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THE USAGE OF BEGA RIVER WATER FOR LOCAL IRRIGATION SYSTEM IN OTELEC DRAINAGE UNIT*

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Abstract

The paper aims to present the possibility to use the surface water from the Bega River for a local irrigation arrangement. The study analyses the agricultural land from Otelec, Timis County, Romania, that is part of Draining System Teba - Timisat, Otelec Draining Unit. On Bega River is analyzed the Otelec section located on the north part of the analyzed area.
The Teba - Timisat Draining System, Otelec Draining Unit, was design and implemented back in the 1980 and it is administrated by the National Agency of Land Reclamation. Using the opportunity to overlap the proposed irrigation arrangement would bring increased results for the agricultural crops in the studied area and also will improve the quality of the environment.
The local irrigation system will use part of the existing draining channels, which will be redesigned. The other part of draining channels will be maintained as they are in order to preserve the draining character of the Otelec Unit. Water will be transported from Bega River through an irrigation supply channel. Mechanized linear irrigation sprinkler installations will then apply the irrigation to the plants. In the rainy or excessive humidity periods, the Draining Unit will operate at the normal parameters that were initially designed.The paper will also analyze the quality parameters and quantities of water for irrigation according to the European Regulations in the studied area.

Keywords: irrigation arrangement, sprinkler installations, water quantity, water quality, water pollution

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1. Introduction

Due to the high interest in obtaining increased agricultural crop, the private sector manifest interest in setting up local irrigation system (Iurciuc and Dima, 2013; Nair et al., 2013; Norton-Brandão et al., 2013). In the West Plain of Romania there is a great opportunity to use existing reclamation work in order to obtain increased results of agricultural crops (Costache et al., 2014). The Teba - Timisat Draining System, Otelec Draining Unit, was design and implemented back in the 1980. The system works like a drainage unit, but has also the possibility to support local irrigation arrangements from its original design (AQUAPROIECT, 2006; Giurgiu et al., 2011). The management system is assigned to the National Agency of Land Reclamation in accordance with the Romanian law of land reclamation (Law 138, 2004). The surface water source which can feed the local irrigation arrangement is Bega River course. This water course is managed by the Romanian Water National Administration in accordance with the Romanian water law (Law 107, 1996).

Following the changes of national laws in accordance with European legislation, for designing, constructing and operating local irrigation systems, besides the agreement of the two institutions which manages the water course and the reclamation works, it is mandatory to obtain the environmental approval according to environmental law (Law 137, 1995).

2. Experimental

2.1. Water quantity for irrigation

In order to assess the water demand for irrigation, we analyzed an area of 900 hectares of agricultural land in West Plain of Romania, Otelec locality, Timis County. The analyzed surface overlaps with Otelec Draining Unit, part of Draining System Teba – Timisat (Fig. 1, Man, 2014).

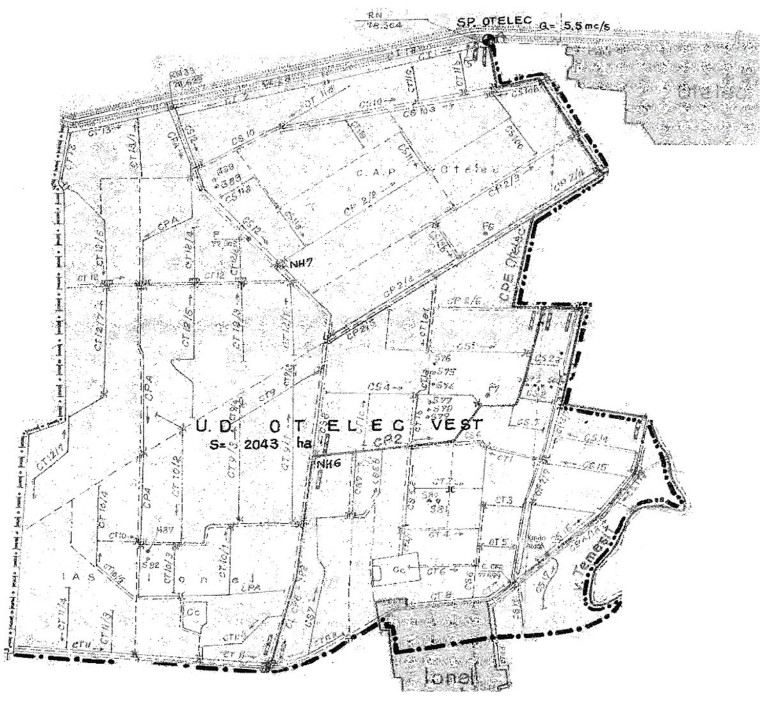

Fig. 1. Otelec west drainage unit (Man, 2014)

The local irrigation arrangement will be supplied through a main irrigation channel from Bega River which flows north from analyzed surface (Fig. 2). The irrigation scheme will use the existing draining channels which will be redesigned with dual role irrigation – drainage, during the irrigation period the channels will transport water to sprinkler irrigation installations and in excessive humidity period the channels will drain the agricultural land. Sprinkler irrigation installations will be of two types: linear and central pivot. Average rainfall deficit underlying the introduction of irrigation is presented in Table 1.

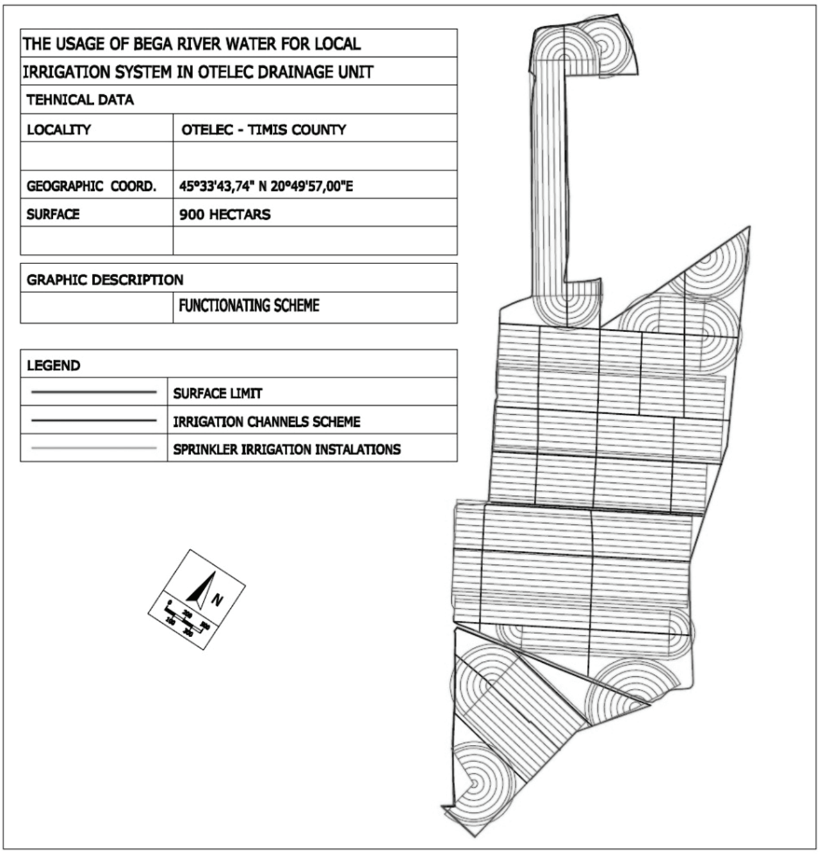

Fig. 2. Local irrigation arrangement model

Table 1. Climate data and average water deficit in West Plain of Romania

Parameter / *Month*	*Temperature T (^0C)*	*Precipitation P (mm)*	*ETP (mm)*	*P-ETP (mm)*
X	11.2	35.4	44.2	-8.8
XI	5.6	48.6	16.0	32.6
XII	1.0	43.0	3.2	39.8
I	-0.2	32.0	1.2	30.8
II	0.3	30.1	3.5	26.6
III	5.4	30.1	19.9	10.2
IV	11.0	40.7	51.9	-11.2
V	16.2	60.7	95.0	-34.3

VI	15.6	73.2	121.5	-48.3
VII	21.4	51.8	137.1	-85.3
VII	20.4	50.5	123.0	-72.5
IX	17.1	34.6	82.1	-47.5
Annual total	10.6	530.7	698.6	-167.9
Hot season	17.0	311.7	610.6	-298.9

Average rainfall deficit in hot season is 298.9 mm. Adopted crop plan for the surface that is proposed to be irrigated is presented in Table 2.

Table 2. Crop plan and occupy surface

Type of crop	*Percentage of total surface (%)*	*Crop surface (ha)*
Corn	47	423
Wheat	30	270
Sunflower	20	180
Alfalfa	3	27

Data on water consumption in July, month of maximum consumption, are correlated with climate data and presented in the Table 3 (Blidaru et al., 2000).

Table 3. Water consumption in July

Type of crop	*Water consumption in July (m^3/ha)*		
	80% assurance	*groundwater intake*	*irrigation*
Corn	1586	460	1126
Wheat	-	-	-
Sunflower	1862	468	1394
Alfalfa	1531	430	1101

Average irrigation rate in July (relations 1, 2):

$$m = \frac{1126 \times 423 + 1394 \times 180 + 1101 \times 27}{630} = 1202 \ m^{3}/_{ha} \quad (1)$$

$$q_u = \frac{1000 \times 1202}{30 \times 72000} = 0{,}557 l / s \times ha \quad (2)$$

Technical system efficiency (relation 3):

$$\eta = 84\% \quad (3)$$

The hydro module at the entrance in irrigation installation (relation 4):

$$q_u = 0.557 \div 0.84 = 0.663 l / s \times ha \quad (4)$$

The hydro module at the motor pump (relation 5):

$$q_u = 0.663 \div 0.90 = 0.737 l / s \times ha \quad (5)$$

Water lost through the channels (infiltration and evaporation) (relation 6):

$$50\% + 8\% = 58\% \quad (6)$$

The hydro module at the water source (Bega River) (relation 7):

$$q_u = 0.737 \div 0.58 = 1.270 \ L / s \times ha \quad (7)$$

Necessary flow to intake from Bega River for the irrigation system (relation 8):

$$Q_s = 630ha \times 1.270 \quad L / s \times ha = 800 \ L / s \quad (8)$$

2.2. Water quality for irrigation

Bega Hydrographic Basin is situated in western Romania, occupying the northern part of Banat Hydrographic Area. Bega Hydrographic Basin is bordered to the north by the basin Aranca and Mures, Mures basin to the east, south by the Timis basin and west is bounded by the border with Serbia (Fig. 3). Its area of 4492 km^2 overlaps small areas of Caras-Severin county (0.06 km^2), Hunedoara county (9.99 km^2) and Arad county (452.38 km^2), almost 90% of its area stretching in Timis county (4030.01 km^2). For monitoring water quality for irrigation we have established monitoring section Otelec (Costescu, 2008).

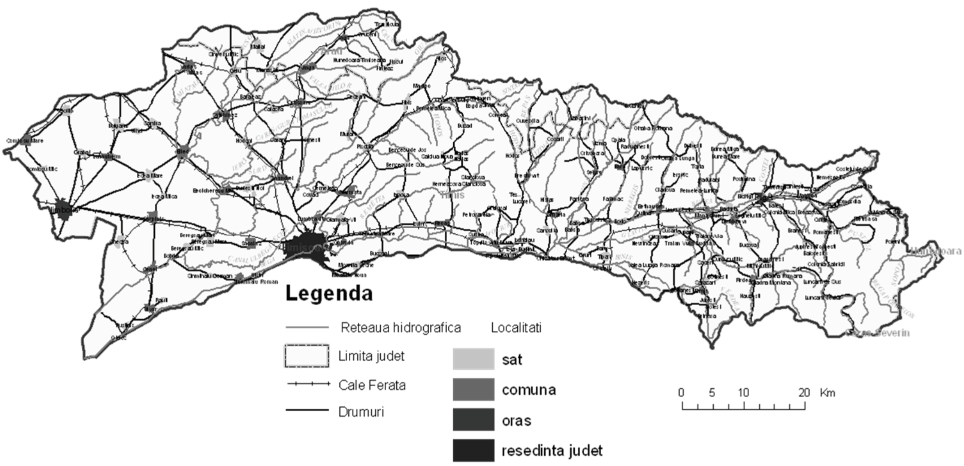

Fig. 3. Hydrographic network of the hydrographic basin Bega

Otelec section is located close to the border with Serbia and water quality is still affected by discharges of wastewater from Timisoara city based on 2005 statistical data. In the Table 4 and in Fig. 4 there are presented the Bega River water quality in Otelec section of the four representative groups control quality indicators, namely: oxygen, nutrients, metals, organic and inorganic micro pollutants and overall quality of the course water which are the most unfavorable of the three groups of indicators of water quality characterization.

Classification of surface water quality, according to MO 161 (2006) was made in relation to the arithmetic average value of qualitative indicators of river flow at harvest water samples (Fig. 4).

Bega River quality was monitored during the years 2000-2005 in four sections of monitoring, namely: Luncani, Balint, upstream Timisoara and Otelec (MO 161, 2006). Ecological status of rivers was determined using the macro invertebrates saprobes index (MZB) calculated by the method Pantle-Buck (Costescu, 2008).

3. Results and discussion

The maximum volume of water to intake from the Bega River into the irrigation system in the month of maximum consumption will be about 1728000 m^3. The linear sprinkler irrigation installations will have a flow rate between 0.150 – 0.300 m^3/s. The central pivot sprinkler irrigation installations will have a flow rate between 0.030 – 0.080 m^3/s.

The productions possible to obtain using an average technology in not irrigated regime for crops cultivated on the analyzed area are presented in Table 5. In Table 6 there is presented the average production of crops reported in statistical records at commune level.

Following the introduction of irrigation can be obtained crop production by more than 20% higher. According to recent statistics taken from the Annual Report on the state of the environment in Timis County, the water quality in Otelec section is improving. The RW5.1_B4 water body (BEGA - cf. Behela-border RO-SMR), artificial water body with a length of 43.975 km, RO11 typology, characterized by locality Otelec section, type EIONET and TNMN, in terms of biological elements water body was classified as good ecological potential. Biological elements assessed were classified as benthic invertebrates and phytoplankton good ecological potential classified as maximum ecological potential (APMT, 2013) (APMT, 2013).

Table 4. Water quality parameters in Otelec section

Water parameters	*Year*	*Section Otelec (groups)*
OXYGEN	2000	III
	2001	II
	2002	II
	2003	II
	2004	III
	2005	III
NUTRIENTS	2000	IV
	2001	IV
	2002	III
	2003	III
	2004	IV
	2005	III
METALS	2000	I
	2001	II
	2002	II
	2003	II
	2004	I
	2005	I
ORGANIC AND INORGANIC MICRO POLLUTANTS	2000	II
	2001	II
	2002	I
	2003	II
	2004	II
	2005	II

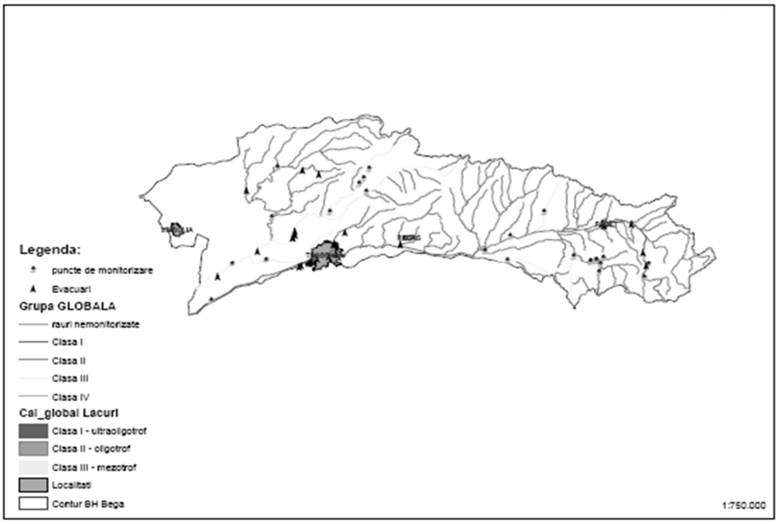

Fig. 4. Global characterization of surface waters in the river basin Bega (DAB)

Table 5. Possible production (not irrigated)

Type of crop	***Production (kg/ha)***		
	Minimum	***Medium***	***Maximum***
Corn	3059	4673	6288
Wheat	2440	3569	4698
Sunflower	1371	1768	2164
Alfalfa	27335	31052	34769

Table 6. Statistical crop production

Type of crop	***Production in 2005 (kg/ha)***
Corn	3.21
Wheat	3.39
Sunflower	2.26

Table 7. Evaluation of ecological potential of the water body

Parameter type	***Classification***
physico-chemical	moderate ecological potential
specific pollutants	moderate ecological potential
biological elements	good ecological potential

4. Conclusions

The implementation of the irrigation system is necessary to obtain increased agricultural production. The irrigation system can be relatively easy to realize given the existence of land reclamation works on the studied area. To accomplish this irrigation system the drainage network must be modified to fulfill the dual role of irrigation and drainage, with relatively low cost. Water will flow gravitational in irrigation channels and it is not necessary pump it into the irrigation system.

Using modern sprinkler irrigation installations with high efficiency and also applying high agricultural methods, the volume of water consumption can decrease. The network of channels in the system must be maintained regularly to avoid clogging. Water surface in Otelec monitoring section presents overall quality parameters suitable for irrigation. It is recommended that before applying irrigation to perform a water quality sample to avoid environmental pollution.

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