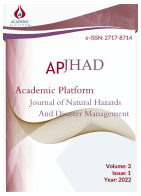

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The Situation of Combined Disasters Caused by Climate Change: Antalya

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Abstract

There are often negative and difficult-to-manage natural disasters that leave permanent effects and traces in the natural and built environment. While the proportion of people living in cities is expected to increase to 66% in 2050, considering that disasters caused by climate change will increase rapidly, the probability of simultaneous/simultaneous occurrence of multiple hazards is high. It is an inevitable fact that combined disasters (earthquake, pandemic, flood, storm, etc.) will occur more and disasters will occur especially in coastal cities. The aim of this study is to determine the combined (simultaneous/simultaneous level) situations of disasters caused by climate change in Antalya in 2012-2021 with content analysis method and to draw attention to the importance of combined / multiple hazard risk management before disasters occur. As a result of the content analysis made in the study, it was seen that there are combined disaster situations in Antalya and extreme precipitation plays an active role in this.

Key words: Antalya, Combined disaster, Climate change

1. Introduction

Due to population growth and urbanization, the number of people affected by natural disasters is increasing in many parts of the world [1]. With the fact that many regions of the world are exposed to more than one type of natural disaster and human disasters such as COVID-19 are added to these, multiple hazard risks arise. The lack of multi-hazard risk assessments and management, especially in recent years, has created catastrophic environments in the COVID-19 pandemic crisis [2], [3].

Multiple hazards are “an approach that considers multiple hazards at a given location and the interrelationships between these hazards, including their simultaneous or cumulative occurrence and potential interactions” [4]. Multiple hazards are divided into interactive (interacting) and independent approaches. Independent multiple hazards do not take into account the interactions of hazards, that is, they include the independence of more than one different hazard [5].

These hazards are, in fact, both the container and the origin of disasters [6]. While the level of being affected by disasters increases with urbanization, an important point to be considered in disaster response in the 21st century is the possibility of simultaneous/simultaneous occurrence of multiple hazards: “Combined disaster”. A disaster system can have complex network system behaviours such as cascading disasters, disaster compounds, disaster swarms, disaster chains,

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and disaster compounds [7]. A disaster swarm refers to the phenomenon in which disasters usually occur in spatial and temporal clusters [8]. Disaster chains (or cascading disasters) refer to the triggering or causal relationship between one disaster and other disasters. It can also be divided into parallel disaster chains (multiple; or ripple behaviour) and irregular disaster chains (one after another; or domino effect) [7], [8]. The disaster compound, on the other hand, should be understood as a situation in which two or more disasters occur simultaneously or in succession without any causal relationship and cause far greater consequences than the simple sum of each disaster, even if they are not excessive when taken separately.

In recent years, to understand this complex structure of the disaster system, there has been a growing body of theoretical and conceptual work to understand so-called cascading disasters (disasters generating secondary disasters) [9], compound disasters (combinations of simultaneous or successive extreme hazard events) [10], [11], and recurrent disasters (in which the same hazard repeats) [12]. Combined disasters can be considered as the encompassing of all these disaster definitions (Table 1).

Table 1. Terminologies describing multiple disasters

Terminology	Description
Consecutive disasters [13]	Two or more disasters that occur in succession, and whose direct impacts overlap spatially before recovery from a previous event is considered to be completed.
Compound disasters [10]	A term to describe natural hazards and the combination of two or more extreme events, which occur simultaneously or successively and have substantial effects.
Cascading disasters [11]	Extreme events, in which cascading effects increase in progression over time and generate unexpected secondary events of strong impact. These tend to be at least as serious as the original event and contribute substantially to the overall duration of the disaster's effects.
Recurring or recurrent disasters [12]	The recurrence of a single natural hazard in the same geographic region over one year.
Combined disaster (definition of authors)	A combined disaster is a set of disasters in which one disaster triggers another, is a precursor or a consequence of the disaster and includes independent disasters.

Since understanding these complex features of disaster systems correctly means better understanding the formation process of hazards and disasters, the concept of "combined disaster" is used as a single concept including all these disasters in this study. Also, the combination of especially hydro-meteorological disasters (flood, storm, landslide, etc.) caused by climate change is expressed as a “combined disaster”.

Compound weather and climate events are defined as a combination of multiple drivers and/or hazards that contribute to risk [14]. The turn of these events into a combined disaster is a strong case. For example, "In 2012, Hurricane Sandy hit the New York metropolitan area. The unusual path of Hurricane Sandy was affected by multiple weather systems over the North American continent and the north Atlantic" [11]. This combination of multiple climate hazards, culminating in an unusual hurricane path and subsequent intense effects (widespread flooding), is referred to as a combined disaster.

The meaning of "Compound (Multiple) Events" explained by the Intergovernmental Panel on Climate Change (2012) overlaps with the meaning of "combined disaster"; “(1) two or more extreme events occurring simultaneously or successively: (2) combinations of extreme events with underlying conditions that amplify the impact of the events: (3) combinations of events that are not themselves extremes but lead to an extreme event or impact when combined” [15]. The contributing events can be of similar (clustered multiple events) or different types. Examples of combined disasters resulting from events of different types are varied; for instance, high sea level coinciding with tropical cyclone landfall: cold and dry conditions, the impact of hot events and droughts on wildfire; a combined risk of flooding from sea level surges and precipitation-induced high river discharge [16], [17].

The double, triple, ..., and multiple nature of the damage triggered by the events that will occur in natural disasters with the effect of climate change will create serious problems. For example, catastrophic damage can occur when hydro-meteorological disasters are combined with the worst-case scenario, a major earthquake (combined disaster). While earthquake is already an immediate risk, the increase in the size and number of disasters caused by climate change strengthens the likelihood of worst-case scenarios. In this case, “combined disaster” can also be defined as disasters that are exposed to the combination of more than one disaster.

The origin of the word "combine" means "*early 15c., "to associate, unite, join two or more things together" (transitive), from Old French combiner (14c.) and directly from Late Latin combinare "to unite, yoke together," from Latin com "with, together" (see com-) + bini "two by two," adverb from bi- "twice" (from PIE root *dwo- "two")"* [18]. In the study, it is appropriate to use Combine, as it can be seen in the meaning of the word, to describe the occurrence and unity at the same time or sequentially.

From the perspective of Turkey, it has experienced a combined disaster in the current period. While there was a tsunami risk in the Izmir earthquake that occurred on October 30, 2020, there was also a fight against the pandemic. If heavy rain and flood were added while all this was happening, the infrastructure and the city would have been dragged into chaos. In such a scenario, especially the coastal cities of Turkey are at great risk; because while these regions are more affected by disasters caused by climate change, coastal regions come to the fore in Turkey's earthquake risks.

This study aims to determine the combined (simultaneous/simultaneous level) of disasters caused by climate change in Antalya in 2012-2021 with the content analysis method and to draw attention to the importance of combined / multiple hazard risk management before disasters occur. Within the scope of the study, hydro-meteorological disasters caused by recent climate change will also be discussed in this context.

2. Materials and Method

2.1. Research area

Disaster events from the past to the present have been analysed in detail within the scope of the study to see which types of disasters are more common on the global scale and to what extent. According to the EM-DAT (The International Disasters Database) database, which contains comprehensive information and has a global-regional-local data inventory, a total of 13,234 natural disasters were reported in the world between 1900 and 2020, approximately 65% of them are hydro-meteorological disasters and have been increasing rapidly in the last decade

[19]. In Turkey, about 2 million people have been affected by hydro-meteorological disasters recently. The concentration of these disasters in urban areas also means increased socio-economic-spatial (SEM) vulnerability and intense exposure [20], [21]. The geographical situation of many major cities around the world (especially coastal cities) faces serious natural disaster risks [22], [23]. For these reasons, hydro-meteorological disasters caused by climate change will be discussed in this study.

In the report prepared by the General Directorate of Meteorology (2022), a total of 8274 natural disasters with meteorological character were reported in Turkey between the years 2010-2021. Storms (32%), heavy rain/flood (31%), and hail (17%) constitute approximately 80% of these disasters. Antalya was the province most affected by these disasters (Figure 1). According to the report of general Directorate of Meteorology (MGM) (2022), Antalya is the province that stands out in storms, tornadoes, and heavy rain/flood disasters in Turkey. Also, disasters such as landslides, hail, and frost have greatly affected the province [24]. Due to these data, the province of Antalya was chosen as the study sample.

The geographical situation of many large cities around the world (especially coastal cities) faces serious natural disaster risks [25]. As seen in Figure 1, it is seen that important coastal cities such as Antalya are and will be exposed to hydro-meteorological disasters. According to the scenarios that emerged as a result of scientific studies conducted by national and international organizations, it is predicted that important coastal cities such as Antalya will be exposed to disasters such as floods, droughts, floods, and sea level rise. The simultaneous occurrence of these disasters (combined disasters) poses a great risk (catastrophic). For this reason, "Antalya province" was chosen as the sample area in the study, and the combined situations of disasters were analysed.

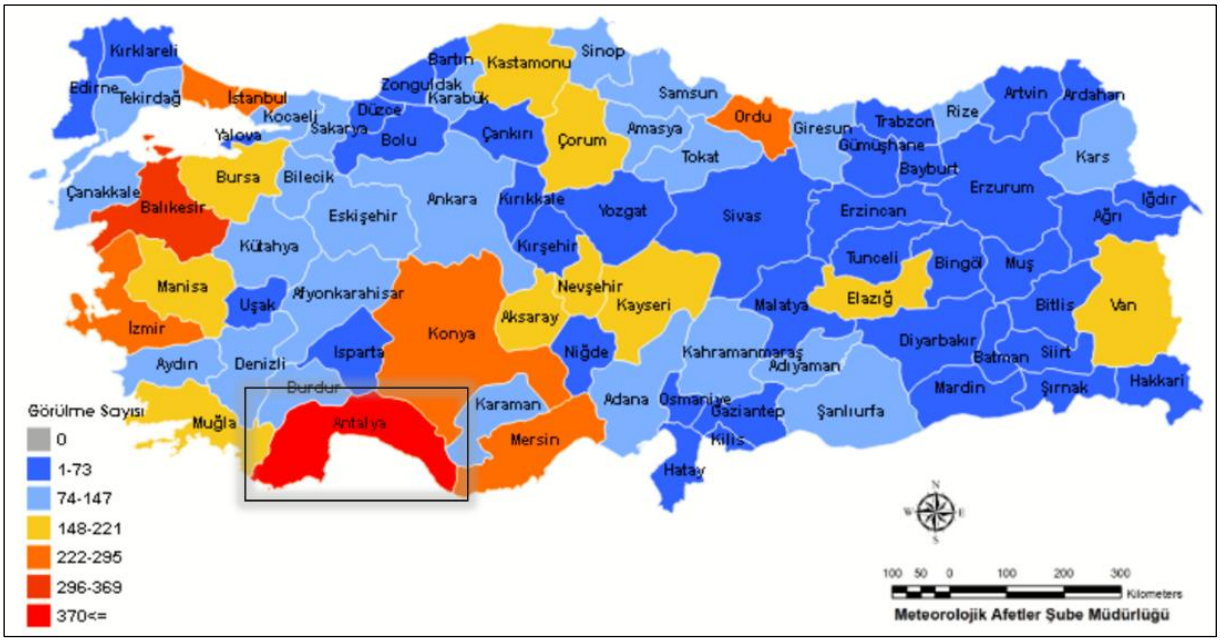

Figure 1. Distribution of meteorological disasters by provinces between 2010-2021 in Turkey [24]

2.2. Study method: content analysis

In the study, content analysis methods and techniques were used to identify "combined disasters caused by climate change in Antalya". In the content analysis, the research universe/sample was

selected in accordance with the purpose of the study, conceptualization, and code categories were determined, and data collection, coding, context formation, inference, and interpretation were made.

In the study, in order to detect combined disasters (simultaneous/simultaneous), hydro-meteorological disasters that occurred in the last 10 years (2012-2021) were scanned in the "Google News" database based on the words in Table 2 and data sets were obtained.

Table 2. Words scanned in “Google News”

Scanned Words	“disaster”, “flood”, “flash flood”, “landslide”, “storm”, “tornado”, “heavy rain”, “extreme precipitation”, “hail”
Scanned Years	2012 to 2021

Documents related to 95 news obtained were analysed by content analysis method. Content analysis is used to make reproducible and valid inferences from texts and increases the researcher's understanding of certain phenomena [26]. Content analysis, it is tried to “describe the data and reveal the truths that may be hidden in the data”. For this reason, it is aimed to obtain a meaningful output by coding the data in the research documents within the framework of certain concepts/themes. The MAXQDA 2022 program, known as the qualitative data analysis program, was used in the content analysis process. This program was preferred because it provides auxiliary maps and visuals by clarifying the relationships between themes and codes [27].

As a result of the searches carried out on “Google News”, 95 news stories were compiled, each documented over the years, and the coding phase was started (see Figure 2). As a result of the data obtained at this stage, the codes "flood, landslide, storm, tornado, hail, extreme precipitation" were created. The information in the news was read in detail and the identified disasters were coded.

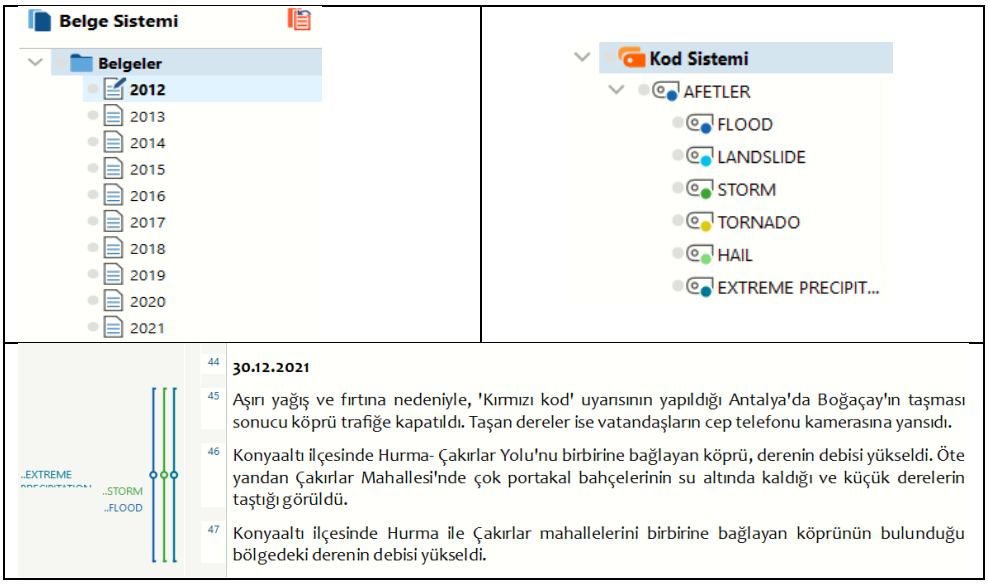

Figure 2. Coding phase the search content

3. Results

In the study, 95 news obtained as a result of the scans in Table 2 were coded specifically for disaster types. As a result of this coding, it was found which disaster or disasters (combined disaster) occurred in which news. Meaningful chromatic diagrams were used to visualize these codes.

148 disasters were coded in 95 news, which showed that more than one disaster (combined) occurred in one news. The "Extreme Precipitation" disaster was coded 44 times and was seen as the most occurring disaster. Then came the “Flood” disaster, which was coded 39 times. “Storm” and “Tornado” disasters were coded 24 and 23 times, respectively, and ranked 3rd. The least coded disasters were “Landslide” (11 codes) and “Hail” (7 codes) disasters (Figure 3).

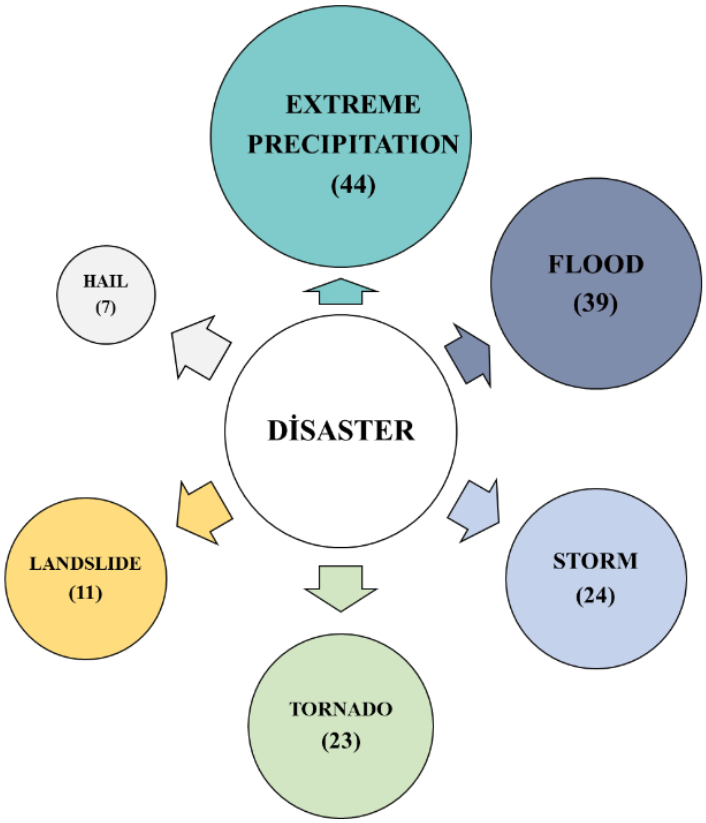

Figure 3. The situation of disasters in coding analysis

Combined disaster situations could be determined by the intersection of the disaster codes that occurred in the same news. Double (intersection of two disasters) and triple (intersection of three disasters) hydro-meteorological combined disaster is seen in Antalya. In 17 news reports, "Extreme Precipitation" and "Flood" disasters intersected together. Then, “Extreme Precipitation” and “Storm” disasters 5 times, “Extreme Precipitation” and “Tornado” disasters 4 times, “Extreme Precipitation” and “Hail” disasters 3 times, “Storm” and “Tornado” disasters 2 times, “Storm” and “Hail” disasters 2 times, “Landslide” and “Flood” disasters 2 times occurred in combination. In the case of double combined disasters, 7 situations occurred in Antalya, and 4 of these situations were triggered by the excessive precipitation disaster (see Figure 4).

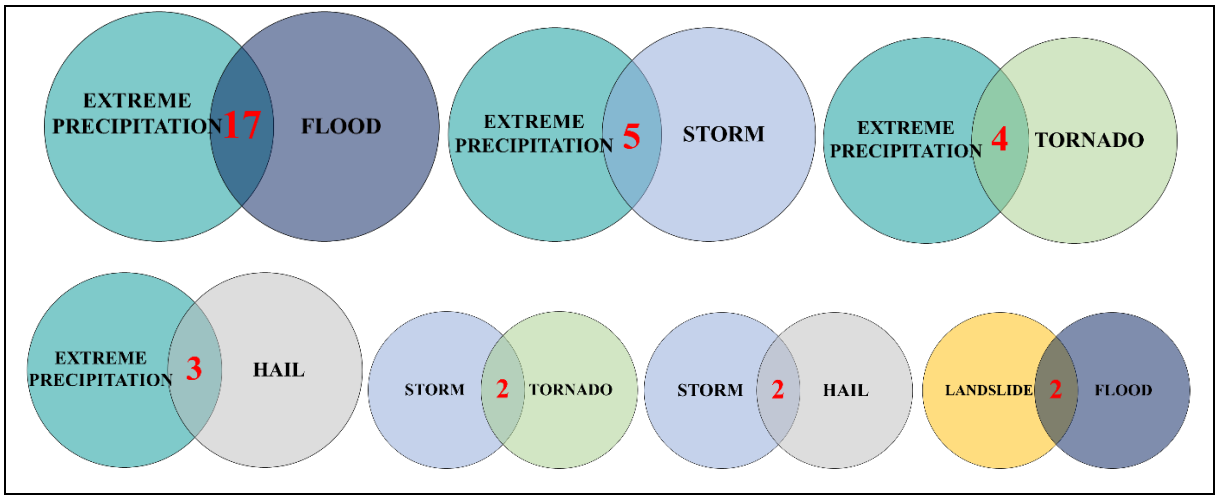

Figure 4. Hydro-Meteorological binary combined disaster situation

When the triple combined disaster situation is examined, it is seen that “Extreme Precipitation”, “Storm” and “Flood” disasters intersect in the same news 6 times. It was concluded that “Extreme Precipitation”, “Tornado” and “Flood” disasters and “Extreme Precipitation”, “Tornado” and “Storm” disasters intersect 3 times. “Extreme Precipitation”, “Storm” and “Hail” disasters, on the other hand, were a triple combined situation that intersected once. In triple combined disasters, as in double combined disasters, the "Extreme Precipitation" disaster has played a role in all of them. In Antalya, in total, 4 cases emerged in the triple combined disaster (see Figure 5).

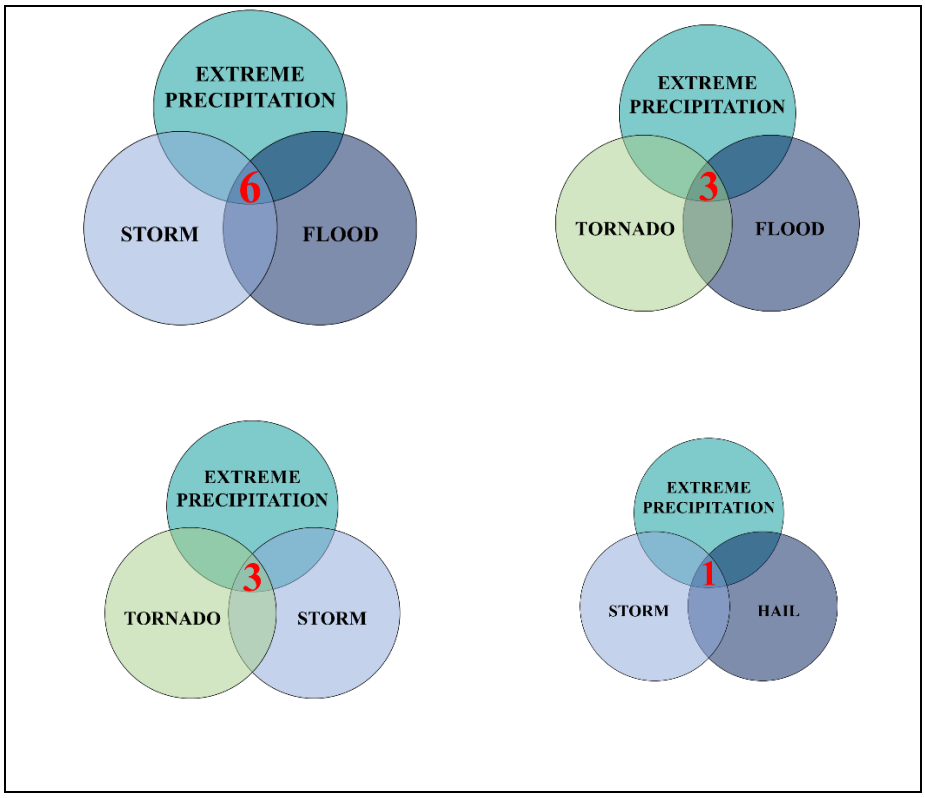

Figure 5. Hydro-Meteorological triple combined disaster situation

4. Conclusions

In terms of the level of realization of disasters in the world and in our country, there are serious material and life losses. In case of combined disasters caused by the combination of more than one of these, the result is more effective. Therefore, handling and evaluation of combined disasters in this regard will ensure that possible damages and effects are minimized.

It has been observed that among the coded 148 disasters, the extreme precipitation disaster stands out. In the case of double combined disasters, 7 situations occurred in Antalya. In Antalya, in total, 4 cases emerged in the triple combined disaster. The "extreme precipitation" disaster played an active role in the formation of the dual and triple combined situations.

In this context, as a result of the content analysis made in the study, it was seen that there are combined disaster situations in Antalya and extreme precipitation plays an active role in this. Extreme precipitation, which is an effect of climate change, has also revealed other disasters interactively. Antalya is a coastal city affected by combined hydro-meteorological disasters, and the spatial-temporal risk of more than one disaster in the relevant time period has the potential to drag this city into chaos. In this case, it is seen that by analysing the combined disasters and situations that occur as a result of multiple hazards in Antalya, practitioners should produce solutions by analysing the multiple hazard risks specific to the location so that combined disasters do not occur in the future.

The geographical situation of many major cities around the world (especially coastal cities) faces serious natural disaster risks. In this case, as the trend of urbanization continues rapidly around the world, disaster scientists should pay more and more attention to the specificity of urban disaster risk by evaluating the probability of combined disasters when evaluating regional disasters and disaster management approaches.

There is a need for further studies to examine differences between the effects of recurring disasters (of the same hazard type), cascading disasters and consecutive disasters, and combined disasters with different hazard types. Linking studies on the documented effects of past disasters with future-facing studies on modelling and reducing combined disaster risks will be important in future work.

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Conflict of Interest

Conflict of Interest: The authors declare that there is no conflict of interest.

Author Contribution

Sumeyye Kahraman, and Erkan Polat both contributed to the design and implementation of the research, analysis of the results and the writing of the manuscript.

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