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Hydraulic characterization of the heterogeneity of the "Valle del Cauca" Aquifer (Colombia)

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This research consists of a regional study in which is analyzed and defined in detail the response of a large alluvial aquifer to external imposed stresses of varying magnitude at multiple points within its area. On the other hand, this work evaluates and establishes the spatial correlation structure of the transmissivity and specific capacity values and provides a spatial stochastic prediction model. The later acceptably synthesizes the field properties of each of these parameters. The prediction model was developed from the cross correlation between 852 series values of specific capacity and 316 from transmissivity.

This model lead us to demonstrate from the geological perspective that exits a relation among geomorphology and recharge areas so that, higher transmissivity values are presented in the lowlands of the valley through which rivers flow localized in recharge areas generated by geological folds.

Since 1950, began an intensive development of this aquifer (Colombia). Despite the country has a positive water balance (IDEAM, 2003), this aquifer is the most productive one in Colombia, has an extension of 3,300 km2. Approximately 1,500 wells supply about 92,540 L/s used for agricultural and industrial purposes. This research uses about 1,000 pumping tests carried out since 1970 by the regional environmental agency (CVC).

We interpreted those pumping tests using the diagnostic plot method (Rennard, 2008) to determine aquifer transmissivity and specific capacity. The model figures out a significant geological heterogeneity in the apparently homogeneous alluvial aquifer that leads us to use several interpretation methods for different boundary and well conditions. This brings into question the validity of the regional scale research using a single method of interpretation. Similarly, the results permit us to review the current conceptual model of a three layers aquifer (unconfined – aquitard – confined aquifers) with a defined thickness to a heterogeneous model in which a middle layer of variable thickness and low permeability lay between unconfined and semiconfined aquifer.

Finally, we approached from a stochastic perspective the spatial heterogeneity of the hydraulic parameters using a semivariogram and showing that the spatial correlation structure of the values is closely related to the geology and geomorphology of the different areas of the valley. For transmissivity, we evaluate the uncertainty in the predicted values of a stochastic model of simple spatial correlation based on relatively short series. Having verified the existence of a strong correlation between the values of transmissivity and specific capacity, develop a second stochastic model based on spatial cross correlation of a short series of transmissivity and a much more extensive one from specific capacity. The evaluation of the uncertainty of the later predictions demonstrates its significant advisability of the second model over the initial one.