Mashreq Waters Knowledge Series Disruptive Technologies for Improved Groundwater Management in the Mashreq Region

Innovative Groundwater Storage and Managed Aquifer Recharge

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Water Harvesting: what is in a name?

Water harvesting: interventions to store water during periods of excess water for use during periods of shortage. Different names used:

- (Rooftop) Rainwater harvesting,
- 3R (Recharge- Retention - Reuse)
- Water Buffering
- Soil and Water Conservation (SWC)
- Managed Aquifer Recharge (MAR)

Managed Aquifer Recharge (to supplement the natural groundwater recharge): interventions to intentionally recharge an aquifer under controlled conditions for later recovery, environmental benefit, or to mitigate the impacts of over abstraction
Framework for managing the water buffer

Rainfall and evapo(trans)piration

- Roofs and paved surface
- Land surface
- Open water

Surface run-off and natural infiltration

Streambed flow and natural infiltration

NATURAL RECHARGE

Reducing Flash floods & river flows

Reducing Evapo(transpiration)

Increasing the water buffer

Closed storage in tanks (rain) C

Groundwater storage A

Soil moisture storage B

Surface water storage D

RECHARGE RETENTION & REUSE -3R- SOLUTIONS

MAR: managed aquifer recharge
The storage options

- Blue water incl. MAR
- Green water incl. SWC
# MAR typologies

<table>
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<tr>
<th>Riverbed Infiltration</th>
<th>Land Surface Infiltration</th>
<th>Direct Infiltration</th>
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<tr>
<td>• Sand Dams</td>
<td>• Infiltration ponds</td>
<td>• Infiltration wells</td>
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<td>• Sub Surface Dams</td>
<td>• Trenches, drains, ditches</td>
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<td>• Recharge dams / Retention Weirs</td>
<td>• Wetland protection</td>
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<td>• Floodwater spreading</td>
<td>• Dune infiltration</td>
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[Images of various infiltration methods]
Developments in the last 15-20 years

- Documenting and sharing experiences from around the world:
  - IAH- UNESCO Strategies for MAR (Ian Gale / Peter Dillon) 2005
  - IAH - MAR Symposia every 3-4 yrs since 1988 (nr 11 in 2022) [www.IAH.org](http://www.IAH.org)
  - Series of booklets in Water buffering: [www.bebuffered.com](http://www.bebuffered.com)

- Evolvement from a typical (semi)arid solution for rural water supply >> to application in industrialized, intensive agricultural and densely populated areas for different uses (water quality, climate change, environmental protection).

- In rural setting: development of (remote sensing) tools for mapping, design and impact assessment of dams, catchment-based /community-based approach, solar energy

- In urban/industrialized setting: technology development in construction (ASR, ASTR), remote control & monitoring (dashboard)

- Linkage with IWRM, integration in catchment management and physical planning, financing instruments (climate funds, IFI)
Scaling up sand dams & subsurface dams

Worldbank Somalia/Biyoole Project / $0 Million USD
Water for Agro-pastoral Productivity and Resilience

Sand dam in dry season

Sand dam during runoff

Wadi Evaluation Tool
Kenya: water buffering in dry lands

Topography (DEM)
Geology
Rainfall (TRIMM)
Landuse
Soils
Population
Classification with potential recharge/storage method:

- Class 1, slope 2° - buffer 5km, sandy riverbeds:
  - In-stream - riverbed storage
  - Runoff reduction
  - Off-stream storage reservoirs

- Class 2, alluvium along rivers:
  - Riverbank infiltration
  - Wells

- Class 3, alluvium:
  - Direct aquifer infiltration
  - Landsurface infiltration
  - Wells

- Class 4, other sedimentary formations:
  - (direct) aquifer infiltration, landsurface infiltration
  - Open water storage

- Class 5, Non-sedimentary formations with sandy soils:
  - (direct) aquifer infiltration
  - Land surface infiltration
  - Open water storage

- Class 6, Non-sedimentary formations with clay soils:
  - Open water storage
  - Closed storage tanks

*This map is prepared to provide an indicative and generalistic overview of the SIR potential in the area. No rights can be derived. The actual on-ground situation might vary from what is indicated in the map. A local study is required to determine actual situation and potential for specific interventions.*
Catchment based multiple interventions

Stone bunds
Check dams
Sand dam
Subsurface dam
Participatory planning process

Based on facts and knowledge of all stakeholders, sustainable strategies and measures are determined.
Agricultural MAR in coastal zones

- EC
- Drainage
- Filter
- Storage of fresh water
- Quality improvement
- Less water needed (<50%)
- Higher yields due to fertigation
- Better water quality reduces plant diseases for certain crops

Brackish groundwater
MAR for RWS in coastal Bangladesh
Conclusion

• MAR is about increasing additional groundwater storage and therefore is a water harvesting measure which has specific advantages for improving resilience under the present challenges to cope with the impacts of climate change (drought, floods) and pollution threats due to population growth, urbanization etc.

• Sharing the MAR technology development and operating experiences in the different countries and for different purposes and scale will greatly help to expand its application and use.

• In the same time, the sustainability of MAR system in the rural sector will greatly benefit from a community based approach in planning, design, construction and management.