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Comparison Between Topographic Expression of RADARSAT and DEM in Simpang Pulai to Pos Selim, Malaysia

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Abstract

Radar and digital elevation model had been utilised in many structural studies. The main objective of this study is to compare the RADARSAT and digital elevation model for lineament interpretation which probably represent the main joints or faults along the Simpang Pulai to Pos Selim highway, Malaysia. These joints and faults may influence the instability along the highway. Manual comparison in terms of topographical aspect was undertaken between RADARSAT with 25 m spatial resolution and digital elevation model derived from 20 m contour interval of the topographical map. The previously interpreted lineaments of more than 2 km in the study area was draped over the RADARSAT and digital elevation model to compared whether the lineament concurred with the topographical representation. The interpreted lineaments were derived from Landsat TM of 1990 and 2002, where the DEM had been utilised in the negative lineament determination. It is concluded that the application RADARSAT is not very useful in terms of topographical expression in the structural geological interpretation for the study area compared to DEM derived from contour data. Further work is suggested before any conclusion can be confidently derived.

Keywords: RADARSAT; DEM; Remote sensing; lineament.

1. Introduction

The capability of Radar in structural geology is well known. Many researchers had utilised Radar for structural geological studies in many areas. One way of interpreting the structural information such as fault or structural orientation is by lineament mapping. Lineament mapping had been undertaken in Malaysia by Juhari and Ibrahim (1997) in northwest Malaysia. Nawawi *et al*. (2004) utilised radar (AIRSAR) in Kedah, Malaysia with a success (Parnadi *et al.* 2005) also utilised radar (RADARSAT) for structural geological interpretation. Napiah *et al.* (2004) utilised RADARSAT to map the circular feature in Malaysia. However none of them utilised RADARSAT to detect lineament that may be related to fault. Although Juhari and Ibrahim (1997) also did the study on lineament detection, however, Landsat TM was used and not the Radar.

The main advantage of RADARSAT is that the image capture is not hindered by the presence of cloud cover. The authors experience in ordering the high resolution optical remote sensing data took two years without much success showed the problem in the data acquisition in hilly terrain under tropical conditions.

Apart from the capability of Radar to penetrate the cloud, radar are also sensitive to topographic variations and surface roughness (Napiah *et al*., 2004). The capability to choose different incidence angle that will enhance the shadow also redeemed it to be suitable to be used for structural mapping.

Integrated of remote sensing data including multi-spectral optical (Landsat Enhanced Thematic Mapper (ETM+) and the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)), radar (RADARSAT), and Digital Elevation Models (DEMs) extracted from the Shuttle Radar Topography Mission (SRTM) data are used to trace along strike continuity of different lithological units as well as mapping morphologically defined structures in southern Tunisia (Pena and Abdulsalam, 2006). RADARSAT images had been used to specifically for tracing geological formations and geological structures that are buried under thin sand.

The DEM from USGS Shuttle Radar Topography Mission (SRTM) had been successfully utilised to delineate the geomorphological lineaments on a regional scale in Mexico where shaded reliefs with different sunlight inclinations were utilized (Concha-Dimas *et al*., 2005)

The main objective of this paper is to compare the topographical expression in DEM and RADARSAT which is useful in lineament interpretation. The interpreted lineaments from Landsat imageries will also be draped over the DEM and Radarsat for comparison purposes.

2. The study area

The study area is located along the Simpang Pulai to Pos Selim highway (Fig. 1). Geologically the area consists of metasedimentary and granitic rocks. The highway had been build across the terrain where landslide is a common occurrence. The occurrences of landslides had delayed the highway for more than four years. Field inspections showed that more landslides occurred in metasedimentary rocks and it is expected that apart from type of rocks that influence the landslides, structural geology is also one of the major influence of landslides occurrence in the study. Generally the elevation of the study area range from 420 m to 2100 m.

3. Methodology

For this study, two sets of data had been utilised. The RADARSAT, dated 13 October 2003, with beam S7 and spatial resolution of 25 m was utilised. Beam S7 of 45^{o} to 49^{o} where chosen because it is considered the best for structural interpretation (Singhroy, 1997). The Radarsat was georeferenced to Malaysia RSO. The radar was then orthorectified using the DEM to correct the terrain distortions. The DEM is the subseted to fit the study area. The DEM of the study area were derived from Department of Survey and Mapping Malaysia with contour interval of 20 m.

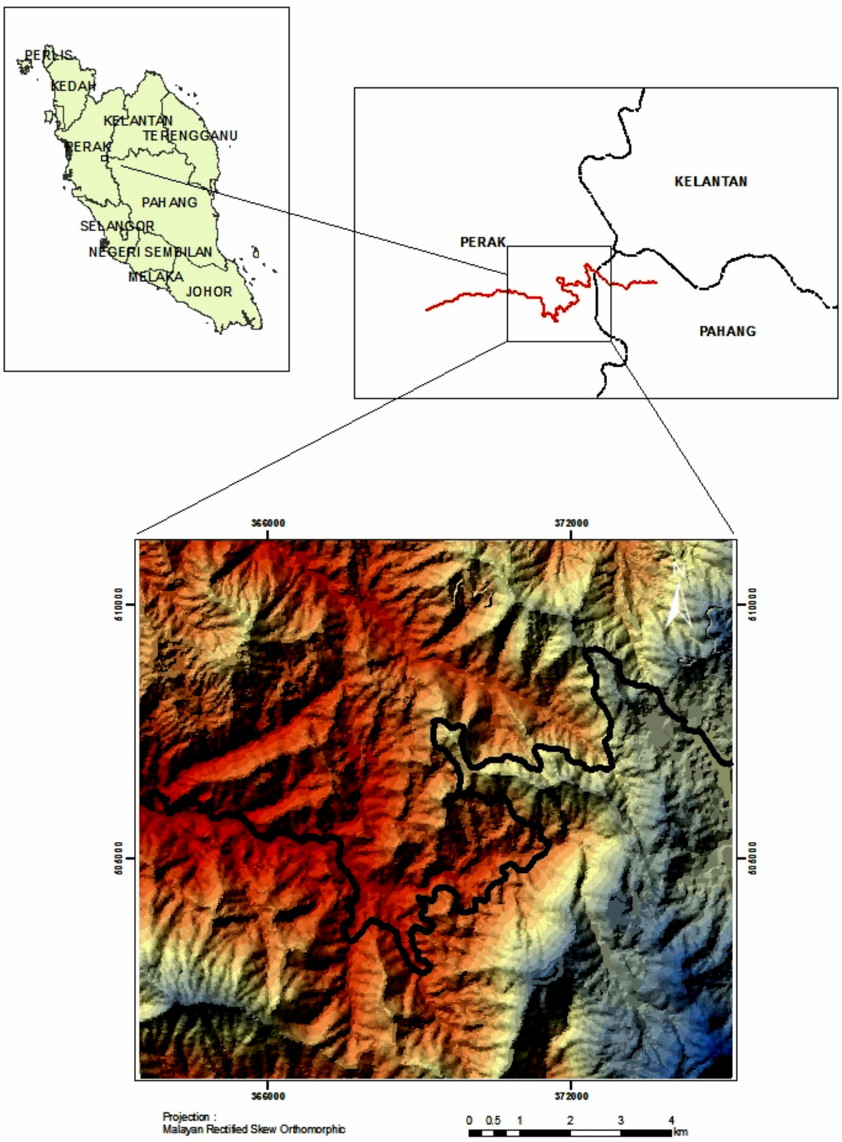

Figure 1. The location of the study area

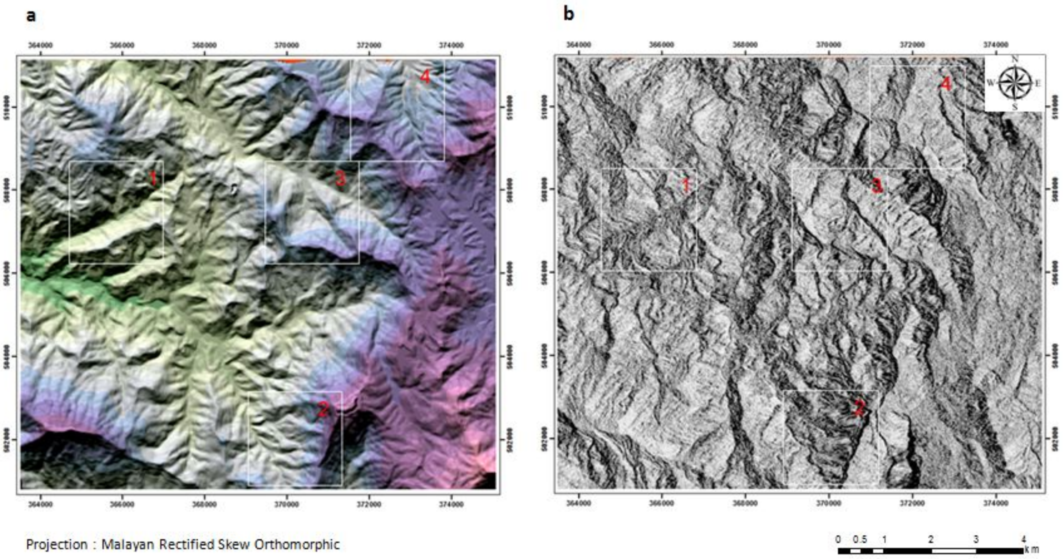

Figure 2. The comparison between a) DEM and b) Radarsat of the study area. The topographical features can be straight away

Lineament interpretation of the study area was undertaken utilising two Landsat TM of 1990 and 2002. Only lineaments of more than 2 km were taken for ease of explanation. Only lineaments that matched between 1990 and 2002 interpretations were taken in order to reduce subjectivity. The lineaments were then double checks with the DEM to ensure that only negative lineaments were taken. Negative lineament normally resemble negative topographical which may related to fault and joint in the study area. The interpreted lineaments were then overlaid onto the DEM and RADARSAT for comparison purpose.

4. Results and Discussion

In lineament interpretation, topographical representation is crucial, especially in the negative lineament determination. It is expected that major topographical features may be easily be determined between the DEM and RADARSAT imagery (Fig. 2). However, for the DEM, general topographical is much easily to understand compared to the Radarsat imagery. The topographical change is very easy to recognise where valley and hill crest may be determined by just observing the topography. However, in RADARSAT,

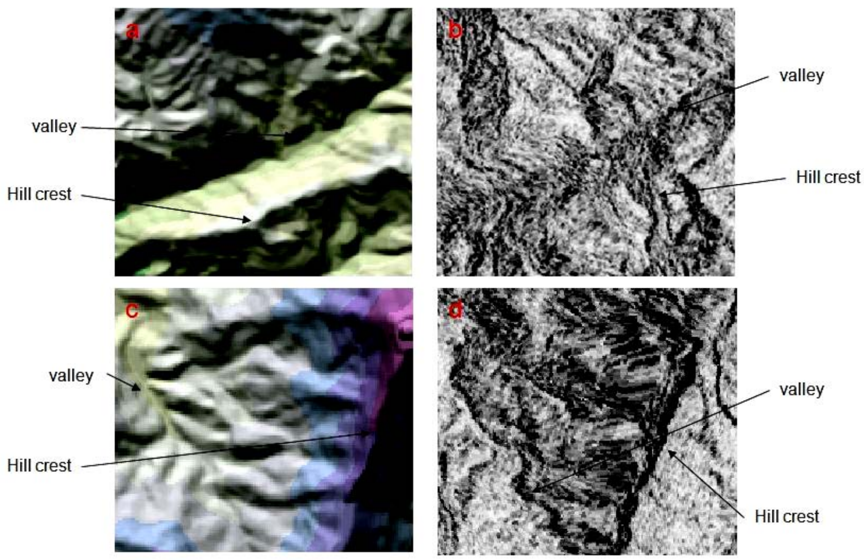

Figure 3. The location of a and b is in box 1, c and d in box 2 in figure 2 . Figures a and b showed that valley can be easily delineated in a and b, but hill crest is quite difficult to distinguish in Radar imagery compared to DEM, where the hill crest is very clear. However in figures c and d, both valley and hill crest are easily distinguished. Similarly to figure in box 3 and 4 where both features may be easily distinguished.

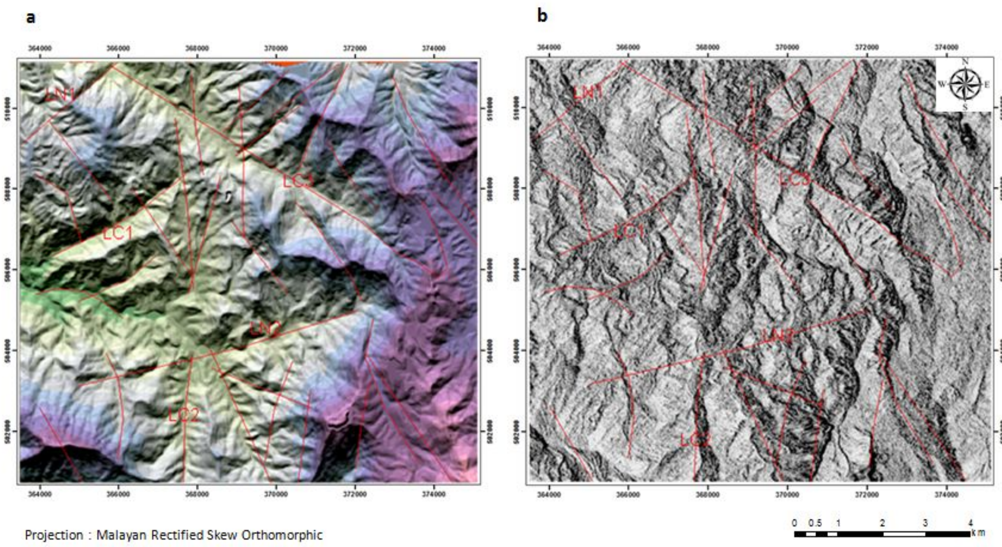

Figure 4. Lineaments interpreted from Landsat imagery were draped onto the DEM and Landsat. Some of the lineaments may be discerned easily in DEM and Radarsat (LC) and some are only easier in DEM only (LN)

the topographical features are quite difficult to recognise. After overlaid the RADARSAT above the DEM, and using “swipe” capability of the image processing software, the topographical features in RADARSAT can then be understood.

Observation on the RADARSAT (Figs. 2-3) showed that although most of the hill crest and valley can be discerned, however, some positive topography features such as hill crest (Fig. 3a and b) is not clear. Without the DEM, it is not possible to confidently identify the area as a hill crest. However, most of the topographical features of hill crest and valley may be identified (Fig. 2-box 2 to 4), provided, the ancillary data such as DEM or Landsat imagery is utilised.

The interpreted lineaments may also be easily identified in DEM where it forms a negative topography (Fig. 4a). In RADARSAT, sometimes the negative topography is quite difficult to observe. Although some of line such as LC1, LC2 and LC3 may be easily delineated in RADARSAT, however there are also lineaments such as LN1 and LN2 that are not shown quite clear in terms of topographically negative representations.

From both observations, in terms of topographical expression and lineament draping over the DEM and RADARSAT, it showed that if RADARSAT, needs to be utilised, ancillary data are compulsory. If not, it is quite difficult to understand the RADARSAT. Any how, DEM is also needed in the distortion correction of the RADARSAT. This is probably the main reason that RADARSAT is always be utilised with other type of remote sensing imagery (Concha-Dimas *et al* (2005); Pena and Abdulsalam (2006)). It is also probably that the RADARSAT is useful in detecting major and obvious lineament for regional studies, whereas the DEM is more suitable for local studies.

5. Conclusions

It may be concluded that from this study, the RADARSAT is not that useful in terms of topographical expression for lineament interpretation compared to DEM. However, further study is needed, where the RADARSAT is subjected to filtering and also sun-shade. It is also possible that because of the more or less similar resolution between RADARSAT and DEM, the usefulness of the RADARSAT is reduced.

Acknowledgments

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