Rock Slop Analysis in Duhok Governorate /Bekhair Anticline by Using GIS Technique

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Abstract

This study aims to make analysis to the rock slop of Bekhair anticline which lies in the north part of Iraq in the Duhok Governorate by use Digital Elevation Models (DEM) that taken from the Shuttle Radar Topography Mission (SRTM) with GIS technique. The slope image has been created depending on the DEM image and the angle from 35.1 to 81.7 degree given a color to avoid the confuse that may be occur in the image when all angle given a color, the angle from 45.1 to 81.7 concentrate in the middle part of the study area. Also the curvature image has been created. Curvature values represent the morphology of the topography, from the value of this image the more positive value, the higher, the probability of landslide occurrence, also the more positive value occupy the middle part of the study area, so the middle part considered as steep slopes with high value of curvature, thus it is more probable for sliding.

Keywords: Slope, Curvature, GIS, Land slide, Duhok.

Introduction

Landslides are one of the major hazards that cause losses in lives and property. Landslide is defined as outward and downward movement of masses formed from rock and soils due to natural or manmade. High intensity rainfall triggered many landslides. As long as landslides occur faraway from populated region, this Phenomenon.

Treated as just a natural process disturbing the environment, but when it occurs in populated regions it will become a serious matter to investigate. Many landslides occur due to manmade such as development of the area, deforestation and plantation. These disturbing lands will simply absorb the rainwater and cause instability slope [1].

It is simple to classify the wide variety types of movement (failure), into three classes;
1. Slides: rotational slips, translational slide
2. Falls: rock slides, rock fall.
3. Flow: mudflows, soil creep.

There are some causes of landslide can by classified in to:
1. Nature related causes

Action of earthquake on slope is very complex; it involves an increase in shear stress and decrease in shear strength. Rainfall also contributes to increase in pore water pressure, which increases a shear stress.

2. Human related causes

Removing the lateral support such as cut for roads and canals, also removing trees and vegetation, which all of these activities.

Location of the study area

The study area lies in the north of Iraq, near the boundary with Turkey Fig.(1), and lies between Latitude 37° 00′ 00″ N and 37° 07′ 30″ N, and Longitude 42° 27′ 30″ E and 42° 47′ 30″ E .

The aim of this study

The main objective of this study is to assess the risk of slope on their Susceptibility to fail and the hazard probabilities that might cause the danger, damages in the study area**.**

Methodology

1.Data and Software: In this search the software that used is GIS (ArcGIS version-9.3), With the DEM (digital Elevation Model) from SRTM (Shuttle Radar Topography Mission).

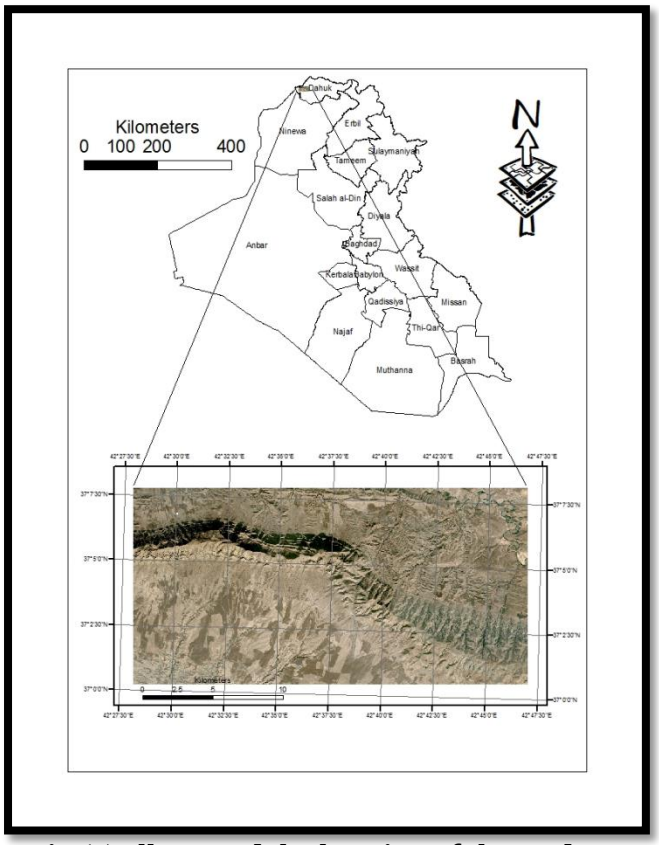

Fig.(1) Illustrated the location of the study area.

2. **Processing**: The DEM has been given as the input into Arc GIS to prepare Slope image which is one of the important factors in landslide study, then create curvature image.
3. **Interpretation**: after the obtaining of the slope and curvature image it has been assessed to determine the probable areas that have ability to landslide.

Stratigraphy:

The study area is located within Duhok Governorate, in the high folded zone, the Cretaceous sediment occupy the core of Bekhair anticline which underlay the Kolosh Formation. Fig.(2) [2] illustrate the geological map of the study area. The formation in the study area belongs to Cretaceous, Tertiary and Quaternary period, the name, age and description of this formation is illustrate in Table (1) [3].

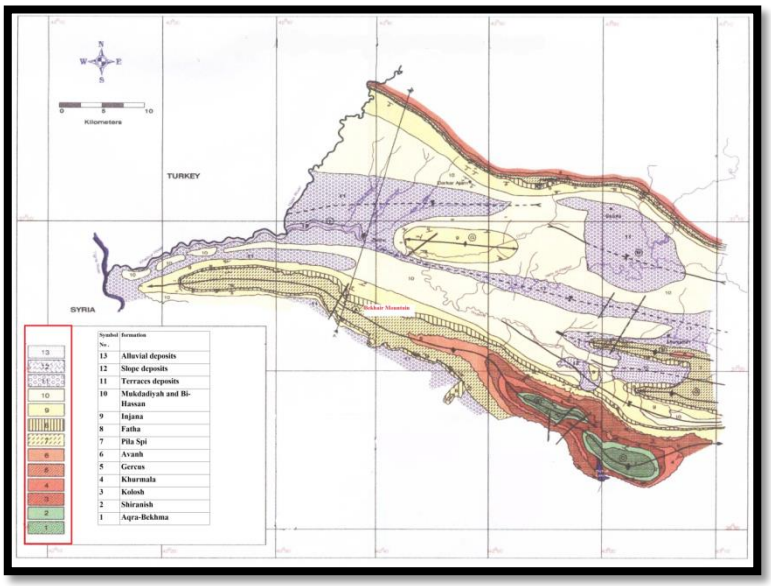

Fig.(2) Geological map of study area [2].

Table (1)
The name, age and description of formation of study area
[by the researcher according to [3]].

Symbol No.	*Formation*	*Age*	*Description*
13	Alluvial deposits	Holocene	Gravel, sand, fine sand, silt, silty clay and clayey silt
12	Slope deposits	Pleistocene	Non cemented gravel, sand and soil
11	Terraces deposits	Pleistocene	Sand and silt with varying amount of gravel and clayey silt
10	Mukdadiyah and Bi-Hassan	Pliocene	-Gravely sandstone, sandstone and red mudstone. -Conglomeratic Facies
9	Injana	Late-Miocene	Thin bedded calcareous sandstone and red and green mudstones with one thin gypsum bed
8	Fatha	Middle - Miocene	Anhydrite, gypsum and salt, interbedded with limestone and marl
7	Pila Spi	Middle - Eocene	Bituminous, chalky, and crystalline limestone, with bands of white, chalky marl
6	Avanh	Middle - Eocene	Limestone, generally dolomitised and recrystallised
5	Gercus	Middle - Eocene	Red and purple shales, mudstone, sandy and gritty marls, pebbly sandstone and conglomerate
4	Khurmala	Paleocene-Early Eocene	Dolomite and finely recrystallised limestone
3	Kolosh	Paleocene	Limestone and marl, limestone and shale, blue shale
2	Shiranish	Late Campanian-Maastrichtian	Thin bedded argillaceous limestone overlain by blue pelagic marls
1	Aqra-Bekhma	Late Campanian-Maastrichtian	Reef limestone, forereef and shoal limestone

The structure of the study area

To the north of Duhok syncline occurs the gigantic and peculiar Bekhair anticlinal structure. The road from Gully Duhok to Gully Zawita crosses this structure. Bekhair anticline has an axis which is about 80 km. long, the anticline is situated in the Taurus range (generally east-westerly trend). Nevertheless a substational length of the axis (about 45 km.) shows a swing in sympathy with the Zagros trend which is N.W.–S.E. thus the western eastern parts of this structure have Taurus trend (E-W) whereas the middle part displays a Zagros trend (N.W.–S.E.). Both plunge areas

in the anticlinal structure have some strange features. The western plunge near the Iraqi – Syrian –Turkish triple point is Vertical and in places overturned. The eastern plunge to the east of Zawita is very broad and in plan- shape forms the base of a triangle; the other two sides of the triangle being the two limbs of Bekhair anticline [4].

Climate

The climate of the study area is semi arid in general, which is affected mainly by Mediterranean climate, it can be described as savanna climate. The climate in the area is characterized by cold Winter with moderate rainfall and snow fall especially at high mountains, and hot and dry Summer. Table (2) shows the climate factors which taken from the records of Zakho Metrological station covering the period of 1970 – 2007 [5].

Table (2)

Summery of climatic factor (1970-2007) [5].

Climatic factor	Maximum value	Minimum value	Average value
Temperature(C°)	24.33	11.44	18.30
Wind(Km/hr)	10.85	3.93	7.39
Evapotranspiration (mm/month)	141.23	98.55	119.89
Precipitation (mm/month)	106.80	26.46	66.63

Rock slope analysis:

Analysis of rock slop extracted from DEM, the DEM used to derive topographic features such as slope and curvatures. DEM (digital Elevation Model) from SRTM (Shuttle Radar Topography Mission), which is a joint project of the (NGA) National Geospatial Intelligence Agency and the National Aeronautics and Space Administration (NASA). It was launched on 11 February 2000 with the aim of producing digital geographic data for over of 80% of Earth's land surface [6]. The DEM of study area is illustrated in Fig.(3).

Slope is defined as the rate of elevation change in a cell's 3 by 3 neighborhoods. The degree angle of the slope defined as the angle defined by rise (vertical distance change) and run (horizontal distance change), Fig.(4), it is obtained by computing the partial derivative components in x, y direction for each point. In practice, because DEM image is the discrete grid data, the derivative is computed using finite difference method in each cell's neighborhood [7].

Slope is always determined in relative to the elevation of the surrounding pixels. As a result, lowland pixels get separated from upland pixels [8].

From GIS program Spatial analyst offers many analysis function which are accesses through the menus of spatial analyst or from the Arc Toolbox > spatial Analyst Tool > surface analysis > slope [9]. Surface analysis include a set of function for calculating properties of a surface, such as slop. Although most commonly applied to elevation data, these function can be used on any type of continuous grid, a slop map showing the steepness of the Terrain, could help identify sites flat enough to build on [10].

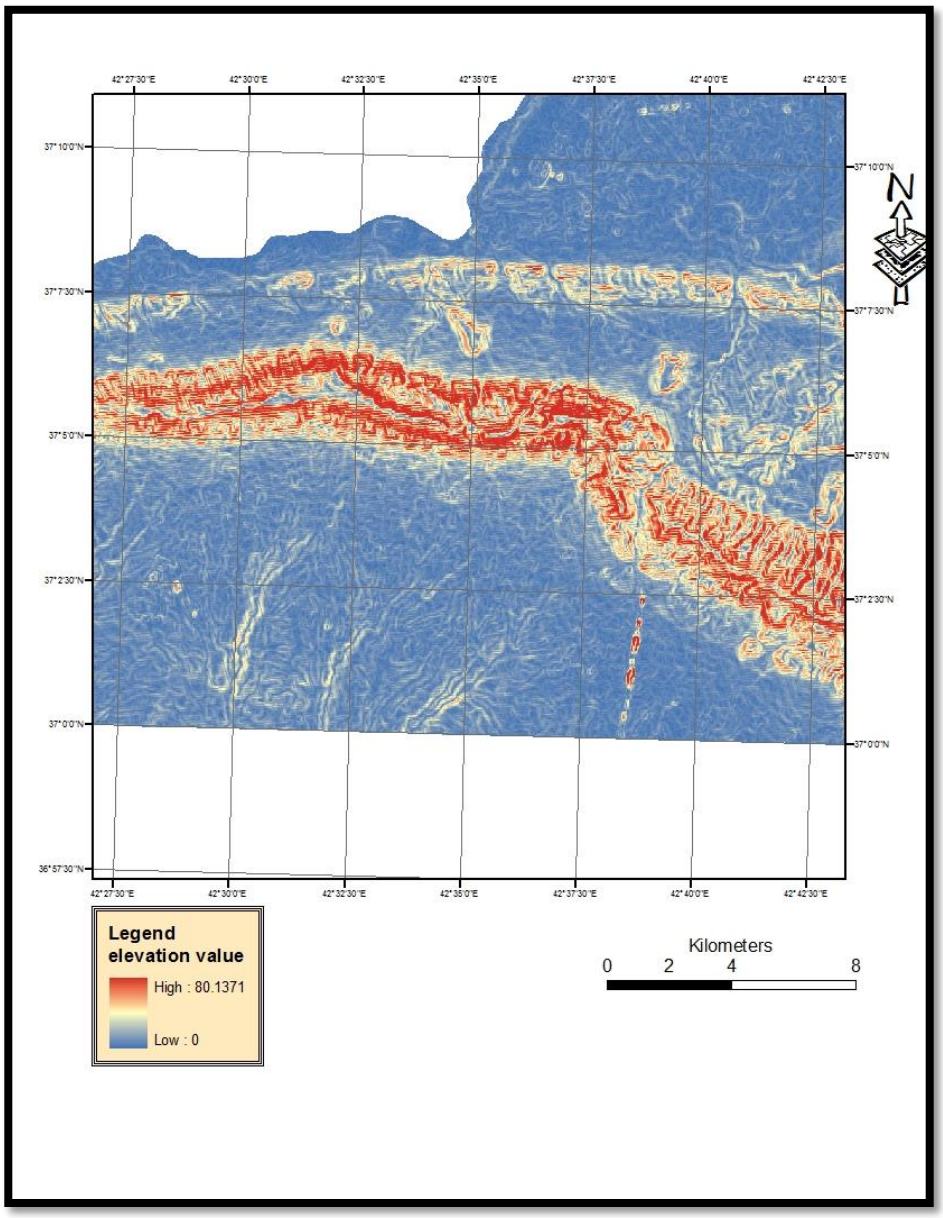

Fig.(3) Illustrate the DEM of study area.

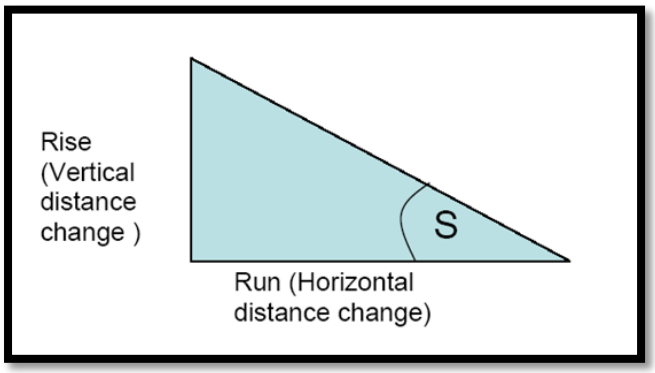

Fig.(4) Triangle slope measurement [7].

The Slope tool calculates the maximum rate of change between each cell and its neighbors, for example, the steepest downhill descent for the cell (the maximum change in elevation over the distance between the cell and its eight neighbors). Every cell in the output raster has a slope value. The lower the slope value, the flatter the terrain; the higher the slope value, the steeper the terrain. The output slope raster can be calculated as percent

of slope or degree of slope (can vary from 0 to 90) [9]. Fig.(5) showing the slope image of study area which illustrate the slopes which have 0 to 81.7 degree, and just the angle from 35.1 to 81.7 degree given a color to avoid the confuse may be occur in the image when all angle given a color, also this figure shows that the angles from 45.1 to 81.7 concentrate in the middle part of the study area. In the case of the relationship between landslide occurrence and slope, landslide probability increases according to the slope angle [11]. Steep slopes are less stable than shallow slopes [12]. This reflects unstable slope concentrate in the middle part of the study area.

Curvature:

The term curvature is generally defined as the bend of a line formed by intersection of a random plane with the terrain surface [13]. The primary output is the curvature of the surface on a cell-by-cell basis, as fitted through that cell and its eight surrounding neighbors. Curvature is the second derivative of the surface or the slope of the slope. Two optional output curvature types are possible; the profile curvature is in the direction of the maximum slope, and the plan curvature is perpendicular to the direction of the maximum slope [9]. As shown in Fig.(6).

The curvature values represent the morphology of the topography, a positive curvature indicates the surface is upwardly convex at that cell. A negative curvature indicates the surface is upwardly concave at that cell. A value of zero indicates the surface is flat. [9].

If one considers the lateral restraint provided by the material on either side of a potential failure. It is clear that this restraint will be greater if the slope is concave than it would be if the potential failure is situated in nose which has freedom to expand laterally[14], and after some studies Hoek and Bray suggest that the convex slopes are less stable than concave slopes [14].

Fig.(7) shows curvature image of the study area, and the high value of positive curvature (convex value) from 15.1 to 38.7 concentrate in the middle part of area, as the high value of slop, referring to probable landslide.

Thus the view be more clear when the slop and curvature image merge. Fig.(8) illustrates this merge, and the middle part of the study area shows high value of slop and positive curvature, consequently it appears more probable landslide.

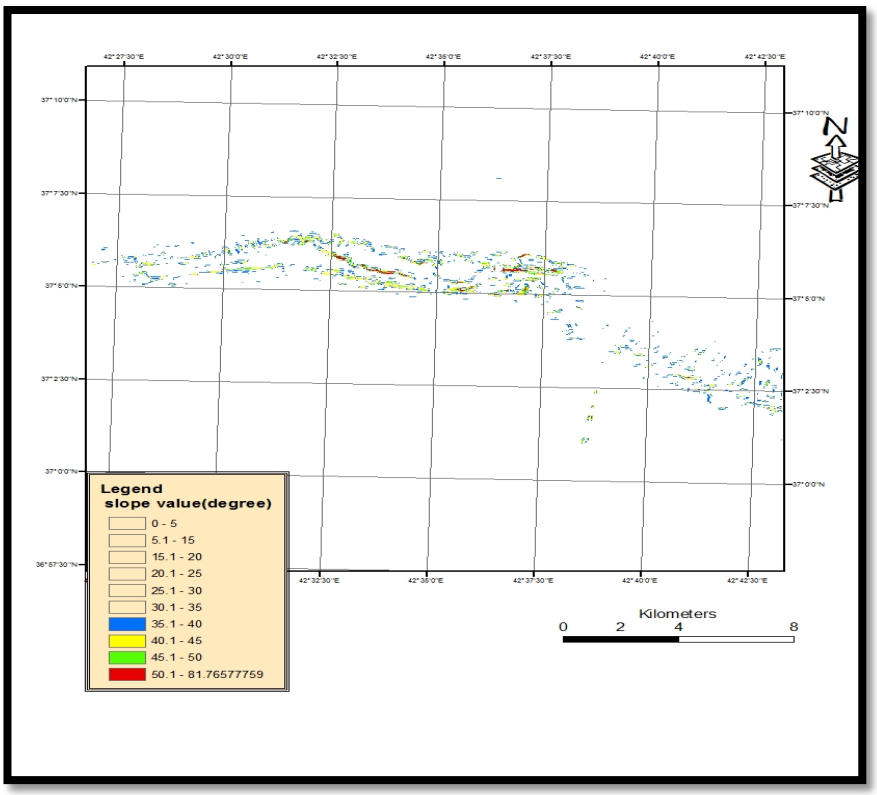

Fig.(5) Slope image of the study area.

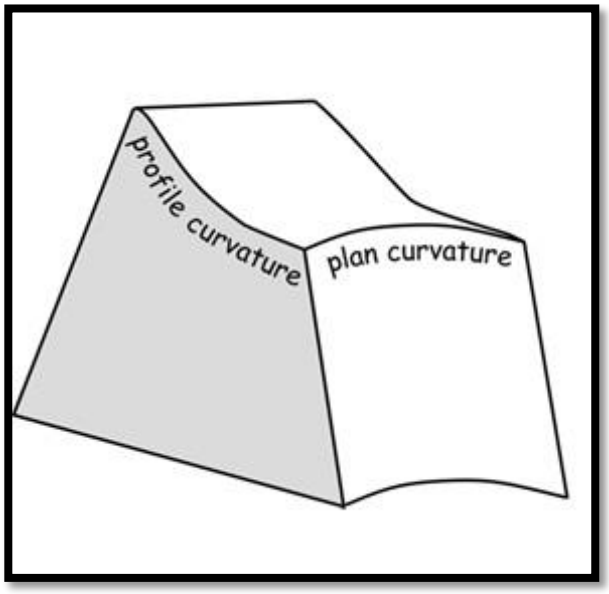

Fig.(6) The profile &plan curvature.

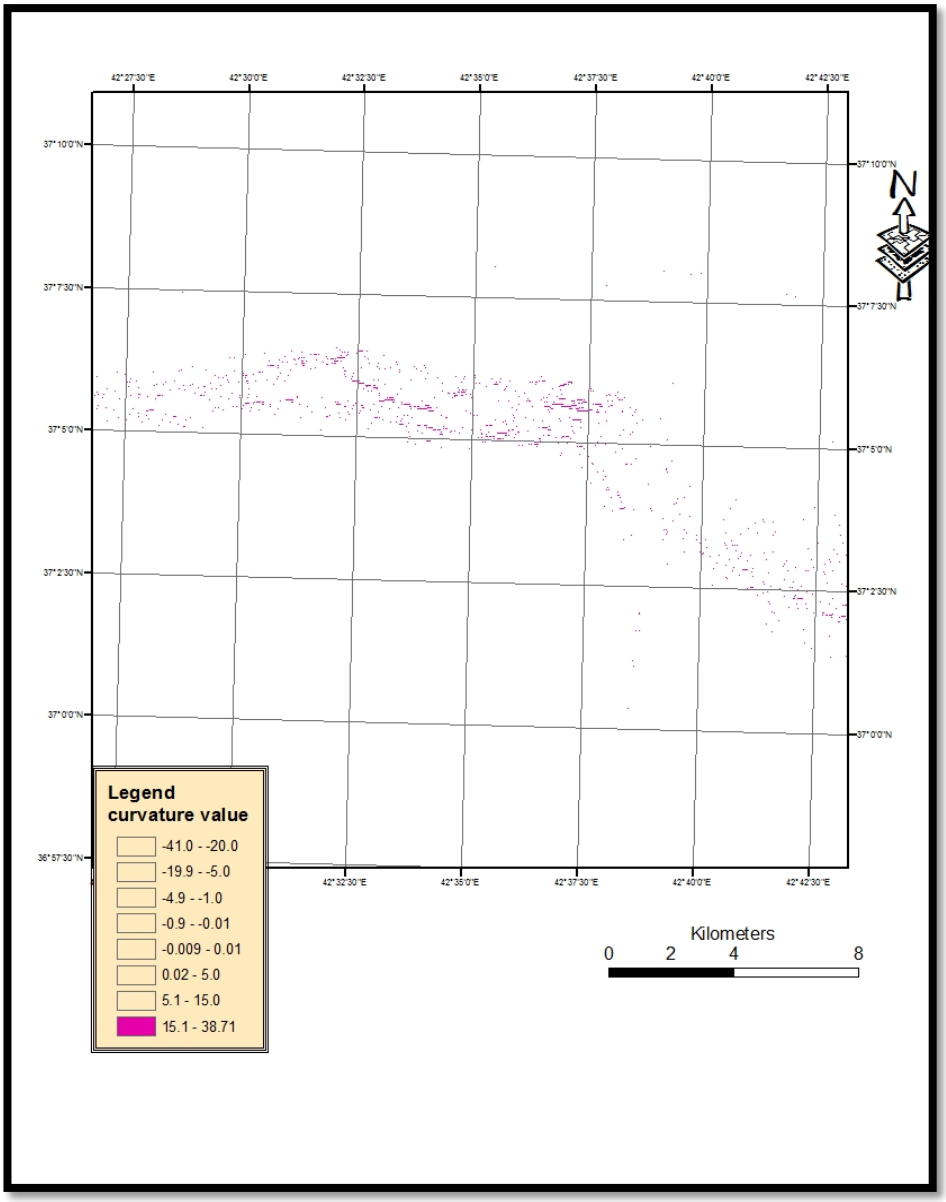

Fig.(7) Curvature image of the study area.

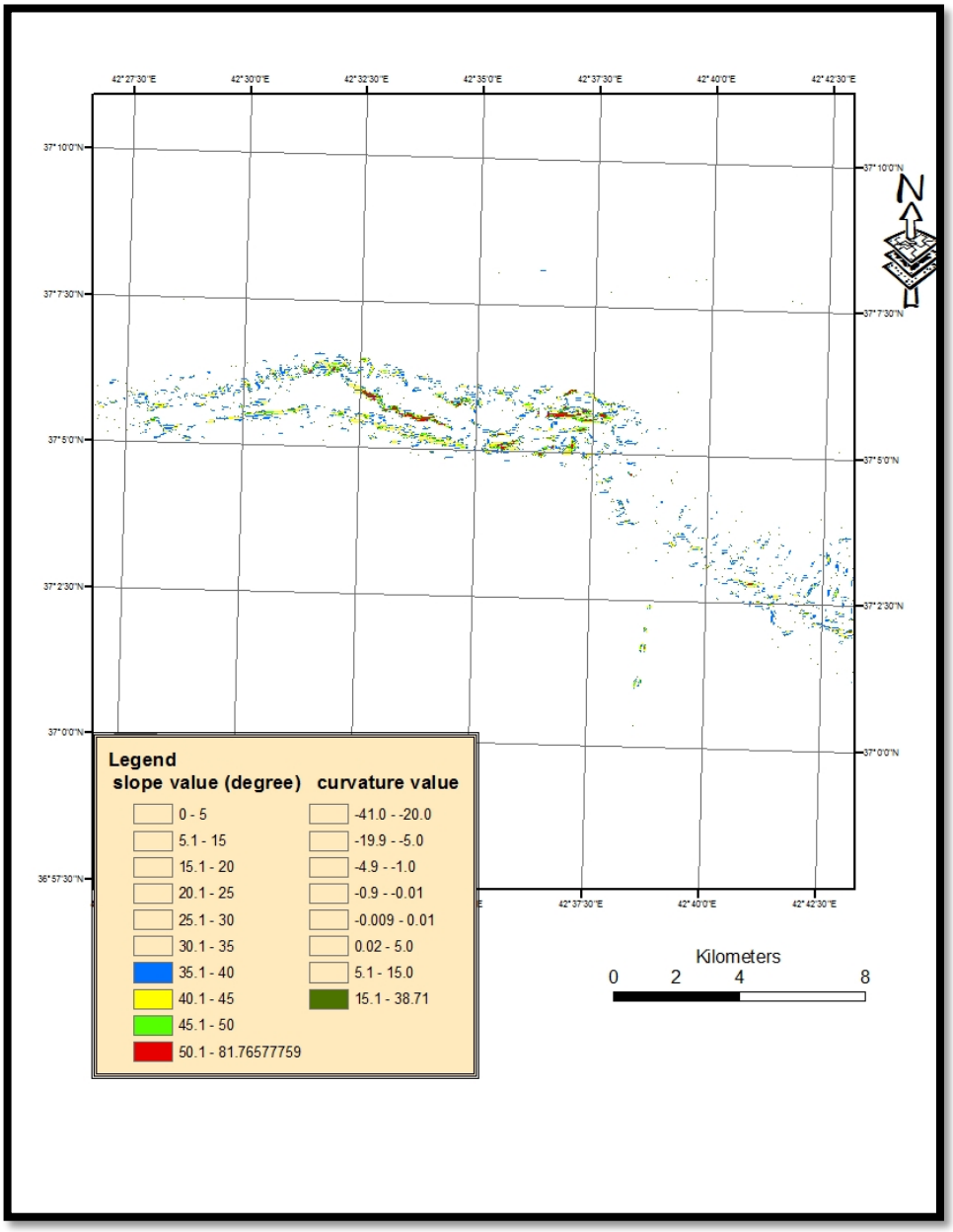

Fig.(8) Slop - curvature image of study area.

Conclusions

Landslide hazard is one of the important tasks in disaster/hazard mitigation project. The analyses from GIS result give the planner a better understanding and visualization of the problem. Thus, its help them for selecting suitable location to implement development schemes in hilly terrain, as well as for adopting appropriate mitigation measures in unstable hazard prone areas. GIS program offers many analysis function very helpful in landslide study like slop and curvature, in this search this function gives image for study area which shows high probable landslide in middle part of Bekhair anticline according to the high value of slop and positive curvature.

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الخلاصة

تهدف هذه الدراسة إلى عمل تحليل للمنحدرات الصخرية لطية بيخير المحدبة والتي تقع في الجزء الشمالي من العراق ضمن محافظة دهوك باستخدام نموذج الارتفاعات الرقمية (DEM) المستحصلة من بعثة المكوك المداري الطوبغرافي (SRTM) مع تقنيات برامج جي أي أس، تم عمل مرئية الانحدار باستخدام مرئية نموذج الارتفاع الرقمي (DEM) و تم إعطاء زوايا الميل المحددة بين (35.1-81.7) درجة، لون معين لتجنب حالة الإرباك التي قد تحدث في المرئية عند إعطاء اللون إلى كل زوايا الميل في المرئية. الزوايا بين (81.7 – 45.1) درجة تركزت في الجزء الوسطي من منطقة الدراسة. أيضا تم عمل مرئية انحناءات لمنطقة الدراسة (curvature image) وتمثل قيم الانحناء شكل الطوبغرافي (شكل المنحدر)، ومن قيم مرئية الانحناء، فان القيم الموجبة العالية هي الأكثر احتمالية للانهيار، وقد تركزت القيم الموجبة العالية الجزء الوسطي من منطقة الدراسة، لذلك فان الجزء الوسطي أكثر انحداراً وذو قيم انحناء عالية وهو بالتالي أكثر احتمالية للانهيار.