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Dynamics of tropical mountain stream channels in response to spatial variability of rainfall and to land cover changes - the case of the Ethiopian Rift Valley escarpment

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The geomorphologic characteristics of stream channels highly depend on rainfall and land cover changes, though long-term studies in tropical mountains are rare. Hence, eleven mountain streams of the western Rift Valley escarpment of Ethiopia were selected for analyzing channel adjustment in response to rainfall variability and vegetation cover changes since 1930s. Land cover changes were analyzed using aerial photographs (APs) of 1936, 1965, 1986 and Google Earth Imageries of 2005 and 2014. Peak discharges (Q_p) were calculated from measurements of 332 peak events at 11 crest stage gauges in 2012-2014. Bed load movement was examined by measuring the size of the 10 coarsest rock fragments (F_{C10}) moved in every peak event. Regression results between vegetation cover (2014), Q_p and F_{C10}(2012-2014) were used to extrapolate Q_p and F_{C10} for 1936, 1965, 1986 and 2005. The 1936 APs showed that the streams were relatively narrow at that time. Overall, woody vegetation cover decreased from 14% in 1965 to 11% in 1986, and then increased to 25% in 2005 and 29% in 2014 due to reforestation. Average Q_p increased from 54 m^3s^{-1}in 1965 to 56 m^3s^{-1}in 1986 and then reduced to 34 m^3s^{-1}in 2005 and 31 m^3s^{-1}in 2014. Average F_{C10} increased from 280 mm in 1965 to 294 mm in 1986 and reduced to 213 mm in 2005 and to 195 mm in 2014. Consequently, stream channels which widened and braided mainly between 1936 and 1986 were again turned to narrow and single-thread rivers recently. Between 2012 and 2014, average channel incision was 6 cm $year^{-1}$and it was positively related to Q_p (R^2 = 0.75, $p < 0.05$) and to catchment area (R^2 = 0.81, $p < 0.05$). The active channels of the 4 closely monitored streams narrowed by 26% to 39%. Overall, this study illustrates that the geomorphologic characteristics of tropical mountain stream channels strongly vary in function of spatial variability of rainfall, and are quickly transformed due to land cover changes.

Key words: bed load, braided channels, clear water, peak discharge, reforestation.