Monitored and Intentional Recharge (MIR). Methodological approach and guidelines

Enrique Fernández-Escalante*, José David Henao Casas & Jon San Sebastián Sauto
Tragsa Group (Spain)
*E-mail: efernan6@tragsa.es**

KEY WORDS
Monitored Intentional Recharge (MIR), Managed Aquifer Recharge (MAR), guidelines, regulations, water quality standards, artificial recharge, Maximum Allowable Concentrations (MACs), monitoring.

ABSTRACT
The guidelines for the implementation of MAR projects are scarce, and most of the technicians and practitioners are using the Australian Guidelines from 2009 and the ASCE ones from 2020. There are some drafts from the European Commission, 2018; and the most employed in developing countries are the WHO standards from 2006. Some important lessons and recommendations have derived from the analysis of 18 different regulations, guidelines, and operator rules, proceeding from the five continents. Also, intentional recharge with reclaimed water (SAT-MAR) is meeting severe constraints to be implemented. Any adapted multi-barrier and multi-level approach should consider not only hydrogeochemical criteria but rather the whole MAR-related aspects from both, technical and organizational approaches.

Within this context, Monitored Intentional Recharge (MIR) acquires whole sense in the implementation of MAR systems, considering inbuilt system control, mechanism tests, monitoring systems for groundwater, surface water, and risks/impacts assessment. The operation between the temporary allowance and the full operational permit must be under permanent control.

Nowadays, it is necessary to establish the basis for future guidelines, at least for the European Union. Among these MAR features, the most remarkable to have into consideration may be:
-Water sources or origin of the water to be "*MARed*" (e.g. treated wastewater, river water, rainwater, etc.)
-The environmental conditions in which MAR activities take place (climate, type of aquifer, materials, and self-purification capacity of the receiving mediums).
-The MAR technologies and systems (taking into consideration the soil and the aquifer beneath, e.g. basins, canals, wells…).
-The sensors used for monitoring and tracking the evolution of the system (water table, specific quality parameters, aggregated water quality indicators, flow rate, humidity, etc.)
-The final use of the water once recovered (e.g. irrigation of crop-lands, urban water supply, positive hydraulic barriers against seawater intrusion, etc.)
-The guidelines for monitoring the water evolution (in both, quantity and quality) and the consequent water security, food safety, and public health, i.e. the exact point of monitoring, the sampling frequency, the data gathering system (remote, on-site, in real-time), the set of parameters to be analyzed, the database structure under standardization, interoperability and ontologic criteria, the track of indicators for emergent pollutants, the cost of the analyses and the degree of involvements of end-users and stakeholders in the process (Co-MAR), etc.

This paper sheds some light on the guidelines-making process so that they count on scientific and legal assessment (including SAT-MAR), proper monitoring… to meet the water security requirements at aquifer scale counting on water quality standards for MAR.

Finally, some recommendations to assist decision-makers in the regulatory and operational frameworks regarding MAR guidelines are:

-A common terminology must be adopted for all the countries using the proposed guidelines, e.g. at the European level.
-Every multi-barrier and multi-level approach should be "aquifer-wide". Common regulations cannot be valid for a country with several aquifers with different properties.
-Distinction must be addressed depending on hydrogeochemical criteria, i.e. the source of water, the aquifer characteristics, the system of recharge, and the final use. Different Maximum Allowable Concentrations (MACs) may apply for each case.
-There is a need for legal guidelines development to acquire a mandatory character.
-Tailor-made water quality standards and MACs should be assessed for each case based on the previous criteria.

-Authorizations for MAR and SAT-MAR systems must be based on a technical background using the proposed guidelines. After a consensus process, the rules for water and environmental authorities to grant permission should be established, common for all the states sharing the guidelines.
-Control and surveillance mechanisms independent from water authorities would be an asset.
-An aquifer-scale risk assessment system should be included in the guidelines for each MAR regulation.
-The stakeholder´s involvement and a bottom-up approach in decision-making add value to the policy process.
-It is important to count on economic and legal feasibility in the implementation programs.
-Early-MAR countries usually adopt the WHO guidelines when MAR activities are developed, especially regarding water quality.
-The guidelines might pursue dialogue, a consensus, final agreement and to be specifically adapted for each site.