Managed aquifer recharge implementation criteria to achieve water sustainability

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Presenter: Huu-Duc Truong

Advisor: Prof. Shih-Jung Wang

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Abstract

In recent years, the demand of groundwater resources increased to serve urban areas, agriculture, energy, and other industries. Therefore, the study of measures to manage groundwater resources is developed in many countries. Managed aquifer recharge (MAR) is a typical groundwater management approach because it is easy to execute, the evaporation loss less than surface reservoirs, and can use water from several sources, such as river and agricultural run-off and treated municipal wastewater. This study analyzed 1127 MAR projects from which to provide a framework to select and implement specific MAR at a site based on water availability, land use, source of water, soils, and aquifer properties. The result shows that MAR projects have been predominantly implemented in sites with sandy clay loam soil (soil group C) and have access to water available for recharge. Besides storage and balancing water flow, MAR also can remove pollutants, but the removal efficiency can vary with MAR design and site conditions. Depending on the type of pollutants and MAR technology, pretreatment of the recharge water or post-treatment of the recovered water may be necessary before its usage. However, MAR facilities need to be carefully designed as improperly designed MAR facilities can contaminate the groundwater or waterlog the area and damage crops.

Keywords: Managed aquifer recharge (MAR), Groundwater Resources, Sustainable groundwater management.

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Review

Managed aquifer recharge implementation criteria to achieve water sustainability

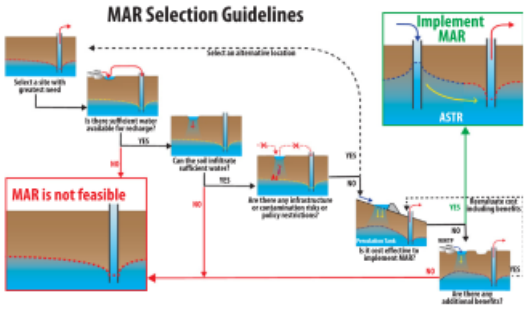
Sarfaraz Alam [a], Annesh Borthakur [a], Sujith Ravi [b], Mekonnen Gebremichael [a], Sanjay K. Mohanty [a,*]

[a] Civil and Environmental Engineering, University of California Los Angeles, CA, USA
[b] Earth and Environmental Science, Temple University, PA, USA

HIGHLIGHTS

- MAR selection depends on soil properties, water availability, and water quality.
- MAR is applied predominantly in sites with sandy clay loam soil with access to river.
- MAR can remove Pb, Zn, *E. coli*, DOC but is ineffective at removing trace organics.
- MAR could minimize flood risk, land subsidence, and salt-water intrusion.
- Source water conveyance and policy restrictions could prevent MAR implementation.

GRAPHICAL ABSTRACT



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ABSTRACT

Depletion of groundwater is accelerated due to an increase in water demand for applications in urbanized areas, agriculture sectors, and energy extraction, and dwindling surface water during changing climate. Managed aquifer recharge (MAR) is one of the several methods that can help achieve long-term water sustainability by increasing the natural recharge of groundwater reservoirs with water from non-traditional supplies such as excess surface water, stormwater, and treated wastewater. Despite the multiple benefits of MAR, the wide-scale implementation of MAR is lacking, partly because of challenges to select the location for MAR implementation and identify the MAR type based on site conditions and needs. In this review, we provide an overview of MAR types with a basic framework to select and implement specific MAR at a site based on water availability and quality, land use, source type, soil, and aquifer properties. Our analysis of 1127 MAR projects shows that MAR has been predominantly implemented in sites with sandy clay loam soil (soil group C) and with access to river water for recharge. Spatial analysis reveals that many regions with depleting water storage have opportunities to implement MAR projects. Analyzing data from 34 studies where stormwater was used for recharge, we show that MAR can remove dissolved organic carbon, most metals, *E. coli* but not efficient at removing most trace organics, and *enterococci*. Removal efficiency depends on the type of MAR. In the end, we highlight potential challenges for implementing MAR at a site and additional benefits such as minimizing land subsidence, flood risk, augmenting low dry-season flow, and minimizing salt-water intrusion. These results could help identify locations in the water-stressed regions to implement specific MAR for water sustainability.

* Corresponding author at: University of California Los Angeles, 420 Westwood Plaza, 5732-C Boelter Hall, Los Angeles, CA 90095-1600, USA.
E-mail addresses: szalam@ucla.edu (S. Alam), annesh@ucla.edu (A. Borthakur), mohanty@ucla.edu (S.K. Mohanty).

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