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Artificial groundwater recharge as integral part of a water resources system in a humid environment

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In Graz, Austria, artificial groundwater recharge has been operated as an integral part of the drinking water supply system for more than thirty years. About 180 l/s of high quality water from pristine creeks (i.e. no pre-treatment necessary) are infiltrated via sand and lawn basins and infiltration trenches into two phreatic aquifers to sustain the extraction of approximately 400 l/s. The remaining third of drinking water for roughly 300.000 people is provided by a remote supply line from the East alpine karst region Hochschwab. By this threefold model the water supply system is less vulnerable to external conditions.

In the early 1980's the infiltration devices were also designed as a hydraulic barrier against riverbank infiltration from the river Mur, which at that time showed seriously impaired water quality due to upstream paper mills. This resulted into high iron and manganese groundwater concentrations which lead to clogging of the pumping wells. These problems have been eliminated in the meantime due to the onsite purification of paper mill effluents and the construction of many waste water treatment plants.

The recharge system has recently been thoroughly examined to optimize the operation of groundwater recharge and to provide a basis for further extension. The investigations included (i) field experiments and laboratory analyses to improve the trade off between infiltration rate and elimination capacities of the sand filter basins' top layer, (ii) numerical groundwater modelling to compute the recovery rate of the recharged water, the composition of the origin of the pumped water, emergency scenarios due to the failure of system parts, the transient capture zones of the withdrawal wells and the coordination of recharge and withdrawal and (iii) development of an online monitoring setup combined with a decision support system to guarantee reliable functioning of the entire structure. Additionally, the depreciation, maintenance and operation costs of the managed aquifer recharge system have been evaluated.

Among numerous results it could be shown that replacing the lawn by sand basins and operating them constantly during winter holds the largest potential to increase the infiltration volume. However, this is only an option for new to build structures since the current basin positions would lead to large direct losses of recharged groundwater into the river Mur. Adjusting the timing of infiltration and withdrawal based on subsurface travel time yields an increase of the pumped amount of about 11% given about the same extension the wells' capture zones. The overall costs of artificial groundwater recharge amount to 0,15 €m^3 excluding pumping and distribution costs compared to a water price of about 1,5 €m^3 charged to consumers. Currently, the implications of building a hydro power plant adjacent to the recharge site are evaluated emphasizing the need for innovative solutions given only limited land resources.

On the basis of the projected impacts of climate change on the availability of surface water and groundwater in the South-Eastern alpine regions, the aquifers can act as a buffer system to help overcome the timely shift between supply and demand. Thus, also in predominantly humid regions artificial groundwater recharge represents a viable and sustainable solution to safeguard the supply of drinking water in the long term.