Co-funded by the Erasmus+ Programme of the European Union

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MULTI CRITERIA ANALYSIS FOR PRIORITIZATION OF INVESTMENTS FOR RECONSTRUCTION AND MODERNIZATION OF IRRIGATION INFRASTRUCTURE

UNIVERSITY OF ARCHITECTURE CIVIL ENGINEERING AND GEODESY

International Symposium "Water Resources Management: New Perspectives and Innovative Practices„
Novi Sad, 23-24 September 2021

Introduction

- Reconstruction and modernization (R&M) of irrigation schemes (ISs) in Bulgaria – a needed process
  - ✓ Old and deteriorating infrastructure
  - ✓ Low efficiency of ISs and lack of adequate water measurement
  - ✓ Climate changes
  - ✓ Importance of Agriculture
- Funds
  - ✓ Rural Development Programme 2014-2020 funds
  - ✓ EU Economic Recovery Plan
- Tool for prioritization of investments for R&M – MCA
- Subject of analysis – 237 ISs

Materials and methods

- **Preliminary analysis**
- **Classification of ISs**
- **The prioritization of investments - a complex process**
- **Simple Additive Weighting**
- **Criteria selection**

Result	Method Criterion	Criterion	Method Sub-criteria	Sub-criteria
Ranking of the Irrigation Schemes	Multi-criteria analysis (MCA)	**Technical**	MCA	**Equipped/Constructed Area ratio**
				Irrigation system size
				Water intake type
				IS efficiency
				Automation opportunity
				Reliability
				Safety
				Others
		Economic	B/C Ratio	Specific investment cost for R&M
				Depreciation, operation and maintenance cost
				Electricity expenses
				Net present value
				Payback period
				Potential additional farm income
				Benefit/Cost ratio
				Others
		Environ-mental	MCA	**Water savings potential**
				Water body status
				Land use
				Others*
		Social		Priority within the NRDP 2014-20
				Social acceptability
				Job creation
				Social benefits
				Others

Planning the research experiment

1) Determining the weights for MCA

2) Forty scenarios

3) Average ranking

4) Overall ranking

Main Criteria	**Relative weight within a group**				
	Variants				
	A	***B***	***C***	***D***	***E***
Technical	0,6	0,4	0,3	0,333	0,25
Economic	0,3	0,4	0,6	0,333	0,25
Environmental	0,1	0,2	0,1	0,333	0,5
Technical Sub-criteria	**Variants**				
	1	***2***	***3***	***4***	
E/C Area Ratio	0,167	0,182	0,100	0,125	
IS size	0,167	0,182	0,250	0,250	
WI Type	0,167	0,182	0,200	0,188	
Present IS Efficiency	0,167	0,182	0,250	0,250	
Automation opportunity	0,167	0,182	0,150	0,125	
Reliability	0,167	0,091	0,050	0,063	
Economic Sub-criteria	**Variants**				
	0				
B/C ratio	1				
Environmental Sub-criteria	**Variants**				
	i		***j***		
RPWS	0,5		0,75		
Water body status (WBS)	0,5		0,25		

Results and discussion

- Three scenarios coincide the most with the average ranking
- Scenario B40i - representative
  - ✓ it matches the best with the average ranking.

Sample on MCA results of Scenario B40i:

№	Irrigation Scheme	IS Type	Technical Criteria						Econ. criteria	Environm. criteria		Final Score
			E/C Area	IS size	WI Type	Present effi-ciency	Autom. opp.	Reli-abilty	Norm. B/C Ratio	RPWS normal.	WBS	S
1	Ihtiman IS	Gp	1.00	0.50	1.00	0.61	0.50	0.75	1.00	1.00	0.60	0.84
2	Dobromirtsi IF	Pp	1.00	0.14	1.00	0.81	0.75	0.25	1.00	1.00	0.41	0.80
3	Karaysen IS	C-P2c-S	0.16	0.50	1.00	0.99	0.45	0.07	0.86	1.00	1.00	0.80
4	Petelovo IF	Pp	0.95	0.00	1.00	0.81	1.00	0.25	1.00	1.00	0.41	0.80
5	Bolyarovo IS	C-Pc-P2c	1.00	0.50	1.00	0.56	0.25	0.41	1.00	0.78	0.54	0.79
6	Peshtera IS	C-Gc-Pc	0.53	0.50	0.50	0.64	0.25	0.93	1.00	1.00	0.71	0.78
7	Yastreb IF	Pp	0.71	0.00	1.00	0.81	0.75	0.25	1.00	1.00	0.41	0.78
8	Gorsko slivovo IS	Gc	0.45	0.14	1.00	0.79	0.25	1.00	1.00	1.00	0.47	0.77
9	Vitska IS	C-Gc-Pg-Pp	0.72	1.00	1.00	0.79	0.25	0.58	0.77	1.00	0.47	0.77
10	Polyanovo IF	P1p	1.00	0.14	0.50	0.81	0.75	0.25	1.00	1.00	0.41	0.77

Results and discussion

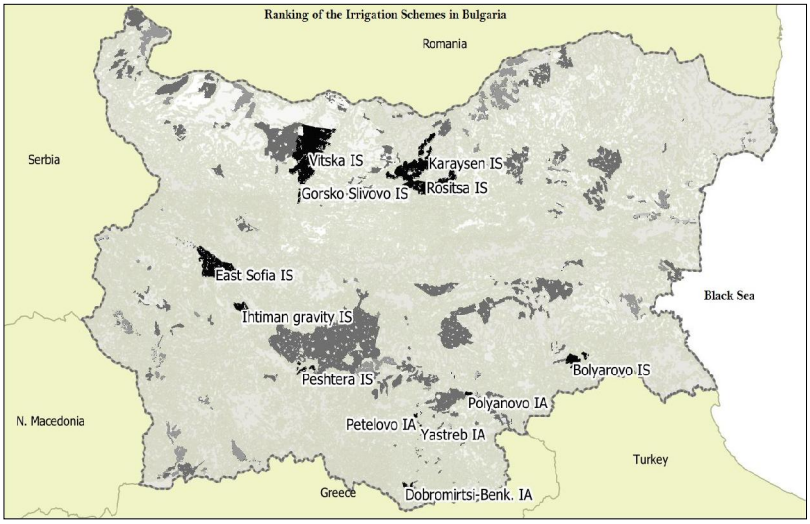
Analysis of Investments for the first ten ISs:

№	IS name	Constructed Area, ha	Total Investments, €	IS Type	Score MCA	Score GIS	Number of times in Top 30	R
1	Ihtiman IS	3901.3	7 553 522	Gp	0.84	0.84	40	0.96
2	Dobromirtsi IF	1538.3	1 347 101	Pp	0.80	0.80	40	0.89
3	Karaysen IS	3119.0	4 253 557	C-P2c-S	0.80	0.80	35	0.61
4	Petelovo IF	350.8	159 194	Pp	0.80	0.80	40	0.89
5	Bolyarovo IS	4975.4	5 479 360	C-Pc-P2c	0.79	0.79	40	0.68
6	Peshtera IS	3596.8	4 376 725	C-Gc-Pc	0.78	0.78	40	0.75
7	Yastreb IF	545.9	190 774	Pp	0.78	0.80	40	0.77
8	GorskoslivovoIS.	1180.8	544 567	Gc	0.77	0.76	40	0.76
9	Vitska IS	29200.4	34 679 990	C-Gc-Pg-Pp	0.77	0.80	32	0.54
10	Polyanovo IF	1097.0	534 348	Pp	0.77	0.79	40	0.69
	Total Investments:		59 119 138	€				

The funds allocated for R&M of IrIs under Rural Development Programme 2014-2020 amount to 54 699 274 €. These funds can be used for R&M of only 10 ISs out of 237, if R&M of the entire ISs are assumed.

Results and discussion

➢GIS overlay analyses result



- Bad (<0.17)
- Satisfactory (0.17÷0.34)
- Good (0.34÷0.51)
- Very good (0.51÷0.76)
- Excellent (>0.76).

The ISs in “Excellent” group are shown in dark grey

Conclusions

➢ This MCA approach can be used both in government and private sector assessments.

➢ The three criteria - technical, economic and environmental, with their sub-criteria, make possible objective ranking of the ISs in Bulgaria.

  ➢ MCA with only major criteria - sensible and not recommended.

➢ MCA method excludes the subjectivity factor in evaluation

  ➢ In all 40 scenarios, Ihtiman IS always ranks first.

➢The GIS overlay analysis - similar results to SAW MCA method.

➢Small ISs (constructed area less than 2,500 ha) are ranked with high scores, despite the low weight, given to *IS Size* sub-criteria.

➢This MCA approach allows for future analyses on the basis of sub-systems.

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Thank you for your attention!