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Catchment Characteristics as Predictors of Base Flow Index (BFI) in Wabi-shebele River Basin, East Africa

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Abstract

The Base Flow Index (BFI) is used as a measure of the base flow characteristics of catchments. It provides a systematic way of assessing the proportion of base flow in the total runoff of a catchment. It indicates the influence of soil and geology on river flows, and is important for low flow studies. Nowadays extreme low flow events are more diligently analysed and given focus in the emerging field of ecohydrology. However, many of the catchments in developing countries are ungauged, thus, it is often difficult to get recorded data on base flows of rivers. This paper seeks to establish a relationship between the climatic, morphologic and geologic features of a catchment to its base flow in the Wabi-Shebele river basin, East Africa. It employs the parameters catchment size, stream density, climate index, soil type, hypsometric integral, normalised digital vegetation index (NDVI) extracted from satellite images and geologic features to derive the base flow index of a catchment. Values of base flow index determined for a network of stream flow gauges are matched to the composite morphometric and climatic data using spatial and regression analyses. To relate the BFI to a usable flow statistic, a relationship was derived between BFI and Q70, the point on the flow duration curve at which flows are exceeded 70 % of the time. Q70 was chosen because it is the critical point that has been most often used in most previous works. The BFI has a strong relationship with climate and geology. Catchments with high climate index (high rainfall or low evapo-transpiration) underlain with granites or basalt tend to give high base flow. Among the topographical parameters tested, drainage density index has better relationship with BFI. The developed relationship can be used for fairly estimating the base flows in the river basin considered. However, in view of the tremendous spatio-temporal heterogeneity of climatic and landscape properties extrapolation of response information or knowledge from gauged to ungauged basins remains fraught with considerable difficulties and uncertainties.

Keywords: Base flow index, catchment characteristics, GIS, ungauged basins, Wabi-shebele river