Rainfall and PET Analysis of Kars

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1 Introduction

Potential evaporation represents the maximum amount of water that could evaporate from a surface under idealized conditions, such as sufficient moisture availability and no limitations like water stress. Precipitation, on the other hand, is the actual amount of water that falls onto the surface. The balance between potential evaporation and precipitation determines whether an area experiences a surplus or deficit of water. Surplus occurs when precipitation exceeds potential evaporation, leading to runoff, groundwater recharge, and increased soil moisture. Deficit occurs when potential evaporation exceeds precipitation, resulting in drying of soils, reduced groundwater recharge, and potential water stress for vegetation.

2 Materials and Methods

2.1 QCIS

The shapefile downloaded from the website of the Turkish General Directorate of Maps was used to extract the minimum-maximum latitudes and longitudes of the Kars province. Through the procedures conducted in QCIS; the maximum latitude was determined as 43.74, the minimum latitude as 42.12, the maximum longitude as 41.09, and the minimum longitude as 39.92.

2.2 CDO and Panoply

Panoply was used to visualize the .nc files downloaded from ERA-5 websites. CDO was utilized to extract monthly and yearly PET and P values. To identify the driest-wettest months and years of the data, P values were compared. The driest period indicates lowest precipitation value, while the wettest period indicates precipitation value. According to this, the lowest precipitation value is 35.28 mm, which occurs in September; while the highest precipitation value is 119.02 mm, which occurs in May. Also, the lowest average precipitation value is 43.59 mm, which occurred in 1961; while the highest average precipitation value is 80.96 mm, which occurred in 1963.

Table 1: Monthly PET and P

Months	Monthly PET	Monthly P
1	9.41	42.10
2	16.74	47.93
3	38.46	68.01
4	70.55	93.08
5	106.64	119.02
6	128.50	89.25
7	144.51	55.69
8	133.51	44.90
9	94.83	35.28
10	55.22	51.34
11	24.77	45.10
12	11.98	40.73

2.2.1 Codes used in CDO

```
verda@LAPTOP-7MQIUVS3 /bin
$ cdo sellonlatbox,42.00,43.50,40.00,41.00 pet_TR.nc karss_pet.nc
cdo sellonlatbox: Processed 3 variables [0.83s 54MB]

verda@LAPTOP-7MQIUVS3 /bin
$ cdo sellonlatbox,42.00,43.50,40.00,41.00 pet_TR.nc karss_pre.nc
cdo sellonlatbox: Processed 3 variables [3.73s 54MB]

verda@LAPTOP-7MQIUVS3 /bin
$ cdo monsum karss_pre.nc monsumkars_pre.nc
cdo monsum: Processed 3 variables [1.30s 34MB]

verda@LAPTOP-7MQIUVS3 /bin
$ cdo fldmean monsumkars_pre.nc preTimeSeriesk.nc
cdo fldmean: Processed 3 variables [0.12s 16MB]

verda@LAPTOP-7MQIUVS3 /bin
$ cdo monsum karss_pet.nc monsumkars_pet.nc
cdo monsum: Processed 3 variables [1.44s 34MB]

verda@LAPTOP-7MQIUVS3 /bin
$  cdo fldmean monsumkars_pet.nc petTimeSeriesk.nc
cdo fldmean: Processed 3 variables [0.12s 16MB]

verda@LAPTOP-7MQIUVS3 /bin
$ cdo ymonsum karss_pre.nc ymonsumkars_pre.nc
cdo ymonsum: Processed 3 variables [1.61s 32MB]

verda@LAPTOP-7MQIUVS3 /bin
$ cdo ymonsum karss_pet.nc ymonsumkars_pet.nc
cdo ymonsum: Processed 3 variables [1.41s 32MB]
```

2.3 Mann-Kendall Trend Test

Mann-Kendall Trend Test is applied with XLSTAT on Excel. When the trend is applied to the precipitation data, the results indicate Kendall's Tau as -0.273 and Sen's Slope as -2.750. They suggests a negative trend, indicating a decrease in the variable being studied over time. But for the PET data, the results indicate Kendall's Tau as 0.121 and Sen's Slope as 2.449. Based on these results, there is a weak positive trend suggested by Kendall's tau and Sen's slope.

Data	Kendall's Tau	Sen's Value
PET	0.121	2.449
P	-0.273	-2.150

Table 2: Mann-Kendall Trend Test Results

2.4 Thornthwaite-Mather Water Balance Graph

The Thornthwaite-Mather Water Balance Graph was created using Python. When precipitation exceeds potential evaporation over a given period, a water surplus occurs. Conversely, when potential evaporation exceeds precipitation, a water deficit occurs.

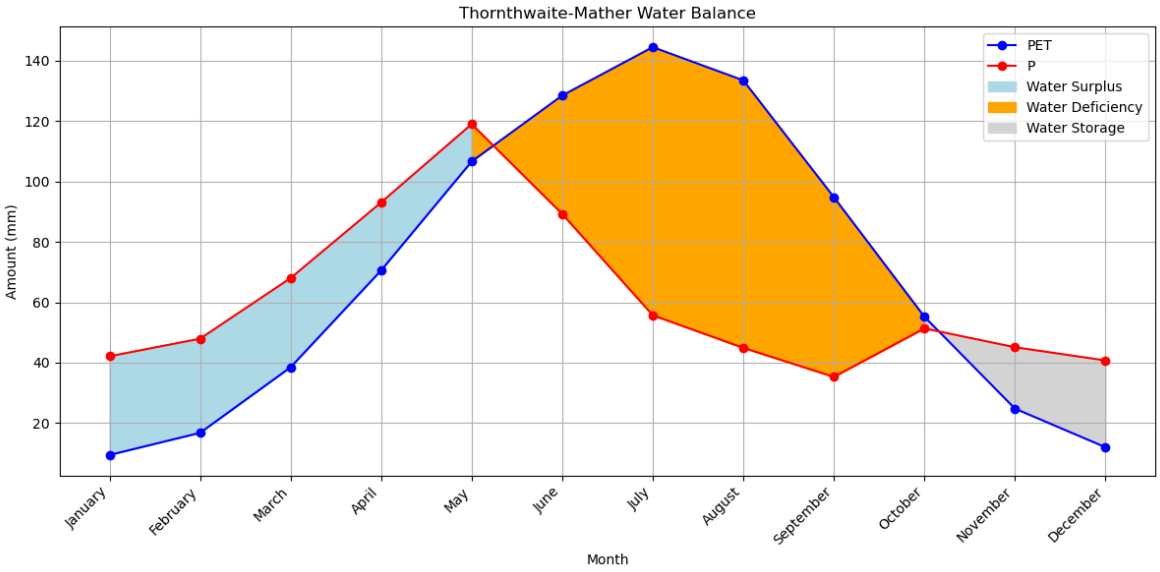

Figure 1: Thornthwaite-Mather Water Balance Graph