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E. Tusat[1], S. Karayel[2], S. Ari[3]

[1] Selcuk University, Cumra School of Applied Sciences
[2]Necmettin Erbakan University, Faculty of Social Sciences and Humanities
[3] Selcuk University, CumraVocational School

USAGE OF GEOGRAPHIC INFORMATION SYSTEMS BASED MODELLING IN MANAGEMENT AND PLANNING; THE CASE OF DISASTER PLANNING IN TURKEY

Natural disasters are a part of life and may have extremely destructive effects if necessary precautions are not taken. Geographic Information Systems (GIS) are a part of the management systems that present both verbal and graphic data, spatial analyses and other bases to those in positions of decision-making to support in their decisions and planning. GIS enables the storage and questioning of data concerning the current situation and at the same time ensures making analyses, inquiries and predictions for the future. In this study, the natural disasters that took place in our country between the years 1970 and 2015 were dealt with. Data belonging to DEMA (Disaster and Emergency Management Authority) were compiled and they were transferred to the GIS database. Using these data, maps of geographical regions which natural disasters affected according to the frequency of occurrence were created in GIS environment. What kind of disasters took place in what geographical regions were revealed through thematic maps obtained as a consequence of spatial analyses.

➢ ***Keywords:*** *disaster management, information technologies, natural disaster, geographical information systems, spatial analysis, thematic map*

Introduction

Various information has been encountered with regard to disasters that have taken place across the world throughout the history of mankind and been registered in records. Large numbers of people have lost their lives in these disasters. There are not many differences between the results that emerged in the regions where past phenomena occurred and the results we see today. However, the consequences caused by disasters are not the same everywhere in the world. The most important reason for this differences lies in the frequency of disasters. One of the most striking examples is that about 16000 people died in the magnitude 7,4 earthquake that struck the Eastern Marmara Region (Gölcük) on August 17th 1999. On the contrary, a few people lost their lives in the magnitude 7,6 earthquake that occurred in Japan in 2003 whereas only one person died of heart attack in a magnitude 8 earthquake that happened in the same year [2]. It has been understood that the damages that may have arisen as a result of different disasters that occurred in different dimensions and in different countries in the past may have been very large in terms of human life, material, spiritual and environment. The material and spiritual losses experienced require that every society in the world have an action plan and attach importance to the work to be done in order to reduce the damages caused by disasters. For this reason, studies on disaster management continue to increase rapidly throughout the world [8].

With disaster management, it is possible to produce comprehensive solutions for disasters on a regional and national disaster. This type of solutions affects success considerably. In this context, especially when computer technology is used for disaster and risk analysis, more economical, efficient, effective and quick solutions are produced and the results are more definite [1].

At this point, Geographic Information Systems (GIS) is of great importance. Today, geographical information systems are widely used in studies related to natural disasters. It is used in natural disasters such as earthquakes, floods, landslides, fires, volcanism and storms. Geographical information systems are used not only in determination of the locations of these natural phenomena and their analysis, but also include a lot of work to be done before and after the disaster.

Management information systems and gis

Management Information Systems

Increasing competition forces businesses to be different from each other, increase product diversity, and maximize productivity. Under these circumstances, management information systems become a necessity to make the best decision possible for decision makers [5]. Management information systems involve ob-

tainment of information about past, present and future related to internal and external developments in an organized manner. Management information systems provide information at the right time and at the right place to assist the decision-making process of an enterprise's planning, control and operational functions [6].

The process that forms the basis of the concept of management information system involves a process of transforming the entered data into information through specific operations. Thanks to management information systems, managers have the opportunity to access whatever information they need whenever they like. In this way, managers can more easily control the organizations they are in charge of and make better decisions [7]. Management information systems are systems that take information from the lower level managers that contribute to the decision making process and transfer it to the middle level managers for use by the user in the form that the user wants. In other words, managers will examine, analyze and evaluate the information they reach, and as a result they will make quick and accurate decisions. But they can do so by accessing the information they need, and this is made possible by the management information systems [4].

Geographical Information Systems (GIS)

Geographical Information Systems (GIS) can be defined as all of the instruments that enable collection of data on earth through certain tools, their storage, interrogation, transfer and imaging [10]. There are different opinions on how Geographical Information Systems are perceived in practice. Therefore, the «tool», «method» and «system» approaches need to be scrutinized thoroughly to determine the best area for the scope of GIS. GIS can be defined, being a tool for gathering information, processing it and presenting it to users, as a management style in which intensive and complex positional information can be controlled effectively based on information technologies, and as a system which enables making more efficient use of this information by simplifying complicated geographical information. Geographic Information Systems are directly linked to information systems such as data management systems, computer aided design (CAD), computer aided cartography, and remote sensing. Their only difference from these systems is that they can conduct analyses in geographical locations and produce new information by processing the collected information [3]. Geographic Information Systems is a computer-based tool that allows mapping of events that occur around the world to be analyzed. Geographical Information Systems, in general terms, combine a broad database such as geographical analysis, questioning and statistical analysis a unique visualization of its own presented by the maps. With this feature, the most important characteristic distinguishing GIS from other information systems is its ability to explain the events with GIS, to predict future ones and to guide decisions of public and private enterprises [9].

The greatest feature that distinguishes GIS from other databases is that the data obtained are stored according to the location they belong to on earth and allow for many spatial analyze. Because of this, GIS has become the most important information system in disaster research and work related to disaster management, since it obtains maps interrelated data as a result of various analyses and comparisons of complex data [2].

Application

Material and Method

First, relevant literature on the management and planning of natural disasters in Turkey has been researched. The disaster data used in the study were obtained by using the questionnaires found on web sites of the Turkish Statistical Institute and MEVKA institutions. The data were taken in the Excel environment on a provincial basis and since theywere not appropriate to be used directly in any GIS software; both data arrangement and transfer to the database were performed. The data obtained for each province were edited in Chart format using ArcGIS software.

5998 earthquakes, floods, hailstones, frost, avalanches, snowfalls, storms, forest fires, landslides, rock falls and drowns occurred in Turkey between 1970 and 2015. The highest in number among these disasters are fires with 2102 disasters; whereas the fewest in number among disaster types is snowfall. Between 1970 and 2015, Antalya became the province where the most disasters were experienced with 358 disasters, while Osmaniye was the province where the fewest disasterswere experienced with 11 disasters. The distribution of these disasters according to their types is shown separately in the following figures with thematic maps. After the creation of the disaster database, ArcGIS software was produced using thematic map construction techniques. ArcGIS software can make thematic maps with color distribution, pie slices, columns, point density representation and proportional symbols methods. When the data structures of the disaster system are examined, it is more accurate to use the color distribution representation since the data are generally displayed in relation to quantity. Since data visualization will be performed on a provincial basis, making color distribution maps of the representations of the polygon (area) data type seems to be the most accurate method.

Findings and Discussion

A total of 5,998 earthquakes, floods, hail, frost, avalanche, snow, storm, forest fire, landslide, rockfall and drowning occurred in Turkey between 1970 and 2015, taken from the data system of the Turkish Disaster Information Bank (TABB). The highest in number among these disasters are fires with 2102 disasters, whereas the fewest disasters are snowfalls. Between 1970 and 2015, Antalya became the province where the most disasters were experienced with 358 disasters while Osmaniye was the province where the fewest disasters were experienced with 11 disasters.

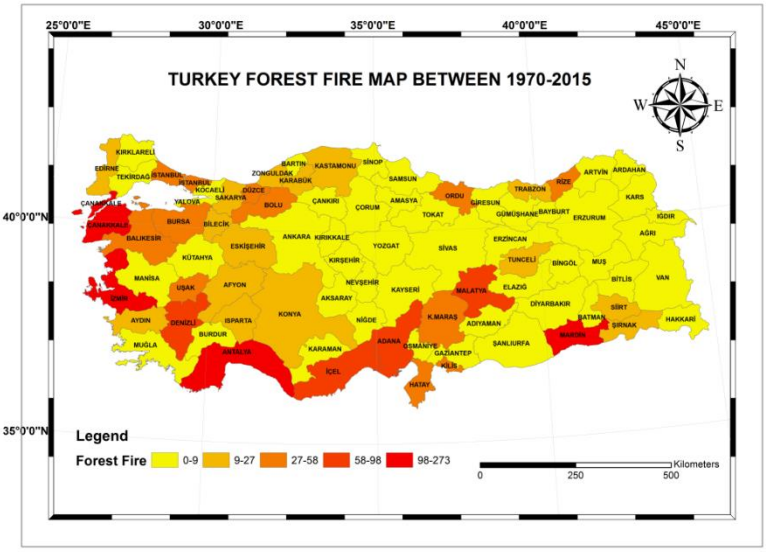

Figure 1 – Map of Forest Fires in Turkey between 1970 and 2015

In Turkey, 2102 forest fires occurred between 1970 and 2015, and forest fires occurred mostly in Antalya, Izmir, Mardin and Canakkale provinces. Between the dates mentioned, there were forest fires between 58 and 98 in number in Icel, Malatya, Adana, Denizli, and Kilis. It is also seen that forest fires concentrate mostly in coastal regions. The fewest forest firesare seen in the Black Sea and Eastern regions, on the other hand. According to the obtained data, there were no forest fires in the records in Adıyaman, Aksaray, Ardahan, Batman, Bayburt, Gaziantep, Giresun, Gumushane, Igdir, Kars, Kırklareli, Kırsehir, Kutahya, Mugla, Sinop, Sivas, Tekirdag, Tokat and Van provinces between the said dates.

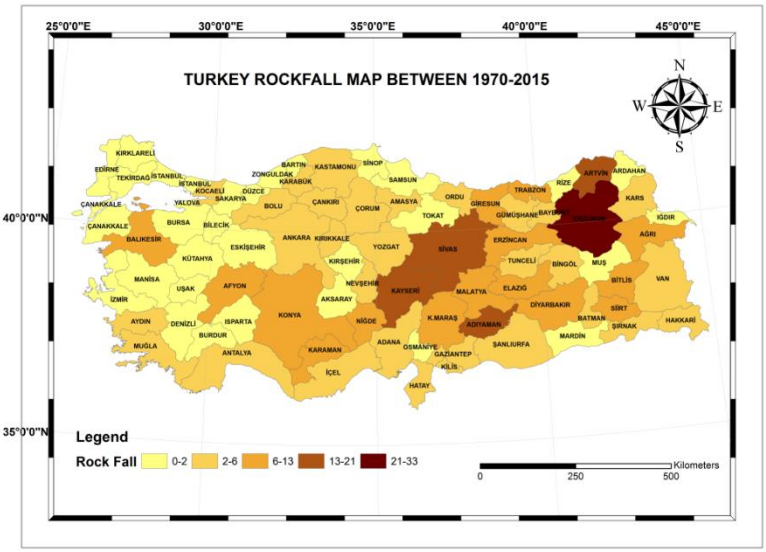

Figure 2 – Map of Rockfalls in Turkey between 1970 and 2015

The total number of rock falls that occurred between these years is 382. The most rockfalls occurred in Erzurum, followed by Kayseri, Artvin and Adiyaman with 21, 19 and 18 rockfalls respectively. In the maps obtained, it is seen that the rockfalls generally took place in the Eastern regions.

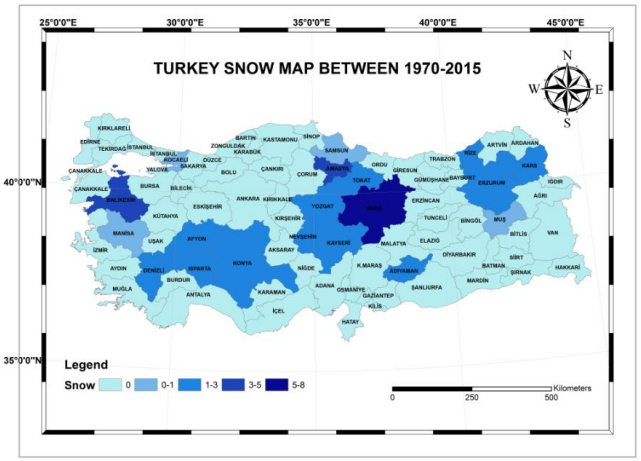

Figure 3 – Map of Snowfall in Turkey between 1970 and 2015

Another disaster involved in the survey is heavy snowfall, which occurred a total of 55 times during the relevant dates. Of these, the most snowfall disasters happened in Nevsehir and Sivas provinceswith 8 disasters, followed by Balikesir, Amasya, Adıyaman, Erzurum, Isparta and Yozgat provinces.

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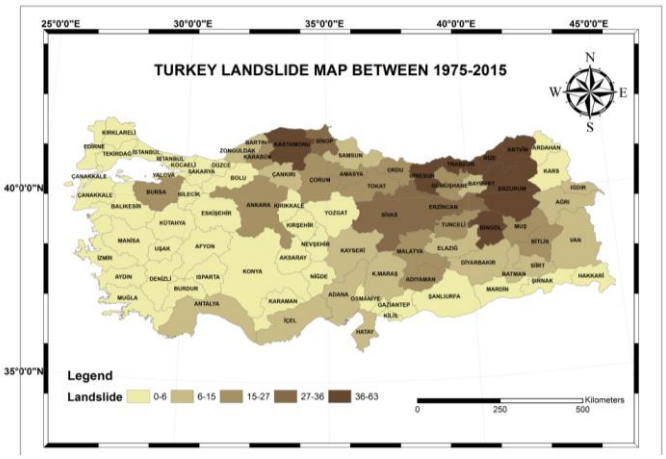

Figure 4 – Map of Landslides in Turkey between 1970 and 2015

One of the most frequent disasters in Turkey, i.e. landslides, were observed intensively between these dates and a total of 1060 landslides were experienced. The maximum number of landslides was recorded in the province of Erzurum with 63 cases, followed by landslide cases in Artvin, Rize, Trabzon, Kastamonu and Bingol respectively.

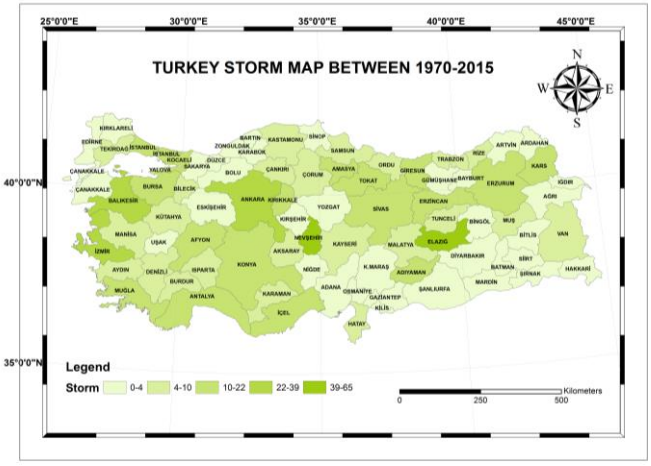

Figure 5 – Map of storm in Turkey between 1970 and 2015

Storms, which were one of the highest disasters in number, occurred 729 times. The Elazig province was recorded as the province where the most storms with 65 storms. Nevsehir, Balikesir, Ankara, Izmir and Kirikkale were the provinces where the most storm place after Elazig.

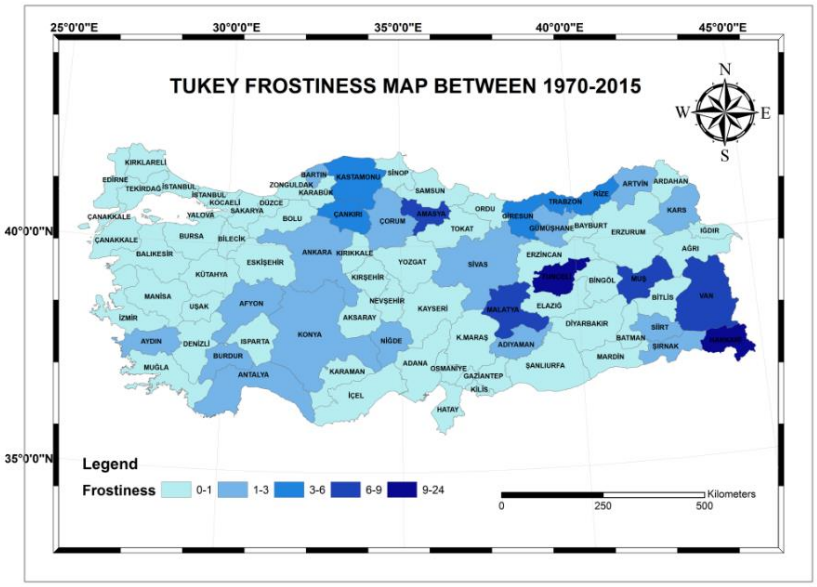

Figure 6 – Map of Frost in Turkey between 1970 and 2015

The frost, which occurred almost every year as a consequence of Turkey's geographical position and natural environmental conditions, struck 172 times between 1970 and 2015. The most frost events frost incidents occurred in Nevsehir with 30 cases, while Tunceli and Hakkâri were recorded as the provinces where the most frost occurrences took place after Nevsehir.

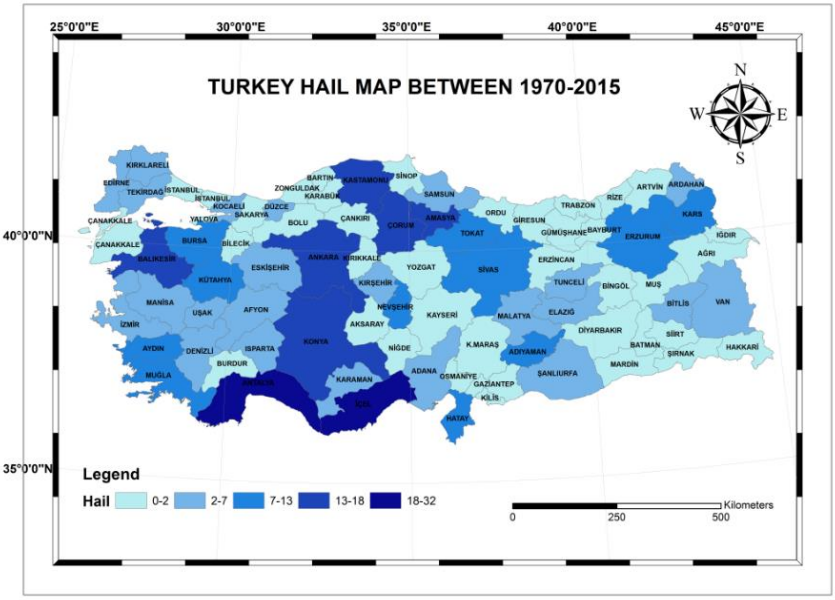

Figure 7 – Map of Hailstones in Turkey between 1970 and 2015

Between the dates included in the review 433 hailstone disasters were recorded. Among these events, the most hail event occurred in Antalya with 32 frost events. In the province of Nevsehir, where the most hail events were experienced, 30 hail events occurred. Icel, Ankara, Balikesir, Kastamonu and Konya are among the provinces where most hail events took place.

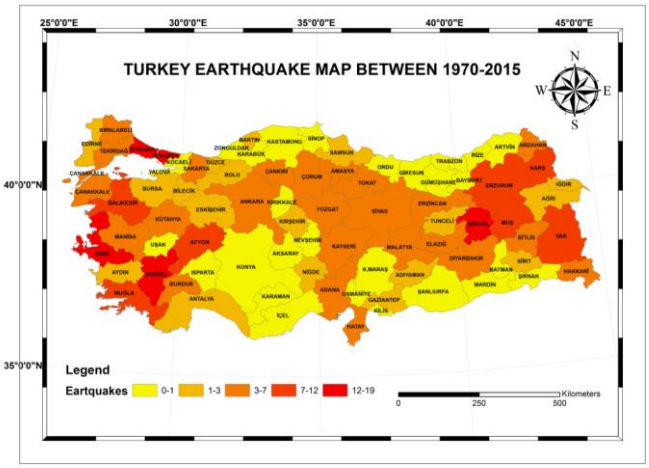

Figure 8 – Map of Earthquakes in Turkey between 1970 and 2015

The earthquake disaster, which is one of the disasters causing the most material damage in Turkey and worldwide, occurred 286 times in Turkey between the said dates. The province of Bingol, where 19 earthquakes were experienced, was recorded as the province where the greatest number of earthquakes occurred, while 16 earthquakes occurred in Izmir, 15 in Denizli, and 12 in Mugla and Mus.

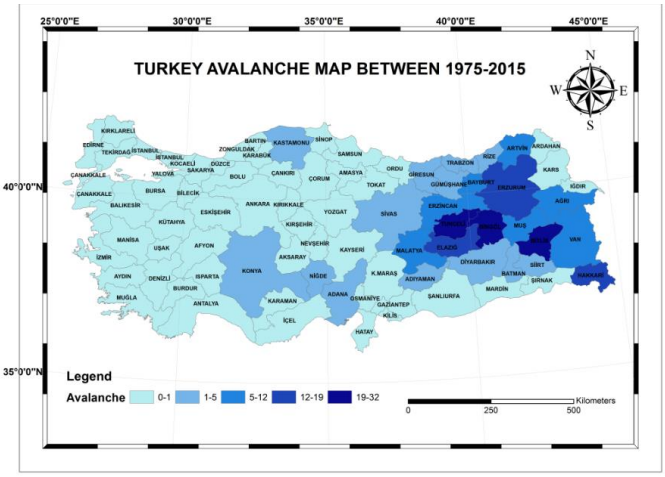

Figure 9 – Map of Avalanches in Turkey between 1970 and 2015

In general, the avalanche disaster, whichtook place in the mountainous and sloping parts of Turkey's Northern Regions, Northeast Regions, Southeastern Anatolian Southeast and Eastern Regions, occurred 246 times, and Bitlis was the province with the most avalanche events. This province is followed by Bingol, Tunceli, Hakkari, Erzurum, Elazig and Artvin.

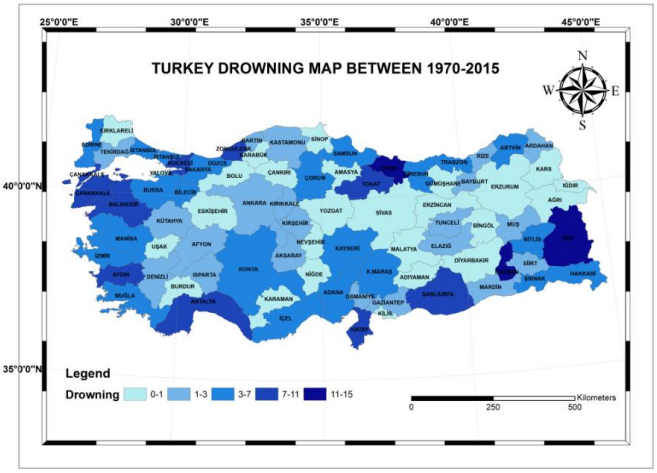

Figure 10 – Map of Drowning Cases in Turkey between 1970 and 2015

Between the years 1970 and 2015, a total of 295 drowning events occurred in Turkey and Ordu was the province where the highest number of drowning occurred with 15 drowning events. After Ordu, there were 14 drowning events in Batman, 12 in Van, 11 in Aydin, 10 in Kocaeli and 10 in Sanliurfa.

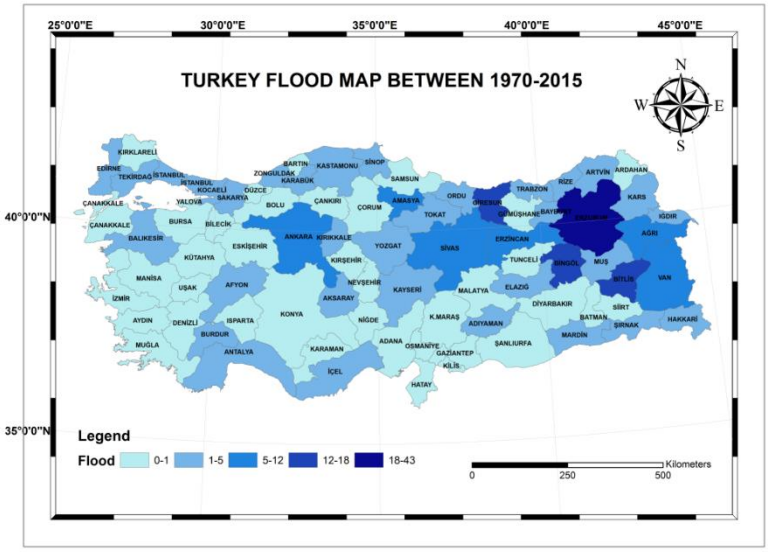

Figure 11 – Map of Floods in Turkey between 1970 and 2015

Floods and inundations, which are natural disasters in Turkey where the highest number of losses of life and property are seen after the earthquake disaster, occurred 268 times. The most flood disasters occurred in Erzurum with 43 disasters, followed by 18 floods in Bingöl, 17 in Bitlis, 14 in Giresun and 12 in Sivas.

Conclusion and suggestions

Many disasters have occurred in Turkey so far and these disasters have caused a lot of loss of life and property. Each of the disasters that has occurred contains data that can be used to reduce to a minimum possible damage that might arise from future disasters. However, these data must be recorded correctly and regularly in order for them to be accurate for the future. A database to be designed with accurate and regular records will form the basis for the creation of hazard maps for many disasters. In order for these maps to be created nationwide, relevant institutions and organizations should cooperate in a national sense and their data on their hands should be ready to share these with appropriate institutions. In order to achieve this, the development of new policies in the national sense is important. As a result of this work, it has been determined that many natural disasters are active in Turkey between 1970 and 2015, including forest fire, landslide, storm, hail, rockfall and earthquake.

In conclusion, with the thematic maps obtained, many complex data can be passed through specific filters to obtain simpler, more easily interpreted data. In other words, the use of geographic information systems in disaster management allows for more effective decisions to be taken quickly. For this reason, it is necessary to establish units that consider work needed to minimize the damage from possible natural disasters that may occur as their main policy and to shareinstantly with the relevant institutions and organizations the necessary data in the event of a disaster, both centrally and locally.

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Э. Тусат, С. Карael, С. Ари

ИСПОЛЬЗОВАНИЕ СИСТЕМ ГЕОГРАФИЧЕСКОЙ ИНФОРМАЦИИ, ОСНОВАННЫХ НА МОДЕЛИРОВАНИИ, УПРАВЛЕНИИ И ПЛАНИРОВАНИИ: СИСТЕМЫ ПЛАНИРОВАНИЯ СТИХИЙНЫХ БЕДСТВИЙ В ТУРЦИИ

Стихийные бедствия являются частью нашей жизни и обладают разрушительным потенциалом в случае несоблюдения мер предосторожности. Географические информационные системы (ГИС) – часть системы управления, включающая вербальные и визуальные данные, пространственный анализ и другие базы, необходимые для принятия и реализации принятых решений. ГИС позволяет хранить и дополнять данные, относящиеся к текущей обстановке и ситуации, проводить анализ и делать прогноз на будущее. В ходе данного исследования были изучены стихийные бедствия, происходившие в Турции с 1970 по 2015 г, составлены данные СРСБ (Служба реагирования на стихийные бедствия) и перенесены в базу данных ГИС. Используя эту информацию, в системе ГИС были разработаны карты географических регионов, пострадавших от стихийных бедствий, с учетом их особенностей. Проведено исследование и сравнение определенных типов стихийных бедствий и конкретных географических регионов с помощью тематических карт, полученных при пространственном анализе.