



## Occurred disasters and environment interaction on the eastern blacksea region

### Doğu Karadeniz bölgesinde, meydana gelen afetler ve çevre etkileşimi

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#### Abstract

Türkiye'nin en fazla yağış alan bölgesi Doğu Karadeniz Bölgesidir. Bölgenin bozuk topografyası ve denizden hemen yükselen dağları nedeniyle yağış kısa sürede akışa geçmektedir. Yamaç ve dere yatakları yapılan ve hala yapımı devam eden barajlar ve hidroelektrik santralleri gibi su yapıları nedeniyle aşırı tahrip edilmektedir. Su yapılarının inşası esnasında yapılan tüneller nedeniyle zemin suyu yolları değişmektedir. Mevcut derelerin tünellere alınması, yeterli can suyunun dereye verilmemesi, derelerin debilerinin minimuma düşmesi anlamına gelmektedir. Bu sonuçlar küresel iklim değişikliği ile birlikte yağış sürelerinin kısılmasına, yağış şiddetinin artmasına neden olmakta ve bu seferde derelerin debileri çok hızlı artmaktadır. Akarsu debilerinde meydana gelen bu minimum ve maksimum değişim, dere yataklarına kayan yapılaşma nedeniyle, yataklardaki daralmayla ve çevresel etkilerle birleştiğinde felaket kaçınılmaz olmaktadır. Özellikle sel ve heyelanlarda bariz bir artış görülmektedir. Bunun sonucu olarak can ve mal kaybı artmakta ve felaket boyutuna ulaşmaktadır. Evlerin ve işyerlerinin yıkılması veya tahrip olması, hidrolik köprülerin kullanım dışı kalması, kıyı boyu çekek yerleri, balıkçı barınakları liman ve kıyı koruma amacıyla yapılan T-mahmuzlar üzerinde meydana gelen olumsuzluklar bu felaketlerin bir sonucudur. Bu makalede, özellikle Doğu Karadeniz bölgesinde, hidrolojik ve hidrolik verilerin ekstrem değerlerde değişimi sonucu meydana gelen, ağırlıklı olarak sel ve heyelan gibi afetler kronolojik olarak irdelenmiştir. Can ve mal kayıpları tablolar halinde verilmiş ve alınması gereken önlemler üzerinde durulmuştur.

**Keywords:** Doğu Karadeniz, Yağış verileri, Doğal felaketler, Sel, Heyelan, Kıyı yapıları

#### Öz

The Eastern Black Sea region, with its rugged topography and steep coastal terrain, receives the highest rainfall in Turkey. In the region, because of the existing dams, hydroelectric power plant those that are currently under constructed the terrain and riverbeds are subjected to excessive erosion. Waterways in the ground due to tunnel made during the construction of the water varies. Take the tunnel of the existing creek, enough can't be a stream of water comes creeks mean falls to a minimum of flow. This results in a shortened period of rainfall with global climate change, causes an increase in rainfall intensity and flow of the river at this time is growing very fast. Occurring in river flow, minimum and maximum change, due to the floating construction of the creek bed, disaster is inevitable, combine with the sharp contraction in the bed and the environmental impact. Especially, there has been a marked increase in flooding and landslides. life as a result of this and loss of property increases and reaches catastrophic proportions. Destruction of their homes and businesses on land or destruction, remain non-use of hydraulic bridge, along the coast; slipway, the negativity that occurred on T-groins made in order to protect coastal fishing ports and harbors are a result of this disaster. In this article, particularly in the eastern Black Sea region, hydrologic and hydraulic data that occurred as a result of changes in extreme values, mainly disasters such as flooding and landslides were examined in chronological order. Life and property losses given in the table and focused on measures to be taken.

**Anahtar kelimeler:** Eastern Blacksea, Rainfall data, Natural disasters, Flood, Landslides, Coastal structures

### 1. Introduction

Global climate change in recent years is a popular subject which everybody is interested in. Besides, it is important in terms of observing and determining climate changes. These changes more or less concern all sectors. Data on climatology are used to develop and plan many sectors, especially agriculture, city planning, industry, forestry, architecture, energy generation, tourism and medicine. Additionally, these data are essential for the prediction and prevention of natural disasters with the meteorological characteristics such as flood and drought.

With the help of these data obtained, interpreted and used properly, It will be possible to provide productivity in the country resources and prevent the possible economic, social and human losses. Additionally, it is likely that flood disasters will cause serious damages to the substructure in the cities and to harbors, fishing port areas, board yards, jetties and especially t-shaped groins in the coasts. The junction points of the streams with the roads built parallel to coastline and the hydraulic bridges constructed on these roads should be built properly. Otherwise, they can harm to the institutions on their springs.

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## 2. General Description

The Eastern Black Sea region is often exposed to landslides, rock falls and flood disasters because of its rough land structure and a large amount of rain.

The soil structure, vegetation, evaporation rate and climatic combinations of the region consistently interact with each other due to the irregular settlement, industrialization and regulations at the stream sides, large water installations as dams built in the area recently and small installations as hydroelectric power plants built in streams. It's an inevitable fact that some disasters will occur in the required time for this system to reach a balance.

Not attaching enough importance to the reasons of this case and not producing fast and effective solution methods increase the extent of damages and loss of life. Consequently, the state and people in the area have an immeasurable financial loss.

Therefore, urgent action plans should be decisively activated. To do this, it is necessary to obtain data carefully, include each detail, and resolutely carry out the results.

In particular, social, psychological and economical reasons for the constructions in stream sides and landslide sites should be taken into account and not tall buildings according to the topography of the area should be encouraged to be built. Additionally, the government should support for these actions, if necessary.

## 3. The Disasters Occurring in the Eastern Black Sea Region

Flood disasters are quite dangerous in the Eastern Black Sea region in especially May and June. It has been found that in this hazardous period, because of global warming and climate change, the rainfall for fifteen days in previous years are the same with the rainfall observed in one day or even within a few hours in recent years. Consequently, it increases the risk of flood in the region.

Many disasters have occurred in the Black Sea region in the long period and these have caused loss of life and property. In this region, 614 people died and 19 people got lost in consequence of 42 different flood and landslides from 1929 to August of 2015 (Figure 1), (Table 1).



Figure 1. A thought-provoking picture after the natural disaster

Tablo 1. The disasters occurring in the Eastern Blacksea region

Area-Year	Landslide	Flood disaster	Number of dead
Of-1929	✓		146
Tirebolu-Görece-1959		✓	13
Akçaabat-Of-1963		✓	5
Trabzon-1963		✓	2
İyidere-Hemşin-1977		✓	4
Güneysu-Kalkandere-Pazarköy-1973	✓		4
Harşit-1974		✓	3
Hemşin-1977		✓	6
Pazar-1981		✓	27
İkizdere-1982	✓		8
Pazar-Fındıklı-1983	✓	✓	27
Rize Merkez-1985	✓	✓	10
Pazar-Ardeşen-Fındıklı-1988	✓		3
Çatak-1988	✓		68
Değirmendere-Akçaabat-Söğütli-1990		✓	57
Çamlıhemşin-1990	✓		51
Güneysu-Ardeşen-Pazar-1995	✓	✓	9
Of-1996		✓	9
Giresun-1997		✓	5
Sürmene-Besköy-1998	✓	✓	50
Taşlıdere-Güneysu-2001	✓	✓	10
Taşlıdere-Güneysu-Çayeli-2002		✓	34
Of, Solaklı-İkizdere-2005		✓	8
Çayeli-Hemşin-2005		✓	4
Veliköy-2005		✓	7
Hayrat-2005	✓		1
Arhavi-2006	✓		1
Giresun-2006		✓	2
Başköy-2006	✓		3
Kalkandere-2009	✓		1
Şavşat-2009		✓	5
Borçka-2009		✓	5
Ordu-2009		✓	2
Kalkandere-2010	✓		1
Gündoğdu-2010	✓	✓	12
Yağlıdere-2010	✓	✓	3
Sürmene-2011	✓		1
Hopa-2015			9
Toplam:			616

### 3.1. The Disasters Occurring in Artvin

The landslide and flood which occurred due to the heavy rainfall affecting the districts and villages of Artvin caused a great environmental disaster with loss of life and property (Figure 2,3).



Figure 2. Flood damage in Hopa

The extent of the damage was able to be determined after days. According to the exact results of the loss assessment by AFAD, 38 buildings (38 houses, 1 office, 26 stables, 17 warehouses, 9 barns) collapsed and 50 buildings (60 houses, 8 offices, 14 stables, 18 warehouses, 2 barns) suffered extensive damage in Hopa, Kemalpaşa and some villages there.



Figure 3. Damage to a hydraulic bridge by flood (Borçka)



Figure 4. The districts of Artvin where the flood disaster occurred (25 August 2015)

According to the final results of the exact loss assessment in Arhavi and its villages, there were 2 buildings having severe damage (11 houses, 2 offices), but no ruined buildings. Similarly, the exact loss assessment which was made in Borçka and its villages revealed that there was one building having severe damage (one stable), but no ruined building. Afterwards, the number of houses requested for mobilization and the precaution to prevent the disaster was determined with the extensive geological investigations by AFAD and other organizations in Hopa, Arhavi and Borçka, the districts of Artvin. The reported numeric data containing the number of houses investigated by DSI, included to the investigation program and examined in total are given in a table (Figure 4), (Table 2).

Table 2. The summary of geological investigations

	Hopa	Arhavi	Borçka	Toplam
The number of houses requested for mobilization	165	30	0	195
The number of houses requested for the precaution to prevent the disaster	77	1	1	79
The number of houses investigated by DSI	102	17	20	139
The number of houses included to the investigation program	123	145	50	318
The total number of houses examined	886	257	97	1240
The total number of houses determined for mobilization and temporary mobilization is 413.				

Tablo 3. The table showing the damage assessment by the provincial special administration and municipalities in Artvin

The table showing the damage to the provincial special administration and municipalities affected by the disaster under the law no 4123.		
institution	special	Cost of the damage
The provincial administration (Hopa)		24274458.50 TL
The municipality of Hopa		21601730.70 TL
The provincial administration (Arhavi)		2755550.16 TL
The municipality of Arhavi		9768114.21 TL
The provincial administration (Borçka)		1944025.22 TL
The municipality of Borçka		5855983.6 TL
The provincial administration (Merkez)		569143.50 TL
The provincial administration (Murgul)		1867824.36 TL
The municipality of Kemalpaşa		108295.87 TL
Total:		68745126.12 TL

Additionally, results of the damage assessment by the employees of the provincial special administration and municipalities are given in a table (Table 2).

Besides, an extensive investigation into the damage was made by the provincial financial Office in Artvin and according to the table showing the damage, it was determined that the total number of citizens and sectors damaged by the disaster were 1462 and 2664, respectively (Table 3,4), [1].

Tablo 4. The table showing the damage (Artvin)

The table showing the damage prepared by the provincial financial office		
Crew	The Number of Findings	Cost of Damage
<b>Hopa</b>		
Food, Agriculture and Livestock	1236	15498720.00 TL
Industry and Manufacturing	335	24275809.11 TL
Energy, Transportation and Communication	311	9993600.00 TL
Culture, Tourism, Education and Health	26	3036453.00 TL
Habitation and Environment	375	7106930.00 TL
Total for Hopa:		59911512.11 TL
<b>Arhavi</b>		
Food, Agriculture and Livestock	148	788150.00 TL
Industry and Manufacturing	59	1550250.00 TL
Energy, Transportation and Communication	45	542950.00 TL
Culture, Tourism, Education and Health	4	133400.00 TL
Habitation and Environment	110	1045430.00 TL
Total for Arhavi:		4060180.00 TL
<b>Borçka</b>		
Industry and Manufacturing	15	830000.00 TL
Total for Borçka:		830000.00 TL
Grand total:		64801692.11 TL

### 3.2. The Disasters Occurring in Rize

Rize is the area where the rainfall is the highest. The total rainfall in a year is nearly 2238, 8 kg/m<sup>2</sup> (Table 5). According to the meteorological measurements, the rainfall is 188 kg in a square meter in Rize in August.

In Gündoğdu, the district where the flood occurred, the total rainfall was 167, 9 kg/m<sup>2</sup> in that time. It almost corresponds with the rainfall in August.

A similar rainfall was observed in Rize in September, 1996. The total rainfall in the 14th day of August was 178, 7 kg/m<sup>2</sup> and this rainfall has been recorded as the highest one of the area in the meteorological archives, [1].

Table 5. Meteorological data in Rize

The realized average values over the long years (1950-2014)												
Rize	January	February	March	April	May	June	July	August	September	October	November	December
Average temp. (°C)	6.6	6.5	7.9	12	16	20	23	23	20	16	12	8.4
Most average high temp. (°C)	11	11	12	15	19	24	26	27	24	20	16	13
Most average low temp. (°C)	3.6	3.5	4.8	8.5	13	17	20	20	17	13	8.7	5.4
Average sun time (hours)	2.2	3.1	3.4	4.3	5.4	6.4	5.2	5.2	5	4.2	3	2.1
Average number of rainy days	15	14	16	15	15	14	14	15	15	15	14	15
Month. total rainfall average (kg/m <sup>2</sup> )	225	179	157	91	98	134	143	188	253	288	251	234
Total annual rainfall: 2238.8 kg/m <sup>2</sup>												

According to the recent data, in Rize, the rainfall is 243.6 kg in a square meter in September and it is 309.9 kg in October. These amounts can be regarded as the result of climate change in recent years. Because Rize is mountainous, the urbanization in this area is towards the stream beds. The materials coming with the high flow from valleys and stream beds accumulate in some areas and the constructions on these areas pose a serious risk (Table 6).

Table 6. The Disasters Occurring in Rize

Date	Landslide	Flood	Avalanche	The number of affected housing	The number of affected workplace	The number of dead
1992			✓			1
1993			✓			2
1995	✓	✓	✓	43	1	6
1996	✓	✓		75	2	
1998	✓			10		
2001	✓	✓		412	3	10
2002	✓	✓		2+228	3+2	0+33
2005	✓	✓		20+44+59	0+1+3	0+7+0
2006	✓	✓		17		
2007	✓	✓		5		
2009	✓	✓		1		2
2010	✓	✓		2+172		2+14
2011	✓	✓		68		1
Total:				1158	15	78

However, not only flood but also rock fall, land slide, avalanche, fire and so forth are the disasters occurring in Rize. The distribution of the disasters occurring in Rize and its districts is as the following (Figure 5-16):

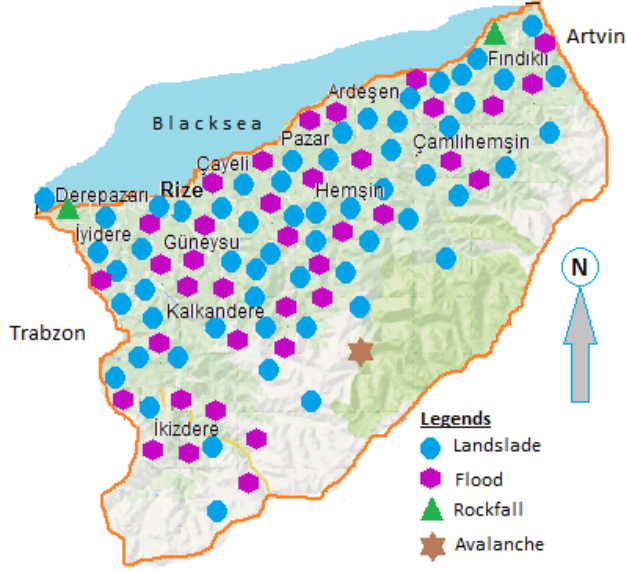


Figure 5. The thematic map of disasters (Rize)

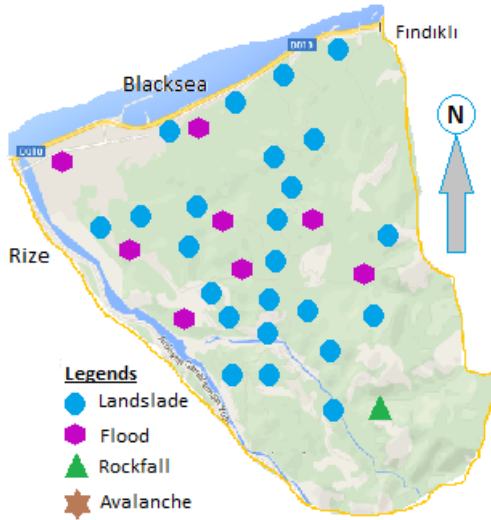


Figure 6. The thematic map of disasters (Ardeşen)

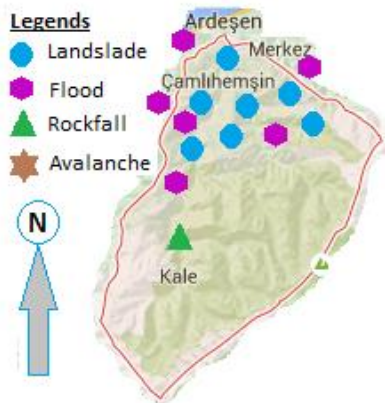


Figure 7. The thematic map of disasters (Çamlıhemşin)

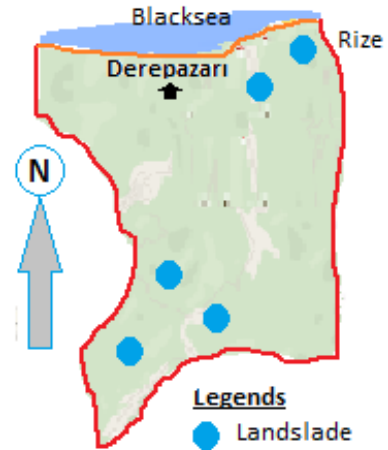


Figure 8. The thematic map of disasters (Derepaşarı)

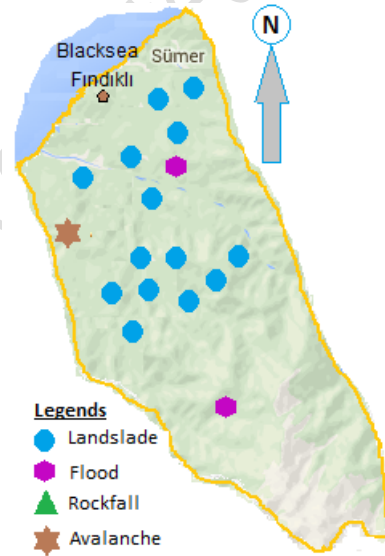


Figure 9. The thematic map of disasters (Fındıklı)

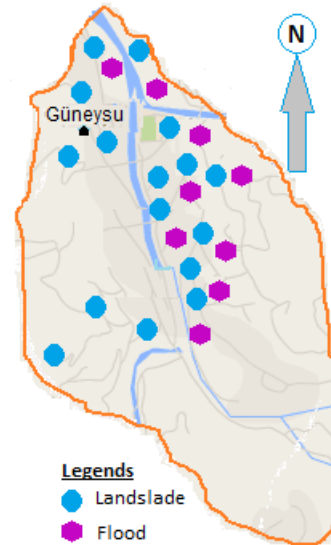


Figure 10. The thematic map of disasters (Güneysu)

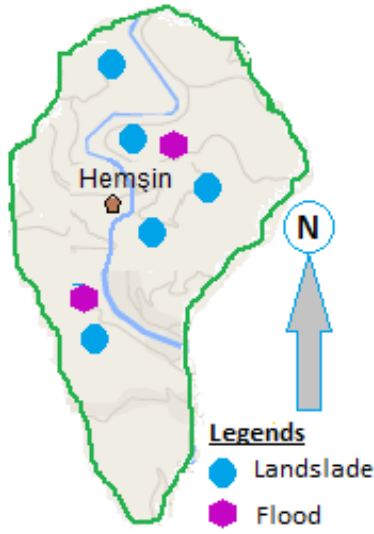


Figure 11. The thematic map of disasters (Hemşin)

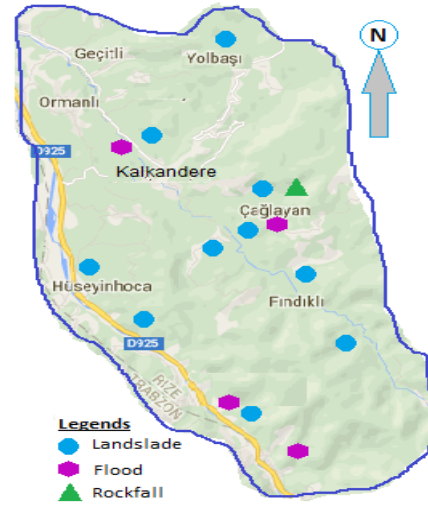


Figure 14. The thematic map of disasters (Kalkandere)

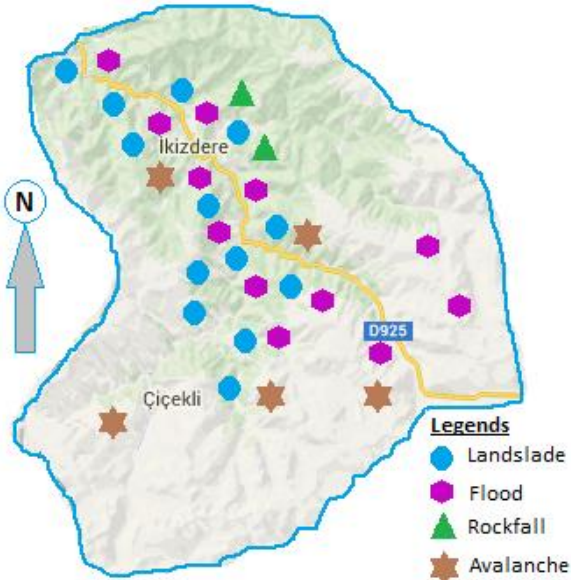


Figure 12. The thematic map of disasters (İkizdere)

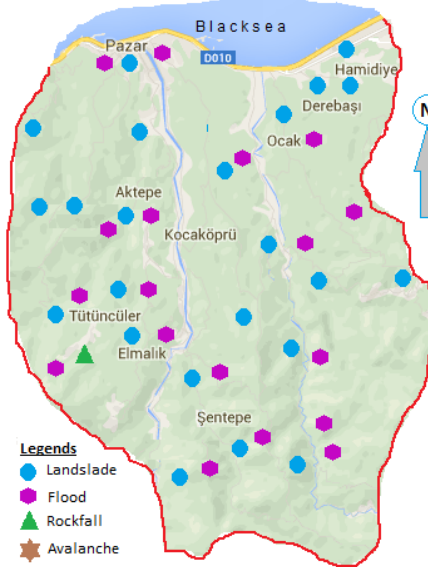


Figure 15. The thematic map of disasters (Pazar)

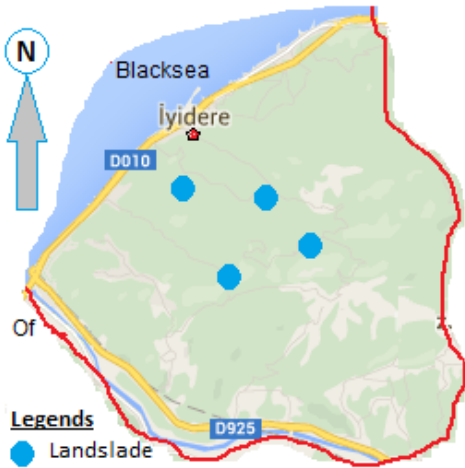


Figure 13. The thematic map of disasters (İyidere)

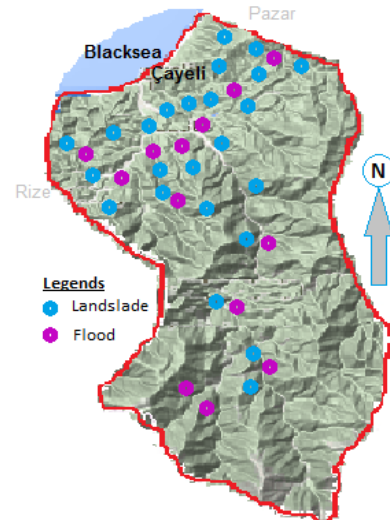


Figure 16. The thematic map of disasters (Çayeli)

### 3.3. The Effects of Disasters on Coastal Structures

The disasters occurring in the Eastern Black Sea region not only cause loss of life and property, but also damage hydraulic bridges on streams, t-shaped groins protecting the coasts, fishing port areas, boat yards and harbors. Due to flood disasters, either hydraulic bridges have been destroyed or they have malfunctioned in consequence of damages to their abutments.

Fishing port areas, boat yards and harbors have malfunctioned for a short time because of the adrift materials, sediments, tree branches and roots. Similarly, heads and main bodies of T-shaped groins in the coasts have been destroyed and so they have become useless (Figure 17, 18).



Figure 17. The effect of the flood on T-shaped groins



Figure 18. The damage to the coasts and bridges by the flood

## 4. The Reasons and Results of Natural Disasters

Flood, avalanche, landslide, erosion, earthquake, tsunami, war, traffic accidents, labor accidents, eruption, meteorological natural disasters such as storm, whirlwind, drought, typhoon, and stroke of lightning seen in Turkey and different parts of the World are called as natural disasters. While some natural disasters are caused by natural reasons, the others occur because of humans. Every president should take precautions and implement them in terms of possible natural disasters which can occur in the regions. Devastating floods occur when

streams, watercourses and rivers overflow in consequence of heavy rainfall or melted snow and ice, seas submerge the coasts with high waves or dams and barriers collapse.

When the accumulated snow banks on the top of the mountains roll down and become much bigger, avalanche occurs.

Landslide occurs when stones, rocks and soil slide down sloping lands. Landslide is a natural disaster experienced most in the Black Sea region in Turkey, because of heavy rain falls and sloping lands. Stones, rocks and soil on the top of hills slide down and accumulate in the bottom parts of mountains. It kills humans and animals, prevents transportation, damages to buildings and farm lands [2-7].

Vegetation prevents soil from being eroded. If vegetation is destroyed, soil becomes eroded and it is transported by water and wind. This incident is called as erosion.

The major reasons for erosion can be listed as the following: unconsciously destroyed vegetation which protects soil, soil excessively cultivated and ploughed towards the gradient, heavy rainfall, strong winds, and interferences by humans in soil and natural vegetation [8].

## 5. Suggestions

- A. To avoid the harmful effects of flood;
  1. The stream beds should be kept clean and open channels should be built,
  2. Forested areas should be increased, lands should be terraced and more trees should be planted,
  3. Dams should be constructed on the rivers,
  4. The necessary infrastructure works should be done to dispose water,
  5. River, stream and water channel beds should not be filled with soil or rocks and settlements should not be built near these areas and in the low lands,
  6. High and strong bridges should be constructed and abutments of these bridges should not be placed in soft and slippery ground,
  7. Huge and large underground sewerage and waste water channels should be built and these channels should be poured into the seas or river basins,
  8. Water outlets should be built to prevent water from accumulate on the streets and bridges and strong loopholes should be placed on these water outlets,
  9. Buildings in the places exposed to the risk of flood should be strengthened and if necessary, weirs or levees should be built,
  10. Some precautions should be taken against materials such as soil and stones that might be stranded from higher lands by water and places in danger of landslide should be concreted and if necessary, surrounded by a steel wire mesh,
  11. It is important to be on alert for flood as earthquake. To do so, sufficient plumbing pumps, sewage trucks and boats should be stocked in rapid response teams and organizations and far-reaching scenarios should be prepared for an urgent action [9, 10].

- B. To avoid avalanche and its harmful effects;
1. Vegetation should be protected and enhanced,
  2. The areas in danger of avalanche should not be chosen as a settlement,
  3. Supporting walls should be constructed in the areas in danger of avalanche.
- C. To decrease the harmful effects of landslide to the least;
1. The areas in danger of landslide should not be chosen as a settlement,
  2. Trees should be planted in the sloping lands and supporting walls should be constructed in such areas.
- D. To avoid erosion and its harmful effects;
6. More trees should be planted,
  7. The sloping lands should be terraced,
  8. The fields should be ploughed towards the gradient,
  9. Trees should be planted in slopes of dam lakes and the present vegetation should be protected,
  10. People should be educated about the harmful effects of erosion and an environmental awareness should be created. Otherwise, fertile cultivated areas will be smaller, major economic losses will occur and the lifespan of dams will decrease because of becoming full, [11].

## 6. Thanks

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