Managed aquifer recharge (MAR) in Punjab and Haryana: A strategy for groundwater sustainability

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Abstract:

The states of Punjab and Haryana are known as the breadbasket of India. Together they represent around 2.88% of India's geographical area but produce > 70% of grain for the country's Central Pool of Food Grains, particularly rice and wheat. Over the last 30–40 years there has been a 60% increase in cropping intensity across both states driven by high-yielding crop patterns, with 98% of Punjab and 88% of Haryana now irrigated. Much of the increase in irrigated land has been due to the development of groundwater abstraction driven by subsidized electricity leading to severe groundwater depletion and groundwater quality deterioration. Prior to the development of groundwater, surface water irrigation canals were built across both states, and poor management of these canals led to waterlogging and salinisation. These issues pose a direct threat to groundwater-based agriculture and drinking water supply.

Managed aquifer recharge (MAR) has emerged as a vital strategy for sustainable groundwater management in these states. The challenges of groundwater depletion—reduced water security, increased pumping costs, land subsidence, and deteriorating water quality—underscore the urgent need for sustainable interventions. MAR, which involves the intentional infiltration and storage of surface water, treated wastewater, or stormwater into aquifers, offers a pathway to replenish depleted groundwater reserves, enhance water availability, and improve ecosystem resilience [1].

In Punjab and Haryana, potential MAR techniques include surface spreading methods, recharge wells, percolation tanks, check dams, riverbank filtration (RBF) and farm pond recharge structures, calibrated to local hydrogeological conditions. Integrating MAR with existing irrigation infrastructure, canal networks, and rainwater harvesting systems can enhance recharge efficiency. The implementation of MAR addresses multiple sustainability dimensions: it mitigates groundwater overdraft, supports agricultural productivity, maintains baseflows in rivers and wetlands, and contributes to climate change adaptation by capturing episodic monsoon flows for year-round use. Additionally, MAR can improve groundwater quality by diluting contaminants and promoting natural attenuation processes if carefully designed and monitored. The establishment of RBF systems in Punjab has been

recommended as a safe long-term solution, with groundwater yields likely to be sufficient to support multi-village drinking water production schemes [2].

Successful adoption of MAR in Punjab and Haryana requires research in conjunction with enabling policy frameworks, stakeholder engagement, and institutional coordination. Groundwater user associations, farmers, water resource departments, R&D/higher education institutions and local governance bodies must collaborate to identify suitable sites, allocate resources, and develop monitoring protocols. Economic incentives, capacity building, and community awareness are critical to overcoming social and technical barriers. While MAR alone is not a panacea, when integrated with demand management, crop diversification, and efficient irrigation practices, it constitutes a pragmatic and scalable strategy for sustainable groundwater management. As climate variability intensifies water stress, MAR presents a forward-looking approach to secure water resources and promote long-term environmental and socio-economic resilience in the region.

References

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