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Low-land Gully Formation in the Amhara Region, Ethiopia

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Land degradation and related processes such as gullying, flooding and sedimentation, are global phenomena. Their economic consequences however are more severe in developing countries, which lack resources for prevention and mitigation. In Ethiopia, therefore, gully erosion as a form of land degradation is a prime issue. Over the past decade, gullies have formed in the foothills of the Minizr sub-catchment in the highlands of North-Western Ethiopia. Local extension workers have reported increased gully growth rates in the past five years in the downslope foothill areas. This study answers the following questions: has the gully growth rate indeed increased over the past five years compared to historical rates? What is the mechanism behind gully formation in the study area? In addition, this study looked at three possible root causes for increased erosion rates: changing land use, an increase in the ground water level, and the implementation of soil and water conservation measures in the watershed of the study area.

The merit of this study is twofold. First, it shows the applicability of a fast, accessible and accurate way to digitally represent gullies through the use of video footage and photogrammetry. Secondly, it shows the dominant processes in gully formation in the area, allowing for a justified selection of measures to halt further gully growth and rehabilitate existing gullies.

Two medium and one large gully were selected for detailed analysis. All gullies were located in gently-sloped areas (0-5%), with Vertisol-dominated soils. Gully shape and volume were derived using terrestrial photogrammetry in AgiSoft PhotoScan Professional. Still frames exported from video footage served as input. Approximately 30 points per gully were sampled weekly for soil moisture content over the course of September, November, and December 2014. In addition, the sites were checked for signs of subsurface flow at the end of the rainy season and again 3 months into the dry season.

We expect that erosion rates have increased compared to historical rates. Gully formation in the study area is primarily driven by subsurface flow, leading to dispersion and bank collapse. Extensive signs of subsurface flows are visible in and around all research gullies. Land use has not changed significantly over the past decade, so will not have played a role in the increased erosion rates. The influence of the change in groundwater level since reservoir construction (2011) is pending analysis of current groundwater levels. With the implementation of stone bunds and fanja yuu on all fields on every hillslope surrounding the study area, infiltration will have increased significantly. Although this has decreased overland runoff, it will have increased ground water flows toward the study area and therefore made the area more susceptible to erosion through subsurface flow mechanisms.