Groundwater

Guest Editorial/

Managed Aquifer Recharge: A Proven Technology for Water Supply Resilience

by Timothy K. Parker[1], William M. Alley[2], and Charles A. Job[3]

Managed aquifer recharge (MAR) is "the purposeful recharge of water to aquifers for subsequent recovery or for environmental benefit," a definition accepted broadly and by the NGWA MAR Work Group. Surface infiltration basins and well injection are the two main methods of MAR in the United States, although many other methods are being used, including in lieu recharge, bank filtration, dry wells, etc. At a time of widespread groundwater depletion and increasingly dramatic swings between wet and dry conditions, MAR can help provide water supply resiliency for communities and industry, small and large. *Groundwater* journal found it timely to devote a special issue to MAR, focused largely on North America to provide case studies, lessons learned, innovations, and some context on regulations of this important water management approach. This special issue supplements recently published international compendiums of MAR case studies, overview, and governance (Zheng et al. 2021; Dillon et al. 2022).

MAR is not new by any means, having been practiced for decades and even centuries in some locales. Recharge water may be stored in a wide spectrum of confined and unconfined aquifer types, from unconsolidated alluvial deposits to karstic and fractured rocks. The current focus in many areas is on increasing and enhancing MAR to manage water supply through droughts and provide increased water supply reliability as demands grow and hydrology changes due to climate and human modifications of the land surface.

In California alone, under the 2014 Sustainable Groundwater Management Act, new groundwater sustainability plans submitted to the state propose more than 2.5 million acre-feet (3 km^3) of MAR annually, at a projected capital cost of US$3 billion. MAR may be one-third or less of the cost of traditional surface water reservoir storage and without the evaporative loss. Not only in the West, but across the United States, states and communities are addressing groundwater governance factors in water rights, availability, and access at MAR sites to respond to water supply and quality management challenges. Similar actions are taking place throughout the world.

The sophistication of MAR has grown in the past 50 years with innovative supply strategies, institutional arrangements, technologies for optimized approaches, and enhanced monitoring and management tools to improve performance and accounting of water recharged, stored, and recovered. Recycled water is also playing a much larger role as a reliable source water for MAR. Indirect potable reuse using groundwater as an environmental buffer provides the benefits of dilution and attenuation of contaminants by biological, chemical, and physical processes and helps address perception issues. Institutions have been able to utilize in lieu recharge and institutional agreements to store groundwater by substitution of surface water, as well as water markets and trading to allow access to water that may not otherwise be available to recharge. Surface and advanced borehole geophysics and other technologies have improved and become relatively more cost-effective over the past few decades to improve subsurface understanding and design of MAR systems for better performance and improved project success rates. MAR project monitoring also has improved as has access to sophisticated online water market tracking for users.

On-farm recharge at locations of permanent crops has received a lot of attention and investment for research and pilot projects in the past decade. The agricultural and water industries are assessing how to recharge from the locations needing it most, in agricultural fields. The challenges are huge, from possible crop damage from shallow submergence to potential mobilization of nitrates and pesticides, but the potential payoffs may be even greater by being able to recharge aquifers depleted by agricultural pumping at the source without significantly reducing food production.

[1]Corresponding author: Ramboll USA, 2200 Powell Street Suite 700, Emeryville, CA 94608; tkparker@ramboll.com
[2]National Ground Water Association, Leesburg, VA, 20176; walley@ngwa.org
[3]National Ground Water Association, Montgomery Village, MD, 20886; cjob@ngwa.org

doi: 10.1111/gwat.13222

Forecast informed reservoir operations is another water management leap being made to modify dam operation rules to reflect operational capabilities created by improved weather forecasting. The approach basically applies advances in weather forecasting capabilities and technologies to reduce reservoir flood control reservation volume compared to historical operations, thus preserving more reservoir water that can be used for MAR.

Whatever your area of expertise or interest, we hope you will find this MAR publication useful for your work in groundwater to help increase recharge, reduce depletion, improve water quality, and increase water supply reliability and resilience in your area.

References

Dillon, P., W. Alley, Y. Zheng, and J. Vanderzalm (eds.). 2022. Managed aquifer recharge: Overview and governance. IAH Special Publication. https://recharge.iah.org/ (accessed July 08, 2022).

Zheng, Y., A. Ross, K.G. Villholth, and P. Dillon. 2021. *Managing Aquifer Recharge: A Showcase for Resilience and Sustainability*. Paris: UNESCO. https://unesdoc.unesco.org/ark:/48223/pf0000379962