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Determination of groundwater sustainable yield using numerical modelling approach

Lin, L & H. Lin

Council for Geoscience, South Africa (llin@geoscience.org.za)

Abstract

Groundwater sustainable yield is defined groundwater sustainability as the development and use of groundwater in a manner that the water can be maintained for an indefinite time without causing unacceptable environmental, economic, or social consequences. This definition implies that the amount of sustainable yield is a dynamic figure which requires a policy for the compromise between governmental authority and groundwater user. Technically, it can be determined by the prescriptive water table without causing costly pumping experience and the deterioration of adjacent groundwater and ecological environment. Groundwater numerical modelling provides an effective way to determination by taking into account the responding water levels to various pumping scenarios.

In this study, natural flow system and flow with pumping scenarios were simulated using Feflow, respectively, for the fractured rock aquifer bounded by fault in Rawsonville, Western Cape. Simulated results with different pumping alternatives show a distinct impact of groundwater abstracting on the hydraulic head. A continuous pumping may change the original groundwater dynamics reflected by the change in flow direction and the development of depression cone on damage zone. A long-term abstraction slowly increases the well drawdown but it would stabilize at the certain level which is dependent on pumping rate. For estimate the aquifer sustainable yield, a relationship between simulated drawdown and pumping rate was established, which is represented by:

$$s_w = 2.2189 \cdot Q_a^{1.0653}$$, where s_w is the drawdown and Q_a the pumping rate.

This empirical relation derived from the site specific study, provides an option for the informed decision making. Issue of how to sustainably pump might rely on the compromise between the groundwater user and governmental authority. Based on the understanding of the aquifer setting, the maximum stabilized drawdown is recommended as not more than 20 meters. Therefore the recommended amount of pumping rate was estimed at 4 l/s to 7 l/s, with corresponding drawdowns of 9.7 m to 17.6 m, respectively.