EVALUATION OF SOIL WATER REGIME IN THE VIABLE IRRIGATION SYSTEMS FROM ROMANIA

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Abstract

The aim of this study was to evaluate the active soil moisture range, soil water deficit, and water requirements for plant consumption at agricultural parcel level (NUTS5) where irrigation is applied. In order to evaluate the active soil moisture range, soil water deficit, and water requirements for plant consumption, the method used values of hydro-physical indices (field capacity, wilting point, and active soil moisture range), potential evapotranspiration according to Thornthwaite equation and climatic data for the time period 1961-2014. The evaluations of the different indicators were done at agricultural parcel level fitted within the viable irrigation systems. Irrigated agricultural parcels (NUTS5) are located mostly in the viable irrigation systems from Romanian Plain, south of Moldavia and Dobrogea. The obtained results showed a high variation of the active soil moisture range values. Low values are recorded especially in viable irrigation systems from south part of the country. High and very high values are recorded in eastern and south-eastern part of the country. There is a high water deficit in the most areas of the viable irrigation systems which require irrigation application. High values of water requirement were recorded in south and south-east. This means that there is a high water demand for crop consumption, especially during drought periods.

Key words: (viable irrigation systems, active soil moisture range, water deficit, water requirement)

Field capacity (CC) is the upper limit of soil moisture range that is important for plant growth because above this value the water is no longer sustainably retained in soil. At the same time, field capacity is the lower limit of soil porosity range that is usually free of water, ensuring soil aeration and mostly influences permeability and drainage of the soil. Therefore, field capacity has a significant practical importance. Wilting point (CO) represents the value of soil water content below which plants irreversibly wilt, without being able to recover in case of a subsequent increase of soil moisture.

The range between field capacity and wilting point is known as available water capacity. In practice of irrigations this range is also known as active soil moisture range (IUA).

The minimum moisture content for irrigation (Pmin) is defined as the lower limit of critical soil moisture before irrigation is applied. It varies between 1/3 and 2/3 from active soil moisture range.

Methodology of calculating the water requirements started from the actual plants consumption under irrigation conditions (Grumeza N. and Kleps Cr., 2005). The monthly reference evapotranspiration (ETo) was used because there are data covering all areas of interest for irrigations, which was then converted into optimum actual water consumption (ETR opt.) by using monthly correction coefficients (Kc). These correction coefficients results from the ratio between plants water consumption determined by field investigations and reference evaporation (ETO) that correspond to the years and months in which studies were carried out. The optimum actual water consumption (ETR opt.) represents the plants water consumption that is obtained by maintaining the soil moisture between field capacity and minimum moisture content for irrigation in order to obtain high yields.

The aim of this study was to evaluate the active soil moisture range, soil water deficit, and water requirements for plant consumption at agricultural parcel level - NUTS5 where irrigation is applied.

MATERIALS AND METHODS

In order to evaluate the active soil moisture range, soil water deficit, and water requirements for plant consumption, the method used values of hydro-physical indices (field capacity, wilting point, and active soil moisture range), potential evapotranspiration according to Thornthwaite equation and climatic data for the time period

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1961-2014. The evaluations of the different indicators were done at agricultural parcel level - NUTS5 fitted within the viable irrigation systems. The Arc GIS software was used for aggregation of data.

RESULTS AND DISCUSSIONS

Agricultural parcels (concept used at UE level for Integrated Administration and Control System) are mapping land units with well-defined limits (for example, roads, channels, forests boundaries, water bodies etc.), which are numbered. These agricultural parcels are composed from more sub-parcels with various owners. When farmers apply for subsidies and intend to apply irrigation next year, in the application forms they have to thick the specific line for irrigation. If at least one farmer declares that apply irrigation, the entire agricultural parcel is considered as viable area for irrigation. In this study the viable areas for irrigation established in 2014 are used.

The agricultural parcels registered by the Agency for Payments and Intervention in Agriculture (APIA) were identified and fitted within the irrigation systems considered viable as was established by the National Research and Development Institute for Land Reclamation (ISPIF Bucharest) (*figure 1*).

Figure 1 shows the agricultural parcels - NUTS5 level where irrigations are applied according to farmer's statements from APIA. It can be observed that the irrigated areas are located mostly in viable irrigation systems from Romanian Plain, south of Moldavia and Dobrogea.

Active soil moisture range (*figure 2*) was calculated by using the parameters of van Genuchten equation. These parameters were estimated after determination of soil water contents at different water potentials. Then the pairs of values for water content and water potential were used for determination of values corresponding to field capacity and wilting point. The active soil moisture range was obtained as the difference between field capacity and wilting point.

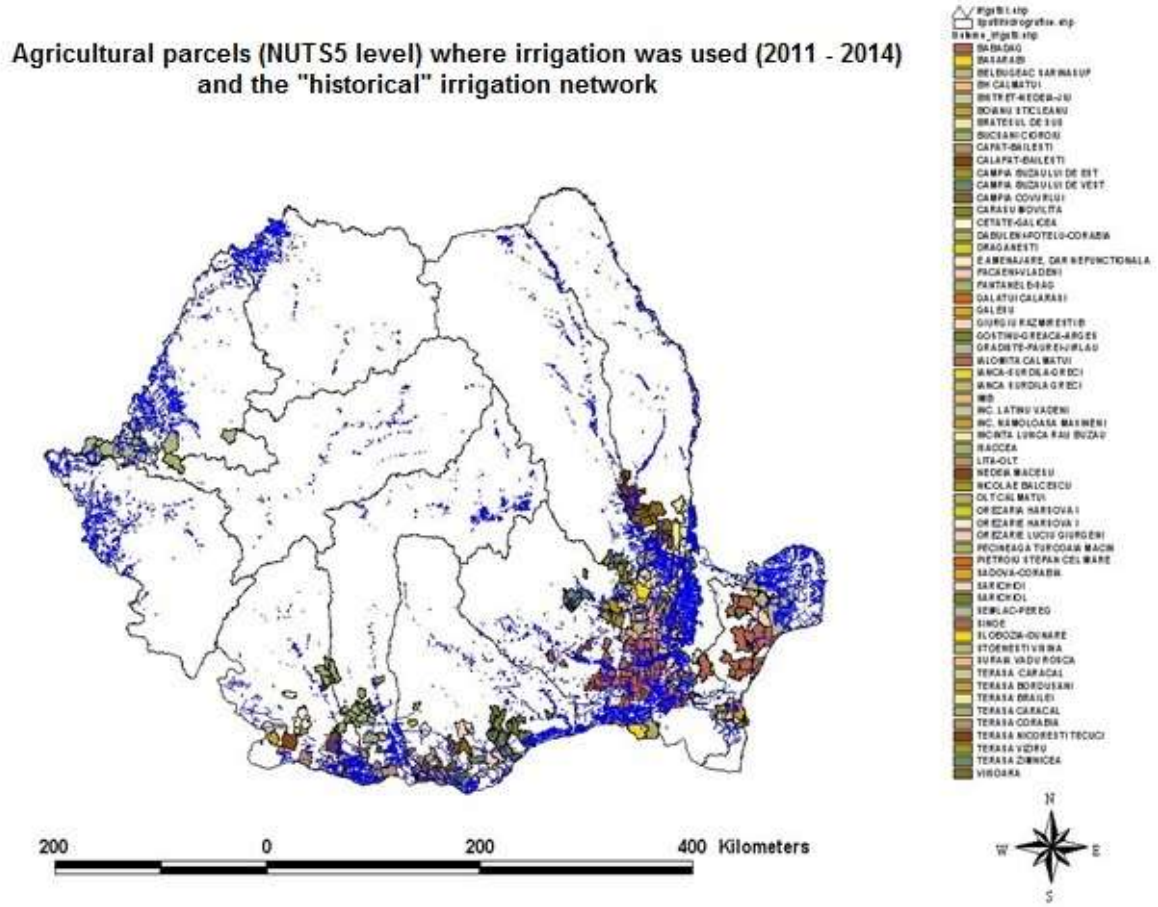

Figure 1 **Agricultural parcels (NUTS5 level) where irrigations were used and the "historical" irrigation network**

There is a high variation of active soil moisture range values. Low values are recorded especially in viable irrigation systems from south part of the country. High and very high values are

recorded in eastern and south-eastern part of the country. In areas with low values records, the irrigation should be done at short time intervals as compared with areas where high values of active soil moisture range records.

The water deficit for the period between may and august was evaluated at agricultural parcels - NUTS5 level (*figure 3*) located in viable irrigation systems. There is a high water deficit in the most areas of the viable irrigation systems which require irrigation application.

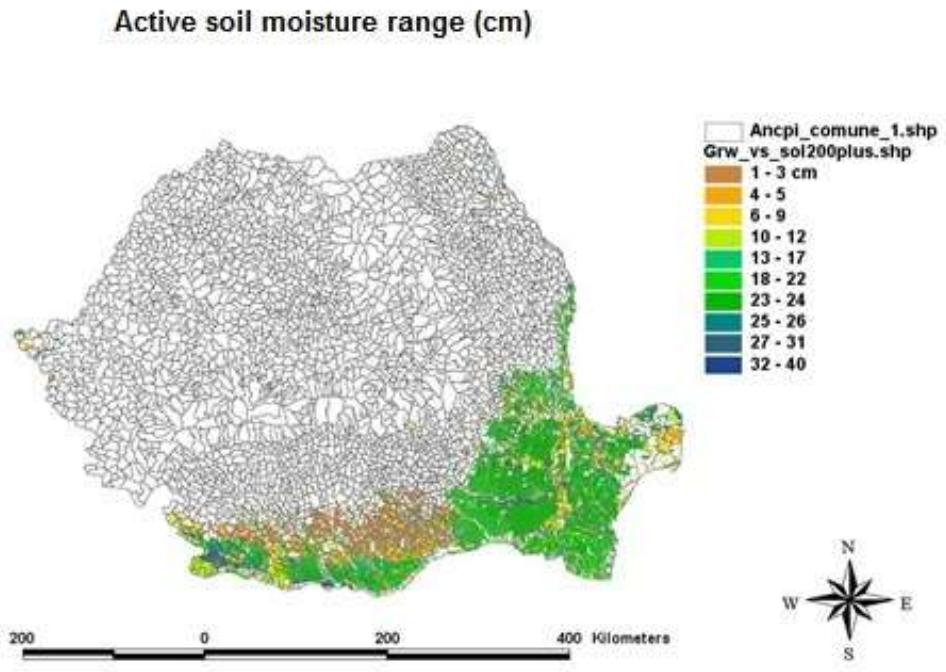

Figure 2 **Active soil moisture range in viable irrigation systems**

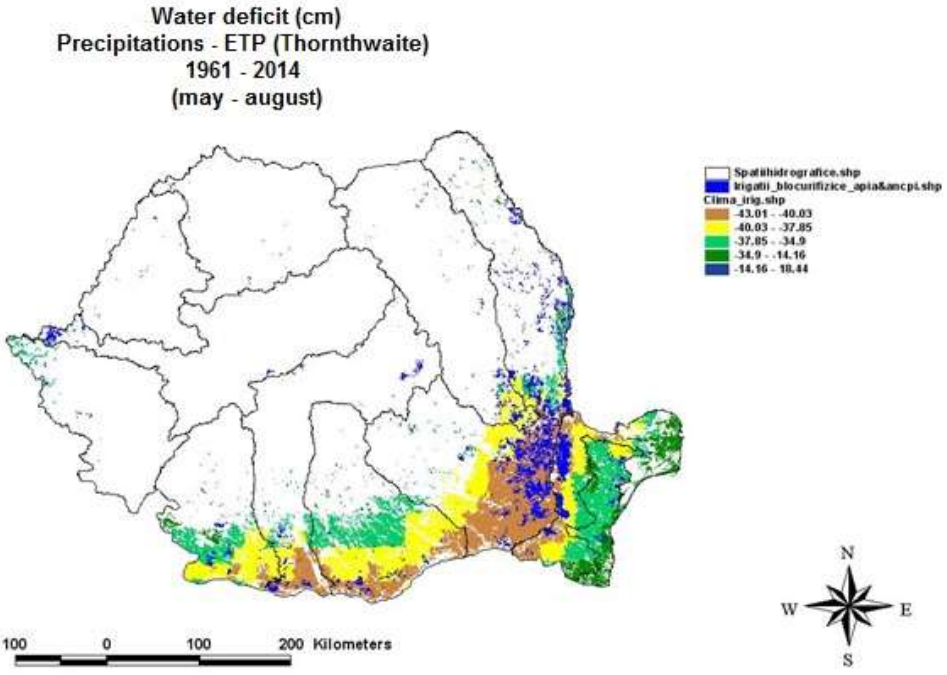

Figure 3 **Water deficit in viable irrigation systems**

Table 1 presents the water requirement at the level of agricultural parcels - NUTS5 from viable irrigation systems (m^3/year). High values of water requirement are recorded on irrigated areas from the south and south-eastern part of Romania. This means that there is a high water demand for crop consumption, especially during drought periods. In these periods and on these areas, there is an increased need for irrigation.

Table 1

Water requirement at the level of viable irrigation systems (m^3/year)

Crt. N°	Viable irrigation system	Water requirement (m^3/an)	Crt. N°	Viable irrigation system	Water requirement (m^3/an)
1	BH CALMATUI	1048454	28	BRATESUL DE SUS	662617
2	GRADISTE-FAUREI-JIRLAU	105402	29	CAMPIA COVURLUI	822039
3	IANCA-SURDILA-GRECI	1762535	30	SURAIA VADU ROSCA	66716
4	IMB	1052974	31	TERASA NICORESTI TECUCI	64556
5	IMB INC. LATINU VADENI	181133	32	FACAENI – VLADENI	629807
6	INC. NAMOLOASA MAXINENI	183645	33	IALOMITA CALMATUI	1548520
7	INCINTA LUNCA RAU BUZAU	143206	34	OREZARIE LUCIU GIURGENI	259771
8	OREZARIA HARSOVA I	135600	35	SLOBOZIA – DUNARE	171345
9	TERASA BRAILEI	1408601	36	TERASA BORDUSANI	424278
10	TERASA VIZIRU	927468	37	BOIANU STICLEANU	125812
11	CAMPIA BUZAULUI DE EST	253083	38	GALATUI CALARASI	461270
12	CAMPIA BUZAULUI DE VEST	15148	39	PIETROIU STEFAN CEL MARE	298139
13	BASARABI	110451	40	GIURGIU RAZMIRESTI B	219397
14	CARASU MOVILITA	929	41	GOSTINU – GREACA – ARGES	69689
15	GALESU	64416	42	DABULENI – POTELU – CORABIA	71682
16	ISACCEA	63567	43	STOENESTI VISINA	6124
17	NICOLAE BALCESCU	5392	44	TERASA CORABIA	221306
18	OREZARIE HARSOVA I	7392	45	GIURGIU RAZMIRESTI B	48422
19	SINOE	118711	46	LITA – OLT	179188
20	BISTRET – NEDEIA – JIU	43556	47	OLT CALMATUI	16663
21	CALAFAT – BAILESTI	33162	48	TERASA ZIMNICEA	161660
22	CETATE – GALICEA	174807	49	VIISOARA	335622
23	DABULENI– POTELU – CORABIA	434933	50	BABADAG	104525
24	NEDEIA MACESU	14733	51	BELBUGEAC SARINASUF	80835
25	SADOVA – CORABIA	24858	52	PECINEAGA TURCOAIA MACIN	4913
26	TERASA CARACAL	87503	53	SARICHIOL	317466
27	TERASA CORABIA	43225	54	SINOE	133085

The economic viability of irrigation systems as well as the selection and prioritizing criteria for investments in rehabilitation of main viable irrigation infrastructure were done in different studies. Ministry of Agriculture and Rural Development developed the National Program of Main Irrigation Infrastructure Rehabilitation (2016). The aim of the program is to rehabilitate the main irrigation infrastructure from 86 systems which cover 1.8 millions ha until 2020. Also the program supports the sub-measure 4.3 from National Program of Rural Development which has an eligibility condition for non-refundable funds application (the irrigation system from the beneficiary's project has to be connected to a viable main irrigation infrastructure).

CONCLUSIONS

Irrigations are applied in areas that are located mostly in viable irrigation systems from Romanian Plain, south of Moldavia and Dobrogea.

There is a high variation of active soil moisture range values. Low values are recorded especially in viable irrigation systems from south part of the country. High and very high values are recorded in eastern and south-eastern part of the country.

There is a high water deficit in the most areas of the viable irrigation systems which require irrigation application.

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