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Hydrologic partitioning and vegetation response in selected moist zone catchments of Ethiopia: Analyzing spatiotemporal variability

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Analysis relating the spatiotemporal variability of water balance parameters with that of catchment-ecosystems is one of the avenues to explore vegetation response to climate variability and the resulting impact on water resources dynamics. In this study, we analyzed spatiotemporal variation of hydrologic budget and remotely sensed index of vegetation greenness in six moist zone catchments of Ethiopia between the years 2000 and 2006. We use L'vovich's water balance theory whereby hydrologic partitioning concept is applied to partition precipitation into quick flow and catchment wetting; the wetting component is then partitioned between baseflow and catchment vaporization (evaporation plus transpiration; V). Nadir BRDF Adjusted Reflectance Normalized Difference Vegetation Index (NBAR-NDVI, 16day composite with 500m spatial resolution) is computed from Moderate Resolution Imaging Spectroradiometer (MODIS) combined product (MCD43A4) to quantify catchment-scale terrestrial vegetation greenness. It was found that the fraction of precipitation potentially available to catchment-ecosystems (wetting; W) ranged from 0.73 to 0.96, demonstrating up to 27% of precipitation was not available to plants. There is strong positive correlation between humidity index (HuI) and W (with Pearson's r = 0.91), which suggests HuI can be considered as a good indicator of catchment-ecosystems water availability and thus, soil moisture condition. Likewise, Horton index (HI), which is the ratio of V to W and considered as catchment-ecosystems water use factor, ranged from 0.42 to 0.92 in the study areas. Therefore, up to 58% of available water was not consumed by the vegetation while other catchment-ecosystems left only as small as 8% of the available water unused. Although HI shows strong inter-catchment variation, it is relatively constant from year-to-year and thus, HI is a catchment signature as suggested by previous studies conducted elsewhere. But, HI alone is not enough to represents whether vegetation is limited by moisture availability as NDVI of 0.77 was observed in a catchment with lowest HI while on contrary, NVDI of 0.56 was observed in another catchment with highest HI. Moreover, there is inter-regional variability in the timing of observed lag between monthly precipitation and NDVI peaks where two months lag was observed in catchments with monomodal rainfall pattern while up to one month lag was observed in those with bimodal rainfall. Our results demonstrate that catchments within the same climate zone exhibit variable hydrologic partitioning and vegetation response.
Keywords: catchment-ecosystems, hydrologic partitioning, moist zone, spatiotemporal variation