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Slopes Dip Changes and Their Effects on Detecting the Faults Located in Salavat Abad Mountain, Sanandaj

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ABSTRACT

Today, the accurate determination of faults locations are done in different ways, such as using geological maps, physiographic evidences, aerial photographs, computer models, etc. In the present study it has been tried to detect the exact location of faults using Digital Elevation Model (DEM) and slopes dip changes in homogenous geologies. To reach this purpose, surveys and field works, DEM of the case study area, various cross and longitudinal profiles, as well tools such as GPS, topographic and geological maps, aerial photographs, and Arc Gis, Arc Map and Arc view soft wares have been used. The results indicate that in 15 cases, i.e. 25 percent of total cases from 60 surveyed cross sections, the exact location of faults correspond to the slopes dip change points; in 25 cases, i.e. 42 percent of total cases, the location of faults were 1 to 20 meters away from dip failure points on the slopes, in other words, the faults locations almost correspond to the slopes dip change points.

KEYWORDS: Digital Elevation Model (DEM), Faults locations, slopes dip changes, Cross profile, Salavat Abad.

1. INTRODUCTION

The slopes do not only form the major part of landscapes but also provide a large part of water and sediment drainage system to rivers. Therefore, recognizing the causes of the formation of slopes dips and their changes are such an important part of this complex forms which research and study on their evolution and formation seems essential.

Today, there are several various ways to detect the exact location of faults and thrusts such as using geological maps, aerial photographs, satellite imagery, and computer models. The earth's surface is three dimensional which must be considered during study the surface and its features. Thus it is possible to obtain three-dimensional image of the surface and its features by collecting elevation data and processing them using computers. Topographic data is given to computers as digital data in a digital format. This digital format of data is known as digital elevation model (DEM). So, it can be said that this model is a computer display of topographic data.

Vassilopoulou and Hurni [1] in a study have indicated the role of digital elevation models in regional planning and its related risks, they have also used other factors such as dip, dip direction, three-dimensional models etc.

Sarapirome et al., [2] have used DEM data for geological interpretations and argued that to achieve the objectives, DEM data should be merged with data obtained from aerial photographs, topographic maps etc.

Hooper et al., [3] have used interferometry (InSAR)-DEM model for geomorphic studies of fault scarps in an area of Nevada. They concluded that digital elevation models can be used to recognize faults movements, seismic patterns and risks associated with faults.

Dalati [4] has studied the role of remote sensing data to detect new fault zones, and in this study which has been conducted in northwest of Syria, he has shown that most subsidence occur in enclosed faults and the displacement took place in the northern area of case study has been caused by young faults activities.

The case study area is a tectonically active area which is located in Sanandaj-Sirjan geological zone. Due to the importance of faults and thrusts in geomorphic studies and their role in forming topographies in terms of degradation, erosion, and facilitate morphogenesis in addition to its influence incorrect positioning structures, residential areas and roads, detecting and determining the exact location of faults and their effects on creating or lack of failures and slopes dip changes on the earth seems necessary. Therefore, in the present study it has been tried to investigate the relations between slopes dip changes and failure and fault lines using digital elevation model.

2. Case study

Salavat Abad Mountain is located almost in center and southern half of Kurdistan at 35° to 35°30' N and 47° to 47°15' E (Fig. 1). In most classifications of Iran morpho-tectonic units by geologists, the study area is located in Snandaj-Sirjan zone and in another classification by Alaei [5] with a spatial view of Iran topography, is located in central Iran zone under Sanandaj-Sirjan zone.

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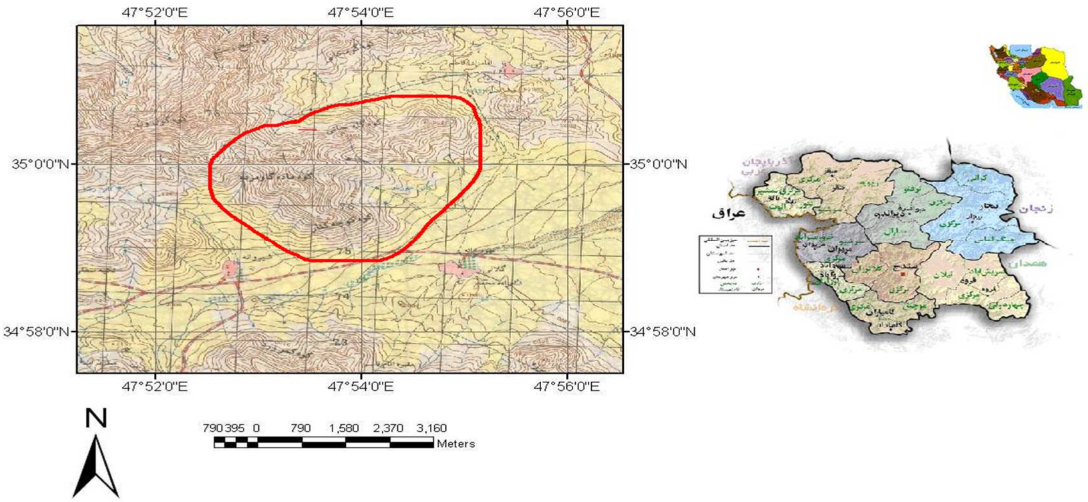

Figure 1. The location of case study area

3. METHODOLOGY

A combination of field works and surveys, as well cross and longitudinal profiles of slopes dips have been used to detect and locate faults on mountains slopes using slopes dip changes observed from DEM data. To this purpose, topographic maps, geological maps, aerial photographs, DEM of the region, GPS and Arc view, Arc GIS and CAD map soft wares have been used and following steps were performed respectively.

At first, the fault map of the study area was extracted from geological map using CAD map and Arc GIS. Then, it overlapped with geological layers and DEM of the area in Arc view, and 15 faults were randomly selected from all over the region on the slopes. Given the importance of the work and the high accuracy required for exact locating fault sand probable errors in the geological map, after determining their locations on geological maps and digital elevation models, in a field work selective faults identified and the exact location and some other characteristics of them have been recorded using GPS and minor errors, if anything found, were corrected. In the next step, longitudinal profiles of slopes which faults have crossed them were plotted. Four profiles for each slope especially with homogenous geologies, and totally 60 cross profiles were plotted in Arc view.

After plotting longitudinal and cross profiles, dip change points on the slopes were determined, in the next step using PE tool in Arc view environment, the distance between dip change points in a homogenous geology from selective faults (15 cases) were measured in the metric scale and then were classified into three groups.

4. RESULTS

4.1. Cross profiles: The distance between the location of selective faults and dip change points on the slopes have been calculated in meters and the results have been presented in table 1.

Table1. The distances between faults and dip change points on the slopes in meters.

Strike slip fault of north of the area	Western thrust of Seraj-Al-Din mountain	Northern thrust of Veys mountain	Strike slip fault of northeastern Sanandaj	Middle part of Chenaran fault	Western fault of Chenaran village	Northwestern fault of Moeineh village	Eastern fault of Ghoojheh mountain	Northern fault of Soltan mountain	Southern fault of Khiareh village	Northern fault of Boneh Abad mountain	Northern fault of Boneh Abad mountain	Hanis faults	Western fault of Soltan mountain	Eastern fault of Taze Abad village	Fault name
17	13	50	15	10	21	-	151	11	11	-	2	-	35	64	Distances between faults and dip change points
6	22	-	7	10	85	17	227	-	25	24	11	-	-	11	
-	21	-	6	10	10	-	101	42	13	12	4	5	35	-	
50	-	14	-	10	6	65	122	50	-	20	32	5	-	21	

Due to the differences in the distances between faults locations and dip change points, data obtained has been classified into three groups and according to probable errors, the location of faults with a difference of up to 1 m, 1-20 m and more than 20 m have been considered as full compliance, with an approximate compliance and non-compliance respectively (table 2).

Table2. The range of numbers and data related to fault zone and dip change points.

The fault is exactly located on the dip change point	X<1
The fault is almost located on the dip change point	1<X<20
The fault is not located on the dip change point	20 <X

4.1.1. Full compliance

Here, full compliance refers to some parts of slopes where the distance between dip change points and faults was less than 1m (X<1). Figure 2 is shown two examples of full compliance where dip change points on the slopes are specified by un1 to un4. The number of full compliance points in the study area is equal to 15 cases, i.e. 25% of total selective faults. So it can be said that dip changes on this part of slopes are mainly the result of crossing fault.

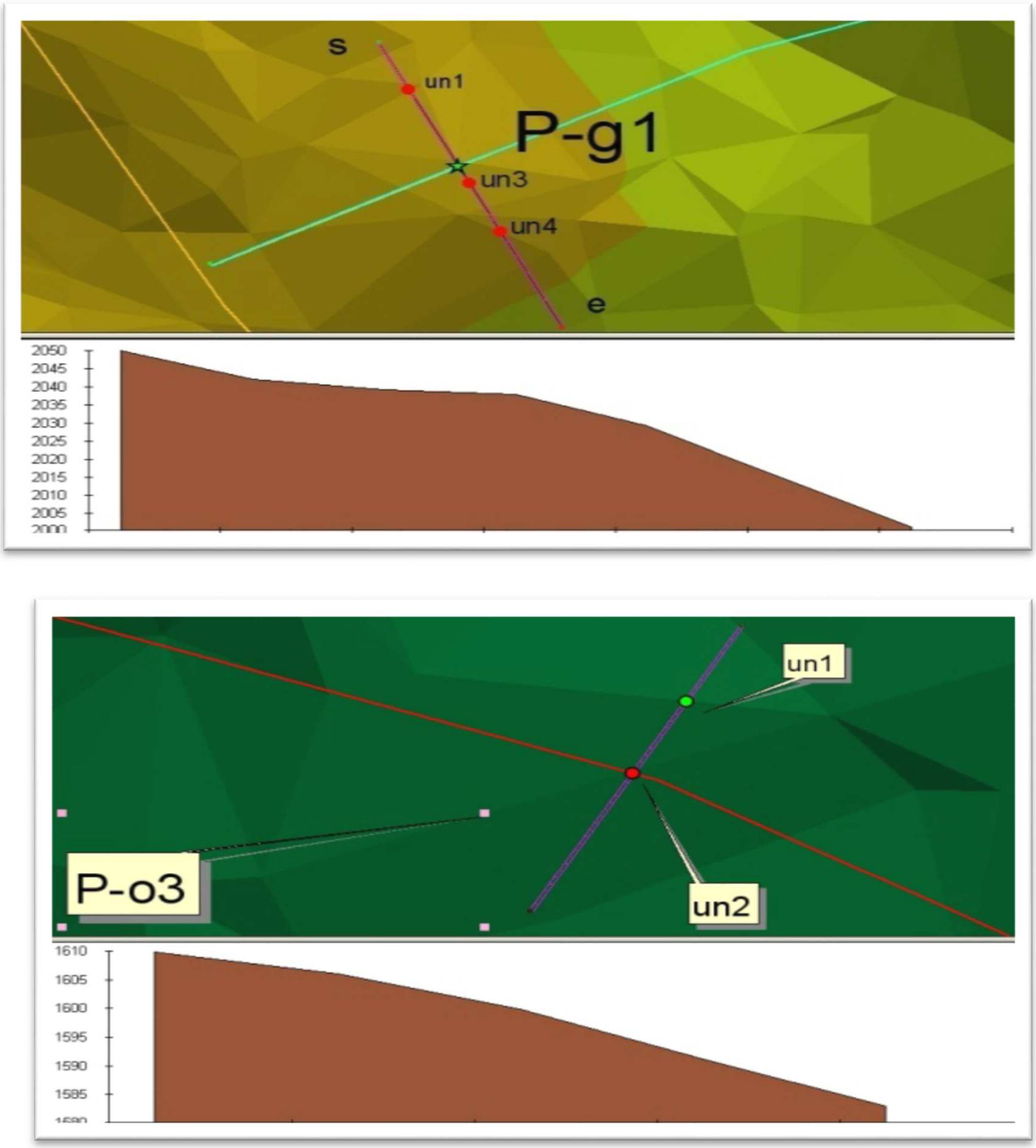

Figure 2. Two profiles of slopes where fault lines comply with failure points.

4.1.2. Approximate compliance

Approximate compliance refers to lack of full compliance between the location of crossing faults and slopes dip change points. In other words, as it is shown in figure 3, in some parts of slopes the distance between faults and dip changes is equal to 1 to 20 m. These slopes are about 25 investigated cases in the study area, i.e. 42% of them. So we cannot certainly comment about interference or noninterference of faults in the creation of these dip changes on the slopes.

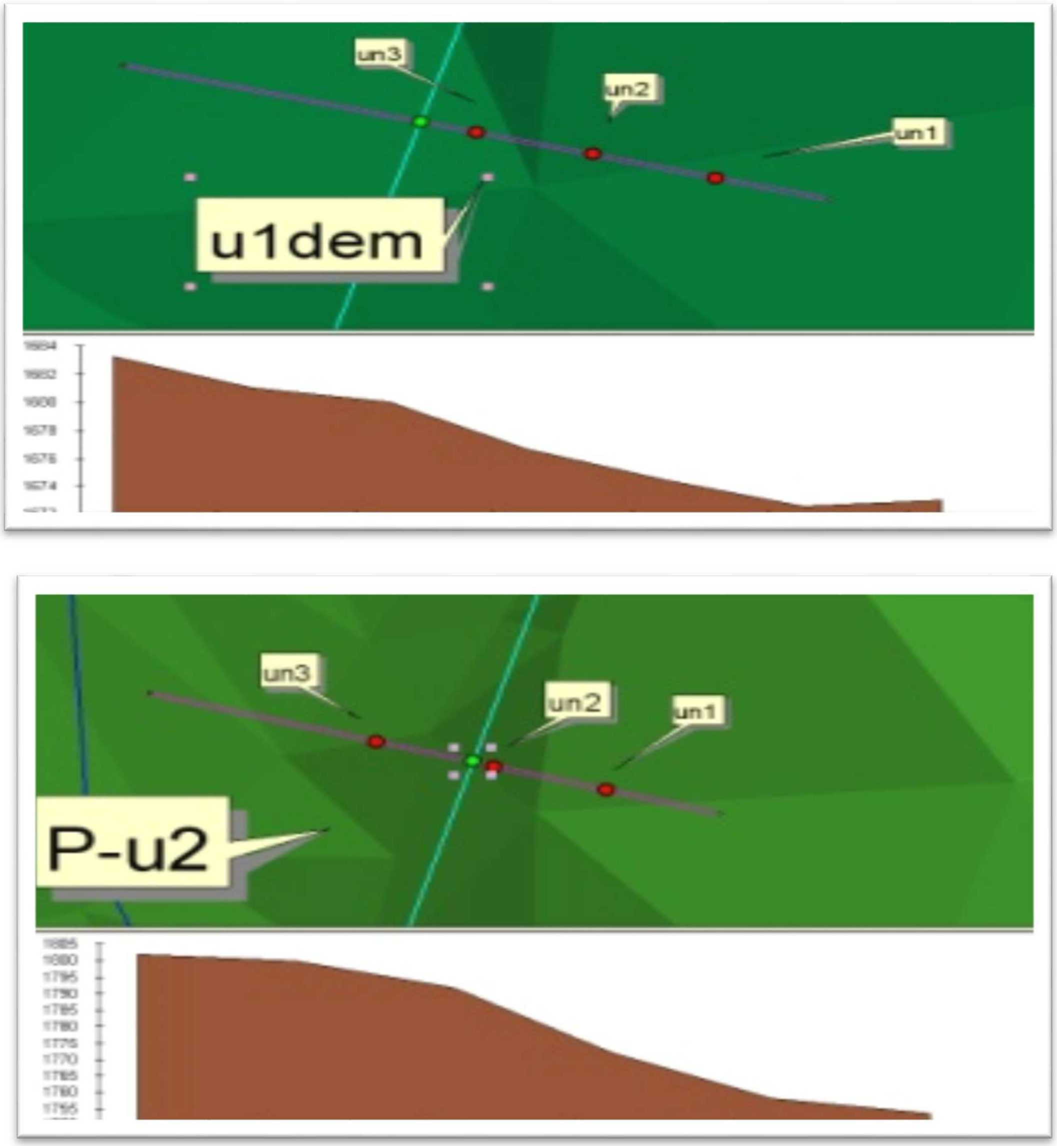

Figure3. Two profiles of slopes where fault lines approximately comply with failure points.

4.1.3. Non-compliance

In some profiles plotted on slopes sections, the distance between dip change points and fault lines was great. In other words, the distance between faults and failure lines and dip changes on these slopes was more than 20 m and in some cases such as the profile of eastern fault of Goozheh village even reached to 227 m. In these cases which include 20 cases of data, i.e. 33% of samples, the location of faults was not only in non-compliance with but also far from anomaly points, i.e. dip change points. Two examples of profiles of these samples have been shown in figure 4.

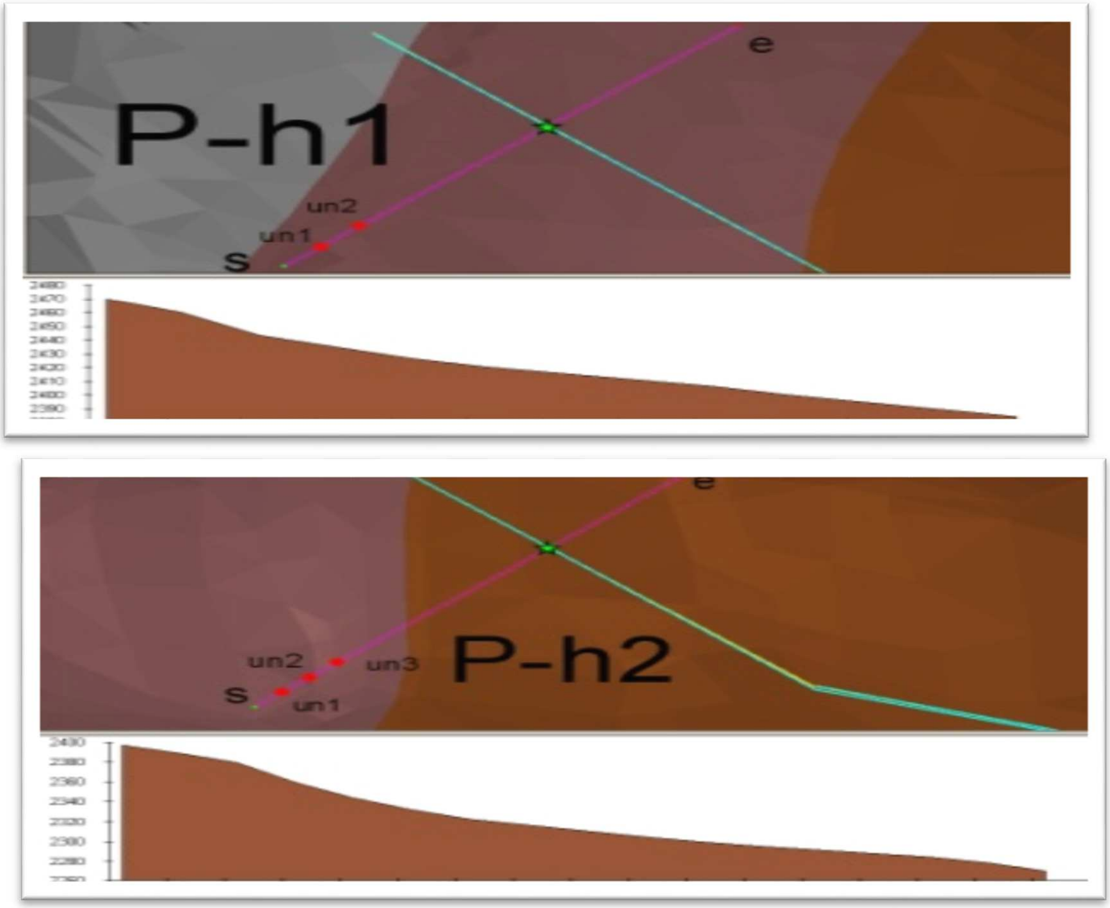

Figure 4. Two profiles of slopes where fault lines do not comply with failure points.

5. DISCUSSION AND CONCLUSION

Basically, geological data are basic information in geomorphic studies of every regions and any analysis on geomorphology matters especially structural geomorphology are done with regard to geological changes. Faults and thrusts are two basic data in geological maps which are also the main subject of geomorphology maps. Since in geomorphology maps, the geomorphic location of features, and their dimensions are exactly specified, so detecting and determining the location of these features seems essential to study tectonic processes and their role in creating or lack of geomorphic forms on slopes.

Often the study on the role of faults and thrusts in making slopes dip changes and failures carry out using geological maps and field works, but in the present study it has been tried to evaluate the efficiency of digital elevation model (DEM) in detecting the exact location of faults using slopes dip failures. Close to 67 percent of surveys and profiles plotted on sections of slopes took place in the range between the first and the third quarter, in other words in these profiles the positions of fault lines are entirely compliant with the locations of the dip changes or have almost very little distance. Therefore it can be said that in the study area most slopes dip failures are caused by fault lines, in other words, fault lines were mostly compliant with slope failures and also it can be argued that using digital elevation model of an area we can determine tectonic forms and their role in creating geomorphic phenomena.

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