RELATION BETWEEN THE LOCATION OF CHECK DAMS AND ADJACENT VEGETATION COVER IN EPHEMERAL GULLIES (SOUTHEAST SPAIN)

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1. Introduction

In general, the work carried out on vegetation in the Mediterranean catchments is focused more on the hillside vegetation cover than the riparian. Apart from occasional contributions by Alcaraz *et al*. (1997), Salinas *et al*. (2000), Mant (2002), Corbacho *et al*., (2003), Hooke *et al*. (2005), little more has been published about the vegetation of ephemeral channels in the Southeast of Spain. Specifically, the gullies create a very dynamic fluvial environment of which its connection with the morphological and hydraulic effects of riparian vegetation has been little studied up until now. The channel stability within these torrential streams depends a great deal on how much it is subject to erosion, as well as the production of sediments from the areas directly related to them (upper channel reaches and adjacent hillslopes). This is of unquestionable interest in channels being corrected by check dams, especially to assess the adequacy of their location (Conesa-García *et al*., 2007). The current paper adds a straightforward methodology in such a way, which relates the location of check dams to the level of vegetation cover developing in the plots of land surrounding the thalweg.

For the purpose of study, two semiarid gullied catchments have been chosen, which have a strong tendency to dry up: the Torrecilla and Cárcavo catchments (Southeast Spain). The catchment of Torrecilla (15.5 km^2) shows a "gullied" landscape developed on metamorphic materials (slates, phyllites, schists and quartzites), while the Cárvaco catchment (34.8 km^2) is drained by ephemeral channels and gullies that deeply dissect the Miocene marls and Quaternary pediments. The projects of hydrological rectification undertaken are similar in both catchments: 33 and 40 check dam series were respectively built during the 1970´s, most of them with gabions.

2. Methodology

Firstly, a cartography of vegetation response has been drawn up, using the information of the high resolution sensor of the *Quickbird* satellite (images from 2003). The resulting information is taken from the data obtained by this same sensor that works within the visible range (450-690 Ìm) up to the infrared range (760-900 Ìm). The vegetation response has been assessed by means of the *Transformed Normalised Difference Vegetation Index* (TNDVI), which allows to obtain values of chlorophyllous production from the spectral emission of the different vegetation classes.

$$TNDVI = \left(\frac{IR - R}{IR + R} + 0{,}5\right)^{2} \qquad (1)$$

where *IR* is the information taken from the close infrared and *R* represents the values of the visible or red spectrum. In turn this information is analyzed statistically by means a not supervised sorter of maximum probability, obtaining four classes of different degrees of vegetation cover: nonexistent, low, average or high cover (Fig. 1).

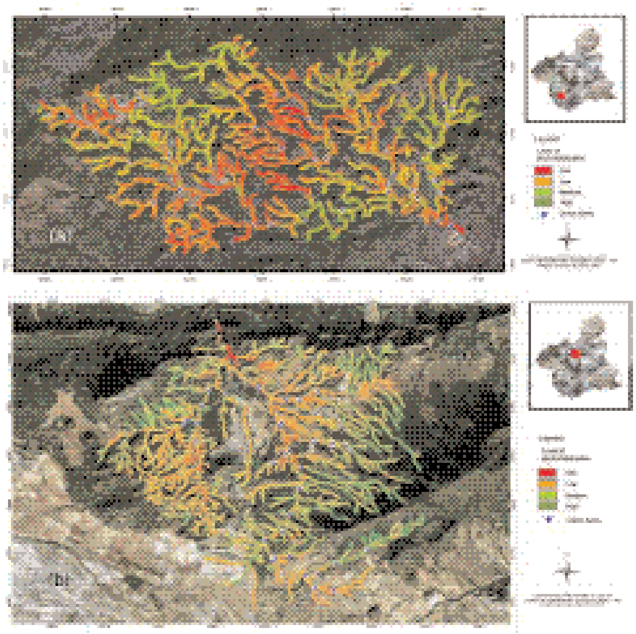

Fig. 1. Degree of vegetation cover and phytostabilization in plots of land adjoining the channel (buffer of 30 m) from TNDVI values using *Quickbird* images (2003). Torrecilla (a) and Cárcavo (b) catchments. Murcia Region, Spain.

To obtain the adjoining areas to the channel in both streams a "*buffer*" has been created, or an adjacent area to the thalweg. This surface of land is generated with a radius of 15 and 30 m from the central channel axis (Fig. 1).

The processing and analysis of the images have been carried out by ERDAS Imagine 8.7, whilst the "buffers" have been taken from ArcGis 9.0. Both GIS are technologies of information, processing and spatial analysis of great capacity. Finally, different effects of check dams in

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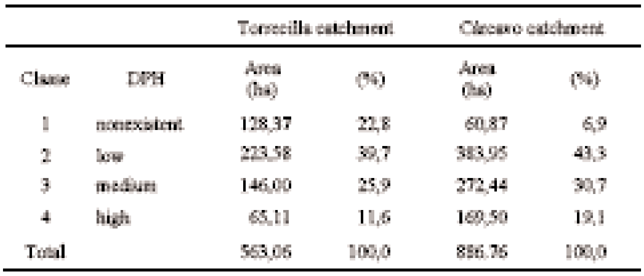
their very immediate neighbourhood have been analysed from fieldwork.

3. Results and discussion

The four identified classes show a clearly uneven distribution in the study catchments. In fact, the Torrecilla catchment has a medium area of practically bare soils, with nonexistent or very poor vegetation. This area (34 % of the watershed area) has links with other sectors of less spatial continuity located in the headwaters of *ramblas* and gullies, extending the sparse character of the vegetation to more than 62 % of the total length of channel reaches. The lithological characteristics are an influential factor in such distribution, as the majority of the buffers as those of areas extracted from quartzites, schistes and metaconglomerates show a very limited development of vegetation. The emphasis is on a fairly significant proportion at the base of hillslopes and the remainder of geoforms surrounding such channels, represent a nonexistent phytostabilization in 22 % of the total surface of buffers (Table 1).

Table 1. Superficial distribution of the classes of vegetation cover defined by TNDVI values for a buffer of 30 m around the Torrecilla and Cárcavo drainage networks. Data from Quickbird images (2003). DPH: degree of phytostabilization.



		Torrecilla catchment		Cárcavo catchment	
Clase	DPH	Area (ha)	(%)	Area (ha)	(%)
1	nonexistent	128,37	22,8	60,87	6,9
2	low	223,58	39,7	383,95	43,3
3	medium	146,00	25,9	272,44	30,7
4	high	65,11	11,6	169,50	19,1
Total		563,06	100,0	886,76	100,0

The comparison of the TNDVI values included in the buffer of the Torrecilla drainage network with the slope data and silting level of check dams show that the location of almost 26% of these structures is not suitable enough for the retention of sediments. In the case of the Cárcavo the check dams are located more practically in relation to the source areas of sediments, and to the TNDVI values of the buffer which contains the fluvial stretches. The classes of non existent and low phytostabilization represented in the *buffers* of these streams makes up 29 % of the total surface of *buffers* in the Cárcavo catchment, but in this area there only exists an 8 % of the check dams installed in the whole catchment. Three main situations can be observed:

- Geomorphological uselessness or limited effectiveness of check dams in densely vegetated headwater areas of gullies.
- Lack of check dams in areas of gullies with channel reaches and adjoining talus lacking in vegetation and morphologically active.
- Unequal control of the erosion and the bed slope in middle and low reaches, depending on the degree of dam filling, its geometric characteristics and spacing amongst them.

Check dams have strong local effects on vegetation along the channel. In fact, the initial growth and survival of riperian vegetation are favoured by the presence of silt, waterlogging and temporary water retention, and above all by the greater degree of bed stability arrived at upstream from these grade control structures. The greatest density of undergrowth can be found upstream from the headwater dams (*Nerium oleander, Rhamnus lycioides* y *Pistacia lentiscus*). *Tamarix canariensis* bushes are more frequent in silt beds on the lower reaches. Downstream from the check dams short-term pools are formed where groups of long-stemmed juncus predominate along with cane breaks of *Phragmites australis* in the channel bottom and *Limonium delicatulum* on the banks. At the dam foot a more entrenched and deeper new channel is formed. While the process of morphological readaptation is going on in this new channel, the main bed shows a high roughness, with bedrock outcrops and armoured reaches, and riperian vegetation is displaced onto narrow side sectors subject to periodical flooding. When channel depth downstream from the check dams is considerable, the old bed hangs above the level of ordinary floods, and this is where esparto grass usually takes over.

Together with morphological adjustments produced by the check dams, changes in sediment transport capacity, marked variations in bed texture and roughness, location of sediment supply sources and groundwater influences may also be important.

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