SAPHPANI

Natural Treatment Systems for Safe and Sustainable Water Supply in India: Results from the "SaphPani Project"

Best Management Practice Fact Sheet on Managed Aquifer Recharge

I. What is Managed Aquifer Recharge (MAR)?

Managed Aquifer Recharge (MAR), previously known as 'artificial recharge', is the *deliberate* storage and recharge of surface water in aquifers by modifying the natural movement of surface water through a variety of techniques. The main purpose of Managed Aquifer Recharge is to augment groundwater resources by storing excess surface water for later use and restore groundwater levels which may have been depleted due to over-abstraction (UNESCO-IAH, 2005), thus enhancing the sustainability of groundwater development.

MAR is also employed to address water quality issues, notably rising salinity, by improving the quality of existing groundwater through dilution, as well as removing bacteriological and other impurities from poorer quality surface waters (e.g. treated waste water) through geo-purification and natural attenuation so that it is suitable for re-use. The groundwater depletion in an aquifer can be restored by MAR. As an example, MAR through percolation pond will replenish the depleted aquifers and mitigate seawater intrusion by improving the groundwater quality (Figure 1).

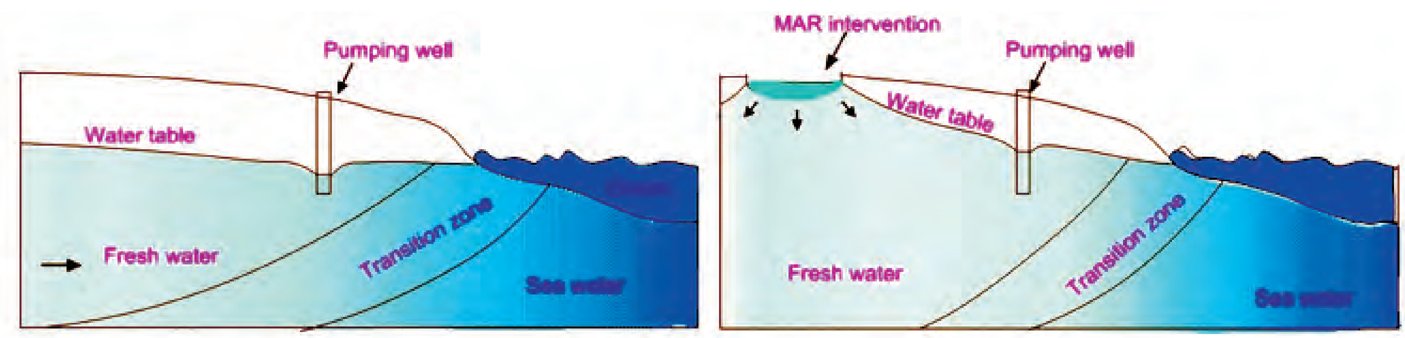

Fig-1: Percolation pond for mitigation of seawater intrusion (Deliverable D 2.1, Saph Pani)

II. Where can MAR be used?

MAR is used in many countries to enhance water supplies, particularly in semi-arid and arid areas. MAR can be employed at varying scales and complexities, from backyard infiltration and recovery systems to large-scale augmentation of drinking supplies.

India has a long tradition in implementing MAR schemes. Artificial recharge of groundwater is one of the oldest activities undertaken all over the country to conserve rainwater above ground and underground. Since the 1970s, numerous watershed development programs (WDP) have been implemented. They include the construction of check dams, percolation ponds or other structures to recharge water to the aquifers.

MAR can be implemented in areas where

- Water supply has to be improved
- Groundwater quality has to be improved and saline water intrusion has to be controlled in coastal aquifers
- Floods and flood damage are to be mitigated
- Excess surface water flows or other potential water sources are available
- The hydrogeology is suitable for the smooth functioning of MAR structure
- The construction and operation of the MAR structure are feasible.

MAR can be generally practiced in regions having

- Unconfined aquifers
- Thick unsaturated zone
- High porosity and permeability

III. How Do MAR Work?

MAR improves the groundwater recharge by storing rain water and reducing the run off or by recharging surface water or treated water by wells. Thus, MAR attempts to improve the groundwater recharge much above the natural rainfall recharge. MAR can be achieved by several methods which are shown in Figure 2.

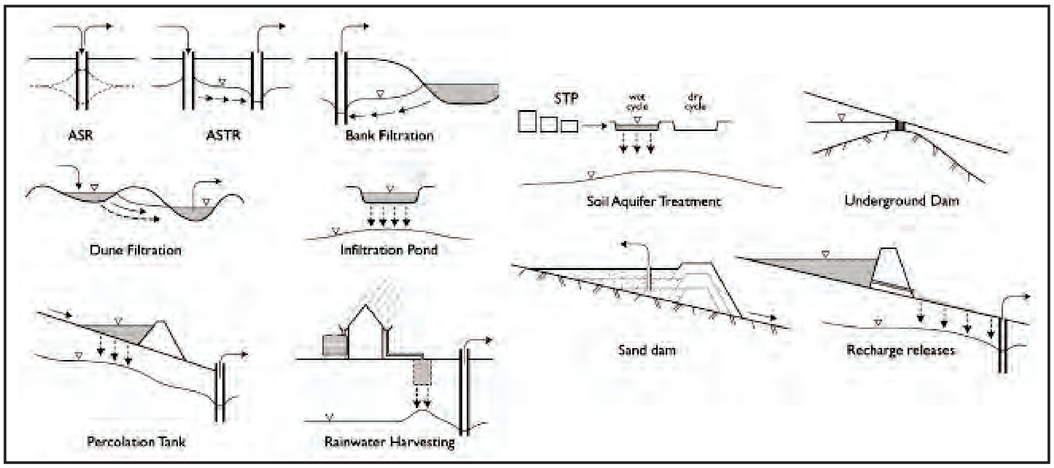

Fig-2. Lay out of different MAR structures

Maheshwaram percolation tank

Check dam in Chennai

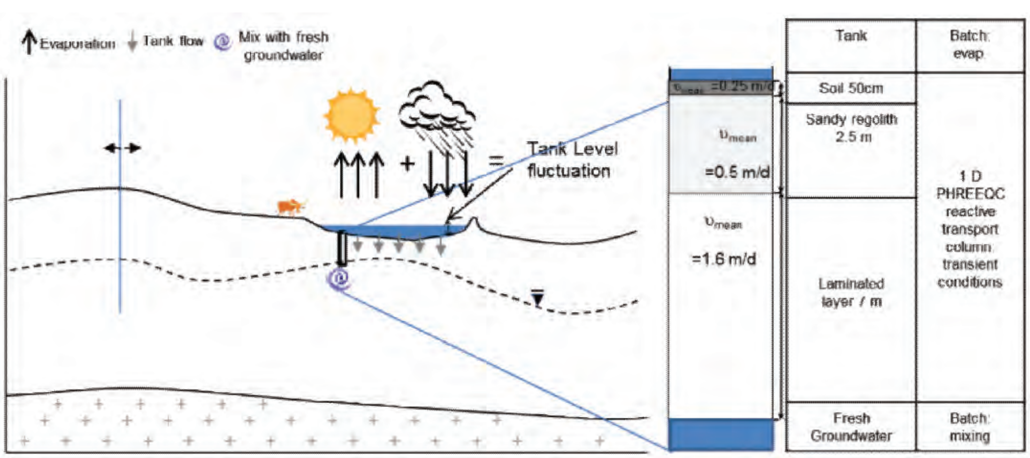

Fig-3. Conceptual model of regolith-hard-rock aquifers in southern India with MAR through infiltration tanks.

IV. Maintenance

There are guidelines and operational recommendations for the proper functioning of managed aquifer recharge structures. In accordance with best management practice, regular monitoring will be the responsibility of the proponent. The management of non potable MAR schemes is usually undertaken by local governments. The proponents of all projects which recharge more than 20 ML/year should install at least one continuous monitoring device (which controls a cutoff valve) for any variable which can be correlated with pollutant sources (Environmental Protection Authority, 2004). It is strongly recommended that a monitoring program be designed and interpreted by a suitably qualified professional hydrogeologist, with the goal of protecting the environment.

At regional scales, the stakeholders in the ownership and management of the MAR systems include the developer, local authority and service provider. The responsibility of developers are water supply, sewerage and drainage infrastructure for the subdivision, that of service providers includes ownership of the assets upon completion of the works and maintenance of these assets in line with their operating licence conditions.

Annual maintenance of percolation pond and check dam includes scraping of the clogging layers at the surface of the infiltration pond to improve the infiltration, removal of sediments in the upstream of the check dam and bund. The recalibration of monitoring equipments at manufacturer's specified intervals, maintenance of Pumps and pre-treatment equipments are to be taken into consideration.

The water storage area of the check dam should be strengthened so as to avoid sliding during monsoon season. Downstream of the check dam should be properly cushioned so as to avoid erosion, which will strengthen the foundation of the check dam. The sluice gate of check dams should be greased be regularly, so that it can be easily operated during flooding. The collapse of sides of percolation ponds during heavy runoff seasons can be reduced by plantation of shrubs around the pond.

V. Performance

Water from the MAR systems is generally well accepted and no problems have been reported. The recharge structures are assumed to provide community-wide benefits, and are viewed as community assets, to be financed and managed by the community.

The benefits of MAR projects especially in urban areas over and above the provision of additional water supply include

- improved waterway health and ecosystem protection,
- flood alleviation and reduced pollution loads,
- reduced asset management costs for storm water and storage infrastructure,
- reduced land-use requirements compared to dams,
- reduced evaporation losses,
- groundwater quality improvement
- changes in quantity and quality of water

Due to the increased agricultural practice near check dam, sustainable food supplies could be made which provided employment opportunities to the farmers. The assured water supply for irrigation improves educational opportunities, health care treatment. *In-situ* benefits include

- reduced groundwater pumping costs,
- a*nd avoid*ance of the need to replace or deepen production wells,
- restoration or maintenance of environmental flows,
- avoidance of land subsidence,
- prevention of seawater intrusion and land subsidence.

VI. Limitations

Even though MAR can enhance the volume of groundwater abstracted, it is not a cure of over exploited aquifers. An integrated program is required to solve the problem of unbalanced distribution of water among upstream and downstream users of check dams. *The common problems that are associated with MAR are management of* clogging, misconception of geology/hydrology, poor design of infiltration structure/borehole, stability of structure/borehole under operating conditions, operation/management of scheme, protection of groundwater quality, loss of infiltrated/injected water, transition from trial to operational scale, policy, societal and religious acceptability, availability and dissemination of information/knowledge, availability of skills and human capacity.

VII. Expected Cost

Implementing MAR structures requires capital and operational costs. A study of the GOI (2007) showed that construction costs per m^3 recharged water vary between 2.5 INR and 455 INR depending on the type of structure applied.

Existing MAR schemes have proven to be a cost-effective water supply measure in comparison to other supply options. The cost of a MAR scheme will depend on the quality of source water, the intended end use for the water, the level of treatment required and any storage or piping costs. Low technology schemes such as controlled flooding / spreading basins and sand dams are less expensive than, for example, borehole injection methods and consequently borehole injection methods are often less viable, particularly for agricultural purposes, although in some areas may be suitable for urban and domestic water use (Water Partnership Program, 2010). This provides an example where the economic feasibility is driven not only by cost, but also other considerations such as the scale of the scheme and the end-user of the water resource. The cost of pilot percolation ponds constructed as a part of Saph Pani project site at Chennai was about 15000/- INR. Considering the annual maintenance expenses, the cost of water recharge works out to be 0.3 to 0.15 INR per litre.

VIII. Additional Information

Recent MAR experience has highlighted numerous impediments to the wider adoption of MAR within existing policies and frameworks for water management. These include lack of certainty around rights and entitlements to source waters, recovery, transfer and pricing. There is a need to build new MAR guidelines to ensure that consistent approaches to the assessment, approval and management of MAR schemes. There is a need to build scientific data base, sound protocols for the validation and verification of MAR schemes. It is necessary to fill other research gaps including the mapping of groundwater systems to ensure MAR activities do not impinge on each other or the environment.

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