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Water resources management using artificial groundwater recharge to replace shallow surface water reservoirs: An example from Xinjiang China

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Artificial groundwater recharge is a topic of worldwide interest in recent years. In semi-arid and arid regions, it may be an important method for sustainable water resource utilization. The Urumqi river catchment is a typical hydrological unit of North West China, suited for artificial recharge. To bridge the gap between demand and supply in space and time some unreasonable methods have been applied: on one hand, shallow surface water reservoirs in the plain have been constructed, conveying the mountain rainfall and glacier melt runoff directly to these reservoirs by concrete channels. This led to large wastage of water due to the high evaporative losses from the shallow reservoirs. On the other hand, groundwater has been abstracted at a large rate to meet the water demands. As a result, both ecological problems and also some geo-environmental problems appeared. The duration and amount of runoff infiltration are the key factors of artificial groundwater recharge. But the complexity of the aquifer (upstream large depth to groundwater depth, more than 100m, and downstream direct groundwater discharge by springs) and the uncertainty of infiltration rates and capacity, also set limits to the artificial groundwater recharge in Urumqi river catchment.

Long term runoff and groundwater abstraction data have been collected and the water demand and supply have been analyzed using integrated data analysis. The results show that the average yearly runoff in Urumqi river basin (total water resources) is about 296 Mio. m3 (245 Mio m3 from Urumqi river, 51 Mio. m3 from other rivers), the total water demand is about 250 Mio. m3.The water supply is mainly from May to September and amounts to about 251 Mio m3/a while the water demand of about 178 Mio m3 is mainly from March to June and September to November. From June to September there are about 168 Mio. m3/a of runoff available for artificial recharge.

4 fields experiment have been performed using fiber-optic distributed temperature sensing (DTS) system to retrieve the temperature for estimating the infiltration capacity of the river course. These data were used in a saturated flow model coupled with a model for the unsaturated zone, which has been developed for studying the following issues: (1) the feasible amount of infiltration,(2) the suitable place and time for artificial recharge ,(3) the groundwater abstraction strategy,(4) the storage plan of water resources (surface reservoir and underground reservoir contributions),(5) the time for reaching a new water resources balance. Finally, an assessment of the economics of artificial groundwater recharge was performed.