Application of Electronic Spread Sheet and Water Balance Error Optimization Technique in Ground Water Model Study to Improve the Ground Water System in Restricted Area

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Abstract

A study was carryout for a restricted ground water catchment about 160 sq. meters in Vavuniya in northern Sri Lanka to find out an operational policy of minor and medium Irrigation schemes, to recharge the ground water system to increase the economic pumping. Forty one wells were identified as observation wells within the study area of 160 sq. meters to represent the aquifer. This study area was divided into forty one Thiession polygons by connecting the perpendicular bisectors of adjoining observation wells with four year seasonal collected (Oct.2000 - May.2004) water levels and three years seasonal historic (Oct.1997 - May.2000) water levels. A ground water simulation model was formulated for this polygonal network using integrated finite difference method in spreadsheet. The model was calibrated for the period from 1997 to 2001 having eight seasons. Since the initial values were taken as October 1997, the time step Δt was taken as 8 months followed by 4 months. These time steps were used alternatively throughout the calibration period from 1997 to 2001. The rainy season was taken from 1st October to 31st May of next year and non-rainy season was taken from 1st June to 30th September. By this calibration the hydrogeological stress parameters such as Transmissibility, Storage coefficient, Recharge coefficient for Irrigation scheme, Recharge coefficient for irrigation field, Recharge coefficient for rainfall and the Withdrawal factor for agro and domestic pumping were found using optimization technique. A complete water balance study for each polygon for each season was carried out. Forty one error models were prepared for the water balance, for each polygon for all the season. Each error model is a function of Transmissibility, Storage coefficient, Recharge coefficient for Irrigation scheme, Recharge coefficient for irrigation field, Recharge coefficient for rainfall and the Withdrawal factor for agro and domestic pumping. To avoid the negative & positive errors get cancelled, the squares of each seasonal error were added and minimized with suitable constrains. Practicable range for Transmissibility, Storage coefficient, Recharge coefficient for Irrigation scheme, Recharge coefficient for irrigation field, Recharge coefficient for rainfall and the Withdrawal factor for agro and domestic pumping were given during minimization as constrains. MATHCAD2000 was used for this optimization. Using the results obtained a validation of the model was carried out with three seasonal water level (Oct.2001 – May 2003). The model successfully predicted the water levels with very little error (less than three percent). Recalibration was done by slightly adjusting the stress parameters with all the eleven seasonal Oct. 1997 – May 2003) data. This integrated finite difference model in spreadsheet & calibrated by error optimization technique, validated and recalibrated was used to predict the system behavior for various operational policy of the Vavuniya restricted ground water catchment during this research. This article elaborates the use of electronic spread sheet and the use of optimization packages in this research work to formulate a ground water simulation model in any restricted catchment.