3rd National training session on PILOT FEASIBILITY STUDIES

MAR economic feasibility study: Cost-benefit analysis

Methodology and example of application for Polish case study

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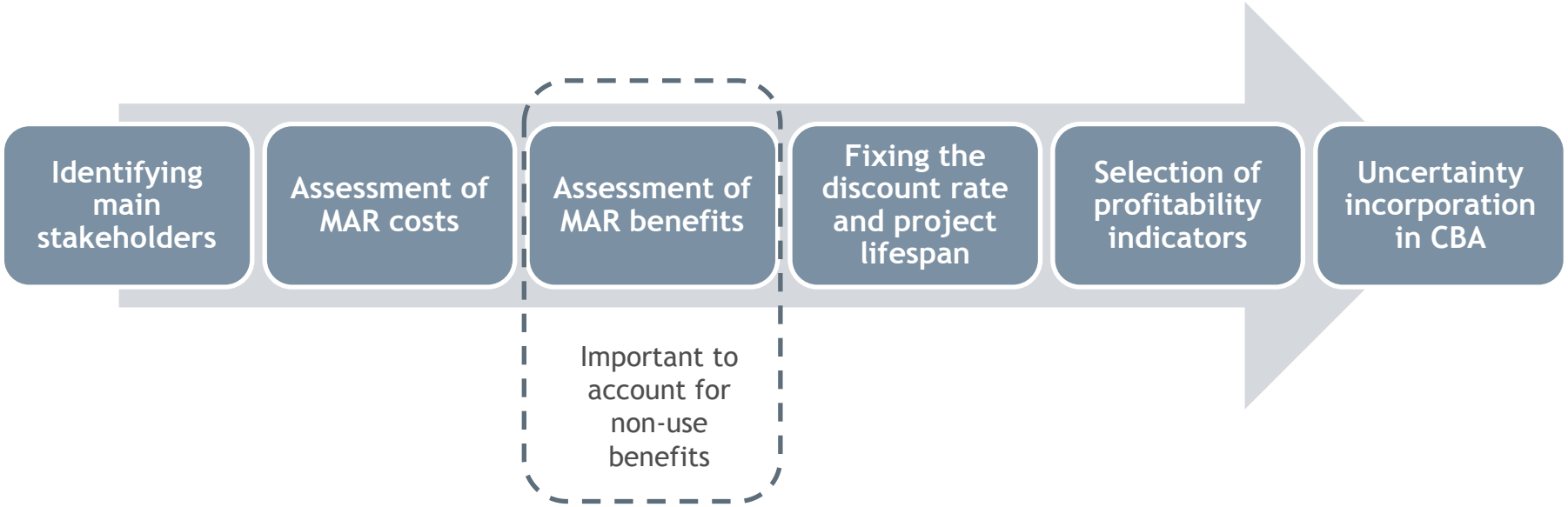
BACKGROUND

Despite all advantages that MAR schemes can bring, it is important to ascertain that the net benefit of MAR implementation is positive.

- Along with hydrogeologic considerations and institutional feasibility assessments, economic analysis is an essential part of MAR projects' evaluation.
- Cost-Benefit Analysis (CBA) is among the most widely used approaches for the economic evaluation of MAR schemes.
- This approach allows measuring the economic profitability of current and future investments by comparing all benefits and costs (private and social, direct and indirect, tangible and intangible).
- The criteria for approval of MAR system construction under CBA is the total economic value of benefits that exceeds the total costs.

STAGES OF COST-BENEFIT ANALYSIS



CONTINGENT VALUATION STUDY

Contingent Valuation for non-use values and ex-ante valuations

- Contingent Valuation Method (CVM):
  - captures non-use values
  - is suitable for ex-ante evaluations
  - is survey-based method
  - determines an individual's willingness to pay (WTP) for a good or service.

- Stated preference techniques (in particular CVM) are widely used in studies revealing the total economic value of MAR systems (Damigos et al., 2017; Rupérez-Moreno et al., 2017).

REVEALLING WTP: POLISH PILOT STUDY

The pilot study area in Poland is the Tarnów agglomeration, which is supplied with drinking water partially from the MAR scheme and has a large nitrogen plant, which puts groundwater at risk of potential contamination.

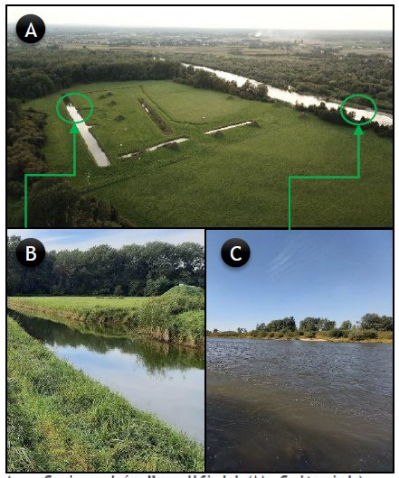
MAR system is already in place and operates regularly.

Two types of MAR techniques are applied in the Świerczków well field:

1. induced riverbank filtration
2. surface-spreading method

Wells are recharged by the system of infiltration ditches and by riverbank filtration.

Source: https://en.wikipedia.org/wiki/Tarn%C3%B3w



A - „Swierczków" wellfield (M. Sołtysiak)
B - infiltration ditch (S. Jakóbczyk-Karpierz)
C - Dunajec river (S. Sitek)

Source: DEEPWATER-CE Newsletter 3

The aim is to investigate the willingness of the local population to support financially the existing MAR system's extension.

The latest will allow to increase the efficiency of the intake and improve groundwater quality.

SURVEY DESIGN

Developed questionnaire is in line with the concept of “general specific”

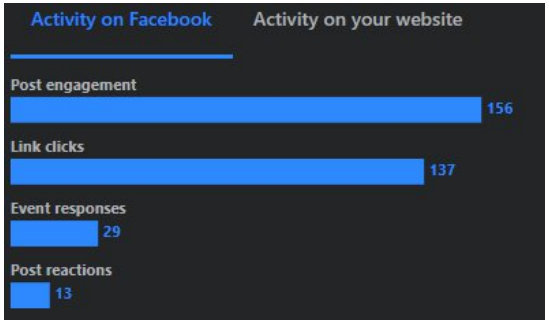
- The survey starts with general questions on the state of the environment:
  - questions on knowledge regarding problems related to groundwater quality and quantity in the area
  - main concerns and prevailing pressures on groundwater etc.
- Questions gradually become more specific in the second part of survey, which deals with the **willingness to pay for the proposed MAR scheme** (its description provided in the questionnaire is below).
- The concluding part of the survey contains questions on the respondent’s profile.

“A plan is proposed in your area that aims to extend the area of existing managed aquifer recharge scheme in order to increase the available water resources for your city/town. The main objective of the artificial aquifer recharge is to store excess water and thus to increase available reserves of groundwater for future use while improving water quality. In addition, it can have a significant environmental benefit by mitigating the negative effects of a functioning chemical plant that may lead to contamination of drinking water in your area. However, if this extension of MAR scheme was implemented, it would cost money. So citizens would be asked to financially contribute to putting this MAR’s extension in place.”

SURVEY IMPLEMENTATION

Survey was distributed in paper form and online via LimeSurvey

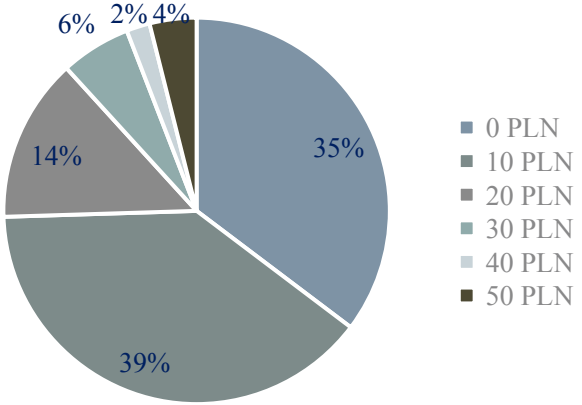
Along with conventional ways of survey link's distribution, a social media ad (in Facebook) was used to boost the post with survey description and link to increase awareness of it among the targeted population.



SURVEY RESULTS: WILLINGNESS-TO-PAY

One-third of respondents stated zero WTP, while monetary contribution of 10 PLN account for 60% of non-zero answers

If you were given the choice to make a monetary contribution, through your preferred way of donation, what is the MAXIMUM amount you would be willing to pay per month?



If your answer is zero in the previous question, please, choose the reason for your decision

Reason	Share of respondents
I already pay enough municipal/income taxes	29.41%
I cannot afford it	7.84%
It is the government's responsibility	5.88%
The proposed plan is not feasible, good enough, convincing, etc.	3.92%

SURVEY RESULTS: WILLINGNESS-TO-PAY

Variable	Definition	Average partial effect (Robust standard error)
Gender	Male	-0.213*** (0.091)
Age	30-45	-0.338*** (0.049)
	45+	-0.453*** (0.091)
Income	Close to the average level	0.278** (0.113)
	Above the average level	0.315*** (0.096)
Education	Bachelor degree	-0.412*** (0.125)
	Master degree and higher	0.324** (0.132)
Protection plan	Should be in place	0.738*** (0.195)
Concern chemical contamination	Great or modarate concern)	0.189 (0.127)
Household impact	Household impacts groundwater quality	-0.491*** (0.13)
Number of observations	42	
Wald chi2	360.09	
Pseudo R2	0.499	

Probit model results

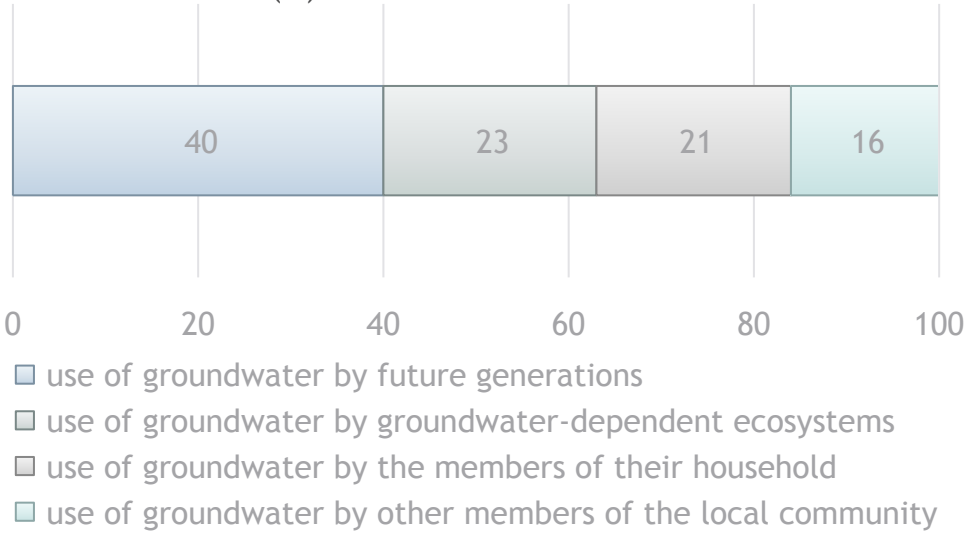
The probability that respondents will have non-zero WTP increases when respondent:

- believes that there should be a protection and preservation plan for groundwater;
- is of younger age;
- has close to average or above-average income;
- has high education.

SURVEY RESULTS: WILLINGNESS-TO-PAY

Obtained results clearly support the importance of the MAR scheme's non-use benefits

Respondents distributed the amount of their financial support according to the following distinct categories of MAR scheme's benefits (%):



COSTS AND BENEFITS OF MAR SCHEME'S EXTENSION

Annual net present value (calculated as difference between discounted values of costs and benefits) is positive starting from the 3rd year (start of the operation of MAR scheme's extension)

COSTS

Main groups of **initial investment and capital costs**:

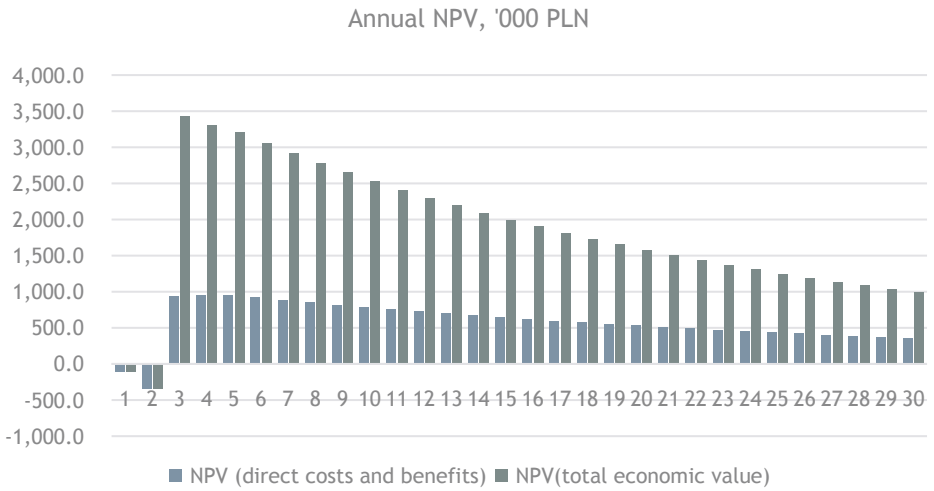
- Investigation costs
- cost of wells, piezometers and infiltration ditch

Operating and maintenance costs

- calculated using the ratio of the extension's size to the size of the MAR system in place, which was multiplied by historical operating costs.

BENEFITS

- **Direct benefits** proxied by annual revenue from water supply
- **Both use and non-use benefits** estimated as weighted median WTP value multiplied by number of users of drinking water



In calculation the EC benchmark of financial discount rate is used, which is 4% in real terms for 30 years reference period for water supply projects and the social discount rate of 5%

UNCERTAINTY INCORPORATION: SCENARIOS

One of the methods applied to incorporate uncertainty in the feasibility study of MAR schemes is sensitivity analysis.

Scenarios	Assumptions	
	Costs	Benefits
Conservative	Maximum value of capital costs	Including only direct benefits
Neutral	Average value of capital costs	Lower bound of the confidence interval of estimated WTP median value; 45% of targeted population has zero WTP
Optimistic	Minimum value of capital costs	Estimated WTP median value; 35% of targeted population has zero WTP (based on survey data)

Scenarios	NPV over 30 years, thous PLN	Change compared to neutral scenario,%
Conservative	17,216.2	-54
Neutral	37,773.3	
Optimistic	55,318.8	46

It allows investigating how net benefits will change under different scenarios, which are determined by plausible deviation of specific parameters from their expected values.

MAIN TAKEAWAYS

- Cost-Benefit Analysis is an important part of MAR scheme's feasibility assessment.
- Since MAR schemes bring not only use benefits, it is important to account for non-use values of MAR schemes in economic feasibility analysis.
- Stated preference techniques (in particular contingent valuation method) are widely used in studies revealing the total economic value of MAR systems.
- The criteria for approval of MAR system construction under CBA is positive net present value.
- Performing sensitivity analysis allows to incorporate uncertainty in CBA and check how net benefits will change under different scenarios.

Thank you
Q&A

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