Gully prevention and rehabilitation: a review

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Drainage lines are the most dynamic places in the landscape and even minor anthropogenic (road construction) or environmental disturbances (fire) can trigger gully erosion. An increasing number of studies have, therefore, been devoted to understand processes and factors of gully erosion in various human-environmental settings, which has recently resulted in a number of review papers. Concomitantly, the number of studies on gully rehabilitation has also seen a sharp increase in recent years, but a comprehensive review on the effectiveness of gully prevention and rehabilitation methods (Fig. 1) is lacking.

Therefore, we provide a review of gully prevention and rehabilitation methods and report on their effectiveness towards gully erosion control. More specifically, we aim at presenting state-of-the-art knowledge on the following key questions that arise when aiming at restoring degraded gully systems:

- What type of measures exist to prevent and rehabilitate gullies and how effective are they?

- What is the effect of implemented measures on gully morphology and erosion dynamics?

- How are rehabilitation measures affecting catchment sediment yield?

A literature review was done by retrieving publications from the SCOPUS (https://www.scopus.com/) database. This resulted in 899 records on gully erosion that mention 'Control', 'Stabili(z)(s)ation', 'Rehabilitation', 'Reclamation' in the titles, key words or abstracts.

This review indicates that both gully prevention and gully rehabilitation methods suffer from relatively high failure rates. Vegetation barriers applied where ephemeral gullying is recurrent or flow diversions upslope of permanent gullies often do not have the envisaged effect. Gully rehabilitation measures consist of channel filling and reshaping, applying in-channel check dams and channel revegetation. These measures, also, suffer from high failure rates. In the case of check dams, breaching rates of about one-third are common only a few years after construction. If not breached, their effect on sediment storage can be considerable, and cause a sediment yield reduction of 20-50% (partial data). We argue that vegetation plays a key role in controlling gully erosion and is, by far, the best and most effective long term strategy for gully rehabilitation. Conditions of vegetation establishment, survival and trapping efficiency as bioengineering works, are therefore, discussed. We conclude that, although an increasing number of studies are devoted to gully prevention and rehabilitation, relatively few studies report on negative results related to gully erosion control, or investigate the impact of prevention and rehabilitation measures from multi-year studies. Improving knowledge on successes and failures of gully stabilization is key. Applying gully prevention and rehabilitation measures is costly and with global environmental projections, we may need more interventions to control erosion.

Figure 1: Examples of gully prevention and rehabilitation measures discussed. A: fascine (willow) (N France), B: woodchips barrier (W Belgium), C: in-channel check dams (bypassed) (N Ethiopia), D: revegetation (NW Ethiopia).