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INFLUENCE OF METEOROLOGICAL PARAMETERS ON SOIL WATER BALANCE FOR THE AREA OF METEOROLOGICAL STATION BUTMIR

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Abstract

This thesis evaluates the soil water balance in the region of Sarajevo for the average, driest and wettest hydrological years over the period 1991-2010.

High air temperatures in summer period cause significantly high values of potential evapotranspiration, which reaches maximum in July and August .High air temperatures and high values of potential evapotranspiration lead to deficits of soil water during summer months, while low air temperatures, reduced values of potential evapotranspiration and increase of rainfall's during winter months lead to excessive amount of water in it.

The predominant type of soil in the area of meteorological station Butmir is alluvial soil (fluvisol) and it has favorable chemical characteristics on the aspect of mechanical composition it can be listed as light mechanical composition soil.

Key words: *climate elements, water deficits, water suficits, potential evapotranspiration*

Introduction

Primary task of designing irrigation systems is to determine rational system of irrigation. Irrigation system is determined by climate conditions, evaporation, optimal content of accessible water in the area of root system and depth of first outcrop.

Climate conditions determinate annual precipitation income, consumption of water, evapotranspiration as well as necessity for irrigation. The most significant ones are natural precipitation because they should provide constant of water for normal growth of plants. Different plants have different needs for water. Amount of water needed for growth of agricultural plants is determined by potential evapotranspiration..

Needs of agricultural plants for water is expressed through evapotranspiration (Doorenbos and Pruitt,1977), including plant transpiration and evaporation emitted from plant covered soil.

Base for quantity change of water amount in soil (water balance) during certain time period in specific area is provided by elements that contribute such water fluctuation. Those elements are water income (precipitation, P, capillary rise, irrigation, subsurface inflow), as well as water outlay emitted from soil (evapotranspiration, PET, runoff, deep percolation, change in soil water content). Issue of calculating water balance has been occupation of many authors, insufficiency of soil water for the area of meteorological station Vrsac appear in july-october in amount of 340 mm (Stojiljković et al., 2001).

Yearly forecast of soil water balance of bare soil deficit for the area of Cacak is 285 mm every 10, 235 mm every 5 and 143 mm every 2 years. (Šekularac and Pavlović, 1996).

Results of water balance of the bare soil unsaturated zone for the area of Cacak points out deficits of soil water from May until November.

Maximum insufficiency is in August and July. Exercisable amount of water is apparent throughout whole year not in significant values for June-October but in sufficient values throughout November - May (Šekularac, 2003).

Analyzing crop needs for water on locations under irrigation systems it is necessary to use methods which will adequately approximate average values of evapotranspiration. Those are mainly empirical and semi empirical methods based on regional relation of evapotranspiration and climate conditions, Thornthwait, Turc, Blaney-Criddle and Penmans methods are frequently used. Calculation of potential evaportranspiration by Thornthwait method is presented in this study since it gives best results in sub humid climate conditions.

Thornthwait method is used world wide, it is very suitable because only records of average daily air temperatures are needed and those are acquired as quotient value of maximal and minimal air temperature. Camargo et al. (1999) states that Thornthwait method is more reliable on monthly level if instead of average daily temperature, effective temperature is used.

For calculate the potential evapotranspiration used are two climatic parameters air temperature and precipitation (Thornthwaite methods), and based on the obtained values of potential evapotranspiration calculated that the water balance. Ability to absorb and remain saturation depends on type,profile depth and characteristics of soil, this was used as base fact for calculation of water balance by Thornthwait method (Mihalić and sar.,1978). Thornthwait maid this method for soil that has water capacity of 300 mm. However his approach has been modified in practice, by calculating water balance it is assumed that soil contains 100 mm of water in reserve in the area of rhizoshpere and that it is fully saturated.

Goal of this study is to complete analysis of soil water balance for the area of meteorological station Butmir and to determine water deficiency and surpluses. Soil water balance has been determined for average, driest and rainy year.

Materials and methods

Climate elements (air temperature and precipitation) for the area of meteorological station Butmir in twenty year period (1991-2010) have been used in this study. Based on collected records reference potential evapotranspiration for each month of every analyzed year has been determined, and based on values of ETP and rainfalls, water balance has been determined as well as deficiency and accession of water in the area of meteorological station Butmir.

Determining potential evapotranspiration has been calculated by Thornthwait method based on air temperatures and then corrected with appropriated coefficient for reference area with respect to the latitude of 43 degrees Sarajevo area is then found in the appropriate table corresponding correction coefficient for the area Saraevo where is meteorological station Butmir.

Water balance was calculated starting from the fourth month when the soil contains 100 mm of rainfall, and when it is completely in the rhizosphere zone is saturated with water.

Results and discussion

Out of all exterior factors climate has biggest influence on crop production. To evaluate climate of a certain area requires long term observation and knowledge of its elements, such: yearly and monthly average temperatures, amount and sum of rainfall's, number of non frost days, frequency and wind strength, hail etc. Crop production is mostly

conditioned by air temperatures and rainfalls commonly based on them certain area climate is determinate.

Table 1. Average monthly air temperatures (˚C) and average monthly sum of rainfall (mm) for m.s. Butmir (1991-2010).

Months	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	**M**
Temperature of air (°C)	-0,1	1,1	4,7	9,3	14,8	18,1	19,6	19,9	15,3	10,8	5,0	1,4	**10,1**
Rainfall (mm)	71	67	70	74	82	91	79	71	70	77	91	85	**929**

Average yearly air temperature for tested period (1991-2010) was 10,1 0C, and average yearly rainflls was 929 mm (Table. 1). Coldest months were January, February and December with average temperature of -0,1; 1,1 i 1,4 ˚C, while warmest months were July and August with average temperature of 19,6 i 19,9˚C (Table 1).

Low temperatures during winter months lead to low potential evapotranspiration while during summer months potential evapotraspiration has maximal values as result of high air temperatures.

Alluvial soil (fluvisol) is predominant in the area of m.s. Butmir (Resulović et al, 2008). That soil is distinguished by favorable chemical characteristics (neutral reaction, good sufficiency of accessible phosphorus and potassium) regarding mechanical composition it belongs to light mechanical composition soil.

Table 2. Water balance for average hydrological year in the area of m.s. Butmir

Months	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	Sum of years
METEOROLOGICAL STATION BUTMIR													
P (mm)	45	63	148	26	32	95	48	113	100	105	70	62	907
PET (mm)	45	77	115	124	116	68	30	26	0	0	0	18	619
AET (mm)	45	77	115	98	84	68	30	26	0	0	0	18	561
RWR (mm)	100	86	86	0	0	0	18	87	100	100	100	100	-
M(-) (mm)	0	0	0	-98	-84	0	0	0	0	0	0	0	-182
S (+) (mm)	0	0	0	0	0	0	0	0	+100	+105	+70	+44	+319

RWR-reserwe water in the soil
M- deficits water in the soil
S- suficits water in the soil

Because of practice of hydro-meliorative works values used were reserve of water in the soil 100 mm.

Study results of water balance for average hydrological year points out that yearly sum of precipitations for the area of m.s. Butmir is 907 mm, potential evapotraspiration (PET) is 619 mm, and actual evaporation (AET) 561 mm. Actual evapotranspiration is obtained from the relation rainfall, water reserves in the soil compared with the values of potential evapotranspiration. Water deficits (M) is displayed during summer months July and August totaling 182 mm, while water surpluses occured during winter months of December, January, February and March when soil is saturated with water. Total yearly water surpluses (S) is 319 mm (Table 2).

Table 3. Water balance for driest year of the area m.s. Butmir

Months	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	Sum of years
METEOROLOGICAL STATION BUTMIR													
P (mm)	51	72	23	52	16	67	83	75	94	32	50	32	647
PET (mm)	46	78	104	119	126	63	45	28	10	0	0	30	649
AET (mm)	46	78	104	67	110	63	45	28	10	0	0	30	571
RWR (mm)	100	94	14	0	0	0	38	47	100	100	100	100	-
M (-) (mm)	0	0	0	-53	-110	0	0	0	0	0	0	0	-163
S (+) (mm)	+5	0	0	0	0	0	0	0	+16	+32	+50	+2	+105

Table.3 of water balance for dry year shows sum of yearly rainfall's for area of m.s. Butmir is 64 mm, potential evapotranspiration (PET) is 649 mm and actual evapotranspiration (AET) 571 mm. Water deficits (M) is displayed during summer months july and august totaling 163 mm, while water surpluses present during winter months but in significantly smaller amount than what they are in years with increased rainfall's, that water surpluses (V) is 105 mm.

Table 4. Water balance for wettest year in the area of m.s. Butmir

Months	IV	V	VI	VII	VIII	IX	X	XI	XII	I	II	III	Sum of years
METEOROLOGICAL STATION BUTMIR													
P (mm)	109	68	75	99	84	103	57	137	294	49	57	58	1.190
PET (mm)	50	98	123	126	120	79	45	10	0	0	0	13	664
AET (mm)	50	98	123	27	36	79	45	10	0	0	0	13	481
RWR (mm)	100	70	22	0	0	0	12	127	100	100	100	100	-
M (-) (mm)	0	0	0	-5	-36	0	0	0	0	0	0	0	-41
S (+) (mm)	+59	0	0	0	0	0	0	0	+294	+49	+57	+45	+504

Analysis of water balance for the rainy year in the area of m.s. Butmir points out that rainfall total 1.190 mm, potential evapotranspiration (PET) is 664 mm, and actual evapotranspiration (AET) 481 mm. Deficits water in this hydrological year is present only in summer months (July and August) in relatively small amount of 41 mm, while surpluses water occured during the winter months totaling 504 mm (Table 4).

Conclusion

During an average, driest and wettest hydrological year in the area of meteorological station Butmir water deficits is expressed during summer months (July and August),while water surpluses is expressed during December, January, February, March and April, with exception of average hydrological year that in April has no water surpluses in soil.

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