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Investigation of drought status of Konya Closed Basin with Percent of normal index

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Abstract

In this study, meteorological drought situation of Konya Closed Basin was analyzed by PNI method. In the analysis, annual total precipitation data covering the records of 11 meteorological stations in the basin between 1972 and 2020 were used. Drought classes obtained from the analyzes made according to the PNI index were interpreted in the entire data period and the results of the last years (2015-2020) were mapped using the Inverse Distance Weighting (IDW) method. When the results were examined, it was determined that 2 of the 11 stations (Konya and Niğde stations) in the region had 4 extreme dry years at most. According to the PNI method analyzes of the last 5 years of the basin, it was observed that the driest year was 2020. The IDW map provides information about the spatial distribution of results. When the IDW interpolation map of the results was examined, it was observed that the drought values changed in our basin over time (2015-2020).

1. Introduction

Drought is an event that can significantly affect the level of welfare of the people with the country's economy and development capacity. For this reason, the evaluation of drought scenarios that may occur in the future has great importance for many components of the country's economy such as agriculture, energy, ecology, biodiversity, forestry, health and water sectors (Osuch et al. 2016).

Drought is a meteorological natural catastrophe that seriously affects daily life, restricts people's activities, and creates ecological issues. The time of occurrence, duration, severity and area of impact of drought change every year.That is why drought leads to environmental, social and economic impacts.

Over time, changes in temperature and precipitation in a region cause important events that affect human life and should be taken seriously. As a result of the constantly increasing trend of temperature values and the continuous decreasing trend of precipitation values, drought-desertification phenomenon, which is a phenomenon that takes place in long periods, occurs.

On the contrary, the continuous increase in precipitation or the tendency of instantaneous precipitation to increase continuously cause dangers such as floods and landslides.

In this study, meteorological drought situation in Konya Closed Basin was analyzed by PNI method. The annual total precipitation data recorded over the years from 11 meteorological stations in the basin were used. The drought classes obtained according to the PNI index were interpreted in the entire data period and the situation in recent years (2015-2020) was examined with the IDW interpolation maps obtained using the value of the last years.

2. Method

2.1. Percentage Index of Normal (PNI)

The Percentage Index of Normal (PNI) is a method widely used among drought indices and is based on precipitation data. PNI is a method that is widely used among drought indices and is based on precipitation data. It is a method that finds the PNI value by dividing

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the amount of precipitation in a certain time period by the average amount of precipitation in the same time period and multiplies it by a multiplier of 100 and finds the PNI value converted to a percentage. The general equation of the method is given below.

$$\text{PNI} = \frac{P_i}{P_{i(avr)}} \times 100 \qquad (1)$$

Here, PNI, Percentage of Normal Index value. Pi(mm), the current amount of precipitation. Pi (avg, mm) refers to the average amount of precipitation (McKee et al. 1993). The classification for the 12-month period given in Table 1 is included. According to PNI values, there are 4 different drought classes for 5 different periods.

Table 1. Percentage Index Classes of Normal

Period	Normal	Slightly Arid	Medium Arid	Severe Arid
1	> % 75	% 65 - % 75	% 55 - % 65	< %55
3	> % 75	% 65 - % 75	% 55 - % 65	< %55
6	> % 80	% 70 - % 80	% 60 - % 70	< %60
9	> % 83.5	% 73.5 - % 83.5	% 63.5 - % 73.5	< %63.5
12	> % 85	% 75 - % 85	% 65 - % 75	< %65

2.2. IDW (Inverse Distance Weighting) Method

This method will be used to obtain interpolation maps of PNI index results. IDW is an interpolation method used to generate data from non-sampleable data with sample points. The general equations of the method are given below.

$$f(x.y) = \sum_{i=1}^{n} w_i f_i \qquad (2)$$

$$w_i = \frac{h_i^{-p}}{\sum_{j=1}^{n} h_i^{-p}} \qquad (3)$$

Here; p, Is taken as the power parameter and is denoted by the exponent. Hi, represents the spatial distance between Decimation points and interpolation points. wi, Refers to the sum of weights and values. fi: Represents the known height value (Krige, 1951).

2.3. Study Area

Konya Closed Basin, located in Central Anatolia in Türkiye and encompassing most of Konya's lands, is one of the most important basins of the country in terms of agriculture. Semi-arid continental climate conditions prevail in the basin. It is located between latitudes 36° 51' N and 39° 29'N and longitudes 31° 36'E and 34° 52'E. The province of Konya, located in this basin, is the largest city in Türkiye in terms of surface area and is approximately 38,257 km long, excluding the area where it was established and the lakes. The average elevation of the city above sea level is 1016 m. The study area is shown in Figure 1.

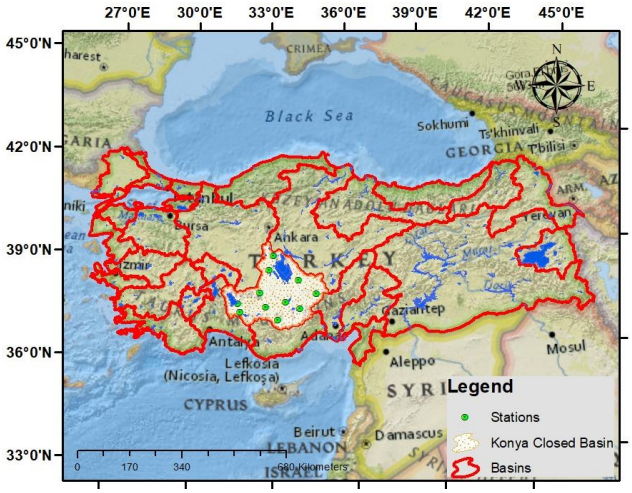

Figure 1. Konya Closed Basin and Other Basins in Türkiye

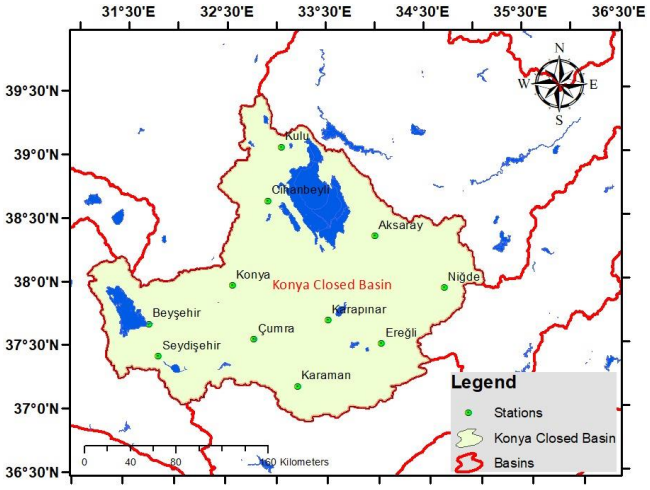

Figure 2. Stations used in the study

3. Application

According to the PNI method, the number of occurrences of drought classes between 1972 and 2020, which is the data period, is given in Table 2.

PNI values for the last years are given in Table 3.

The maps obtained by using the IDW method of the PNI values in Table 3 are given in Figure 3-9.

Table 2. The number of drought indices

Stations	Normal	Slightly Arid	Medium Arid	Severe Arid
AKSARAY	36	5	7	1
BEYŞEHİR	37	6	6	0
CİHANBEYLİ	38	3	6	2
ÇUMRA	34	8	4	3
EREĞLİ	37	7	3	2
KARAMAN	35	7	6	1
KARAPINAR	36	9	2	2
KONYA	36	6	3	4
KULU	38	6	3	2
NİĞDE	37	5	3	4
SEYDİŞEHİR	36	6	6	1

Table 3. PNI values of recent years

İSTASYON ADI	2020	2019	2018	2017	2016	2015	2010
AKSARAY	112.33	87.07	126.60	89.34	103.94	114.28	135.08
BEYŞEHİR	85.27	114.00	100.54	118.35	96.00	79.60	120.10
CİHANBEYLİ	80.01	85.71	118.61	84.03	86.20	138.85	106.04
ÇUMRA	66.61	114.83	138.72	117.46	90.25	76.68	122.56
EREĞLİ	73.92	96.42	104.46	91.30	114.12	114.42	112.56
KARAMAN	82.70	144.16	113.58	106.40	123.21	86.66	99.76
KARAPINAR	83.70	144.55	133.96	124.66	105.99	88.96	116.38
KONYA	89.54	111.80	115.27	95.85	87.02	114.84	108.20
KULU	75.48	88.83	122.57	87.76	96.36	111.62	112.13
NİĞDE	91.60	97.57	143.25	69.12	93.66	120.23	142.11
SEYDİŞEHİR	78.52	98.95	94.39	110.77	95.46	92.72	121.66

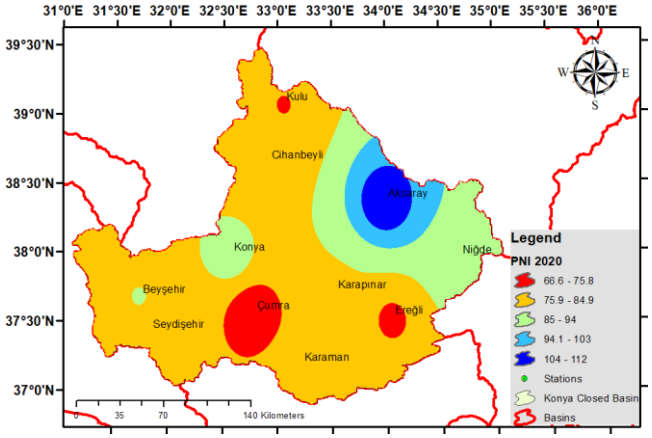

Figure 3. PNI-IDW map of 2020 year

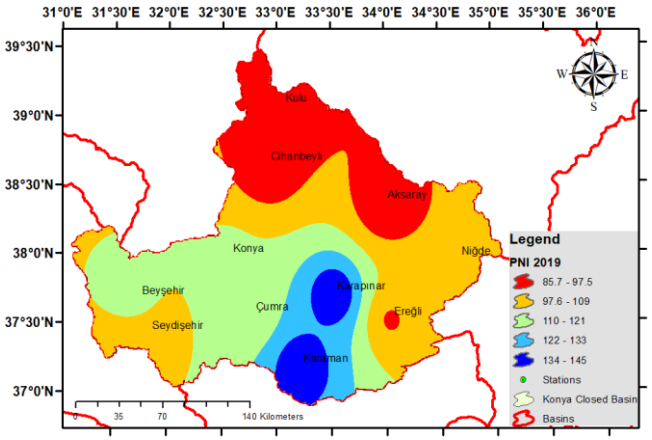

Figure 4. PNI-IDW map of 2019 year

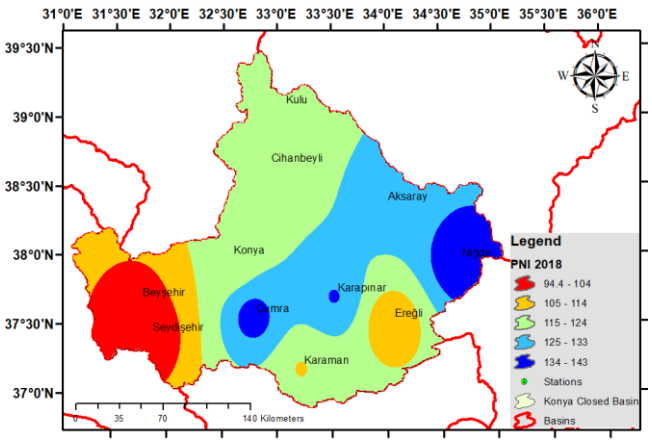

Figure 5. PNI-IDW map of 2018 year

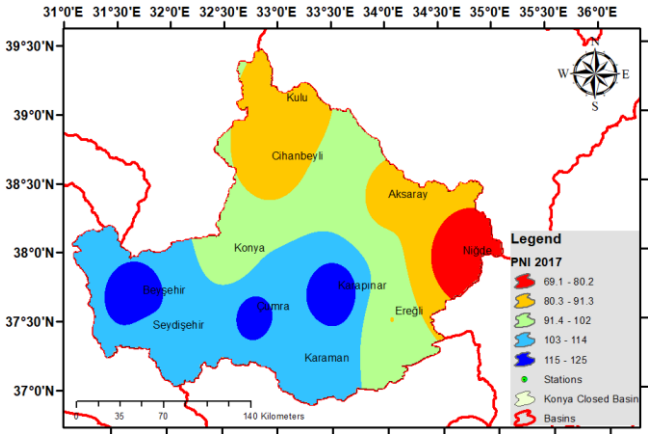

Figure 6. PNI-IDW map of 2017 year

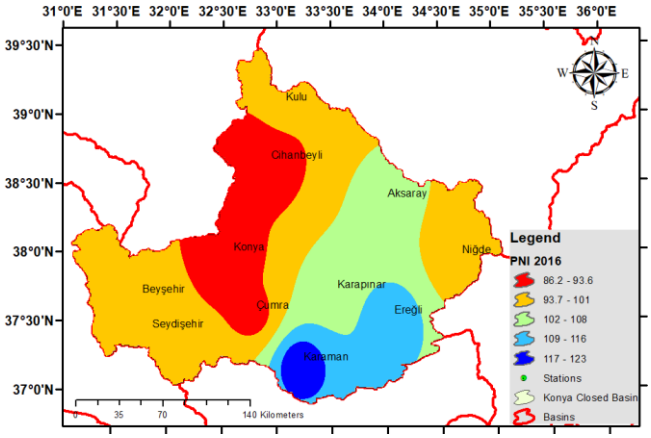

Figure 7. PNI-IDW map of 2016 year

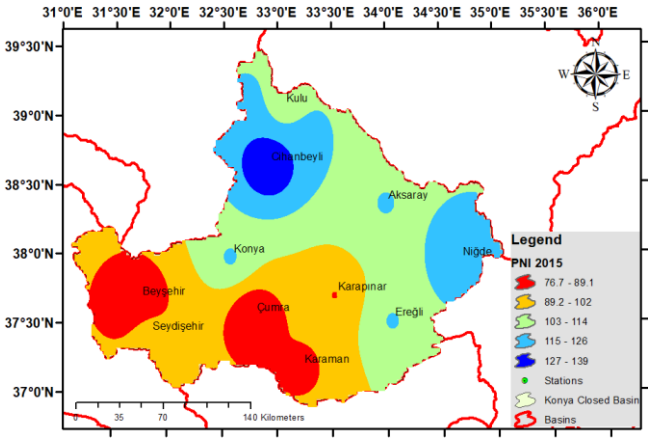

Figure 8. PNI-IDW map of 2015 year

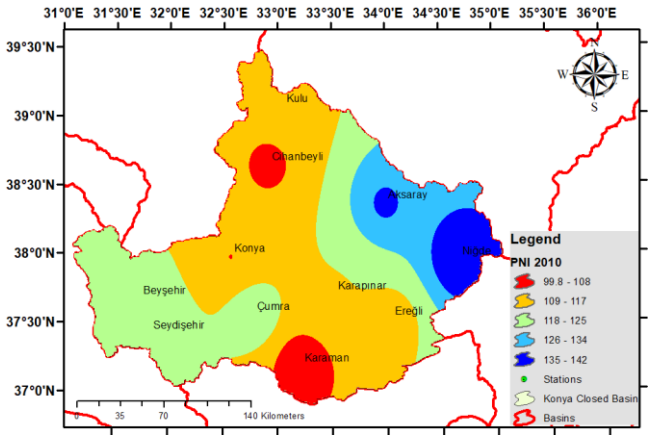

Figure 9. PNI-IDW map of 2010 year

4. Discussion

Duygu, Kirmencioğlu and Aras created a comprehensive drought management plan of the Konya closed basin with Standard Precipitation Index (SPNI), Percent of Normal Method (PNI) and other methods. To determine Water Management, precipitation data between 1972 and 2013 were analyzed (Duygu et al. 2017). Dalkılıç, et al. 2021 evaluated the combined use of the precipitation data of the Konya closed basin between 1981-2010 with SPNI, PNI and other known drought indices. As a result of their studies, the reliability of the drought index methods was determined. Efe and Özgür examined the drought data between 1972 and 2013 with SPNI and PNI methods in the study covering Konya and its surroundings. As a result of the annual evaluation of their work, severe drought was observed in 6 of 20 stations Efe and Özgür, 2014. As a result of the PNI tests conducted in Kulu and Çumra, which are included in our study, drought was observed and adaptation to this study was achieved. As a result, our study is different from other studies in terms of timeliness and stations.

5. Conclusion

In this study, annual total precipitation data recorded between 1972 and 2020 at 11 meteorology observation stations located in the Konya Closed Basin were used. According to the PNI method, the annual drought status of the total precipitation was examined for the basin. As a result of the analysis, when we examined the last 5 years, it was seen that the driest years were 2019 (especially around Karaman and Karapınar) and 2018 (around Çumra and Niğde).

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