SIDEWALL EROSION CONTROL STRATEGIES IN GULLIES OF THE THE PENEDÈS – ANOIA VINEYARD REGION (NE SPAIN)

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1. Introduction

The Penedès-Anoia (NE Spain) is a well know region because its dedication to vineyards for production of high quality vines and "cavas" (sparkling wines produced by the champagnoise method). It is part of the Penedès Tertiary Depression, where calcilutites (marls) and, occasionally, sandstones and conglomerates outcrop. One of the main characteristics of this area is the dissection of the landscape by a dense and deep network of gullies (Fig. 1), which have been object of different research works to determine the retreat and sediment production rates at regional as well as detailed scales (Martínez-Casasnovas, 1998; Martínez-Casasnovas, 2003; Martínez-Casasnovas et al., 2003). Those works have shown that the area affected by gullies reach up to 23 - 32% of the land, with average retreat rates of 0.1 m year^{-1} and sediment productions rates of 846±40 Mg ha^{-1} year^{-1}. Frequent failure of gully-walls and the retreat of sidewalls towards vineyard drainage outlets are usually observed (Fig. 1), being necessary the implementation of control measures to avoid the retreat of walls to vineyard fields that cause damages in the fields and infrastructures.

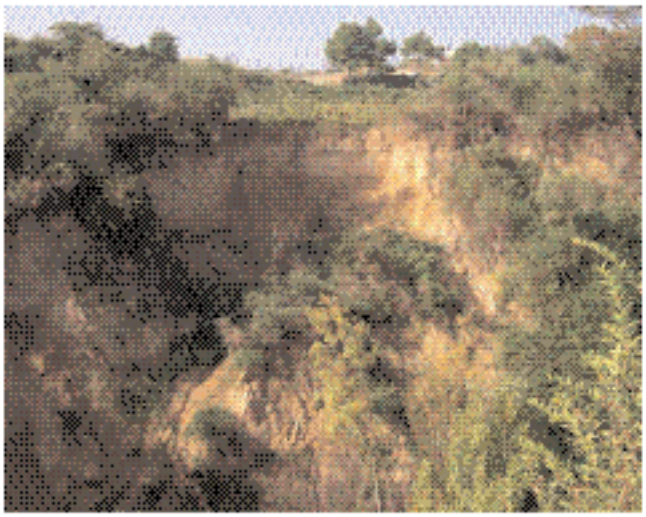

Fig. 1. Sidewall erosion in a sample gully of the Penedès-Anoia region.

In this respect, recent research by Martínez-Casasnovas et al. (2004) carried out in this study area has suggested that gully sidewall processes are determined by two types of interrelated factors. The first type of factors express the progressive preparation of gully-wall materials, acting against the shearing resistance of the soil, e.g. tension crack development in the vicinity of the wall's border area by saturation of the materials and by changes in wetting-drying conditions. The second type of factors express a local short-duration drop in slope stability, such as large and high intensity rainfalls, that generate important runoff and provoke undercutting by concentrated runoff. In those cases, sidewall failures are not so dependent on slope angle and bank height, but merely on material cohesion and runoff flow intensity.

According to this background, the objective of this work is to formulate different sidewall erosion control strategies to reduce retreat and sediment production rates in the gullies of the study area.

2. Methods and material

The determination of sidewall erosion control strategies has been based on both field observations and farmers' survey and research on the processes determining sidewall processes (Martínez-Casasnovas et al., 2004). The survey has been addressed to know the manner that runoff and infiltration water is managed from the fields to the gullies.

3. Results and discussion

Field observations and research conducted to know the processes associated to the development of sidewall erosion revealed that the retreat of gully walls is mainly caused by mass movements, which mainly occur in the saturated zone of sidewalls. This is caused by the infiltration and the accumulation of water in the lower parts of the fields (Fig. 2.A). To intercept the excess ob subsurface water flow going to gully walls, a belt drainage system along the border between the parcel and the gully is proposed. It would avoid the saturation of water in gully bordering areas (Fig. 2.B). The distance of the drain from the gully border as wells as its depth should be studied for each case. No less than 3 m from the sidewalls is recommended to avoid the collapse of the wall during the drainage installation. This is usually the distance between the last vineyard row and the gully border. The recommended depth should vary according to the depth to the lutite layer, installing the drains above the upper boundary of the impermeable layers.

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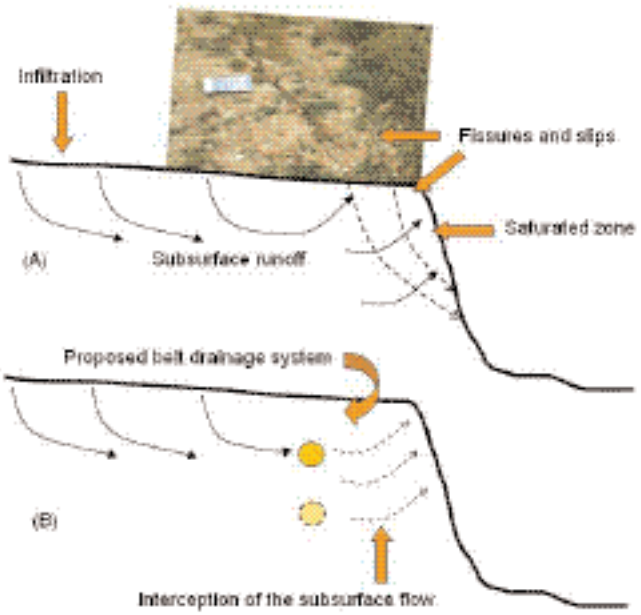

Fig. 2. (A) Process in the neighbour of gully walls determining tension crack development and wall failure and (B) proposed solution to avoid the saturation of field-gully contact areas by subsurface runoff.

Another observed process of gully wall retreat is caused by the concentration of water in drainage channels (Fig. 3). The outlets of these channels are located in the border between the fields and gullies. During high intensity rainfalls, the strength of the water flow in the outlet of drainage channels produces the erosion of the gully wall border and the development of new gullies towards headwater areas. These new gullies usually experiment a rapid growth thanks to the high relative relief with respect to the base level of the main gully. The free fall of water in the border of fields may constitute truly waterfalls. This erodes the base, and the upper part of the wall finally falls by gravity (Fig. 3A). The proposed solution is the canalisation of runoff water from the present outlets to the gully water courses (Fig. 3C).

These measures should be complemented with other, as for example the stabilisation of the gradient of the large gullies with structures as check dams, or the implementation of drainage terraces to conduct the runoff excess originated in the fields to specific outlet points. In those points the proposed tubes to conduct the water to the gully bottom should be implemented.

The field work has shown that none of the above mentioned control measures are usually implemented in the study area. Farmers conduct runoff water to the border of their fields and they fill ephemeral gullies that appear after high intensity rainfalls. When a gully wall falls and part of a field goes away, farmers fill the gully with soils or parent materials, which are moved from other parts of the field. It involves big investments and it does not avoid gully erosion. At present, this is in most of the cases the erroneous idea that many farmers have about the problem of gully erosion and its solutions.

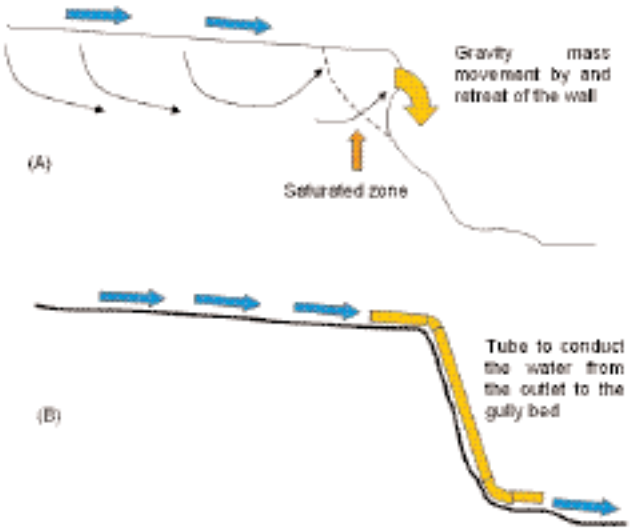

Fig. 3. (A) Concentration of runoff water in drainage channels and free fall of water on the gully walls, erosion of the gully walls and gravity mass movements, and (B) proposed solution by means of the canalisation of runoff water from fields to gully beds.

4. Conclusions

A change in the manner water is managed in the Penedès – Anoia vineyard region (NE Spain) must be considered to reduce gully erosion rates and to avoid further field and infrastructure damages. It is very important to persuade farmers to implement those control measure to secure the agricultural land uses as in its present form in decades to come.

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