DEEPWATER-CE

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About DEEPWATER-CE project

Seven partners from five countries (Croatia, Germany, Hungary, Poland and Slovakia) have joined their efforts as part of the **DEEPWATER-CE** Interreg Central Europe Project to minimize adverse consequences of the climate change in order to provide good quality water for people and for the economy, including agriculture. They developed a joint strategy for the management of water resources which based on the implementation of Managed Aquifer Recharge (MAR) systems in Central European countries.

Managed Aquifer Recharge (MAR) refers to the intentional recharge of aquifers for subsequent water recovery or environmental benefit. These methods apply processes by which excess surface water is intentionally directed into the subsurface. MAR techniques offer promising solutions for water management, also with regard to tackling future climate change impacts.

In the first phase of the project the partners built a transnational knowledge base on MAR and its benefits. Subsequently, a transnational toolbox of decision-support for the designation of potentially suitable MAR sites in Central Europe was developed. Based on this toolbox, pilot sites with suitable MAR types were identified in Hungary, Slovakia, Croatia and Poland. A pilot feasibility study of MAR schemes with integrated environmental approach has been investigated in each country covering a different type of MAR scheme, **in Hungary the study investigated Underground dam.**

This press release provides a key summary of the results obtained during the feasibility study of MAR in the Maros alluvial area.

Results from pilot feasibility study of Managed Aquifer Recharge (MAR) schemes with integrated environmental approach in Hungary

Pilot site: Maros alluvial fan – paleo-channels of Ancient Maros River

A. Pilot site characterization

The Hungarian pilot site is in the Maros alluvial fan between the two largest tributaries of the River Tisza (River Körös and River Maros), providing one of the most characteristic distributive fluvial systems in the Hungarian Quaternary succession. Despite of its large catchment area, the water network of the Maros alluvial fan is sparse and except for the artificially maintained channels, most of the surface waters are temporary. Our goal was to explore some paleo-channels of the Maros River which can be suitable for groundwater storage by installing an underground dam.

The feasibility of an underground dam was investigated from different aspects. Geophysical measurements (electrical resistivity, geophysical cone penetration test) were performed to provide information on the shallow aquifer lithology and depth, define the locations of the groundwater samplings, and the geological and hydrogeological interpretation of the sediment layers. Groundwater sampling supported the hydrogeological characterization of the pilot site and provided data for the validation of a 3D hydrogeological modelling of the pilot area, as well as the additionally installed groundwater level data loggers, complementing the existing monitoring data.

B. Risk management related to MAR implementation or operation

For the implementation of an underground dam in the Hungarian pilot area on the Maros alluvial fan, a comprehensive risk analysis was carried out, as a joint application of two methods. The frame of our risk analysis methodology is based on suggestions in the Australian guidelines (NRMMC-EPHC-AHMC, 2006; NRMMC-EPHC-NHMRC, 2009), where the likelihood and the severity of a risk is examined and their joint interpretation – based on a risk factor matrix – shows the total magnitude of a risk. Into this system we incorporated the list of risk events of the MAR-specific study of Rodríguez-Escales et al. (2018) which compiles the risk events of literature reviews of 51 MAR facilities. This list was slightly further modified to better fit the underground dam MAR type, resulting a

risk identification list of 82 different possible risk events. Risk analysis was carried out in 2 temporal phases, separately for the design and construction, and separately for the time of operation phase of the MAR facility.

According to our risk assessment the highest risks are assigned mainly to non-technical (economic) risks in design phase – like the low price of water, high installation costs and lack of private/public funding – and to a technical event of low water storage capacity.

To decrease the possibility of a risk event, some risk treatment methods are suggested for all risk events. The ones which would mitigate the possibility of occurrence of very high- and high-risk events are:

- adequate support
- suitable information sharing and education
- thorough preliminary research
- appropriate monitoring

C. Cost-benefit analysis of the MAR

Despite all advantages that MAR schemes can provide, it is still important to perform an economic evaluation to ascertain that the benefits of the MAR scheme can justify anticipated costs. The main beneficiaries of the MAR scheme under consideration are agricultural producers in the pilot study area. The proposed MAR scheme is expected to provide a source of water that can be legally used to fulfil the need for irrigation water. Moreover, the introduction of the MAR system is envisaged to mitigate the negative effects of unregistered wells that may lead to the contamination of water in the pilot study area.

Comprehensive assessment of the MAR scheme requires evaluation of its economic feasibility along with hydrological, geological, and institutional considerations. Cost-Benefit Analysis is among the tools, which are widely used to assess the profitability of the MAR scheme. To state whether the MAR system is feasible from an economic perspective, the costs of its construction and maintenance are compared with the system's total economic value, which is the sum of use benefits and non-use values. In order to reveal the latest stated preference techniques, more specifically survey-based contingent valuation method, are widely used in MAR studies. Following the CBA literature, we used the net present value (NPV) as a profitability indicator assessing the economic feasibility of the MAR scheme. NPV is a sum of private and socio-environmental net cash flows (the difference between the present value of benefits and the present value of costs over a selected time horizon). Aiming to estimate both use and non-use (socio-environmental) benefits, we surveyed local farmers and agricultural producers to find out the maximum amount of money that they are willing to pay (WTP)

to have a stable supply of irrigation water, ensuring its quality and improvement of the ecological status of the water body.

It is essential to mention that since today there are no operating underground dams in Hungary, estimates of costs are quite rough with a wide range of possible values. Also, survey results suggest that a noticeable share of individual farmers currently don't normally irrigate crops, thereby direct benefits were estimated under a number of assumptions using very limited data. Thus, obtained CBA results should be treated as more indicative and with a portion of cautiousness.

D. Conclusions

The investigated pilot site is situated in one of the climatically most exposed regions to the effects of climate change, situated in the Maros alluvial fan, in the vicinity of Csanádapáca and Medgyesbodzás. As it is an agricultural region without permanent surface water courses, the water demand is expected to increase in the future. Therefore, managed aquifer systems (MAR) can play an important role in water management. Although, the alluvial environment is characterized by variable geological and hydrogeological conditions, the ancient river channels can be locally favourable for such a MAR scheme. However, detailed field investigations are required to verify the suitability of a selected site.

Studying the feasibility of the underground MAR type several possible solutions were analysed such as underground dam located in the first or in the second aquifer layer, analysis of climate effect considering different recharge values. The different scenarios were compared by hydrogeological modelling. Potential risks have been identified and risk treatment methods have been suggested for all 111 risks. While the hydrogeological modelling was performed for different scenarios, the cost benefit analysis – which beyond the direct costs considered the expected changes of water demand, and socio-economic benefits - has been carried out for one option, for underground dam installed in the uppermost aquifer.

The results based on the available data show that an underground dam MAR scheme would be socio-economically feasible in a long term period.

Join our project actively!

To find out more about our activities please visit the project homepage:
https://www.interreg-central.eu/Content.Node/DEEPWATER-CE.html

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