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Opinion

USE OF AQUIFERS AS STORAGE FOR TREATED WASTE WATER

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Most of the water stressed countries are vulnerable to the potential adverse impacts of climate change, the most significant of which are increased average temperatures, less and more erratic precipitation, sea level rise (SLR) and desertification. The combined effect of existing adverse conditions and likely impacts of future climate change will make water management even more difficult than what it is today. Managed Aquifer Recharge (MAR) is practiced in some advanced countries to store water during periods of surpluses and withdraw during deficits from an aquifer. Time has come to think seriously that such practice should be adopted in most countries where there exists the right conditions. With reasonable care the water is protected from pollution. It uses minimum land area and causes no environmental damage. Recharged water is distributed across the aquifer due to natural gradients. An added benefit is that when practiced along coastal aquifers, MAR mitigates seawater intrusion. It is less expensive, and easier to operate and maintain compared to surface dams, and it is always available on demand. On the other hand, MAR has some disadvantages. In most cases, only a part of the recharged water is recovered. Quality of recharging water could lead to changes in physical and chemical characteristics of the soil and aquifer. Some impurities, such as microbes, heavy metals or trace elements, if present in recharging water will contaminate the aquifer, and will be very expensive to contain and clean. To avoid these problems, the injected water usually undergo treatment processes that can satisfy drinking water standards. Existing models can be utilized to identify aquifers for possible storage and abstraction. Various types of boundary conditions with various types of input variables and constraints can be simulated for helping decision makers to make the right decision. An economic analysis can be done under prevailing market conditions to see the economic feasibility. Such a case study was performed for treated wastewater storage in aquifers for Muscat, Oman. In Muscat, there will be a surplus of 100,000 m^3/day of treated effluent (TE) during winter months by 2015. The aquifer along the northern coast of Oman (Lower Samail Catchment) is conducive for MAR. Data show that TE volumes will increase from 7.6 Mm^3 in 2003 to 70.9 Mm^3 in 2035. HYDRUS 3D simulations show that, areas with sandy loam soils are suited for infiltration ponds. Numerical simulations with MODFLOW (in combination with PEST and GWM) show that injection wells can be used for recharge without causing undue water ponding. Numerical simulations show that when groundwater level is limited to 10 m below the ground surface, no feasible solution that satisfies the optimization problem was found (with 4 month recharge and no abstraction), but when the head constraint is relaxed to 5 m below the ground, a feasible solution was found. Therefore, in order to maximize the amount of water injected into aquifer, MAR was subjected to the following constraints: limit groundwater mound below 5 meters, maximum allowable injection rate is 1000 m^3/day and decision variables are injection rate and location of the wells. Results show that 68 injection wells with a total injection rate of 62,205 m^3/day was found to be a feasible option, there will be a discharge of maximum 7,500 m^3/day towards the sea and the injection rate of each wells ranges from 200-1000 m^3/day. Preliminary financial analysis has shown that the cost USD 0.353/m^3 will be incurred for further Reverse Osmosis (RO) membrane treatment and injection. Issues such as ownership of the water, quality requirements of recharged water, uses of such waters, health and safety considerations and cost recovery need concrete government decisions after discussions with all stakeholders and on the basis of proper environmental and technical analysis.

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