



## **Water harvesting and sediment trapping in exclosures - A gully diversion experiment in the Tigray Highlands, Ethiopia**

K. Descheemaeker (1,2), J Nyssen (3), J Poesen (1), D Raes (1), L Terry ( ), M Haile (4), B Muys (1), and J Deckers (1)

(1) Department of Earth and Environmental Sciences, K.U.Leuven, B – 3001 Heverlee, Belgium, (2) International Water Management Institute / International Livestock Research Institute, Addis Ababa, Ethiopia, (3) Department of Geography, Ghent University, B – 9000 Gent, Belgium, (4) Department of Land Resources Management and Environmental Protection, Mekelle University, Mekelle, Ethiopia

Due to rapid vegetation restoration, exclosures (i.e. areas protected from grazing) are an effective and efficient measure for soil and water conservation. As a result, exclosures have become a widespread measure to combat the severe soil erosion and to rehabilitate the degraded land in the Tigray highlands of northern Ethiopia. Given the high infiltration rates and sediment trapping capacity of exclosures, this study investigates to what extent these characteristics can be optimized through the diversion of runoff water from an eroding gully into a well-restored exclosure.

A representative exclosure of 20 years old was selected for the gully diversion experiment. The exclosure was located on a steep limestone escarpment and was cut by a strongly eroding gully. The runoff from the gully was diverted into the exclosure by three diversion structures and canals, which led the runoff about 50 – 100 m into the exclosure and allowed it to infiltrate gradually. At the bottom of the exclosure, a cut-off drain served to evacuate the excess water back into the gully. The aim of the experimental set-up was (1) to supply additional water to the restoring vegetation in the exclosure so as to increase biomass production, (2) to decrease sediment and runoff output from the catchment, (3) to decrease gully erosion rates. The experiment was evaluated using a sediment budget and a water balance.

The sediment budget of the gully diversion system was drawn up based on records of the sediment load in the runoff water of the gully and measurements of the volumes of sediment deposited in the exclosure. The water balance of the exclosure system was developed based on measurements of the additional runoff input at the three inlet canals and of the outflow of excess runoff water in the cut-off drain. Runoff discharge measurements were made using v-notches in the canals. Weekly soil water content measurements allowed for calibration and validation of the BUDGET soil water balance model. This model was then used to determine the contribution of the additional water input to groundwater recharge and to biomass production for different rainfall scenarios.

The gully diversion experiment indicated that sediment deposition rates of 60 Mg ha<sup>-1</sup> y<sup>-1</sup> can be easily achieved in well-restored exclosures. Infiltration of runoff water from gullies in exclosures resulted in water harvesting, as 1100 mm extra water can infiltrate in normal rainfall years. This had important beneficial effects for the exclosure as fertile sediment was trapped and extra water infiltration resulted in water stress alleviation, increased transpiration and therefore a far higher biomass production. The gully diversion also resulted in a huge increase in deep percolation of water (up to 850 mm of water) and thus recharge of the groundwater, which is expected to result in spring formation downstream. Finally, the trapping of runoff and sediment from the gully in the exclosure decreased runoff and sediment discharges downstream of the exclosure, which resulted in smaller runoff erosivity and hence smaller sediment yield from the gully.