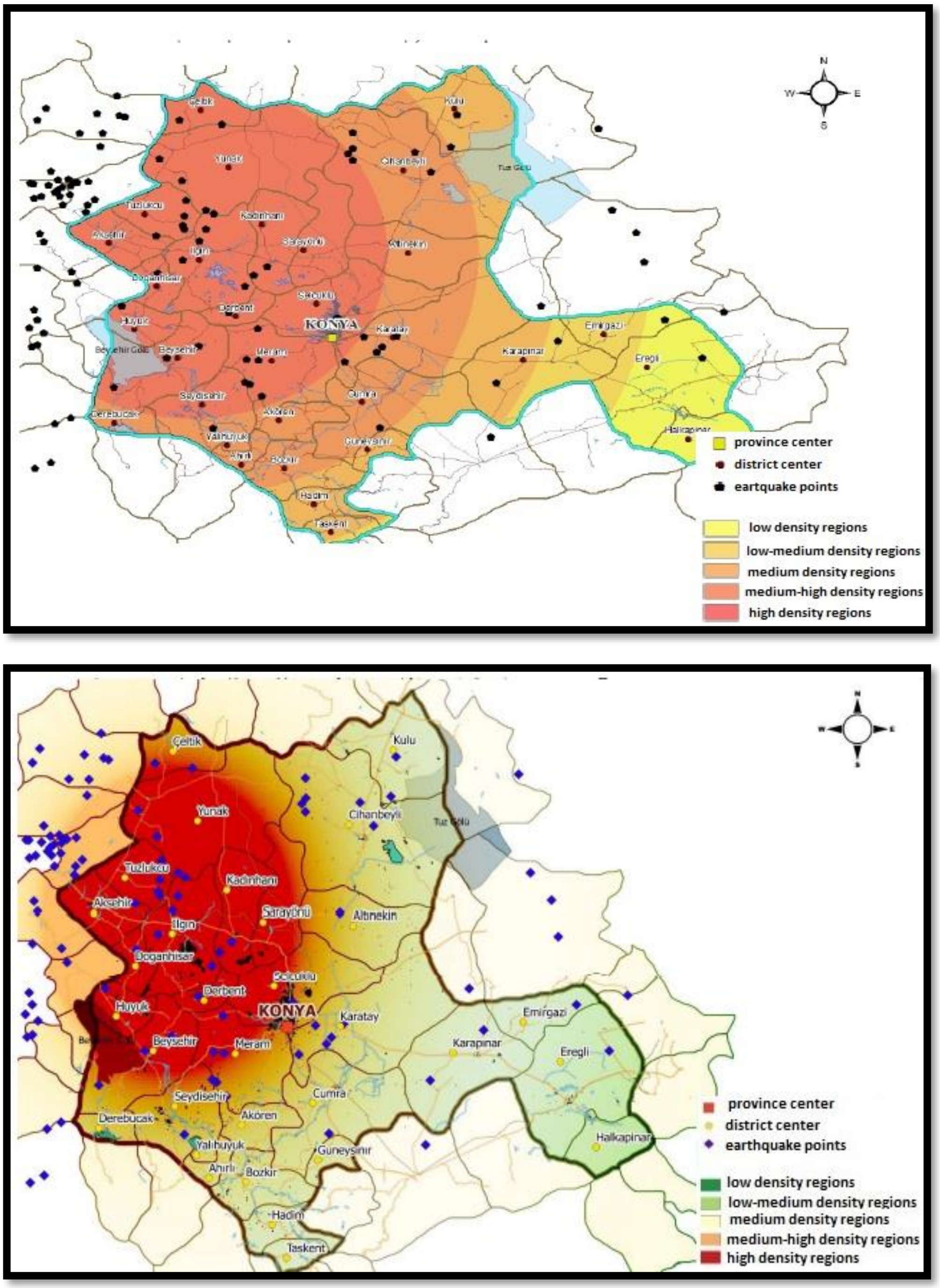


Figure 9. ArcGIS Quantum GIS - Konya 1900-2015 Seismicity Map

Earthquake Hazard Zones were determined by transferring to the ArcGIS and QGIS programs Earthquake Zones produced from active faults obtained from the Mine Technical Search Agency's Geoportal and earthquake outer-center points. The West-Northwest extension Konya was identified as the most dangerous zone (Figure 10).

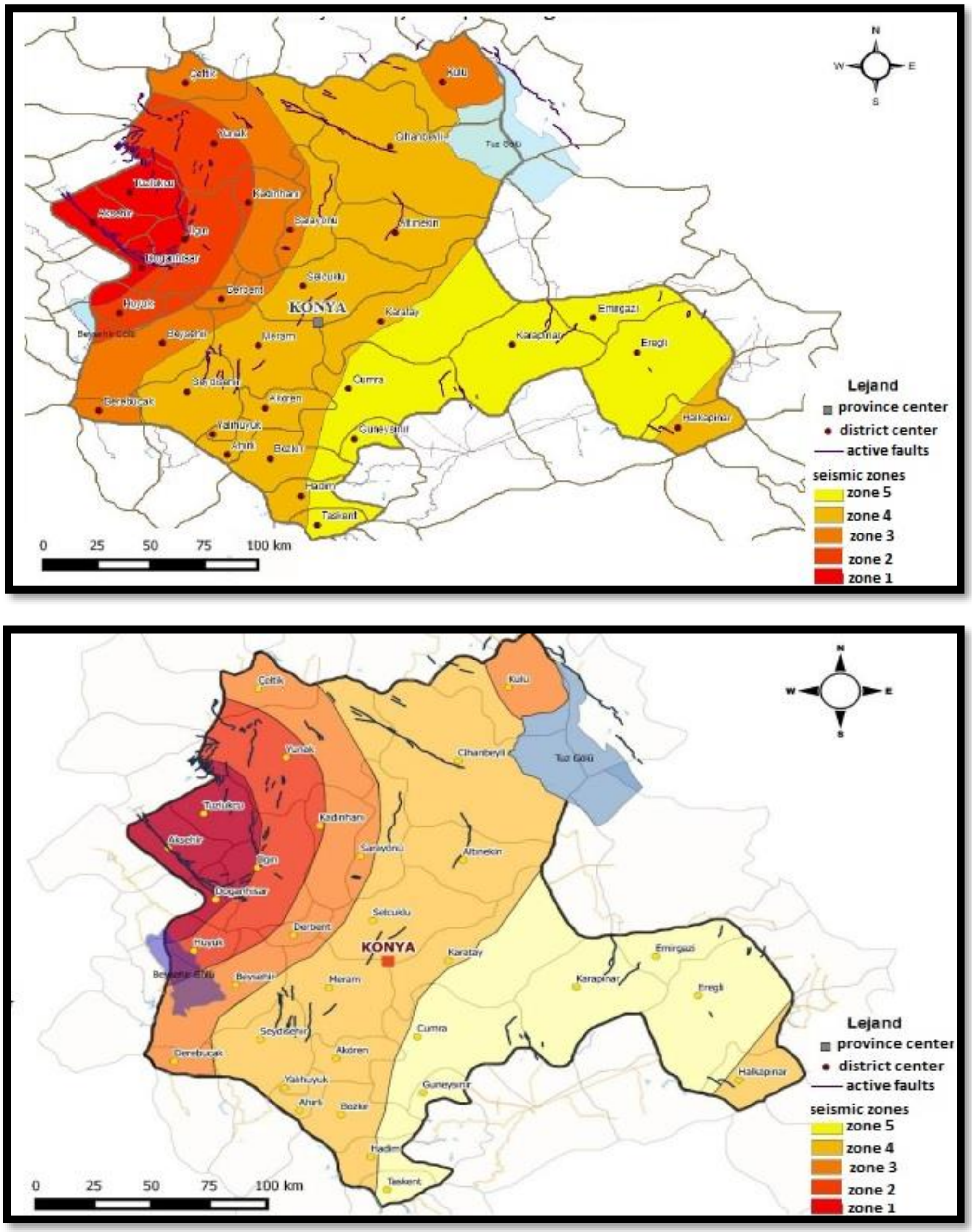


Figure 10. ArcGIS Quantum GIS - Konya 1900-1995 Seismicity Map

4. CONCLUSION

Between 1900 and 2015, obtained from the AFAD database, density maps generated with the help of earthquake external center data were obtained with open and closed source software. According to the density analysis carried out in Konya province borders, it is seen that seismicity is higher in the West of Konya. When the district borders of Konya are considered, Aksehir, Tuzlukcu, Ilgin, Doganhisar and Huyuk districts are defined as "High Dangerous Regions" in comparison with other districts. It has been seen that the dangerous regions determined in the earthquake region maps created with the active faults and the earthquake external center points are used and the determined dangerous regions have consistent results with each other. It has also been seen that it gives consistent results in maps prepared according to Kernel Density Distribution in different GIS software.

There is no difference in ease of use between QGIS and ArcGIS. QGIS is a constantly renewing platform. It has been seen that different analysis tools can be added to the basic version for free. In cartographic mapping production, the transition between color tones has been found to be softer in QGIS software. With QGIS software, it seems that accurate and consistent results are obtained without paying any license free.
In addition, QGIS is continually updated and can be installed and uninstalled on demand, so that the computer runs unnecessarily, it runs more quickly, and different analysis tools can be added to the basic version easily and continuously if needed. In ArcGIS, the most basic version is very expensive and limited. Different add-ons are bought at high prices and added to the software.

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BIOGRAPHICAL NOTES

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