Metode de fundamentare a deciziilor în analiza tehnico-economică a randamentului sistemelor de irigații

Decision – make methods in technical-economic analysis of irrigation systems efficiency

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Rezumat. *În această lucrare, este prezentată o abordare multicriterială a tehnicilor de decizie, utilizate în managementul amenajărilor de irigații. Analiza economică a fost realizată utilizând metoda Electre III în cadrul căreia se cuantifică importanța relativă a criteriilor considerate. Alegerea pragurilor este determinată de specificitatea fiecărui criteriu, astfel încât să reflecte preferința factorului de decizie. Prin relevarea zonelor cu eficiență economică scăzută, analiza realizată contribuie la îmbunătățirea deciziilor care trebuie luate, constituind un important punct de plecare pentru alegerea celor mai bune metode de modernizare a amenajărilor de irigații. Lucrarea prezintă o analiză a unor importante criterii de evaluare a eficienței sistemelor de irigații în Sistemul hidrotehnic „Carasu - Nicolae Bălcescu", județul Constanța.*

Cuvinte cheie: tehnici de decizie pe criterii multiple, optimizare, sistem de irigatie

Abstract. *This study presents a multi-criteria approach for decision techniques used in irrigation system management. Economical analysis was made using Electre III method which counts the relative importance of the considered criteria. The level of importance is awarded by the decision-maker according to each specific criterion. By identifying the low economic efficiency areas, the analysis leads to the decisions improvement. It allows us to choose the best modernizing methods for the irigations systems. This study reaveals the analysis of the most important criteria evaluation of the irrigation system eficiency for Nicolae Balcescu hydrotechnical system which is part of Valea Carasu's irigation system.*

Key words: multi-criteria decisions tehniques, optimizing, irigation system

1. Introducere

The great changes that came in Romanian agriculture after 1989 had an impact on the irrigation system activity therefore reducing the irrigated areas percentage. The recovery of this activity is bound of assuring the efficiency of water distribution through a rigurous cost analysis also considering field and environment conditions, irrigation method, pumping levels and human factor.

Methods and techniques can be used in decision-making processes of management or the exercise of their functions (forecasting, organization, coordination, control - evaluation). Using methods and techniques result in a decision to increase the degree of rigor and thus the effectiveness of decisions, however distinguished, depending on the type of decision situations involved.

After the nature of the variables involved, state the objective conditions that mark the decision to solve the problem subject:

- decision-making methods and techniques used in optimizing decisions in conditions of certainty: additive method, the method ONICESCU decision table, the coefficient K method, etc.;

- methods and techniques used to optimize decision making under uncertainty: technical pessimistic, optimistic technique, technique optimality, proportionality technique, the technique of minimizing regret, etc.;

- methods and techniques used to optimize decision making under risk: decision tree technique, the method of mathematical expectation.

ELECTRE (Eliminasion et Choix Traduisant la Realité) is a method of ranking and selection in the presence of multiple viewpoints, allowing decision makers to adopt the most favorable solution for managing business entities.

ELECTRE was initialy developed to estimate the uncertainty of the decision process by using the preference and indifference levels. ELECTRE is a non-compensating method - a low grade for a certain criteria cannot be compensated with better grades for other criteria. ELECTRE models allow incomparability. This element appears between A and B alternatives when there is no relevant evidence for A or B. There are interesting applications of this method in multi-criteria decisions theory. Main ELECTRE method concepts are: thresbolds and ranking. First preordonation Zt descending filtration process. The ascending filtration is made in the same way except for the fact that the low quality projects are restrained at the beggining. The result will be a pre-arrangement Z. In the same group the projects are equally arranged.

In is shown the efficiency irrigation criteria analysis such as the energetical one, the economic-financial and irrigation water distribution, from a water provider point of view, using the ELECTRE. By showing the critical areas, with low economic efficiency, this kind of analysis is improving the decisions that have to be made for the irigation system administration. It’s also a very important starting point for making the best modernizing choices. This study works with ELECTRE III version to syntetize the relative importance of the considered criteria.

2. Considerations of the Electre method implementation

Prezentarea va fi clară şi concisă, iar simbolurile utilizate vor fi definite în cadrul unei liste de simboluri (dacă este cazul). Se va folosi Sistemul Internațional (SI) de unități de măsură.

Pentru editare folosiți stilurile predefinite în prezentul document, pentru păstrarea formatului cerut a textului. Numele stilurilor predefinite încep cu "RRIC_".

The following types of criteria are taken into consideration:

- composed criteria: economical; hydro; energetical;
- primary criteria: modernization and readaptation costs, maintenance and repair costs, irrigation efficiency, the importance of the grants-in-aid, water volumes, lost volumes of water; improved area; contracted area; active/reactice energy consumption; specific consumption.

To be able to define a set of policies that includes economical, hydro and energetical aspects, a series of factors have been defined, factors that can be subject to exterior influences and can be modified according to the purpose of the analysis and the requirements of the system. These are: the method of setting up the irrigation system (A), the cost of the water (B), the irrigation stages (C) that has a strong influence on the energy consumption andthe lost volume of water, crops planning (D), the irrigation system (E), grants-in-aid (F).

Total area of 28125 ha, the irrigation system „Nicolae Balcescu", built in four energetical stages: stage 1 (Hpumping = 65 Mca, Surface = 3310 ha); -stage 2 (Hp = 91mCA, s = 4560 ha); -stage 3 (Hp = 113Mca, S = 16640 ha); -stage 4 (Hp = 143 Mca, S= 358 ha).

Disposing the irrigable surfaces in the four energetical stages makes one think that the irrigation system „Nicolae Balcescu" is a major energy consumer, having an impact on the economical indicators of A.N.I.F. R.A. Constanta which delivers water to the consumers.

The water distribution for plants is done by means of affusion on 24.049 ha (86%) and on furrows of 4.076 ha (14%). A surface of 21.990 ha is improved with underground pipes, and the surface of 6.135 ha with external pipes.

The amount of water necessary for this was calculated according to a crops planning in which the corn crop is dominant – 40% of the total surface, followed by cereal crops – 30%, sun-flower and alfalfa – 8%, soya – 7%, sugar beet – 3%, vegetables, vineyards and fruit trees – 2%.

For the evaluation of the chosen factors, the following qualifications habe been used:

A = excellent, B= good, C= medium, D= sufficient, E = insufficient, and for the evaluation of the criteria were used numbers from 5 (=A) to 1 (=E).

There are four hypothesis influenced by each decision factor:

1. $P_{ECO}^{=} 0,6 \quad / P_{HIDRO} = 0,2 \quad / P_{ENG}^{=} 0,2;$
2. $P_{ECO} = 0,2 \quad / P_{HIDRO} = 0,6 \quad / P_{ENG} = 0,2;$

3. $P_{ECO} = 0,2 \quad / P_{HIDRO} = 0,2 \quad / P_{ENG} = 0,6;$
4. $P_{ECO} = 0,334 / P_{HIDRO} = 0,333 / P_{ENG} = 0,333.$

The qualitativ matrix is the start point and it highlights 6 groups of factors and their subdivisions (18). According to this, there have been selected 3 factors (actions) whose hefts double when it comes to estimating the criteria. The results are: „B- the price of the water", „C-the irrigation stages" and „E-irrigation equipment". All these factors have been sorted and analyzed, resulting a set of alternative policies. From the total we then obtain 18 realistic policies of interest. The selection criteria are: the sorting method, named the „screening method"; grading the global criteria: the profit, hydro criteria, energetical criteria: =B=C=0; D=1; E=2; declaring 9 incompatible or irrational policies such as: incompatibility (A1) „Irrigation through furrows"(D2) „Haulm crops", incompatibility B1 „current price of water" with F2 „cutting off the subventions". Still, in the process of choosing these 18 policies there are also elements taht are influenced by subjective decisions. The result is 8 final arrangements (Id3, Id10, Eco3, Eco10, Hidro3, Hidro10, Eng3, Eng10).

Table1

Interest and realistic policies

No. policies	Alternat.	ID		ECO		HIDRO		ENG	
		Id3	Id10	Eco3	Eco10	Hidro 3	Hidro10	Eng3	Eng10
1	111111	1	4	2	2	5	5	1	3
2	111321	3	6	1	6	4	8	3	9
3	12 1222	3	4	3	2	3	5	3	4
4	122422	5	6	4	4	5	7	5	7
5	123322	7	8	5	9	9	9	8	10
6	123422	3	2	4	2	4	3	3	4
7	121312	9	2	7	5	8	4	5	2
8	211121	2	3	2	2	3	5	1	1
9	211421	1	1	1	1	2	2	2	2
10	211521	1	1	1	1	1	1	1	1
11	221512	11	5	7	4	10	5	7	5
12	223212	8	3	6	3	9	4	7	6
13	2224 12	5	6	4	7	3	4	5	5
14	31132 1	10	2	8	3	7	3	6	3
15	322322	7	7	5	8	5	5	4	8
16	322222	6	5	3	6	4	3	6	7
17	323512	8	7	6	9	6	6	6	10
18	323322	4	4	3	8	2	2	4	9

Electre maintains the diversity of the three criteria so that even if a strategy has a great performance within a criterion and a low performance within another criterion, they're both taken into consideration. Although policies 9 and 10 are on the first position, the method reveals interesting things about ranks 2,3 and 4.

a) ECO 10: decision maker interested in all involve-economic conditions:

PECO = 0,6 / PHIDRO= 0,2 / PENG =0,2 (0.1/0.2/0.1/0.2 0.1/0,04/0.04/0.02 0.1/0.1).

Table 2

ECO10

No. Crt.	No. policies	Alternative A B C D E F
1	P9 P10	2 1 1 4 2 1 2 1 1 5 2 1
2	P1 P8	1 1 1 1 1 1 2 1 1 1 2 1
3	P12 P14	2 2 3 2 1 2 3 1 3 3 2 1
4	P4 P11	1 2 2 4 2 2 2 2 1 2 1 2

The institutional frame is not modified: the subventions are the same (F1); the irrigation stage is the most favorable (C1). The economical criterion predominating over, leads to an opposition towards progress and modernization. The method of irrigation through affusion is well positioned and her spreading can be seen on the entire surface. From a crops planning perspective, each of the proposed strategies are present here.

b) HIDRO 10: the decision factor involving the distribution of water:

PEC0 = 0,2 / Phidro= 0,6 /PEng=0,2 (0.04/0.06/0.04/0.06/0.3/0.12/0.12/0.06/ 0.1/0.1).

Table 3

HIDRO 10

No. Crt.	No. policies	Alternative A B C D E F
1	P10	2 1 1 5 2 1
2	P9 P18	2 1 1 4 2 1 3 2 3 3 2 2
3	P6 P14	1 2 3 4 2 2 3 1 1 3 2 1
4	P7 P12	1 2 1 3 1 2 2 2 3 2 12

P18 is surprisingly ell positioned. It's a policy of changes in all departments, therefore, within this action there is nothing left from the initial state. A strong intervention is necessary in the following directions:increasin the price of the water with 150%, establishing a strict consumption of water, cutting off the subventions which leads to the minimalization of the irrigated surfaces. Even if the effect of the consequences on this is positive this policy can't be taken into consideration. P16, the policy that achieved the best position in this scenario involves giving up grants-in-aid,

doesn't have an appliable effect and this shows how insegnificant is a singular action within the whole estimating policy.

c) ENG 10: the decision factor involving the energy:

PEC0 = 0,2 / PHIDRO= 0,2 / PENG = 0,6 (0.04/0.06/0.04/0.06/ 0.1/0.04/0.04/0.02/ 0.3/0.3).

Table 4

ENG10

No.Crt.	No. policies	Alternative ABCDEF
1	P8 P10	211121 211521
2	P9 P7	211421 121312
3	P1 P14	111111 311321
4	P3 P6	121222 123422
5	P11 P13	221212 222412

The criteria comprise aspects about specific consumption and the energy consumption. It is clear that the most favorable criterion is the first stage of pumping (C1 = stage 1), and giving up subventions is out of question (F1). The irrigation by dripping method (A3), that would have saved energy can't be considered, requiring a great financial and technological effort.

d) ID 10: the decision factor involving all three criteria:

PECO = 0,33 / PHIDRO= 0,33 / PENG = 0,34 (0.06/0.1/0.06/0.11/0.17/ 0.07/0.06/ 0.03/ 0.17/0.17).

Table 5

ID 10

No. Crt.	No. policies	Alternative A B C D E F
1	P9 P10	2 1 1 4 2 1 2 1 1 5 2 1
2	P6 P7 P14	1 2 3 4 2 2 12 1312 3 1 1 3 2 1
3	P8 P12	2 1 1 1 2 1 2 2 3 2 1 2

The decision factor has to choose between many alternative policies: some of them are not suggesting radical changes, for example, best arrangement method is the affusion which has the majority in this case. The crop plan includes all strategies, mostly corn which is till now the predominant culture, but also sun-flower and

vegetable + potatoes, which act very good during irigation. As for the increasing water price, 60% of the versions maintain the actual one, same for subventions. Medium politics dominance reflects the multiple problems from which the decision factor has to choose.

Results

PI - 1 1 1 1 1 1 -: „Actual state" (clasifications: Id10: 4 / Eco10: 2 / Hidro10: 5 / Eng10: 3)

Most of the 1 criteria reflects the actual state from the studied system. PI has a good evaluation considering the economic point of view, but a low classification from the hydro-energetical point of view because it's considering only the I stage. Overall, the 4-th place obtained considering policies is not satisfying.

P4 -1 2 2 4 3 2-: „No subventions, in favor for sun-flower" (clasifications: Id10: 6/Eco10: 4/Hidro10: 7/Eng10: 7)

This very liberal strategy (cutting off the subventions and rising the water price) has a high cost not only from the economic reasons but also energetic ones, with no compensations for a hidro level. Theese are the reasons for low clasifications in each sharing system

P9 - 2 1 1 4 2 1 -: „Compromises" (clasifications: Id10: 1 / Eco10: 1 / Hidro10: 2 / Eng10: 2)

Number 9 strategy provides compromises for the economic, energetical and environmental fields as to obtain best classifications in each share system. Considering the arrangement, the option is "affusion" (A2), suggest the expansion of sun-flower culture (D4) and, of course, the proper irrigation equipment (E2).

P12 - 2 2 3 2 1 1 -: „for the III-rd degree" (clasifications: Id 10: 3 / Eco 10: 3 / HidrolO: 4 / EnglO: 6)

First 2 2 pair is a proper strategy for water saving: affusion irrigation system(A2), rising the water price(B2), but working on the IIT scale (C3) leads to a high hydro-energetical cost so , eventually, the strategy gives us unsatisfactory classification.

P13-2 2 2 4 1 2-: „Revolution"(Id 10: 6 / Eco10: 7 /Hidro10: 4 /Eng10: 5)

This strategy implies too many changes – even changes at an institutional level: cutting off subventions, the semnificative growth of the price of the water. Although is very efficient for the hydro criterion, economically it's eutopic.

P17 - 3 2 3 5 1 2 -: „Pro vegetables + potatoes" (cotări: Id10: 7 / Eco10: 9 / HidrolO: 6 / Eng10: 10)

This strategy also implies important changes at an institutional level, but it's not acceptable due to high economical and energetical costs.

3. Conclusion

The way of approaching the decisional matter, used in this study leads to achieving some orientative results for the decision factor. The next step is replacing the criteria with real facts, which makes it more precise and easier to be interpreted.

As a conclusion, we can say that the best hydro strategy is by far keeping things the way they are and requiring major changes regarding the water volumes (measurement, the impermeability of sewers and most of the surfaces equipped with underground pipes), the crops structure (advising the farmers to cultivate high rated crops for irrigations and for the farmer itself), the price of water and the subventions (maintaining the current price by investments made for rehabilitating the system).

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