THE STUDY OF POTENTIAL EVAPOTRANSPIRATION IN THE BANAT PLAIN IN 1897-2011

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Abstract: *The present study of potential evapotranspiration has taken into consideration a priority issue confronting our entire planet: global climate changes. This phenomenon can be revealed only through long-term monitoring. Consequently, for convincing results, the study considered all the data about the monthly temperatures that are recorded at Timisoara Weather Station, as this station has the oldest records in the Banat Plain. The studied period covers 114 years, from 1897 to 2011; unfortunately, the records between 1917 and 1920 are missing. Potential evapotranspiration is calculated with the Thornthwaite method, as this fits our country's conditions best; however, for the water use calculation, it is necessary to determine the coefficients for each plant culture. The results were interpreted and systematised with the Bravais-Pearson correlation coefficient and linear regression. The study has concluded that annual potential evapotranspiration has a slightly increasing trend that is explained by the high temperatures of the past years that have exceeded the multiannual mean. Consequently, maximum evapotranspiration, 840.2 mm, was reached in the agricultural year 2008-2009, which caused a humidity deficit of 339.2 mm. The 1975-1976 agricultural year had the lowest value of evapotranspiration: 617.4 mm. Surprisingly, in the same year, the precipitations did not cover the plant water use, leading to a deficit of 117.2 mm. As far as evapotranspiration in the vegetation period is concerned, a much stronger increasing trend is observed than in the case of the annual trend. The maximum calculated value was 728.3 mm in the 2008-2009 agricultural years, accounting for 86.68% of annual evapotranspiration. In this vegetation period, the humidity deficit was also high - 464.3 mm. The minim, 532 mm, was recorded in the 1977-1978 agricultural year, which still had a 136.4 mm humidity deficit. On summing up the results, we have discovered that Banat is undergoing a process of transformation from the climatic viewpoint. The transformation is both thermal, as a result of its increased values in the past years, and pluviometric, caused by decreased rainfalls that no longer cover the plant water use. The present paper is a reference and original study, given the long period of time that was analysed - 114 years.*

Key words: *potential evapotranspiration, climate changes, temperature*

INTRODUCTION

Potential evapotranspiration or plant water use is the amount of water taken from the soil and lost through plant transpiration, to which direct evaporation on the soil surface is added (GRUMEZA, 1988; 2000).

Although it is difficult to decide which environment factors are more important in plant growth and development, there are reasons to consider water as one of the most significant issues. Given its ecological function, acknowledging the importance of water use for the soil-water-plant-climate relations is more than necessary (JACQUES et al., 2001; ERNEST et al., 2000). Evapotranspiration is influenced mainly by climate, but other elements play a major role as well: the plant (through the anatomical and physiological particularities of its species, its development stage etc.), the soil (through its humidity and water availability for the plant), land use, watering methods, pest attacks etc. (ONCIA, 2009)

Many authors like, Domuta et al. (2000), Plesa et al. (2000), MARTIN et al. (2004), ONCIA (1998) specify that evapotranspiration calculated with methods based on temperature comes closest to the plant water use resulting from the experimental fields.

Of all the indirect methods, the fundamental one is the Thornthwaite formula. It has the advantage of using only meteorological data for which there is long-term information. It is a promising method for us as well, provided that corrections are made to the soil storage capacity.

The present study of potential evapotranspiration has taken into consideration a priority issue confronting our entire planet: global climate changes. This phenomenon can be revealed only through long-term monitoring (BUSUIOC, TRAŞCĂ, 2005; Houghton et al., 2001).

MATERIAL AND METHODS

Evapotranspiration was determined with the Thornthwaite method, as it fits our country's conditions best. Thornthwaite is superior to other methods such as Blaney-Criddle (that overestimates results) or Papadakis (that underestimates them).

Thornthwaite method leads to the best results, but for the water use calculation it is necessary to determine the coefficients of proportionality varying with climate and plants.

The climate element that this method is based on is temperature. This is an advantage, as the errors that may occur in recording it have little influence on the calculation of evaporation.

This study has used the monthly temperatures recorded for 114 years (1897-2011) at Timisoara Weather Station, as this station has the oldest records in the Banat Plain. Unfortunately, the records between 1917 and 1920 are missing.

The results were interpreted with the Bravais-Pearson coefficient of correlation (representing linear intensity) and linear regression (representing a means to study and estimate the relation between two variables).

RESULTS AND DISCUSSIONS

Graphic 1 is based on the values of annual potential evapotranspiration. On analysing the values recorded during the 11 years, a slightly increasing trend is seen, especially in the past years. The maximum annual potential evapotranspiration, 840.2 mm, was recorded in the 2008-2009 agricultural year (table 1).

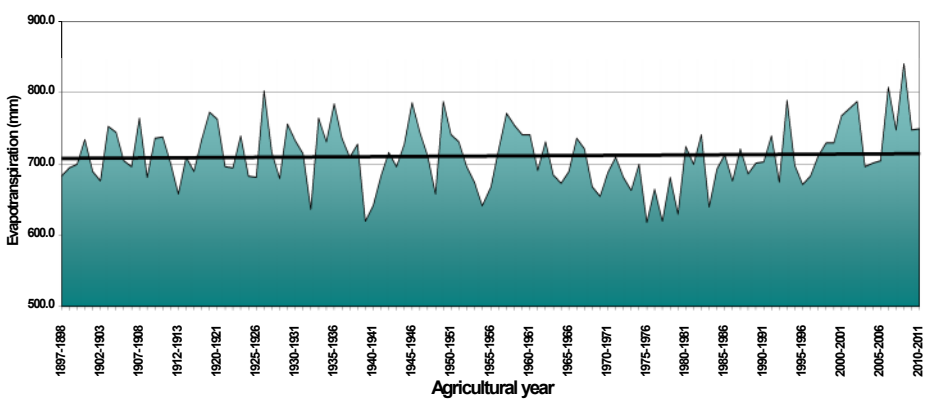

Figure 1. Annual potential evapotranspiration calculated for 1897-2001 interval

That year, the precipitations did not cover the plants water use, which led to a deficit of 339.2 mm (figure 3). The minimum annual potential evapotranspiration was calculated for the 1975-1976 agricultural year - 617, 4 mm. Although this was the lowest value in the studied years, there was still a rainfall deficit of 117, 2 mm.

After calculating the monthly evapotranspiration value for 1897-2011, graphic 2 was drawn to render the evolution of potential evapotranspiration during the vegetation period. The increasing trend is noticeable here as well, but it is much stronger than in the case of the annual trend. The maximum value was reached in the 2008-2009 agricultural year – 728, 3 mm – that had a rainfall deficit of 464.3 mm. the minimum value of 532 mm was recorded in 1977-1978. That year the plant water use exceeded the rainfalls with 136.4 mm.

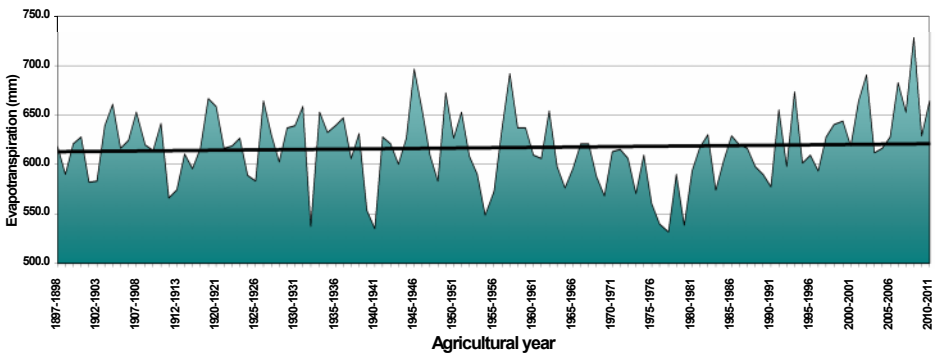

Figure 2. Potential evapotranspiration during the vegetation period (IV-IX) calculated for 1897-2001 intervals

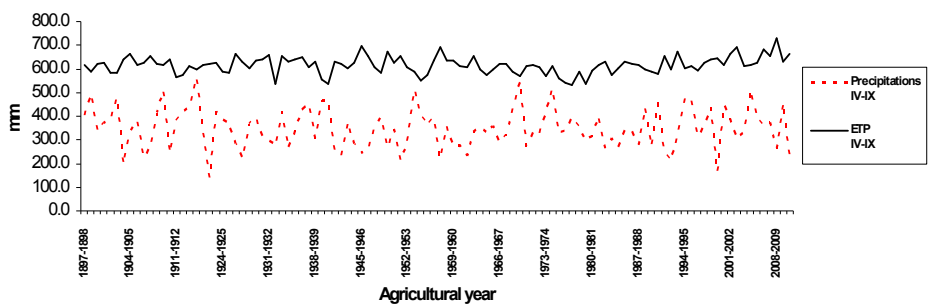

Figure 3. Humidity deficit during the vegetation period (IV-IX) calculated for 1897-2001 intervals

The analysis of the annual evapotranspiration values and the values of precipitations in the 1897-2011 has revealed that they are not interdependent, the correlation coefficient being very small: -0.33 (figure 4). However, there is a close dependence relation between the annual temperature means and the evapotranspiration values calculated for Timisoara, as the correlation coefficient (0.81) demonstrates (figure 5).

Table 1

Multiannual means of potential evapotranspiration calculated for 1897-2011 for Timisoara

Month	Multiannual mean (mm)	Minimum ETP (mm)	Maximum ETP (mm)
X	44.6	27.3	66.7
XI	17.5	0.0	40.3
XII	4.5	0.0	28.3
I	1.3	0.0	14.2
II	4.6	0.0	17.6
III	22.2	0.0	44.6
IV	53.9	4.8	82
V	98.2	73.3	145.2
VI	121.8	91.5	155.0
VII	139.2	116.0	165.5
VIII	123.4	96.7	155.8
IX	80.5	54.6	104.3
Vegetation period	616.9	532.0	728.3
Annual ETP	711.5	617.4	840.2

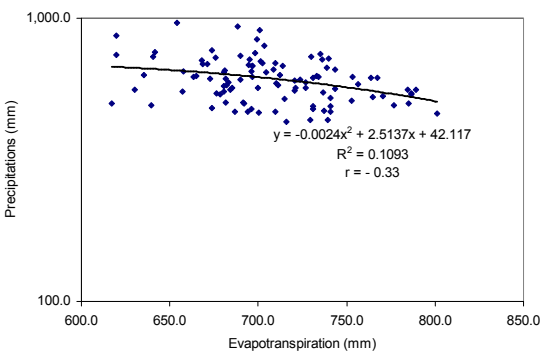

Figure 4. Correlations between potential evapotranspiration and annual precipitations recorded in Timisoara in 1897-2011

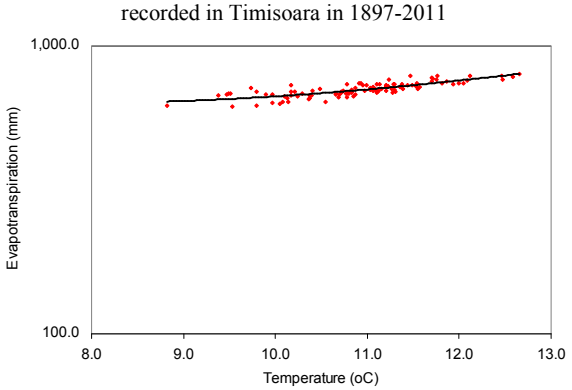

Figure 5. Correlations between potential evapotranspiration and annual temperatures recorded in Timisoara in 1897-2011

On summing up the results obtained during the 114 years (1897-2011), we have discovered that potential evapotranspiration is increasing (mainly in the past years), both during the whole agricultural year, and the vegetation period. This theoretical water use is not covered by precipitations and humidity deficits are recorded even in years with minimum evapotranspiration values. Therefore, in Banat, the climate is undergoing a process of transformation. This transformation is both thermal, as a result of the increased values recorded in the past years, and pluviometrical, caused by decreased rainfalls.

CONCLUSIONS

On analysing the results of the 114 years of research (1897-2011) the following conclusions can be drawn:

1) The values of annual potential evapotranspiration have been following an increasing trend, especially in the past years. The highest value, 804.2 mm, was recorded in the 2008-2009 agricultural year, causing a humidity deficit of 339.2 mm;

2) In the vegetation period, potential evapotranspiration is also increasing, but the increase is much stronger than in the case of the annual value. The maximum calculated value was 728,3 mm in the 2008-2009 agricultural year, accounting for 86.68% of annual evapotranspiration. A precipitation deficit of 464.3 mm was also recorded in the vegetation period.

3) Even when both the annual evapotranspiration values and the values recorded in the vegetation period were at a minimum, those years still had humidity deficits;

4) In Banat, the climate is undergoing a process of transformation. The transformation is both thermal, as a result of the increased values recorded in the past years, and pluviometric, caused by decreased rainfalls that no longer cover the plant water use.

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