Trends and Sustainability of Groundwater in Highly Stressed Aquifers (Proc. of Symposium JS.2 at the Joint IAHS & IAH Convention, Hyderabad, India, September 2009). IAHS Publ. 329, 2009, 80-88.

Abstraction influence on alluvial aquifer of the Tuul River, Mongolia

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Abstract The quantity and quality of water is essential for socio-economic conditions and for regional development. The water supply of Ulaanbaatar, the capital of Mongolia, totally depends on groundwater withdrawn from alluvial aquifers along the Tuul River Basin, located in the southern part of the city. Water demand of the capital has increased to a great extent as a result of the rapid industrial development and population growth, partly due to the migration from rural areas. According to the Master Plan of Ulaanbaatar for 2020, the municipal water demand alone will reach 314 000 m^3 per day by 2020, and the city may start to face a water shortage crisis from 2010. The main purpose of the study is to predict future groundwater decline in an aquifer. Mathematically-based finite difference numerical models are important tools for prediction. Although a numerical 3-D model is available for this purpose, it is expensive to run, and it contains many uncertainties of identification of hydrogeological parameters. Before a 3-D model is utilized, it is efficient to develop a 2-D model under the assumption that the aquifer is homogeneous parallel to the plane of profile. "3-D unsaturated flow code" and well developed software, Visual MODFLOW Pro, were used for this study. The result of the 2-D modelling shows that calibrated recharge rate was less than zero and hydraulic conductivity was inhomogeneous. The result of 3-D modelling shows that the area of dry area and drawdown will be reduced in heterogeneous alluvial aquifer with an optimal pumping rate of groundwater. Optimal pumping rate of groundwater is 57 487 m^3 per day during the winter season and 95 236 m^3 per day in the warm season. The pumping rate of extraction wells must be optimized and it will be kept away from over-exploitation of the alluvial aquifer and protect the main water source of the city's water supply.

Key words groundwater decline; water shortage; pumping rate; groundwater modelling; aquifer; recharge rate