УДК 528.92
DOI: 10.33764/2618-981X-2019-1-2-81-88

ОСОБЕННОСТИ СОЗДАНИЯ КАРТОГРАФИЧЕСКОЙ ОСНОВЫ ГЕОМОРФОЛОГИЧЕСКОЙ КАРТЫ МОНГОЛИИ

Улзийсайхан Ганболд
Монгольский государственный университет науки и технологии, Горно-геологический институт, 14191, Монголия, г. Улан-Батор, Сухбаатарский район 8, Бага тойруу, 34, главный корпус, магистр технических наук, ст. преподаватель кафедры геодезии, тел. (976)1145-2485, (976)9909-8479, e-mail: ulziis@must.edu.mn

Оюунцэцэг Даш
Монгольский государственный университет науки и технологии, Горно-геологический институт, 14191, Монголия, г. Улан-Батор, Сухбаатарский район 8, Бага тойруу, 34, главный корпус, кандитат технических наук, профессор, зав. кафедрой геодезии, тел. (976)9917-2910, e-mail: daoyunaa@must.edu.mn

Геоморфология изучает тектоническое движение, структуру ландшафта, старение, происхождение, впадины, выпуклую структуру и факторы, влияющие на них природой, физическими и географическими условиями на основе топографических карт. Поэтому геоморфология является промежуточной наукой, объединяющей результаты и методологию географии, геологии и геодезии. Хотя геоморфология – относительно молодая наука, она продолжает расти неуклонно. На сегодняшний день встает задача использования некоторых современных геодезических технологий и методов, таких как наземное лазерное сканирование и БПЛА для создания картографической основы геоморфологических карт Монголии в масштабе 1 : 50 000.

Ключевые слова: топографическая карта, цифровая модель рельефа, наземный лазерный сканер, БПЛА, ортофото.

ISSUES OFCREATION OF A LARGE-SCALE GEOMORPHOLOGICAL BASE MAP OF MONGOLIA

Ulziisaikhan Ganbold
Mongolian University of Science and Technology, School of Geology and Mining, 8th khoroo, 34, Baga toiruu, Sukhbaatar district, Ulaanbaatar, 14191, Mongolia, MSc, Senior Lecturer, Department of Geodesy, phone: (976)1145-2485, (976)9909-8479, e-mail: ulziis@must.edu.mn

Oyuntsetseg Dash
Mongolian University of Science and Technology, School of Geology and Mining, 8th khoroo, 34, Baga toiruu, Sukhbaatar district, Ulaanbaatar, 14191, Mongolia, Ph. D., Professor, Head of Department of Geodesy, phone: (976)9917-2910, e-mail: daoyunaa@must.edu.mn

It is an alternative science, as the geomorphology plays out in a complex geographic, topographic setting in which both the tectonic and climate processes responsible for driving evolution of the topography change in style and intensity. Geomorphology is a relatively young science, growing along with interest in other aspects of the earth sciences in the mid-19th century.

While geomorphological development continues to grow steadily today, there is a need to use some advanced theoretical and mapping techniques. This paper is issued to cover the creation of topographic maps with a scale of 1 : 50 000 of geodetic measurements by terrestrial a laser scanner and an unmanned aerial vehicle (UAV) for geomorphological map.

Key words: topographic map, digital elevation model (DEM), terrestrial laser scanner, unmanned aerial vehicles (UAV), orthophoto.

Introduction

Geomorphology determines the processes of the internal and external forces of the earth, and based on topographic maps and geology maps, remote sensing, aerial photos [1]. The result depends on structure and shape, distortion of the land surface.

Geomorphological research has required a new surveying system with new techniques and technologies based on geographic information system (GIS), remote sensing, modern geomorphological mapping techniques by laser scanners technology, combined with traditional methods. Therefore, it has required an analyzed DEM and 3D digital images, such as hillshade, aspect, slope etc. and topographical map using laser scanner and UAV for the geomorphological map.

Geomorphological map is the categorization and description of the nature, origin and development of landforms. The fundamental framework is that a geomorphic unit can be classified based collectively on its origin and development (process), on its general structure and shape (landform), on measurements of its dimensions and characteristics (morphometry), and on the presence and status of process overprinting (geomorphic generation). This paper will describe creating topographic map scale 1 : 50 000 with UAV and laser scanning results. The basics of all these study will depend on the topo relief and DEM representation.

Subject area

Chosen territory is in Manlai soum, Umnugobi province, it is located in the southern of the Mongolia, in the Gobi Desert (Figure 1).

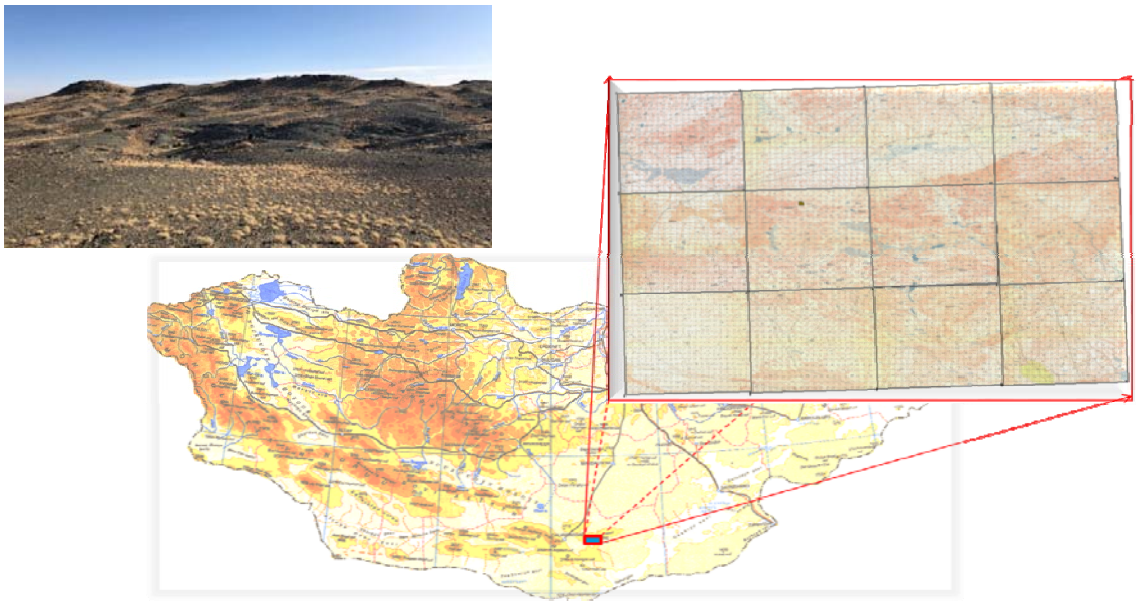

Fig. 1. Area of interest – Ulziit mountain in Manlai soum

It is surrounded by natural scenery of Bayangol, Argalant, Ulziit, Buural Ugalz, Sum suvarga, Haraat dependent mountain ranges between steppe such as Zagiin Us, Bulan Delger, Uudbayar, and Amgalan Gobi. Subject area is destined in 470 km from Ulaanbaatar, 230 km east of the Dalanzadgad, bordering Mandakh soum of Dundgovi province. Umnugobi means South Gobi, whole territory of the sub province locates in gobi desert regions. Unlike the Sahara, there are few sand dunes in the Gobi. The elevation of the subject area varies in the range between 1000 m and 1300 m, with a mean altitude of 1154 m.

Methodology, equipment and processing

Geomorphological map is based on the field study geodetic measurements, high accurate digital elevation model (DEM), topographical map and targeted to use mapping methodology on chosen territory. Mapping methodologies are depending on base map, such as topographic map and geology map, additional other field works using aerial photographs (Figure 2).

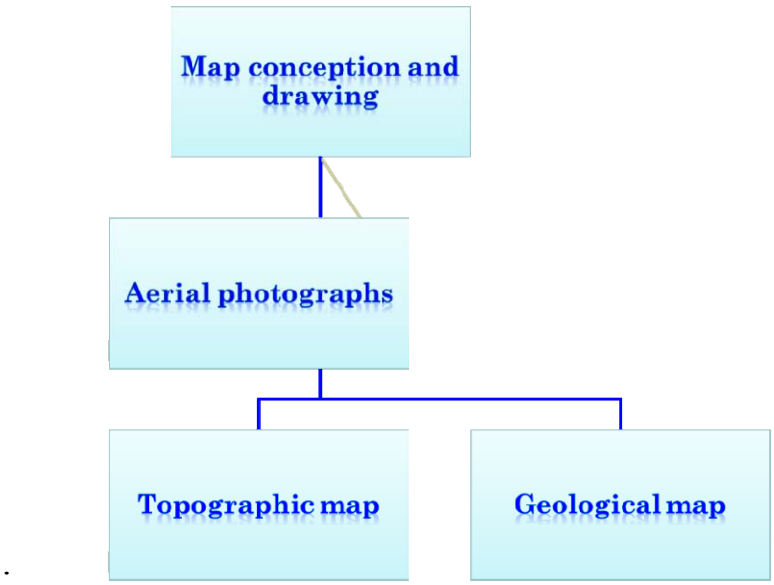

Fig. 2. Brief method of geomorphological mapping

The purpose of research is focused on preparing 1:50000 topographic map, DEM, hillshade, aspect, slope, orientation with indicators and profiles for geomorphology.

In 2009, legal frame about map projection and coordinate system is changed by cabinet decision of Government of Mongolia. In this decision, UTM is must be used to topographic map with various scale [2]. X, Y coordinates of UTM are calculated for topographical map scale with 1 : 50 000. It will connect of geodetic measurement data. UTM is conformal secant transverse cylindrical map projection and scale factor is 0.9996 [3]. Coordinate grid is drawn in AutoCAD and area. Datum and parameters, distortion are shown in following Table 1.

Table 1

Datum and Parameters of UTM projected coordinate system

Datum	WGS 84	
Parameters	a	6378137
	b	6356752.314
	f	0.003352811
	1/f	298.2572236
	r	6367435.68
	k_0	0.9996
	e	0.081819191
Distortions	m	1.00098
	p	1.00099
	ω	0^o

In first, topographic surveying with UAV Phantom 4 pro was done in subject area about 40 hectares in November, 2018. The selected technical parameters of "Phantom 4 pro" are as below:

– Weight: 1388 g;

– Sensor: 1" CMOS, Effective pixels: 20M;

– Lens: FOV 84° 8.8 mm / 24 mm;

– Resolution: 5472 × 3648.

Vertical overlap is 80 % and horizontal overlap is 70 %, about 180 images are captured with pixel 5 cm from flight height 180 m. Quality of used UAV digital camera and lens is very important for image processing.

The results of the processing of the aerial images in specialized software are typically orthophoto map, point cloud or DEM for geomorphological mapping. The general workflow for UAV data acquisition and processing is shown in Figure 3.

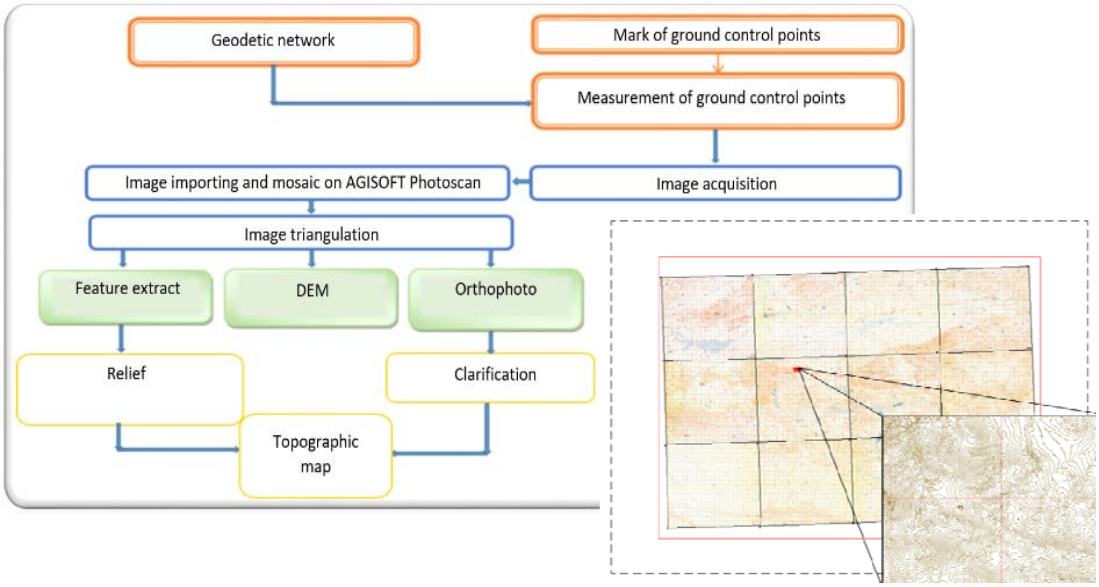

Fig. 3. Workflow for UAV data processing and part of topographic map with scale 1 : 50 000

AGISOFT Photo Scan software can perform the calibration automatically when processing images [4]. The most common method to determine elements of external orientation is the use of ground control points with known coordinates determined by geodetic methods in the field.

The geometric survey was operated with horizontal field-of-view (360°) Trimble FARO HD x130 laser scanner (Figure 4). The laser scanner is a 0.6–130 m reflection, a dynamic frame with a high resolution 170MP camera, 1-million-point data per a second, a measurement error ± 2 mm, and a telescope. The general workflow for laser data acquisition and processing is shown in Figure 5.

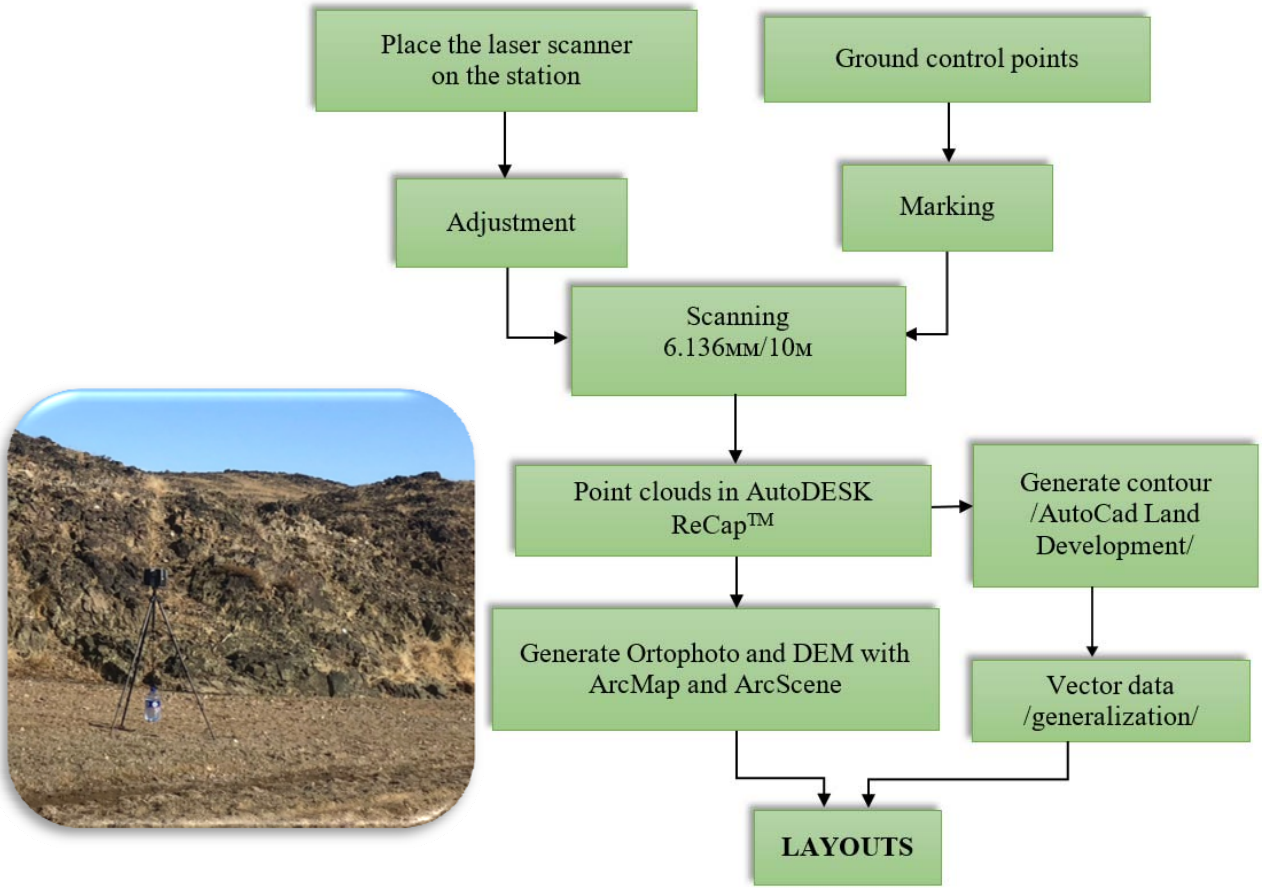

Fig. 4. Workflow for laser data processing of Trimble FARO HD x130 laser scanner

Study was purposed to create DEM and relief, which is an important component of any project dealing with the territory (geomorphology, hydrology, land resources etc.). One mean is the digital elevation model, considers the altitude as continuous variable over the space.

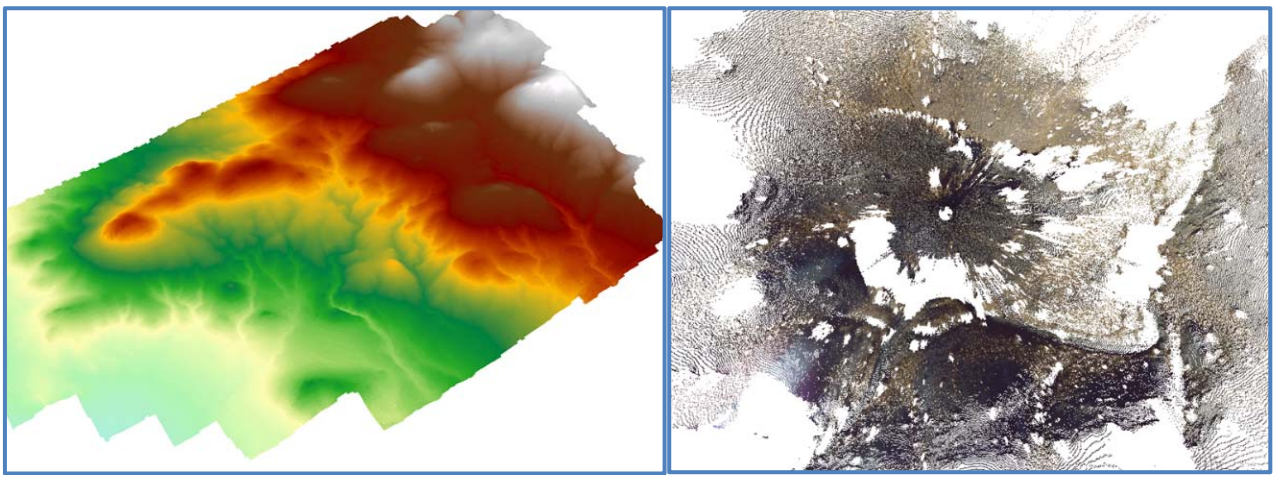

Fig. 5. Point clouds data with 4M points) and acquired a 1m DEM

The digital elevation model corresponds to a regular grid of elevation. Each node of the grid shows an altitude value. Quality value and geometric data of geomorphology map depend on DEM accuracy. Several analyses are used to digital elevation models as below:

- hillshade;
- slope, aspect and orientation indicators;
- curvature indicators;
- visibility analysis and radiation;
- profile and contour extraction.

Created analyzed DEM and slope, aspect by GIS software are shown in Figure 6. Recently analysis is helped for geomorphological mapping and others.

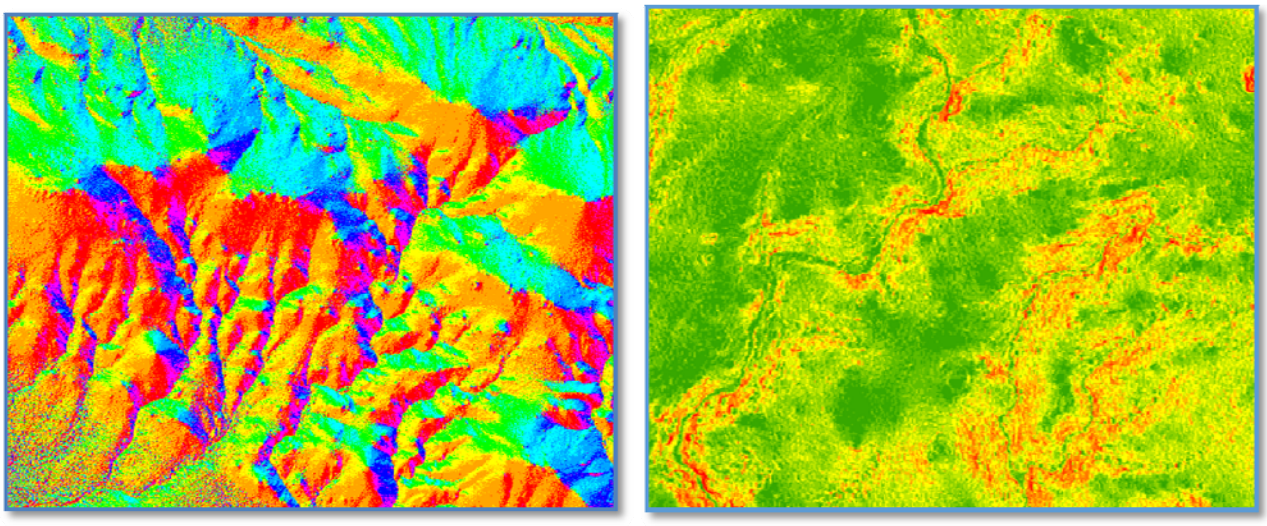

Fig. 6. Analyzed DEM (Slope and Aspect)

Created hillshade raster from the DEM is a grayscale 3D representation of the surface as shown in Figure 7, with the sun's relative position taken into account for shading the image [3]. The sun's position was calculated on date of June 22, latitude is 43°20', as follow:

$$H_s = 90° - \varphi \pm 23.5°, \quad (1)$$

where H_S – the sun's position, φ – latitude.

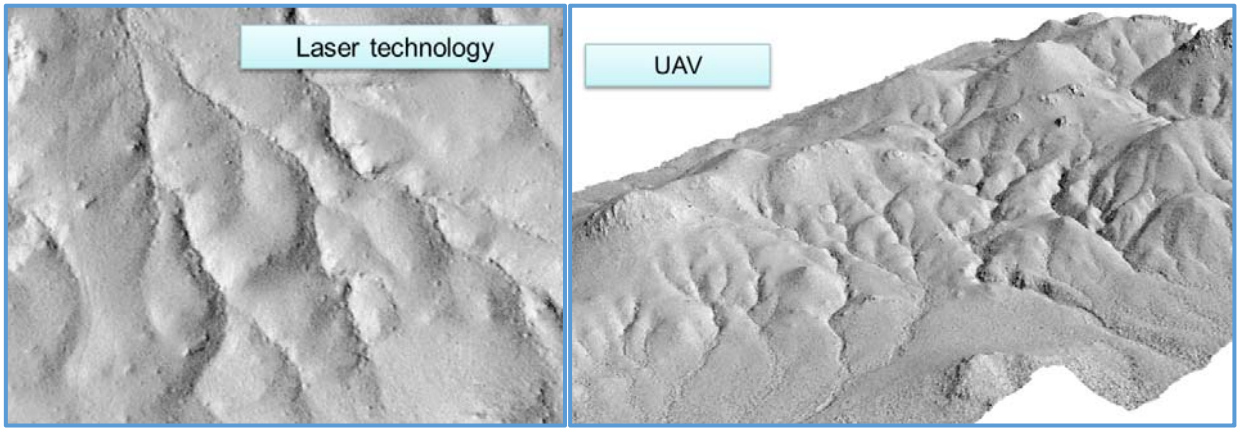

Fig. 7. Hillshade raster by UAV and laser scanner

Acquired a 1m DEM from UAV was overlapped with orthoimage, which is an aerial photographs corrected to scale such that geodetic measurements may be taken directly from perpendicular point. In result, overlapping orthophoto is provided for geomorphological map (Figure 8).

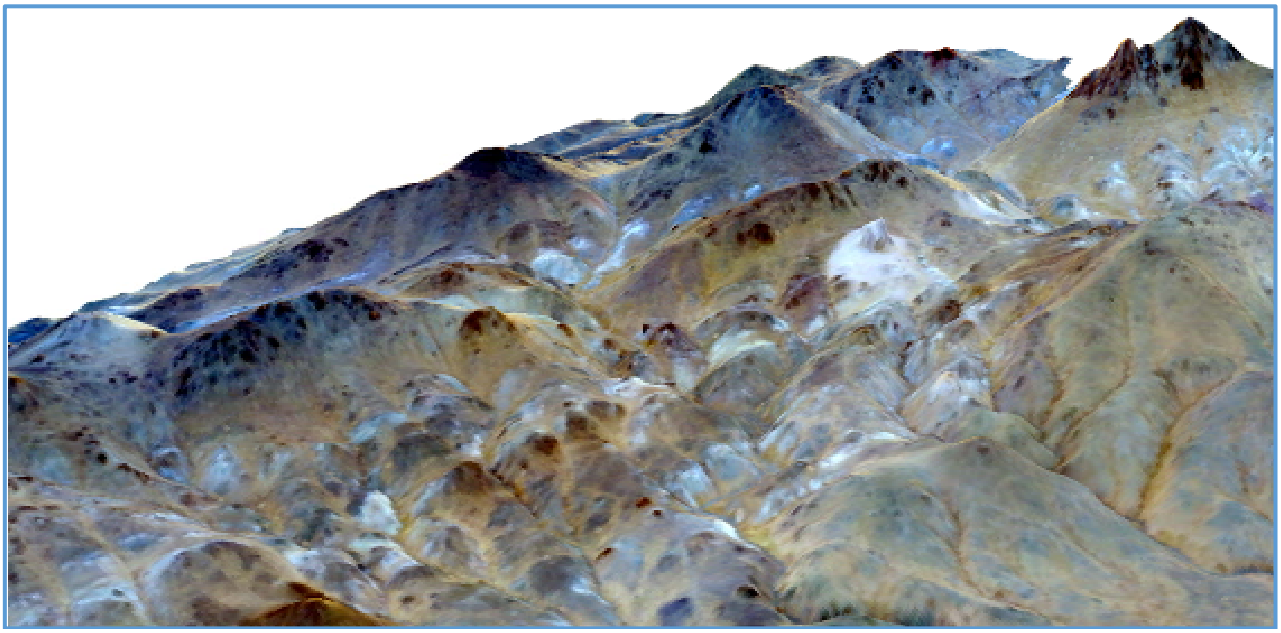

Fig. 8. Overlapping of orthophoto and DEM

Therefore, overlapped orthophoto and topographic map will be geomorphological base map and used to many various geomorphological topics, surveying and monitoring researches.

Conclusion

The main base for preparing geomorphological map is topographic maps and it commonly depends on 3D representing of relief and raster data of DEM. In first, grid lines and X, Y coordinates was calculated on UTM projected coordinate system. Distortions are provided of requirements of topographical surveying. Using aerial photogrammeter technology with UAV for topographic map, can reduce the timing of fieldwork compared to traditional methods, as well as massive amounts of required data. Acquired DEM and overlapped orthophoto are important basis for geomorphology. About the result of laser technology can be used to determine the boundaries of surface, elevation crease, age, lateral slope, and surface shapes. Some of data are limited from point station, in besides that data are more accuracy than UAV.

REFERENCES

1. Bayanjargal B. Nyamkhuu M. Methodological issues in processing medium-scale geomorphological map. 2017 [in Mongolian].
2. Government of Mongolia. Decision of Coordinate system, projections and elevation, 2009 [in Mongolian].
3. Oyuntsetseg D. Ulziisaikhan G. Mathematical Cartograpy. 2016 [in Mongolian].
4. Peter Blistan. Ľudovít Kovanič, Vladislava Zelizňaková. Using UAV photogrammetry to document rock outcrops, 2016.
5. Colomina, I. and Molina, P.: Unmanned aerial systems for photogrammetry and remote sensing: A review, ISPRS Journal of Photogrammetry and Remote Sensing, 2014.
6. Bemis, S. P., Micklethwaite, S., Turner, D., James, M. R., Akciz, S., Thiele, S. T. and Bangash, H. A.: Groundbased and UAV-Based photogrammetry: A multi-scale, highresolution mapping tool for structural geology and paleoseismology. Journal of Structural Geology, 2014.
7. Fritz, A., Kattenborn, T. and Koch, B.: UAV-based photogrammetric point clouds tree stem mapping in open stands in comparison to terrestrial laser scanner point clouds, international Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences, 2013.
8. The Future of Geomorphology Olav Slaymaker* Department of Geography, University of British Columbia 2008.
9. Snyder, John P. Flattening the earth: two thousand years of map projections. University of Chicago Press, 1993.
10. Choosing a World Map. Falls Church, Virginia: American Congress on Surveying and Mapping, 1988.
11. American Cartographic Association's Committee on Map Projections, 1986.
12. Understanding Map projections, GIS by ESRI, 2004.