TeMA

Journal of Land Use, Mobility and Environment

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Tema is the Journal of Land use, Mobility and Environment and offers papers with a unified approach to planning and mobility. TeMA Journal has also received the Sparc Europe Seal of Open Access Journals released by Scholarly Publishing and Academic Resources Coalition (SPARC Europe) and the Directory of Open Access Journals (DOAJ).

METHODS, TOOLS AND BEST PRACTICES TO INCREASE THE CAPACITY OF URBAN SYSTEMS TO ADAPT TO NATURAL AND MAN-MADE CHANGES

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Contents

TeMA Journal of
Land Use, Mobility and Environment

CALL FOR PAPERS: TEMA VOL. 11 (2018)

The Resilience City/The Fragile City. Methods, tools and best practices.

The fragile/resilience city represents a topic that collects itself all the issues related to the urban risks and referred to the different impacts that an urban system has to face with. Studies useful to improve the urban conditions of resilience (physical, environmental, economical, social) are particularly welcome. Main topics to consider could be issues of water, soil, energy, etc.. The identification of urban fragilities could represent a new first step in order to develop and to propose methodological and operative innovations for the planning and the management of the urban and territorial transformations.

The Journal also welcomes contributions that strategically address the following issues:

- new consideration of the planning standards, blue and green networks as a way to mitigate urban risks and increase city resilience;
- the territorial risks and fragilities related to mobility of people, goods, knowledge, etc.;
- the housing issue and the need of urban regeneration of the built heritage;
- socio-economical behaviour and the "dilemma" about emergency and prevention economy;
- the city as magnet of the next future's flows (tourism, culture, economy, migration, etc.).

Publishing frequency is four monthly. For this reason, authors interested in submitting manuscripts addressing the aforementioned issues may consider the following deadlines

- first issue: 10th January 2018;
- second issue: 10th April 2018;
- third issue: 10th September 2018.

CALL FOR PAPERS: GENERAL CALL.

Papers in Transport, Land Use and Environment

The Journal welcomes papers on topics at the interdisciplinary intersection of transport and land use, including research from the domains of engineering, planning, modeling, behavior, economics, geography, regional science, sociology, architecture and design, network science, and complex systems

TeMA Journal of
Land Use, Mobility and Environment

CALL FOR PAPERS: SPECIAL ISSUE 2018

Urban Travel Behavior in the Middle East and North Africa

The characteristics of urban travel behaviors and the attitudes of passengers in the Middle East and North Africa (MENA) is less-studied. When it comes to the effects of urban form, residential self-selections, and lifestyles, it is entirely not investigated in majority of the countries of the region. There is a considerable knowledge gap about the circumstances of how people think and decide about their short-term, medium-term, and long-term mobility for commute and non-commute travels. The we do not know if the land use traits such as population and employment densities as well as mix of land uses, accessibility to public transportation and neighborhood amenities, and connectivity of street networks are as influential as they are in western counties or in higher income societies. There is a very limited understanding about the extent to which the personal preferences, lifestyles, and in general psychology of the people of the region affect their transport behaviors. The complexity of the analysis methods applied for studying urban travel phenomena of the MENA region is even less-developed. Longitudinal or discrete choice molding methods are applied in mobility research considerably less than studies coming from high-income countries.

This special issue collects the results of some of the most-recent studies on the MENA countries to fill out a part of the gap in English-language publications. The main topics covered by the issue include the following with focus on the MENA region:

- The role of urban form and land use in forming urban travel behavior;
- Urban sprawl and urban travel behavior;
- The effects of historical urban transformations on urban mobility decisions;
- Car ownership and use; car dependency;
- The impacts of socioeconomics and culture in forming the transport patterns;
- Lifestyles and personal preferences and urban travels; Perceptions of mobility, safety, security, neighborhoods;
- The interactions of travel behavior and health effects of different ages, genders, and income groups;
- Travel behavior of public transport riders;
- and similar topics.

The target countries of this issue are the ones that are referred to as the MENA counties in most of the definitions. Studies on the cities of Turkey and Pakistan are also of particular interest and welcome. Manuscripts about all city sizes are reflected by the issue. The authors interested in submitting manuscripts addressing the aforementioned issues may consider the deadline of 31st January 2018. All submissions will go through rigorous double-blind review, and if accepted will be published. Interested authors are requested to contact Houshmand Masoumi at masoumi@ztg.tu-berlin.de, to discuss submission and review procedure.

TeMA Journal of Land Use, Mobility and Environment

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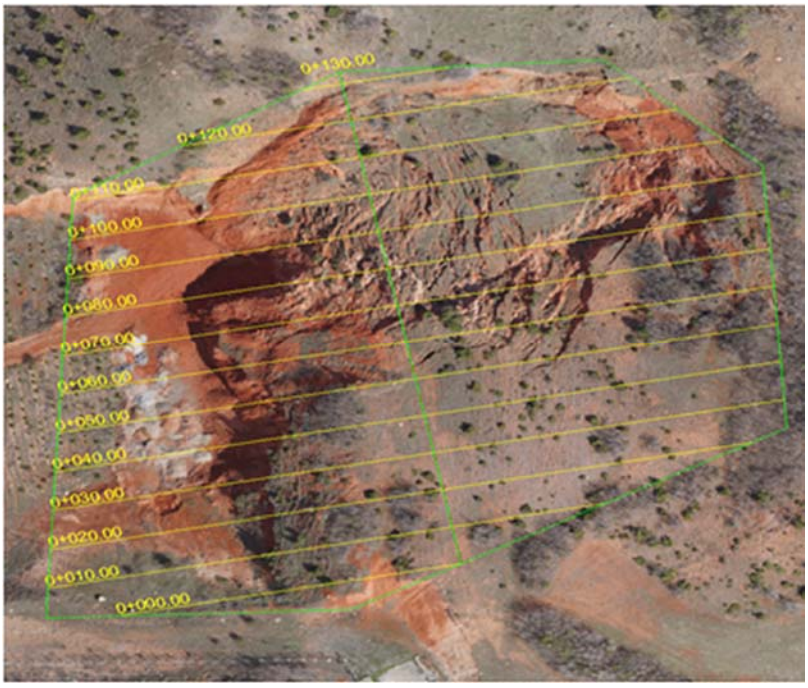

UAV BASED LANDSLIDE MONITORING

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ABSTRACT

Unmanned Aerial Vehicle (UAV) is finding a wide application field in areas such as map production, land survey, landslide, erosion, agricultural activities, and forest fires monitoring. In this study, an UAV equipped with SONY 6000 camera was used. The flight plan was prepared from 100 m height, and having 80% overlap and 60% sidelap rates. GNSS geodetic receivers and Ground Control Points (GCPs) were observed. GNSS signals were processed with LGO V.8.4 software to receive precise location information. 291 photographs for 50 hectares of landslide area were taken by UAV. All photos were processed by PIX4D software. In the field of the landslide area, 8 GCPs were included in the evaluation.
3D model were produced with pixel matching algorithms. Six period flights in different months were made for the landslide area and ground movements between the periods were observed. During this time interval , the volume of moving soil was determined. At the end of the study, RMSE for soil movement was obtained ±1.79 cm for landslide area. This study demonstrates that UAV-based high resolution orthophoto, 3D terrain model and point cloud data sets can be used to monitor the landslide, especially in micro small areas. It also was revealed that this method has some advantages over other traditional geomatics methods.

KEYWORDS:
UAV Remote Sensing, Pix4D, image processing, orthomosaic and landslide monitoring.

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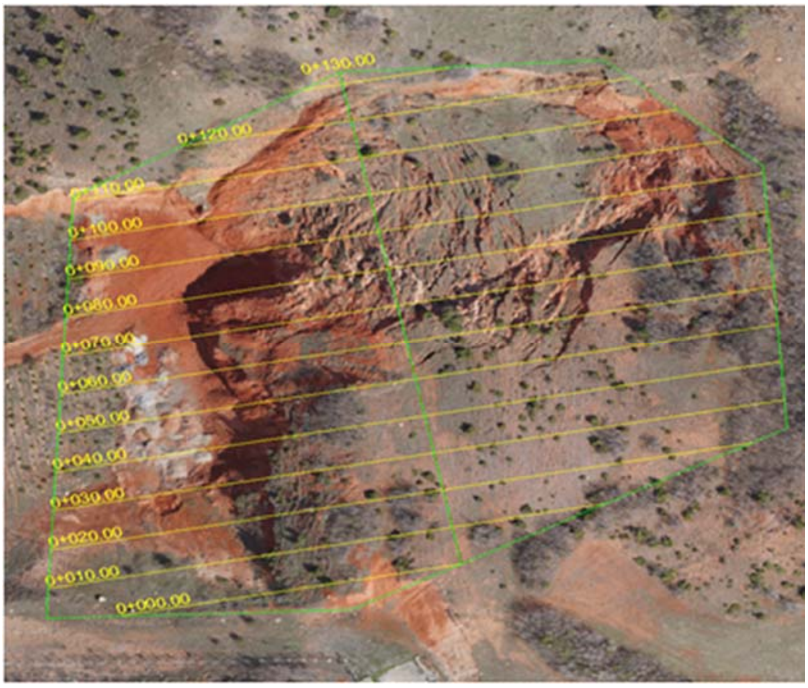

基于无人机的农业规划和滑坡监测

摘要

无人机（UAV）正在地图制作、土地测量、滑坡、土壤侵蚀、农业活动、以及森林火灾监控等领域中有着广阔的应用范围。本研究使用了一台配备索尼 A6000 相机的无人机。准备的飞行计划起点是 100 米高，并有 80%的重叠以及 60%的侧向重叠率。GNSS 大地测量接收器和地面控制点（GCP）。GNSS 信号用 LGO V.8.4 软件进行处理，从而接收精确的位置信息。无人机为 344 公顷农业土地拍摄了 985 张照片，为 50 公顷滑坡区域拍摄了 291 张照片。所有照片都经由 PIX4D 软件进行处理。在农业领域，评估包含了用于滑坡区域的 25 个 GCP 和 8 个 GCP
。
利用像素匹配算法制作了 3D 模型。为滑坡区域进行了 5 个周期的飞行，并且在周期之间可以观察到地面运动。在这个过程中，确定了活动土壤的量。在另一个研究区域中，根据土地模型和横截面确定了是否有灌溉农业，并为农业区域准备了最优利用规划。在坡度和过敏性方面不合适的区域则被规划用于其他目的。在评估结束时，滑坡区域获得了±1.8 米的 RMS 评估，农业区域是±5.4 米。本研究展示出，基于无人机的高清晰度数字照片、3D 地形模型和点可以用于监控滑坡，尤其是在较小的区域中。它还揭示出，与其他测绘方法相比，这种方法拥有一定优势。

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关键词:
无人机、遥感、农业土地规划、图像处理、滑坡监控。

1 INTRODUCTION

Landslides are one of the most widespread natural disasters in the world, which not only threaten human life but also cause economic losses (Davies, 2015; Regmi et al., 2015). Landslides usually appear in the spring after long rains or after snowfall. Landslides cause major changes in the landscape; causing great damage to settlements and infrastructure, and can cause huge economic losses. It is impossible to estimate the timing and speed of the soil flow caused by the ground clearance. Tracking changes on the surface and in the topography is very important. For this reason, it is of great importance to monitor landslide risky areas, to develop monitoring systems and to study landslide behavior. Landslide monitoring and analysis involves both spatial and temporal measurements and requires continual assessment of landslide conditions, including changes in surface topography, as well as the extent and speed of resettlement.

Landslide and ground motion movements are monitored by ground based and geomatics measurement techniques. Ground based landslide monitoring approaches are usually performed using geotechnical or geophysical techniques such as piezometers, pore pressure sensors, inclinometers and electrical resistance tomography (Chidburee et al., 2016). Ground-based techniques consist of the placement of sensors in the landslide area and the entire technical spectrum, which requires the use of locations to be measured at different times. These techniques have proven to be sensitive (0.2 - 2 cm) to track ground movements, but these techniques have some disadvantages such as installation and maintenance costs (Tofani et al. 2013; Rossi, 2016). Geomatics techniques can be examined in two groups as aerospace and ground based approaches. The most important advantage of airborne approaches is that it requires less labor and time. Remote Sensing has been an important method for landslide investigations. Remote Sensing, Interferometric Synthetic Aperture Radar (InSAR) and Light Detection and Ranging (LIDAR) techniques have been applied to investigate and monitor the flowing behavior of landslide and mapping (Riedel & Walther 2008; Mazzanti et al., 2014; Jaboyedoff et al., 2010; Jones, 2006; Lindner et al., 2016). Differential InSAR (Interferometric Synthetic Aperture Radar) has been used for detailed displacement analysis on active landslide surfaces (Belardinelli et al., 2003), although it may block the signal from the vegetation cover. With relatively high cost, air laser scanning (ALS) and terrestrial laser scanning (TLS) techniques enable the production of high quality digital elevation models (Ackermann, 1999; Pirotti et al., 2013).

Panchromatic QuickBird satellite images can provide data with a floor resolution of 0.61 m (Niebergall et al., 2007). Air and terrestrial geodetic LIDAR scans (Light Detection and Interference) are techniques that give high density fine and high resolution 3D surface coordinates. The quality of the point clouds is affected by the roughness of the surface, its reflection, the measuring angle and the observation interval (Cheok et al., 2002; Lichti et al., 2005). Digital terrain models (DTM) can be derived from point clouds with sub-meter accuracy (Carter et al., 2007; Van Den Eeckhaut et al., 2007). Airborne images can provide significant surface textural data, but photogrammetric DTMs are generally not as accurate as airborne LIDAR-based DTMs (Baltsavias, 1999). Conventional air and satellite based remote sensing techniques are suitable for landslide detection in a few square kilometers (Henry et al., 2002). However, these techniques cannot provide data for the landslides and displacements that occur in smaller areas and the high resolution digital image below the decimeter and the desired period (Neithammer et al., 2012).

Nowadays, UAVs equipped with suitable compact cameras offer fast and cost-effective solutions for many photogrammetric applications compared to conventional aerial photometric studies Peppa et al., 2016). UAV System and Peripheral Units: UAV systems have been used extensively in agriculture, environment, mining, and disaster monitoring, archeology and land follow-up activities with various purposes. UAV applications generate significant alternative solutions in these areas (Nex & Remondino, 2015). There are only a few studies in the literature regarding with the use of UAVs for monitoring of landslides. Rau et al. (2011) in Taiwan; Niethammer et al. (2012) and Stumpf et al. (2013) in France and Lindner et al. (2013) used a quadrotor system and a The biggest advantage of UAV remote sensing is the ability to collect risk-free information in real-time, flexible, high-resolution, low-cost, and hazardous environments. (Chang Chun et al., 2011; Rossi et al., 2016). Terrestrial approaches to landscape monitoring work are risky approaches because they require direct contact with risky areas and require longer time for measurement and evaluation.

Unmanned Aerial Vehicle (UAV) is a very useful system that has begun to be used for solving a wide range of problems (Tahar et al., 2011). In parallel with the developing technology, UAVs have begun to be used in recent years by integrating with Global Positioning System (GPS), Inertial Measurement Units (IMU) and high-resolution cameras.

Remote Sensing (RS) is also being used in commercial and scientific research such as digital map production, landslide and disaster monitoring, as well as agricultural land monitoring and planning. Although high resolution positional data can be obtained in 20-50 cm/pixel band with satellite and manned air vehicles, it is possible to obtain 1 cm/pixel high resolution data thanks to fly at lower altitudes with UAV systems (Hunt et al., 2010). Various monitoring techniques such as GPS, PS-INSAR, total station and leveling instruments are used to monitor the movements in the landslide area and to carry out planning in agricultural areas (Turk et al., 2015). However, these techniques may not be in the desired availability/suitability in terms of time and cost. Although the above-mentioned methods have the capacity to provide sufficient positional accuracy, they cannot always be preferred because of the disadvantages such as the necessity to obtain data for a longer time and the risk of measuring in the landslide area. As a result of the downsizing of sensors and the developments in sensor technology, the cameras integrated into UAVs, and the structural developments of IMU systems have enabled the creation of precise 3D terrain model, point cloud and orthomosaic production. For this reason, it has become an alternative to aerial photogrammetry (Remondino et al., 2011). In this case, the UAVs allow achieving the results with sufficient sensitivity, pursuant to appropriate camera selection and short-term field measurement. Especially in recent years, close range photogrammetry and image based measurement systems have been widely used in such researches (Tschari et al., 2015).

This study consists of two parts; the availability of UAV photogrammetry in agricultural planning and landslide monitoring has been researched.

a) UAV flights were carried out at Gaziosmanpaşa University (GOU) Agricultural Application Area (approximately 344 hectares) to test the utility of UAV systems in agricultural planning. The obtained digital surface model (DSM) and orthophoto are used to produce orthomosaic map and cross sections. The optimal use plan of the area is prepared by using slope, view, irrigability and soil properties of the land.

b) The study area of the landslide area (about 50 hectares) in the Organized Industrial Zone was selected to examine the monitoring of the landslide motion with UAV systems. The study area was observed with UAV at five different times to determine the speed, direction and characteristic of the landslide motion. In addition, the amount of displaced soil was calculated for a period of five months.

2 MATERIALS AND METHODS

GEO_2 UAV was used for this study. In addition, GNSS/IMU integrated into UAV, Sony a6000 camera, and the peripheral units consisting of moving platforms were used as well. Four geodetic GNSS receivers were used to observe eight Ground Control Points (GCP). GCPs were evaluated by using Leica LGO V.8.3 software with static GNSS observations. As a result of the process, the coordinates of the GCPs in ITRF96 Datum were determined. The GEO_2 UAV and peripheral units used in this study was given in Figure 1. Peripheral units consist of multi-copter carrier bag, conveyor platform, control unit (IMU, GPS, mainboard) and camera systemsin Table 1.

Fig. 1 GEO_2 UAV and environmental equipment

In both studies, in order to take pictures in RAW format, the Sony A6000 16mm - 6000 x 4000 camera was used for collecting visible imaginary.

Env. Specification	Environmental Detail
Weight with environment	4.30 kg
Edge to edge Wing Span	0.74 m
Effective Payload	4.00 kg
Height from bottom to up	0.34 m
Max. Range	4000 m
UAV Endurance	0.5 hour
Duty Speed	14 m/sec
Maximum flying Speed	70 km - 30 mm /sec
Frequency(Radio Control)	433 MHz
First Person Video (FPV)	2.4 GHz
Frequency(Telemetry Radio)	868 MHz
GPS	5 Hz – 72 channels
Kind of Battery	6S li-po 25C 1600 Mah
Monitor	40 Channels 5.8 GHz DVR 7 inch LED system
Kind of gimbal	Gimbal for mapping
UAV motors	35 x 15 Brushless Motor
Kind of frame	22 mm 3K Carbon
Elect. Speed Control(ESC)	60 Ampere 400 Hz
Size/kind of Prop	15 x 55 inch Carbon
Camera	Sony A6000
Camera dimension	4.72x2.63x1.778 in
Camera weight	12.13 oz
Magapixels	12 MP
Type of camera sensor	23.5x15.6 mm(APS-C)
Size of camera sensor	24.3 MP
Camera ISO sensitivity	100-25600
Zoom(Digital)	L:4x, R:5.7, S:8
Speed of shutter	0.00025 to 30 sec
Speed of flash sync.	0.00625 sec.

Tab.1 GEO_UAV and peripheral unit features

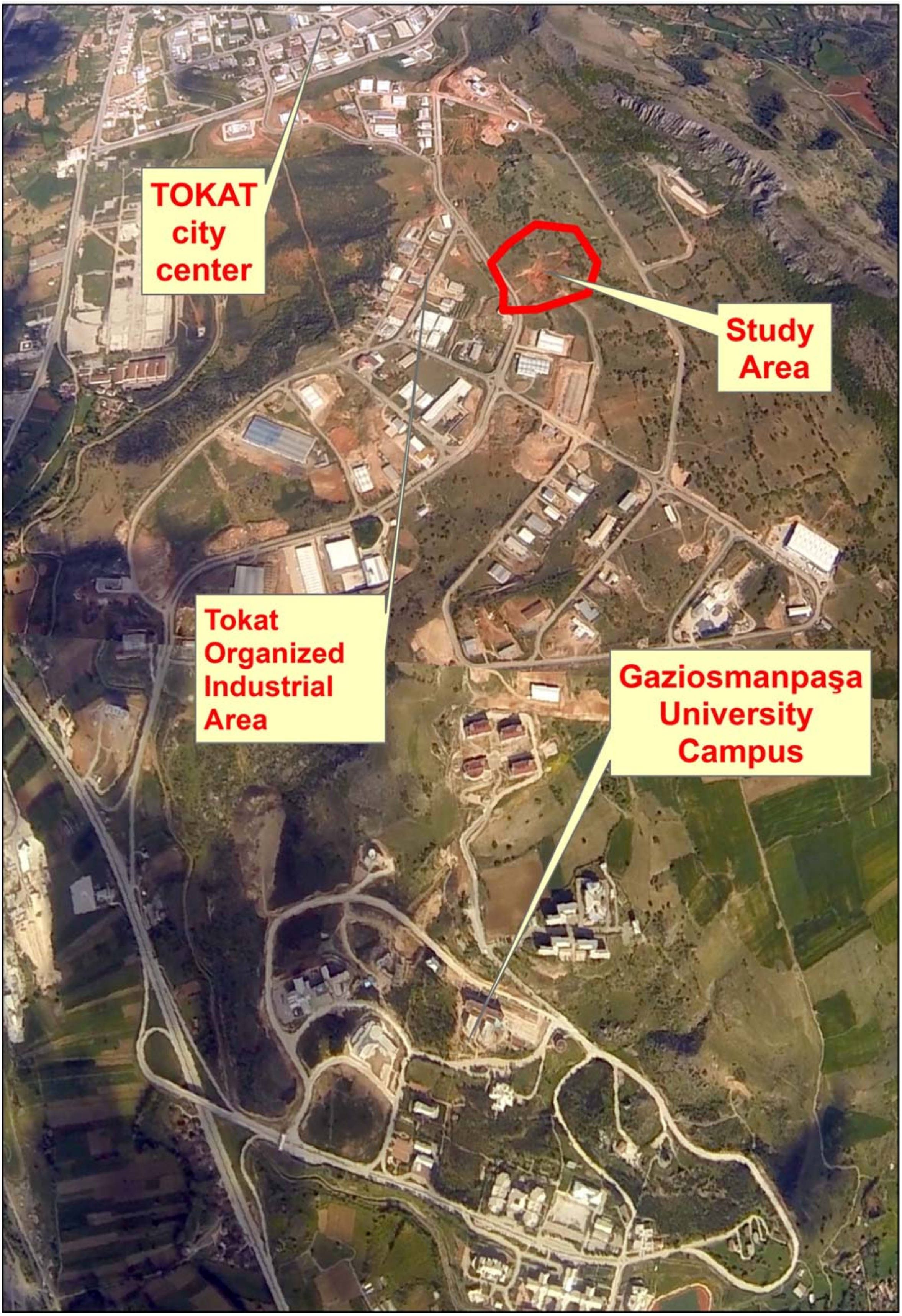

Fig.2 Study Area is in the Tokat Organized Industrial Zone

The study area is on the southwest side of the Gaziosmanpaşa University (GOU) campus and having an approximate coordinates of 40°19'21.03"K, 36°30'6.25"D (Figure 2). This area is located in the factories area of Tokat Organized Industrial Zone. The continuation of the landscape movement will create a great risk for the factories in the region. Raw images were taken, having 80% overlap and 60% sidelap rates from 100 meters height relative to ground. A total of 6 flights were carried out for the same area at different times. Flight planning was carried out in accordance with the weather conditions and the conditions in which the light was most appropriate. In order to orient pictures, eight GCP points were staked out in the field. GCP points were observed with precise GNSS instruments with two hours of static observation mod and processed by using Leica LGO V.8.3 software. RMS value calculated as ± 2.4 mm.

The absolute accuracy obtained depends on the difference between the position of the features on the model and the accuracy and distribution of the number of measured GCPs. By using pictures taken at each flights and GCPs, dense point clouds, digital surface models and orthomosaic were produced by using Pix4d photogrametry software.

The characteristics of the landslide movement (direction, speed and volume changes) were determined by taking advantages of these outputs. The displacement volumes (fill and excavation volumes) between 1st and 6th periods were also calculated by cross section method.

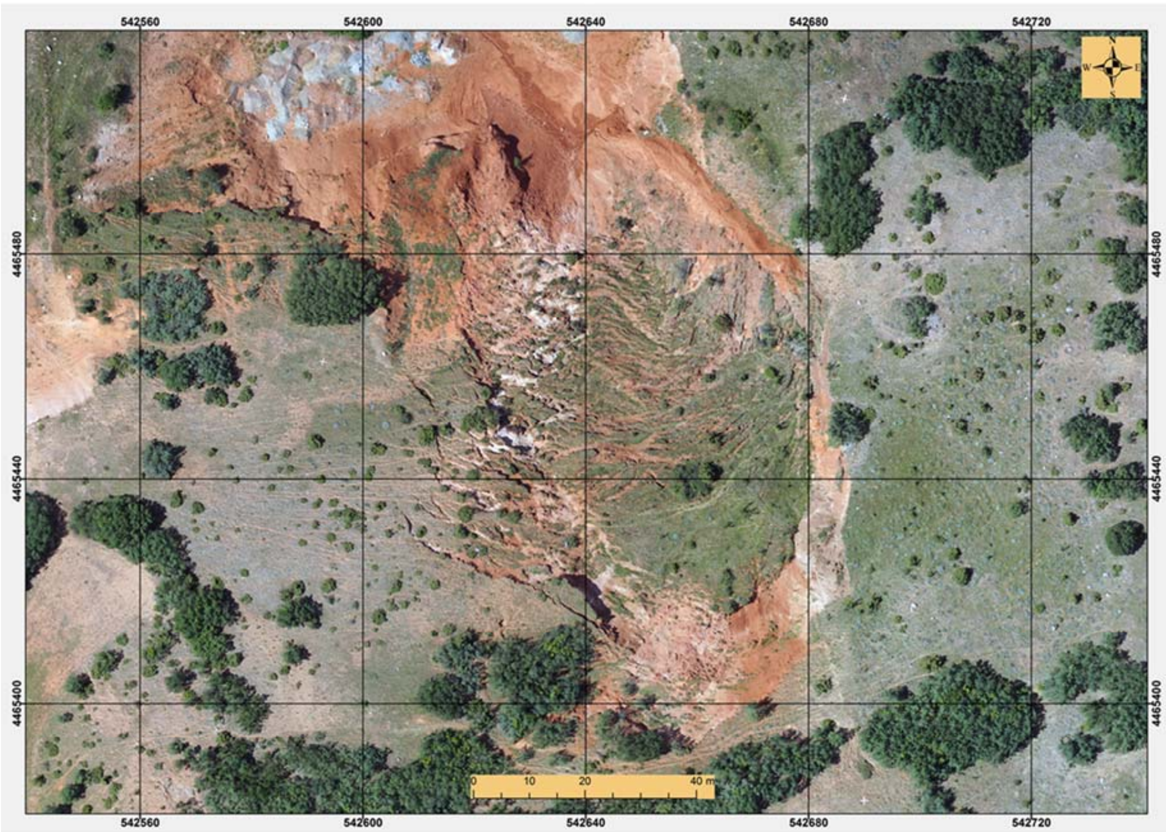

Fig.3 Landslide area orthomosaic map

3 RESULTS

The main purpose of this research is to analyze the usability of UAV monitoring landslide movements. Ground Sampling Distance (GSD) for the study area were calculated as ± 3.56 cm, GSD is the distance between two following pixel centers measured on the ground. The bigger the value of the image GSD, the lower the spatial resolution of the image and the less visible details. The spatial data results of the generated orthomosaic were determined on TUREF / TM36 in ITRF datum. The amount of earth movement in the study area (excavation/fill) was calculated by using the section method shown in Fig. 4 and calculated from the numerical data obtained from the dense point cloud, DSM and orthomosaic produced at the beginning and end of the period. Between sixth and first observation, 2.976 m^3 excavation volume and 978 m^3 fill volume difference were calculated.

In addition, pixel comparisons have been made in the DSMs for the determination of surface movements. For this, the following function was defined and the pixel ratios between the periods were examined.

$\Delta = f(H_6)/f(H_1)$ (1)

In the function;

Δ: criterion of benchmarch,

$f(H_6)$, Orthometric height function in period 6,

$f(H_1)$, Orthometric height function in period 1.

H_i: Orthometric height of object points at period I,

If $\Delta > 1$, then there is an increase in height

If $\Delta < 1$, then there is a decrease in height

If $\Delta = 1$, then no change observed.

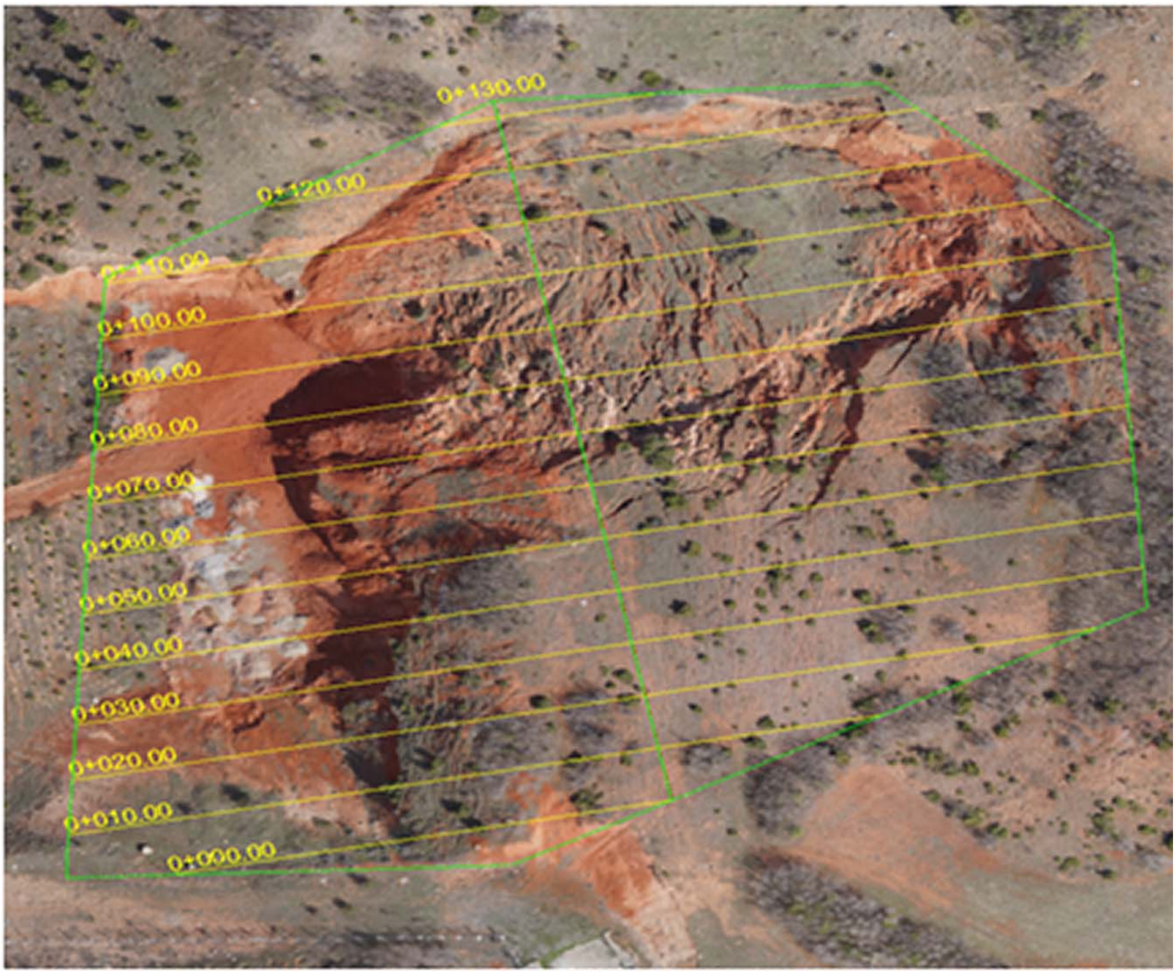

Fig.4 Base lines that were used for all six periods

According to the relation given above, pixel comparisons between periods were presented in Figure 5. The dots with increasing height are shown in brown color and the points with decreasing height are shown with dark-yellow color.

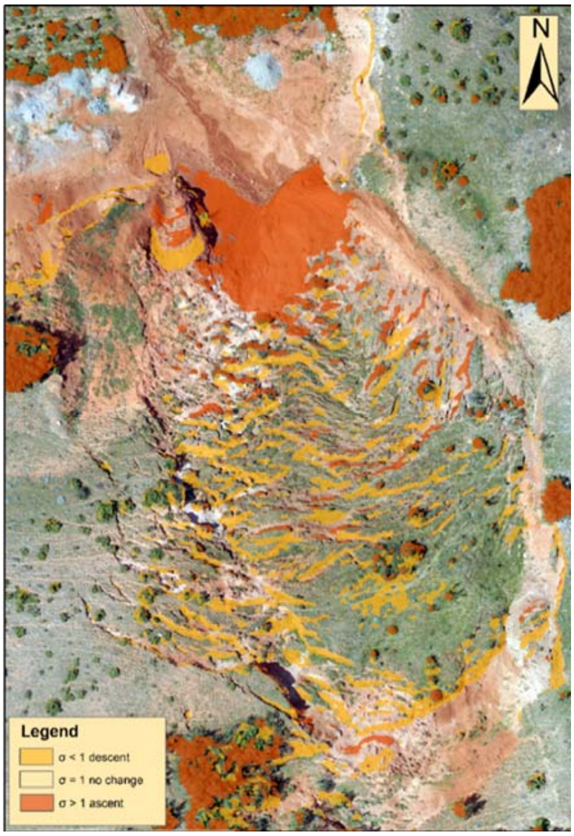

Fig.5 Pixel matching map of landslide area

4 DISCUSSION

Recent developments in UAV technology offer significant new advances that allow high resolution (1 - 20 cm) mapping and monitoring. UAV displays have indisputable contributions to the management of disasters such as landslides, avalanches, sellers and earthquakes, and have many advantages when compared to other methods. Over the last decade, the use of remote sensing technology and UAV photogrammetry has been increased to map and track landslides. Nowadays, UAVs equipped with suitable compact cameras offer fast and cost-effective solutions for many photogrammetric applications compared to conventional aerial photometric studies (Peppa et al., 2016). There are only a few studies in the literature regarding with the use of UAVs for monitoring of landslides. Rau et al. (2011) in Taiwan; Niethammer et al. (2012); Stumpf et al. (2013) in France and Lindner et al. (2013) used a quadrotor system and a fixed-wing system for monitoring a large landslides.

The biggest advantage of UAV remote sensing is the ability to collect risk-free information in real-time, flexible, high-resolution, low-cost, and hazardous environments. (Chang Chun et al., 2011; Rossi et al., 2016). Terrestrial approaches to landscape monitoring work are risky approaches because they require direct contact with risky areas and require longer time for measurement and evaluation. One of the advantages of UAV systems is its ability to deliver fast, high temporal and spatial resolution image information in critical situations where instant access to 3D location information is required. First of all, it is impossible to make local measurements in areas where disaster impact continues. Second, obtaining a satellite image or photogrammetric image is difficult and expensive. In fact, UAV has real-time capabilities such as fast data acquisition, transmission and image processing (Mazzanti et al., 2014). In addition, UAVs do not only record disaster-affected regions, but also assist in the coordination and communication of disaster management. (Kauai et al., 2016). The main advantage of the UAV photogrammetry is that it can provide information about the moving speed using image correlation algorithms using orthophoto images and digital surface models (DSMs). (Leprince et al., 2008). Another significant advantage of UAV-based remote sensing applications for hazardous environments such as landslides and rocks is the ability to acquire information in very dangerous areas with minimal risk. Direct measurements in such areas are usually not possible (Neithammer, 2012). Orthomosaics obtained by UAV allow detailed analysis of landslide materials and fissure structures (Walter et al., 2009). In addition, high resolution textural information in orthophotos obtained by the UAV may allow for soil moisture analysis of the landslide surface (Niethammer et al., 2009). Extremely sensitive DSMs were used to detect surface fissures and measure the mass movements of the landslide. Alternatively, it is known that providing satellite images is expensive and difficult when satellite images are used. It is also impossible to obtain this sensitivity from satellite images. Panchromatic QuickBird satellite images can provide data with a floor resolution of 0.61 m (Niebergall et al., 2007). Conventional air and satellite based remote sensing techniques are suitable for landslide detection in a few square kilometers (Henry et al., 2002). However, these techniques cannot provide data for the landslides and displacements that occur in smaller areas and the high resolution digital image below the decimeter and the desired period (Neithammer et al., 2012).

5 CONCLUSION

In this study, 985 raw pictures were taken for the landslide area with UAV and Sony a6000 digital CMOS camera. All images were taken from 100 meters high with 80% overlap and 60% sidelap rates. Pix4D software was used to process images to create 3D dense point cloud and orthophoto.

As a result of evaluating the images the horizontal position accuracy of GCPs were calculated as ± 1.79 cm. A total of 12 months have elapsed between the first period and the last period of the measurements. At the end of 6 periods it was calculated that 2976 m^3 of soil was displaced in the landslide area. In addition, the speed and direction of the motion of the landslide was determined. It has also been found that ground motion accelerates after rainy weather events.

Flight altitude and RMSE show a linear relationship with a correlation coefficient greater than 0.9 independently of the forward and side turn settings (Javier et al., 2016). It is a known fact that more precise position accuracy can be achieved by increasing the number of GCPs and decreasing flight altitude as well as increasing camera resolution. For the landslide movements, more sensitive results can be obtained by changing these parameters when requested. However, the results obtained from this study show that 3D surfaces obtained by processing UAV-based images, DEMs and orthophoto can be used for monitoring landslide movements.

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IMAGE SOURCES

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