Characteristics and Causes of Gully Erosion in Iran

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Abstract: A research plan is going to start to study the characteristics and causes of gully initiation. To set up its methodology, a questionnaire was designed and tested by experts in the field in 1998 and 1999 in five provinces with different physical and socio-economic conditions. The pre-results indicate that gullies are initiated in different ecological and climatological conditions. Their view plans are dendretic with U-shaped cross section and medium size with respect to their depth. The vertical profile of the headcuts is dominantly vertical, that is the activity of surface runoff is important. The results reveal that the important factors in gully initiation are deterioration of vegetation cover, flood and rainfall intensity and mismanagement of watersheds. Important on site damages are disconnection of rural roads and bridge breakage, land scoring, recession of water table, immigration of rural people and movement of the location of villages. At this stage it seems that the combination of high intensity rainfall with ground surface disturbance by road construction and deterioration of native vegetation cover are the most important factors for gully initiation. Surface runoff would be the dominant hydrological process in gully development.

1 Introduction

Many hypothetical causes of erosion have been found and these can be grouped into three categories of human impact, climate and intrinsic change (Soufi, 1997). Human impact was invoked because of the association of gully erosion with European settlement in USA and Australia. Vegetation changes due to human impacts have been introduced as the main cause of the formation of arroyos in coastal California (Cook and Reeves, 1976) but these researchers stated that the relationship between settlement and arroyos formation was not perfect. Similarly, much research in southeasthern Australia (Eyles, 1977;Gillespie, 1981;Melville and Erskine, 1986;Prosser, 1991;Starr, 1989) showed that environmental changes by human impact were the main cause of channel initiation. Degradation of valley floor vegetation by grazing or regional development was identified as the impact of human activities on gully initiation (Prosser and Slade, 1994, Soufi, 1999).

Evidence of previous phases of gully erosion before the introduction of modern agriculture led the researchers to consider the climate as another hypothesis. Intense rainfall and drought have been invoked as significant aspects of climate changes (Huntington et al., 1914;Eyles, 1977;Balling and Wells, 1990;Imeson and Kwaad, 1980). High runoff periods due to intense rainfall (Leopold, 1951;Blong, 1970) and drought (Eyles, 1977) are suggested to be different aspects of climate impact on gully initiation in New Mexico, New Zealand and Australia, respectively. Moreover, increased precipitation and the number of high intensity summer storms are claimed to be the most important causes of channel incision in the Zuni catchment, southeast USA (Balling and Wells, 1990). Evidence such as tree rings and the degree of soil development was used to reject the role of timber harvesting, grazing and settlement as major reasons in channel incision.

Lack of synchronous erosion across regions and the recognition of internal changes within basins have introduced intrinsic changes as the third hypothesis (Schumm, 1973;Patton and Schumm, 1975). The steepening slope of some reaches and base level lowering are introduced as causes of channel incision in Fernances Creek catchment, southeast Australia (Melville and Erskine, 1986).

Changes in force and/or resistance is associated with each of the above three causes, for example human impact causes increased runoff and/or decreased vegetation cover. Climate change could be divided into high intense rainfall causing high runoff periods and also low rainfall (droughts) causing degradation of vegetation due to low moisture and increased grazing pressure. The intrinsic change of valley steepening causes an increasing force which leads to incision.

Despite the passage of three decades in studying soil erosion and conservation in Iran, there is still no documented data on gully erosion. There is an attempt in this study to remove this deficiency. In order to prepare a unique instruction and survey the resulting problems, a questionnaire was prepared and tested in a few areas in Iran with ecological, climate and social conditions. Before filling the questionnaire, necessary instructions were given to the staff for field surveying.

2 Method

Gullies in each province were identified by using the existing data in watershed management offices. To supplement the data, satellite images, new aerial photos and topographic maps were also used. After the identification of gullies in each province, the climate of the eroded areas was determined using Demarton method. Then two areas with gullies were chosen in each climate, one typical gully was determined in them and morphometric measurements and soil sampling were performed. Gully characteristics as length, width, depth, general view plan, head view plan, vertical head profiles, shape of cross section, and location of gullies were assessed. Required data about geological formation, pedology, plantation, land use and physiography were also used. Evidence of destruction and improper use of ecosystem were proved with the residents. In this research, Fars province, Sistan and by field survey and intervies Balochestan province, Golestan province in flood plain and hilly areas, Zanjan province in hilly areas and Mazandaran province in mountainous areas are studied and the results of the pilot study are presented.

3 Results and discussion

The areas under this study were selected from five provinces situated in the south, north and northwest containing gully erosion in an area of at least 500 hectares. The climate of these areas varies from hot and dry to cold and humid (Table 1). The average precipitation in these areas varies from 100 to 570mm. The altitude of these areas varies from 20 to 2,000 meters above sea level. Rainfall regime in the southern areas is rain and in the north and northwest is in the form of rain – snow.

Generally, it rains in winter. The slope of land around the gullies varies from 0.3 to 50 percent. The land is mostly used as rangeland and dry farming.

Table 2 shows the morphometric features. The gullies are formed on the slope alongside the natural drainage ways and on the valley floor. Their length changes from a thirty meters to a few kilometers. Upper and lower width varies from 1 to 40 meters. The gullies have extended with a medium depth and in some areas of Zanjan province, being deep. The cross section in gullies in south provinces such as Fars, Sistan and Blochestan and in north such as Golestan is U-shaped and in other provinces such as Mazandaran and in northwest such as Zanjan, V-shaped in the upstream and U-shaped in downstream. The soil texture of most gullies is loam and in some parts, siltyloam, loamclay, loamysand and sandyloam are seen. In the most of studied provinces, runoff is determined as the dominant hydrological process. In some areas, sub-surface processes such as piping and tunneling are also observed.

4 Causes of gully initiation

One of the most significant causes of gully initiation is destruction of natural vegetation due to over grazing or cutting forest trees, leading to the reduction of soil resistance against floods. The occurrence of gully erosion specifically increases in the areas where land slope increases to a few percent.

In flood plains, gullies are initiated due to poor management of flood farming and lack of maintenance of embankments. Unfortunately, necessary attention is not paid to this type of management in Iran. Road construction, urban development and construction of bridges on the foot of slope will

increase the hydraulic gradient alongside the long profile from uphill to downhill after roads. Therefore, gullies develop immediately at the upper hand of bridges and roads. Tillage of dry lands, trace of vehicle tyres and soil excavation for construction of embankments around the head of gullies in the flood plains are the other significant factors in gully formation in Iran.

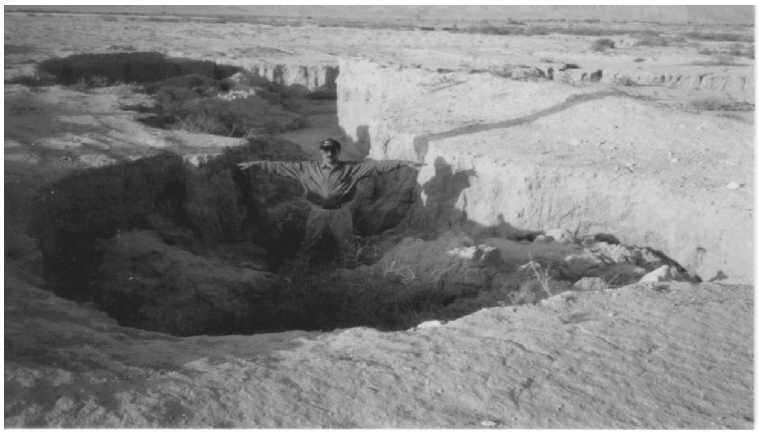

Photo 1 Medium size gully in Lamerd, Fars provice, southweast of I. R. of Iran

Photo 2 Dendretic gully in the floodplain of Lamerd, Fars province, southwest of I.R.of Iran

Photo 3 The signe of runoff along vegetation upstream of gully head in Chahoo, Lamerd, I.R. of Iran

Table 1 Climate, edaphic and physiographic features in areas with gully erosion in five provinces of Iran based on presurveying

Province	Location	Climate	Average Annual Precipitation (mm)	Altitude above sea level (m)	Precipitation Regime	Dominant Raining season	Land Slope (%)	Land use
Fars	Chahoo	Hot and arid	150-200	450	Rain	Winter	1-1.5	Rangeland, dry farming
Sisan and Balochestan	Dashtiari	Hot and arid	100	20	Rain	Winter	0.3	Rangeland, Bennana plantaion
Golestan	Gonbad	Arid desertic	274	55	Rain	Winter	10	Poor rangeland
Golestan	Maraveh – tapeh	Moderate arid desertic	274	240	Rain	Winter	4	Poor rangeland
Golestan	Kolaleh	Moderate arid	570	175	Rain-snow	Fall-Winter	10	Poor rangeland
Mazandaran	Savadkooh	Cold humid / semi arid cold	513	1400-2000	Rain-snow	Fall-Winter	30-50	Poor rangeland
Zanjan	Idehloo	Arid cold	200	1450	Rain-snow	Winter-Spring	1-3	Dry farming, Poor rangeland

Table 2 Morphometric features of gullies in five provinces in Iran

Province	Location	Gully location	Length (m)	Upper width (m)	Lower width (m)	Average depth (m)	Shape of cross section	Soil texture	Process
Fars	Chahoo	Valley floor	50-1000	6	7	2.5	U	Loamy-Sandyloam	Runoff/Piping
Sisan and Balochestan	Dashtiari	Valley floor	150-1200	20-40	20-40	6	U	Loamy	Runoff
Golestan	Gonbad	Valley floor	25	5	5	1	U	Loamy	Runoff
Golestan	Maraveh -tapeh	Valley side	1500	8	8	8	U	Loamy	Runoff
Golestan	Kolaleh	Valley side	130	12	3	8	U	Loamy	Runoff
Mazandaran	Savadkooh	Drainage line	200-3500	4	1.5-3	5	V(upst.)/ U(downst.)	Loamy sandy/Loamy clay	Runoff/Piping
Zanjan	Idehloo	Drainage line	10-2000	1-3	0.5-2	7	V(upst.)/ U(downst.)	Loamclaysilt /lloamsilt	Runoff

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