Modified Use of the "SDF" Semi-Analytical Stream Depletion Model in Bounded Alluvial Aquifers

Calvin D. Miller[1]
Ph.D. Candidate, Groundwater Program, Civil Engineering Department, Colorado State University, Fort Collins, Colorado

Deanna S. Durnford
Professor, Groundwater Program, Civil Engineering Department, Colorado State University, Fort Collins, Colorado

Abstract. A widely-used semi-analytical model (the "SDF method") describing stream depletions and accretions induced from groundwater pumping and augmented groundwater recharge was reviewed for accuracy when applied in bounded alluvial aquifers. The SDF method is based on the Glover analysis of stream depletion induced by groundwater pumping in a mathematically ideal aquifer, but uses a model-derived input parameter to account for non-ideal conditions such as variable transmissivities and nearby aquifer boundaries. Though it is still an approximation, this parameter adjustment can increase the accuracy of estimates. This modeled parameter is called the Stream Depletion Factor (SDF) and has units of time. The spatial distribution of SDF values was modeled and mapped by the USGS for the alluvial aquifers of the South Platte and Arkansas rivers. The SDF method yields small errors near the time of the SDF, but recent experience has highlighted the larger errors at times much greater than the SDF. In light of this, users have been prompted to use the Glover method combined with the method of images to account for aquifer boundaries. Yet, this approach is not without its own challenges. This paper reviews the approximations inherent in the SDF method and presents expanded SDF response curves and error curves as functions of well position within the bounded aquifer. It is shown that SDF values mapped in the half of the aquifer nearest the river do not account for aquifer boundaries, and that values in the other half follow a predictable adjustment. By removing the boundary-induced adjustments, the method of images can be used with the SDF method as well as the Glover Method, thereby benefiting from the additional information contained in SDF maps and retaining their value as standardized references for water rights administration.

[1] Civil Engineering Department
Colorado State University
Fort Collins, CO 80523-1372
Tel: (970) 491-3452
e-mail: Calvin.Miller@ColoState.edu