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Modelling a landslide site using UAV photogrammetry in Değirmençay village, Mersin

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Abstract

Natural disasters cause loss of life and property. This situation causes both economic and psychological problems on the society. Developing countries' economies are more affected by disasters than developed countries. Turkey is frequently exposed to natural disasters due to its geological, geomorphological and hydrogeological features. Landslide is the most common natural disaster. Modeling and regular monitoring of disaster risk areas is necessary to reduce disaster risk. The development of remote sensing techniques facilitates the work of engineers. Creating a three-dimensional (3D) model of the terrain can be done practically by modeling the pictures taken from unmanned aerial vehicles (UAVs) in computer environment. The current status of the land can be documented. In this study, a flight was carried out with a UAV in order to determine the current status of the land after the landslide that occurred as a result of heavy rains in the Değirmençay Village of Mersin in January 2021. The images were combined using the structure from motion algorithm and a 3D model of the land was created. Using the 3D model, the Digital Elevation Map, and orthophoto maps of the terrain were created with high precision and resolution. With future UAV flights, the condition of the land will be re-documented. By using the difference between point clouds, the amount of sliding and volume change in the region will be determined.

1. Introduction

Natural hazards cause loss of life and property. This situation causes both economic and psychological problems on the society. The economy of developing countries is more affected by disasters than developed countries. Natural hazards are seen all over the world. There is no place where natural disasters are not seen.

Turkey is frequently exposed to natural disasters due to its geological, geomorphological and hydrogeological characteristics. Landslide is the most seen natural disaster. Landslide may occur due to change of forces acting on the soil and rock mass. Heavy rainfall, tectonic movements, uncontrolled excavations and stream erosion are the main factors causing landslide.

Field study performed by well-trained geologist is essential to understand landslide dynamics. However, it is time consuming and labor intensive. Fine-scale terrain structures may be omitted with the traditional mapping.

The development of remote sensing techniques demystifies the mechanism of landslides. Satellite images, unmanned aerial vehicles (UAV) and light detection and ranging (Lidar) have been used frequently in natural disaster studies since last decade.

Data can be obtained easily from rough and inaccessible terrain using UAV with centimeter accuracy. High-resolution 3D model can be generated using pictures taken from UAV. Geomorphologic features can be extracted from 3D model.

A low-cost UAV can obtain pictures from inaccessible terrain. This facilitates the job of engineers. Data from dangerous steep slopes can be obtained in a practical way.

In December 2019, heavy rainfall caused landslide in Değirmençay village. In this study, we model the using UAV photogrammetry.

2. Study area

Değirmençay village is located in the northern part of Mersin (Figure 1). The study area is characterized by Mediterranean climate. Rainfall amount is increasing

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each year (Figure 2). The average rainfall amount is 972.26 kg/cm^2 between 2015 and 2019. The monthly rainfall amount of 2019 is shown in Figure 3. In January and December, most rainfall is seen. Tha average rainfall amount is 98.89 kg/cm^2.

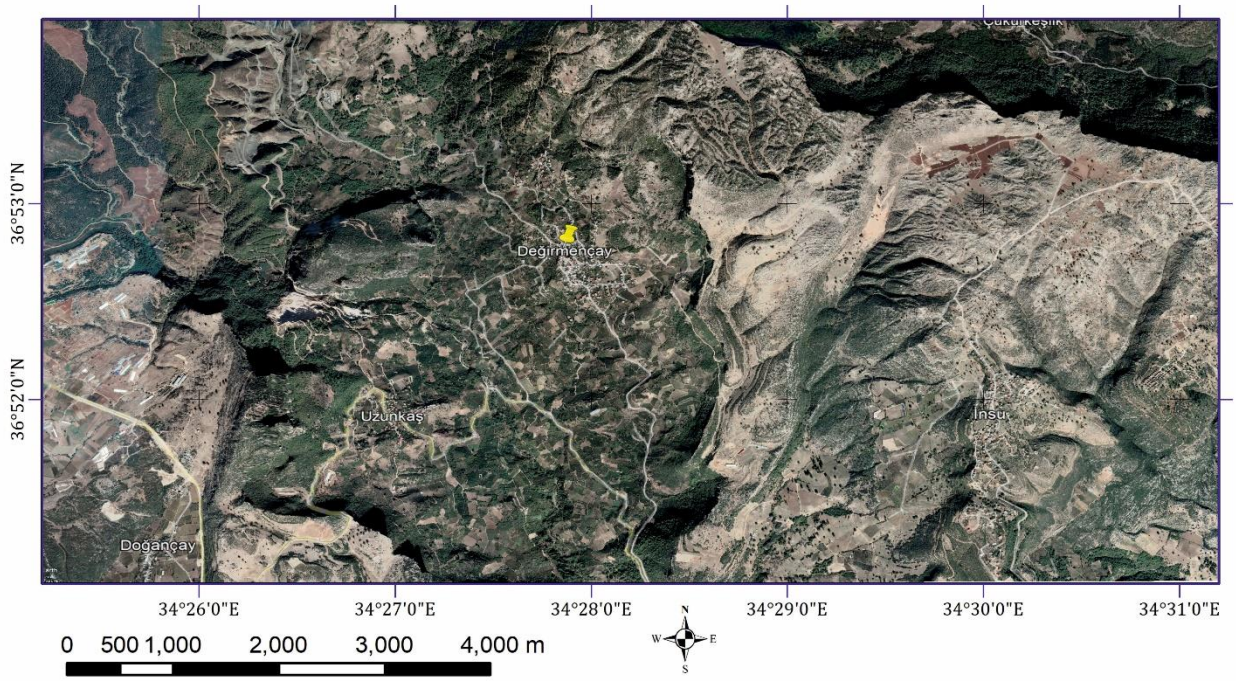

Figure 1. Location map of the study area

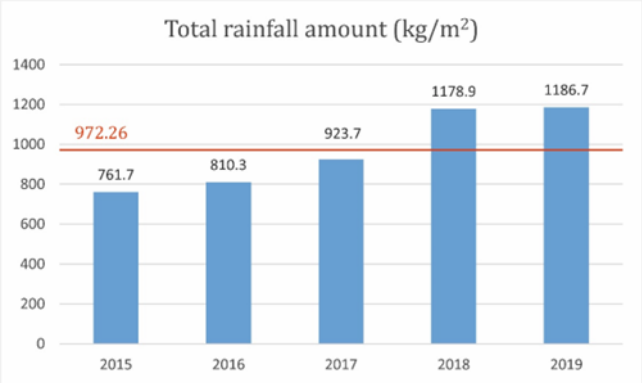

Figure 2. Rainfall amount per year

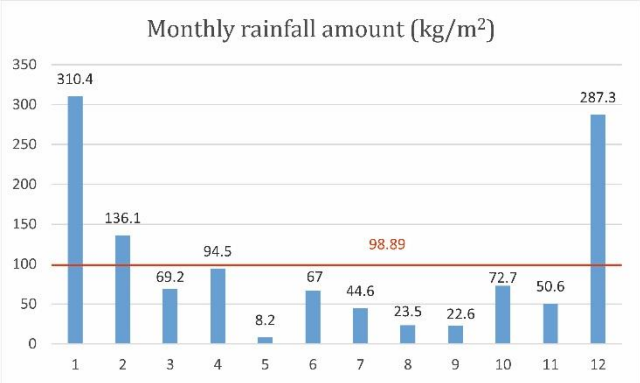

Figure 3. Rainfall amount per month

3. Methods

Unmanned aerial vehicles contribute to the modern solution of many engineering problems. 3D model of the terrain can be obtained in high resolution using the point clouds obtained from the photographs. Structure from motion algorithm enable us to construct 3D models from 2D pictures.

UAV has been used in many engineering projects since last decade. Landslide site mapping (Alptekin and Yakar 2020a; Kuşak et al. 2021), rockfall site mapping (Alptekin et al. 2019), shoreline detection (Unel et. al. 2020), pond volume measurement (Alptekin and Yakar 2020b), cultural heritage modelling (Alptekin and Yakar 2021; Kanun et al. 2021)

In this study, Anafi Parrot (Figure 4), which is a low-cost UAV, was used to obtain pictures. The flight information is given in Table 1.

The pictures were processed in Agisoft Metashape software. We modelled the landslide site to characterize landslide dynamics. We created Digital Surface Model (DSM) (Figure 3) and ortho-mosaic (Figure 4) of the study area.

Figure 4. Anafi Parrot set

Table 1. Flight information

Item	Number
Ground Control Points	7
Pictures	1053
Flight height	40 m
Coverage area	0.166 km^2

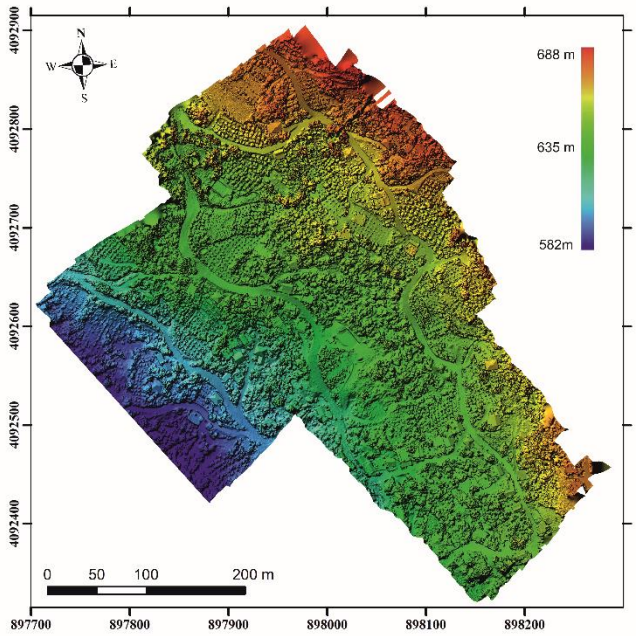

Figure 4. Digital surface map

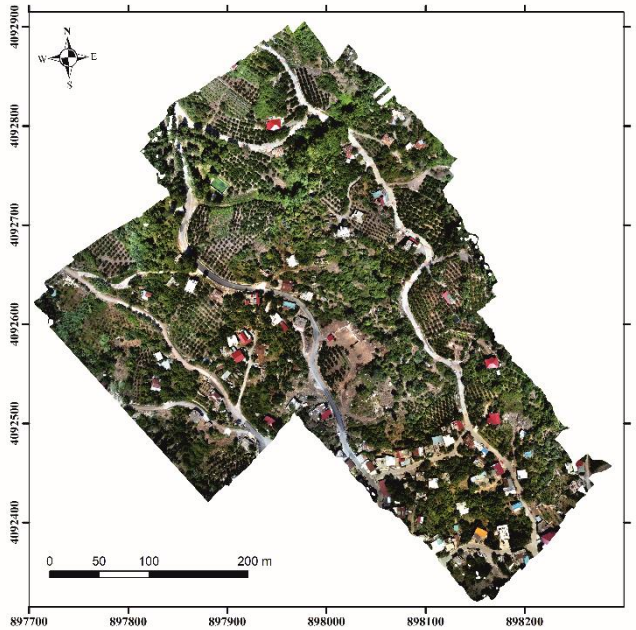

Figure 5. Orthomosaic

4. Discussion

UAV photogrammetry is very useful for geoscientists. Creating terrain model is very practical. High-resolution models enable us to interpret the fissures, displacements and geomorphologic structures.

The flight height is very important to produce models. The lower flight height enables us creating more detailed map (Çelik et al. 2020). However, when we take pictures from low height, we get too many pictures. This will be a problem for modelling. A high standard computer will be needed as there will be too many point clouds.

DSM shows us how the elevation changes in the landslide site. Slope and rainfall are the main reasons of this landslide event.

5. Conclusion

In this study, we modelled the landslide site with high-resolution. In order to be prepared for natural disasters, dangerous areas should be modeled at regular intervals. In near future, we will repeat the field study and determine the displacement amount.

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