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Natural Disaster Potential and Risk Reduction Recommendations of Agri (Turkey) Province and Its Surroundings

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INFORMATION

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ABSTRACT

Agri Province and its immediate surroundings are areas at risk of natural disasters. It is frequently affected by these disasters and poses serious threats to the safety and quality of life of the people of the region. The most common natural disasters in the study area are floods, landslides, rockfalls, avalanches, and earthquakes. Disasters such as landslides, rock falls and avalanches occur frequently due to the geological and topographic characteristics of Agri Province and its immediate surroundings, which consist of depression plains surrounded by high mountains and high slope-elevation values. Disaster events that have occurred or are likely to occur to date have been compiled from the AFAD Provincial Directorate archive (IRAP-AGRI, 2021), and it has been observed that flood and avalanche disasters occur at a higher rate than the countrywide. Flood disaster is the most common natural disaster throughout the province, and due to global climate changes, it is frequently seen especially in settlements near streams. Landslide disaster is especially seen in Eleşkirt-Center, Diyadin, Doğubayazıt, Hamur, and Tutak Districts, where topographic slope values are high. Rock falls are seen in Eleşkirt-Center, Doğubayazıt, Diyadin, and Hamur Districts. Due to the continental climate prevailing in the region and heavy snowfall throughout the province, avalanche disasters are seen especially in settlements surrounded by high mountains such as Köse Mountain and Süphan. These types of disasters occur together, and it is thought that the trigger mechanism for multiple disasters to occur together is mostly caused by earthquakes. To prevent natural events from turning into disasters, engineering applications in residential areas should be carried out by considering the geological and geotechnical characteristics of the region. In addition to these measures, Provincial Disaster Preparedness Plans, Community Information and Awareness Programs, Infrastructure Strengthening and Restructuring, Post-Disaster Rapid Recovery Strategies, and Provincial Disaster Risk Reduction Plans should be prepared.

1. Introduction

Considering its geological, tectonic, morphological structure, and climatic conditions, our country is among the countries where natural disasters occur frequently. In order of importance, Due to the effect of global climate changes, natural disasters such as earthquakes, floods, landslides, rockfalls, avalanches, and storms occur frequently, causing loss of life and property. Failure to take necessary precautions against these disasters further increases the loss of life and property.

Natural disasters that occur in our country occur in many parts of the world due to their general characteristics. Despite this, natural disasters such as earthquakes, floods, landslides, avalanches, and rockfalls cause loss of life and property beyond expectations. This situation is incompatible with the level that today's Turkey has reached in the field of science and technology. To prevent natural disasters that may occur with the least loss of life and property, applications to be made in residential areas should be carried out by considering the geological and geotechnical characteristics of the region.

In engineering applications and regulations to be made in a region, it will be important to take the natural geological structure of the region into account and to take the necessary precautions to prevent the geological balance from being disrupted. Although the loss of life and property resulting from natural disasters can be reduced by taking precautions in advance, the importance of the work to be done before and after the disaster cannot be ignored. Unconscious behavior during a disaster and the resulting panic can cause people to be injured or even die. Trained people (such as AFAD teams) must undertake this task in post-disaster rescue efforts and early intervention, especially in reducing casualties. Instead of crowds who do not know what they are doing in the disaster area, the coordinated work of even slightly educated people will play an important role in reducing casualties.

2. Examination Area

Agri (Turkey) Province, which was determined as the study area, is one of the border provinces located in the east of our country. It is located between 39°-40° northern parallels and 42°-45° eastern meridians (Fig. 1). The province, named after Mount Ararat, is located at an altitude of 1640 meters above sea level.

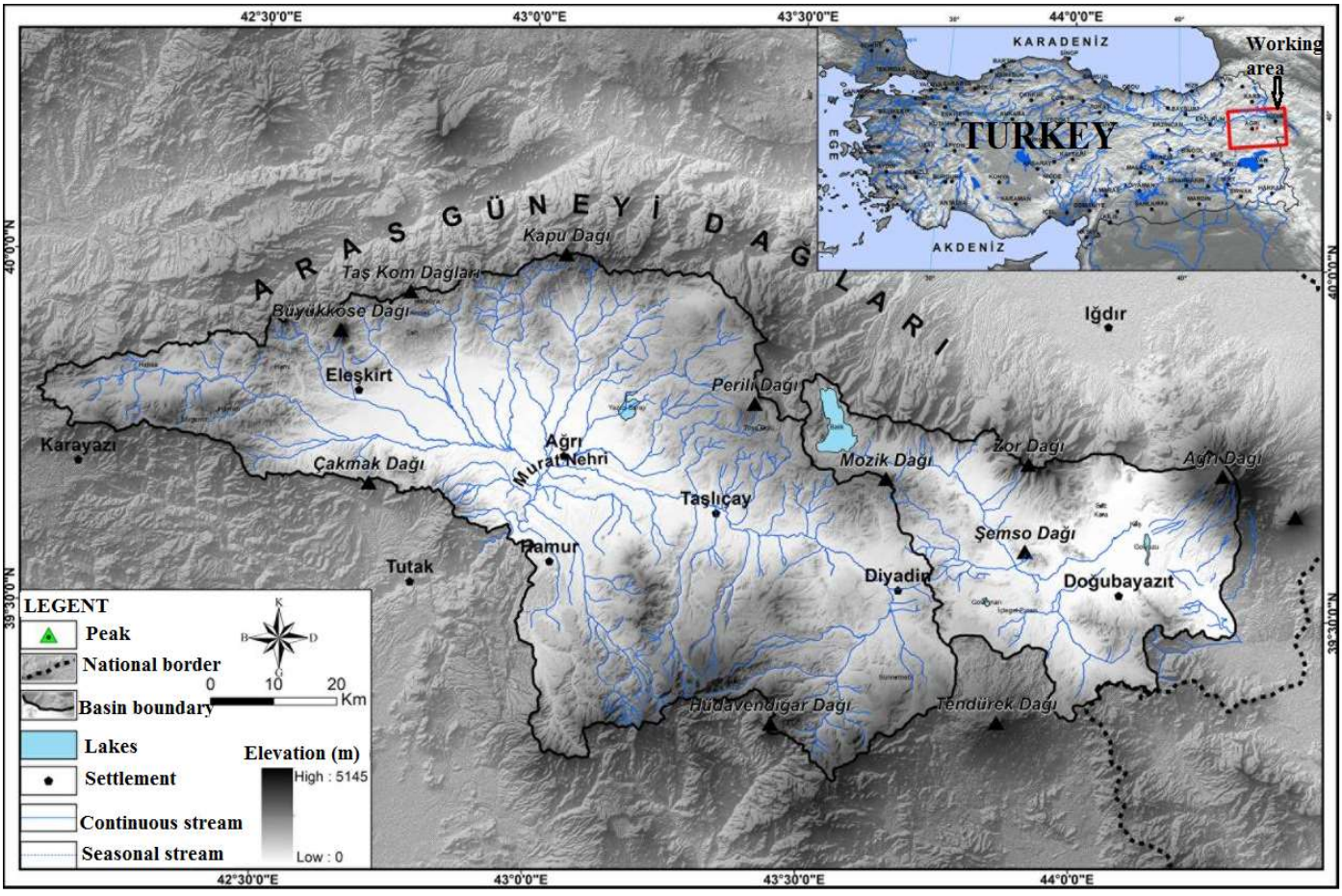

Fig. 1. Location map of Ağrı and Doğubayazıt Basins (revized from Toprak and Sunkar, 2019)

The Agri Basin, located within the borders of the Upper Murat - Van Section of the Eastern Anatolia Region and included in the Murat River Basin, is bordered by the Aras Güneyi Mountains (Taşkom Mountains) in the north and east, Kösedağ and Çakmak Mountains in the west, and Kılıç and Aladağlar in the south. Doğubayazıt Basin, which is included in the Aras River Basin, is bordered by Mount Ararat in the north and east, the extensions of the Aras Güneyi Mountains in the west, and Tendürek Mountain in the south, and is a basin opening to Iran (IRAP-Agri, 2021).

3. Geological Structure

The geology of Agri Province generally consists of volcanic cover rocks, pliyo-quaternary aged river, and lake sediments, and paleozoic-mesozoic aged metamorphics on their basis due to intense volcanic activities (IRAP-Agrı, 2021).

Agri and Doğubayazıt Basins are located in the east outside the Anatolian plate. There is right-lateral strike-slip faults in the Agri, Van and Igdir triangle. Among these faults, the Tutak, Balıkgölü, and Doğubayazıt Fault Zones, which limit the Agri and Doğubayazıt Basins within the study area, are NW-SE oriented, right lateral strike-slip faults. These faults are in the form of shear zones consisting of several parallel and semi-parallel fault segments, with a width ranging from a few hundred meters to 8 km (Tapan, et al., 2005). Active faults in the immediate surroundings of Agri Province are shown in Fig. 2.

4. Method

In the evaluation of the disaster events, the report data were used that were transferred to the electronic environment within the framework of the Disaster Information Inventory Project in the archives of the Disaster and Emergency Management Presidency-General Directorate of Earthquake and Risk Reduction and Agri Governorship Provincial Disaster Emergency Directorate-AFAD, Provincial Disaster Risk Reduction Plan, IRAP-Agri Data obtained from 2023 databases. Considering the spatial distribution of the data obtained as a result of this process, an attempt was made to determine the risk reduction solutions that should be adopted and implemented today.

5. Data Findings

5.1. Natural Disasters Affecting Agri Province and Its Surroundings

Disasters frequently experienced in Agri Province and its immediate surroundings are listed as floods, landslides, earthquakes, rock falls, and avalanches. Disasters such as landslides, rock falls and avalanches occur frequently in Agri Province, as it consists of collapsed plains surrounded by high mountains and has high slope-height values. Disaster events that have occurred or are likely to occur to date have been compiled from the archives of Agri AFAD Provincial Directorate, and it is seen that flood and avalanche disasters are at a high rate when compared to the countrywide.

5.1.1. Floods

Floods and floods caused by excessive rainfall and snowmelt are the most common disasters in Agri (Turkey) Province and its immediate surroundings. It is commonly seen in stream beds and their immediate surroundings. Floods and overflow events significantly affect residential areas close to stream beds.

5.1.2. Landslide

Landslides that occur in Agri and its immediate surroundings, where geomorphological and climatic characteristics are effective, are affected by snowmelt and heavy rainfall, especially in the spring months. Landslide disasters are most intensely seen in Eleşkirt, Diyadin, Doğubayazıt, Hamur, and Tutak Districts, where topographic slope values are high.

5.1.3. Rockfalls

Rock falls are seen throughout the province in Eleşkirt-Merkez, Doğubayazıt, Diyadin, and Hamur districts, and are most intensely seen around Köse Mountain, Süphan Mountain, and Agri Mountain and around residential areas surrounded by high mountains consisting of block-sized volcanic rocks.

5.1.4. Avalanche

Due to the dominance of continental climate conditions in Agri Province and its immediate surroundings, snow depth increases significantly due to heavy snowfall in winter. Avalanches occur on sloping slopes where excessive amounts of snow accumulate, there are temperature changes and sometimes triggered by earthquakes. Avalanche events are frequently seen in provincial and district settlements such as Köse Mountain, Süphan Mountain, Agri Mountain and Agri, Eleşkirt, Hamur and Diyadin.

5.1.5. Earthquake

Agri Province and its immediate surroundings have been exposed to earthquake disasters in historical and instrumental periods due to its geological location and geomorphological characteristics. In the pre-1900 period, which is considered the historical period, heavy damage occurred in the earthquakes of 1002/03, 1104, 1151, 1319, 1605, 1647, 1679, 1707, 1766, 1840 in Agri Province and its surroundings. Kağızman-Agri-Igdir and Yerevan Regions. It was stated in E. Lahn's (1957) article published in the Journal of the Turkish Geographical Society in 1957 (IRAP-Agri, 2021).

During the period from 1900, which is considered the instrumental period, to the present day (1900-2018), 4 earthquakes of 5-5.9 instrumental magnitudes, 4 earthquakes of 6-6.9 instrumental magnitudes, and 2 earthquakes of 7-7.9 instrumental magnitudes have occurred. dead. In the Van earthquake with an instrumental magnitude of 7.5 that affected the region in 1976, 9,232 buildings were damaged and 3,840 people lost their lives (Eyidoğan et al., 1991). In addition, on October 23, 2011, the earthquake, whose epicenter was Tabanlı village, 17 kilometers away from Van, and whose instrumental magnitude was Mw = 7.2, was felt in 13 more provinces, including Agri. In this earthquake, 2262 buildings collapsed and 601 people lost their lives (https://tr.wikipedia.org/wiki/Ekim-2011-Van_earthquake).

Agri and Doğubayazit Basins are in the second-degree earthquake zone (AFAD, 2023) (Fig. 3). With these types of disasters, more than one type of disaster occurs together. Disasters called multiple disasters are especially seen in regions where geological-geotechnical and climatic conditions create the environment. In such cases, landslides, rock falls, floods and/or avalanches occur together in residential areas. It is stated that the co-occurrence of more than one disaster is mostly caused by earthquakes as a trigger mechanism (IRAP, Agri, 2021).

According to the disaster database of the Disaster and Emergency Management Presidency, 1025 natural disasters occurred in the Agri and Doğubayazit basins between 1955 and 2018 (Table 1). Wherever the name Agri is mentioned, the first thing that comes to mind when disaster is mentioned is Noah's Flood, and Agri and Doğubayazit basins are places identified with the disaster. Agri stood out as a province with a high disaster risk, with a total of 1025 disasters occurring across the province between 1955 and 2018. According to administrative borders (Table 2).

Table 1. Types and Numbers of Natural Disasters Occurring in Agri Province and Its Surroundings (Toprak and Sunkar, 2019)

Natural disasters	Landslides	Rockfalls	Floods	Avalanches	Earthquake	Other disasters
1955 and 2018	151	40	547	23	123	141

Table 2. Distribution of natural disasters occurring in the immediate surroundings of Agri according to administrative borders (Toprak and Sunkar, 2019)

Administrative borders	Center	Doğubayazıt	Diyadin	Taşlıçay	Patnos	Eleşkirt	Hamur	Tutak
1955 and 2018	188	285	191	70	15	153	67	56

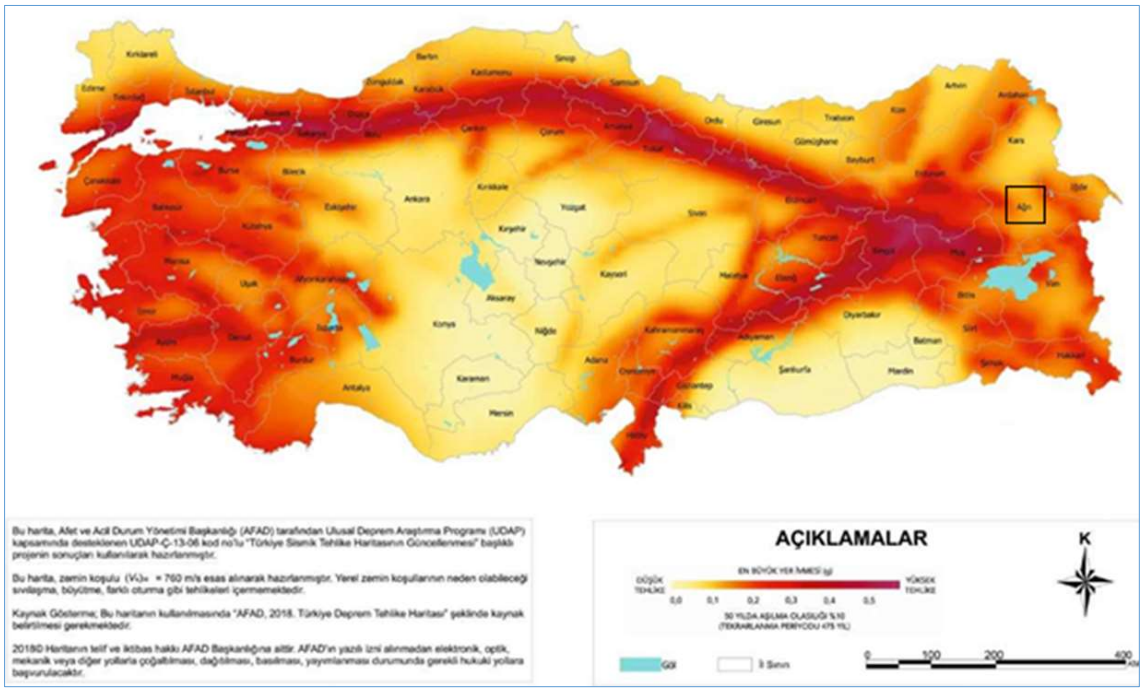

Fig. 3. Türkiye Earthquake Hazard map-2023 (AFAD/earthquake.afad.gov.tr)

The study area, located in the Eastern Anatolia Region, is important in terms of reflecting the fact that Turkey is an earthquake country and revealing the fact of earthquakes, one of the important natural disasters of the region. To minimize the destructive effect of the earthquake in the study area, earthquake-resistant buildings should be produced by revealing detailed geological features as well as the geotechnical properties of the ground on which the building will sit. Planning should be made considering conditions such as residential area plans, improvement of existing places, and detailed information on earthquake response. Selected images from natural disasters experienced in Agri Province and its immediate surroundings are shown in Figs. 4-8.

Fig. 5. Agri-Telceker Landslide, AFAD

Fig. 4. Agri-Diyadin Kapanca Village rock falls, AFAD

Fig. 6. Agri-Taslıcay Gozucu Flood, AFAD

Fig. 7. Agri-Catalipasa Avalanche, AFAD

Fig. 8. Van Earthquake-2011
(https://en.wikipedia.org/wiki/2011_Van_earthquakes)

Fig. 9. Van Earthquake-2011
(https://tr.wikipedia.org/wiki/Dosya:AKUT_2011_Van-1.jpg)

6. Conclusions and Recommendations

The fact that 547 of the 1025 natural disasters that occurred in Agri Province and its immediate surroundings between 1955 and 2018 were floods and floods, indicating that residential areas were established in high-risk areas. Agri and Doğubayazit Provinces are the most striking examples of this negative situation. Landslides throughout Agri Province also affect rural settlements. Landslides, where geological, geophysical, geomorphological and climate characteristics are effective, are triggered by snow melting and spring precipitation (Toprak and Sunkar, 2019). Rockfalls often occur in areas where volcanics, especially basalts, cover large areas and affect rural settlements. In addition to geophysical and geomorphological features, the effect of continental climate is also observed in rock falls throughout the province. Avalanche events occur on higher slopes where snowfall increases. Excessive snow, high slopes and sudden temperature changes are effective in avalanche disaster.

Agri and Doğubayazıt basins are a region where earthquakes occur frequently due to their tectonic features. However, very severe earthquakes are not observed. Agri and Doğubayazit basins are in the second-degree earthquake zone (AFAD, 2023) (Fig. 3). Especially the 5.0 magnitude earthquake that occurred in Doğubayazit in 2004 was also effective in Agri Province and its immediate surroundings. Since these losses experienced in a moderate earthquake are seen especially in rural areas, it is a very important result in terms of questioning the relationship between earthquake and building material and building style.

With the increasing frequency of natural disasters throughout Turkey in recent years, losses of life and property are also increasing. The fact that natural disasters cause a lot of loss of life and property shows that this event is among the problems that need to be solved first. Parallel and complementary actions need to be considered to reduce exposure to disasters and achieve a more sustainable development approach.

We must live with the awareness that Turkey is an earthquake country, and with this awareness, we must build earthquake-resistant structures in areas determined by science and technology and strengthen our buildings accordingly. For this reason, multidimensional and multidisciplinary studies must now become a necessity in order to reduce the destructive and lethal effects of the earthquake. It will be possible to minimize the damages caused by natural disasters, especially earthquakes, with projects prepared according to the basic characteristics of the region (natural disasters such as earthquakes, landslides, rock falls, floods, avalanches).

It should not be forgotten that natural disasters can be caused by technological and human reasons, and this situation affects the people in the disaster area physically, economically and socially. In this context, Local Disaster Preparedness Plans, Disaster Management Plans of Municipalities, Community Information and Awareness Programs, Infrastructure Strengthening and Restructuring, Post-Disaster Rapid Recovery Strategies, Emergency Equipment and Early Warning Systems and Provincial Disaster Risk Reduction Plans (IRAP). It should also be known that the developments and problems experienced throughout Turkey should be shaped according to disaster trend analyzes based on administrative borders.

References

AFAD-2023. AFAD-2023/earthquake.afad.gov.tr

Bayraktutan, M.S., 1999. Active tectonics and evolution of thrust bounded Pasinler Basin on the Erzurum Fault Zone, Eastern Anatolia. Vol. XIII-N.1-2-51-70 1999.

Eyidoğan, H., Güçlü, U., Utku, Z., Değirmenci, E., 1991. Turkey Major Earthquakes Macro-Seismic Guide (1900-1988), Istanbul

Technical University, Faculty of Mining, Geophysical Engineering Department, Istanbul.

IRAP-Agri, 2023. Provincial disaster risk reduction plan. AgriGovernorship Provincial Disaster Emergency Directorate. AFAD.

Koçyiğit, A., Yılmaz, A., Adamia, S., Kuloshvili, S., 2001. Neotectonics of East Anatolian Plateau (Turkey) and Lesser Caucasus: implication for the transition from thrusting to strike-slip faulting. Geodinamica Acta 14, 177-195.

Philip, H., Cisternas, A., Gvishiani, A., Gorshkov A., 1989. The Caucasus is an actual example of the initial stage of continental collision. Tectonophysics 161, 1-21.

Tapan, T., Özvan, A., Şengül, A., 2005. July 2004 Doğubayazıt Earthquake Location-Structure Relationship and Losses. Earthquake Symposium Kocaeli 23-25 March 2005.

Toprak, A., Sunkar, M., 2019. The Analyse of Spatial Distribution of Natural Disasters at Agri and Doğubayazit Basins. The Fifth International Mount Ararat and Noah's Ark Symposium. 16th-18th October 2019-Agri, Turkey.