GULLY DEVELOPMENT AND TOPOGRAPHIC THERSHOLDS, CASE STUDY: KERMAN PROVINCE, SOUTHEAST OF I. R. IRAN

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1. Introduction

Gully development in Kerman province, southeast of I. R. Iran has caused many problems for stakeholders, especially for croplands and their landusers. Gullies are defined as erosional channels with a cross-sectional area larger than 929 cm^2 (Poesen, 1993). Gully erosion is a threshold phenomenon. As such, identification of topographic threshold for gully development in different environments is essential (Poesen et al., 2003). This threshold concept was first applied by Patton and Schumm (1975). Based on this theory, there is a critical slope and drainage area above a gully head to produce sufficient runoff to cause gully development. This phenomenon is examined in an arid environment with dominantly cropland in Kerman province (Fig. 1). Desmet et al.(1999) found that a negative power relationship exists between slope and drainage area above the headcuts for gullies formed by surface runoff.

2. Materials and Methods

In order to test the impact of different control measures on gully development, a research project began in 2002. At first, the gullies were classified based on their location in the landscape, their general and headcut view plans, shape of their cross-sections, land use above headcuts, and soil material. Six representative gullies of one class were selected and benchmarks were installed inside and outside the gullies. The view plan of each gully and headcut and its long profile were surveyed. The soil samples were collected from different layers of gully headcuts. Drainage area and slopes above the headcuts were determined by surveying. After rainstorms with significant runoff (rain which caused changes in gullies) gully development was measured., correlation between gully development as the dependent parameter and drainage area, slope, and the product of drainage area and slopes above headcuts was analyzed using regression method. Correlation coefficients (R^2) were used to determine the most important factors influencing on gully development.

Fig. 1. Map of study area, Kerman Province, I. R. Iran.

3. Results

The research site located in a longitude between 56º, 13', 31.6"E and 56º, 14', 52.4"E and a latitude between 28º, 49' N and 28º, 49', 20"N in Kerman province. The average rainfall in the nearest rain station, Khabr, was 287.8 mm. Study area is mainly croplands and gullies are formed and distributed around them.

Selected gullies had U shape cross section with the average depth of 1.2 m and average length of 17.7 m. Soil texture in the surface and depth was silt-loam and sand content decreases from surface to under layers in the bank of gullies. Fig. 2. shows a sample of studied gullies.

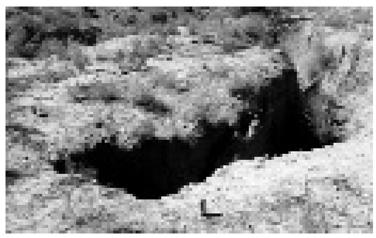

Fig. 2. Sample of studied gullies.

Gully development was measured by two benchmarks inside and outside of headcut in a direction that surface runoff enters into the headcuts (Fig. 3). The distance between two points and headcut was measured after each effective rainfall with surface runoff.

IV International Symposium on Gully Erosion. J. Casalí and R. Giménez (Eds.)
 ISBN 978-84–9769-198-7

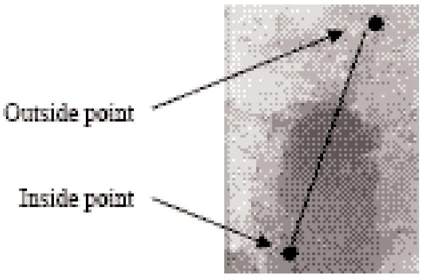

Fig. 3. Inside and outside points to determine gully development.

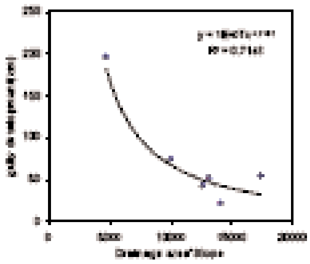

Fig. 4. Relationship between length progress and drainage area*slope.

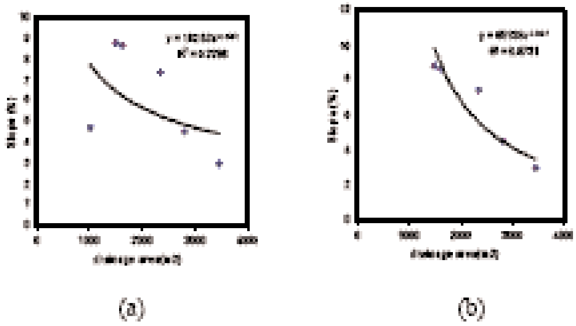

Fig. 5. Relationship between Slope and drainage area.

Headcuts extension was between 22.7 and 196.5 cm in 3 years (Table 1). A power relationship was established between gully development as dependent variable and drainage area, slope and the product of drainage area and slope above headcut in Kerman Province.

Table 1. Values of gully development, slope above headcuts, and headcut drainage area.

Gully	Slope (%)	Headcut drainage area (m^2)	Gully development (cm)
1	4.7	1004.5981	196.5
2	2.9	3452.0294	74.7
3	8.7	1615.8495	22.7
4	4.5	2808.1219	43.2
5	8.8	1493.9235	52
6	7.4	2351.1286	54.5

Comparisons were made between correlation coefficients derived for gully development with (1) only drainage area above headcuts, (2) only slope above headcuts, and (3) product of drainage area and slope above headcuts. These data indicated correlation coefficient of the relationship between gully development and the product of drainage area and slope was the highest(R^2 = 0.71) as compared to using just drainage area or just slope (Fig. 4).

Examining the relationships between gully development with drainage area above headcut and gully development with slope revealed that drainage area is more important than slope on gully development in this arid and agricultural environment.

A negative power relationship indicated in Figure 5 to show the proposed relationship between slope and drainage area above headcuts by Desmet et al.(1999), Our results are agree with Desmet et al.(1999) results(Fig.5-a). It implies that Kerman gullies were formed by surface runoff. Between gullies, one dariange area was covered by croplands and with deletion of this data the correlation coefficient of the relationship between slope and drainage area was improved(Fig 5-b). In our research area, the optimal relative area exponent(b) ranged from 0.46 to 1.2 in gullies.

4. Conclusion and Discussion

This research indicated that gully erosion can severely damage croplands in this area of Iran. Significant gully development occurred in the 3 years of study and the product of drainage headcut area and slope was more strongly correlated to gully development than using just slope or drainage headcut area.

Slope and drainage area indicated an inverse relationship for initiation and development of gullies The relative area exponent (b) ranged from 0.46 to 1.2 in this research. Our results are agree with Desmet et-al's findings. Results imply that with these drainage area above headcuts , slopes less than 2 percent is required for gully development. Therefore, changing slopes above gullies in this region would be recommended to mitigate gully erosion.

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