



## Management of aquifer recharge system

### KEY MESSAGES

1. Groundwater recharge is vital in semi-arid and arid Mediterranean contexts.
2. Managed Aquifer Recharge (MAR) enhances water storage and mitigates depletion.
3. Recharge chambers improve infiltration into existing aquifers.
4. Monitoring hydrogeological dynamics ensures sustainable use of groundwater.
5. MAR supports agriculture by increasing water availability.
6. Surface water availability and geological conditions limit feasibility.
7. Cost and technical barriers require strategic investment.
8. Stakeholder engagement fosters adoption and sustainable governance.
9. MAR can reduce drought impacts and enhance water security.
10. Business opportunities exist in infrastructure and water management

### SUMMARY

The Mediterranean basin is increasingly threatened by water scarcity, characterized by a growing gap between escalating demand and dwindling natural supplies. Managed Aquifer Recharge (MAR) represents a proactive water management strategy that involves the intentional injection or infiltration of excess surface water (such as rainwater, treated wastewater, or storm runoff) into underground aquifers for later recovery or environmental benefit.

In the context of the Salam-MED project, the focus is on optimizing existing infrastructures in arid regions like the Koutine watershed in Tunisia. The core challenge lies in the "mismatch" between the timing of water availability (short, intense flash floods) and agricultural needs. Related themes include Sustainable Land and Water Management (SLWM), hydrological modeling, and the preservation of groundwater-dependent ecosystems. By utilizing subsurface storage, MAR offers a cost-effective alternative to surface reservoirs, which suffer from high evaporation rates and land footprint issues. This approach not only addresses water quantity but also focuses on "water polishing" through natural soil-aquifer treatment (SAT) processes.

### RESEARCH AND RESULTS

Salam-MED research highlights the critical role of innovative geophysical surveys, such as Electrical Resistivity Tomography (ERT), in designing effective recharge chambers around traditional wells. In the Koutine watershed, modeling results (using



tools like SWAT and WEAP) demonstrate that implementing Water Harvesting Techniques (WHT) and MAR structures can increase groundwater recharge by approximately 5% to 7% compared to natural conditions. Research indicates that without intervention, aquifer storage in these regions could decrease by over 75% by 2050 due to climate change. Conversely, the integration of recharge chambers with smart irrigation practices at the farmer scale has shown a dual benefit: increasing crop yields while simultaneously reducing the net extraction pressure on the aquifer. Field data confirm that MAR significantly slows down regional salinization—a major threat in overexploited coastal areas. However, results also point to technical challenges such as well clogging and the need for rigorous monitoring, as occasional fluctuations in recharge water quality (e.g., nitrates or salinity) can impact localized groundwater characteristics if not managed through predictive modeling.

### RECOMMENDATIONS

- Institutionalize MAR in National Water Strategies: Policymakers should officially integrate Managed Aquifer Recharge into River Basin Management Plans. MAR should be recognized not just as an experimental tool but as a standard component of integrated water resource management (IWRM).
- Incentivize Private-Public Partnerships: Encourage investment in MAR infrastructure through subsidies or tax incentives for agricultural cooperatives. Since the economic benefits are closely tied to increased crop productivity, funding mechanisms should support both large-scale recharge structures and on-farm smart irrigation systems.
- Establish Standardized Monitoring Protocols: Implement mandatory, real-time monitoring of groundwater levels and quality (chemical and microbial). This is vital to ensure that the water recharged into the aquifer meets safety standards for agricultural and domestic use, preventing long-term degradation.
- Prioritize Advanced Site Selection: Utilize geophysical and topographical surveys (like ERT) to identify high-permeability zones. Avoiding poorly suited sites prevents technical failures such as groundwater mounding or rapid runoff without infiltration.
- Implement Clogging Prevention Programs: Provide technical training and funding for the maintenance of recharge wells. Physical and chemical treatments for clogging must be part

of the operational budget to ensure the longevity and effectiveness of the infrastructure.

- Promote Integrated Land Management: Combine MAR with upstream sustainable land practices, such as leveled terraces and wadi stream-bed modifications. This reduces sediment load in recharge water, minimizing clogging risks and maximizing the volume of water captured.
- Foster Local Stakeholder Engagement: Adoption is higher when local farmers are involved in the design and management process. Educational programs should highlight the long-term benefits of MAR for local income and climate resilience to prevent the "rural exodus."
- Adopt Decision Support Systems (DSS): Use modeling tools (like those developed by Salam-MED) to simulate future climate scenarios. This allows managers to adapt recharge schedules and volumes according to predicted drought cycles and changing precipitation patterns.



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