

Using Stable Isotopes and Hydrochemical Characteristics to Assess Stream Water Sources and Flow Paths: A Case Study of the Jonkershoek Catchment, South Africa

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Abstract : Understanding hydrological processes in mountain headwater catchments, such as the Jonkershoek Valley, is crucial for improving the predictive capability of hydrologic modeling in the Cape Fold Mountain region of South Africa, incorporating the influence of the Table Mountain Group fractured rock aquifers. Determining the contributions of various possible surface and subsurface flow pathways in such catchments has been a challenge due to the complex nature of the fractured rock geology, low ionic concentrations, high rainfall, and streamflow variability. The study aimed to describe the mechanisms of streamflow generation during two seasons (dry and wet). In this study, stable isotopes of water (^{18}O and ^2H), hydrochemical tracer electrical conductivity (EC), hydrometric data were used to assess the spatial and temporal variation in flow pathways and geographic sources of stream water. Stream water, groundwater, two shallow piezometers, and spring samples were routinely sampled at two adjacent headwater sub-catchments and analyzed for isotopic ratios during baseflow conditions between January 2018 and January 2019. From these results, no significance ($p > 0.05$) in seasonal variations in isotopic ratios were observed, the stream isotope signatures were consistent throughout the study period. However, significant seasonal and spatial variations in the EC were evident ($p < 0.05$). The findings suggest that, in the dry season, baseflow generation mechanisms driven by groundwater and interflow as discharge from perennial springs in these catchments are the primary contributors. The wet season flows were attributed to interflow and perennial and ephemeral springs. Furthermore, the observed seasonal variations in EC were indicative of a greater proportion of sub-surface water inputs. With these results, a conceptual model of streamflow generation processes for the two seasons was constructed.

Keywords : electrical conductivity, Jonkershoek valley, stable isotopes, table mountain group

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