

# ***Examining the Impact of Natural Disasters on Air Transportation: The Example of the February 6, 2023 Kahramanmaraş Earthquake***

*Doğal Afetlerin Hava Taşımacılığına Etkisinin İncelenmesi: 6 Şubat 2023 Kahramanmaraş Depremi Örneği*

Ahmet ERTEK\*

## **ABSTRACT**

*This study examines the impacts of the Kahramanmaraş-centered earthquakes that occurred on February 6, 2023, on air transportation. Due to their sudden and destructive nature, earthquakes cause serious disruptions to transportation systems; damage to air transportation infrastructure, in particular, directly impacts passenger transportation, logistics activities, and disaster response processes. In this context, the study analyzed passenger, aircraft, and cargo traffic data from airports in the provinces of Kahramanmaraş, Hatay, Adıyaman, Malatya, Diyarbakır, Gaziantep, Adana, Şanlıurfa, and Elazığ. The study's unique contribution is its quantitative analysis of the impact of post-disaster evacuation and relief operations on aviation traffic. The study conducted a comparative analysis of statistics published by the State Airports Authority for 2022 (pre-earthquake), 2023 (earthquake year), and 2024 (post-earthquake). The findings indicate that Hatay Airport suffered the greatest loss due to infrastructure damage; It reveals that Kahramanmaraş and Adıyaman saw an increase in evacuation and relief flights. While Adana emerged as a temporary hub, airports in surrounding provinces served as capacity-building hubs. The results demonstrate that natural disasters have multifaceted impacts on air transportation, and that infrastructure resilience and "disaster flight protocols" are critical in disaster management.*

## **KEYWORDS**

*Airline, Airport, Air transportation, Earthquake, Natural disaster*

## **Öz**

*Bu çalışma, 6 Şubat 2023'te meydana gelen Kahramanmaraş merkezli depremlerin havayolu taşımacılığı üzerindeki etkilerini incelemektedir. Depremler, ani ve yıkıcı doğaları gereği ulaşım sistemlerinde ciddi aksaklıklara yol açmakta; özellikle hava taşımacılığı altyapısındaki hasar, yolcu taşımacılığını, lojistik faaliyetleri ve afet müdahale süreçlerini doğrudan etkilemektedir. Bu bağlamda çalışmada Kahramanmaraş, Hatay, Adıyaman, Malatya, Diyarbakır, Gaziantep, Adana, Şanlıurfa ve Elazığ illerinde bulunan havalimanlarının yolcu, uçak ve kargo trafiği verileri analiz edilmiştir. Çalışmanın özgün katkısı, afet sonrasındaki tahliye ve yardım operasyonlarının havacılık trafiğini artırıcı etkisini nicel verilerle ortaya koymasındır. Araştırmada Devlet Hava Meydanları İşletmesi tarafından yayımlanan 2022 (deprem öncesi), 2023 (deprem yılı) ve 2024 (deprem sonrası) istatistikleri karşılaştırmalı olarak incelenmiştir. Bulgular, Hatay Havalimanı'nın altyapı hasarları nedeniyle en büyük kaybı yaşadığını; Kahramanmaraş ve Adıyaman'ın ise tahliye ve yardım uçuşlarıyla artış gösterdiğini ortaya koymaktadır. Adana geçici bir hub olarak öne çıkarken, çevre illerdeki havalimanları kapasite artırıcı merkez işlevi üstlenmiştir. Sonuçlar, doğal afetlerin havayolu taşımacılığı üzerinde çok boyutlu etkiler yarattığını ve afet yönetiminde altyapı dayanıklılığı ile "afet uçuş protokollerinin" kritik önem taşıdığını göstermektedir.*

## **ANAHTAR KELİMELER**

*Havayolu, Havaalanı, Hava taşımacılığı, Deprem, Doğal afet*

| Makale Geliş Tarihi / Submission Date<br>31.08.2025 |                                                                                                                                                                                                                                           | Makale Kabul Tarihi / Date of Acceptance<br>03.10.2025 |  |
|-----------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|--|
| Araf                                                |                                                                                                                                                                                                                                           |                                                        |  |
|                                                     | Ertek A., (2025). Examining the Impact of Natural Disasters on Air Transportation: The Example of the February 6, 2023 Kahramanmaraş Earthquake. <i>Selçuk Üniversitesi Sosyal Bilimler Meslek Yüksekokulu Dergisi</i> , 28 (2), 439-451. |                                                        |  |

\* Asst. Prof. Dr., Aviation management, School of Civil Aviation, Kastamonu University, Kastamonu, Türkiye, aertek@kastamonu.edu.tr, ORCID: 0000-0002-8156-5075.

## INTRODUCTION

Natural disasters have profound and multidimensional impacts on societies. Earthquakes, one of the natural disasters, cause serious losses and can have devastating effects at both the regional and national levels. The aviation sector, which plays a crucial role in ensuring the mobility of people, the continuity of trade, and the coordination of emergency responses, is among the sectors most affected by earthquakes. Following an earthquake, air transportation faces specific threats and suffers significant damage and losses. Furthermore, the effects of disrupted aviation operations spread throughout global supply chains, tourism industries, and national economies, further exacerbating their impact. Earthquakes are defined as geological events caused by seismic fluctuations in the Earth's crust caused by sudden energy release (Edemen et al. 2023). Earthquakes that occur as a result of cracks in the Earth's crust can have critical negative consequences (Rostami Moez et al., 2020). Türkiye, which constitutes the scope of this study, is located in an earthquake zone and is frequently subject to earthquakes (Şenol et al., 2023; Solmaz & Özel, 2012). The scope of the study consists of the Kahramanmaraş earthquakes of February 6, 2023. These earthquakes occurred consecutively at 04:17 and 13:24 local time in Türkiye, with epicenters in Pazarcık (Kahramanmaraş) and Elbistan (Kahramanmaraş) (Akıncı & Ünlügenç, 2023, p. 554). These earthquakes profoundly affected the provinces of Kahramanmaraş, Hatay, Adıyaman, Gaziantep, Malatya, Kilis, Diyarbakır, Adana, Osmaniye, Elazığ, and Şanlıurfa. The earthquake, felt strongly in these provinces, caused numerous casualties, injuries, and the collapse and damage of buildings, and aftershocks continued for several days following the earthquake. From the first minutes of the disaster, the General Directorate of Civil Aviation, in collaboration with civil aviation stakeholders, ensured the operation of both humanitarian aid and intensive evacuation flights to the earthquake-affected provinces. During this period, air transport, which served as the largest air evacuation operation, ensured the rapid and safe evacuation of earthquake-affected individuals, particularly the sick, elderly, and injured. This demonstrates the importance of the aviation sector and airports during natural disasters. In addition, aid flights were organized to earthquake-affected cities, transporting essential supplies to the local population. Between February 6 and 28, a total of 3,540 flights were conducted to evacuate 617,593 earthquake victims, and 292 flights were organized to transport aid to the earthquake-affected areas, transporting a total of 14,288,701 kg of cargo via air. Additionally, 690 foreign aircraft also provided assistance to the region by bringing aid supplies (Airporthaber, 2023). An earthquake can damage infrastructure such as airports and air traffic control systems, disrupting aircraft operations. Furthermore, the effects of an earthquake extend beyond immediate structural damage; transportation disruptions can hinder the delivery of aid and support. They can also delay the evacuation of people from earthquake-affected cities and restrict the flow of goods and essential services. Despite the growing interest in disaster management and resilience in the aviation sector, existing studies generally focus on general disaster resilience or weather-related hazards, and academic research on the impact of earthquakes on air transportation remains relatively limited. In this context, this study examines the impact of the February 6, 2023, Kahramanmaraş earthquake on air transportation. This study is important for identifying earthquake impacts on air transportation in Türkiye, a seismic zone, and for developing scenarios regarding the use of infrastructure and alternative airports.

## 1. CONCEPTUAL FRAMEWORK

Disasters are events that can spread from small-scale communities to large societies and even globally. The effects of these events, which can result from both natural processes and human activities, are not limited to loss of life, injury, and economic damage; they can also directly or indirectly alter individual mental health, social and economic structures, local government regulations, and international relations. Disasters, which leave profound impacts on society in the short, medium, and long term, lead to the emergence of various social problems; they can lead to disruptions in the order of daily life and the development of unusual social structures (Ergünay, 2009). The Annotated Disaster Management Dictionary defines the concept of disaster as natural, technological, or human-induced events that affect the entire society or certain segments of society, causing physical, economic, and social losses, completely halting or interrupting daily life and human activities, and that the affected community is unable to cope with by its own means (AFAD, 2014, p. 23). Similarly, the United Nations Office for Disaster Risk Reduction defines disasters as: It refers to events that cause serious disruptions in the functioning of a society or community, lead to insufficient available resources, and cause widespread loss of life, economic damage and environmental destruction (UNDRR, 2020).

Disasters can generally be classified as suddenly developing; earthquakes, floods, inundations, landslides, rockfalls, avalanches, storms, tornadoes, volcanoes, fires, etc. and slowly developing; severe cold

snaps, droughts, famines, etc. (Bardakçı & Demirtaş, 2023, p. 188). According to another classification, disasters are classified into two main groups as natural and human or technological origin (Rodriguez et al., 2007, p. 483). Perrow (2007) evaluates this classification in more detail under; he divides natural disasters into those that occur unintentionally (mostly of industrial or technological origin) and those that occur intentionally. Accordingly, natural disasters include earthquakes, tsunamis, volcanic eruptions, floods, landslides, droughts, hurricanes, forest fires, epidemics and meteorite strikes. Unintentional disasters include situations such as fires, explosions, various transportation accidents, and the spread of hazardous wastes or toxic substances. Intentional disasters, on the other hand, consist of events that occur directly with human will, such as terrorist acts, sabotage and cyber attacks (Perrow, 2007, p. 522). In addition; Wars, illegal construction, dam collapses, nuclear and chemical accidents, and famines are also cited as examples of human- or technologically induced disasters (Işık et al., 2012, p. 85). During disasters, transportation plays a crucial role in both the evacuation of individuals and the delivery of aid supplies and support teams. Transportation is shaped by many factors. These factors include geographical location, sea and land distribution characteristics, distance, climate characteristics, topographic conditions, natural vegetation, epidemics, tsunamis, volcanic eruptions, earthquakes, social structure and population demands, political preferences, level of economic development, wars, and conflicts. Earthquakes, one of the natural factors affecting transportation, cause many interconnected problems, particularly due to the damage they cause to transportation infrastructure. This situation not only hinders aid delivery to earthquake zones but also complicates or completely eliminates rapid and healthy evacuation from earthquake zones. Among disasters, earthquakes stand out with the severe damage they inflict on transportation infrastructure, leading to multifaceted problems. In the post-earthquake period, not only aid delivery activities to the region but also the rapid and safe evacuation of disaster victims are significantly hampered or become completely impossible. This is where the concept of disaster logistics comes into play. Disaster logistics can be generally defined as the process of delivering first aid supplies, food products, equipment used in rescue efforts, and response teams from relevant supply centers to the disaster area; as well as the safe evacuation of disaster victims and their transfer to healthcare institutions (Barbarosoğlu et al., 2002, p. 118). Antosia (2006) defines disaster logistics as a system application in which experts and support personnel in this field exhibit a coordinated and integrated performance. Effectively planned and executed disaster logistics ensures the most efficient delivery of resources to disaster-affected communities; It brings together basic elements such as storage, transportation, supply, distribution, shelter and human resources (Thompson, 2015, p. 168). Similarly, Thomas and Kopczak (2005) define disaster logistics as “the cost-effective management of the process from the point of production to the point of consumption, starting from the storage of necessary products and materials under appropriate conditions to meet the needs of disaster victims.” Therefore, disaster logistics goes beyond mere aid delivery activities; it is a strategic process aimed at protecting human life and, when carried out in a planned and systematic manner, plays a critical role in increasing social resilience. Road damage due to earthquakes and the faster speed of air transportation compared to road transportation also gain importance. In addition, air transportation is primarily preferred for the delivery of international support. Studies on this subject from the perspective of the earthquake and aviation sectors are presented below.

Selek (2024), strategically examined how aircraft could be used in disaster and crisis management following potential major earthquakes in Türkiye. The study reviewed disaster management literature, evaluated the post-disaster use of aircraft using a SWOT analysis, and analyzed 20 expert opinions using the Analytical Hierarchy Process (AHP) method. The findings identified airport congestion in Istanbul and its surrounding areas as a strength, bureaucracy as a weakness, pilot/technical personnel inaccessibility as a threat, and earthquake experience as an opportunity. The author emphasized the criticality of coordinated use of aircraft, especially in the first 72 hours.

Bayazıtöğlu & Güngör (2023), examined the crisis management processes created by natural disasters at airports. Using document analysis, the study examined Kansai and Dubai International Airports, which were flooded by Typhoon Jebi in 2018, and Dubai Airport's floods caused by heavy rainfall. The findings highlighted inadequate pre-disaster planning, infrastructure deficiencies, and passenger safety risks; the authors emphasized the need for a holistic implementation of the crisis management cycle (risk reduction, preparedness, response, recovery).

Bayat (2025), used a multiple case study to examine the Van, Elazığ, and February 6, 2023, Kahramanmaraş earthquakes in Türkiye, including Hatay Airport. The study demonstrated the importance of strategic planning, interagency coordination, and emergency management for the post-earthquake

sustainability of airport operations. The findings revealed that Van and Elazığ airports rapidly maintained operations to contribute to logistics, while Hatay Airport's inability to operate due to runway damage demonstrated the critical importance of infrastructure resilience.

Çınar & Mutlu (2020), examined the problems encountered in disaster logistics activities and the key factors affecting success through a literature analysis. The findings demonstrated that disaster logistics, unlike commercial logistics, is characterized by high uncertainty, limited resources, time pressure, and coordination problems. Additionally, difficulties in assessing damage and needs, infrastructure destruction, and information flow were highlighted. The authors emphasized that the use of technology, planning, rapid decision-making, experienced personnel, capacity building, and international cooperation are critical for success.

Fırat & Dabak (2023), examined the role of unmanned aerial vehicles (UAVs) in delivering relief supplies during disasters. A literature review and theoretical analysis determined that UAVs offer an effective solution in critical areas such as rapid distribution, access to inaccessible locations, medical supply, and damage assessment. The findings demonstrated that UAV use contributes to preventing deaths by shortening delivery times and offers cost and time advantages compared to land/air transportation. The authors stated that UAVs should be included in disaster planning.

Boztepe & Aktaş (2023), evaluated the seismic performance and isolation effect of air traffic control towers. The study, based on a literature review, revealed a lack of comprehensive research on this subject in Türkiye, noting that only the 2021 Earthquake Code introduced criteria for these structures. The need for a specific seismic design guide was emphasized internationally, and the positive effects of earthquake isolation were highlighted. Consequently, it was recommended that isolation practices and design parameters be updated for existing and new towers.

Bakırcı & Aydoğdu (2023), examined the spatial impacts of the Kahramanmaraş earthquakes on transportation systems. This descriptive study examined the highway, railway, airline, maritime, and pipeline systems of 11 provinces. The findings revealed collapses in highways, deformations in railways, runway and terminal damage in airports, fire and dock damage in ports, and pipeline explosions. The authors emphasized that these earthquakes differed from previous earthquakes in Türkiye in terms of intensity and impact area.

Rakipoğlu (2024), analyzed the impacts of the February 6, 2023, earthquakes on the aviation sector. Changes in passenger, aircraft, and cargo data at airports were examined using statistical data for the period 2016–2023. The findings showed that passenger numbers increased by 101.9% in Adıyaman, aircraft traffic by 174.3%, and freight traffic by 65.7%; increases were also observed in Adana, Diyarbakır, Elazığ, Gaziantep, Kahramanmaraş, Malatya, and Şanlıurfa. Hatay Airport was out of service due to runway damage. Furthermore, steady increases were observed in the sales revenues of two major airlines between 2020 and 2024. The author stated that the aviation sector plays a critical role in disaster management, but that alternative airport planning and flexible pricing policies should be developed.

## 2. METHODOLOGY

This study examines the impact of the February 6, 2023 Kahramanmaraş Earthquake on air transportation. The study covers the provinces affected by the earthquake: Kahramanmaraş, Hatay, Adıyaman, Malatya, Diyarbakır, Gaziantep, Adana, Şanlıurfa, and Elazığ. The study's analysis used data on annual passenger traffic, annual commercial aircraft traffic, and annual cargo traffic during the year of the earthquake, before the earthquake, and after the earthquake. Quantitative research methods were employed in the study, and numerical data (number of aircraft, number of passengers, and cargo volume) were used to analyze the impact of the February 6 Kahramanmaraş earthquake on air transportation. These data were interpreted using descriptive analysis, presenting the current situation and comparing changes over time. First, the total number of aircraft, number of passengers, and cargo volume were examined by year, and the annual change rates were calculated from pre- to post-earthquake periods. Then, two cities affected by the earthquake (Kahramanmaraş and Hatay) and two control cities (Konya and Trabzon) were identified, and monthly passenger traffic, commercial aircraft traffic, and cargo data for 2023 were compared. The change rates for the data obtained by State Airports Authority were calculated, and the formulas used to determine these values are given below.

### *Pre-Earthquake - Earthquake Year - Post-Earthquake Change Rate Formulas:*

#### **Formula 1:** Change Compared to Pre-Earthquake (%)

Change Compared to Pre-Earthquake (%) = (Passenger2023 - Passenger2022) / Passenger2022 \* 100

**Formula 2:** Change Compared to Earthquake Year (%)

Change Compared to Earthquake Year (%) = (Passenger2024 - Passenger2023) / Passenger2023 \* 100

**Note:** The earthquake year (2023) is taken as the pre-earthquake year (2022) and the post-earthquake year (2024). A positive result indicates an increase, a negative one a decrease. The same formulas were applied to the commercial aircraft traffic, total load, and cargo tables.

### Sample Calculation – Kahramanmaraş

Change by Earthquake Year (%) = (Passengers 2024: 243,453 - Passengers 2023: 248,264) / Passengers 2023: 248,264 \* 100 = -1.9% The calculation results show that Kahramanmaraş's post-earthquake change was -1.9%.

Secondary data was used in the study, and the data included in the study was obtained from statistics published by the State Airports Authority (State Airports Authority, 2024). In this context, passenger traffic, commercial aircraft traffic, and cargo traffic data for the earthquake-affected airports for the years 2022, 2023, and 2024 were used. In addition, 12-month passenger traffic, commercial aircraft traffic and cargo traffic data for January-December 2023 of two earthquake-affected cities (Kahramanmaraş and Hatay) and two control cities (Konya and Trabzon) were used.

### 3. FINDINGS

The analysis of total passenger traffic data used the earthquake year, pre-earthquake, and post-earthquake annual passenger traffic, and change rates. Total passenger traffic and change rates for 2022, 2023, and 2024 are shown in Table 1, while the changes in the data are shown in the graph in Figure 1.

**Table 1. Annual passenger traffic and change rates for the earthquake year, pre-earthquake, and post-earthquake**

| AIRPORT       | 2022<br>(Pre-<br>Earthquake) | 2023<br>(Earthquake<br>Year) | 2024 (Post-<br>Earthquake) | Change<br>Compared<br>to Pre-<br>Earthquake<br>(%) | Change by<br>Earthquake<br>Year (%) |
|---------------|------------------------------|------------------------------|----------------------------|----------------------------------------------------|-------------------------------------|
| KAHRAMANMARAŞ | 175.794                      | 248.264                      | 243.453                    | +41.2                                              | -1.9                                |
| HATAY         | 1.058.214                    | 183.908                      | 288.706                    | -82.6                                              | +56.9                               |
| ADIYAMAN      | 182.423                      | 368.398                      | 366.377                    | +101.9                                             | -0.5                                |
| MALATYA       | 665.907                      | 730.395                      | 808.182                    | +9.6                                               | +10.6                               |
| DİYARBAKIR    | 1.672.377                    | 2.040.747                    | 2.148.881                  | +22.0                                              | +5.2                                |
| GAZİANTEP     | 2.325.808                    | 2.627.193                    | 2.955.231                  | +12.9                                              | +12.4                               |
| ADANA         | 3.874.593                    | 4.728.808                    | 3.085.048                  | +22.0                                              | -34.7                               |
| ŞANLIURFA     | 641.580                      | 814.478                      | 924.157                    | +26.9                                              | +13.4                               |
| ELAZIĞ        | 682.024                      | 920.689                      | 972.295                    | +34.9                                              | +5.6                                |

**Source:** (State Airports Authority, 2023).

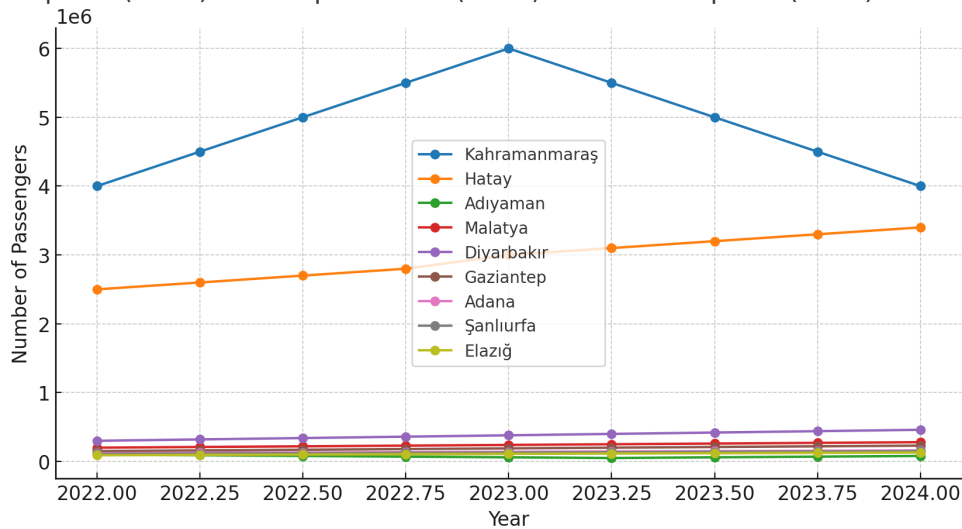
An examination of the data in Table 1 reveals that the sharpest decline occurred in Hatay. Passenger numbers, which stood at 1,058,214 in 2022, decreased by 82.6% to 183,908 in 2023. This can be explained by the serious damage to the airport infrastructure and the prolonged suspension of operations. In contrast, there was a 56.9% increase in 2024, but it was still well below the pre-earthquake average. The increase in Kahramanmaraş during the earthquake year was notable. Passenger numbers increased by 41.2% in 2023 compared to the pre-earthquake level. This increase is interpreted as the result of intensive use of evacuation flights and aid. In parallel, a slight decrease of 1.9% was observed in 2024 due to the decrease in aid flights. Adıyaman saw a 101.9% increase in 2023, indicating a doubling of flights. This increase is thought to be related to additional flights to Adıyaman following the loss of capacity at other airports in the region. Adana

experienced a sharp decline after the earthquake compared to its pre-earthquake level. The explanation for this is that traffic, which increased in 2023 due to disaster logistics and migration, may have returned to normal in 2024. Diyarbakır, Gaziantep, Malatya, Şanlıurfa, and Elazığ airports generally saw increases during the earthquake year. These airports are believed to be critical alternatives for logistics and passenger transport after the earthquake.

Analyzing the graph in Figure 1 reveals that Hatay suffered the heaviest damage, consistent with the unusable airport infrastructure and the prolonged cancellation of flights. In contrast, Kahramanmaraş and Adiyaman experienced an increase specific to the earthquake year. This increase is likely related to evacuations, aid flights, and emergency personnel transport, and is thought to be related to the shift of cargo to Hatay due to the closure of Hatay and some surrounding airports. Finally, airports that were not directly severely damaged, such as Malatya, Diyarbakır, Gaziantep, Şanlıurfa, and Elazığ, experienced increases in passenger traffic during the earthquake year. This suggests that airports close to the disaster area, but still operating, functioned as evacuation and aid centers.

**Figure 1. Annual total passenger traffic change graph**

Pre-Earthquake (2022) - Earthquake Year (2023) - Post-Earthquake (2024) Passenger Traffic



In analyzing total commercial aircraft traffic data, annual passenger traffic and change rates for the earthquake year, before, and after were used. Total commercial aircraft traffic and change rates for 2022, 2023, and 2024 are shown in Table 2, and the changes in the data are shown in the graph in Figure 2.

**Table 2. Annual commercial aircraft traffic and change rates for the earthquake year, before, and after.**

| AIRPORT       | 2022<br>(Pre-Earthquake) | 2023<br>(Earthquake Year) | 2024 (Post-Earthquake) | Change Compared to Pre-Earthquake (%) | Change by Earthquake Year (%) |
|---------------|--------------------------|---------------------------|------------------------|---------------------------------------|-------------------------------|
| KAHRAMANMARAŞ | 1.346                    | 1.845                     | 1.756                  | +37.0                                 | -4.8                          |
| HATAY         | 7.144                    | 1.266                     | 1.803                  | -82.2                                 | +42.4                         |
| ADIYAMAN      | 1.266                    | 2.252                     | 2.300                  | +77.8                                 | +2.1                          |
| MALATYA       | 4.403                    | 4.526                     | 4.684                  | +2.7                                  | +3.4                          |
| DİYARBAKIR    | 10.059                   | 12.057                    | 12.483                 | +19.8                                 | +3.5                          |
| GAZİANTEP     | 15.142                   | 16.224                    | 17.696                 | +7.1                                  | +9.0                          |
| ADANA         | 27.092                   | 30.636                    | 19.927                 | +13.0                                 | -34.9                         |
| ŞANLIURFA     | 4.229                    | 4.887                     | 5.514                  | +15.5                                 | +12.8                         |
| ELAZIĞ        | 4.415                    | 5.474                     | 5.648                  | +23.9                                 | +3.1                          |

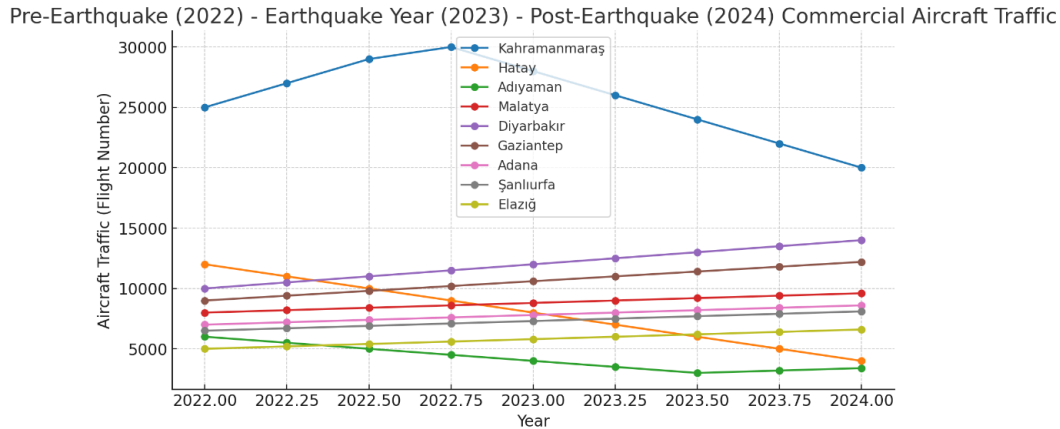
Source: (State Airports Authority, 2023).

An examination of the data in Table 2 reveals that Hatay experienced the largest decrease in passenger traffic during the earthquake year, paralleling the decrease in aircraft numbers. While there was a recovery in

aircraft numbers in 2024, they are still well below their previous levels. Kahramanmaraş and Adıyaman showed significant increases in aircraft traffic during the earthquake year, indicating an increase in aid and evacuation flights. Adana experienced an increase during the earthquake year, but experienced a sharp decline in 2024 as the intense activity of the disaster period ended. Diyarbakır, Gaziantep, Malatya, Şanlıurfa, and Elazığ showed steady increases during and after the earthquake year. This suggests that these airports were used as alternative hubs for extended periods after the disaster.

An examination of the graph in Figure 2 reveals a significant loss in aircraft traffic in Hatay. This is believed to be due to the prolonged unusability of Hatay Airport's runway and infrastructure. While there was a recovery in 2024, it is still not at pre-earthquake levels. This demonstrates the impact of long-term infrastructure repairs and flight planning. Kahramanmaraş experienced an increase in air traffic during the earthquake year. This increase demonstrates its critical role in transporting evacuations, aid supplies, and search and rescue personnel. The increase in Adıyaman, on the other hand, demonstrates that flight demand from surrounding provinces was diverted there during the disaster period. Adana Airport appears to have peaked in commercial flights but returned to normal with a decline in 2024. This suggests that Adana served as a primary evacuation and aid center during the disaster period, but traffic loads decreased after the crisis. Airports such as Diyarbakır, Gaziantep, Malatya, Şanlıurfa, and Elazığ experienced steady increases during and after the earthquake year. This suggests that the load from Hatay and some other heavily damaged airports was shifted to these centers. This suggests that these airports function as backup hubs in regional air logistics.

**Figure 2. Annual total commercial air traffic change graph**



In the analysis of total cargo data, the earthquake year, pre-earthquake, and post-earthquake annual cargo data, and change rates were used. Total cargo data and change rates for 2022, 2023, and 2024 are shown in Table 3, while the changes in the data are shown in the graph in Figure 3.

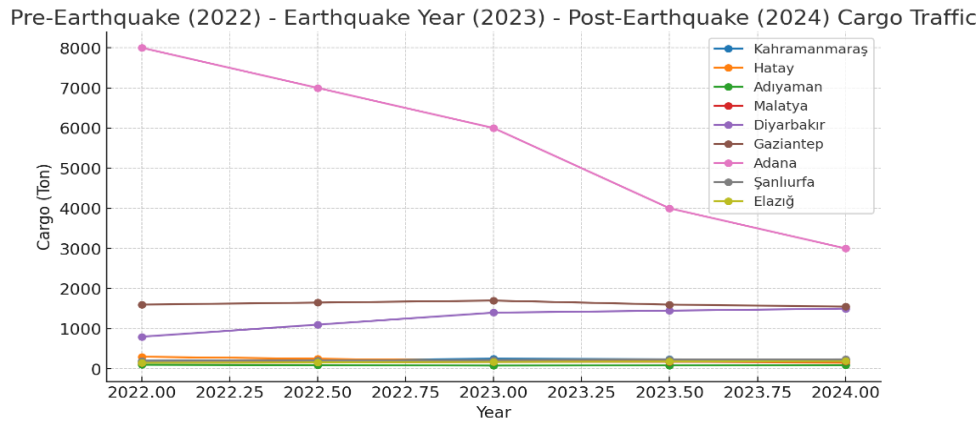
**Table 3. Annual cargo data (tons) and change rates for the earthquake year, pre-earthquake, and post-earthquake**

| AIRPORT       | 2022<br>(Pre-Earthquake) | 2023<br>(Earthquake Year) | 2024 (Post-Earthquake) | Change<br>Compared to Pre-Earthquake (%) | Change by<br>Earthquake Year (%) |
|---------------|--------------------------|---------------------------|------------------------|------------------------------------------|----------------------------------|
| KAHRAMANMARAŞ | 65                       | 83                        | 167                    | +27.6                                    | +101.2                           |
| HATAY         | 78                       | 11                        | 19                     | -85.8                                    | +72.7                            |
| ADİYAMAN      | 143                      | 108                       | 74                     | -24.4                                    | -31.4                            |
| MALATYA       | 186                      | 303                       | 226                    | +62.9                                    | -25.4                            |
| DİYARBAKIR    | 800                      | 1.373                     | 1.508                  | +71.6                                    | +9.8                             |
| GAZİANTEP     | 1.611                    | 1.573                     | 1.491                  | -2.3                                     | -5.2                             |
| ADANA         | 8.099                    | 5.337                     | 2.867                  | -34.1                                    | -46.2                            |
| ŞANLIURFA     | 104                      | 168                       | 127                    | +61.5                                    | -24.4                            |
| ELAZIĞ        | 165                      | 181                       | 164                    | +9.6                                     | -9.3                             |

Source: (State Airports Authority, 2023).

When the data in Table 3 is examined, cargo volume in Kahramanmaraş in 2024 doubled, with an increase of +101.2% compared to the earthquake year. This is likely due to reconstruction and material shipments. Cargo traffic in Hatay decreased by 85.8% during the earthquake year. There was a recovery in 2024, but it remains very low. Adiyaman experienced a continuous decline both during and after the earthquake year; cargo transport was more limited there than passenger baggage. Centers such as Malatya, Diyarbakır, and Şanlıurfa increased cargo volume during the earthquake year, but the decline began with normalization in 2024. Adana experienced one of the sharpest declines in cargo traffic, decreasing by 46.2% in 2024 compared to the earthquake year. This indicates that its role as a cargo hub ended during the disaster period. In Gaziantep and Elazığ, however, cargo volume fluctuated slightly, meaning the disaster impact was limited.

**Figure 3. Annual total cargo traffic change graph**



An examination of the graph in Figure 3 reveals that while there was a small increase at Kahramanmaraş Airport in 2023, the real increase occurred in 2024. This indicates that construction materials, equipment, and aid cargo were transported to the region by air during the post-earthquake reconstruction process. Malatya, Diyarbakır, and Şanlıurfa experienced an increase in cargo traffic during the earthquake year. This is thought to be due to the extensive use of cargo planes to transport materials to the disaster area. However, this increase was replaced by normalization in 2024. A sharp decrease was observed in Hatay in 2023. This change indicates that the airport infrastructure was out of service for an extended period. In Adiyaman, cargo traffic decreased in both 2023 and 2024; this may indicate limited cargo capacity and a predominantly road-based logistics operation. In Gaziantep, there was a slight decrease in cargo tonnage during and after the earthquake year, indicating that the region's cargo logistics played a stable, but not directly proportional, role in cargo logistics. In addition to this data, a comparison was made between two earthquake-affected cities (Kahramanmaraş and Hatay) and two unaffected cities (Trabzon and Konya) as control cities. This comparison used passenger traffic, aircraft traffic, and cargo data for the four airports in question for the 12 months of January-December 2023. Konya and Trabzon were selected because they have similar capacity and usage to the impact airports and were not affected by the earthquake. Data obtained by the State Airports Authority is presented in tables, and analysis was conducted using the existing data.

The 2023 monthly total passenger traffic data for Kahramanmaraş, Hatay, Konya, and Trabzon is presented in Table 4.

**Table 4. Comparative monthly passenger traffic**

| Month    | Kahramanmaraş | Hatay   | Konya   | Trabzon   |
|----------|---------------|---------|---------|-----------|
| January  | 14.576        | 96.983  | 69.844  | 215.866   |
| February | 19.821        | 115.689 | 127.002 | 383.060   |
| March    | 49.827        | 117.126 | 193.478 | 552.962   |
| April    | 80.143        | 139.165 | 256.761 | 751.177   |
| May      | 107.992       | 157.175 | 332.479 | 1.022.402 |
| June     | 129.278       | 160.779 | 411.666 | 1.390.983 |

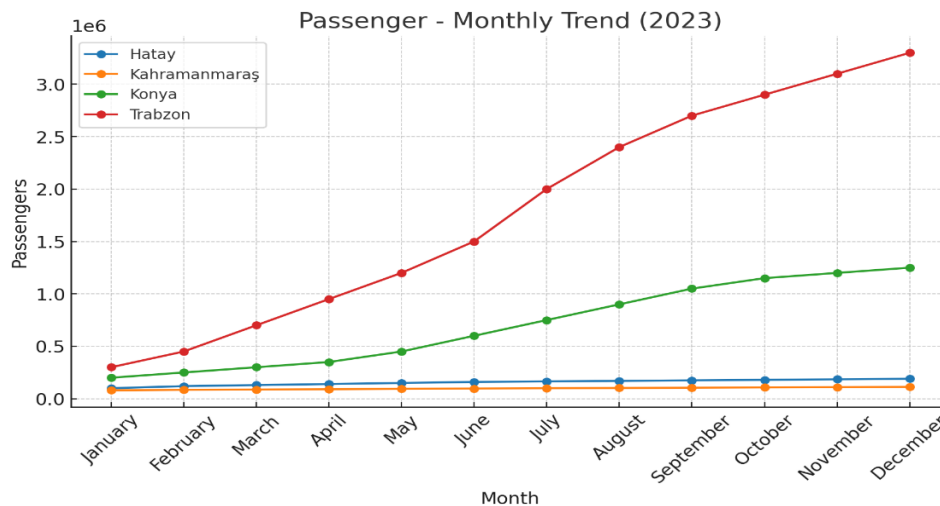


|           |         |         |         |           |
|-----------|---------|---------|---------|-----------|
| July      | 148.943 | 162.407 | 512.514 | 1.976.412 |
| August    | 167.750 | 162.663 | 605.610 | 2.538.701 |
| September | 187.779 | 164.564 | 680.706 | 2.881.587 |
| October   | 208.582 | 169.268 | 754.906 | 3.124.632 |
| November  | 228.667 | 176.454 | 826.683 | 3.336.339 |
| December  | 248.264 | 183.908 | 903.361 | 3.535.902 |

Source: (State Airports Authority, 2023).

Analyzing the data in Table 4 reveals that the earthquake's impact was not a decrease in flights as expected, but rather an increase in February. This change is believed to be due not to normal passenger demand, but rather to disaster logistics and evacuation flights. Considering the control airfields, it appears that Hatay has progressed much slower in recovery than Kahramanmaraş. Recovery in Kahramanmaraş was very rapid, with a significant increase by the end of the year. Control cities (Konya, Trabzon) also show strong increases, but the rates of increase are generally not as critical as Kahramanmaraş. It is also observed that the earthquake increased passenger traffic due to increased disaster logistics and evacuation flights. Under normal circumstances, a sudden decrease in passenger traffic is expected in the central cities of a major disaster, but in Kahramanmaraş and Hatay, passenger numbers increased in February 2023. This increase suggests that disaster logistics, evacuation, and relief travel predominated over regular tourism/business travel. The increase observed in February in unaffected cities like Trabzon and Konya suggests that the post-earthquake migration flow may have affected these areas. Furthermore, comparing February and March data, Kahramanmaraş experienced a significant increase in March, and this increase is thought to be due to the second wave of post-disaster mobility (support personnel, material logistics, and return movements). Hatay, on the other hand, showed a very limited increase during the same period, indicating further damage to the airport infrastructure or flight restrictions. This difference is a significant indicator of the damage status and operational continuity of air transportation infrastructure in both cities. The growth rates in Konya and Trabzon peak in the summer months, and this may be particularly linked to tourism and domestic demand. The general increase in the summer months is observed in both cities unaffected by the earthquake and those affected. However, while the increase in Kahramanmaraş continues at a steady rate, the increase in Hatay appears to be limited even during the summer months. This suggests that the earthquake's impact was more persistent in Hatay. The increase rates in Konya and Trabzon during the summer months indicate a regional tourism impact.

Figure 4. Monthly total passenger traffic change graph for 2023



An examination of Figure 4 reveals a significant jump in Kahramanmaraş's passenger traffic in March, paralleling a strong upward trend throughout the year. While Hatay experiences slight increases, the trend is lower, lagging behind the other three cities. Konya and Trabzon, on the other hand, experience steady increases, accelerating during the summer months.

2023 monthly cargo data for Kahramanmaraş, Hatay, Konya, and Trabzon are presented in Table 5.

**Table 5. Comparative monthly cargo data (tons)**

| Month     | Kahramanmaraş | Hatay | Konya | Trabzon |
|-----------|---------------|-------|-------|---------|
| January   | 2             | 7     | 32    | 71      |
| February  | 10            | 9     | 59    | 122     |
| March     | 24            | 9     | 88    | 180     |
| April     | 34            | 9     | 120   | 243     |
| May       | 38            | 11    | 148   | 324     |
| June      | 42            | 11    | 174   | 398     |
| July      | 47            | 11    | 197   | 468     |
| August    | 49            | 11    | 223   | 539     |
| September | 52            | 11    | 244   | 614     |
| October   | 63            | 11    | 272   | 676     |
| November  | 73            | 11    | 300   | 744     |
| December  | 83            | 11    | 322   | 822     |

**Source:** (State Airports Authority, 2023).

An examination of the data in Table 5 reveals a very sharp increase in cargo traffic in Kahramanmaraş in February, five times that of January. This rate reflects the intensity of post-disaster aid and material shipments. Hatay's February increase was limited, with no change observed in March and April, suggesting airport capacity issues, flight restrictions, or damage to the airport. Konya and Trabzon also experienced a high increase in February, suggesting that these cities may have served as transit hubs for disaster logistics. While the increase in Kahramanmaraş continued in February and March, the rate of increase gradually slowed. Hatay experienced a complete stagnation after February. In Konya and Trabzon, the increase progressed steadily, with growth continuing even in the summer and fall months. The earthquake's impact resulted in an increase in all cities in February, but Kahramanmaraş's rate was much higher, confirming its central role in disaster logistics. Hatay, on the other hand, is experiencing limited growth and prolonged stagnation in cargo traffic, as well as passenger traffic.

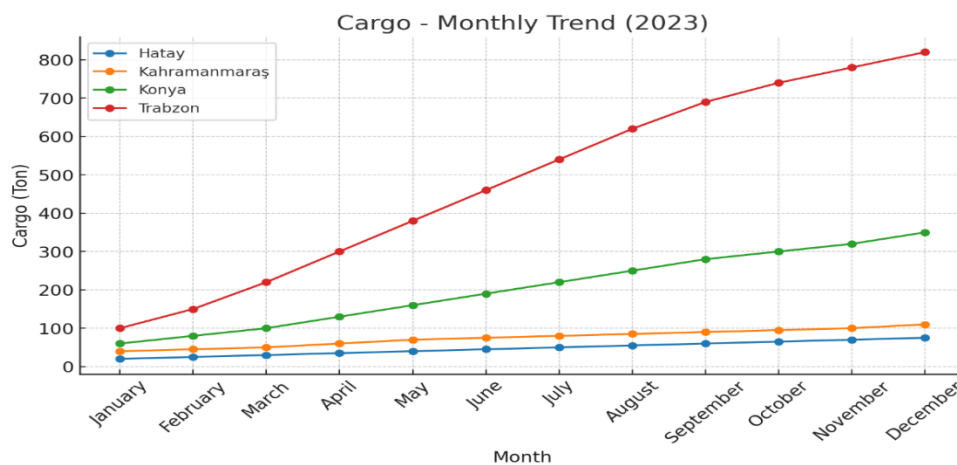
**Figure 5. 2023 monthly cargo data change graph**

Figure 5 shows a sharp jump in Kahramanmaraş in February, followed by a steady increase. In Hatay, the line remained almost completely flat after February, indicating that the airport was unavailable, with capacity constraints or infrastructure issues. Konya and Trabzon, on the other hand, showed a steady increase, with a positive trend continuing even in summer and autumn.

Data for the total monthly commercial air traffic for Kahramanmaraş, Hatay, Konya, and Trabzon in 2023 is presented in Table 6.

**Table 6. Comparative monthly commercial air traffic**

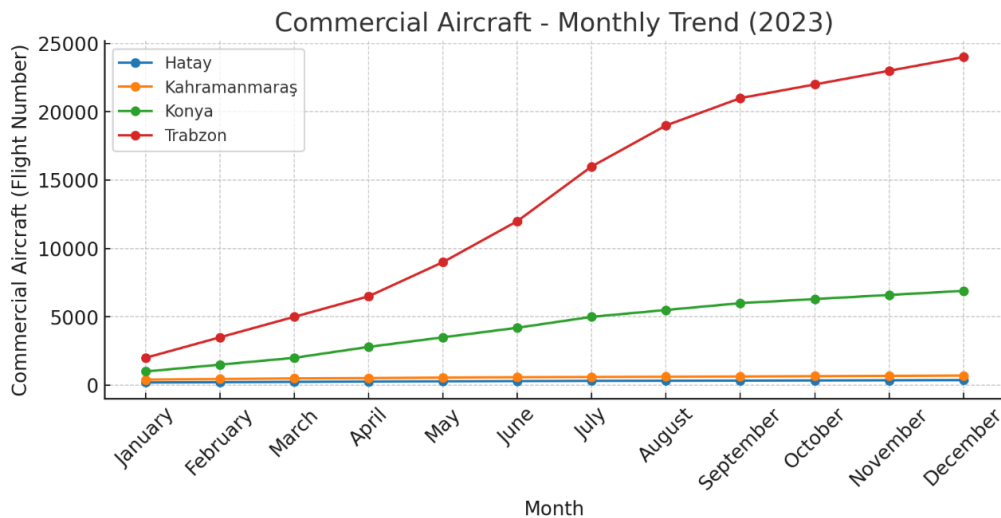
| Month     | Kahramanmaraş | Hatay | Konya | Trabzon |
|-----------|---------------|-------|-------|---------|
| January   | 111           | 645   | 520   | 1513    |
| February  | 150           | 753   | 942   | 2684    |
| March     | 380           | 762   | 1456  | 3992    |
| April     | 598           | 911   | 1961  | 5460    |
| May       | 809           | 1036  | 2563  | 7436    |
| June      | 975           | 1066  | 3185  | 10147   |
| July      | 1113          | 1079  | 3853  | 13980   |
| August    | 1245          | 1081  | 4490  | 17681   |
| September | 1389          | 1099  | 5025  | 20133   |
| October   | 1547          | 1137  | 5514  | 21890   |
| November  | 1693          | 1194  | 5979  | 23298   |
| December  | 1845          | 1266  | 6501  | 24698   |

**Source:** (State Airports Authority, 2023).

When examining the data in Table 6, Kahramanmaraş and Hatay saw increases in February, but the increase in Kahramanmaraş was more pronounced. The increase rates in Konya and Trabzon were quite high, suggesting that these cities may have been heavily used as control cities after the disaster.

Kahramanmaraş showed a very strong increase between February and March, while Hatay remained almost constant. Control cities also experienced significant increases between February and March, but Kahramanmaraş's increase rate appears to be higher. Just as passenger and cargo data indicate a significant increase in commercial flight numbers in disaster-affected cities in the first months of post-disaster flight operations, Kahramanmaraş stands out in this regard, showing increases similar to, and in some months exceeding, the increase rates in control cities in both February and March. Hatay lags behind, with both the number of flights and the increase rate being lower. Konya and Trabzon are thought to continue their increases, particularly during the summer months, driven by tourism and domestic demand.

**Figure 6. Monthly commercial air traffic change graph for 2023**



When Figure 6 is examined, the increase in Kahramanmaraş, even in February, reflects post-disaster evacuation and relief travel. It rises with a progressive slope from March onward, reaching one of the highest growth rates by the end of the year. In Hatay, by contrast, the change curve is horizontal, the rate of increase is slow, and it remains almost straight throughout the graph. Konya and Trabzon, on the other hand, show gradual and steady increases, with the slope becoming steeper in the summer months (June–August), and the impact of the tourism season is clearly visible during this period.

## CONCLUSION

The 2023 Kahramanmaraş-centered earthquake significantly impacted air transportation in the region in terms of passenger, commercial aircraft, and total cargo volumes. Data from the nine airports analyzed for 2022–2024 reveal that the effects of the disaster varied in both magnitude and duration. Hatay Airport was the hardest hit, with significant traffic loss across all categories. Infrastructure damage and operational restrictions slowed the airport's recovery process. In contrast, Kahramanmaraş and Adıyaman experienced increased traffic during the earthquake year and became important centers for evacuation, aid, and search and rescue operations during the disaster. The doubling of cargo volume in Kahramanmaraş in 2024 clearly demonstrates the impact of the reconstruction process on air cargo transportation. Adana served as a temporary main hub during the disaster, but traffic levels quickly returned to normal after the crisis. Diyarbakır, Gaziantep, Malatya, Şanlıurfa, and Elazığ, on the other hand, increased their traffic during and after the earthquake, ensuring the continuity of the regional air transportation network.

The earthquake that occurred in February 2023 had varying impacts on air transportation indicators in Kahramanmaraş and Hatay, the directly affected provinces, and Konya and Trabzon, the control groups. Comparative analyses conducted on three main indicators (passenger traffic, cargo traffic, and commercial air traffic) reveal that the short- and medium-term impacts of the disaster differed both quantitatively and structurally. In Kahramanmaraş, a rapid and sustained increase in passenger, cargo, and commercial flight numbers was observed after the earthquake. The picture is different in Hatay. Post-earthquake increases in passenger and cargo traffic were quite limited. However, an increase was recorded in total aircraft traffic. This contradictory situation suggests that Hatay is heavily used for non-commercial flights (military, aid, private charters, etc.) and that commercial aviation activities have been restricted for a long time.

While Konya and Trabzon were not directly affected by the earthquake, they showed a steady and strong upward trend in all indicators. Sharp increases were observed, particularly in February and March, related to post-disaster migration and relief operations; while momentum was maintained during the summer months by seasonal demand increases stemming from tourism. The infrastructure resilience and operational continuity capacity of airports in disaster areas are key factors determining the pace of recovery. The rapid recovery seen in the Kahramanmaraş example highlights the importance of effective infrastructure management and capacity-enhancing measures, while the limited recovery in Hatay reveals how long-term capacity constraints can have lasting effects on regional air transportation.

In conclusion, this study demonstrates that the impacts of natural disasters on air transportation are multidimensional, that the relationships between different indicators require detailed examination, and that infrastructure resilience and operational planning play a critical role in post-disaster recovery.

As a recommendation, as seen in the Hatay example, the runway, terminal, and control tower infrastructures of critical airports should be strengthened against earthquakes, floods, and similar disasters. Regional backup airport plans should be developed; When one center becomes inactive, the operational load should be quickly shifted to others. As seen in the examples of Diyarbakır, Gaziantep, Malatya, Şanlıurfa, and Elazığ, the capacity of alternative centers should be increased according to pre-determined scenarios during disaster periods. To ensure efficient transportation of aid and construction materials during disasters, the capacity of cargo terminals and storage areas should be increased. Flexible planning procedures should be developed to quickly increase the number of commercial aircraft, flight frequency, and cargo capacity in emergencies. "Disaster flight protocols" should be established between airline companies and the General Directorate of Civil Aviation to be automatically activated in crisis situations.

## REFERENCES

- AFAD. (2014). Annotated glossary of disaster management terms, Ankara.
- Airporthaber, (2023). Airporthaber website, <https://www.airporthaber.com/havacilik-haberleri/thy-93-seferle-16-bin-808-kisi-tahliye-edecek.html>.
- Akıncı, A. C. and Ünlügenç, U. C. (2023). February 6, 2023 Kahramanmaraş earthquakes: Geological data from the field, evaluation, and implications for Adana. *Çukurova University Faculty of Engineering Journal*, 38(2), 553–569.
- Antosia, R. E. (2006). “Disaster Logistics”, Handbook of Bioterrorism and Disaster Medicine (Eds. R. E. Antosia and J. D. Cahill), (pp. 19-21). Boston, MA: Springer.
- Bakırcı, M., & Aydoğdu, M. (2023). Earthquake and transportation: Spatial reflections of the Kahramanmaraş (Pazarcık-Elbistan) earthquakes on transportation. *Turkish Geography Journal*, 83, 115–129. <https://doi.org/10.17211/tcd.1296634>
- Barbarosoğlu, G., Özdamar L. and Çevik, A. (2002). “An Interactive Approach for Hierarchical Analysis of Helicopter Logistics in Disaster Relief Operations”, *European Journal of Operational Research*, 140/1, 118-133.
- Bardakçı, H., & Demirtaş, F. (2023). Doğal Afetlerin Dış Ticarete Etkisi: 2023 Türkiye Depremleri ve Sonuçlarının Değerlendirilmesi. *Avrasya Dosyası*, 14(1), 171-191.
- Bayat, F. (2025). Crisis management at airports: A multiple case analysis in the context of Turkish earthquakes (Van, Elazığ, Kahramanmaraş, and Hatay). *International Journal of Crisis and Policy Studies*, 9(1), 175–202.
- Bayazıtöğlu, A. A., & Güngör, H. (2023). Crisis management due to natural disasters at airports: The example of Kansai and Dubai International Airports. *Journal of Theoretical & Empirical Research on Management*, 3(1), 37–48.
- Boztepe, A., & Aktaş, G. (2023). Earthquake performance and isolation effect of air traffic control towers. *Dicle University Journal of Engineering Faculty (DUJE)*, 14(4), 743–751. <https://doi.org/10.24012/dumf.1358505>
- Çınar, S., & Mutlu, H. M. (2020). Disaster logistics problems and main success factors: A literature analysis. *Journal of Business and Economic Studies*, 8(2), 50–69.
- Edemen, M., Okkay, M., Tuğrul, R., Kurt, M.Ş., Bircan, O., Yoldaş, H., Necimoğlu Güzel, M., and Aslan, A. (2023). “What is an earthquake? How does it occur? What are the earthquakes that occurred in Turkey and their effects? Recommendations for precautions against earthquakes” *International Journal of Social and Humanities Sciences Research JSHSR*, Volume: 10 Issue: 93, pp. 719-734.
- Ergünay, O. (2009). Natural disasters and sustainable development. National Earthquake Symposium, Abant İzzet Baysal University.
- Fırat, S., & Dabak, R. (2023). Use of unmanned aerial vehicles in the delivery of relief supplies during disasters. *Meriç International Journal of Social and Strategic Research*, 7(Special Issue), 35–58.
- Isık, Ö., Aydınlioğlu, H. M., Koç, S., Gündoğdu, O., Korkmaz, G., and Ay, A. (2012). “Disaster Management and Disaster-Focused Health Services”, *Okmeydanı Medical Journal*, 28(Supplement Issue 2), 82-123.
- Ozel, G., and Solmaz, A. (2012). Estimation of Earthquake Recurrence Time in Türkiye and Investigation of Seismicity According to Neotectonic Regions with Markov Chain. *Çankaya University Journal of Science*, 9(2).
- Quarantelli, & R. R. Dynes) (pp. 476–488), New York, USA: Springer Science+Business Media, LLC. Perrow, C. (2007). “Disasters Ever More? Reducing U.S. Vulnerabilities”, Handbook of Disaster Research, (Eds. H. Rodriguez, E. L. Quarantelli, and R. R. Dynes) (pp. 521–533), New York, USA: Springer Science+Business Media, LLC.
- Rakipoğlu, C. (2024). An examination of the aviation sector in relation to the February 6, 2023 earthquakes. *Journal of Aerospace Science and Management*, 2(2), 42–66.
- Rodriguez, H., Diaz, W., Santos, J. M., & Aguirre, B. E. (2007). “Communicating Risk and Uncertainty: Science, Technology, and Disasters at the Crossroads”, Handbook of Disaster Research, (Eds. H. Rodriguez, E. L. Rostami-Moez, M., Rabiee-Yeganeh, M., Shokouhi, M., Dosti-Irani, A., and Rezapur-Shahkolai, F. (2020). Earthquake preparedness of households and its predictors based on health belief model. *BMC public health*, 20, 1- 8. <https://doi.org/10.1186/s12889-020-08814-2>.
- Selek, H. (2024). A strategic approach to the use of aircraft in disaster and crisis situations (Master's thesis, Maltepe University, Institute of Graduate Education).
- State Airports Authority, (2024). State Airports Authority, <https://dhmi.gov.tr/Sayfalar/Istatistikler.aspx>.
- Şenol, A. F., Akbaş, A., and Çalışkan, Ö. (2023). Destructive earthquakes that occurred in Turkey in the last century (1923-2023) and the earthquake codes used. In A. Bayram (Ed.), *Innovative Studies in Engineering*, Duvar Publications.
- Thomas, A. S. and Kopczak, L. R. (2005). From Logistics to Supply Chain Management: The Path Forward in the Humanitarian Sector. (March 15, 2020). <http://www.fritzinstitute.org/pdfs/whitepaper/fromlogisticsto.pdf>.
- Thompson, D. D. (2015). “Disaster Logistics in Small Island Developing States: Caribbean Perspective”, *Disaster Prevention and Management*, 24/2, 166-184.
- UNDRR. (2020). Risk and disasters. <http://www.un-spider.org/risks-and-disasters>.