Lineament automatic extraction analysis for Galal Badra river basin using Landsat 8 satellite image

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Abstract

This research including lineament automated extraction by using PCI Geomatica program, depending on satellite image and lineament analysis by using GIS program. Analysis included density analysis, length density analysis and intersection density analysis. When calculate the slope map for the study area, found the relationship between the slope and lineament density.

The lineament density increases in the regions that have high values for the slope, show that lineament play an important role in the classification process as it isolates the class for the other were observed in Iranian territory, clearly, also show that one of the lineament hit shoulders of Galal Badra dam and the surrounding areas dam. So should take into consideration the lineaments because its plays an important role in the study area.

Key words

PCI Geomatica, GIS, Lineament analysis.

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تحليل التراكيب الخطية المستخرجة أوتوماتيكيا لمساحة حوض نهر كلال بدرة باستخدام الصور الفضائية لاندسات 8

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الخلاصة

تضمن هذا البحث استخراج التراكيب الخطية اتوماتيكيا باستخدام برنامج PCI Geomatica وبالاعتماد على الصور الفضائية الحديثة و تحليل التراكيب الخطية باستخدام برنامج نظم المعلومات الجغرافية. وشمل التحليل تحليل كثافة التراكيب الخطية، وتحليل كثافة الاطوال وتحليل كثافة التقاطع. عند احتساب خريطة الانحدار لمنطقة الدراسة، وجدت علاقة مابين الانحدار وكثافة التراكيب الخطية. وجد بان كثافة التراكيب الخطية تزداد في المناطق ذات الانحدار العالي. تبين أن التراكيب الخطية تلعب دورا هاما في عملية التصنيف لأنه يعزل فئة لأخرى لوحظت في الأراضي الإيرانية، بشكل واضح، كما لوحظ بان احد التراكيب الخطية يضرب الكتف الايمن لسد كلال بدرة والمناطق المحيطة بالسد. لذا يجب اخذ التراكيب الخطية بنظر الاعتبار لما تلعبه من دور هام في منطقة الدراسة.

Study area

Galal Badra river basin is locating in East part of Iraq, north east Kut city. The area covers about (2722 km^2) between latitude (32º55'- 33º40') N, and longitude (45º50'- 46º40') E. This area is divided between Iraq and Iran, the greater part is located in Iranian territory. Fig. 1 location of the study area.

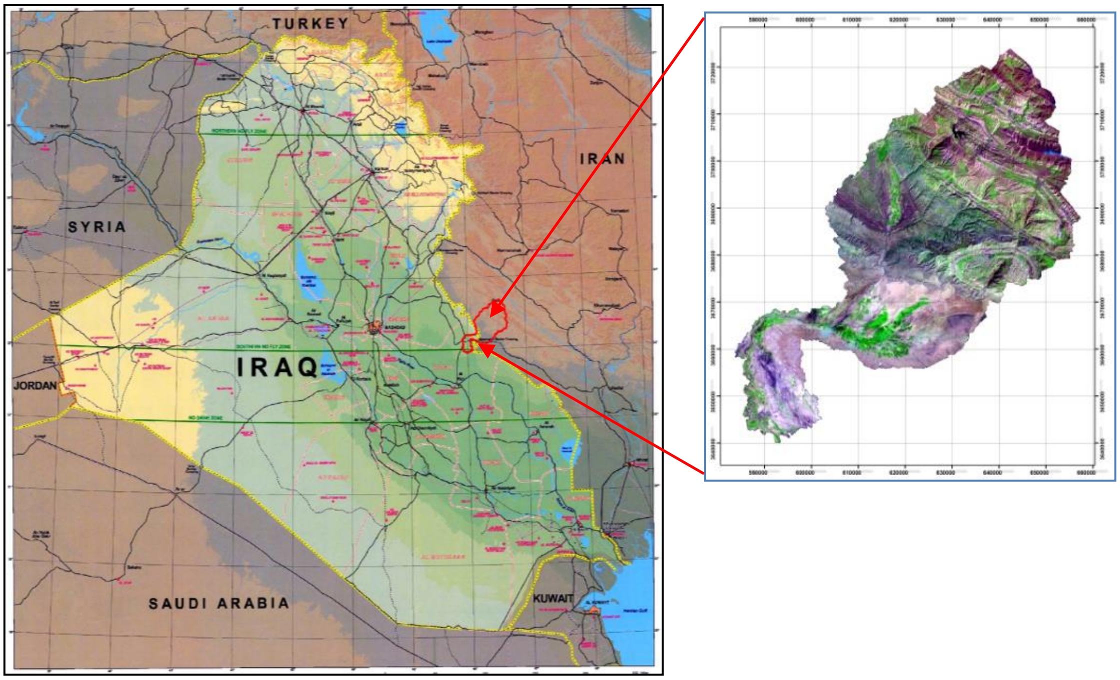

Fig. 1: Location of the study area.

Introduction

Lineaments are defined as map able linear surface features, which differ distinctly from the patterns of adjacent features and presumably reflect subsurface phenomena [1]. The subsurface effect is valid if the origin of the lineament is controlled by geological structures such as faults and fractures. Other types of lineaments resulted from morphological effects (stream channels or drainage divides) or human effects (roads, field boundaries) can also exist in the region. Lineament mapping is considered as a very important issue in different disciplines to solve certain problems in the area. For example, in site selection for construction a dams, bridges, roads, etc., for seismic and landslide risk assessment [2].

Satellite images and aerial photographs are extensively used to extract lineaments for different purposes. Since satellite images are obtained from varying wavelength intervals of the electromagnetic spectrum, they are considered to be a better tool to discriminate the lineaments and to produce better information than conventional aerial photographs. [3].

The image-interpretation of lineaments is often more reliable than their detection in the field because some lineaments may have a weak expression on the ground and may not be visible underneath a thin screen cover or vegetation cover, or may build a distinct geomorphological feature recognizable only from a distant overview point. Moreover, the changes in vegetation and surface texture related to lineaments are difficult to recognize at a close range. The synoptic view of satellite images enables widely separated pieces of evidences to be linked as sharp or semi-continuous linear features or lineaments. However, [4] argued that only 15-25% of lineaments observed on an image may reflect the subsurface geology. Therefore, before mapping structurally significant lineaments, it is necessary to critically analyses the image, in order to identify the linear features not caused by the geology. Such features are classified as artificial (e.g. roads, railways, power-cables, field-boundaries), or geomorphological (stream valleys, hill spurs, vegetation and soil borders). Nevertheless, stream valleys, rivers, hill spurs and soil borders or vegetation lines usually have a very clear lithological or structural (tectonic) explanation.

Lineament analysis by using automated extraction techniques

Applied the Hough transform to automatically detect the straight lines that represent geologic lineaments on the satellite images [5]. The main advantages of this method are that it is relatively unaffected by gaps in lines and by noise. The method involves transforming each of the shape points into a straight line in parameter space. The method is applied to a Landsat TM image of Sudbury (Ontario - Canada) the result of this study shows that automated interpretation identifies more of the faults than visual interpretation.

Emphasized importance of the rock types on the lineament patterns existing in the area. They extracted lineaments from Landsat ETM+ image data using GeoAnallst PCI EASI/PACE software [6]. The digitally extracted lineaments were compared with the visually interpreted lineaments to detect and count true/false lineaments. The extracted lineaments were counted as frequency, length, lineament to cell intersection using square counter. Correlating lineament density maps with radiometric contour maps show that rock units with high radioactivity are also characterized by high lineament density and lineament intersection density [6].

Methodology

The data set is used in this study:

The satellite image of the area Landsat 8 2014, band 7, to extract the lineaments.

Programs used, PCI Geomatica v.9.1, to extract the lineament and Arc GIS v. 9.3, to the result analysis.

The method is composed of three successive steps:

1. Selection of input data for analysis.

2. Lineament extraction by using automated lineament extraction techniques.

3. Evaluations of lineament map and include density, direction, intersection length, and orientation analysis.

1. Input data

The first step of the methodology is selection of initial input data for lineament extraction. Although the lineaments can be extracted from several data such as aerial photographs, geophysical data etc, in this study the satellite image is preferred for the application.

2. Lineament extraction

The second step of the methodology is extraction of lineaments from satellite images and final map generation. This is the main step in the application. Applied automated lineament extraction by using PCI Geomatica.

Automated lineament extraction

Lineaments are extracted from satellite images using automated extraction techniques in order to compare with the manually extracted lineaments. The main advantages of automated lineament extraction over the manual lineament extraction are its ability to uniform approach to different images; processing operations are performed in a short time and its ability to extract lineaments which are not recognized by the human eyes. The automated lineament extraction in this study is performed by the line module of Geomatica software. The logic of this method is similar to "Segment Tracing

Algorithm STA". A brief explanation of the algorithm of this module will be given here [7].

3. Evaluation of the automatically extracted lineaments

The final map of the automatically extracted lineaments and the chart of lineament frequency can be shown in Figs. 2 and 3. The total numbers of lineaments are (749) lines, max. length (3.2285) km, min. length (0.042918) km. In this study four processes of evaluation are applied. These are: 1) density analysis, 2) intersection density analysis, 3) length analysis, and 4) orientation analysis.

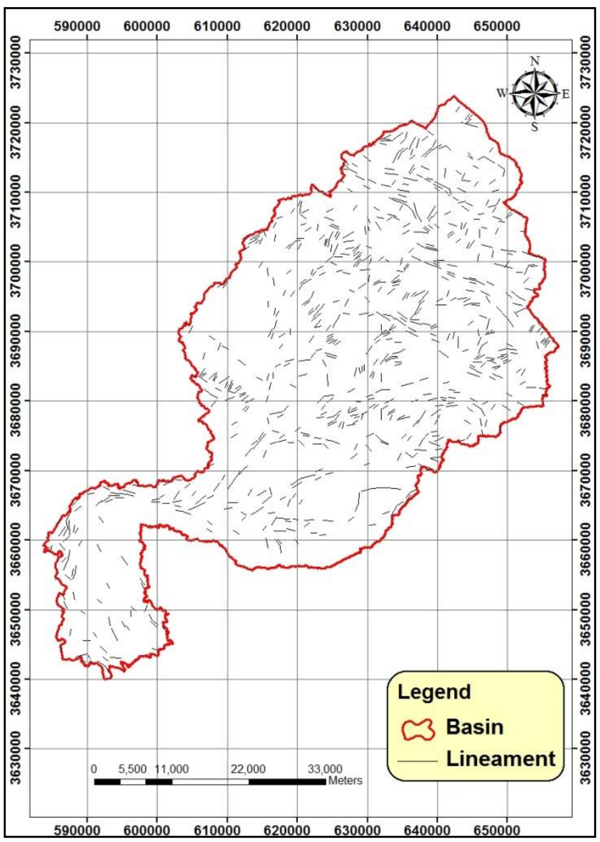

Fig. 2: The automatically extracted lineaments.

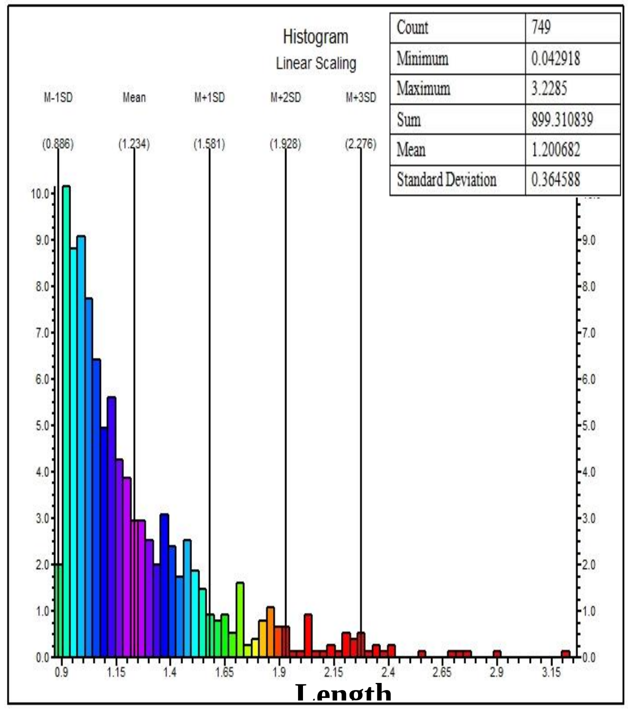

Fig. 3: Length of lineaments frequency.

Lineament density analysis

Lineament density maps display the distributions of the lineaments in two-dimensional maps. The area was divided into equal area grids. The number of lineaments in each grid were counted and recorded. The purpose of the lineament density analysis is to calculate frequency of the lineament per unit area. With this analysis a map has been produced showing concentrations of the lineaments over the study area. Analysis of lineament density is performed by counting number of lineaments contained in specified unit area. To calculate lineament density, search radius in (6) km to given acceptable density. The result of these analyses is shown in Fig. 4. The purpose from this analysis to known the location of high lineament density.

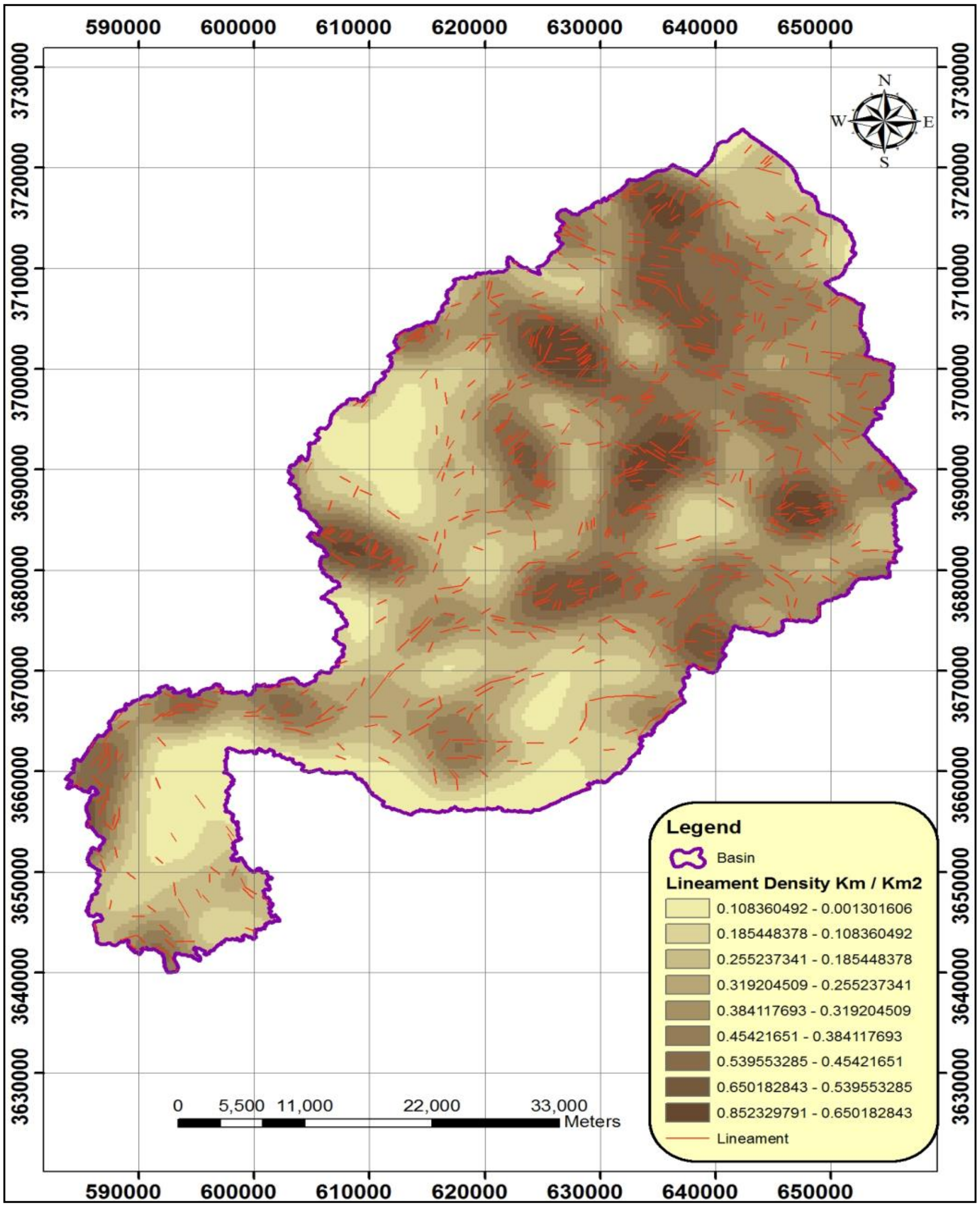

Fig. 4: The lineament density map by using Arc GIS.

Intersection lineament density analysis

Lineament intersection density is a map showing the frequency of intersections that occur in a unit area. The purpose of using intersection density maps is to estimate the areas of diverse lineament orientations. If the lineament do not intersect in an area, the resultant map will be represented by a plain map with almost no density contours and the lineament are almost parallel or sub parallel in an area. The lineament intersection map of the study area Fig. 5 Indicates high and very high intersection in the same areas where there is very high density of lineaments. The zones of high lineament intersection over the study area are feasible zones for groundwater potential evaluation. Other purpose of using intersection density map is to estimate the areas of diverse lineament orientations.

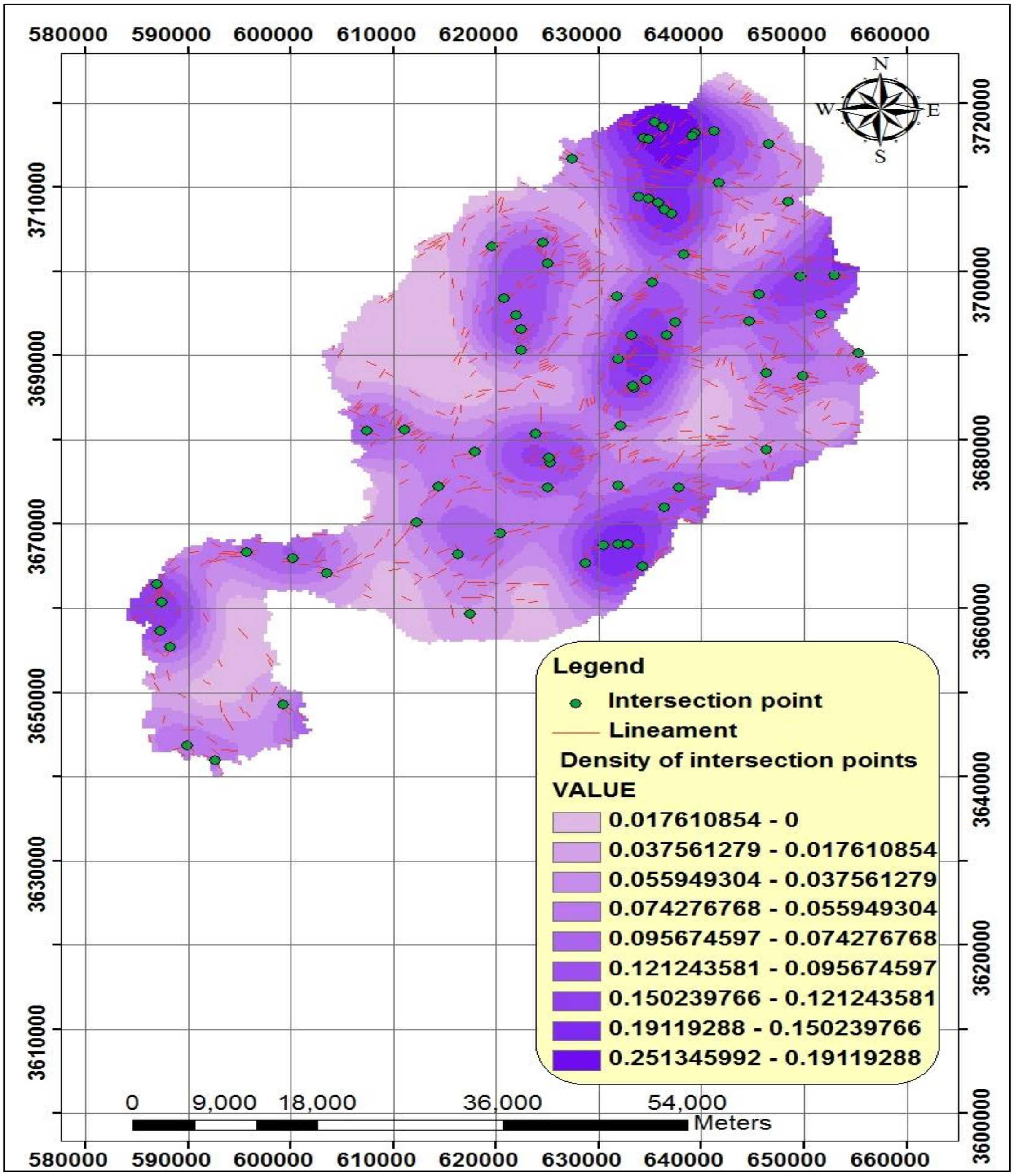

Fig. 5: The lineament intersection density Map by using rc GIS.

Length of lineament density analysis

Analysis of the lineament length density is useful guide for interpreting the lineament map. Calculating lengths of lineaments more accurately gives the image of lineament density, since the total length per unit area depends on the lines or segment of lines completely contained within the cell Fig. 6 length density. A grid of cells is constructed over the area and the total length is calculated within this unit area.

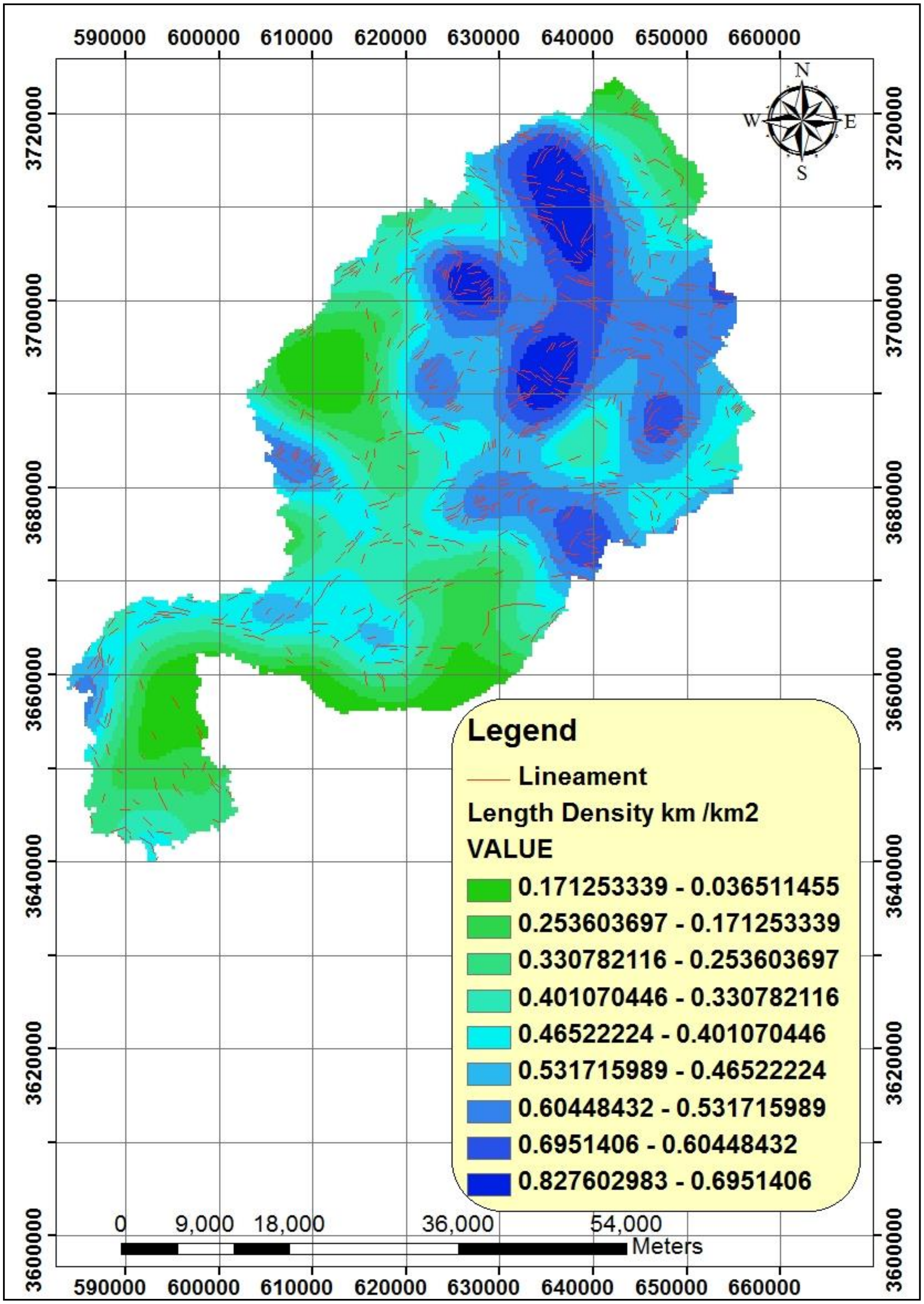

Fig. 6: The lineaments length density Map by using Arc GIS.

Orientation of the lineaments analysis

Orientation of the lineaments is usually analyzed by rose diagrams in all applications in the literature. These diagrams display frequency of lineaments for regular intervals. The interval in this study for all analyses is selected as 15 degrees. Lineaments are normally statistically analyzed using frequency or length against azimuth or rose diagram. The anticlockwise azimuth, away from the horizontal axis (0°) represents the strike direction of the lineament, and the radius from the origin stands for the frequency, as shown in Fig. 7 the diagram is prepared using the frequencies of the lineaments and therefore are not length-weighted. The diagram is being concentrated in NE-SW direction. The lineaments direction can be calculate by using rock work software as shown in Fig. 8.

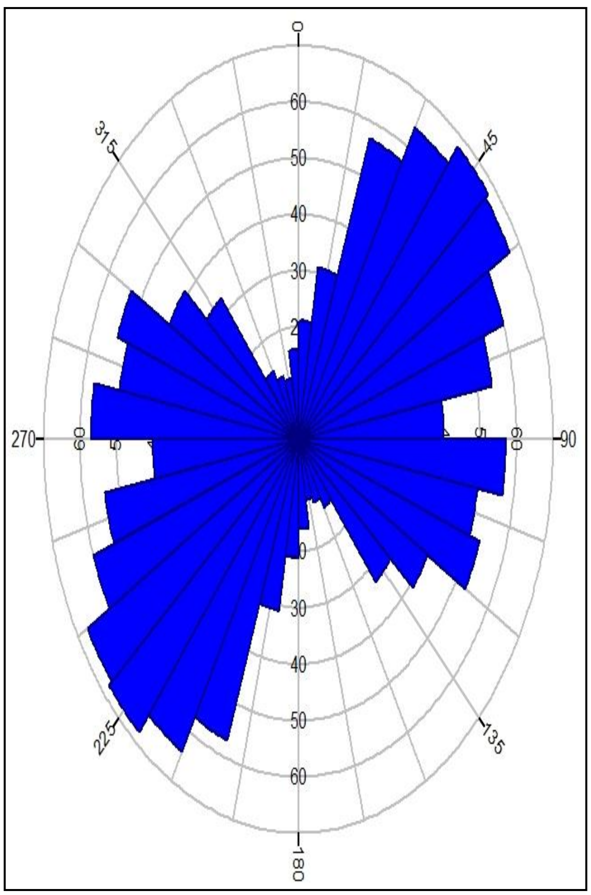

Fig. 7: Rose diagram for the lineament.

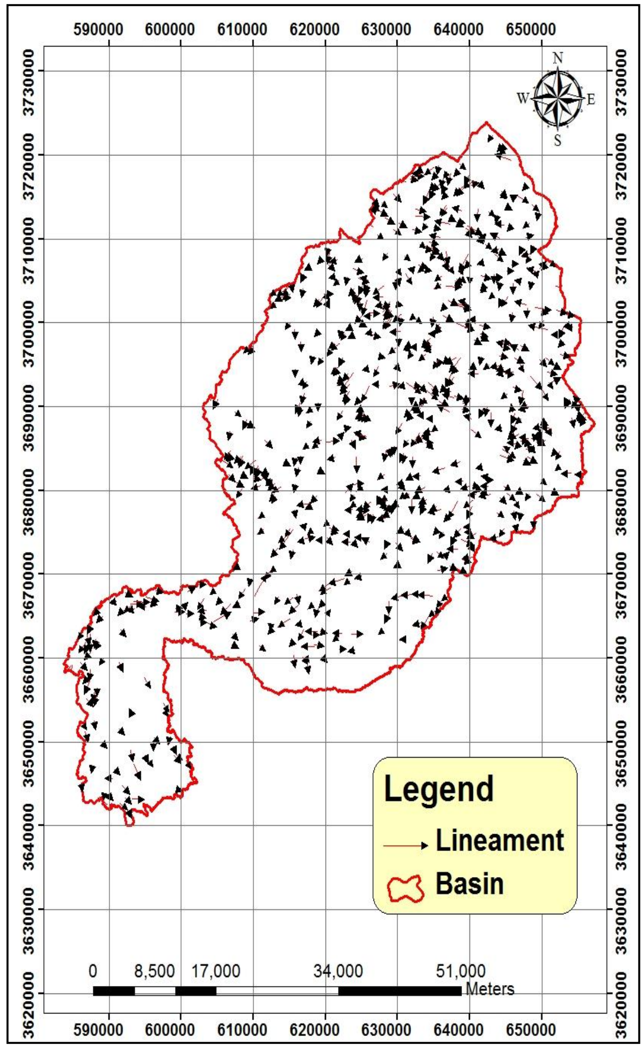

Fig.8: lineaments.

Analysis of slope data and relationship with lineament

The slope data can be derived from a DEM, represented by degree or percentage, expressing the change in elevation over a certain distance. High values suggest steep slopes and low values correspond to flat areas Fig. 9 represent the study area slop the value of slop in degree ranging (0º-77.2197º) the high values in slope image correspond to abrupt changes, which can represent the probable lineaments. The lineament density increases in the regions that have high slope value, when comparison the map of slope and map of lineament density as shown in Fig. 10.

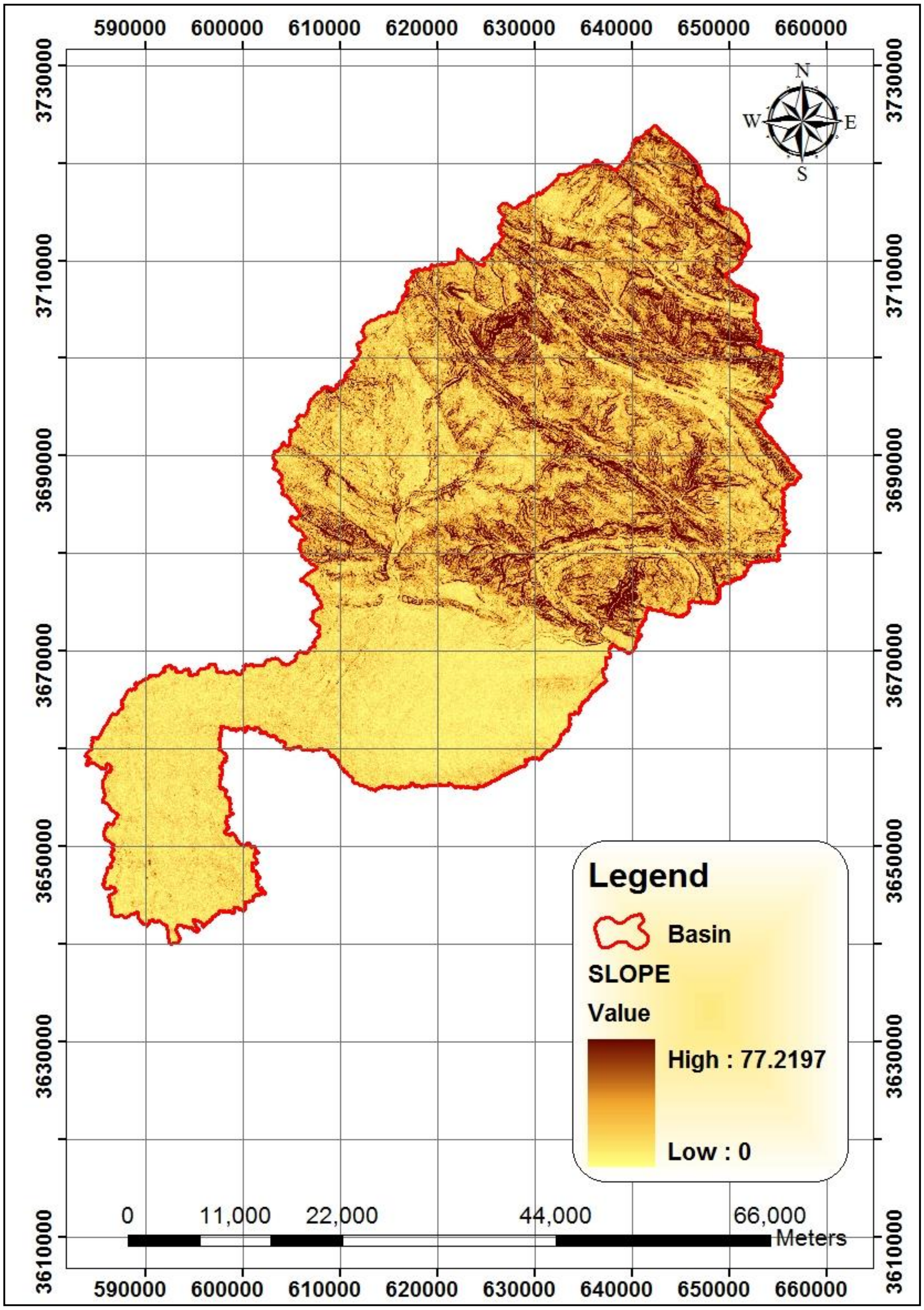

Fig.9: Slope map of study area.

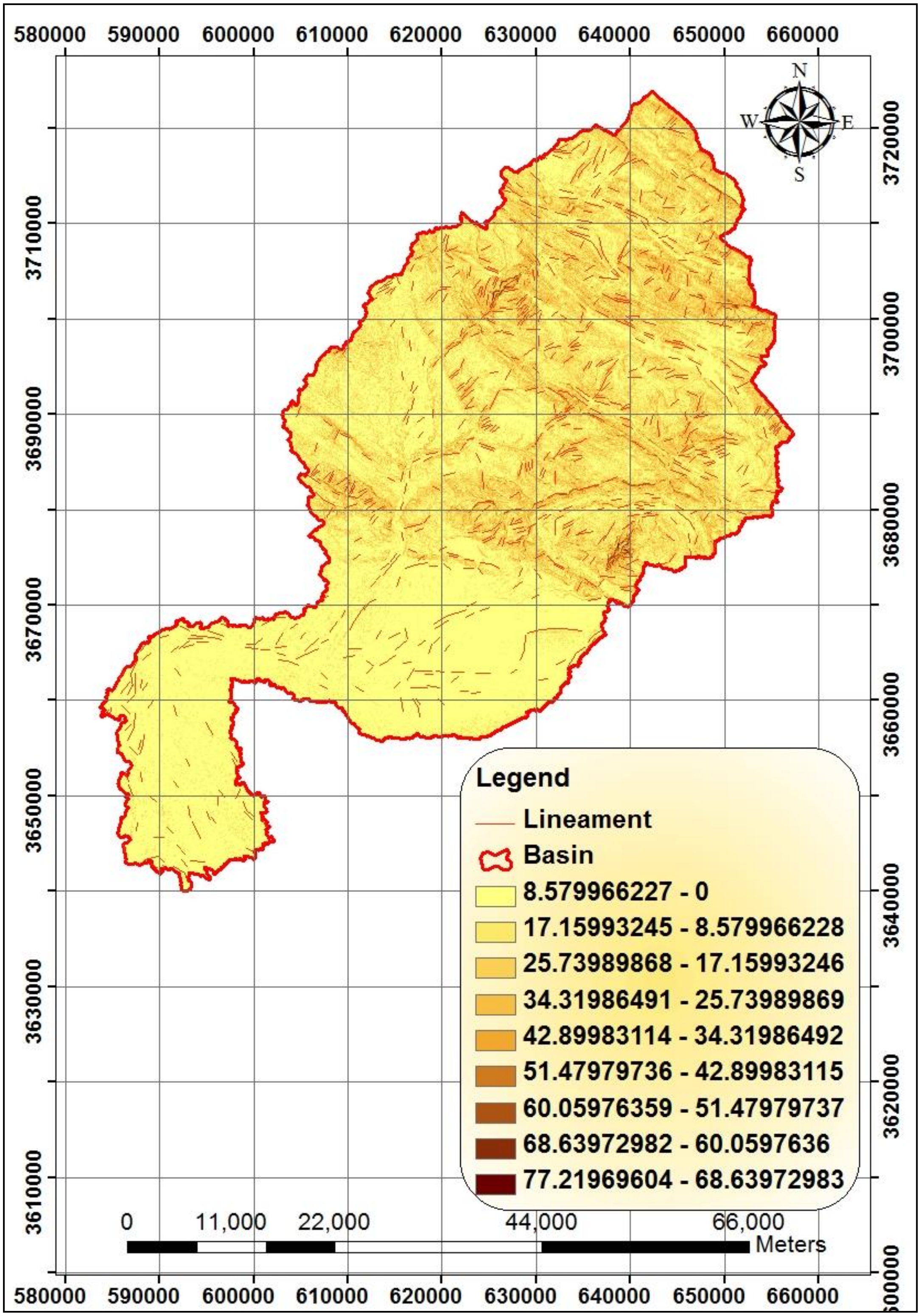

Fig.10: Map of relationship between the lineament density and slope value.

Lineaments effect for the Galal Badra Dam axis

When examining the lineaments found in the study area observed it hit one of the shoulders of the dam, which left shoulder and there is another lineament of distance (318 m) Fig. 11 shows that. Lineaments that constitute a danger to the body of the dam and the areas that surround it, due to the displacement resulting from the lineaments, so you must take into consideration the lineaments and studied attention to detail and the use of modern satellite images of the area before the execution of any project and its impact. As it turns out that the region is not valid for dam construction or the surrounding areas, so you must choose the features of the area to be far away, within the body of the dam safety line.

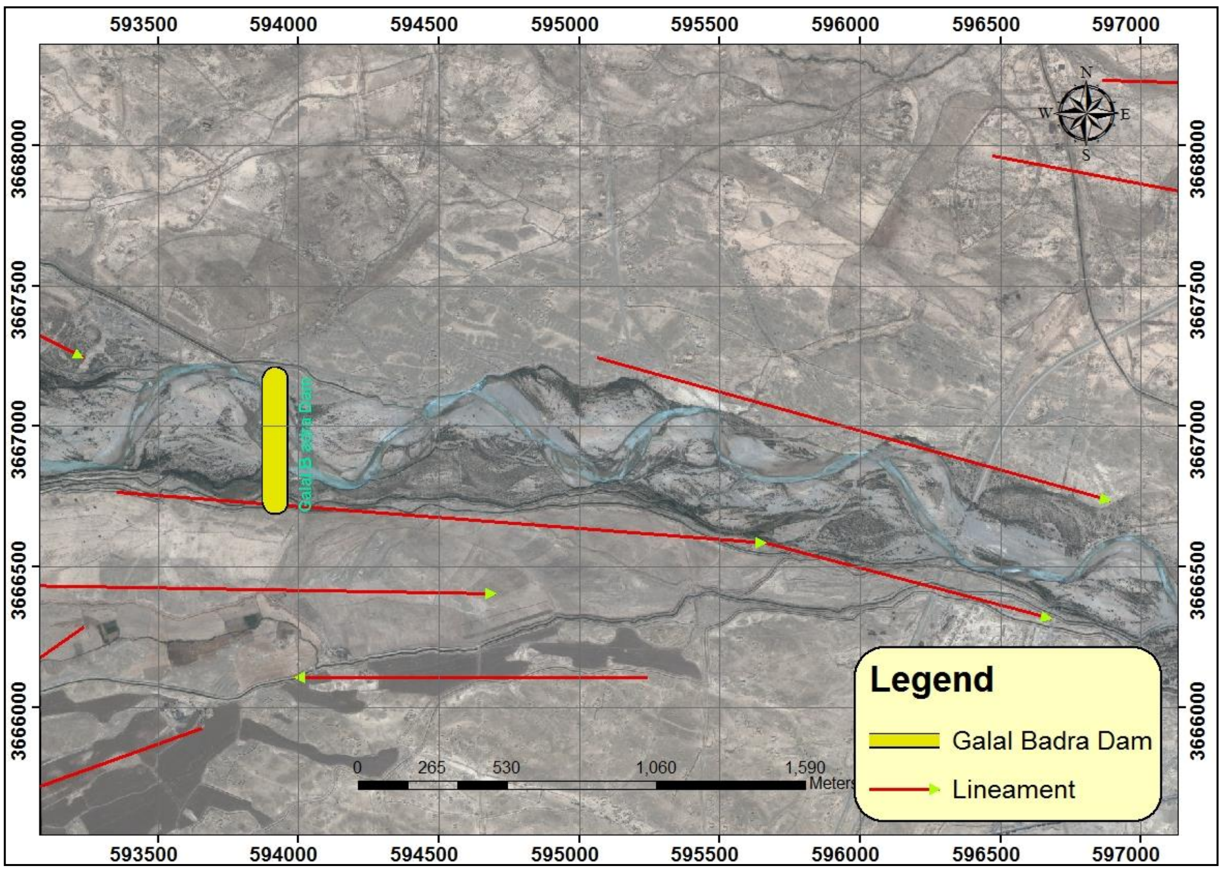

Fig.11: Lineaments effect for Galal Badra dam body.

Conclusions and recommendations

The study showed the importance of satellite images to extract lineaments by using PCI Geomatica program and analysis it by using geographic information systems in terms of density of lineament, density of lengths and density of lineament intersections.

The study showed that the lineament play an important role in the classification process by comparing the map of slope with a map of the lineament density, show that the lineaments are concentrated in areas that have high slope.

The study showed that the lineaments that have been extracted from the satellite image affect on the shoulders of Galal Badra dam. So you should take into consideration the lineaments before starting the implementation of any project and its effect on the project.

Use the satellite image Landsat 8 because it is modern images and covering the large areas and related good clarity and the possibility obtained free by the website www.usgs.glovis.com.

The necessity of extract lineaments depending on modern satellite images, before starting any project of their importance in determining the appropriate location and land surrounding it, and find out extent future impacts of these lineaments on the project, such this project, dams, building ... etc.

References

[1] O'Leary, D. W. Friedman, J. D., Pohn, H. A., Geological Society America Bulletin, 87 (1976) 1463-1469.

[2] Stefouli, M., A. Angellopoulos, S. Perantonis, N. Vassilas, N. Ambazis, E. Charou, "Integrated Analysis and Use of Remotely Sensed Data for the Seismic Risk assessment of the southwest Peloponessus Greece". First Congress of the Balkan Geophysical Society, 23-27 September, Athens Greece (1996).

[3] A. M. CasasCortes, L.Angel, A.Maestro, M.A.Soriano, A.Riaguas, J. Bernal, Computers and Geosciences, 26, 9-10 (2000) 1011-1022.

[4] M. E, Mustafa, F. A. Zakir, 17, 15 (1996) 2923-2943.

[5] Wang, Jinfei, Member, IEEE, Howarth, Philip J., IEEE Transactions on Geoscience and Remote Sensing, 28, 4 (1990) 561-566.

[6] M.E. Mustafa and A.Z Bishta, International Journal of Remote Sensing, 26, 7 (2004) 1463-1475.

[7] E.E.Nama, International Journal of Remote Sensing, 25, 3 (2004) 501-510.