WATERFALL EROSION AS A MAIN FACTOR IN EPHEMERAL GULLY INITIATION IN A PART OF NORTHEASTERN IRAN

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1. Introduction

Gully erosion is defined as the erosion process whereby runoff water accumulates and is concentrated in narrow channels and, over short periods of time, removes the soil from this narrow area to considerable depths. In some areas, gully erosion is also a main source of sediment yield (Poesen et al., 2003; Nagasaka et al., 2005). Classical gullies can be described for agricultural land as permanent channels too deep to easily ameliorate with ordinary farm tillage equipment, typically ranging from 0.5 to as much as 25-30 m depth (Soil Science Society of America, 2001). Ephemeral gullies result from concentrated flow erosion larger than rill erosion but smaller than classical gully erosion (Poesen et al., 2003). Gully erosion consists of four stages: formation, development, healing and stabilization. As reported by Sidorchuk (2005), the gully initiation stage comprises only about 5% of the entire gully lifetime, but in that stage more than 90% of gully length, 60% of its area and 35% of the gully volume may be formed. In the remaining gully lifetime the morphologic conditions are relatively stable. Thus is important to understand the controlling factors in the formation stage. Sidorchuk (2005) also mentioned that in humid conditions the linear water erosion at the gully bed and rapid shallow mass movement at the gully sides of major importance during the first stage of gully evolution. The present study assesses the factors controlling gully formation in a study area located in northeastern Iran. Gully erosion in northeastern Iran is very high because of the high rate of human encroachment and the resulting impacts on soil erosion.

2. Materials and Methods

The study took place in the rolling hills region of the Sanganeh Plateau at almost 600 m absl in the vicinity of the Turkmenistan border (Fig. 1). This area is covered by highly erosion susceptible brown soils (Iranian Planning and Budget Organization, 1994). The area receives some 200-300 mm of precipitation per annum (Jafari, 1997) and is primarily covered by annual grasses. These grasses grow during the time of the main precipitation, i.e. during December to March, and then diminish with the onset of rising temperatures. The main land use of the area is natural rangelands that are intensively and untimely grazed by sheep. The rate of soil erosion is very high and vegetation pedestals have been well developed in the area.

The study was based on long-term field investigations and detailed monitoring of gully stages. The intermediate stages of soil erosion (i.e. sheet and rill erosion) were also considered to determine the dominant processes in gully formation and development. The study cases were then depicted pictorially.

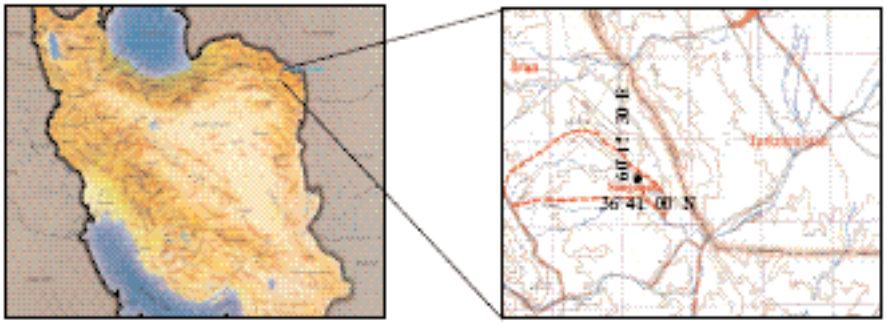

Fig. 1. General view and location of the Sanganeh study watershed, Iran.

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

3. Results and Discussions

The study was concentrated in Sanganeh Watershed which drains to Turkmenistan. The burrowing activities of animals and insects such as mice, ants and rabbits and untimely overgrazing were recognized as initiating factors for gully formation. It was interesting that no intermediate stages of intensive sheet and rill erosion were observed that contributed to the more intensive gully erosion. The successive processes of gully formation and subsequent development in the study region are illustrated in Fig. 2.

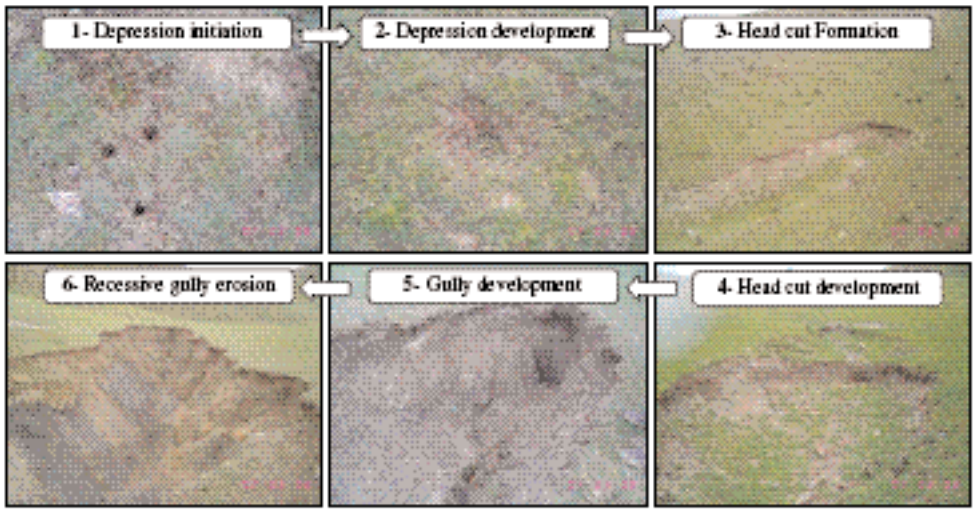

Fig. 2. Processes of gully formation and development in Sanganeh Watershed, Northeastern Iran.

The initial stage of depression formation and subsequent gully initiation were recognized in the area. Once the water accumulated in depressions made by rodents, uprooted plants and animal hooves, the gully head cut was then shaped as the result of waterfall erosion. The erosion processes then proceeded to develop an upward progressing gully channel. No downward extending channel/rill erosion could be distinctly identified as a gully forming process. Dominant mechanisms other than waterfall erosion were not observed contrary to Sidorchuk (2005) regarding the role of channel erosion in gully formation and development in humid conditions. The gullies developed until they were subjected to stoppage of waterfall erosion and surface runoff. It was also observed the linear water erosion at the gully bed, rapid shallow mass movement at the gully sides as well as tunnel roof collapse were of major importance for gully evolution after initial first stage gully development. During the second stage of gully evolution slower processes such as ground water seepage, earth flow and soil creep became more important in gully extension as partially mentioned by Sidorchuk (2005).

4. Conclusion

The mechanisms of gully formation were scrutinized in a part of northeastern Iran through field observations. Waterfall erosion was recognized as an important factor in gully initiation originating from depressions made by rodents, uprooted plants and animal hooves leading to waterfall erosion and developing gully erosion. The authors believe that gully erosion can be controlled by implementing managerial measures that focus on timely prescribed grazing and prevent overgrazing of the area. Continued monitoring and field data collection are advised.

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