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Erosion control by check dams in a hydrological and forest restoration (Tórtoles, Spain)

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Gully erosion is a problem with serious consequences in terms of loss of soil resources on which life is based. A check dam is one of the techniques to control gullies. The effectiveness of these structures used in hydrological-forest restoration projects is controversial in recent years. Here is the importance of a detailed measurement of the wedge of the sediment trapped, from which erosion and sediment yield rates can be obtained. Furthermore, emission of sediment downstream of the check dams can accurately estimate sediment impact on the watercourses.

The aim of this work is to study the effectiveness of check dams on trapping sediment, studying the dams built in the gullies of Tórtoles (Corneja River basin, Spain) during the 60s, by means of applying a new method that measures accurately the wedge of sediment retained by them.

In this study, we measured the volume of sediment trapped by check dams by means of a detailed topographic survey, using a total station (accuracy of $\pm$ 1 cm). The method is based on measurements of cross-sections of the sediment wedge. The volume is further determined by matrix calculation. The methodology was compared with other methods based on simple geometric elements (prisms and trapezoidal pyramids). The characterization of sediment, the determining of the trap efficiency of check dams and the measured surface of the basin, which yield sediment each check dam, were used to estimate retention rates, total emission and erosion rates. Then the consequences of total sediment emission downstream of the restoration area was analyzed. Furthermore, the analysis of the equilibrium bed-slope of the gully channel allowed the study of some of the geomorphological changes of the gully beds made by these structures.

According to the results, 123 check dams built in Tórtoles held 6194.95 m3 of sediment over 48 years, which means a mean of 50.37 m3 per check dam. These values were higher than those obtained using the other geometric methods, which use a less detailed survey and shorter fieldwork. According to the proposed method, the erosion rate from the study area is 5.56 t·ha-1·year-1, which means an 18.44% and a 12.60% higher than those obtained by the geometric methods). The mean trap efficiency of the check dams in the area was 92.12%. Consequently, the mean sediment emission rate was 0.096 t·ha-1·year-1. Both values had significant differences respect to those obtained by means of the geometric methods. If the sediment retained by check dams had been delivered downstream the restoration area, the Corneja River could have been severely contaminated and the trouts living in its waters had been injured. Nevertheless, waters have adequate levels of suspended solids, since a suspended solid rate lesser than 25 mg·L-1 is necessary for salmonid survival. Furthermore, the Santa Teresa reservoir has currently a good water quality because of the sediment trapped by the Tórtoles check dams upstream. Total sediment yield by check dam in the area exceed tolerable rates in 64.60% of cases. For this reason, soil loss in the study area was not admissible, however check dams retained the greatest amount of sediment and sediment emission rate was very low. Additionally, the sediment wedge behind the check dams lowered the slope of the gullies over 11.29%. Furthermore, the sediment wedges created 2787.68 m2 of land suitable for crops and 5150.30 m2 suitable for grazing or reforestation.

In conclusion, using the proposed method for measuring sediment retained by check dams by means of a detailed topographic survey, more accurate erosion and sediment yield rates can be estimated in a restored area. This t allows a better understanding of how these structures work, what about their effectiveness in sediment control and about geomorphological changes generated. The proposed method proved that check dams built in Tórtoles played a very positive role in sediment control. Furthermore, the method allowed checking positive geomorphological changes as lower gully-bed slopes, hillslope stabilization and recovering a great useful area for cropping, grazing or reforestation, which was lost due to gully erosion and badland formation.