MONITORING AND ESTIMATION OF SOIL LOSSES FROM EPHEMERAL GULLY EROSION IN MEDITERRANEAN REGION USING LOW ALTITUDE UNMANNED AERIAL VEHICLES

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ABSTRACT:

Calculation of gullies by remote sensing images obtained from satellite or aerial platforms is often not possible because gullies in agricultural fields, defined as the temporary gullies are filled in a very short time with tillage operations. Therefore, fast and accurate estimation of sediment loss with the temporary gully erosion is of great importance.

In this study, it is aimed to monitor and calculate soil losses caused by the gully erosion that occurs in agricultural areas with low altitude unmanned aerial vehicles. According to the calculation with Pix4D, gully volume was estimated to be 10.41 m^3 and total loss of soil was estimated to be 14.47 Mg. The RMSE value of estimations was found to be 0.89. The results indicated that unmanned aerial vehicles could be used in predicting temporary gully erosion and losses of soil.

1. INTRODUCTION

Large part of soil losses in the Mediterranean region takes place with the gully erosion in agricultural lands and is caused by heavy rains of the early spring (Poesen, 1995).
Calculation of gullies by remote sensing images obtained from satellite or aerial platforms is often not possible because gullies in agricultural fields, defined as the temporary gullies are filled in a very short time with tillage operations.
Although temporary gully erosion, which firstly identified in 1986 by Foster (Foster, 1986), is common throughout the world, it commonly takes place in the terrains of arid and semi-arid regions where morphological activity and dynamics are high (Cassali et al., 1999).

2. MATERIAL AND METHODS

2.1. Study area

The study was performed in Kahramanmaras Sutcu Imam University Campus area in Turkey. (Figure 1). The survey area has a 30% concave topography and a slope of about 14% and a slope length of 300 m. The soils of survey area have been classified as Typic Calcixererts (Gündogan et al., 2012), and are characterized by clay loam texture, slightly alkaline and high cation exchange capacity.

The skeleton material (rock fragment) content ranges from 12.2% to 30.4%. The lime content of surface soils is lower than 15% and subsoil lime content is between 44% and 66%. Organic matter content in surface horizon is 1.23% and is below 1.0% in subsoil (Gündogan et al., 2012).

Figure 1. Descriptive field image and occurrence of ephemeral gully erosion in study area dated at 14/04/2017

2.2. Field Study

This study examined a multicopter (hexacopter) as an air platform. In this study, it is aimed to monitor and calculate soil losses caused by the gully erosion that occurs in agricultural areas with low altitude unmanned aerial vehicles.

The image was taken by unmanned aerial vehicle at an altitude of 80 m on April 24, 2017 (Figure 2). The flight altitude was defined 80 m, and the ratio of side and forward overlaps were planned as 80% (forward) and 60% (side).

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Figure 2.Orthophoto of the study area acquired dated 04/24/2017

2.3. Image Process

Processing and analysis of images were performed with Pix4D. The main procedure was applied as previous studies about volume calculation and the derivation of Digital surface model (Figure 3;4).

Figure 3.Calculation of cut volume of ephemeral gully by Pix4D.

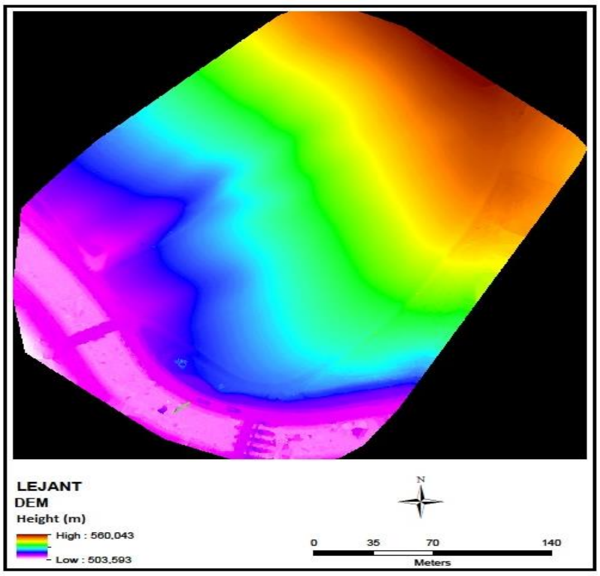

Figure 4. DEM of study area with high resolution generated orthophotos acquired by UAV

Days	**Oct.**	**Nov.**	**Dec.**	**Jan.**	**Feb.**	**Mar.**	**Apr.**
-							
9	0	0	0	52,3	0	0	13,3
10	0	0	0	6,4	0	0	0
11	0	0	0	0	0	3,5	0
12	0	0	0	0	2,6	12,7	0
13	0	0	9,6	1,1	1,1	23,2	7,1
14	0	0	13,9	0	0	7,5	**40,1**
15	0	0	0	0	0	9,9	1,1
-							
Total	**13,6**	**26,7**	**145,7**	**126,7**	**3,7**	**74,2**	**68,1**

Table 1.Daily rainfall records within October 2016-April 2017 period

Channel No	**Cut Volume (m^3)**	**Soil Loss (Mg)**
1	0,04	0,06
2	0,11	0,15
3	0,26	0,36
4	9,54	13,26
5	0,29	0,40
6	0,07	0,10
7	0,01	0,01
8	0,08	0,11
9	0,01	0,01
Total	**10,41**	**14,47**

Table 2. Cut volume (m3) and soil losses (Mg) of some gullies in study area after heavy rain dated at14/04/2017

3. RESULTS

A 1.82 cm resolution of digital elevation model was produced from the ortho photographs obtained from aerial images. In the study area, during the period of October 2016 to May 2017 (14/04/2017), the gully was formed after 40.1 mm of rainfall (Table 1). A total of 945 m gully channels has formed following this precipitation. The depth of channel ranged from 5 to 18 cm and the width ranged from 10 to 23 cm (Figure 1).According to the calculation with Pix4D (Figure 3;4), gully volume was estimated to be 10.41 m^3 and total loss of soil was estimated to be 14.47 Mg (Table 2). The RMSE value of estimations was found to be 0.89. The results indicated that unmanned aerial vehicles could be used in predicting temporary gully erosion and losses of soil.

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