

Low-cost measures can reclaim gullies and reduce soil erosion in the Ethiopian highlands

Summary

Implementation of low-cost gully reclamation measures at an early stage of gully development can be effective in controlling gully erosion and reducing the associated sediment losses. Gully head treatment is low cost, effective in stopping gully advancement and can be managed by the financial and technical capacities of the local communities. Beginning gully reclamation at an early stage is important, as reclaiming big gullies with other measures, such as loose rock and gabion check dams, is costly and difficult for smallholder farmers to manage, considering their financial and technical capacities. Adoption of gully reclamation measures at a wider scale is crucial to control gully erosion in the highlands of Ethiopia.

Background

In the highlands of Ethiopia, gully erosion is a serious environmental and social problem. Gully erosion reduces agricultural productivity by degrading valuable land resources, increasing sediment concentrations, reducing water quality and filling up reservoirs. Gully rehabilitation has proven to be challenging, especially in the high rainfall areas of the Ethiopian highlands, where wide and deep gullies are now a common landscape feature.¹

A few case studies have demonstrated the extent of the problem: For example, 2.6 million hectares of the Amhara National Regional State is considered degraded, and 200,000-300,000 hectares of land are covered with gullies.² In south Gondar, substantial crop yield

losses, ranging from 1,100 to 3,600 kg per ha of gully-affected area per year, representing an average yield loss cost of US\$135 per ha of affected land per year, has been reported.³ It has been estimated that gully erosion account for about 28% of the total soil loss in Tigray, northern Ethiopia,⁴ and one study demonstrated that the livelihood of more than 3% of the population of two rural villages in the north-western Ethiopian highlands was affected due to losses of soil and crop yield caused by gully erosion.⁵

In response to the problem of soil erosion, a large-scale soil and water conservation campaign has been carried out in the Ethiopian highlands for the past decades.⁶ Its focus has been to reduce soil erosion through soil and

RECOMMENDATIONS

1. **Giving priority to reclaiming and restoring gullies formed in the valley bottom areas of a watershed can significantly reduce sediment losses.**
2. **Stopping the uphill advancement of gully heads by reclaiming gullies at an early stage of their formation and development (i.e., while they are shallow) is effective, less costly than reclaiming a bigger gully, and can easily managed by local communities.**
3. **Improving the design and implementation of diversion canals above gully heads is crucial for effectively reclaiming gullies and for preventing another branch of gullies from appearing.**
4. **Working with local communities to reclaim gullies could help change people's perception on gully formation and reclamation, lower costs for gully reclamation, and enhance the effectiveness of gully rehabilitation measures.**

¹ Billi and Dramis F. (2003), *Catena*, 50, 353–368; Yitbarek et al. (2010), *Land Degradation and Development*, 23: 157–166.

² Lakew and Belayneh (2012), Eastern Nile Technical Regional Office, P.O. Box 27173-1000, Addis Ababa, Ethiopia.

³ Yitbarek et al. (2012), *Land Degradation and Development*, 23, 157–166.

⁴ Nyssen et al. (2008), *Earth Surface Processes and Landforms*, 33, 695–711.

⁵ Belay and Bewket (2012), *International Journal of Environmental Studies*, 69, 714–728.

water conservation measures. However, little attention has been given to erosion 'hotspots' in landscapes, such as gullies, which can produce a great proportion of total sediment losses. This in turn has led to limited success in reducing soil loss following the implementation of SWC measures.

Implementing gully reclamation measures in collaboration with farmers

This study was carried out in the Birr watershed in the Amhara Regional State, northwestern Ethiopia, in 2014-2015 (Picture 1). We tested gully head treatment in five of the twelve gully heads observed, each of which had an average volume of about 1.5m³.

To reclaim gullies, gully heads were reshaped to have 45 degree slope, and stone riprap were added at gully heads. The steps followed were

- Excavating the base of the gully heads to get a stable ground for constructing the foundation
- Shaping the head at 45 degree inclination without disturbing the side banks
- Putting big stones at the base to form a well-stabilized foundation and different sized stones on the reshaped gully head



PICTURE 1: PART OF THE BIRR WATERSHED, WHERE 12 GULLIES WERE MONITORED, IS SIGNIFICANTLY AFFECTED BY GULLY EROSION. (PHOTO: MESERET B. ADDISIE).

- Sowing and planting fast growing grasses around the gully head and gully banks to stabilize the built structure (Picture 2)

To monitor gully head retreat, we placed erosion pins at a distance of three meters from gully heads in treated and untreated gullies. In addition, changes in the depth and width of the gully heads were monitored to quantify volumetric soil loss at each gully head. Further, the rehabilitation work on part of the watershed was implemented in collaboration with the district agricultural office to prevent people

or domestic animals from interfering with the treated and untreated gullies.

Halting gully advancement

Our study shows that halting gully formation is most effective when starting at the most active part of the gully formation. In the sub-humid highlands, such as in the Birr watershed, gully head retreat or gully head erosion is the dominant form of gully erosion when compared to gully channel and bed erosion (Picture 3). This indicates that halting the upward migration of gullies (i.e., gully head retreat) is crucial to halt the



PICTURE 2: GULLY HEAD TREATMENT USING STONES OF DIFFERENT DIAMETERS (PHOTO: MESERET B. ADDISIE)



PICTURE 3: GULLY EROSION AND GULLY HEAD RETREAT IN THE BIRR WATERSHED
(PHOTO BY: MESERET B. ADDISIE)

upward expansion of gullies and reduce the amount of sediment produced at these active gully parts. Also, poor design of diversion canals above gully heads may form another branch of gullies in the watershed, indicating that improving the design of diversion canals is equally important to control gully erosion.

Simple measures are effective and costs are low

Our results demonstrated that gully head retreat or upward movement varied between 0 and 22.5 m, with a mean value of 4.2 m during the entire study period

(Picture 4). In all the treated gullies, the treatment halted head retreat. From the seven untreated gullies, however, a total of 397 m³ of soil was lost, a surface area of 176 m² was eroded, and new channels created.

Thus, results demonstrated that gully head treatments were effective in stopping gully head retreat and further development of gullies. It is also observed that gully head treatments can be effective in reducing gully erosion when implemented at early stage of gully development. The effectiveness of the rehabilitation of gully

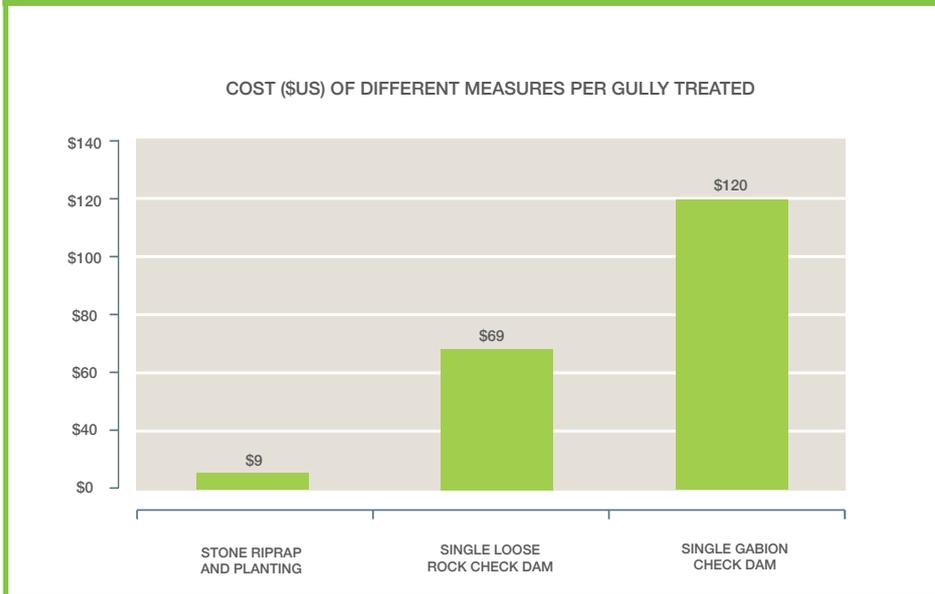
erosion using gully head treatment can be enhanced by protecting gullies from the interference of human and livestock as well as by sowing grasses in between stones and on gully banks. However, gully rehabilitation through plantation only might be effective in reducing sediment losses, but they cannot stop the upward movement of gullies as observed in nearby gullies rehabilitated with grasses only.

The tested gully rehabilitation measures are low cost, especially compared to the cost of other gully reclamation measures (Figure 1). We used locally available materials,



PICTURE 4: THE SAME GULLY IN THE HE BIRR WATERSHED IN 2015, BEFORE (A) AND AFTER (B,C) TREATMENT.
(PHOTO: MESERET B. ADDISIE)

FIGURE 1: RECLAIMING GULLIES USING STONE RIPRAP AND PLANTING IS LOW COST COMPARED TO OTHER GULLY RECLAMATION MEASURES.



such as stones and grasses. The cost was mainly payments for daily laborers (eight persons for two days) and for grass seedlings. In addition, local communities, considering their financial and technical capacities, can easily manage the tested gully rehabilitation measures.

Changing people's perception on gully formation and reclamation

Finally, our study brought a change in farmers' attitude regarding the possibility of reclaiming gullies. For example, before the implementation

of this action research, farmers in the study area believed that "gullies are created because of the will of God, and it is impossible to stop the formation and development of gullies." However, after the implementation of this study in collaboration with local people, farmers were convinced of the possibility of reclaiming gullies and converting them to productive land.

For further information, please view this video on gully treatment:

<https://www.youtube.com/watch?v=Z4LhmAdjh0U>

Acknowledgements

This study was supported by USAID (AID-OAA-A-11-00012); The CGIAR Research Program on Water, Land and Ecosystem's East Africa focal regional program; the Norman E. Borlaug LEAP, 2015, UC Davis; the First Presbyterian Church in Ithaca; the Blue Nile Water Institute, and Quarit Woreda office of Agriculture. We would like also to thank the Birr watershed communities for their support while conducting the fieldwork.

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