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A Chronological Research of Samsun City Floods

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ABSTRACT: Samsun is the largest city of the Turkey's Middle Black Sea region, between Kizilirmak and Yesilirmak river deltas. With a height of 735 mm mean annual precipitation Samsun is above the national average. In addition to Kizilirmak and Yesilirmak rivers, there are many large and small streams in study area. Samsun city is exposed to floods every two to three years. A long-time series of damaging flood records in Samsun for 1960–2017, gathered from many documentary sources, is reviewed. In this study, a historical chronology of Samsun city floods has given. Depending on the rapid growth and development of urbanization, the decrease of rural areas, the paving of soil floors with concrete and asphalt and impermeable materials, most of the precipitation has become runoff, and besides the infrastructure system has not been able to carry that flow. Some dry stream beds were ignored and transform into the streets, stream beds were zoned for construction and multi-story buildings were built on them. The lack of adequate infrastructures caused the water could not reach the sea and caused a wound in this region. According to the data of the State Hydraulic Works, over the last 20 years, more than 300 floods have come to the whole of Turkey and about 500 people have lost their lives in these floods. Floods are natural phenomena for Turkey like earthquakes, but the human factor is turned these natural phenomena into a disaster.
Keywords: *Flood History, Samsun, Turkey*

1. Introduction

As in the past, natural disasters will continue to exist in the world today and in the future. However, it is possible to estimate a major part of the natural disasters before hours and even days with the developed technological facilities and observations. Though, rapid and irregular urbanization turns natural processes into the disasters. In Turkey after earthquakes, floods are natural disasters that responsible for serious economic and human disasters. Especially floods affecting residential areas leads to significant loss of life and economic losses. Referring to the observation of the floods that occurred in Turkey, it is understood that floods are frequently seen in March, April, May, June and July. Considering the geographical distribution of the floods, it is observed that they are concentrated in the Black Sea Coastal Zone. However, the Marmara, Aegean and Mediterranean coasts of Turkey are also subjected to flood disasters. More rarely, flood events occur in the inner regions as well. In Turkey, many people damaged in the several flood events that occurred in various ways and at different times. The settlement of the flooded areas also increased flood damage. In 1953, State Hydraulics Works aimed to prevent this situation by starting the flood protection activities. The annual average loss of floods is 0.55 billion dollars, which is 0.8 % of the Gross National Product. It is estimated that real losses are at least 50 % higher than the given values. Rapidly growing population since the 1960s brought with urbanization. Especially the increase of the industrial areas

causes the population immigration to the cities from rural areas. As a result of rapid urbanization, the natural processes of rivers and basins have been distorted. Besides, development of stream beds for urbanization, improper land use, the coating of surfaces with impervious materials such as asphalt causes floods. The seasonal meteorological changes are causes the changes of the precipitation regimes, therefore the sudden floods increase, the droughts and the floods are seen. In Turkey, there are many people affected by different types of floods events at different times.

Table 1. Historical floods in Samsun province from 1960 to 2017

Flood Date	Location	Discharge Value (m^3/s)	Damage
29.08.1960	Carsamba and Tekkekoy	80	-
17.02.1963	Bafra's Kosu Village	556	Various damages occurred along with the coastal carvings by overflowing.
January, 1966	Carsamba	219	-
26.06.1967	Abdal River	350	-
09.06.1971	Alacam district (Gumenez stream)	92.5	A person died at the area of the flood.
31.7.1972	Samsun (Kurtun River)	270	Flood caused a great damage in the area.
04.07.1977	Engiz Stream	456	-
04.07.1977	Karakoy stream	306	-
30.08.1979	Havza (Suluova Kavalcik River)	88	The overflowing of the water caused the death of 27 people.
30.06.1988	Carsamba and Tekkekoy districts	676 - 1300	-
16.06.1992	Samsun-Tekkekoy and Ayvacik region	60	The area where the floods have taken place is the coast of the Black Sea on the left bank of the Yesilırmak basin.
24.08.2007	Samsun city center and Derekoy area	-	-
04.07.2012	Yilanli Stream	710	7 people lost their lives and the shopping center, many houses, old industry and stadium of the city were damaged by the flood.
04.07.2012	Incirli Stream	172.7	A big damage in shopping areas
04.07.2012	Karaagac Stream	131.4	5 people lost their lives
07.08.2012	Cobanli (Kuruzeytin Stream)	55	Material damage in many buildings and workplaces around the access road.
07.08.2012	Afanli Stream	75	Material damage has occurred in vehicles and workplaces.
07.08.2012	Degirmen Stream	35	Property damage has occurred in the vehicles and in the workplaces.
07.08.2013	Alanli and Degirmen streams	-	Damages in the Highway Bridge and in Atakum coastal road bridge.

The Black Sea Region is one of the most common regions in flood and landslide events due to topography and the annual excess of precipitation. In 1998, 60 people died, and 1000 people were affected by Trabzon-Beskoy flood. In the Western Black Sea region floods in 1998, 10 people died, 47 people were injured, 40 000 people become homeless and 1 200 000 people were affected by floods, and the damage determined was around 1 billion

dollars (Korkanc and Korkanc, 2006). In 2001, Rize flood which results in the death of 6 people; caused 15 houses destroyed and 122 houses evacuated (Öztopal and Şen, 2007). The link between weather types and a long-time series of damaging flood records in Samsun is investigated in the present study. In the Table 1 general information about historical floods in Samsun province from 1960 to 2017 was given.

2. Study Area

Samsun province is located in the middle of the Black Sea region between the Kızılırmak and Yeşilırmak rivers with a surface area of 9083 km². Samsun province has three distinctive features in terms of geographical formations. The first one is mountainous in the South, the second one is plateaued between the mountainous coastline and coastal strip and the last one is the coastal plain between the springs and the Black Sea.
Samsun generally has a temperate weather. Beside of that, climate has two distinct characteristics in the coastal strip and interior areas. The effects of the Black Sea climate are seen on the coastline (City centre, Terme, Carsamba, Bafra, Alacam, 19 Mayis, Tekkekoy and Yakakent). Summer is hot on the coast and the winter is warm and rainy, while inner areas, (Vezirkopru, Havza, Ladik, Kavak, Asarcik ve Salipazari) under the influence of Akdag Mountain, which is 2000 meters high and Canik Mountains, which is 1500 meters high. As a result of this influence of the mountains, the winter season is cold, rainy and snowy and summer season is cool. The mean annual precipitation total is above the country average (735 mm). On the other hand, the rate of precipitation at the end is different from that of the western Black Sea region. Most of rainfall values are between October (86.5 mm) and November (81.2 mm). The amount of precipitation in the east of the province is higher than in the west. The average number of rainy days per year is around 156 days (web, 2017). Precipitation values of Samsun province between 1975 and 2010 are given in Table 2. Samsun city is very rich in terms of water resources. The greatest rivers of the province are Kizilirmak and Yesilirmak. These two rivers reach the Black Sea after passing the provincial lands. Besides of that, there are many small streams on the eastern side as shown in Figure 1. However, these streams have irregular regimes.

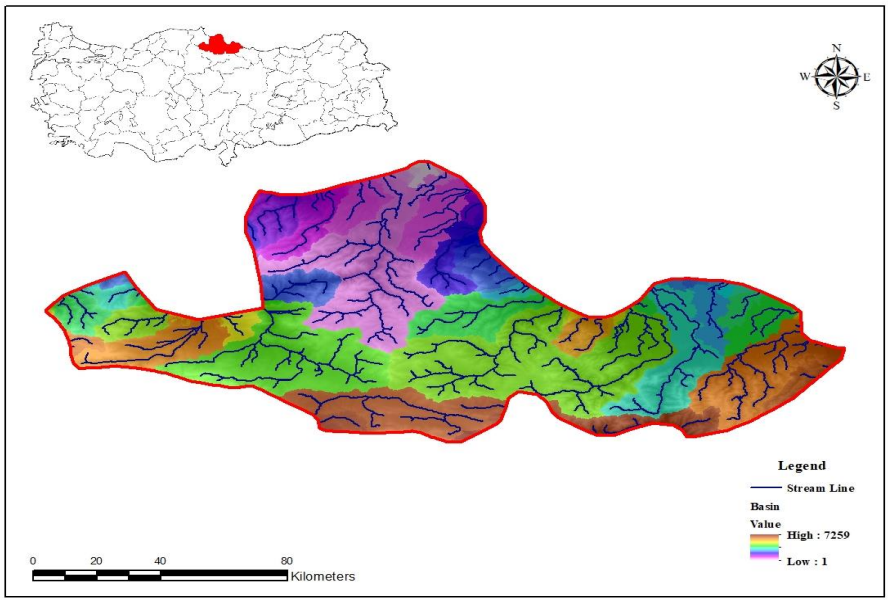

Figure 1. Location of the Samsun city with streams and basins

3. Samsun Floods

The first measurements in the region started by State Hydraulic Works in 1960. The records show that since 1960 there have been 13 significant flood disasters.

Table 2. Precipitation values of Samsun province between 1975 and 2010

Months	Average Number of Rainy Days	Average Rainfall Amount (kg/m^2)
1	13.2	58.0
2	13.4	50.2
3	15.0	57.1
4	14.7	58.8
5	12.5	51.1
6	9.6	48.0
7	6.3	31.8
8	6.6	36.7
9	10.0	52.9
10	12.8	91.9
11	12.2	80.2
12	13.6	76.9

3.1. The August 1960 flood event

On 29.08.1960, the large amount of precipitation which falling in Carsamba and surrounding area was gathered at places deprived of the possibility of drainage and caused significant damage (Figure 2). The daily precipitation value was measured 203 mm at Carsamba. At the same time for Samsun this value was 9.4 mm; especially in the upstream parts Tekkekoy and Abdal canals is more filled up. The flood value calculated from the water traces in Tekkekoy was 80 m^3/s.

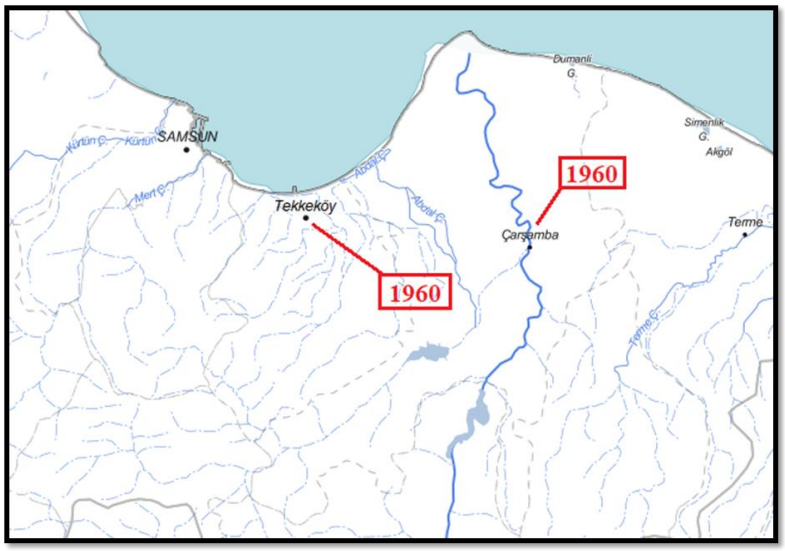

Figure 2. 1960 Flood Event

3.2. The February 1963 flood event

As a result of continuous precipitation and snow melt in the Kizilirmak basin on 17.02.1963, various damages occurred along with the coastal carvings by overflowing to Kizilirmak River, especially to Bafra's Kosu Village (Figure 3). The flow value was measured, 556 m^3/s on 16.02.1963, at the Kizilirmak-Inozu gauge station. In the same area, the flood peak value was measured 800 m^3/s for the same observation station that occurred on 25 May of the same year.

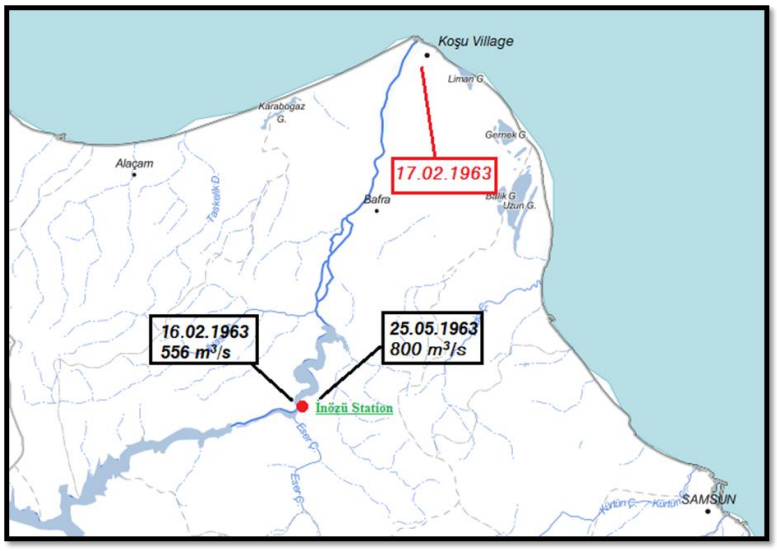

Figure 3. 1963 Flood Event

3.3. The 1966 flood event

Abdal River passes through the Carsamba Plain and intervenes in the sea (Figure 4). In the first week of January 1966, the peak value of this flood was reached to 219 m^3/s, which was taken at the highest section in view of the traces of flood waters.

3.4. The 1967 flood event

On 26 June 1967 at Abdal River, in the upstream parts of Yesilırmak and Terme, the flood was caused by the heavy precipitations (Figure 4). In the downstream of the Abdal River, the overflow is determined in the channel was 350 m^3/s. Although the part of the Abdal River that was improved as a canal according to the flow 500 m^3/s was opened, the canal overflowed as a result of the canal filled with water.

As a result of the heavy and high amount of precipitation that has fallen on 8-9 November 1967, there have been significant floods around Samsun and caused great damage. The floods and flood areas that participate in this flood along the coast of Black Sea can classify as follows:

- Tekkekoy-Kerimbey-Kirazlik Villages

In this section, one of the areas that participate in the flood are Guneyyaka Stream, Hizirilyas Stream, and Okse Stream. These three streams are brought over amount of fine sedimentation. Guneyyaka and Okse streams became extremely dry. Hizirilyas stream was

constantly flow and the maximum 10-year flow rate in this area was 11.7 m^3/s. But until that time no facility was built for flood control.

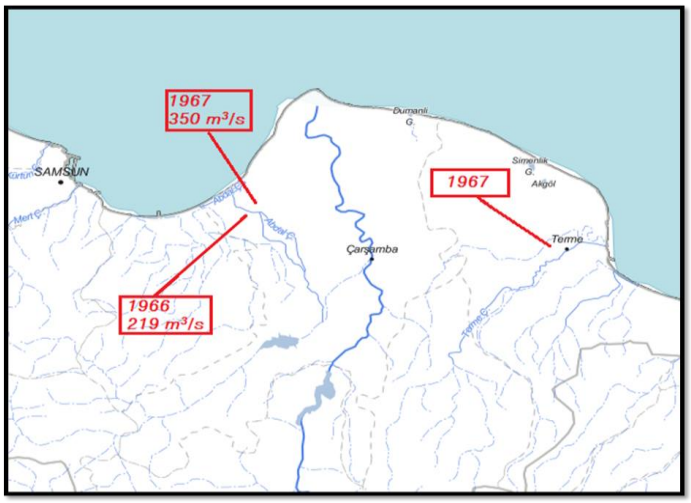

Figure 4. 1966-1967 Flood Events

- Samsun city and surroundings

Samsun and surrounding areas were one of areas that involve in this flood are Mert River, Samsun city side branches (Mezarlik stream, Doymaz Stream and Agabeli Stream) and Kurtun River. Generally, Kurtun and Mert rivers, which cross the center of the city carry a lot of rainfall. The flow of this flood was found to be 730 m^3/s, and this flood branch was seen to correspond to a 50-year cycle in the calculations made according to the sections of flood taken from 500 m of the railway bridge located 8 km from the sea on the Mert River. On the same date, the flow rate was passed 160 m^3/s from the Kurtun River.

- Alacam surroundings

The increasing of the precipitation caused to strike the valley slopes and open fields in the forest. According to the tracks of left Ulucay Stream Flood, the flood flow was calculated 565 m^3/s. In Alacam province a person died at the area of this flood.

3.5. The June 1971 flood event

On 09.06.1971, in the upstream parts of the basin at Samsun-Alacam district Gumenez stream was filled with heavy rainfall and eventually it was flooded (Figure 5). The local precipitation which made the flood was measured more than the precipitation values measured at meteorological stations. According to the calculations made at the cross section of the flood, the flood discharge was 92.5 m^3/s. The flood peak value calculated 86 m^3/s and the flood flow exceeded this value. There is also a person died at the area of this flood.

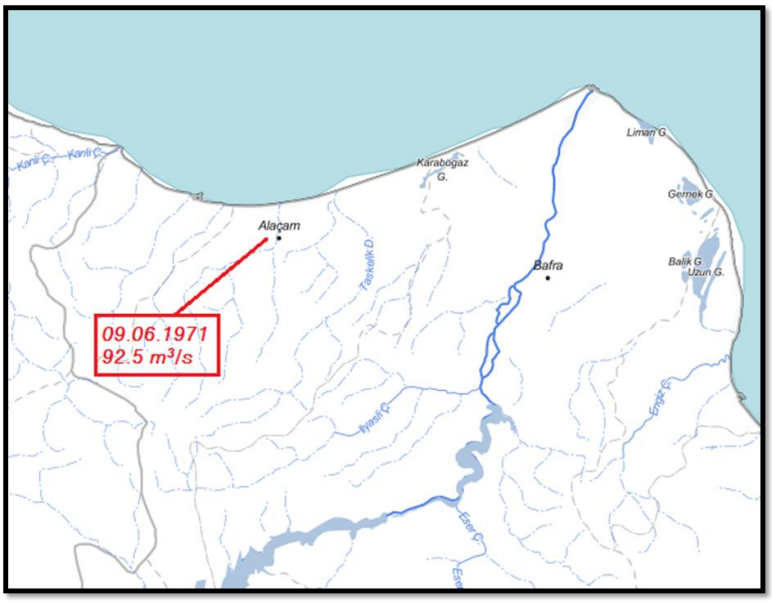

Figure 5. 1971 Flood Event

3.6. The July 1972 flood event

On the 31st of July 1972 around Samsun city, after the extreme precipitation, the flood occurs. From the distance, 8 km in the west of Samsun, flood caused a great damage in the area. Flood streams were Kuruzeytin, Afanli, Otekoy, Turkercesme, Gerceme, Derecik and Kurtun. The flood discharge calculated from the most extreme flood trails taken from the Kurtun River with value equaled 270 m^3/s.

3.7. The July 1977 flood event

On the day of 04.07.1977, floods occurred on the right side of the Bafra delta, between the Samsun and Bafra which is pouring into the Black Sea, at Degirmen, Cakirlar, Taflan, Musta, Karakoy and Kumsalcayi (Figure 6). The peak values observed during the floods vary between 22 and 90 m^3/s. However, in this flood the greatest flow was in Engiz and Karakoy streams with peak values 456 m^3/s and 306 m^3/s respectively which calculated from the flood traces. These values correspond to the 100-annual flow for Karakoy Stream and 25 annual flow for Engiz Stream.

3.8. The 1979 flood event

Extreme precipitation and extreme cold on 30.08.1979 caused floods which leading to loss of life and property in the Samsun-Havza, Amasya-Suluova-Merzifon, Tokat-Turhal and Corum-Mecitozu regions (Figure 6). As a consequence of the flood, the flood discharge of Suluova Kavalcik River was 88 m^3/s and the overflowing of the water caused the death of 27 people.

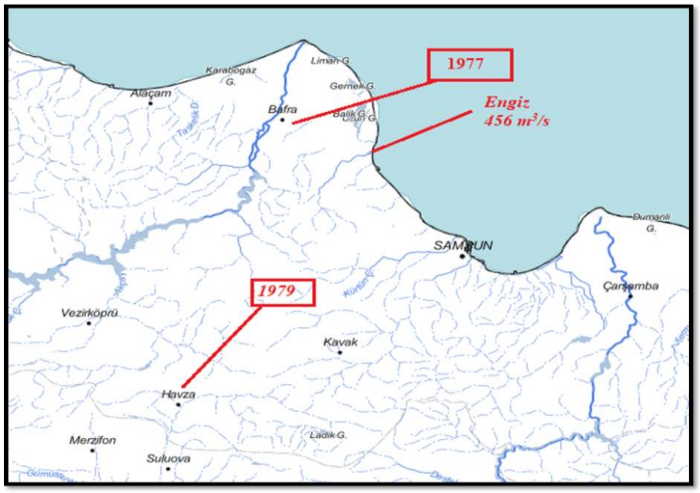

Figure 6. 1977-1979 Flood Events

3.9. The July 1988 flood event

The precipitation which started between 30.06.1988 to 01.07.1988 at Carsamba and Tekkekoy districts caused the floods (Figure 7). On the same day, precipitation was measured 406 mm at Hasanugurlu State Hydraulic Works station. On 01.07.1988, the flood measured 676 m^3/s and 1300 m^3/s in Yesilirmak Kale and Carsamba stream gauging stations (SGS) respectively. The important result of this flood that the construction of the Hasan Ugurlu and Suat Ugurlu dams provide great control on floods. Also on the same day, the flood passed the peak value 1175 m^3/s in the Abdal River. This flow value is recurrence every 250 years.

3.10. The June 1992 flood event

Between 16.06.1992 and 22.06.1992, on various days in Samsun-Tekkekoy and Ayvacik region, very local and variable heavy torrential rainfalls led to floods on the side of Catak in Ayvacik district (Figure 7). The area where the floods have taken place is the coast of the Black Sea on the left bank of the Yesilırmak basin. Tekkekoy Kirazlik, Sabanoglu and Hidirellez of streams flood are estimated to be 60 m^3/s. This corresponds to a recurrence of about 13 years.

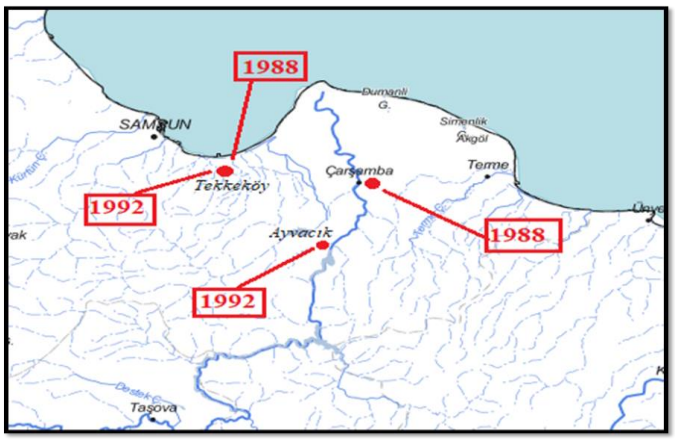

Figure 7. 1988-1992 Flood Events

3.11. The July 2007 flood event

On 24.08.2007 Friday, extreme precipitation started from 03:40 and continued till 05:18 which caused floods in Samsun city center and Derekoy area (Figure 8). Floods occurred at Karasamsun stream, Military Branch stream, Agabali, Kelin, Stream No. 1, Sitmapinari, Gulistan, Ortadag and Fideli streams which located in Samsun city center and Derekoy area. Flooded area was about to 25 km^2 .

Figure 8. Damages of Flood in Derekoy and Samsun City

3.12. The July 2012 flood event

As a result of the extreme precipitation in Samsun provinces and districts between 04.07.2012 and 07.08.2012, a flood occurred that caused serious damage in the city center and the districts (Figure 9).

3.12.1. 04.07.2012 Flood event

From 03.07.2012 at 23:30 to 04.07.2012 at 05:50 a heavy rainfall especially in the eastern areas that caused floods. According to the meteorological evaluation made by General Directorate of Government Meteorology Works, it was reported that the amount of the rainfall was "240 mm" on Yilanli, Incirli and Karaagac basins.

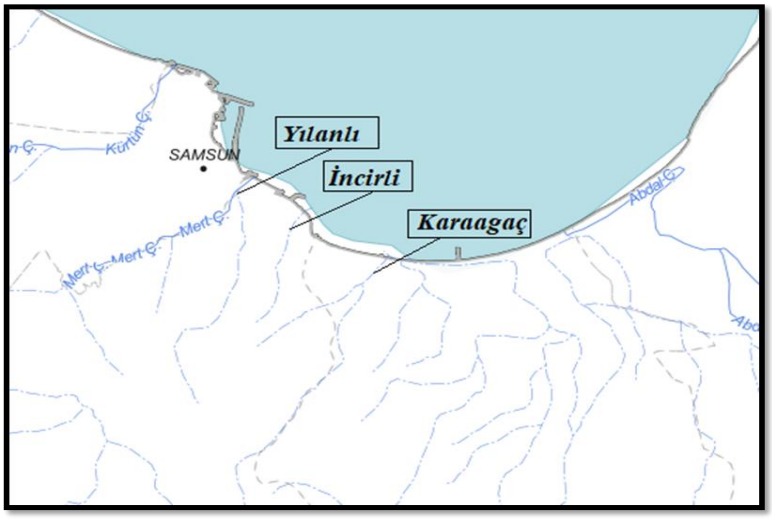

Figure 9. 2012 Flood Event

- Yilanli Stream:

The 1000-year frequency flood peak of the dam was Q=217 m^3/s. Flow rates during flood calculated as 710 m^3/s. The important thing that the incoming flood was 2.37 times bigger than the catastrophic peak and that indicates us that was a disaster dimension. As a result of this flood, 7 people lost their lives in Yesilova Street and the shopping center, many houses, old industry and stadium of the city were damaged by the flood (Figure 10).

Figure 10. Damages of Yilanli Stream Flood in Canik District

- Incirli Stream:

The 1000-year frequency flood peak of the stream was Q=121.3 m^3/s. The flow rate during the flood was calculated 172.7 m^3/s. It is also seen that the incident was in disaster dimension. The shopping centre which located in the Haskoy surrounding has also suffered from big financial damage (Figure 11).

Figure 11. The Damage Caused by Incirli Stream Flood to the Shopping Mall

- Karaagac Stream:

The 1000-year frequency flood peak of the dam was Q=103.5 m^3/s. The flow rate during the flood calculated as 131.4 m^3/s. This flow corresponds to the flood peak of the frequency 9087 years according to the calculated flood peak. After the flood, the industrial facilities have suffered from big financial damage and 5 people lost their lives in Kirazlik and transportation has been accelerated because of the flood.

3.12.2. 07.08.2012 Flood event

Severe heavy rainfall which started at 05:00 in the morning and continued at 8:00 am, was effective in the western regions of the province, especially in the district of Atakum.

- Kuruzeytin (Cobanli) Stream

The 1000-year frequency flood peak was Q=160.7 m^3/s. Flow rate during flood calculated as 55 m^3/s. This flow rate is even smaller than the calculated Q_{100}=100.3 m^3/s. Since the downstream part of Kuruzeytin (Cobanli) was used as a road after the flood, flood waters caused material damage in many buildings and workplaces around the access road (Figure 12).

Figure 12. The Damages Caused by the Kuruzeytin (Cobanli) Stream Flood

- Afanli Stream

The 1000-year frequency flood peak was Q=254.1 m^3/s. The flow rate during flood calculated as 75 m^3/s. This flow is calculated as the flood gauge Q_{100}=157.1 m^3/s. It shows that flood disaster occurs because of interfering in the stream beds. After the flooding, material damage has occurred in vehicles and workplaces due to the inadequacy of the culvert on the stream passing over the Samsun-Sinop Highway.

Figure 13. The Damages Caused by the Afanlı Stream Flood

- Degirmen Stream

The 1000-year frequency flood peak of the stream was Q = 192.4 m^3/s. Flow rate during flood calculated as 35 m^3/s. This flow is even smaller than the calculated Q_{100} =117.5 m^3/s. This also shows that flood disaster occurs because of interfering in the stream beds.
After the flood, property damage has occurred in the vehicles and in the workplaces due to the inadequacy of the culvert on the Samsun-Sinop Highway (Figure 14) (Ulke et al. 2013; DSİ, 2012).

Figure 14. The Damages Caused by the Flood of Degirmen Stream

3.13. The August 2013 flood event

Precipitation started at 01:00 am at night and continued until 04:00 in the morning and the heavy precipitation has left 250 kg rainfall per square meter in Atakum district in 07.08.2013. Alanli and Degirmen stream overflowed, especially the result of the overflow of Degirmen stream was tied traffic up and Sinop-Samsun highway traffic was provided after several hours with control (Figure 15).

Figure 15. Flood Damage (Highway Bridge) and in Atakum Coastal Road Bridge

4. Conclusion

Due to Samsun city where located in climate zone with continuous rainfall and floods are located in a region under risk. In the past, frequent floods occurred in the region. When these floods are examined, it is seen that especially the summer rains are causing floods.

With increasing rainfall intensity, global climate change is seen to have an effect, but when it comes to the 2012 and 2013 floods, it is seen that even when rainfall values are not in disaster dimension, floods are seen. The reason is that irregular urbanization and inadequate infrastructure. In 2012 flood event, the volume of effects can be clear from the study of Bahadir (2014) which focused about the climatic analysis of the Samsun 2012 flood event.

Depending on the rapid growth and development of urbanization, the decrease of rural areas, the paving of soil floors with concrete and asphalt and impermeable materials, most of the precipitation has become runoff, and besides the infrastructure system has not been able to carry that flow. Some dry stream beds were ignored and transform into the streets, stream beds were zoned for construction and multi-story buildings were built on them (Marım, 2002; TMMOB, 2012; Uskay and Aksu, 2002).

Over the years, a filling area of about 500 m was built on the sea-facing part of the city. For this reason, rain water which coming from the sloping southern ceiling reaches to the flat area and must reach the sea through the filling. The lack of adequate infrastructures caused the water could not reach the sea and caused a wound in this region.

According to the data of the State Hydraulic Works, over the last 20 years, more than 300 floods have come to the whole of Turkey and about 500 people have lost their lives in these floods. Floods are natural phenomena for Turkey like earthquakes, but local dministrations and administrators are turned these natural phenomena to a disaster.

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