CLIMATIC BALANCE OF THE WATER FOR THE SOIL OF THE KRUŠEVAC REGION IN CENTRAL SERBIA

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Abstract

The paper was aimed at analyzing the climatic water balance of the soil of the Kruševac region in the Central Serbia. There were used the average monthly long–term (30 years) data on the mean air temperatures (T), the mean precipitations (P) and the mean potential evapotranspiration (PE) for the coordinates of the meteorological station of the area studied. The highest mean air temperatures were recorded in July (21.8°C), then in August (21.5°C) and in June, (20.0°C), respectively, whereas the highest precipitations were recorded in June and in May (86 mm and 79 mm, respectively). The potential evapotranspiration was the highest in July (129 mm), to drop in August (116 mm) and in June (114 mm), respectively. On average, the real evapotranspiration (RE) was reported to be the highest in June (114 mm), followed by those reported in May (99 mm) and in July (92 mm), respectively. The average water deficit (WD) in the soil was evidenced as the highest in August (71 mm), lower in July (37 mm), September (34 mm) and the lowest in October (8 mm), respectively, when the soil needed irrigation. The analysis denoting to the average water surplus (WS) recorded in January (30 mm) and in February (17 mm) suggested that drainage be needed.

Keywords: climate, water balance, soil, evapotranspiration.

INTRODUCTION

Soil irrigation is referred to as the water use in the plant production for more intensively utilized environmental conditions of the particular area, thereby relating nor only to the plant but also to the agricultural production in a wider sense. Water gives life in the desert and semi–desert areas, while in the regions of a moderate climate with sensible and expert management, it can provide abundance and safety.

The most significant factors of water irrigation are considered to be climatic–meteorological characteristics, soil features plant requirements for water due to which, they ought to be studied for each area. Within this type of analysis, the water balance of the soil meaning the quantitative changes in the water content during a particular period of time on a particular area is considered to be a highly significant indicator of using soil reclamation measures, irrigation and drainage, too. When defining the soil water balance of the particular area, all the elements of water stored and consumed along with all the resulting changes in its content are taken into consideration [1]. The most important factors of the soil water balance of a certain area are considered to be precipitations as a natural item and the potential evapotranspiration, i.e. plant requirements for water as a consumption item [2]. Eagleson [3] describes water balance as a quantitative relation among long–term averages of the partition of precipitation and evapotranspiration, which are the most critical parameters. Those parameters are typically computed as the average values from a time–series data set. Also, according to Milly and Fischer and Du Toit [4,5], the long–term water balance is determined by the interaction of precipitation and potential evapotranspiration and is regulated by the soil water storage.

Therefore, this paper aims at showing the results of the analysis made on the soil water balance for the region of Kruševac.

MATERIALS AND METHODS

For achieving the climatic soil water balance of the Kruševac region (middle/southern part of central Serbia, 43°35’00” N 21°19’36” E, 137 m.a.s.l.) (Figure 1), the elements favouring both, water inflow into and its outflow from the soil, i.e. it loss, are considered to be air temperatures (1981–2010) and the average precipitation sums (1961–1990) [6] as well as the average values of evapotranspiration following the method of Penman–Montheit (1971–2000) [7].

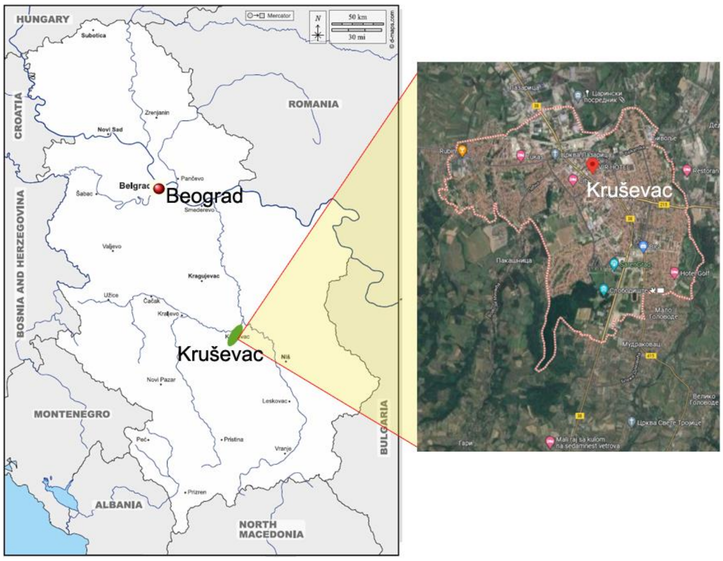

***Figure 1** Kruševac area*

Water balance in the soil was calculated after the method of Thornthwaite [8], assuming that the soil containing 100 mm of the readily available water in the rhizosphere zone was entirely saturated. Evapotranspiration seemed to be quite constant until 100 mm of the water stored was consumed whereas the remaining water amounts ran off, being the water surplus,. In there was no water reserve in the soil, the evapotranspiration would be equal to zero, with the water deficit prevailing till the new rainfalls.

In addition to the water deficits and surpluses, the soil water balancing also established the values of the real evapotranspiration within the real natural conditions of the area studied.

RESULTS AND DISCUSSION

According to the data collected for the period from 1961 to 1990, the annual air temperature for the republic of Serbia averaged 10.1°C, with January being the coldest and July the hottest month averaging 19.9°C [9]. In addition, the normal annual precipitations averaged 734 mm and those in the valley of the Velika Morava 650 mm, with their higher decreasing intensity noticed over the last series of 35 and 30 years, respectively.

Kruševac is characterised by the annual air temperature (T) of 11.4°C, with the maximum mean monthly values evidenced in July and in August (21.8°C and 21.5°C, respectively) and the minimum one of 0.2°C in January (Figure 2).

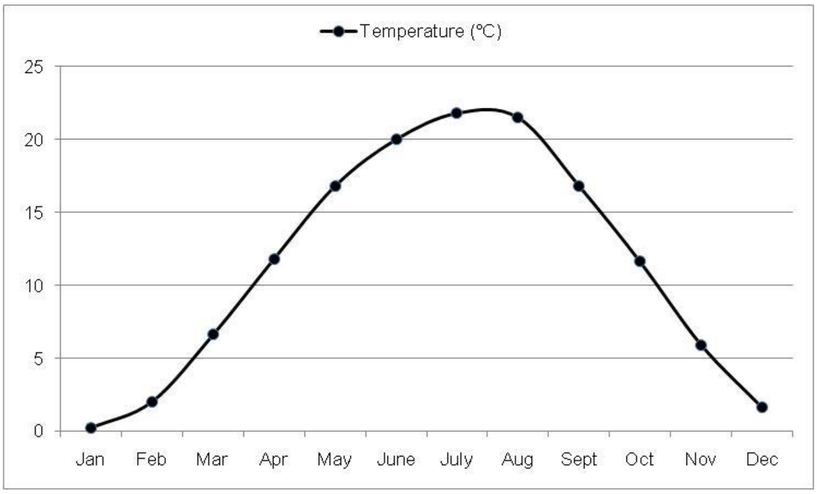

Figure 2 *Average monthly temperatures (T)*

The annual precipitation (P) sum of the Kruševac region amounted to 647 mm, with its maximum reported in June (86 mm) and that in May (79 mm) and the minimum over the winter months (Figure 3). Practically speaking, the period during which the average annual air temperatures increased most was accompanied by that when the average annual precipitations began to decrease (Figures 2 and 3).

Within the climatic conditions of Kruševac, as the average plant requirement for water, the average annual potential evapotranspiration (PE) amounted to 776 mm (maximum in July 129 mm, August 116 mm and in June 114 mm, respectively) (Figure 3).

Water balancing procedure helped determine water deficit and surplus in the soils of the Kruševac region. Water deficit in the soil takes place when the required water (PE) is higher than the available water. The mean annual value of the water deficit (WD) for the soil of the region Kruševac was found to amount to 150 mm, with the most expressed deficit established in August (71 mm), followed by those found in July (37 mm), September (34 mm) and in October (8 mm), respectively (Figure 4).

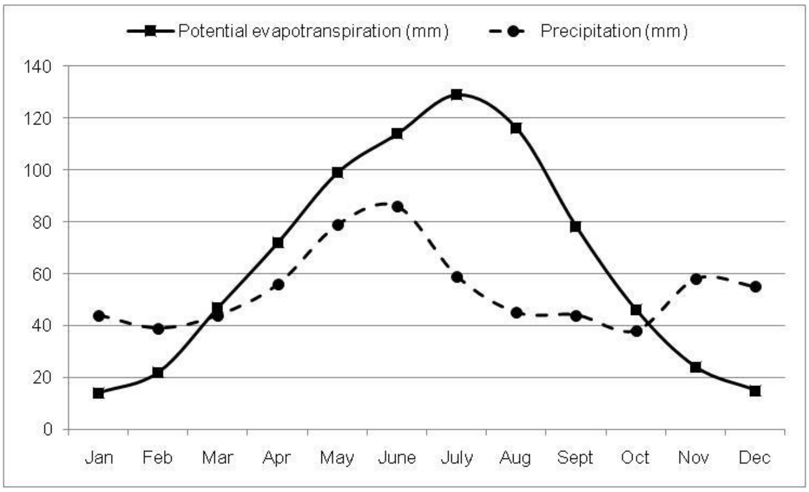

Figure 3 *Average monthly precipitation (P) and potential evapotranspiration (PE)*

Water surplus (WS) in the soil of the area concerned takes place when the water entirely available to evapotranspiration (the existing water reserve in the soil form the rainfalls, i.e. the readily available water reserve, REAV) is higher than the real requirement for water (PE). When the part of the available water was used for the water reserve renewal (REAV) of 100 mm, then the water surplus was exhibited in it [10]. The mean annual value of the WS for the area of Kruševac amounted to 47 mm of which 30 mm was recorded in January and 17 mm in February (Figure 4), noticing that while controlling the average annual water balance for an insight in the calculations reliability, the water surplus of 26 mm, which would be carried over and added to the next period of calculation, occurred.

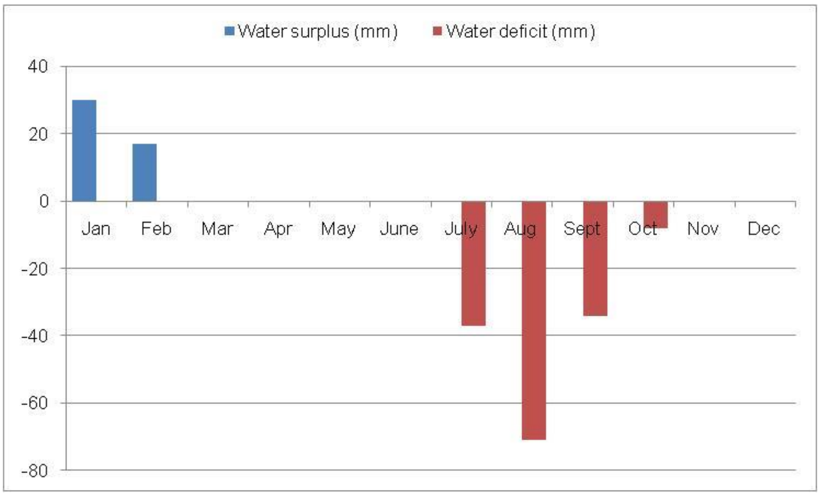

Figure 4 *Average monthly water deficit (WD) and water surplus (WS)*

Thus, the mean annual value of the real evapotranspiration (RE) indicated the real amount of the water availability in the soil depending on the environmental conditions [1], which amounted to 626 mm for the region of Kruševac (Figure 5). The maximum RE was revealed in June (114 mm), and the minimum in December (15 mm).

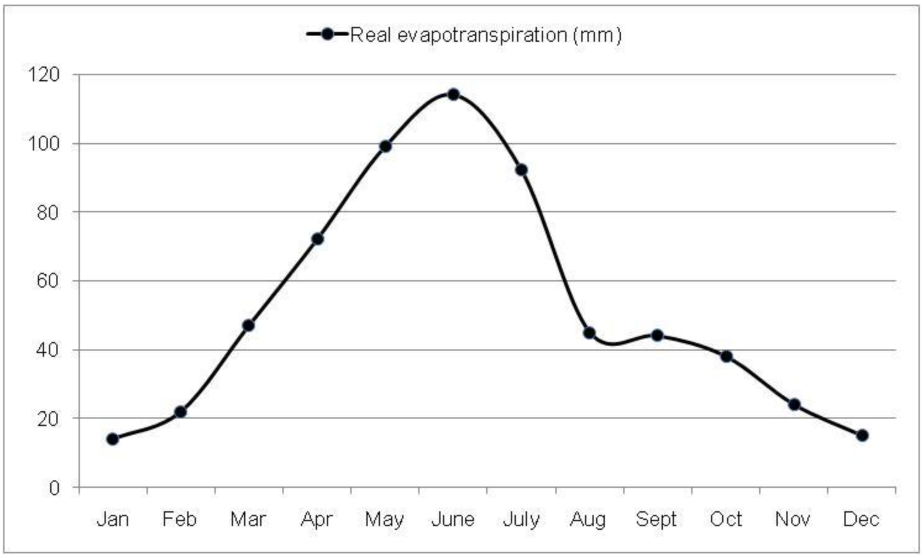

Figure 5 *Average monthly real evapotranspiration (RE)*

For comparison, the research results for the soil of the Middle Podunavlje through Vojvodina (1964–2007) can be mentioned, with the mean values of the rainfalls recorded to be 693.90 mm, the potential evapotranspiration 725.53 mm, the total water deficit averaging 115.91 mm, its surplus being 84.28 mm, along with the real evapotranspiration amounting to 609.62 mm [11].

CONCLUSION

The aim of the paper was to analyze the climatic water balance in the soil of the Kruševac region using the long–term series of values obtained for all the elements over the balancing procedure in order to establish water deficit for the purpose of irrigation as a regular practice, alleviate the impact of consequences of drought on the plant as well as determine the water surplus for drainage. On average, water deficit was exhibited from July to October and its surplus from January to February, with an extra surplus of water of 26 mm carried over to the following period of calculation.

ACKNOWLEDGEMENT

The authors are grateful to the Ministry of Science, Technological Development and Innovation of the Republic of Serbia for financial support (contracts no. 451-03-47/2023-01/200088; 200189 and 451-03-47/2023-01/200027) as well as by the Provincial Secretariat for Higher Education and Scientific Research activity of the Vojvodina (contract no. 142-451-3114/2022-01/2).

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