E24

Conjunctive Simulation of Surface and Subsurface flow within Water Budget

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1. Background

Conjunctive use of surface and ground water as an effective tool for water shortage has been the subject of many studies. This is more significant for arid to semiarid regions where considering an additional dam is not feasible. Yet, the achievement of any conjunctive-use scheme relies on estimation of long-term inflow to the system or “renewable storage”. As for surface reservoirs, it can be done simply by “mass curve analysis” of long term inflow. Nevertheless for ground water storage this can be of high potential error at regional scale due to the random field of unsaturated hydraulic conductivity. Traditionally this randomness can be dealt with by “Parallel Homogeneous Columns” [PHC] approach[1) which in turn is limited in handling different natural conditions by the “piston flow” mechanism. As a result, common conjunctive-use studies still use the deterministic numerical approach which can be slow and prone to high error at regional scale.

2. Objectives

The current study was proposed to fill this gap by reformulating of a “multiple-piston flow” coupling mechanism for simultaneous (conjunctive) simulation of long-term surface and subsurface inflow; which in turn is essential for application of multi-reservoir management techniques such as mass-curve analysis to estimate sustainable discharge regime from aquifer in terms of environmental effects such as ground water mining.

3. Methodology

To achieve the objective, first the “Piston flow” equations were reformulated for more realistic initial and boundary conditions met at regional scale of conjunctive-use applications including: (a) variable flux boundary, (b) step-profile initial condition and (c) upper evapotranspiration layer. At second step, a semi-two dimensional kinematic wave model[2) was reformulated for implicit scheme to estimate runoff and upper boundary condition for the piston flow model. At Third step, an analytical water budget framework[3) was incorporated into the model, to estimate time series recharge at the water table due to successive wetting front. Thus the inputs for mass curve analysis for dynamic storage were obtained.

4. Conclusion

The simulation results could reveal the feedback of water table depth on ground water recharge and surface water discharge, verifying the proposed piston flow approach as an effective joint mechanism at regional scale. Further, the analytical structure of the proposed mechanism requires just upper boundary condition and can provide a convenient way for generating time series of aquifer recharge for following analysis sustainable discharge from aquifer due to mining impact on aquifer storage.

References

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