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Are observed stream flow records sufficient to understand natural hydrological process heterogeneity in the Incomati River Basin?

The Incomati is a semi-arid trans-boundary river basin in southern Africa, which is water stressed because of high competing demands from irrigated agriculture, forestry, environmental flows and other sectors. The impacts of these demands relative to the natural flow regime can be significant. Hence, there is an opportunity to improve water management, if it can be underpinned by a better scientific understanding of water resources availability and variability. Despite being a relatively well gauged basin (at least in perception) in South Africa, the natural flow regime and its spatial and temporal variability are poorly understood and remain poorly described.

In this study, observed flow data from 104 gauges was screened, and analyzed using the Indicators of Hydrologic Alteration (IHA) software, and various metrics of catchment similarity were compiled and compared to provide a preliminary classification of catchments based on their hydrological behavior. Screening of the gauges revealed that only 14 micro to meso scale catchment (50 to 1060 km^2) have sufficiently long (20 to 65 years) and natural (or little disturbance) flow records. This limits detailed analysis of spatial variability of hydrological characteristics across the Incomati Basin, especially at larger spatial scale of macro catchment level i.e. Incomati River and its major tributaries. Nevertheless, long term analyses were conducted to identify temporal variability and trends. Temporal variability was high with coefficient of variation (CV) of annual flows in the range of 1 to 4. However, trends in the selected indicators of hydrological alteration were found to be insignificant in most cases, with the exception of significantly declining trends in October flows and extreme low flows in the case of 4 gauges. This suggests that the temporal changes in the stream flow are not likely driven by climatic forcing and are rather a response to some other impact. The flow duration curve analysis indicated that quick flow dominates the overall volumetric contribution in stream flow generation in most gauges. The base flow contribution is comparatively low but sustains the stream all year around. The variation of the base flow contribution is also high among the studied catchments. The paper provides detailed discussion the major climatic and physiographic factors controlling the runoff regime of the Incomati Basin and concludes that human demands are major drivers of water stress, particularly in low flows and in time of drought, implying that restrictions are needed in these months.