World Applied Sciences Journal 10 (4): 416-420, 2010
ISSN 1818-4952


# Rainfall Effectiveness of Safranbolu (Karabük) in Turkey

*Mücahit Coşkun*

Department of Geography, Karabük University, Karabük, Turkey

**Abstract:** Safranbolu is an area which is located in the Western Black Sea Section of the Black Sea Region. This area is a district which is administratively bound to Karabük province. Average annual temperature in and around Safranbolu is 12.3 °C and the total annual average rainfall is 462.2 mm. Research area is located between Black Sea coastline and Central Anatolia. It is aimed in this research to determine the rainfall effectiveness features of Safranbolu district by means of using De Martonne, Erinç and Thornwaite methods. Safranbolu and occasionally Karabük station are used in determining the rainfall effectiveness. When all the three methods are taken into consideration in terms of the rainfall effectiveness of Safranbolu; 3 months of hot-arid (July-September) and 3 months of cold-humid (December-February) seasons are experienced. In general, similar results are obtained by means of the rainfall effectiveness methods applied. Safranbolu bears distorted Mediterranean climate features due to the fact that there is the summer drought, winter rainfall rate is high and Mediterranean vegetation cover elements are encountered.

**Key words:** Rainfall effectiveness · Drought · Climate · Safranbolu

## INTRODUCTION

Rainfall effectiveness is a type of determining the climatic features, which is defined in accordance with the features basically such as temperature, rainfall and evaporation. De Martonne, Erinç and Thorwaite methods are among the important known rainfall effectiveness determination methods. Knowing about the rainfall effectiveness in a certain place is one of the main natural determinants in food production, tourism activities and in ensuring their sustainability. Therefore, rainfall effectiveness shapes the natural and social phenomena. Some researches carried out researches on the features and development of rainfall effectiveness in Turkey draws attention to this subject [1-10].

The research has been carried out so as to cover Safranbolu and its surroundings. Determining the rainfall effectiveness features of Safranbolu will contribute to making use of the natural potential in a sustainable manner. Thus, overexploiting the resources and various problems that may occur will be prevented in advance. De Martonne, Erinç and Thornwaite methods have been used in the study.

**Study Area:** Safranbolu, which constitutes the field of study, is located in the Western Black Sea section of the Black Sea Region. The aforesaid area is a district which is administratively bound to Karabük (Figure 1). The district is a plateau along which lay same hills; Sarİçiçek mountain on the north and northwest; and split by series of canyon valleys. It is the largest and most developed district of Karabük province. It is famous for its historical houses which reflect Ottoman urban architecture and they were established in the canyon valley. These historical houses have been in the "World Heritage List" of UNESCO since 1994 and attract the attention of the tourists. In those times, the houses in the valley were used during wintertime; and, vineyard houses built on higher areas in the northern part of the city were used during summertime. The district was named after the "saffron" plant which grow in the surrounding area and it is valuable a plant.

Safranbolu not only reflects the Classic Ottoman urban architecture, but there are also a great deal of remnants, mounds, rock graves, historical graveyards belonging to ancient periods; and natural caves, thick forests, highlands and canyons.

## METHOD AND MATERIAL

Since rainfall effectiveness is one of the main climatic features which directly affect life; it is an area in which some methods have been developed from 1800s, until now [11]. However, since it is a subject on which

**Corresponding Author:** Mücahit Coþkun, Department of Geography, Karabük University, Karabük, Turkey

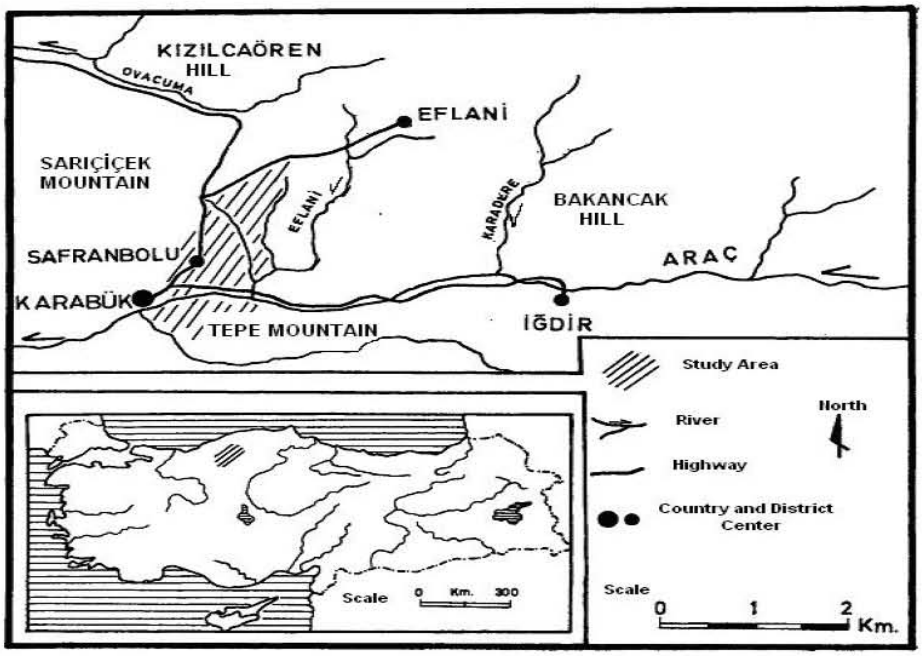


Fig. 1: Location Map of the Study Area

no consensus has been reached, there are a great number of methods in use. All the methods which have been asserted have their peculiar reasons and an aspect which makes up for a missing part. No matter how different the methods were; purposes of all the scientists were the same. Therefore, methods of De Martonne (1923 and 1942), Erinç (1965) and Thornwaite (1948) have been utilized in this research in order to stress the different aspects of the rainfall effectiveness in Safranbolu. Data source of the specified methods are the observations of 38 years (1952-1990/this station is closed today), held in Safranbolu Station (General Directorate of Meteorology – DMİ). Currently the station is out of operation, since DMİ has closed it down. Therefore, the values are occasionally compared to the Karabük station and evaluated accordingly.

**Findings**

**De Martonne Climatic Classification:** According to the Annual Drought Index Formula "1923 and 1942", [12].

**Safranbolu Station in reference to 1923:**

I = P / (T + 10)
= 462,2 / (12,3 + 10)
= 462,2 / 22,3
= 20,7 Safranbolu station is somewhere between semi arid climates and humid climates.

**Safranbolu Station in reference to 1942:**

I = (P / (T + 10) + ( 12.p / (t+10)) )/ 2
= (462,2 / 22,3) + (12x2.1 / (20.5 + 10)) )/ 2
= (20,7 + 0,83) / 2
= 10,76 Safranbolu station is somewhere between semi arid climates and humid climates.

**According to the Monthly Drought Index Formula (1923):** *When the drought index of Safranbolu per month is analyzed (with reference to 1923);*

January calculation is;

I = (p / (t +10)) x 12
= (48.8 / (2.2+10)) x 12
= (48.8 / 12.2) x 12
= 48

The index values of Safranbolu in July, August and September are below 10. Accordingly, these are the arid months for Safranbolu. June and October, the index values of which are between 10 and 20 are semi arid. March, April, May and November, the index values of which are between 20 and 30 are semi arid to humid features. December, January and February are humid, thus rainy months, since their index values are over 30.

**Erinç Climatic Classification:** Climate of Safranbolu, according to Erinç formula;[11].

| Rainfall Effectiveness Climate | |
|---|---|
| Below 8 | Fully Arid |
| 8-15 | Arid |
| 15-23 | Semi Arid |
| 23-40 | Semi Humid |
| 40-55 | Humid |
| Over 55 | Very Humid |

P = Annual Total Rainfall (mm)
Tom = Annual Average Maximum Temperature (°C)
Im = 462,2 / 18.8
= 24,6 According to the Erinç Formula, Safranbolu is within the semi humid climatic class, since it is between 23-40 index values; and it consists of dry forests with park Outlook.

When the monthly rainfall effectiveness of Safranbolu is examined; July, August and September are arid, June and October are semi arid. While the rainfall effectiveness in December and January is very humid, it is humid in February. The remaining months of the year are semi humid, as the annual average.

**Thornwaite Climatic Classification, [13]**
**Rainfall Effectiveness Index:**
Rainfall Effectiveness = (100s – 60d) / n
s = Annual excess water
d = Annual water deficit
n = Annual potential evapotranspiration
Rainfall Effectiveness = ((100x44.5)-(60x297))/ 714.72
= (4450- 17820) / 714.72
= -13370 / 714.72
= -18,7 Safranbolu station is C1 arid, with low humidity.

**Heat Effectiveness Index:** The heat effectiveness index is found by taking the annual potential evapotranspiration (PE) values as a basis. Since the PE of the Safranbolu station is 714,72, it is in the second degree mesothermal climate group.

**Humidity Index for the Arid Climates:**
Humidity index formula = 100s / n
= (100 x 44.5) / 714.72
= 4450 / 714.72
= 6.2

Table 1: Monthly Drought Index of Safranbolu with Reference to its Annual Average Temperature and Rainfall Values

| Months | J | F | Mr | A | My | Jn | Jl | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature (°C) | 2.2 | 4.2 | 7.6 | 11.9 | 15.8 | 19.4 | 22.3 | 20.5 | 18.3 | 13.5 | 8.3 | 3.8 | 12.3 |
| Rainfall (mm) | 48.8 | 38.2 | 40.2 | 46.2 | 50.5 | 44.8 | 24 | 21 | 22.3 | 35.9 | 41.5 | 48.8 | 462.2 |
| Drought Index | 48 | 32 | 27 | 25 | 23 | 18 | 9 | 8 | 9 | 18 | 27 | 42 | 21 |

Source: Compiled from the DMİ data.

Table 2: Monthly Rainfall Effectiveness of Safranbolu according to Erinç Method

| MONTHS | J | F | Mr | A | My | Jn | Jl | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Avr. High Temp. (°C) | 6.2 | 9.3 | 14.1 | 18.6 | 23.0 | 27.0 | 30.1 | 29.1 | 26.6 | 20.3 | 13.7 | 7.8 | 18.8 |
| Rainfall (mm) | 48.8 | 38.2 | 40.2 | 46.2 | 50.5 | 44.8 | 24.0 | 21.0 | 22.3 | 35.9 | 41.5 | 48.8 | 462.2 |
| Index Value | 94.4 | 49.3 | | | | | | | | | | | |
| 34.2 | 29.8 | 26.3 | 19.9 | 9.5 | 8.6 | 10.0 | 21.2 | 36.3 | 75.0 | 24.5 | | | |
| Rainfall Effectiveness | Very Humid | Humid | Semi Humid | Semi Humid | Semi Humid | Semi Arid | Arid | Arid | Arid | Semi Arid | Semi Arid | Semi Arid | Semi Humid |

Source: Compiled from the DMİ data.

Table 3: Water Balance Chart of Safranbolu According To Thornwaite

| MONTHS | J | F | Mr | A | My | Jn | Jl | A | S | O | N | D | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Temperature(°C) | 2.2 | 4.2 | 7.6 | 11.9 | 15.8 | 19.4 | 22.3 | 20.5 | 18.3 | 13.5 | 8.3 | 3.8 | 12.3 |
| Temperature Index | 0.29 | 0.77 | 1.89 | 3.72 | 5.71 | 7.79 | 9.62 | 8.47 | 7.13 | 4.50 | 2.15 | 0.66 | 52.7 |
| Uncorrected PE | 5.05 | 11.86 | 25.96 | 46.95 | 68.28 | 89.55 | 107.65 | 96.32 | 82.91 | 55.47 | 29.17 | 10.39 | 629.56 |
| Corrected PE | 4.18 | 9.84 | 26.74 | 52.23 | 85.52 | 113.06 | 136.98 | 114.62 | 86.22 | 53.11 | 23.92 | 8.29 | 714.72 |
| Rainfall (mm) | 48.8 | 38.2 | 40.2 | 46.2 | 50.5 | 44.8 | 24.0 | 21.0 | 22.3 | 35.9 | 41.5 | 48.8 | 462.2 |
| Monthly Value of the Accumulated Water | 41.9 | 0.0 | 0.0 | -6.03 | -35.02 | -58.9 | 0.0 | 0.0 | 0.0 | 0.0 | 17.5 | 40.5 | - |
| Accumulated Water | 100.0 | 100.0 | 100.0 | 93.9 | 58.9 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 17.5 | 58.1 | - |
| Real Evapotranspiration | 4.1 | 9.8 | 26.7 | 52.2 | 85.5 | 103.7 | 24.0 | 21.0 | 22.3 | 35.9 | 23.9 | 8.2 | 417.6 |
| Water Deficit | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 9.3 | 112.9 | 93.6 | 63.9 | 17.2 | 0.0 | 0.0 | 297.0 |
| Excess Water | 2.7 | 28.3 | 13.4 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 44.5 |
| Flow | 1.3 | 15.5 | 20.9 | 6.7 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 44.5 |
| Humidity Rate | 10.6 | 2.8 | 0.5 | -0.1 | -0.4 | -0.6 | -0.8 | -0.8 | -0.7 | -0.3 | -0.7 | 4.8 | - |

Source: Compiled from the DMİ data.

With this value, Safranbolu, with letter "d", has an auxiliary climate which has no or very little excess water.

**Ratio Index of Pe to the Three Summer Months:** Ratio of PE to the three summer months is found by multiplying the total of the PE values by 100 and dividing it by the annual PE amount.

Index = = (113.06+136.98+114.62) x100 / 714.72
= 36466 / 714.72
= 51.02

This value shows that Safranbolu is in b'4 category, which means that it is a place close to the marine effect.

## CONCLUSION

Safranbolu, which is located in the inner parts of the Western Black Sea section, is a place where the marine effect cannot fully penetrate due to the mountainous and hilly areas which lay on the northern side. It is possible to observe the effects of the Black Sea, Continental and Mediterranean climates periodically. The study area and its surroundings is a passage between the coastline and the inner parts. When the vegetation cover is analyzed, it is possible to encounter Europe-Siberia, occasionally Iran-Turan and Mediterranean vegetations.

The results obtained according to the De Martonne method shows that the annual drought index, when it is calculated according to either 1923 or 1942 formula, Safranbolu station is located between semi arid climates and humid climates. However, according to the monthly drought index, in June, which is the beginning of the summer season, Safranbolu starts the season as semi arid. The following months that July, August and September are arid months for the district. October, on the other hand is a month when drought decreases when compared to the previous months, but still continues. While the winter months are humid in Safranbolu, other months (March, April May and November) are between semi arid and humid.

When Erinç method is applied to the Safranbolu data, it is determined that Safranbolu is in the semi humid climate class and consists of dry forests with park outlook. When the monthly rainfall effectiveness of Erinç is taken into consideration, June is semi arid, July, August and September are arid and October is semi arid just like in the De Martonne method. Likewise, winter period is very humid.

According to the Thornwaite method, Safranbolu is in arid-low humid, second degree mesothermal climate; with no excess water and it is close to the marine effect.

When all the three methods are taken into account Safranbolu in terms of rainfall effectiveness, during the hot period of three months (July-September) arid conditions and during cold period of three months (December-February) humid conditions prevail. Generally, similar results have been obtained by means of De Martonne, Erinç and Thornwaite methods, which were applied when determining rainfall effectiveness. While Safranbolu station shows similar results to that of Karabük in terms of rainfall effectiveness, it is different from Zonguldak stations [14]. In this, that Zonguldak is open to the marine effect is important. Since summer drought and inter rainfall is effective in Safranbolu and maquis vegetations (Phillyrea Latifolia, Laurus Nobilis, Arbutus Andrachne, Juniperus Nana, Poliurus spina-christi) are dispersed in patches, it indicates Mediterranean climate features.

When the monthly rainfall effectiveness in Safranbolu is examined, complete draught is not observed in any month. However, that Safranbolu experiences some arid months must be taken care of in water use and planning. Safranbolu is a touristic place and that tourists visit the district mostly during summer months; that the district develops and quick housing may cause water problem to emerge in the future. Besides, some precautions are required to be taken to get over the hot and arid period.

## REFERENCES

1. Koçman, A., 1993. Türkiye'de Yağİş Yetersizliğine Bağlİ KuraklİK Sorunu" Ege Coğrafya Dergisi, No:.7ss.77-100, İzmir.
2. Çiçek, İ., 1995. Türkiye'de Kurak Dönemin Yayİlİşİ ve Süresi (Thornthwaite Metoduna Göre) Türkiye Coğrafyasİ AraştİrmaVe Uygulama Merkezi Dergisi, 4: 77-102, Ankara.
3. Türkeş, M., 1990. Türkiye'de Kurak Bölgeler ve Önemli Kurak YİllAr, YayİnlanmamİŞ Doktora Tezi, İ.Ü. Deniz Bilimleri ve Coğrafya Enstitüsü, İstanbul.
4. Türkeş, M., 1995. Türkiye'de YİllİK, Mevsimlik YağİŞ Verilerindeki Eğilimler ve Dalgalanmalar TUJJB Bilimsel Kongresi, 3-5 MayİS, Ankara.
5. Türkeş, M., 1996. Meteorological Drought in Turkey: A Historical Perspective, 1930-93, Drought Network News, 8: 3.
6. Türkeş, M., 1998. İklimsel DeğişebilirlikAçİSİndan Türkiye'de ÇölleşmeyeEğilimli Alanlar, II. Ulusal Hidrometeoroloji Sempozyumu, 18-20 KasİM, Ankara.
7. Erol, O., 1999. Genel Klimatoloji, Çantay Kitabevi, İstanbul.

8. Koç, T., 2000. Kuzeybatİ Anadolu'nun İklim Analizi: Sinoptik, İstatistik ve Uygulama Boyutlarİ İle. BalİkesirÜniversitesi AraştİrmaFonu 97/5 NumaralİProje Sonuç Raporu. BalİkesirÜnaldİ, Ü.E., 2009. Türkiye YağİşlarİnaSinoptik YaklaşİmveAkdenizBölgesiÖrneği 1, Gazi KitabeviYayİnlarİ, Ankara.
10. Atalay, İ., 2010. UygulamalİKlimatoloji, Meta Basİmİzmir.
11. Erinç, S., 1996. Klimatoloji ve MetodlarİAlfa BasİmYayİmDağİtİm, İstanbul.
12. Olivere. J.E. and J.J. Hidore, 2002. Climatology (An Atmospheric Science). Upper Saddle River, New Jersey.
13. Strahler, A.N. and A.H. Strahler, 1992. Modern Physical Geography, fourth edition, John Wilay and Sons Inc., New York.
14. http://www.meteor.gov.tr/veridegerlendirme/il-ve-ilceler-istatistik.aspx