SET OF POLICY RECOMMENDATIONS TO INCLUDE MAR SOLUTIONS INTO THE LEGISLATION

D.T4.2.2

Final Version

02 2022

Lead Institution	Mining and Geological Survey of Hungary
Lead Author/s	T. Szőcs, Á. Rotár Szalkai, A. Szűcs
Date last release	23-02-2022

Contributors	Institution
Zoltán Püspöki	Mining and Geological Survey of Hungary
Eszter Tihanyi Szép	Mining and Geological Survey of Hungary
Éva Pálfi	Mining and Geological Survey of Hungary
Ágnes Ódri	Mining and Geological Survey of Hungary
Nóra Gál	Mining and Geological Survey of Hungary
Julianna Mekker	Mining and Geological Survey of Hungary
Annie Imig	Technical University of Munich
Arno Rein	Technical University of Munich
Sławomir Sitek	University of Silesia in Katowice
Jacek Różkowski	University of Silesia in Katowice
Marek Sołtysiak	University of Silesia in Katowice
Krzysztof Janik	University of Silesia in Katowice
Andrea Vranovská	Water Research Institute
Dana Vrablíková	Water Research Institute
Štefan Rehák	Water Research Institute
Viliam Novák	Water Research Institute
Božidar Čapalija	Split Water and Sewerage Company Ltd
Robert Hegyi	General Directorate of Water Management
Daniella Micsinai	General Directorate of Water Management
Levente Magyar	Geogold Kárpátia Ltd.
Magdolna Ambrus	Geogold Kárpátia Ltd.

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Foreword

The activities and results presented in this report have been carried out within the framework of the DEEPWATER-CE project, with the aim of developing an integrated implementation framework for Managed Aquifer Recharge (MAR) solutions to facilitate the protection of Central European water resources endangered by climate change and potential user conflicts. This document has been compiled by the Mining and Geological Survey of Hungary (MBFSZ), supported by a working group composed of members of project partners and associate partners AP1 (OVF) and AP2 (ARPA) (see contributors list).

The project DEEPWATER-CE is funded by the European Regional Development Fund (ERDF) via the Interreg Central Europe programme. This report reflects the authors' view and the funding authorities are not liable for any use that may be made of the information contained therein.

1. Introduction, intent of this policy recommendation

Natural groundwater and surface water resources are under pressure because of the increased water demand due to developments in different sectors. This is compounded by the negative impacts of climate change, which reduce rainfall or cause extremities in — especially — surface water yields (IPCC, 2007). Innovative approaches to water usage are needed to meet the increasing environmental and user demands (Bouwer, 2002; Dilllon et al., 2019; Evans and Dillon, 2018; Page et al., 2018).

DEEPWATER-CE project aims at developing integrated environmental management capacities for responsible public actors of CE with a comprehensive transnational approach, to plan and manage water resources by adoption of Managed Aquifer Recharge (MAR) schemes as a potential solution to cope the negative impacts of climate change which induce declines in water supply from groundwater.

This policy recommendation briefly aims to help optimise the use of water resources exposed to climate change in the Central European region. It aims to define the legal, financial, institutional and operational instruments on both local and regional levels, to facilitate safe and proper MAR operations. MAR is defined as the intentional recharge of water into aquifers under controlled (managed) conditions for recovering it later for subsequent use in water scarce periods, for surface or groundwater dependent ecosystems' benefits, for mitigating the impacts of groundwater abstraction, to prevent groundwater pollution, or to control saltwater intrusion.

This policy recommendation applies to MAR operations for drinking and irrigation water supply. Various recharging water sources are considered such as surface water (PL, HR, SK) and groundwater (HU). Reinjection for energy and mining, as well as treated wastewater are excluded. MAR is considered as an additional contribution to an aquifer, not a return of abstracted groundwater (Ward and Dillon, 2011).

MAR types/activities that are considered in this policy recommendations are:

- Induced river and lake bank filtration;
- Aquifer storage and recovery;
- Infiltration ditch;
- Infiltration pond;
- Underground dam;
- Recharge dam.

This policy recommendation applies a comprehensive, multisectoral approach for decision-makers. It describes the main elements and characteristics of the MAR policy, highlighting the key challenges, identifying the current gaps and problems and providing suggestions for future potential solutions.

2. The current MAR policy

The main pillars of MAR policy environment are the regulatory framework, the institutional framework including stakeholders, good practices and public awareness, which need to be established and harmonized for any MAR applications (Figure 1) as a useful tool of integrated water resource management.

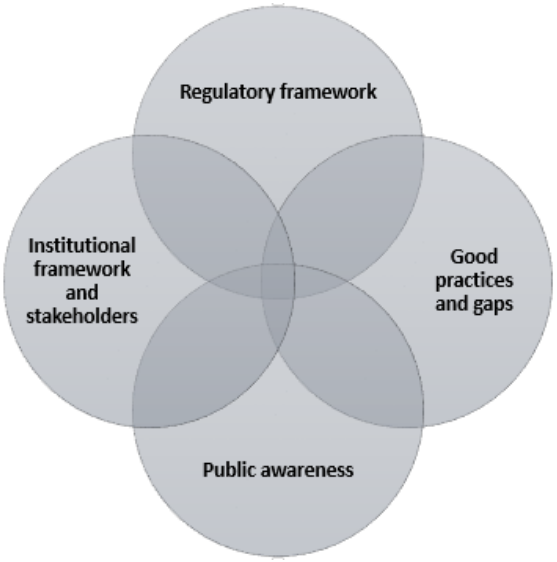

Figure 1. Component pillars of MAR policy.

Regulation is required in order to control activities that might influence the quantity and quality of water resources which are the inherent components of the MAR scheme. This should be harmonized with different national environmental strategies. Due to the different vulnerability and allocation limits for water resources, recharge and recovery water for MAR are proposed to be managed separately.

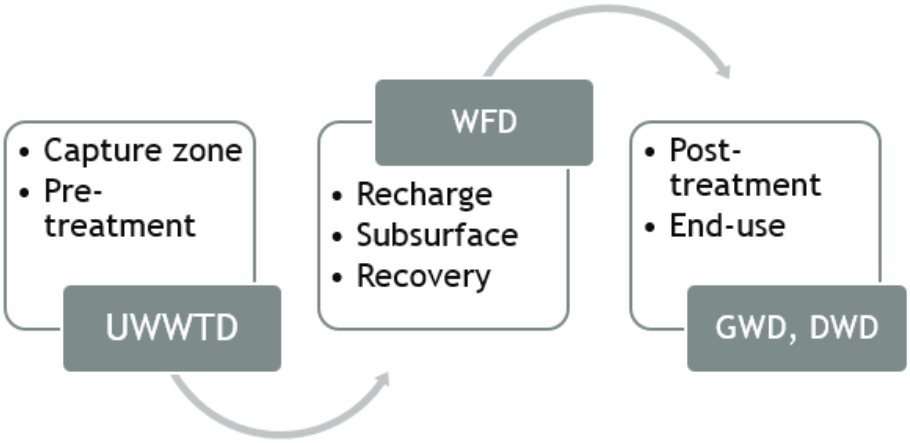

Figure 2. Compliances of the most relevant directives (Urban Wastewater Treatment Directive (UWWTD), Groundwater Directive (GWD), Water Framework Directive (WFD), Drinking Water Directive (DWD)) to the phases of MAR application modified after Fig. 2 in DEMEAU Project, (2012).

The general governing instruments of the regulations are the EU Directives and EU Framework Directives, which are adopted in the national legislations of the CE countries and can relate to the different elements of MAR applications (Figure 2). The national or regional legal instruments are provided by laws and acts, government decrees and ministerial decrees for regulation and implementation. The basic tools for the

implementation of the EU Directives are the main national strategies (eg. Climate Strategy, Water Strategy). An overview of the legislation in the project partner countries has been carried out within the frame of the DEEPWATER-CE project (DEEPWATER-CE, 2021a).

The institutional arrangements for the management of MAR applications and water resources should bring clarity to the roles and responsibilities of the national and/or regional institutions responsible for water resources. The structure of the organizations with responsibilities for both surface and groundwater has to ensure a univocal background for the implementation of regulations and water resource management. This also comprises the financial actors, operators and the authority for monitoring of a MAR project. The problem of groundwater management receiving inadequate attention under this arrangement needs to be addressed in most of the CE countries.

Well-informed, trained communities, spatial planners and water users are able to better scope out the innovative solutions providing more sustainable and attractive water management tools. Scientists have a special responsibility in raising awareness on the role that MAR can play in water management, and in guiding communities towards such novel solutions in the Central European region. Therefore, informing stakeholders and the general public is an important element of MAR policy.

Knowledge is gained through experience from around the world and provides some examples of good practices which can enhance the effectiveness of MAR applications (DEEPWATER-CE, 2020). Additionally, gaps need to be identified to assure a wider application of MAR.

3. What are the key challenges for MAR policy?

The key challenges of MAR policy implementation (which are also discussed in detail in chapter 4 of DEEPWATER-CE, 2021b) can be related to (1) technical, (2) environmental and health, (3) economic/financial, (4) social, (5) governance and (6) legislation issues. This is in line with the PESTLE (Policy, Economic, Social, Technological, Legal and Environmental issues) concept in policy development (Morrison, 2013).

Based on the experience gained within the framework of the DEEPWATER-CE project, we consider the following key challenges:

- Enhancement of the sustainable yield for the various, sometimes competing, end uses of groundwater. Overexploitation or effects of climate change can deplete the aquifer, therefore groundwater levels are significantly decreasing seasonally or on long-term.
- Retention and storage of excess surface or groundwater for future needs, due to seasonal or periodical changes and water demands (e.g. vegetational periods, ecological needs, touristic season).
- To improve existing groundwater quality of naturally or anthropogenically polluted areas, or to maintain good chemical status of groundwater bodies, as defined in WFD and RBMP.
- Lack of specific legislation related to MAR schemes regarding the above (1) — (6) aspects, and also the implementation phases of the MAR schemes throughout Planning →Operation and Maintenance →Final Use and Distribution phases. Additionally, capture and recharge of source water as well as recovery of groundwater for users has also to be addressed.
- Monitoring of groundwater quality and quantity parameters through the entire lifespan of MAR scheme to ensure the safety of the environment and human health, as well as to improve data and information for decision making.
- Lack of knowledge of the general public about MAR solutions.
- Lack of stakeholders' engagement.

4. Analysis assessing the necessity of adopting MAR policies, laws and regulations, gaps of current practices

The assessment of the necessity of adopting MAR policies, laws and regulations is presented in a SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis considering the PESTLE approach.

Table 1. SWOT analysis related to MAR considering the PESTLE approach.

STRENGTHS	*OPPORTUNITIES*
• there is a growing interest in MAR applications • there are worldwide good practices examples • operation of MAR can be more cost efficient as non nature-based solutions such as dams and water treatment plantsexcess water can be collected and stored for later recovery • several MAR technologies and their combinations exist and can be applied • EU water related legislation is already being transposed to national legislations • MAR helps achieving the good groundwater quantitative and qualitative status through the replenishment of aquifer	• good policy can support sustainable management of water scarcity • MAR systems can have a positive impact on the development of different sectors (eg. agriculture, tourism) and therefore increase their economic development and the regional progress • MAR technologies and their combinations can be applied in a variety of geological-hydrogeological environments • the technological development increases the effectiveness of MAR systems • clear framework policy exists already for water governance in the EU, therefore MAR-related legislations are possible to be integrated into it • mitigating climate change effects • improvement of groundwater quality at polluted sites •
WEAKNESSES	*THREATS*
• MAR policies are missing from the national environmental and water strategies in most of the the CE countries • due to traditions surface water reservoirs are preferred to MAR, still nowadays; MAR is not considered as an alternative solution • extra financing is required for installation • financing system does not exist in the CE countries, lack of private/public funding • lack of knowledge of the public, planners and legislators about MAR solutions • chemical, physical, biological clogging-related to recharge and subsurface storage • not sufficient source water availability or not sufficient geological conditions • specific regulations for MAR systems are missing • poor quality of source water	• there can be a long time between the realization of the need for MAR and its implementation in the legislation • willingness of stakeholders to finance MAR is minimal • economic risks due to possible low price of water, which decreases the competitiveness of MAR • uncertain economic sustainability • unplanned costs regarding MAR installation and maintenance • there is a risk for public unacceptance of MAR • engagement of public and policy makers is low • a specific selected MAR technology might not necessarily ensure the required amount or quality of wateemerging or other contaminants in source water might be present in the recovered and distributed groundwater even when applying novel MAR technologies • potential risks related to the ownership and water distribution • questions of land expropriations • missing of legal regulation on recharged and recovered water quality or not harmonized with other relevant legislation and rules • recharged MAR water mixing with groundwater of different chemical composition which might have negative impact on groundwater quality

5. Policy recommendations in order to implement MAR solutions

In order to achieve a wider applicability of MAR in CE, the integration of objectives and measures for the use of MAR systems into each country's strategic planning documents, in particular into the documents of water management, river basin management plans and climate adaptation, is needed. It is advised to define it both on local and on regional levels. In total five key issues are identified in this document, for which policy recommendations are proposed and a short rationale is given.

Issue 1: Elaboration of a strategy on MAR applications.

Recommendation:

- Integration of the objectives and measures for the use of MAR systems into each country's strategic planning documents, in particular the documents of water management and climate adaptation.
- A "National Strategic Plan for the application of MAR systems" should be prepared, which will cover the entire life cycle of a MAR scheme, including its sustainability, and risk assessment.

Rationale:

In order to provide a profound basis for the implementation of MAR solutions, the complexity of the issue needs to be accounted for. National strategies and action plans outline the strategic framework, help establish a planning process, identify priorities, promote effective management and drive implementation of MAR schemes on a longer time scale and in a possibly wider context. They are not binding legally, though are considered important to succeed in legislation. Strategic planning should be objective, evidence-based, as much as possible, should provide clear vision, give forecast and compare alternative scenarios and solution possibilities. With respect to MAR, Water Management Strategy and Climate Adaptation Strategy are the two most relevant ones.

It is suggested to set up a special working group of experts in hydrogeology, economics, and risk analysis to contribute in the preparation of national MAR strategies/action plans, as it is in the case of the Water Safety Plans, for example.

Issue 2: Regulations on MAR in a comprehensive way

Recommendation:

- A detailed system of regulation and licencing of MAR methods should be established.
- The regulatory and licensing specifications for the implementation of MAR systems differ from country to country, which must be considered during this process.
- Direct and indirect incentives should also be developed.

Rationale:

Development of regulations which cover the entire life cycle of MAR activities, sustainability, and risk assessment. Regulations on water accessibility through MAR system, entitlement, tradability and obligations and conditions of water use should be established. The regulations for the implementation of

MAR systems differ from country to country, which must be considered during this process.

Water price policies should also reward the sustainable water management solutions and sanction the non-sustainable solutions. Additionally, each specific sector needs direct incentives to speed up the investments.

Financial assets, resources have to work on the principle of user/polluter pays.

According to the WFD, the poor status of groundwater chemical status can be caused not only by pollutants, but also by a trend change in natural background values, e.g. easily accessible in a saline area with long-lasting surface water replenishment. Therefore, the scope of the regulation should be extended to all types of source water for recharge in addition to those containing potentially polluting substances. However, it is worth restricting the scope of the regulation according to the amount of water leaked.

MAR systems shall be installed based on extensive, detailed examination, monitoring and experimental testing of the local conditions.

Regulation of good practice for using wastewater as source water for MAR needs to be developed.

An economic action plan for MAR implementation is suggested to be prepared to promote the construction of MAR systems.

Issue 3: Suggestion of MAR incorporation into executive documents (e.g. River Basin Management Plans)

Recommendation:

- It is necessary to include the review of the applicability of MAR methods into the River Basin Management Plan (RBMP) revisions, especially in regions exposed the most to the negative effects of climate change and in the water bodies with poor conditions or at risk of contamination, as an important tool for integrated water resources management.
- Potential areas for the implementation of MAR systems can and should be determined based on the environmental assessments of the River Basin Management Plans.

  while considering the following issues:

- MAR systems can be installed based on extensive, detailed examination and experimental testing of the local conditions.
- During the construction of dams and reservoirs for any purpose, the possibility of unintentional groundwater recharge in the vicinity of these facilities should be evaluated to minimise evaporation and leakage.
- Focus on the design of effective monitoring of selected indicators during the operation of the MAR systems (e.g. physico-chemical properties of source water, surface water and groundwater levels, injected yields, water treatment parameters, etc.), and regular evaluation of obtained data during the lifespan of the MAR system.

Rationale:

The poor quantitative status of groundwater bodies is caused by groundwater overexploitation (abstracted water amount exceeds the recharge in a long term). River Basin Management Plans formulate measures for the protection of surface and groundwater-dependent ecological systems and the sustainable water uses. However, groundwater systems are characterized by slow processes, therefore groundwater levels will not necessarily rise as a result of the above measures and that groundwater-dependent ecosystems

will not regain an adequate amount of available water. Thus, MAR systems are suggested to be applied, in order to increase the amount of groundwater that can be extracted without further deteriorating groundwater bodies with poor quantitative status. Improvement of groundwater quality status is also a slow process, in which MAR systems can play an important role.

MAR-specific measures should be incorporated into RBMPs.

At present, MAR is not a supported activity to protect groundwater. In the context of groundwater vulnerability, this could be completely ruled out in some areas but permissible in others. This measure is also in the interest of surface water management.

Indicators of the measures can be e.g.: rising groundwater levels, the quantitative status of the groundwater body, amount of wastewater recovered, amount of water replenishment, groundwater ecosystem assessment.

Issue 4: Improving information on applicability and implementation of MAR for decision making

Recommendation:

- It is necessary to promote MAR solutions in water sector via River Basin Management Plans (e.g. to include MAR schemes into RBMP´s revision)
- It must be noted that MAR systems can be operated only in parallel with the operation of a properly designed monitoring system, which covers all the aspects, including the viability and life cycle of a MAR system.

Rationale:

MAR has a vital role in managing the reduction of the vulnerability and enhancement of the resilience to the effects of climate change. In order to tackle these challenges, the understanding of the impacts, vulnerability and risks need to be strengthened through data collection, monitoring, analyses and assessment. For the sustainable management of the available resources among competing users and also to ensure safety, promoting environmental assessment, screening and experimental testing of local conditions are needed.

Research and development of the projects tailored to regional conditions, and also pilot studies of different MAR types and different priority problems can contribute to this significantly.

Issue 5: Education of professionals and public awareness raising on MAR applications
Recommendation: • The National Strategic Plans and the benefits of MAR systems must be disseminated in the society, educational organisations, decision-making organisations, NGOs and other relevant authorities. • The engagement of the experts, as well as water and climate research-related institutes should be increased.
Rationale: Stakeholders are often not trained in hydrogeology, MAR or in the potential impacts of climate change on water resources. Therefore, they are often reluctant on applying new technologies like MAR, which are not widespread in CE. Additionally, concerns are raised on water quality aspects. Suitable tools for public awareness-raising are leaflets, educational films, presentations, public, school and university handouts and MAR sites visits, trainings, distributed via media (websites, applications, social media channels, etc.). The development of a pilot project for educational and demonstration purposes can play a major role during such promotions.

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