# DRY AND HOT PERIODS IN BALKAN NORTHERN MOUNTAINSIDES

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***Abstract***: This paper aims to analyse the variability of dry and wet periods in Balkan northern mountainsides, from where more of the rivers take their source, and run into Danube. Monthly and annual temperature and precipitation for the period 1931-2000 are used to determine the hot and dry subperiods. The thermal and rainfall conditions during these periods are analysed.

In analysis the emphasis is on the existence of trend and periodicity in the time series.

Precipitation has clearly decreasing trend. Dry years are particularly frequent in the last years of the century.

The severity and frequency of droughts is studied using Pad's and de Marton's indexes. Frequency of severe drought has markedly increased, although very wet periods also occur in the recent years.
***Keywords***: dry and hot periods, temperature, precipitation, trend, drought indexes.

# TROCKENE UND HEISSE PERIODEN IN DEN NÖRDLICHEN BERGABHÄNGEN VON DEM BALKANGEBIRGE

***Abstrakte***: Diese Untersuchung hat zum Ziel die Veränderung der trockenen und nassen Perioden in den nördlichen Bergabhängen von dem Balkangebirge, wo die Quellen der meisten Flüsse, die in Donau einfliessen sind, zu analisieren. Die monatlichen und jährlichen Temperaturen und Niederschlagsmengen für die Periode 1931-2000 wurden benutzt, um die heißen und trockenen Subperioden zu ermitteln.

Die thermische und Niederschlagsbedingungen während dieser Perioden wurden analisiert.

Die Betonung in den Analysen ist auf die Existenz von einem Trend und Periodizität in den zeitlichen Reihen.

Die Niederschläge haben einen klar ausgeprägten, abnehmenden Trend. Die trockenen Jahre sind besonders häufig in den letzten Jahren des Jahrhundertes.

Die Rauheit und die Häufigkeit der Dürre wurden untersucht mit Hilfe der Indices von Ped, de Martrton.

Die Häufigkeit der rauhen Dürren hat sich deutlich erhöht, obgleich auch viele nasse Perioden in den letzten Jahren vorgekommen sind.
***Scchlusselworte***: trockene und heisse perioden, temperature, neiderschlag, trend, durre indeces

## Introduction

Atmospheric precipitation in a given area is the main input component of the hydrological cycle. Water is one of the main natural resources in economy. At the same time, excessive precipitation can cause critical flood condition. Thus, precipitation is a very important element of climatology and reliable knowledge of its quantitative changes is needed.

This paper aims to analyse the variability of dry and wet periods in Balkan northern mountainsides, from where more of the rivers take their sources, and run into Danube. Monthly and annual temperature and precipitation from 11 station for the period 1931-2000 are used to determine the hot and dry subperiods.

Annual precipitations in Balkan northern mountainsides vary from 700 mm at the lowest areas to 1100 - 1200 mm at the highest areas. Annual temperature is ranging from 10

°C to 5 °C in the highest area. Local climate is highly influenced by the dominant atmospheric circulation, altitude and orography. Insignificant precipitation amounts are among the common characteristics of climate and they create a reason for an existence of a drought tendency in the area.

**Data and analyses**

The precipitation distribution is one of the basic characteristics of the drought occurrence in a given region. However, the distributions of additional meteorological elements should be also taken into account in order to describe the degree of the climate dryness. For example, the distribution of air temperature is an especially important characteristic for drought classifications. Usually, average precipitation for a given region is calculated using the analysis of the long-term variations of precipitation. Consequently, the index of anomaly is computed (Koleva, 1988):

$$P_j = \frac{1}{n} \sum_{i=1}^{n} \frac{x_i}{\overline{x_i}} \qquad (1)$$

where: **j** = 1,..., N; $x_i$ - total annual precipitation in the **i**th station, $\overline{x_i}$ - averaged annual precipitation for the same station, **n** – station number.

The correlation between seasonal and annual series is computed. For precipitation the correlation is highest in winter and autumn. Most of correlation coefficients are above 0.60. In summer they are mainly between 0.50 - 0.70. Temperature correlation coefficients are above 0.65-0.70.

On Fig. 1 the long-term variations of annual and seasonal precipitation anomaly index **P** are shown. It can be seen that the decreasing trend of precipitation, observed during the last years of the 20th century is well presented.

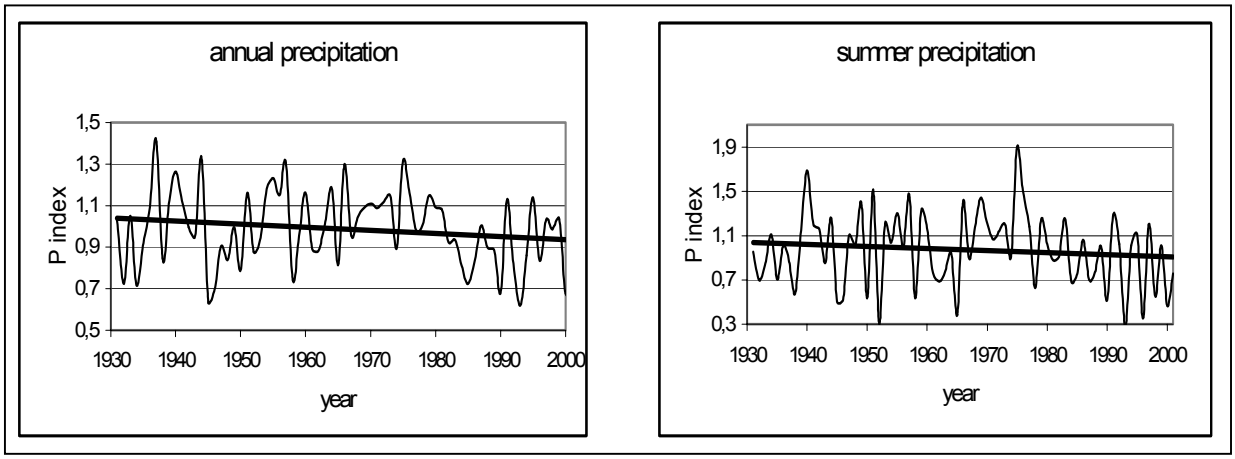


*Fig. 1 Variation of precipitation anomaly index **P** and its linear trend*

On Fig. 2 annual and seasonal long-term variations of air temperature are given. The last years in Bulgaria were drier and warmer than the normal for the period of so-called "current climate" (1961-1990) (Koleva et al., 1996). Precipitation was approximately 80-85 % less than the normal. Last winters were especially dry. The air temperature in January was higher than the current climatic value (fig. 3). Precipitation in July was about the normal, however air temperature was above the normal for the current climate. Such kind of drought conditions during the 20th century was also observed during the period 1945 - 1953 (Koleva, 1995).

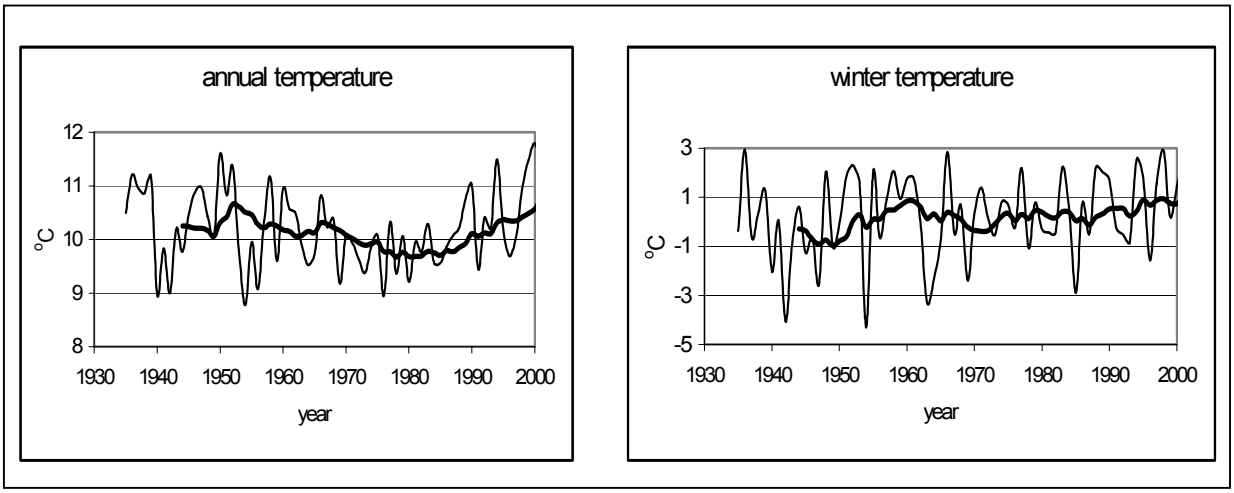


*Fig.2 Variation of average temperature and 10-years moving average*

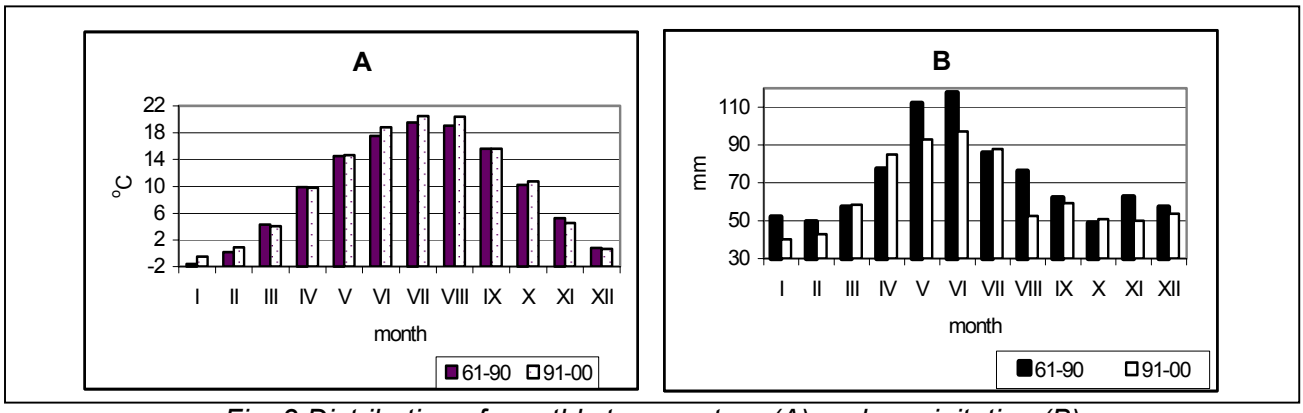


*Fig. 3 Distribution of monthly temperature (A) and precipitation (B)*

Different quantitative criteria were also used for a comparison of the drought frequency and intensity between different regions and years. For example:

Ped index: $$\mathbf{P_{ed}} = \frac{\Delta \mathbf{T}}{\sigma_{\mathbf{T}}} - \frac{\Delta \mathbf{P}}{\sigma_{\mathbf{P}}} \qquad (2)$$

where: $\Delta \mathbf{T}$ and $\Delta \mathbf{P}$ - anomalies of air temperature and precipitation, relative to a given time period; $\sigma_{\mathbf{T}}, \sigma_{\mathbf{P}}$ - standard deviations of air temperature and precipitation. The $\mathbf{P_{ed}}$ index values between 1 and 2 show an existence of an insignificant drought, when $2 < \mathbf{P_{ed}} < 3$ – moderate drought, and when $\mathbf{P_{ed}} > 3$ – significant drought. The negative index values characterize a wet period. There were especially dry years during the last decade of the 20th century, when the $\mathbf{P_{ed}}$ values were higher than 3 and even 4. In general, there is an increasing trend of the $\mathbf{P_{ed}}$ index (Fig. 4).

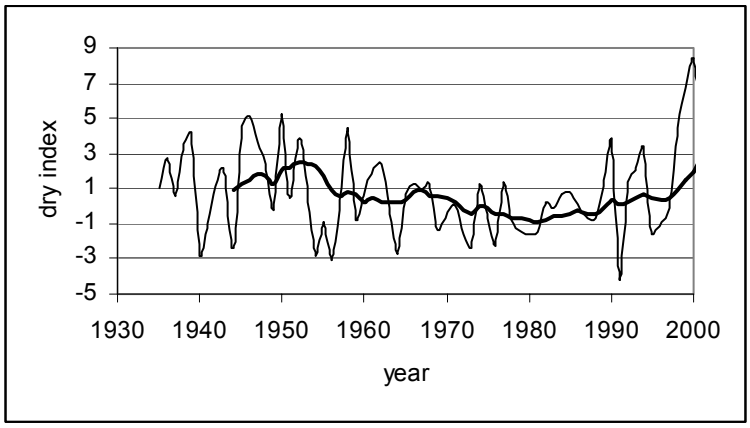


*Fig. 4 Annual Ped index and 10-years moving average*

De Marton index: $$J = \frac{\frac{P}{T+10} + \frac{12p}{t+10}}{2} \quad (3)$$

where: **P** and **T** - total annual precipitation and annual air temperature, **p** –precipitation during the driest month of the year, **t** – air temperature during the warmest month of the year. When the **J** index is less than 30, drought conditions can be observed and when it is less than 20 a severe drought can occur.

The average values of the **J** index during the periods 1961-1990 and 1991-2000 are computed. Figure 5 shows the variations of the **J** index for every month of the year, regarding these two periods. July, August and September are the driest months.

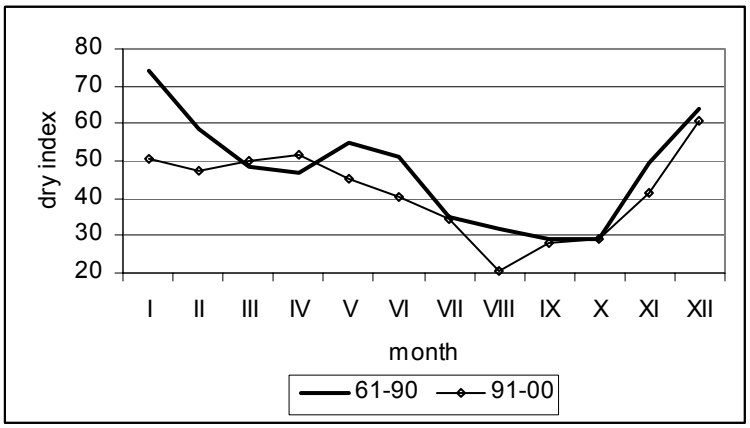


*Fig. 5 Marton index*

As a result of the conducted analysis, the investigated period can be divided to separate sub-periods with duration about 15 years. These years are characterized with different moisture conditions. It is assumed that in normal year the precipitation is from 81 to 120 % of the mean value, in dry one – from 61-to 80 % of mean values, in very dry - lower than 60 %. In wet years – precipitation is above 120 %. Deficits and excesses were calculated as the percentage of mean value in the period 1961-1990.

Two periods characterized by longer and severe droughts can be determined, namely 1942-1953 and 1981-1994. During the first period the drought years were approximately 30% of the total years. They increased up to 40 % during the second period. Another specific characteristic of the last period is that the years with significant precipitation were only 4 %. The last wet period was 1963 – 1979.

The driest year during the investigated period 1931-200 was 1993, which was abnormally dry in almost every part of the considered region. The second and the third driest years are 1945 and 2000, respectively. The characteristics of the precipitation distribution during the above time periods were similar to the characteristics of the moderate-continental distribution of precipitation.

The precipitation distribution in the country for the periods 1961-1990 and 1982-1994 is shown on Figure 6.

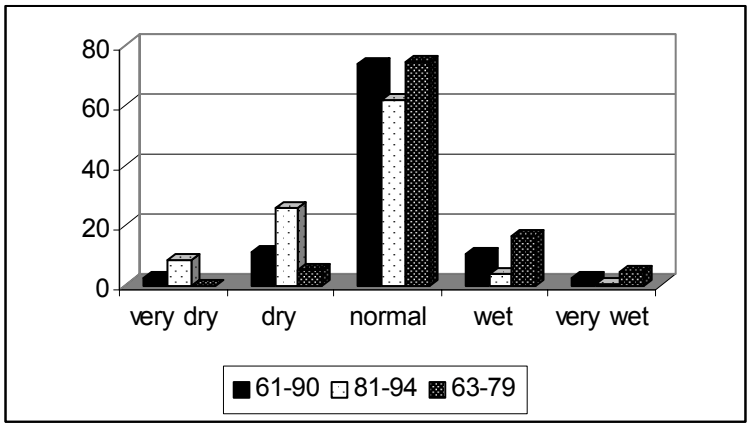


*Fig. 6 Distribution (%) of extremely dry, dry, normal and wet years for periods 1961-1990, 1981-1994 and 1963-1979*

**Conclusions**

Precipitation has clearly decreasing trend. Dry years are particularly frequent in the last years of the century. Frequency of severe drought has markedly increased, although wet periods also occur in the recent years.

It is necessary to emphasize that during the considered period there was no year with monthly precipitation above the normal only, and vise versa. There were always some subsequent wet months even during the most drought years in the region.

**Acknowledgment**

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