Assessment of the contribution of groundwater discharges to rivers using monthly flow statistics and flow seasonality

David C Le Maitre* and Christine A Colvin
Natural Resources and Environment CSIR, PO Box 320, Stellenbosch 7599, South Africa

Abstract

Groundwater discharge is believed to dominate dry season flows in perennial river systems and to sustain aquatic biodiversity. River flow statistics, extracted from the SPATSIM modelling system, were used to estimate the contribution of groundwater to river flow regimes. The flow statistics were compared for the principal aquifer types (based on major geological formations) in South Africa. This analysis focused on seasonal variation in flows rather than the annual totals or Baseflow Index. Groundwater discharge is expected to reduce flow variability and sustain flows, making flow concentrations lower than rainfall concentrations. Catchments dominated by carbonates have the greatest proportion of baseflow (37%), followed by basement complex (31%) and extrusive aquifer types (31%). The weak relationships between river flow indexes (particularly the Baseflow Index, Coefficient of Variation and Hydrological Index) and the seasonality or concentration statistics imply that catchment storage characteristics and other non-climatic factors play an important role in flow regulation. The geographic distribution of total flow concentrations differs markedly from rainfall concentrations, further evidence that non-climatic factors are important determinants of flow regimes. Karoo dykes and sills, extrusives and unconsolidated deposits are under-represented and the TMG sub-type, carbonates and basement complex and younger granites are over-represented among catchments with evenly distributed baseflows. The Baseflow Index and groundwater-fed baseflow are ecologically meaningful variables but lack clear thresholds that correspond with ecologically important changes in river flow regimes, for example perennial versus seasonal flow. Flow concentrations and percentage zero flows are useful and potentially ecologically important variables and should be tested as predictors of the aquatic and riparian biodiversity of river systems at a range of scales.

Keywords: river flow statistics, baseflow, flow concentration, principal aquifer types, groundwater discharge