Analysis of Methods for Estimating Continuous Flows from Upper Floridan Aquifer Springs

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Abstract

Measured continuous flows from Upper Floridan aquifer springs were examined to determine the nature of their flows and to identify the most accurate method to predict the flows. A comparative analysis was conducted to identify the most accurate method to simulate continuous spring flows at Blue Spring, Rainbow Springs, Rock Springs, Silver Glen Springs, Silver Springs, and Wekiwa Springs in central Florida. Data used as independent variables were water levels at observation wells, spring-pool altitudes, and distance between observation wells and spring pools. The measured spring flows were used as dependent variable. Methods used to predict spring flows were the Darcy-Weisbach (DW) equation for conduit flow, multiple linear regressions (MLR), and artificial neural networks (ANNs). The DW equation for conduit flow with no source terms also was used to determine whether flows at each spring were turbulent or laminar. Flows at all springs were estimated to be turbulent. The ANNs had considerably lower residuals between measured and predicted spring flows than the DW or MLR methods (Table), and proved to be the best tool for water-resource managers to establish conditions on the hydraulic gradient between the spring and the observation well to maintain safe specified spring flows.

Table 1- Root-mean square errors, in cubic meters per second, between measured and predicted spring flows for the DW, MLR, and ANN methods. Root-mean-square percentage errors from measured spring flows are shown between parentheses.

[M, number of measurements of spring flow, spring-pool altitude, and water level at observation well made on the same day]

Spring	Well	DW	MLR	ANN	M
Blue Spring	V-0083	0.26 (6.0)	0.29 (6.9)	0.13 (3.1)	1,739
Blue Spring	V-1091	0.36 (6.5)	0.29 (6.7)	0.13 (3.1)	1,707
Blue Spring	V-0867	0.23 (5.2)	0.56 (12.9)	0.12 (2.7)	1,457
Rainbow Springs	RS Well	1.00 (5.4)	0.86 (5.6)	0.26 (1.6)	2,505
Rock Springs	OR-0662	0.24 (14.6)	0.12 (13.7)	0.04 (2.5)	1,184
Silver Glen Springs	M-0021	0.36 (13.0)	0.36 (13.0)	0.14 (5.3)	1,478
Silver Springs	M-0026	1.65 (9.1)	1.74 (9.7)	0.78 (4.6)	5,349
Silver Springs	CE-76	1.16 (6.4)	1.25 (6.8)	0.60 (3.6)	1,913
Wekiwa Springs	OR-0548	0.11 (6.1)	0.10 (6.1)	0.08 (4.4)	1,102