

River flow response to changes in vegetation cover in a South African fynbos catchment

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Abstract

Mountain fynbos catchments in the Western Cape region of South Africa are prone to substantial changes in land cover due to invasion by exotic tree species (and their clearing), fires, and vegetation response to inter-annual variations in rainfall. While small catchment experiments and modelling studies have pointed to reductions in river flow as catchment biomass increases, there is little empirical evidence of land cover change affecting river flow in large catchments that are important sources of water for the region. Monitoring changes in above-ground green biomass in multiple large catchments is challenging, but may be accomplished using a remotely sensed spectral vegetation index. It was hypothesised in this study that annual river yield (river flow as a fraction of rainfall) in the Molenaars catchment near Paarl, South Africa co-varies with an index of green vegetation cover derived from satellite data (the normalised difference vegetation index, NDVI). The catchment was partitioned into 'upland' and 'lowland' zones and the relationship between annual river yield and summer NDVI was determined for each zone over an 18-year period. There was a statistically significant negative linear relationship between annual river yield and the NDVI of the lowland zone when three outliers were excluded from the analysis. These outliers corresponded to periods with prolonged drought conditions when river yield appeared to be decoupled from vegetation water use in the lowland zone. There was no relationship between river yield and changes in the NDVI in the upland zone where plants were unlikely to have sustained access to adequate soil water for transpiration. The importance of considering the location of land cover changes in a catchment, and inadequacies in high-elevation measurements of rainfall in this mountainous region, were highlighted in the study.

Keywords: remote sensing, normalised difference vegetation index, Molenaars River, invasive vegetation, DWAF Working for Water Programme, mountain catchments