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Research Article

Research of the Effect of Climate Change on Natural Disasters Occurring Between 1970-2023 in Terms of the Insurance Sector

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Abstract

The number of natural disasters occurring in the world due to climate change is increasing day by day. Efforts to reduce the loss of life and property resulting from natural disasters are very important for the country's economy. This study emphasizes the importance of disaster management and disaster insurance by examining the relationships between the changes in annual average temperature, precipitation and humidity data in Turkey between 1970 and 2023, the number of natural disasters that occurred, the number of individuals affected and killed by disasters, the total loss amount and the insured loss amounts. requested. For this purpose, the reports of the Emergency Events Database (EM-DAT), Natural Disaster Insurance Institution (DASK) and the General Directorate of Meteorology were examined and the importance of disaster insurance, which has an important place in disaster management, was emphasized. It has been tested that the number of natural disasters increases over the years due to changes in the climate as a result of global warming, and it has been determined that the share of the insurance sector in financing the losses that have occurred and will occur is very small. It has emerged that awareness of disaster insurance, which has an important place in covering the damages arising from natural disasters and in the country's economy, should be created and disseminated.

Keywords

Global warming, climate change, natural disaster, insurance, disaster insurance.

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1. Introduction

Climate change caused by global warming is a global issue that leads to numerous catastrophic risks such as drought, flood, storm, frost, and landslide. The emission of greenhouse gases into the atmosphere in amounts greater than the required levels causes climate change. With the increase in industrialization and fossil fuel consumption every day, the impact of climate change is also growing due to the rise in greenhouse gas emissions in the atmosphere. In addition to the environmental and social impacts of climate change, it also has significant effects on the economy. The involvement of the insurance system in covering potential damages resulting from climate change is crucial both for the national economy and for individuals who have to bear the risks.

An insurance company may face financial difficulties if it has to pay a high compensation to a customer who has suffered a natural disaster due to climate change, and it could even lead to the company's bankruptcy. On the other hand, the increase in the number and severity of climate change-related disasters will raise the number of customers in insurance companies' portfolios and the amount of premiums they pay. Therefore, developing techniques and theories that accurately measure the impacts of climate change and the risks associated with it has become inevitable for the future of the insurance sector.

In the face of the damages caused by the negative effects of climate change, the insurance sector becomes quite important for both individuals and national economies by distributing the risk. With this study, the number of natural disasters occurring between 1970-2023, the total damage amount resulting from these disasters, the insured damage amount, the number of people affected by the disasters and the number of people who lost their lives in the disasters, as well as the changes in temperature, precipitation, and humidity data, which can be considered indicators of climate change, and the relationships between them will be examined over time periods. Among the measures that need to be taken in response to natural disasters, it is necessary to prioritize eliminating factors that contribute to climate change and to focus on efforts to increase the insurance coverage rate.

2. Natural Disasters

Due to global warming causing changes in the climate, the creation of unplanned settlements due to population growth, the destruction of nature and the environment by humans, and the elimination of natural habitats for animals and plants, natural disasters are becoming more frequent every day and their impacts are becoming increasingly devastating.

Natural events that cause negative impacts on people and the environment, significantly disrupt the socio-economic and socio-cultural activities of society, and result in loss of life and property, are defined as "natural disasters" (Büyükbaş & Ormanoğlu 2013).

The Emergency Events Database (EM-DAT), a database for natural disasters occurring worldwide, was initiated by the Centre for Research on the Epidemiology of Disasters (CRED) in 1988. This database is widely used to obtain information about the types and distribution of natural disasters by providing access to historical and current datasets, thereby revealing the socio-economic anatomy caused by recorded natural disasters. EM-DAT classifies natural disasters into five categories: Biological, Climatological, Geophysical, Hydrological, and Meteorological. The distribution of natural disasters observed in Turkey between 1970-2023 is presented in Table 1. The occurrence rate of geological and hydrological disasters is the highest at 40.1%, while the occurrence rate of climatic events is 3.9%.

Table 1. Distribution of Natural Disasters in Turkey (1970-2023**)**

	n	**%**
Biological	4	2,6
Climatic	6	3,9
Geophysical	61	40,1
Hydrological	61	40,1
Meteorological	20	13,2
Total	**152**	**100,0**

Source: EM-DAT (15.02.2024)

EM-DAT classifies types of natural disasters as Earthquake, Epidemic, Extreme Heat, Flood, Landslide (Dry Mass Movement), Avalanche (Wet Mass Movement), Storm, and Forest Fire. Utilizing EM-DAT data, the types of natural disasters that occurred in Turkey between 1970 and 2013 are presented in Table 2.

Table 2. Distribution of Natural Disasters in Turkey by Type (1970-2023)

	n	%
Earthquake	60	39,5
Epidemic	4	2,6
Extreme Heat	7	4,6
Flood	47	30,9
Landslide (Dry)	1	,7
Landslide	14	9,2
Storm	13	8,6
Forest Fire	6	3,9
Total	**152**	**100,0**

Source: EM-DAT (15.02.2024)

When Table 2 is examined and natural disasters are mentioned, the first thing that comes to mind is earthquakes, which have the highest occurrence rate at 39.5%. Closely related to climate change and the second most frequently observed destructive natural disaster after earthquakes, with a rate of 30.9%, is flooding. The least observed type of natural disaster is landslides, with 0.7%.

3. Insurance and Climate Change

Since the day humanity came into existence, it has faced numerous dangers threatening life and property. Especially, the rapid development of industry and technology, global warming, and the increase in fossil fuel usage, among various other reasons, have led to the emergence of the insurance sector as an effort to take various measures to cope with the disasters that occur and whose number and severity increase every day. Thus, the insurance industry was born and developed with the aim of financing damages covered by the policy based on the principle of risk transfer in exchange for a certain amount of money (Acinan, 2005, Scheel et al., 2013).

The level of greenhouse gases released into the atmosphere being above average causes global warming and climate change. People take the route of insuring their lives and properties against the damages that may occur as a result of climate change to avoid losses. The insurance system provides significant assurance in the development of the national economy by covering the financial losses that individuals may face from potential risks (Çekici, 2009, Kunreuther et al., 2007).

Due to climate change, the increasing number and intensity of disasters every day are not only caused by natural reasons but are also greatly influenced by the technology and industry used by humans. Especially the increasing industrialization and the use of fossil fuels such as oil and coal, which disrupt the composition of the global atmosphere, have caused global warming by disturbing the balance of various gases in the atmosphere (Çepel et al., 2007).

Weather events such as floods, droughts, rising sea levels, extreme heat, tornadoes, forest fires, hailstorms, and storms caused by climate changes due to global warming seriously affect people's lives (Anbar, 2008, Mills, 2005).

Scientific studies show that climate change is increasing the number and severity of natural disasters. From the perspective of the insurance sector, the most significant impact of climate change is that the increase in the number and severity of disasters will result in very high amounts of damages covered by insurance, putting insurance and reinsurance companies in a financially difficult position or causing them to go bankrupt (Lyubchich et al., 2019).

The disasters that may occur as a result of climate change have significant impacts on many sectors such as the economy, transportation, health, agriculture, and livestock, and deeply affect the insurance sector as well (Anderson et al., 2006).Property insurance, which covers the movable or immovable assets of individuals or legal entities against risks such as flooding, hail, storm, and fire, is the branch of insurance affected by climate change (Insurance Training Center, 2012).

Health insurance, which covers the expenses and compensations required for the treatment of insured individuals in case of illness or injury during the insurance period, and another type of insurance affected by climate change because it is obligated to cover the necessary expenses and compensations for the treatment of the insured individual in the face of risks such as high temperatures, excessive humidity, drought, forest fires, and floods (Ebi et al., 2021).

For plant and animal agricultural products; agricultural insurance, which secures farmers against threats to the agricultural sector posed by extreme climate events such as frost, drought, excessive rainfall, and temperature, is also affected by climate changes (Akçaöz et al., 2006).

Vehicle insurance, which covers damages that may occur to the other party in the event of an accident, is a mandatory type of insurance that provides security against extreme weather events such as hail, fog, and frost that can cause accidents. Due to the impact of vehicle fuel systems on global warming, the use of bio-fuel, hybrid, or electric engines should be encouraged (Louberge, 1981).

Due to climate change; the loss of body water due to extreme temperatures, inability to maintain a balanced diet, and the increase in the number of patients and deaths due to extreme cold are affecting the life insurance system (Anbar, 2008).

Construction insurance, which offers coverage against risks that may affect real estate due to events such as floods, storms, and tornadoes caused by climate change, is also being affected (Demirbilek&Aydemir 2022).

Transportation insurance, which provides coverage against damages that may occur due to excessive rainfall, storms, hot and cold weather during the transportation of goods and products with commercial value from one place to another, is also affected by climate changes (Hawker, 2007).

All disasters caused by climate change indirectly or directly affect almost all branches of insurance.

4. Materials and Methods

The data used in the research were obtained from the International Emergency Events Database (Emergency Events Database: EM-DAT) (https://www.emdat.be/), utilizing data on the number and type of natural disasters in Turkey between 1970-2023, the resulting loss of life, total damage amount, and insured damage amount, as well as the average temperature, precipitation, and humidity data for the relevant years from the General Directorate of Meteorology of the Ministry of Environment, Urbanization, and Climate Change. Since the data used in the study were obtained from secondary sources, there is no need for ethics committee approval.

In the study, the time period between 1970-2023 was divided into four 13-14 year periods, and descriptive statistics and distribution graphs were obtained to examine the changes in the number of natural disasters, the number of people affected by disasters, the number of fatalities, the total damage amount, the insured damage amount, the annual average temperature, precipitation, and humidity data that occurred in the specified time periods. Additionally, according to the specified time periods of 1970-1983, 1984-1997, 1998-2020, and 2011-2023, the differences in the number of natural disasters, the number of people affected by disasters, the number of fatalities, the total damage amount, the insured damage amount, the annual average temperature, precipitation, and humidity data were examined using One-Way Analysis of Variance (ANOVA) and graphs. The statistical significance level was accepted as $p<0.05$.

5. Findings

In the study, the changes in annual average temperature, precipitation, and humidity data, which are important indicators of climate change, as well as the total annual number of disasters from 1970 to 2023, are presented in Figures 1(a), 1(b), 1(c), and 1(d), respectively.

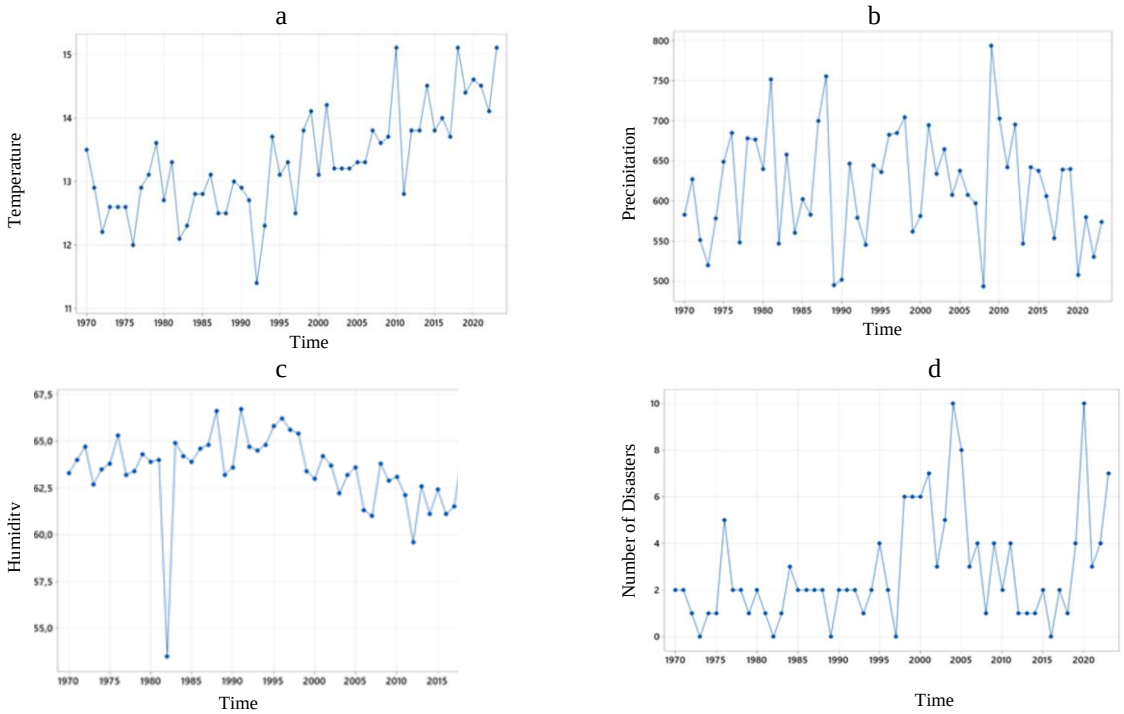

Figure 1. Annual for the Period 1970-2023 **(a)** Average Temperature; **(b)** Average Precipitation; **(c)** Average Humidity; **(d)** Total Number of Disasters

When examining Figure 1. (a), an increase in average temperature over the years is observed, while a decrease in average rainfall is noted in Figure 1.(b) and a decrease in average humidity is observed in Figure 1.(c). The annual total number of disasters given in Figure 1.(d) shows an increasing trend over the years.

Figure 2. a, b, c, and d show that the number of people affected by disasters and the number of fatalities, the total damage amount incurred, and the insured damage amounts can vary according to the year and type of disaster. Especially due to the devastating and significant losses caused by the 1999 Marmara earthquake in our country, the number of people affected by natural disasters between 1998 and 2010 was 1,584,792, while the number of fatalities was 17,982, the total damage was 35,137,907 thousand dollars, and the insured damage amount was 3,513,791. For the years 2011-2023; due to the impact of the 2023 Kahramanmaraş earthquakes, the number of people affected by natural disasters was 9,208,252, the number of fatalities was 50,832, the total damage was 34,025,000 thousand dollars, while there is no record in the EM-DAT database regarding the insured damage amount.

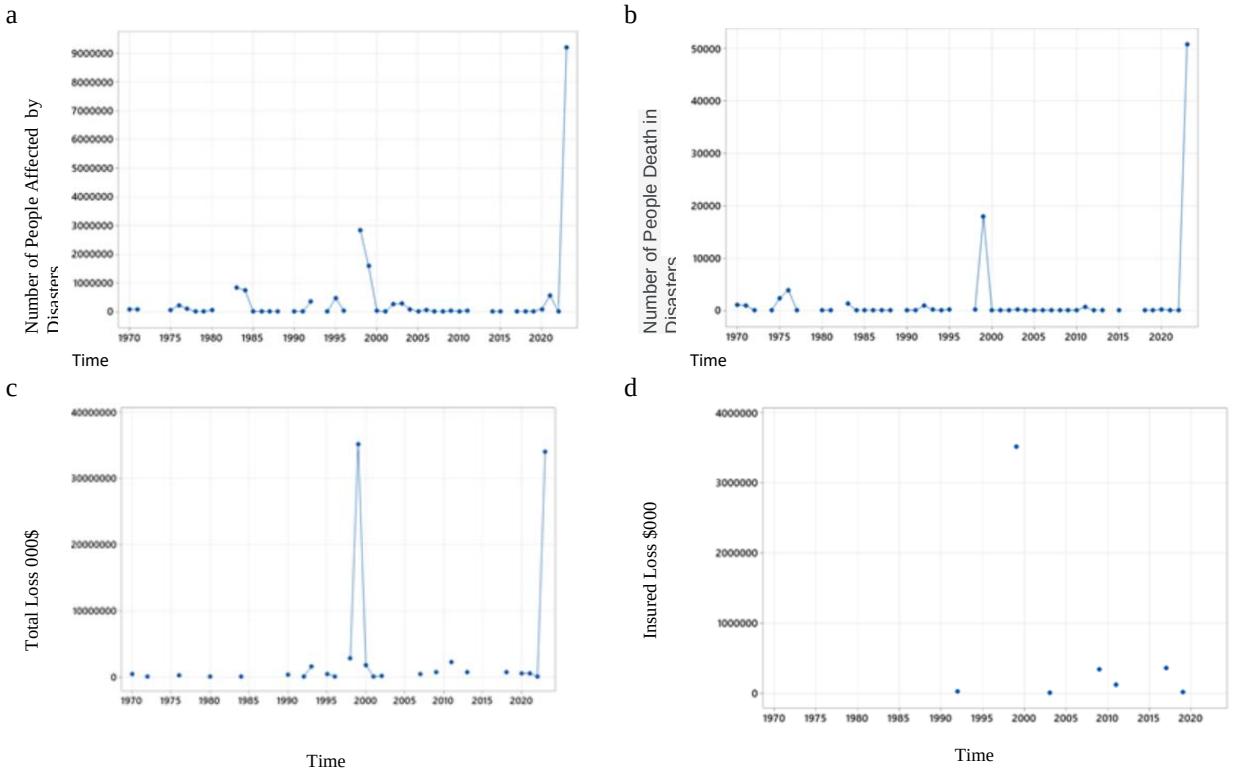

Figure 2. For the Period 1970-2023 in Natural Disasters: **(a)** Number of Affected People; **(b)** Number of People Death; **(c)** Total Loss; **(d)** Insured Loss

Looking at past records, it is shown in Figure 3 that the insured loss amounts are very low compared to the actual loss amounts.

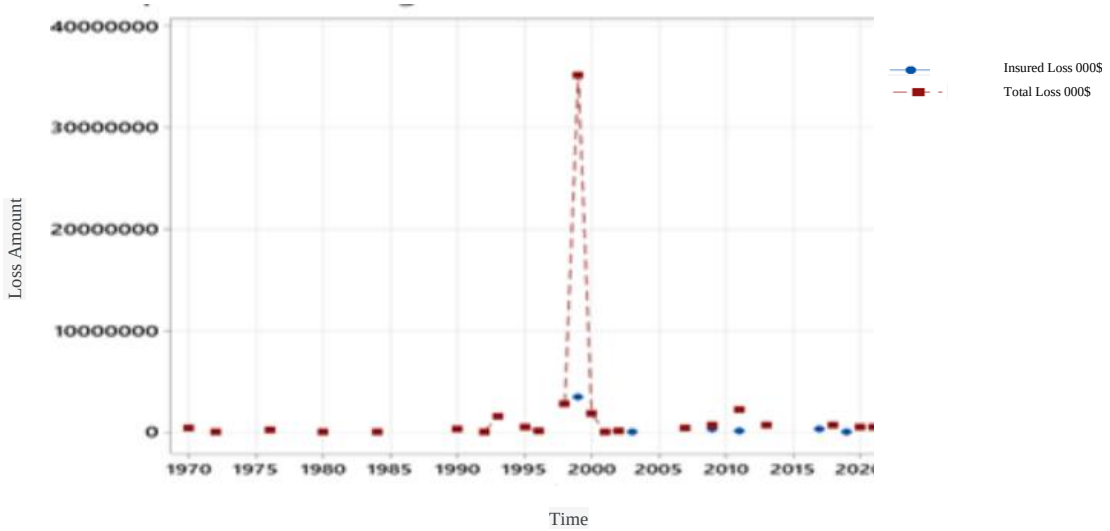

Figure 3. Total Loss and Insured Loss from Natural Disasters

Figure 3 shows the total damage and insured damage amounts caused by natural disasters in Turkey between 1970 and 2023. When examining the International Emergency Database, it is noted that out of the 152 natural disasters that occurred between 1970-2023, 5 earthquakes, 2 floods, and 1 storm and heavy rainfall resulted in damages, a portion of which were covered by insurance companies. In the 1992 Erzincan earthquake, $22,525,000 of the $1,564,256,000 damage was covered by insurance companies; in the 1999 Marmara earthquake, $3,513,791,000 of the $35,137,907,000 damage was covered; in the 2003 Bingöl earthquake, $1,591,000 of the $214,768,000 damage was covered; in the 2009 Marmara and Istanbul floods, $341,031,000 of the $750,268,000 damage was covered; in the 2011 Kütahya Simav earthquake, $5,204,000 of the $317,454,000 damage was covered; in the 2011 Van earthquake, $117,094,000 of the $1,951,560,000 damage was covered; in the 2017 Istanbul storm and heavy rainfall, $358,178,000 of the $716,356,000 damage was covered; and in the 2019 Istanbul flood disaster, the $11,447,000 damage was covered by insurance companies. Especially in the years 1999 and 2023, the damage amounts caused by natural disasters, primarily earthquakes, were quite high, yet the insured damage amounts and their frequencies are almost negligible.

With Table 3, the number of disasters, insured losses, total losses, number of fatalities, number of people affected by disasters, temperature, precipitation, and humidity data for 13-14 year periods since 1970 are presented along with descriptive statistics. Additionally, whether the means of these variables differ by period is analyzed using One-Way Analysis of Variance (ANOVA).

Table 3 Descriptive Statistics

	Time	Mean	Std. dev.	Sum	Min	Max	p-valuei
Number of Disasters	1970-1983	1,500	1,225	21,000	0,000	5,000	0,000*
	1984-1997	1,857	1,027	26,000	0,000	4,000	
	1998-2010	5,000	2,517	65,000	1,000	10,000	
	2011-2023	3,077	2,813	40,000	0,000	10,000	
Insured Losses _000$	1970-1983	-	-	-	-	-	0,587
	1984-1997	22525	-	22525	22525	22525	
	1998-2010	1285471	1937231	3856413	1591	3513791	
	2011-2023	163974	177083	491923	11447	358178	
Total Losses _000$	1970-1983	182380	178499	729518	36138	419101	0,044*
	1984-1997	435624	579495	2613746	53721	1564256	
	1998-2010	5887082	12937436	41209577	41320	35137907	
	2011-2023	5559594	12570974	38917158	50000	34025000	
Death People	1970-1983	988	1296	9883	10	3913	0,048*
	1984-1997	143,1	264,1	1574,0	6,0	914,0	
	1998-2010	1455	4966	18913	2	17982	
	2011-2023	5189	16039	51887	5	50832	
Affected People	1970-1983	161013	260893	1449116	1000	834137	0,047*
	1984-1997	149732	258717	1647056	150	750273	
	1998-2010	399491	847681	5193386	300	2832353	
	2011-2023	993506	2891639	9935063	100	9208252	
Temperature	1970-1983	12,743	0,505	178,400	12,000	13,600	0,000*
	1984-1997	12,757	0,537	178,600	11,400	13,700	
	1998-2010	13,662	0,564	177,600	13,100	15,100	
	2011-2023	14,169	0,628	184,200	12,800	15,100	
Precipitation	1970-1983	620,7	67,4	8690,0	519,5	751,3	0,043*
	1984-1997	615,3	76,5	8614,3	495,1	755,1	
	1998-2010	636,8	76,6	8278,3	493,1	793,8	
	2011-2023	599,4	55,3	7792,6	507,6	695,2	
Humidity	1970-1983	63,179	2,874	884,500	53,500	65,300	0,001*
	1984-1997	64,943	1,091	909,200	63,200	66,700	
	1998-2010	63,138	1,162	820,800	61,000	65,400	
	2011-2023	62,023	1,320	806,300	59,600	64,400	

*p<0,05

When Table 3 is examined, it is revealed with 95% reliability that there is a difference between the average of the data of the number of disasters that occurred, the total amount of damage, the number of people who lost their lives, the number of people affected by disasters, temperature, precipitation and humidity for the 13-14 year periods in our country ($p<0.05$). The total number of natural disasters that occurred between 1998-2010 reached its highest number with 65, and in parallel with this, the total insured loss was 3856413 thousand dollars, the total loss was 41209577 thousand dollars, the total number of people who lost their lives was 18913, and the total number of people affected by disasters was 5193386 people. With the earthquakes in Elazığ, İzmir, Kahramanmaraş and floods such as Bodrum, Ankara, Adıyaman-Şanlıurfa, which occurred in our country between 2011-2023 and had very devastating effects, the total number of people affected by natural disasters was 9,935,063 and the total number of people who lost their lives was the highest with 51,887.

Table 3 also shows that the average insured loss amount is statistically indifferent over time ($p>0.05$). The lack of sufficient number of observations for the insured loss amount for the years examined suggests the reliability of the test result. One of the most important measures taken in Turkey, especially after the 1999 Marmara earthquake, is the Compulsory Earthquake Insurance (ZDS) for housing, which came into force in 2000, and the State Supported Agricultural Insurance System (TARSİM) for producers/growers operating in the field of agricultural production, which came into force in 2005, and the incentives and tendencies to have insurance started late. It was concluded that although increases were observed in the case of insurance companies covering the losses incurred in natural disasters, especially with the widespread use of ZDS and TARSİM insurance practices, they were very low in amount and frequency (EM-DAT, 15.02.2024).

Table 4 shows the number of ZDS policies and premium amounts between 2000-2023. Although the number of policies and premium amounts have increased every year since the date it came into force, the targeted 100% insurance rate has been observed at 55% as of 2023 (DASK 2022 activity report). As seen in Table 2, earthquakes, which have been the most common type of natural disaster in Turkey in the last 53 years, have deeply affected the country's economy by causing inevitable loss of life and property for our country, which is almost entirely considered an earthquake zone, and it has been determined that the amount covered by insurance companies for these damages is quite low.

Table 4. ZDS Policy Numbers and Premium Amounts by Year (2000-2023)

Year	Number of policies(000)	Premium Amount (000TL)
2000	159	3.766
2001	2.428	54.526
2002	2.128	65.756
2003	2.022	85.688
2004	2.090	126.216
2005	2.417	159.085
2006	2.555	205.799
2007	2.618	234.615
2008	2.844	272.637
2009	3.435	322.065
2010	3.316	319.415
2011	3.725	378.782
2012	4.786	509.771
2013	6.029	674.134
2014	6.808	753.881
2015	7.230	786.072
2016	7.628	876.140
2017	8.284	1.020.136
2018	8.846	1.176.967
2019	9.490	1.322.661
2020	9.992	1.629.511
2021	10.532	1.693.202
2022	10.941	2.424.323
2023	11.656	4.746.927

Source: Natural Disaster Insurance Institution (29.02.2024)

Whether changes in climate data such as temperature, precipitation and humidity have an effect on the number of disasters between 1970 and 2023 was tested with the Pearson correlation coefficient; Figure 4 and Table 5 show that there is a low correlation of 30% between the temperature value and the number of natural disasters, but no correlation between humidity and precipitation.

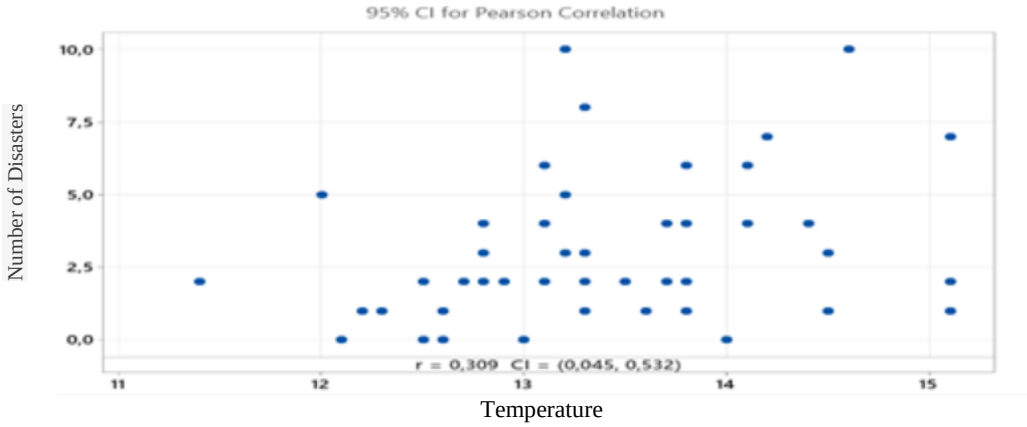

Figure 4. Correlation Between Temperature and Number of Disasters

Table 5. Correlation between the Number of Disasters and Temperature, Precipitation and Humidity

		n	Correlation	95% Confidence Interval	p-Value
Number of Disasters	Temperature	54	0,309	(0,045; 0,532)	0,023*
Number of Disasters	Precipitation	54	0,051	(-0,220; 0,314)	0,716
Number of Disasters	Humidity	54	0,029	(-0,241;0,294)	0,836

p<0,05

Considering the years examined, the increases in the average temperature are given in Figure 5. It has been revealed that the increase in the average temperature may have an effect on the increase in the number of natural disasters that may occur.

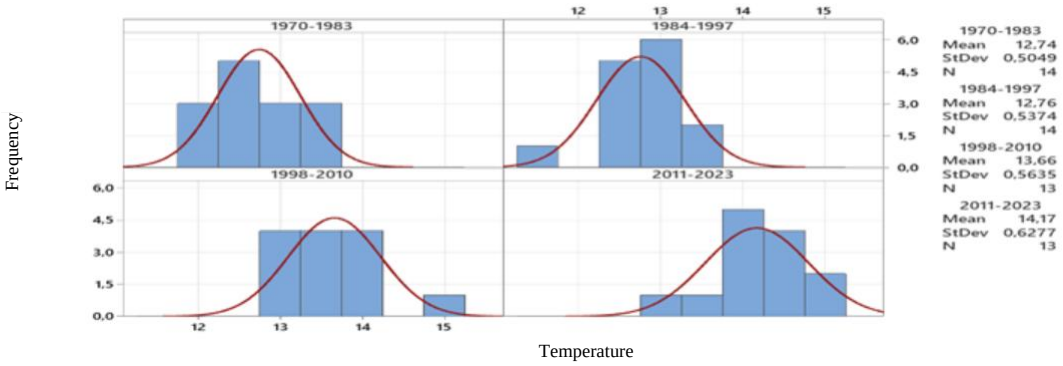

Figure 5. Average Temperature Increases by Year

The increase in the average temperature and the decrease in the amount of precipitation and humidity, which are indicators of global warming, are given in Figure 6. As in the study of Mills (2005), in our country, as seen in Figures 5 and 6, there is a change or shift in the distribution curve of climatic events due to climate change. The distribution trend of climatic events is shifting to the right and flattening. This means that there will be fewer colds and the number of extreme climatic events will increase (Çekici, 2009).

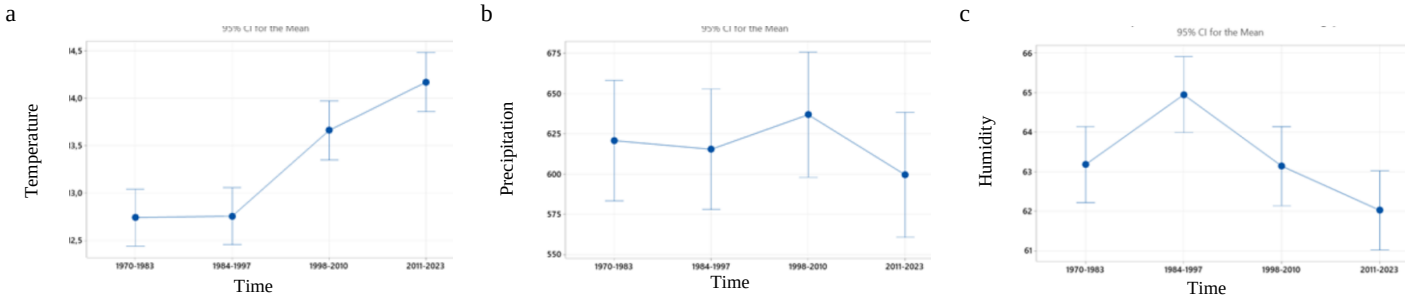

Figure 6. Changes in Average **(a)** Temperature; **(b)** Precipitation; **(c)** Humidity Amounts by Year Groups

6. Conclusion and Discussion

Increases are observed in the number and severity of natural disasters, especially in our country and all over the world. In parallel with the literature, the study shows that the increase in annual average temperature, decrease in humidity and precipitation indicate climate change and as a result, the number and severity of natural disasters are inevitably increasing every year. The fact that a large part of the world's population is exposed to the risk of natural disasters has led individuals and institutions to take out insurance to protect themselves from this risk. Since it is not possible to predict when and how severe natural disaster risks will occur, they are quite different from other risks undertaken by insurance companies. Although the probability of disaster events is very low, the high damage potential can put insurance companies in a difficult situation and even cause them to go bankrupt. Insurance companies usually resort to reinsurance companies to avoid major risks such as disaster risks. However, in the event of high-damage disasters, reinsurance companies may also be unable to meet their obligations or go bankrupt. In such cases, insurance and reinsurance companies should make efforts to develop new financial instruments such as disaster bonds and disaster stocks in order to transfer their risks, and these efforts should be incentivized by the state (Lyubchich et al., 2019)

Climate change is a global problem and the losses and damages that occur as a result of it are increasing day by day. For this reason, the insurance sector is very important for national economies in reducing losses or preventing damages caused by climate change. As

a result of statistical analyzes using data obtained for the years 1970-2023; It has been observed that there has been an increase in the number of natural disasters due to climate change, and despite the increase in the severity and number of damages caused by natural disasters, the insured loss amount is very insufficient. Although there are state-incentivized insurance products such as compulsory earthquake insurance and agricultural insurance, it has been concluded that there is a need for a disaster insurance system that covers all segments of society and that will cover all types of natural disasters that may occur, such as compulsory health insurance, and that will be supported by the state and will be mandatory.

In addition, within the insurance system; It is necessary to give importance to the creation of disaster risk maps, the dissemination of appropriate insurance premium applications, the creation of disaster models and the increase of public awareness of being insured.

It has been concluded that efforts to increase and disseminate measures against global warming such as reducing fossil fuel consumption and carbon emissions, which are effective in global warming, increasing green building projects and afforestation activities, and expanding the use of renewable energy sources are important.

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