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Optimization of an Artificial Recharge- Pumping System for Water Supply in the Maghaway Valley, Cebu, Philippines

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An artificial groundwater recharge-pumping system for water supply has been operated in the Maghaway valley, Metro Cebu, Philippines since 1997. The system consists of five meter high weir for Mananaga river diversion, a settling basin for sediment removal and an infiltration basin to recharge Maghaway valley unconfined aquifer. In this study, a coupled simulation-optimization model was used to determine maximum artificial recharge and extraction rates. Groundwater mangement problem was formulated with constraints of minimum groundwater level and bounds on pumping rates at managed pumping wells.The objective function is to maximize the total pumping rate through artificial recharge-pumping system. Groundwater management model was used to solve optimization problem. The successive linear programming solution method was used to solve the unconfined groundwater management problem [1]

Under steady natural conditions, the significant inflow to the aquifer comes from river leakage whereas the natural discharge is mainly the subsurface outflow to the downstream area. The steady state pumping results show that the inflow from artificial recharge basin is 20,587 m^3/day and accounts for 77% of total inflow. Under transient conditions, the inflow contribution from an artificial recharge varies between 14,000 m^3/day to 20,000m^3/day depending on seasons. In general, during wet periods from June to December, inflow from artificial recharge increases and so does the groundwater heads. From January to May Mananga river discharge are low and the infiltration from artficial recharge basin decreases.

Optimal production rates of the wells were analysed for the current height of weir, increase of height of the weir by 1 m and increase of height of the weir by 2 m. In all cases, the pumping rates are decision variables. The steady state optimisation results show that the total optimal abstraction rate is 37,545m^3/day and infiltration from artificial recharge basin is 29,313m^3/day for the current height weir. Transient optimization results show that the average total optimal pumping rate is 36,969m^3/day for the current height of weir. Transient optimization for increase of height of the weir by 1 meter show that an average total optimal pumping rate 38,768m^3/day and increase height of the weir by 2 meter show an average total optimal pumping rate 40,463 m^3/day. In conclusion, the increase in height of the weir can significantly increase artificial recharge rate and production rate of wells in the Maghaway valley.

References:

[1] Ahlfeld P and Baro-Montes G (2008) J.Water Resour. Plann. Manage 134(5): 404-412