

SOCIO-ECONOMIC IMPACT OF THE EARTHQUAKES OF FEBRUARY 2023 ON AGRICULTURAL PRODUCTION OF TÜRKIYE

Şinasi AKDEMİR^{1*}, Zoubir SAHLI², Elpidio KOUGNIGAN¹, Kasım Eren TUNA¹, Mehmet ÖRTÜLÜ³, Sedef AKINCI³, Günay NARCI³, Issaka saidou ISMAILLA¹

¹University of Cukurova, Faculty of Agriculture, Department of Agricultural Economics, 01330, Adana, Turkey, Phones: +90 532 495 32 55; 0000-0002-4088 8775; +90 531 459 33 95; 0000-0001-6885-246X; +90 535 275 59 56; 0000-0002-8863-5478; +905528783518; 0000-0002-0727-1861 E-mails: sinasi.akdemir@gmail.com, elpidio2k@gmail.com, erentun@hotmail.com, issaka.saidou.ismaila@gmail.com

²University of Blida, Faculty of Agriculture, Department of Agricultural Economics, Blida, Algeria, Phone: +213 7 91234736, E-mail: sahlizbir@gmail.com

³Sarıçam District Directorate of Agriculture and Forestry, Phone: +90 532 175 35 86; 0009-0002-4388-6932, +90 506 690 72 08; 0000-0002-5200-2126; +90 543 611 33 04; 0009-0005-1779-4008; E-mail: mehmet.ortulu@tarimorman.gov.tr, sedef.akinci@tarimorman.gov.tr, gunay.narci@tarimorman.gov.tr

Corresponding author: sinasi.akdemir@gmail.com

Abstract

In order to determine and analyse the socioeconomic impacts on agricultural production of the 2 earthquakes with magnitudes of 7.4 and 7.3 that occurred in Turkey on February 6, 2023, a research survey was conducted and the data obtained from the surveys were evaluated. The survey was carried out in 15 villages in total, in 3 villages selected to represent each of the 5 districts where the earthquake was intensely felt. According to the results, besides the loss of life and property in rural areas, the earthquake had a significant impact on production factors, especially the stock of warehouses, tractor capital, manpower, and caused disruptions in supply chains and delays in agricultural activities.

Key words: earthquake, socio-economic impact, agricultural production, Türkiye

INTRODUCTION

Natural disasters (earthquakes, volcanic eruptions, tsunamis, fires, floods, droughts, etc.) are phenomena that occur naturally, often cyclically, but sometimes abruptly and brutally. These phenomena, which are entirely normal and historically justifiable, occur either absolutely and naturally (as in the case of earthquakes, volcanoes, and glaciations), or as a result of phenomena directly or indirectly caused by human practices and uses (landslides, floods, forest fires, desertification, prolonged droughts, snow melting, etc.).

These disasters have always existed, long before the presence of humans and other living beings. They have marked the different geological and historical eras of the planet Earth. Prehistory and geological studies have shown perfectly the destructive impact of this type of disaster, such as the complete

disappearance of prehistoric animal species (dinosaurs, insects, microorganisms), as well as significant transformations in the geographical configurations of territories and continents (for example, these phenomena often accelerate the drift of continents). This is therefore not something strange or exceptional. However, these phenomena are destructive and cause significant degradation, numerous injuries, incomparable tragedies, and indelible consequences for humans, animals, and lands capes [10].

We are interested in these phenomena mainly for their effects on the way of life and economic conditions of many categories of populations, including farmers and rural populations (their habitats, material goods, and agricultural production systems).

In this research, we focus on earthquakes and their massive destruction of territories, goods, and populations, which are becoming more

and more recurrent and destructive, causing serious and indelible effects.

Earthquakes (like volcanic eruptions) have serious and harmful effects on everything that is on and lives on Earth (and even in the seas and oceans). Large earthquakes (on the order of 6.5° to 7.5° up to 8° on the Richter scale) are violent. The earth is fissured, and everything on it is disrupted and destroyed. In this type of natural disaster, it is primarily cities and large and medium-sized urban areas that are most affected, along with their buildings, basic infrastructure (roads, bridges, dams, railways, ports and airports, etc.), as well as any human and animal populations [3, 8, 9]. These urban areas, often built or constructed without taking into account seismic rules and norms, are destabilized in their foundations and structures. Buildings and structures break, resulting in tragedies and significant human losses. Thus, from an economic and human standpoint, it is mainly urban areas and populated and built-up spaces that suffer the most destruction and losses: losses primarily in human lives, deep physical and psychological disabilities and injuries, incalculable economic losses, not to mention the complete disorganization of all territorial development and urban planning. Therefore, even if the effects of these phenomena appear as serious and costly effects primarily on cities and their populations, they also increasingly appear as serious effects on both the gravity of the economic situation of peasants and farmers and on the significant disruption of all rural environments, their structures and foundations [11]. Even if there are no significant human losses and serious injuries compared to what occurs in cities, many farmers and peasant families, and even agri-food business leaders, record losses in both human and physical and psychological disabilities [18]. This serious situation also creates significant disruptions in family structures and sometimes the breakdown of social structures due to forced rural exodus and sometimes the fragmentation of family units. One must not forget the negative effects on production, conditioning, transformation, marketing, and distribution conditions. This is a field of investigation and research work of a

university and expertise nature, in the medium and long term that should be urgently initiated.

Despite the importance of the subject, few studies on the subject exist in the world and even rarer in Turkey [1, 9]. This is what motivates this research on the impact of earthquakes on agricultural production.

MATERIALS AND METHODS

This study was designed to investigate the impact of earthquakes on agriculture in the affected areas of Türkiye. The study was conducted using both quantitative and qualitative research methods. The quantitative data was collected through reports and TUIK database, while qualitative data was collected through in-depth interviews with farmers and breeders. The group interviews were conducted after the earthquakes to capture the impact of the disaster on agriculture. The choice of that method is justified by the importance given to the opinion of the participants [4, 14].

In this study, we used data from the Turkish Statistical Institute (TurkStat) to investigate the importance of the affected areas of cultivated grains, vegetables, fruits, and ornamental plants in the earthquake regions of Turkey. The data was obtained from the 2022 Agricultural Census conducted by TurkStat, which provided information on the agricultural land and livestock in each of the 81 provinces of Turkey.

We focused our analysis on the 11 provinces that are within the earthquake zone, which covers 40 million hectares of agricultural land. For each province, we obtained data on the total area of cultivated grains, vegetables, fruits, and ornamental plants, as well as the percentage of each crop within the province and the overall percentage for the earthquake zone and Turkey as a whole.

To assess the importance of the earthquake zone in crop production, we calculated the percentage of each crop that was cultivated within the zone and compared it to the percentage of the total agricultural land in the zone. We also identified the top producers of each crop within the zone and calculated their

percentage contribution to the total production.

In addition to crop production, we also analysed the livestock in the earthquake zone. We obtained data on the number of beehives, cattle, and sheep/goats within each province and calculated the percentage of each livestock type within the zone and Turkey as a whole.

All data were analysed using Microsoft Excel and presented in tables to facilitate interpretation.

RESULTS AND DISCUSSIONS

Importance of the affected areas

According to a report of the FAO, the earthquake in Türkiye severely impacted 11 key agricultural provinces, affecting over 15

million people and more than 20% of the country's food production; the affected regions account for almost 15% of agricultural GDP and contributes to nearly 20% of Türkiye's agrifood exports.

Initial assessments estimate \$1.3 billion in damage and \$5.1 billion in losses to the agriculture sector, with disrupted supply chains and financial challenges exacerbating the struggle of rural families to access and afford productive inputs [5].

Türkiye's earthquake zone covers 40 million hectares of agricultural land, which accounts for 16.9% of the country's total agricultural area.

Within this zone, vegetable production covers 16.2%, fruit production covers 26.0%, and ornamental plant cultivation covers 3.3% of the total agricultural area.

Table 1. Cultivated Areas of Grains, Vegetables, Fruits and Ornamental Plants in the Earthquake Regions

	Total Area (100 ha)	Türkiye %	Cereal & Other Plant Product Areas	Türkiye %	Vegetable Areas	Türkiye %	Fruits	Türkiye %	Ornamental Plant Areas	Türkiye %
Adana	5,046	2.0	3,687	2.2	259	3.6	1,038	2.8	1.36	2.4
Hatay	2,380	0.9	1,105	0.7	210	2.9	1,012	2.8	0.23	0.4
Kahramanmaraş	3,557	1.4	2,550	1.5	68	0.9	658	1.8	0.02	0.0
Osmaniye	1,262	0.5	966	0.6	68	0.9	220	0.6	0.04	0.1
Malatya	2,724	1.1	1,023	0.6	42	0.6	988	2.7	0.05	0.1
Elazığ	7,826	3.0	1,125	0.7	75	1.0	301	0.8	0.15	0.3
Gaziantep	3,469	1.3	1,127	0.7	136	1.9	2,190	6.0	0.00	0.0
Adıyaman	2,262	0.9	1,598	1.0	50	0.7	595	1.6	0.00	0.0
Kilis	1,025	0.4	384	0.2	51	0.7	546	1.5	0.00	0.0
Şanlıurfa	11,040	4.3	7,816	4.7	104	1.4	1,802	4.9	0.03	0.0
Diyarbakır	5,754	2.2	5,346	3.2	107	1.5	213	0.6	0.00	0.0
Total of the 11 provinces	46,345	17.9	26,727	16.2	1,170	16.3	9,563	26.0	1.87	3.3
The other provinces	212,106	82.1	138,139	83.8	6,006	83.7	27,191	74.0	55	96.7
Türkiye	258,451	100.0	164,866	100.0	7,176	100.0	36,754	100.0	57	100.0

Source: [16](<https://biruni.tuik.gov.tr/medas/?locale=tr>).

The region also houses 1.35 million tractors, which represents 12.8% of Turkey's 15.1 million tractor stock. In terms of crop production, the largest agricultural area is Elazığ with 16.9%, followed by Sanliurfa with 23.8% and Diyarbakır with 12.4%. For grain cultivation, Adana and Sanliurfa are the top producers with 29.2% and 16.2%, respectively. In terms of vegetable cultivation, Adana ranks first with 22.1%, followed by Hatay with 17.9% and Gaziantep with 11.6%.

The earthquake zone plays a significant role in vegetable production in Turkey.

When it comes to beekeeping, Diyarbakır is the top producer with 10.1% of the region's beehive stock, followed by Sanliurfa with 10.8%, Hatay and Malatya with 7.7%. In terms of animal husbandry, Diyarbakır ranks first with 25.9% of cattle, followed by Sanliurfa with 14.6% and Adana with 11.53%. For small ruminants, Diyarbakır and Sanliurfa rank first and second with 1.1% and

23.2%, respectively, followed by Adana and Kahramanmaras.

Table 2. Livestock in the Earthquake Zone

	Beehives	% Within the 11 provinces	Türkiye %	Cattle	% Within the 11 provinces	Türkiye %	Sheep / Goats	% Within the 11 provinces	Türkiye %
Adana	494,432	34.1	5.5	266,601	11.3	1.6	1,116,289	10.7	2.0
Adiyaman	73,647	5.1	0.8	111,470	4.7	0.7	368,544	3.5	0.7
Diyarbakır	146,857	10.1	1.6	608,214	25.9	3.6	2,209,368	21.1	3.9
Elazığ	118,619	8.2	1.3	187,326	8.0	1.1	1,089,120	10.4	1.9
Gaziantep	28,123	1.9	0.3	200,050	8.5	1.2	698,317	6.7	1.2
Hatay	111,959	7.7	1.2	149,206	6.3	0.9	538,745	5.2	1.0
Kahramanmaraş	122,747	8.5	1.4	242,239	10.3	1.4	1,170,072	11.2	2.1
Kilis	8,179	0.6	0.1	12,785	0.5	0.1	222,698	2.1	0.4
Malatya	111,360	7.7	1.2	174,986	7.4	1.0	367,606	3.5	0.7
Osmaniye	78,677	5.4	0.9	68,292	2.9	0.4	249,684	2.4	0.4
Şanlıurfa	157,201	10.8	1.7	331,181	14.1	2.0	2428459	23.2	4.3
Total of the 11 provinces	1,451,801	100.0	16.2	2352350	100.0	14.0	10,458,902	100.0	18.6
The other provinces	7,532,875		83.8	14,499,606		86.0	45,806,848		81.4
Türkiye	8,984,676		100.0	16,851,956		100.0	56,265,750		100.0

Source: [16] (<https://biruni.tuik.gov.tr/medas/?locale=tr>).

Table 3. Planting Areas of Priority Crops in Earthquake Zone (100 hectares)

	Wheat	% Within the 11 provinces	Türkiye %	Corn	% Within the 11 provinces	Türkiye %	Cotton	% Within the 11 provinces	Türkiye %
Adana	1,420	12.1	2.1	867	27.0	9.5	303	7.1	5.3
Adiyaman	559	4.8	0.8	29	0.9	0.3	82	1.9	1.4
Diyarbakır	2,766	23.7	4.2	180	5.6	2.0	830	19.6	14.5
Elazığ	445	3.8	0.7		0.0	0.0		0.0	0.0
Gaziantep	626	5.4	0.9	64	2.0	0.7	60	1.4	1.0
Hatay	491	4.2	0.7	173	5.4	1.9	460	10.8	8.0
Kahramanmaraş	1,403	12.0	2.1	280	8.7	3.1	71	1.7	1.2
Kilis	222	1.9	0.3	6	0.2	0.1	4	0.1	0.1
Malatya	455	3.9	0.7	2	0.1	0.0	0.025	0.0	0.0
Osmaniye	383	3.3	0.6	393	12.3	4.3	5	0.1	0.1
Şanlıurfa	2,922	25.0	4.4	1,212	37.8	13.3	2,425	57.2	42.3
Total of the 11 provinces	11,692	100.0	17.6	3,206	100.0	35.2	4,240	100.0	74.0
The other provinces	54,596		82.4	5,913		64.8	1,492		26.0
Türkiye	66,288		100.0	9,119		100.0	5,732		100.0

Source: [16] (<https://biruni.tuik.gov.tr/medas/?locale=tr>).

Regarding wheat cultivation, Sanliurfa leads with 25.0%, followed by Diyarbakir with 23.7%, Adana with 12.1%, and Kahramanmaras with 12.0%.

For corn production, Sanliurfa is again the top producer with 37.8%, followed by Adana with 27.0% and Sanliurfa with 12.3%.

In cotton production, Sanliurfa leads with 57.2%, followed by Diyarbakir with 19.6% and Hatay with 10.3%. In total, the earthquake zone accounts for 74% of Turkey's corn production, 35% of its wheat production, and 17.6% of its cotton production.

The region's yield is also higher than the national average, with wheat yield 10% higher and corn yield over 110% higher than the

national average, while cotton yield is similar to the national average.

Impact assessment

After the 7.8 and 7.5 magnitude earthquakes that occurred nine hours apart on February 6, 2023, based in Kahramanmaraş, many sectors in Turkey's region, especially the agricultural sector, were affected. Investigations were conducted in the districts of Ince and Hüyükü in Afşin, and Beyoğlu district in Türkoğlu, as well as Samankaya and Değirmenyolu district in Defne, and Olucak and Emirler districts in Nurdağı.

Since the first product in agricultural production, such as wheat and barley, is planted in the examined districts and

neighbourhoods, no disruption was detected in the cultivation of the fields. Due to the low number of cases resulting in death in rural horticultural activities, no disruptions were identified. The biggest disruption in agricultural activities was found to be in the supply chain of pesticides and fertilizers. Due to the collapse of the buildings where the pharmacies and fertilizer stores were located in the city centres, problems were identified in the supply of drugs and fertilizers in all earthquake zones. Although they tried to be supplied from neighbouring cities, the earthquake affecting 11 adjacent provinces was the biggest obstacle in the supply stage. Although some farmers from Mersin, Konya, and Adana tried to meet their needs through their relatives, there was no solution for large-scale production. It is estimated that there will be a loss of nearly 30% in wheat due to the arrival of weed control in wheat fields, especially in all earthquake zones. This consequence has also been faced in similar cases in Japan impacting the country GDP at 0.35% at least [15]. Studies proved that the economically less developed provinces are more susceptible to larger losses due to future disasters and that severe value-added losses are due to indirect effects through supply chains [7].

When asked about the situation of farmers engaged in vegetable farming, especially in the districts of Defne, Hatay, they reported that they had lost half of their products due to the supply problem of fungal drugs [7, 12]. Similarly, it was predicted that there would be losses in product quality and yield in plant feeding products due to supply problems. In a pumpkin field examined, it was seen that there were calibration and shape problems in the products due to fungal diseases and the lack of plant feeding products. Similar problems were observed in cucumber, tomato, and eggplant fields in the same region.

The biggest disruption in agricultural activities occurred in greenhouse production. 40% of the greenhouses planted in the region became a place of accommodation for both those who migrated from the city to the countryside and producers who could not enter their homes in rural areas after the

earthquake. The conversion of the products inside the greenhouse to a place of accommodation led to a 40% contraction in greenhouse production.

There is sugar beet production in the region due to the sugar factory located in Kahramanmaraş Elbistan. Since there is no obstacle to production in the factory, sugar beet producers did not suffer damage in the earthquake, and the estimated planting time is in March-April, this industry continues without any problems.

In the interviews, it was observed that rural areas were seen as a safe zone, and there was a significant migration from cities to rural areas due to the earthquake. It was observed that the people did not migrate from rural areas, which were usually used as vegetable gardens, to cities, but there were significant migrations from cities to rural areas. Indeed, disasters have proven a migration flux to happen in response of population running from the affected areas [2, 13].

It has been observed that small agricultural lands that used to be used for irrigated agriculture and contributed to the rural family budget cannot be used due to the conversion of these lands into accommodation areas. This is because tents are set up on these lands. Producers have stated that this situation will cause a contraction of around 10% in household income in rural areas. However, there is no problem for the producers to continue production because it is believed that rural areas are safe and it is easier to access food and clean water than in cities. Agricultural incomes are also seen as a guaranteed income. Serious deformations due to earthquakes have not been detected in agricultural areas. It has been observed that the soil has risen and the trees have been uprooted in certain areas. It has been observed that there is earthquake-related damage at a level of 3% in gardens established on fault lines.

With the help of the Ministry of Agriculture and Forestry's support for feed and veterinary services, disruptions in the livestock sector have been addressed. Livestock that were housed in destroyed barns were transferred to safe barns, preventing losses. Although there

were disruptions in feed supply due to the presence of feed dealers in city centres and their exposure to the same damage as agricultural dealers, the Ministry of Agriculture and Forestry coordinated a quick supply from neighbouring provinces as there were live animals that needed daily feeding. The biggest loss in the livestock sector was due to the collapsed barns, which resulted in a 2% loss of total cattle population. Power outages caused disruptions in the milking systems, which seriously affected animal welfare. Small family businesses tried to solve this problem by manual milking. Large-scale farms generated electricity with generators, but there were also disruptions due to fuel shortages. The problem was fully felt in medium-sized businesses. In addition to the risk of losses due to logistics disruptions in milk production, there were also 50% yield losses due to mammary disorders in cows that were not milked. At the same time, the earthquake disaster burdened producers with new cost items such as veterinary and medication expenses.

There was no mechanical damage in poultry houses for broiler chicken production, but there was a 30% loss of chickens in the houses due to earthquake stress. Mass deaths occurred as the chickens tended to gather in one direction during the earthquake. Meeting the feeding needs of broiler and egg-laying chickens is an instant need in poultry production. Although the collapse of feed warehouses and disruptions in feed transportation caused a 20% loss of productivity, officials tried to address the disruptions quickly.

Beekeeping activities are carried out in two ways: migratory beekeeping and stationary beekeeping. During migratory beekeeping, beekeepers stay in huts at the bee yard, so there is no interruption in this activity. Especially during the wintering period, there is no urgency for maintenance in the hives, so there is no interruption in migratory beekeeping activities. Stationary beekeeping represents 10% of the total beehives in the region. The owners of the hives mostly reside in city centres or rural neighbourhoods. Stationary hives have been seen in place, but

information about their owners could not be obtained at that time. This situation will cause damage to beekeeping activities at worst by 10%. Honey, which is a food that has an infinite shelf life when stored properly, has maintained its value due to being the healthiest energy source in natural disasters.

When the tractor presence in rural areas is examined, although the tractors and agricultural equipment and tools parked in open areas generally appear to have not been damaged, more technologically advanced planting equipment with computer support has been kept in enclosed spaces and has been trapped in the debris. During the interviews, it was determined that 30% of the rural neighbourhoods examined were completely destroyed, and 25% of them were damaged compared to the total destruction and clean-up rate. It has been observed that 5% of the total tractor presence in rural areas is trapped under the rubble.

The supports provided to earthquake-stricken producers in terms of agricultural support can be listed as follows:

- Direct support for hay and feed was provided to producers engaged in livestock farming.
- Support payments of 500 TL per large animal and 50 TL per small animal were made.
- Seed grants were provided from the Ministry of Agriculture and Forestry budget to be used for corn, sunflower, soybean, dry bean, and chickpea planting in earthquake-prone areas.
- Support payments for animal feed and diesel fertilizer were paid earlier than the scheduled payment dates to encourage production.
- Animals of the livestock businesses whose barns were destroyed were moved to safe areas to continue production.
- Generator support was provided until electricity was provided to the regions for production to continue.

We can list the priority problems seen in the discussions with earthquake zone producers as follows:

- It was observed that the biggest problem of producers is access to plant protection and plant nutrition products.
- Due to the use of greenhouses as tents for accommodation, there was a contraction in production areas.

In summary, there is a significant migration intensity from cities to rural areas rather than from rural areas to cities. It is predicted that this reverse migration will cause a contraction in agricultural areas. Container-style structures built on agricultural lands are also predicted to cause similar problems of unplanned urbanization in rural areas. As the number of fatalities in rural areas was lower than in city centres, there was no loss of workforce, but it was observed that they needed help in terms of the psychological effects of the losses of their relatives or friends in city centres. Public institutions and organizations are working rapidly to repair the material damages in the region related to the local people. It was observed that producers who need help psychologically also need spiritual support. It was seen that the new people who migrated from cities to rural areas had a need for education if they wanted to start from scratch in agriculture more than the producers who gave up production [6,17].

CONCLUSIONS

The data presented shows the significant impact of the earthquake zone on agriculture in Turkey. The affected areas comprise 16.9% of the country's agricultural land, and within this zone, the production of vegetables, fruits, and ornamental plants are vital with 16.2%, 26.0%, and 3.3% of the total agricultural area, respectively. The regions are also responsible for producing a substantial amount of grains and vegetables, with Adana and Sanliurfa being the top producers. The earthquake zone also plays a crucial role in the livestock sector in Turkey, with the highest number of sheep and goats found in Diyarbakir, and the highest number of beehives in Adana. Thus, the affected areas have a significant impact on the country's agricultural production and should be given special attention in terms of disaster management and preparedness. If in cities the scale of degradation and the magnitude of physical and material losses prompt States to intervene to help compensate, relocate people, and rehabilitate some of the destroyed or degraded infrastructure, the situation is more complex in rural areas. Beyond addressing the

consequences of human losses, injuries, and cases of relocation of rural populations, there is above all a problem of rehabilitating and reviving agricultural activities, of which a large part has been completely wiped out.

ACKNOWLEDGEMENTS

We dedicate this article to our colleagues Prof. Dr. Ercan Efe and Prof. Dr. Lale Ozman Efe, who lost their lives in the earthquake, as well as to all individuals.

REFERENCES

- [1] Akkaya, İ., Özvan, A., Tapan, M., Şengül, M. A., 2015, Determining the site effects of 23 October 2011 earthquake (Van province, Turkey) on the rural areas using HVSr microtremor method. *Journal of Earth System Science*, 124(7), 1429–1443. <https://doi.org/10.1007/s12040-015-0626-1>
- [2] Barman, S. D., Majumder, S. C., Rahaman, M. Z., Sarker, S., 2012, Foundations of migration from the disaster consequences coastal area of Bangladesh. *Developing Country Studies*, 2(4).
- [3] Brookshire, D. S., Chang, S. E., Cochrane, H., Olson, R. A., Rose, A., Steenson, J., 1997, Direct and Indirect Economic Losses from Earthquake Damage. *Earthquake Spectra*, 13(4), 683–701. <https://doi.org/10.1193/1.1585975>
- [4] Duru, S., Gul, A., Hayran, S., 2017, Land Consolidation in Turkey: Legislation and Practices. (Türkiye'de Arazi Topluştırması: Mevzuat ve Uygulamalar). *Turkish Journal of Agricultural Economics*, 23(2).
- [5] FAO, 2023, Initial assessment on possible impacts of earthquake in 11 provinces (CC4779EN/1/03.23; p.9). <https://www.fao.org/3/cc4779en/cc4779en.pdf>, Accessed on 01 March 2023.
- [6] FAO, Newsroom, 2023, Türkiye earthquakes: initial assessment indicates losses more than 20% of food production, <https://www.fao.org/newsroom/detail/turkiye-earthquakes-initial-assessment-indicates-losses-of-more-than-20-percent-in-food-production/en>, Accessed on 31 March 2023.
- [7] Huang, R., Malik, A., Lenzen, M., Jin, Y., Wang, Y., Faturay, F., Zhu, Z., 2022, Supply-chain impacts of Sichuan earthquake: A case study using disaster input–output analysis. *Natural Hazards*, 110(3), 2227–2248. <https://doi.org/10.1007/s11069-021-05034-8>
- [8] Kappos, A., Lekidis, V., Panagopoulos, G., Sous, I., Theodulidis, N., Karakostas, C., Anastasiadis, T., Salonikios, T., Margaris, B., 2007, Analytical Estimation of Economic Loss for Buildings in the Area Struck by the 1999 Athens Earthquake and Comparison with Statistical Repair Costs. *Earthquake Spectra*, 23(2), 333–355. <https://doi.org/10.1193/1.2720366>

- [9]Kundak, S., 2004, Economic loss estimation for earthquake hazard in Istanbul.
- [10]Leroy, S. A. G., Marco, S., Bookman, R., Miller, C. S., 2010, Impact of earthquakes on agriculture during the Roman–Byzantine period from pollen records of the Dead Sea laminated sediment. *Quaternary Research*, 73(2), 191–200. <https://doi.org/10.1016/j.yqres.2009.10.003>
- [11]Liu, J., Wang, S., 2015, Analysis of the differentiation in human vulnerability to earthquake hazard between rural and urban areas: Case studies in 5.12 Wenchuan Earthquake (2008) and 4.20 Ya’an Earthquake (2013), China. *Journal of Housing and the Built Environment*, 30(1), 87–107. <https://doi.org/10.1007/s10901-014-9397-2>
- [12]MacKenzie, C. A., Santos, J. R., Barker, K., 2012, Measuring changes in international production from a disruption: Case study of the Japanese earthquake and tsunami. *International Journal of Production Economics*, 138(2), 293–302. <https://doi.org/10.1016/j.ijpe.2012.03.032>
- [13]Paul, B. K., 2005, Evidence against disaster-induced migration: The 2004 tornado in north-central Bangladesh: Evidence Against Disaster-Induced Migration. *Disasters*, 29(4), 370–385. <https://doi.org/10.1111/j.0361-3666.2005.00298.x>
- [14]Saysr, L., 1998, Book review: Interviews: An introduction to qualitative research interviewing. *American Journal of Evaluation*, 19(2), 267–270.
- [15]Tokui, J., Kawasaki, K., Miyagawa, T., 2017, The economic impact of supply chain disruptions from the Great East-Japan earthquake. *Japan and the World Economy*, 41, 59–70. <https://doi.org/10.1016/j.japwor.2016.12.005>
- [16]Tuik, 2022, <https://biruni.tuik.gov.tr/medas/?locale=tr>, Accessed on 31 March 2023.
- [17]Utkina, I., 2023, Turkiye earthquakes: initial assessment indicates losses more than 20% of food production, FAO, Reliefweb.int, <https://reliefweb.int/report/turkiye/turkiye-earthquakes-initial-assessment-indicates-losses-more-20-percent-food-production>, Accessed on 31 March 2023.
- [18]Wang, Y., Shi, P., Wang, J., Ye, T., 2005, Impact of earthquake disaster on rural residents: A case study on Dayao County of Yunnan Province. *Journal of Natural Disasters*, 14(6), 110.