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Statistical Analysis Of Lineaments Using Landsat 8 Data: A Case Study Of The Fergana Valley (East Uzbekistan)

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ABSTRACT

This paper describes a statistical analysis of lineaments based on multi-temporal Landsat 8 imageries in the Fergana Valley (East Uzbekistan). The results of the statistical analysis showed that determined that the count of lineament structures changes by months. It was also noted that the Namangan region is more prone to the manifestation of lineament structures. The maximum count of lineament structures was in July. And in November, we observe a sharp decrease in lineament structures. According to the results of the rose diagrams, various orientations are observed for these months. There is a coincidence of directions.

KEYWORDS

Lineaments, statistical analysis, rose-diagram, Landsat 8

INTRODUCTION

In the developed countries of the world with the intensive development of remote sensing, to pay attention to the detection and analysis of lineament structures using modern satellite data. Usually, visual interpretation of satellite data to identify linear structures on the Earth's

surface is a more complex process, which often requires a significant investment of time and effort. While an automated process avoids such difficulties, it has high efficiency, cost-effectiveness, and especially objectivity.

Currently, the leading scientists of the world have carried out large significances of research on the study of modern movements of the earth's crust. In most of the works, the authors used modern satellite data, along with software for automatic extraction of lineament structures. Shevyrev S.L. (2017) in his work describes an algorithm for structural-tectonic analysis of remote sensing data. He divides the analysis of satellite data into several stages of processing: generalization, taking into accounts the scale of the analyzed objects with the creation of a series of images of different spatial resolution - "pyramids"; analysis of the "pyramids" of the image; application of graphic filters [1]. Such stages of data processing using Landsat and SRTM DEM made it possible to confirm the localization of ore objects within the fractured permeable areas of the territory and to clarify the position and severity of regional fracture structures. In many scientific works, a comparative analysis of optical satellite data and radar satellite data is carried out for automatic lineament extraction. The basis of the automatic approach involves determining the optimal parameters for automatic lineament extraction with a combination of edge detection and line-linking algorithms and determining the appropriate bands based on optical data suitable for lineament mapping. To verify the results obtained, the extracted lineament structures are compared with the lineaments obtained by hand digitizing from geological maps [2]. The work presents a processing method using multi-temporal Landsat 8 imageries were

determined on base LINE algorithm in software PCI Geomatica in the territory of the water reservoir [3]. The result showed that water level fluctuations have a greater influence on the appearance of the lineaments structure than periods of water filling and downstream in the reservoir.

This paper describes a statistical analysis of lineaments based on multi-temporal Landsat 8 imageries in the Fergana Valley (East Uzbekistan).

STUDY AREA

The Fergana Depression is the largest intermountain depression in Central Asia and is located in the eastern territory of the Republic of Uzbekistan and borders on the Republic of Tajikistan and Kyrgyzstan.

Several large geological faults pass in the Fergana Valley: Tamdi-Karachatir, the approximate length of the fault is 1089.72 km, Besapano-South Fergana, the approximate length of the fault is 1082.19 km, the North Fergana, the approximate length of the fault is 393.52 km, Kumbel the approximate length of the fault is 352.31 km, Andijan the approximate length of the fault is 255.49 km and Kenkol-Arashan, the approximate length of the fault is 148.92 km.

In figure 1 shows an image of the Fergana Valley according to the Landsat 8 satellite with geological faults.

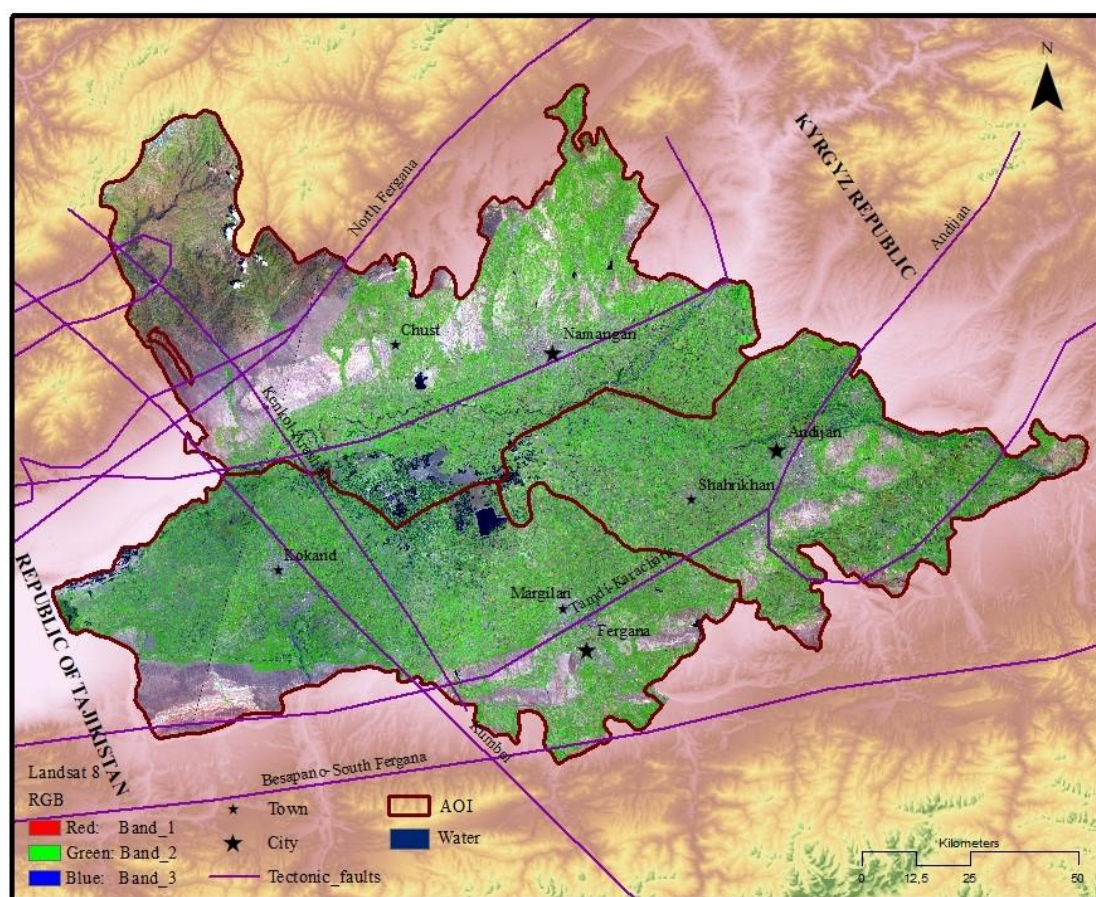


Figure 1. Fergana Valley according to the Landsat 8 satellite with geological faults

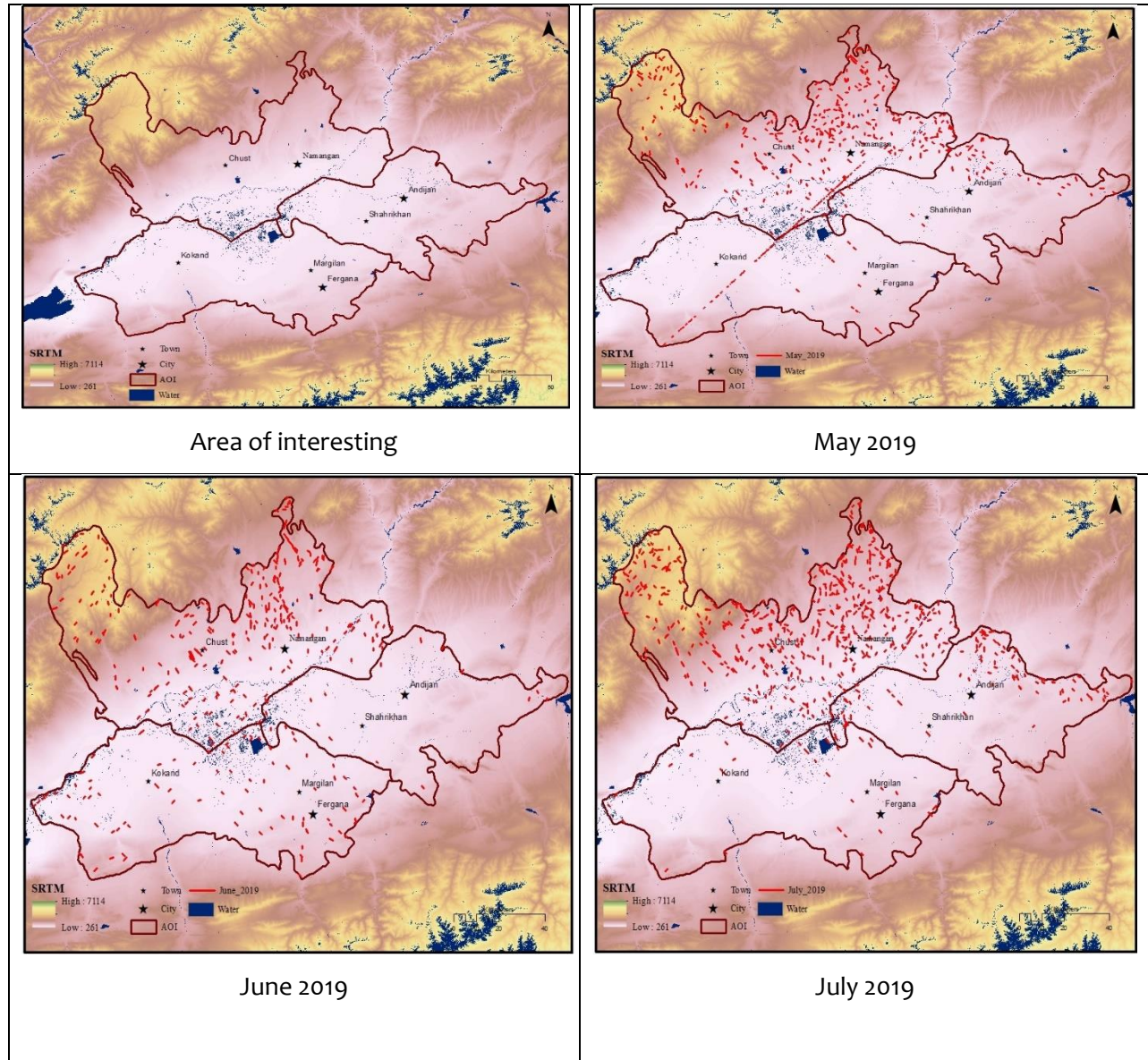
MATERIALS AND METHODS

The first step in the automated process of extracting lineament structures is to select the original data. The main criterion for choosing a suitable image was cloud-free. Data processing was carried out for the period May - November 2019. The Landsat 8 has a spatial resolution of 30 m; to improve the quality of lineament structures extraction, it is necessary to improve the spatial resolution of the images. To do this, it is necessary to carry out pan sharpening for each satellite image. Automatic interpretation of lineament structures was carried out by Principal Component Analysis (PCA). PCA was performed using six Landsat 8

spectral channels (channels 1, 2, 3, 4, 5, 7). Bands 6 (thermal) were not used in the study. Analysis of these components showed that the most informative components from the point of view of displaying geological structures are the sixth, fifth and third components with a standard deviation of 1.5. The automated process of extracting lineament structures was performed in the LEFA (Lineament Extraction and Fracture Analysis) program in the Matlab environment.

RESULTS AND DISCUSSION

In figure 2 illustrates the results of the automated extraction of lineament structures from the PCA results.



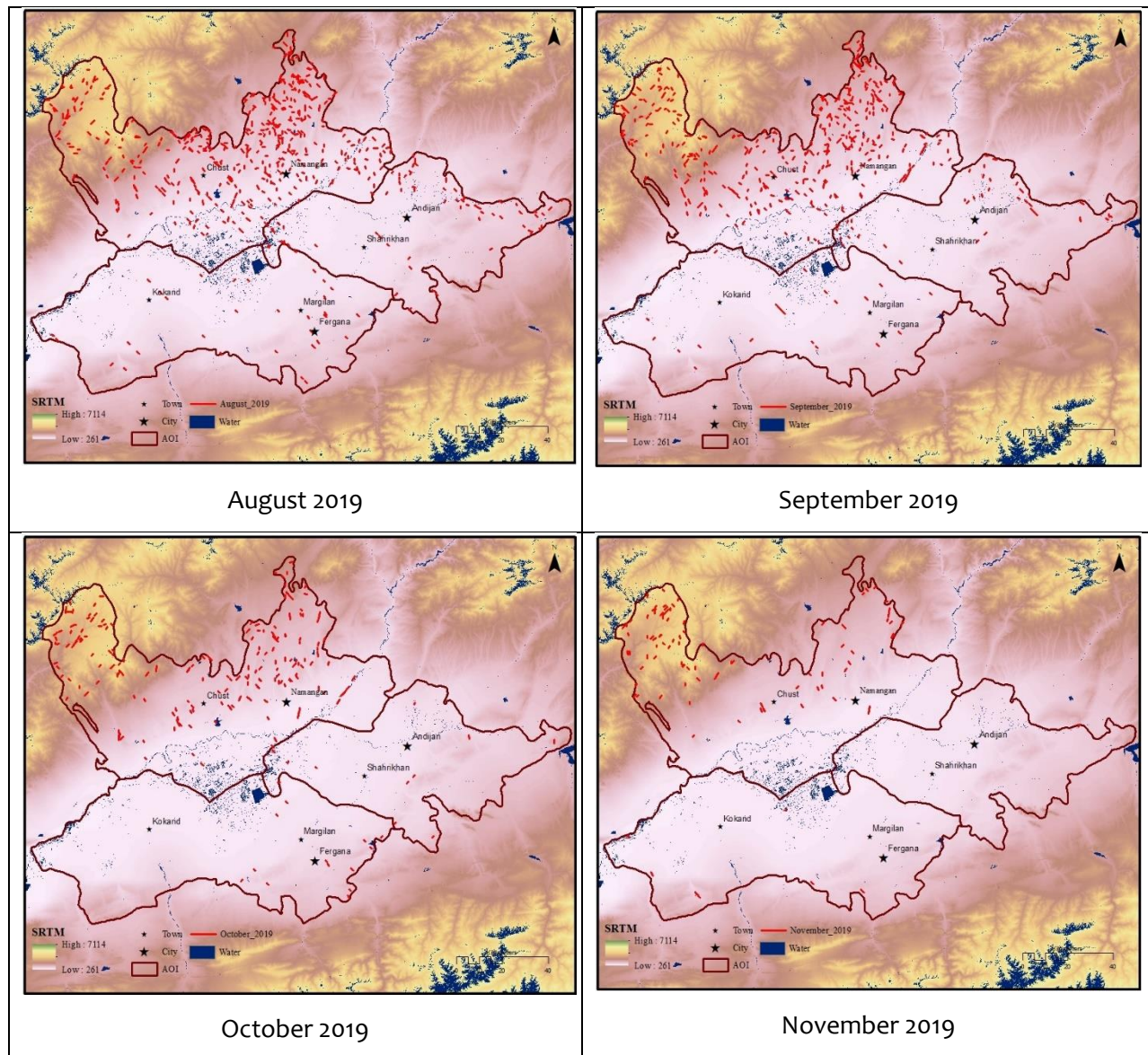


Figure 2. Results of automated PCA processing

Based on the results obtained during visual interpretation, it was determined that the count of lineament structures changes by months. It was also noted that the Namangan region is more prone to the manifestation of lineament structures. It was noticed that in May, July, August, September, and October, some lineaments are practically along one straight line.

Statistical analysis of lineament structures consists of:

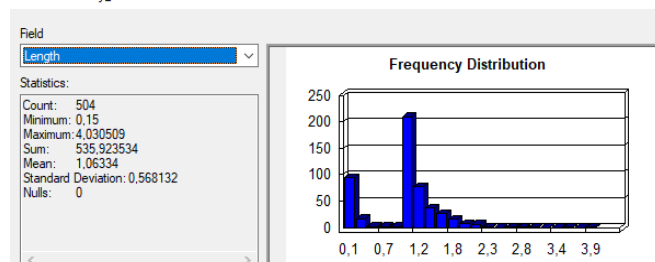
1. The number of lineaments, the maximum and minimum length of lineaments (fig. 3);
2. Rose diagrams showing the orientation of the lineaments (fig. 4).

Rose diagrams display the frequency of the lineaments at regular intervals. Lineament

statistics can be used to test the structural homogeneity of the rock. The intersection of lineaments is of general interest in terms of

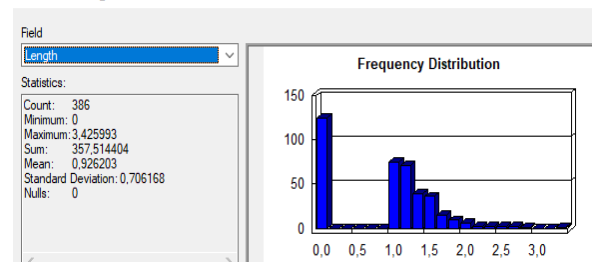
groundwater flow in the rock as they indicate the location of the channels.

Statistics of May_2019



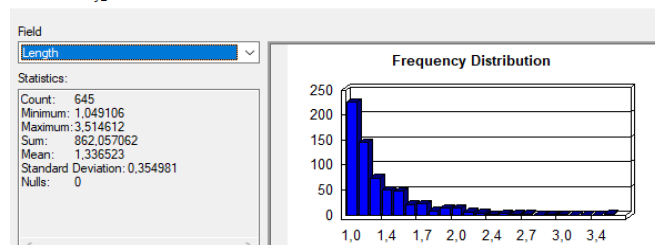
May 2019

Statistics of June_2019



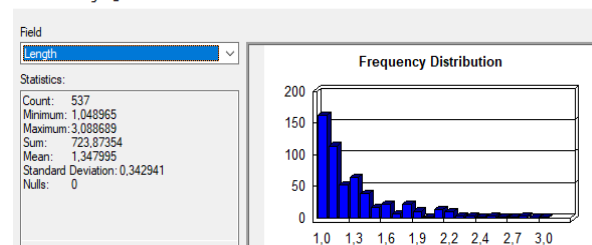
June 2019

Statistics of July_2019



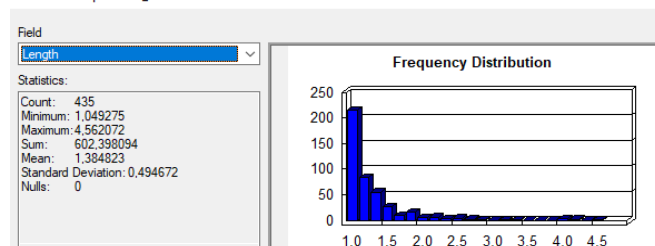
July 2019

Statistics of August_2019



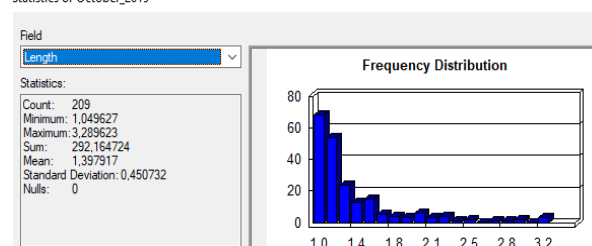
August 2019

Statistics of September_2019



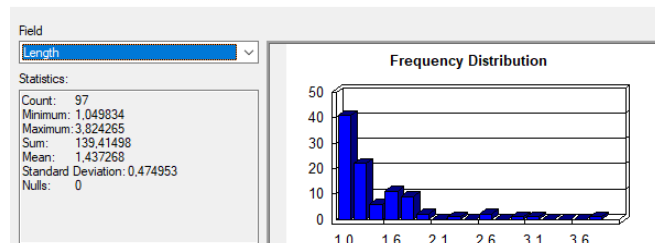
September 2019

Statistics of October_2019



October 2019

Statistics of November_2019



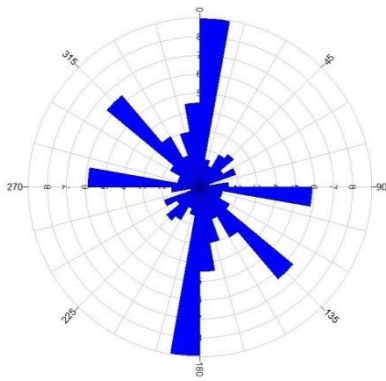
November 2019

Figure 3. Statistical analysis of lineament structures

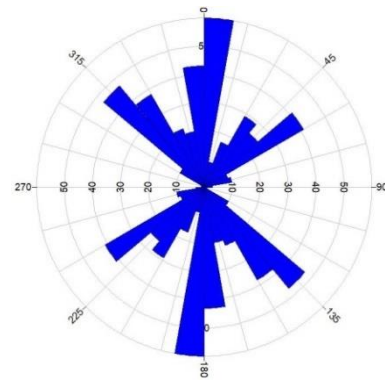
The results of statistical analysis showed that the maximum count of lineament structures was in July; their count was 654 with a maximum length of 3.5 km and a minimum length of 1.05 km. Then there is a gradual decrease in the count of lineament structures. In August, the count of lineaments was 537 with a maximum length of 3.09 km and a minimum length of 1.05 km. In September, the count of lineaments was 435 with a maximum length of 4.6 km and a minimum length of 1.05 km. In October, the count of lineaments was 209 with a maximum length of 3.3 km and a minimum length of 1.05 km. And in November, we observe a sharp decrease in lineament structures; their count was 97 with a maximum length of 3.8 km and a minimum length of 1.05 km. But in May and June, the opposite dynamics was observed, if in the second half of the year there was a gradual decrease in lineament structures, then the opposite is true. In May, the count of lineaments was 504 with a maximum length of 4.03 km and a minimum length of 0.15 km. In June, the count of lineaments was 386 with a maximum length of 3.4 km and a minimum length of 1.05 km.

The analysis of the orientation of lineament structures is carried out. As a result, it was

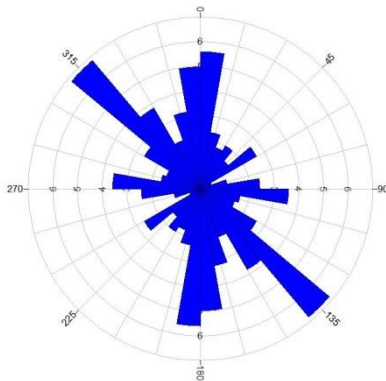
revealed that in May, June, and September the main direction of the lineament structures was the north and south. Also in May, the western and eastern directions are observed, which disappear in June, but their appearance is observed in July, August, and September, and then these directions decrease in October, and in November they practically disappear. In May, the direction is north-west and south-east, which in the following months is the main direction - July, August, and October. In June, there is an almost mirror direction northwest, southeast, east-northeast, and west-southwest.



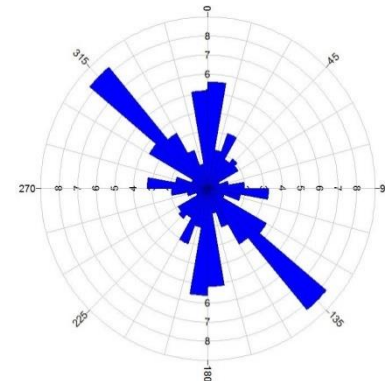
May 2019



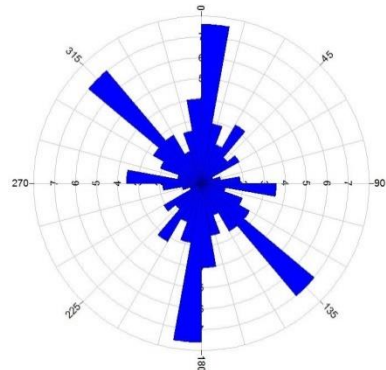
June 2019



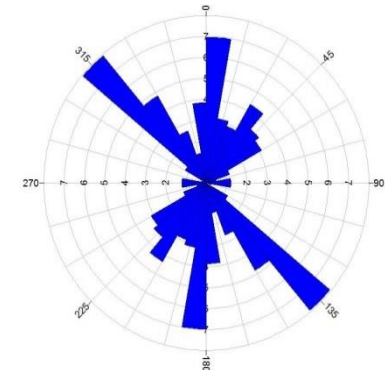
July 2019



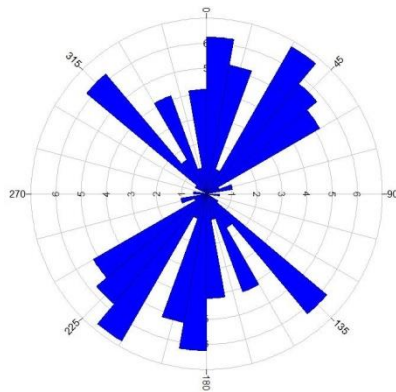
August 2019



September 2019



October 2019



November 2019

Figure 4. Orientation analysis of lineament structures

There is a gradual increase in the north-north-west and south-south-east direction from May to July, then from August it decreases to October and in November the increase in this direction begins again. In November, the main direction is north-north-east and south-south-west, there are also more secondary directions north-east and south-west, east-north-east and given-south-west, north-north-west and south-southeast.

CONCLUSION

This paper describes a statistical analysis of lineaments based on multi-temporal Landsat 8 imageries in the Fergana Valley (East Uzbekistan). The results of the statistical analysis showed that determined that the count of lineament structures changes by months. It was also noted that the Namangan region is more prone to the manifestation of lineament structures. The maximum count of lineament structures was in July; their count was 654 with a maximum length of 3.5 km and a minimum length of 1.05 km. And in November, we observe a sharp decrease in

lineament structures; their count was 97 with a maximum length of 3.8 km and a minimum length of 1.05 km. According to the results of the rose diagrams, various orientations are observed for these months. There is a coincidence of directions north-west and south-east, north and south, north-north-west and south-south-east. Also in November, the appearance of such orientations as northeast and southwest, northeast and south-southwest, east-northeast and west-southwest is observed.

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