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Assessing feasibility and efficacy of the Middle Route of the South-to-North Water Diversion Project in China

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The Middle Route of the South-to-North Water Diversion Project (MRP) was designed to transfer water from the Danjiangkou Reservoir (DR) in Hanjiang (HJ) to Jing-Jin-Ji (JJJ) and Henan (HN) regions to alleviate water shortage and groundwater over-exploitation in those regions. MRP has been under intensive scrutiny since the commencement in December 2014, mainly over its feasibility and efficacy of the designed water diversion volume. This study considers water-receiving (JJJ and HN) and water-delivering (HJ) region along the MRP conveyance route as the three study units. Assuming hypothetically that MRP had already been in operation during 2005-2014, three different water diversion scenarios are devised by referring to the actual implementation of MRP during 2015-2017. An adaptive water diversion and allocation model is developed to evaluate the allowed water diversion volume (Q_d) in HJ and the degree of the recovery of groundwater storage (GWS) in JJJ and HN as judged from the comparison with the historical groundwater level observations without water diversion. Results show that the estimated Q_d (4.6$\sim$12.6 km^3/yr) from HJ can reach the designed target of 6.2$\sim$14.0 km^3/yr except during the prolonged dry period with persistent low reservoir inflow and high downstream water demand in HJ. Q_d can contribute to the recovery of GWS by 3.0$\sim$4.6 and 1.2$\sim$2.2 km^3/yr, and an increase of the regional water table by 0.3$\sim$0.7 and 0.1$\sim$0.3 m/yr, in JJJ and HN, respectively. The important implication of this study is that due to the operation of MRP, the mean water table depth is likely to recover from the present 30 m deep in JJJ and 8 m deep in HN to the mean depth in 1960s, namely, about 4 m deep for both JJJ and HN, in 40 years for JJJ and in 20 years for HN from the commencement of the MRP.