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ECONOMIC VALUE AND PRICING OF WATER IN IRRIGATION IN SERBIA

Svetlana POTKONJAK*, Ksenija MACKIC, Tihomir ZORANOVIC

University of Novi Sad, Faculty of Agriculture, Novi Sad, Serbia
*(Corresponding author: spot@polj.uns.ac.rs)

Abstract

Several factors (technical, economics and social) have major influence on the price of water for irrigation. In addition to these factors and the calculation method of irrigation water prices has an impact on the amount of the same.
For regional subsystem “Srem”, which covers about 1.700 ha of arable land, different approaches of water price were investigated. Cost, benefit and marginal principle formation for irrigation of suggested agricultural plants were chosen. These methods proved that the water price is in the function of selected factors, as well as the ways of calculating the price of water for irrigation. Each of these principles enables water price calculation, which consists of water price on intake and price of water for distribution on specific farm depending on irrigation requirement.
The cost of irrigation in this case amounted to 353-689 €/ha depending from financing conditions. Economic selling price of 1 m^3 water for irrigation (ILRIC method) ranged from 0,29-0,52 €/m^3 depending from amount the discount rate (0-10%).
The obtained water price data are included in the economic analysis for individual agricultural crops on this area. It has been calculated how many tons per hectare covers the costs of irrigation. Using the binomial tariff total costs for irrigation, for the whole subsystem, are assigned to individual crops as follows: fixed irrigation costs are allocated according to the sown area (€/ha) and variable costs according to expected water consumption (€/m^3). Thus farmers, which will be supplied with water for irrigation from this subsystem, will know in advance approximately the expected water price for irrigation.
The application of this methodology requires a complete monitoring by the regional subsystem, as well as the register of all users and their mutual obligations.
Key words: water price, irrigation, crops, distribution

Introduction

The pricing of irrigation water (€/m^3 or €/ha) is a complex process as it penetrates into two sectors: agriculture and water management. Furthermore the current measures of agricultural and water policy can influence the price of water. There are numerous studies on this issue in many countries. In this sense, different methods and tariff rates models of water and water services were proposed.
Potkonjak and colleagues (2012) examined various cases of calculating the price of water for irrigation in Serbia from the local system to the multi-purpose regional hydro-systems. Depending on the type of ownership of the system authors had suggested several principles of calculating the cost of water for irrigation: cost principle, benefit principle and marginal benefit principle.
Bajčetic (2012) states that the pricing of water services is affected by costs, types and methods of providing services, the demand for water, public and customer relations. The structure of the cost of water services in this case is formed on the basis of (1) costs, (2) values, and (3) price from the competition.
Pricing irrigation water in the Member States is considered in detail in the work Berbel, et al. (2007). The implementation of the WFD (Water Framework Directive) is thoroughly described in

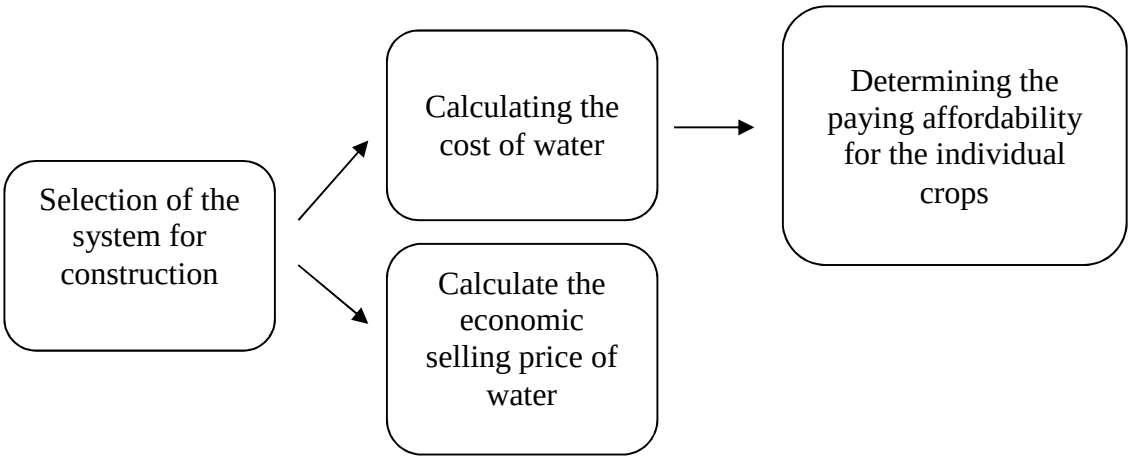
WATECO Guide (2003). EU countries have developed the concept of complete coverage of the cost of water (full cost recovery).
Mesa-Jurado et al. (2008) have presented in their investigation the valuation of water under different scenarios. Aggregated basin value is given as the function relating water value (price) and irrigation consumption.
The economic value of water in agriculture has been considered in research Kasnakoglu & Cakmak (2007). They developed a model in which the economic value of water is determined according to several limitations: different soil types, regions, crops, irrigated land. The model is applied to Anatolia Project in Turkey.
In his paper, Monteiro (2010) systematizes the method of determining the price of water. The marginal method in this case had the highest efficiency in the application. The implementation of each method depended on the way of water supply and demand.
Looking at the present situation and development of water infrastructure for irrigation purposes in the Republic of Serbia, study in this case is focused on the selection of the appropriate method for calculating the cost of irrigation water to suit our economic system and measures of agricultural and water policy.

Material and methods

The methods that would be the most appropriate in this case for use in irrigation systems are binomial tariffication water system to the users and the economic cost of water in the long term management of the system (ILRIC).
When binomial tariff is used, irrigation costs consist of two parts: 1) a fixed costs (amortization, maintenance, gross wages of full-time employees, insurance, interest) and 2) variable costs (energy, seasonal labor, maintenance). Under this method, the fixed costs are distributed on the entire irrigated area (din/ha, €/ha). On the other hand, the variable costs are allocated by the level of the water consumption (m^3/ha * din/m^3, m^3/ha * €/m^3). In this way, the crops that consume more water will have higher costs per unit of irrigated surface. Principle based on customer's willingness to pay can be used so that crops such as wheat, forage crops pay a lower cost of irrigation in relation to intensive crops (fruits, vegetables).
From the socio-economic point of view, irrespectively of the conditions of investment financing in irrigation projects (regional or local), calculating the economic cost of irrigation water that will survive in the long term exploitation of the system can be made using the method ILRIC (long run incremental economic prices method). On these terms, economic cost of 1m^3 of water on the same regional sub-irrigation system had been calculated using the given method which is adapted to the characteristics of the system. The basis for establishing selling prices is economic costs calculated for different discount rates. This price should ensure that the total revenue from the sale of water system to users (farms), averaged throughout the century, covers the cost of capital (investment and replacement) and operating costs (maintenance, insurance, labor, energy, material costs). In addition, the accumulation of the amount applied discount rates should be achieved (the discount rate in this case ranged from 0-10%).

Results of Research. Case study

The procedure applied in this case consists of:



The system chosen was a regional subsystem "Srem" of 1700 ha and the water source is the River Danube. Following the proposed technical solution of a subsystem using the binomial tariffs and ILRIC method the price of water was calculated (Tables 1 and 2). In the binomial tariff, financing conditions were included as well.

Table 1. Total costs of exploitation-an example of regional subsystem „Srem“

No.	Costs	Amount, €		
		interest, 0%	**interest, 3%**	**after repayment**
I	**Fixed costs**	742883	946943	428162
1	Amortization	237415	237415	237415
2	Maintenance	145147	145147	145147
3	Labor power	45600	45600	45600
4	Interest on credits	0	154368	0
5	Uncovered part of annuity	314721	364413	0
II	**Variable costs**	118440	118440	118440
6	Energy	109440	109440	109440
7	Material costs	9000	9000	9000
III	**Overheads**	86132.3	106538.3	54660.2
IV	**Total costs**	947455.3	1171921.3	601262.2
	Unit variable costs, €/m^3	0.0348	0.0348	0.0348
	Unit total costs, €/m^3	0.2786	0.34468	0.17684
	Unit total costs without amortization, €/m^3	0.2786	0.3446	0.1070
	Area of subsystems, ha	1700	1700	1700
	Planned annual consumption, m^3	3400000	3400000	3400000
	Irrigation costs, €/ha	557.32	689.37	353.68
	Unit fixed costs, €/ha	436.99	557.03	251.86

Table 2. Selling price of water for regional subsystem „Srem“

Years	Water quantity,m^3	Nominal value							
		Investment, €	Replacement, €	Operating costs					
				Maintenace and insurance ,€	Labor power, €	Energy, €	Other costs, €	Total, €	Total with investment, €
1		11,199,244							11,199,244
2	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
3	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
4	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
5	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
6	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
7	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
8	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
9	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
10	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
11	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
12	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
13	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
14	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
15	3,400,000		2,917,200	242,388	45,600	109,440	87,970	485,398	3,402,598
16	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
17	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
18	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
19	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
20	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
21	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
22	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
23	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
24	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
25	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
26	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
27	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
28	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
29	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
30	3,400,000			242,388	45,600	109,440	87,970	485,398	485,398
Total	98,600,000	11,199,244	2,917,200	7,029,252	1,322,400	3,173,760	2,551,130	14,076,542	28,192,986
Total (%)		40	10	25	5	11	9	50	100
PW by rate 0%	98,600,000	11,199,244	2,917,200	7,029,252	1,322,400	3,173,760	2,551,130	14,076,542	28,192,986
Economic price		0.11	0.03	0.07	0.01	0.03	0.026	0.14	0.29
PW by rate 6%	43,592,879	10,565,325	1,217,246	3,107,762	584,657	1,403,178	1,127,902	6,223,499	18,006,069
Economic price		0.24	0.03	0.07	0.01	0.03	0.026	0.14	0.41
PW by rate 8%	35,128,315	10,369,670	919,623	2,504,318	471,133	1,130,718	908,893	5,015,063	16,304,356
Economic price		0.30	0.03	0.07	0.01	0.03	0.026	0.14	0.46
PW by rate 10%	28,960,600	10,181,131	698,354	2,064,618	388,413	932,191	749,313	4,134,535	15,014,020
Economic price		0.35	0.02	0.07	0.01	0.03	0.026	0.14	0.52

Considering the yield that can be achieved under irrigation in this area, as well as the selling prices of selected agricultural products the amount of product (t/ha) which should cover the cost of water on the water intake was calculated (Table 3). For most of the crops, additional yield to cover the cost of irrigation is not impossible to achieve.

In addition to these costs, the budget should be expanded to cover the complete cost of irrigation (full cost recovery) including: a) on farm costs, b) resource costs and c) environmental costs.

Table 3. The products need to cover the cost of water intake

No.	Crops	Yield, t/ha	Price, €/ton	Fixed costs, €/ha	Variable costs, €/ha	Costs on hydrant, €/ha	Need, t/ha
1	Wheat	7	170	292.2	31.32	323.52	1.90
2	Maize	12	150	487	69.60	556.60	3.71
3	Sugar beet	65	50	487	83.52	570.52	11.41
4	Soybean	4	350	487	41.76	528.76	1.51
5	Alfalfa	14	120	487	69.60	556.60	4.63
6	Peas	7	300	487	27.84	514.84	1.72
7	Onions	28	200	487	69.60	556.60	2.78
8	Beans	2	1200	487	41.76	528.76	0.44
9	Potatoes	35	160	487	55.68	542.68	3.39
10	Tomato	45	210	487	83.52	570.52	2.72
11	Pepper	35	280	487	83.52	570.52	2.03
12	Cucumber	30	190	487	69.60	556.60	2.92
13	Carrot	30	180	487	69.60	556.60	3.09
14	Apple	25	250	487	83.52	570.52	2.28
15	Pear	20	350	487	83.52	570.52	1.63
16	Plum	25	150	487	76.56	563.56	3.75
17	Peach	25	300	487	83.52	570.52	1.90
18	Apricot	22	320	487	83.52	570.52	1.78
19	Vineyards	12	300	487	62.64	549.64	1.83
20	Double vegetable	20	150	194.8	41.76	236.56	1.57
21	Double forage crops	35	40	194.8	55.68	250.48	6.26

Conclusion

Pricing irrigation water is always a topical field of research. The price depends on agricultural and water policies of each country and is changeable due to supply and demand for water resources.
The research in this paper is based on the selection of appropriate methods that would be used to determine the price of water. There were two methods (binomial rates and economic sales price of water), which would correspond with the budget price of irrigation water in the Republic of Serbia.
On the example of specific regional subsystem in Srem, Vojvodina, the rates of irrigation water had been calculated based upon selected method.
Also, bearing in mind the principle of payment according to the possibilities of users, costs of irrigation in certain crops were distributed on basis of fixed and variable costs. The required amount of yield for selected crops which needs to be allocated to cover the costs of irrigation on the water intake was also calculated.
The research should be extended to the development of methods for the calculation of resource and environmental costs that are to be included in the price of irrigation water to ensure full cost recovery.

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