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Land degradation trends in upper catchments and morphological developments of braided rivers in drylands: the case of a marginal graben of the Ethiopian Rift Valley

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Braided rivers have received relatively little attention in research and development activities in drylands. However, they strongly impact agroecology and agricultural activities and thereby local livelihoods. The Raya Graben (3750 km² including the escarpment) is a marginal graben of the Ethiopian Rift Valley located in North Ethiopia. In order to study the dynamics of braided rivers and the relationship with biophysical controls, 20 representative catchments were selected, ranging between 15 and 311 km². First, the 2005 morphology (length, area) of the braided rivers was related to biophysical controls (vegetation cover, catchment area and slope gradient in the steep upper catchments and gradient in the graben bottom). Second, the changes in length of the braided rivers were related to vegetation cover changes in the upper catchments since 1972. Landsat imagery was used to calculate the Normalized Difference Vegetation Index (NDVI), and to map vegetation cover and the total length of the braided rivers. Spot CNES imagery available from Google Earth was used to identify the total area of the braided rivers in 2005. A linear regression analysis revealed that the length of braided rivers was positively related to the catchment area ($R^2=0.32$, $p<0.01$), but insignificantly related to vegetation cover in the upper catchments. However, there is an indication that it is an important factor in the relationship calculated for 2005 ($R^2=0.2$, $p=0.064$). Similarly, the area occupied by the braided rivers was related to NDVI ($R^2=0.24$, $p<0.05$) and upper catchment area ($R^2=0.447$, $p<0.01$). Slope gradient is not an important explanatory factor. This is related to the fact that slope gradients are steep (average of 38.1%) in all upper and gentle (average of 3.4%) in graben bottom catchments. The vegetation cover in the upper catchments shows a statistically insignificant increasing trend ($R^2=0.73$, $p=0.067$) over the last 40 years, whereas length of rivers in the graben bottom did not change significantly. This is due primarily to the stable vegetation cover conditions between the mid of 1980s and 2000 (average NDVI of 0.34 with std. deviation of 0.07). Vegetation cover and area of upper catchments are important controlling factors of the morphologic characteristics of braided rivers in drylands. Thus, measures geared towards reducing the impacts of braided rivers on agricultural systems and there by the livelihood of the society in plains need to focus on rehabilitation activities (soil and water conservation) in upper catchments.