The Effects of Lineaments and Epicentres on Risk Reduction in Arabian Rift Zone

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ABSTRACT

This paper describes the relationship between lineaments, which determined on space images, and the epicenters and their effects on spatial planning for risk reduction. Several studies have shown that most of the epicenters occur along these lineaments or their zones, or in the block regions which are bordered by these lineaments, or where these lineaments and different tectonic deformation are intersected. This paper presents a case study on the Arabian Rift Zone which is based on the linkages among lineaments, faults, and earthquakes that occurred in the region during 1910-93. Also, this study will show that most of these earthquakes were occurred along the main and secondary rift faults or in their zone, including the faults found in sea that helped in determining the courses of these earthquakes in the sea bottom. This confirms the importance of remote sensing techniques for providing space images of different scales in seismic studies.

Keywords

Lineaments, Arabian rift zone, space images, epicenters.

INTRODUCTION

With the rapid development of economic construction and urbanization, the number of cities and population of the cities are increasing rapidly in Syria. Highly dense population, infrastructure and traffic in cities, as well as rapidly developing economy, caused a lot of troubles to these cities. Great change becomes to integrated management and more to safety construction, especially to the prevention for sever disasters destroyed structure as earthquake. The principal application of space technology to earthquake prediction has traditionally been measurements of ground motion. While this approach has contributed significantly to geophysical studies, it has not yet yielded an earthquake prediction method. An alternative approach that has recently shown great promise is satellite imaging of earthquakes. The continued research on dangerous seismic regions and active tectonic zones pointed out the large benefits and wide use of space images with multi-scales and bands, the small, medium and large scales images used after their processing with the help of other data in solving many problems related to the studies and predicting of earthquakes. This will help and support the activities of the regional planning for major strategic projects. Spatial planning and land management provide various tools to prevent natural hazards. The objective of this paper is to outline the importance of remote sensing in supporting the spatial planning for risk reduction in the Arabian Rift Zone on short and long terms. This paper is divided in several sections as follows. The first Section presents some examples on the relationship between lineaments, faults and epicentres using space images with regards to the earthquakes. The second Section deal with some practical studies based on the use of space images carried out on the Arabian rift zone, while the third Section outlines the active role of planning and land management in risk reduction. Some conclusions and future works are described in last section.

THE RELATIONSHIP BETWEEN LINEAMENTS, FAULTS AND EPICENTERS

In this study, the focus will be on the relationship between the data collected by remote sensing and epicenters. As it has become evident that most epicenters are found along the lineaments identified on space images, or along their zones or blocks which they boundared, or in the intersection points of different tectonic displacements. Landsat images are excellent for recognizing the continuity and regional relationships of faults; the reviewed stereo scopically is ideal for mapping these features. The relationships between faulting and earthquakes in southern California were noted by Allen (1975). The Landsat imagery of California and the map of Magro geologic faults visible on this image along which movement is known to have occurred. These relationships can be seen in Figures 1 and 2. The well-known sanandreas fault that bisects this image is nearly 1000km long. As shown from Figure 1, the San Francisco earthquake of 1906 and others were occurred due to the movement along this fault, the several solid dots shown in the map are the centers of earthquakes of magnitude.

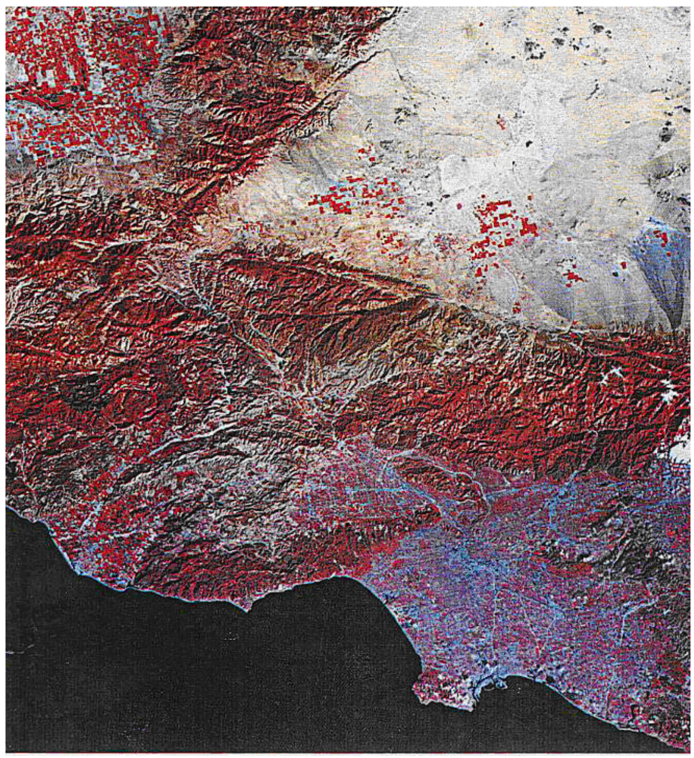

Figure 1. Color-composite Landsat image of southern California, Landsat 1090-18012, acquired October 21, 1972. Digitally processed by Jet Propulsion Laboratory. Courtesy R. J. Blackwell, Jet Propulsion Laboratory, California Institute of Technology

Figure 3 shows the interpretation map of Landsat mosaic of south central Alaska with epicenters of earthquakes. Also, this figure shows that the most of previously unmapped lineaments are the set of one or more epicenters and should be classified as active faults. The interpretation of multi-scales of space images of seismic active Kazli region, pointed out the discovering covering the tectonic zones with different direction branches from the deep center of the earthquakes, which had happened in Kazli in 1976.

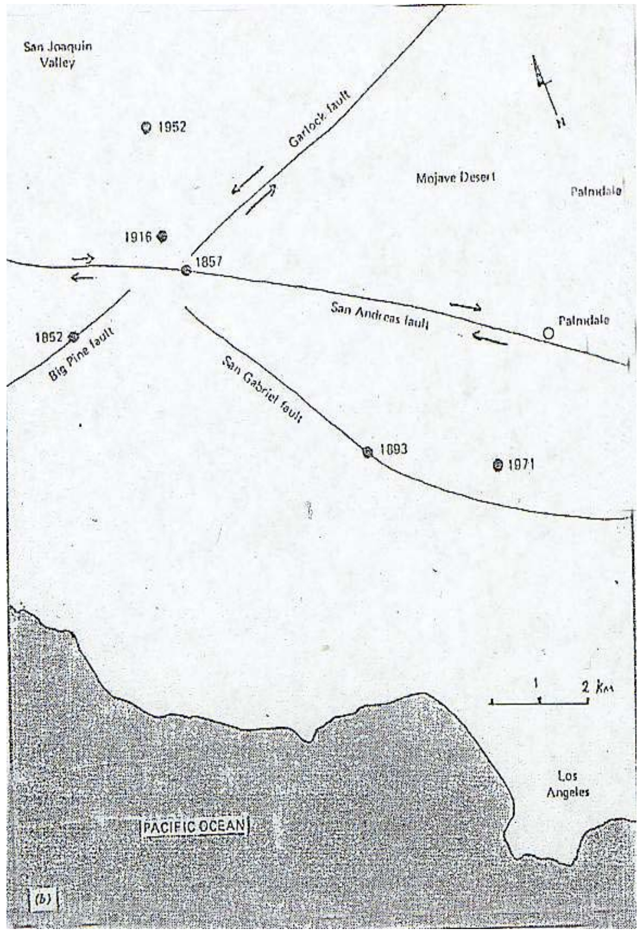

Figure 2. The epicenters, earthquakes and faults determined from spaces images in southern California

The geological and geophysical data enabled for Trifanov and Makarof to the interpretation of these faults as reflectance of deformation in sub and appear earth crust and deformation of crystal basement in central Kyzlikum region. Some practical studies have shown that the meteor images can show active faults, active structural elements, and lateral boundaries of the earth crust at depth 10-60km, while in the lower resolution images the deeper active structures are interrupted (Trifanov, 1985). In arid regions in 0.8-1, 1 m show deep seated structures better than the 0.4-0.7 m ones.

The traditional study for Aghadeer earthquakes, which took place in Algeria 1960, has showed that this earthquake is connected to the movement of one of the transverse fault as shown in Figure 4. Where the analysis of space images shows a development of two separate seismologic zones for the earthquakes not observed previously, and they are connected to a complex of high tectonic activity in which Aghadeer earthquakes took place, and they are occurred on the cross of the transverse fault of south Atlas Ocean and a fault of north direction near Atlas Ocean.

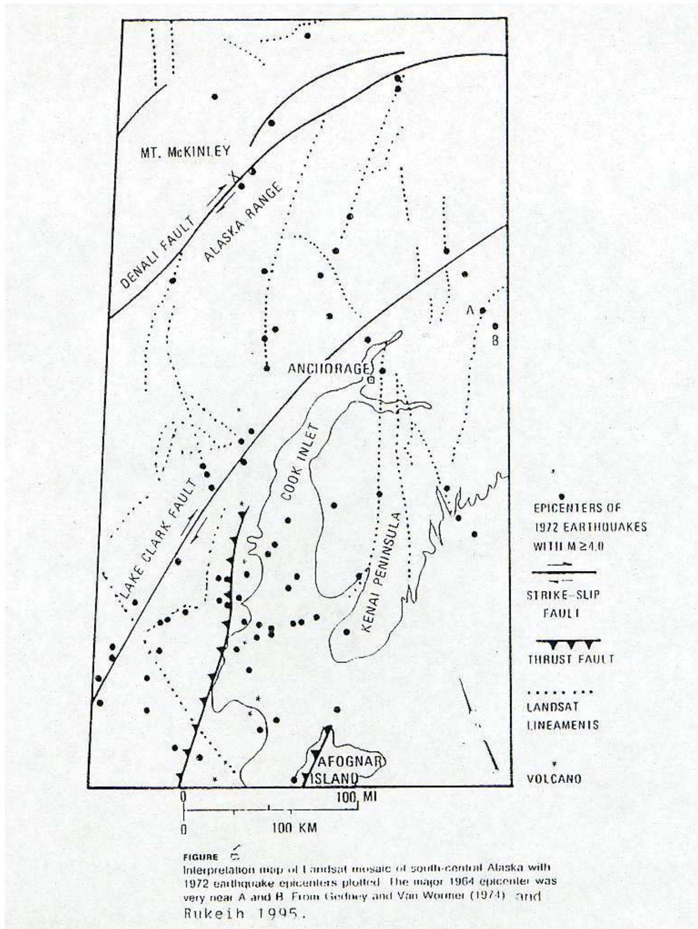

Figure 3. Interpreation map of Landsat mosaic of south-central Alaska with 1972 earthquake epicenters plotted the major epicenter was very near A and B From Gedney and Van Wouner (1974) and Rukieh (1995)

THE ARABIAN RIFT ZONE

Several tectonic studies for the Arabian Rift Zone have been carried out and some schemes of different scales by interpretation of space images have been prepared. The Arabian Rift Zone starts from Red Sea rift, then it moves to the north through the Gulf of Agaba, the Dead Sea, Tabaraya Lake and Lebanese Bokaa, consequently through the rift of Alghab in Syria as far as Turkish borders and Eskandaron regions along about 1000km with branch of the Palmeride foldbelt in Syria. These rift faults are considered left lateral displacement with vertical movement in different sites. The interpretation of space images and the field check gave more information about these faults and their stretch, which are unknown before, and not cleared on the surface with identifying of more motions. These studies show that the value of left lateral movement in region of Dead Sea was 105km, 40km of it in Peleocene and Quaternary (Kenel 1959, Nur 1978), while this displacement in northwest Syria was (20-25km) (Trifanov et al, 1983), or (10-12km) by (Rukieh and Habib, 1993) and the displacement in one year is about 5mm.

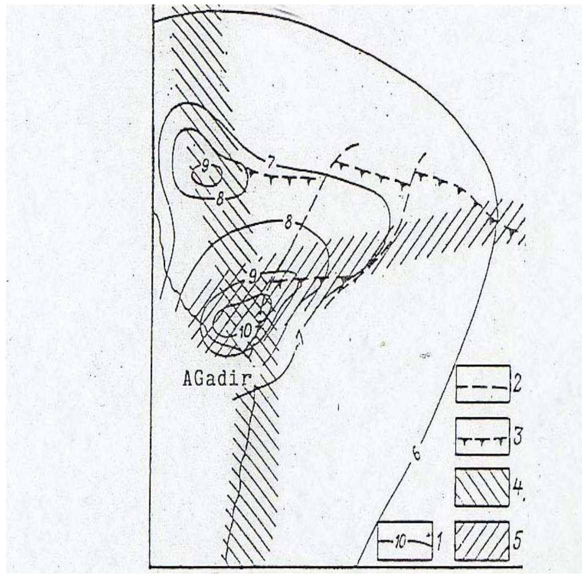

Figure 4. Tectonic scheme shows the existence of two seismic zones, not observed previously; they are crossed in Aghadeer region, Algeria, 1960. this scheme is identified by space images

This study presented in this paper has clarified that the rift is bended inside the Lebanese lands to the northeast. A group of faults are branched of it from the north of Tabaraya lake and took the direction of north east. It is distinguished by the forming of plunges along its course as the Dead Sea, Tabaraya lake, Alboukeaa, Alghab, Alomek and others which is resulted of the joint of several faults. As well as it is characterized by basaltic volcanic activity, which accompanied to its development, especially during the Miocene and Peleocene and Quaternary in Jordan, south or north of Syria. They are connected by different faults and most of them are spread on the eastern side of the rift.

The interpretation of space images shows that there are several annular shapes (small and medium) on the rift course; some of them are interrupted by the rift faults. A connection between the tectonic scheme of the rift region by interpretation of space images of 1/4000000 (Rukieh, 1994) scale and the epicenters (strong, medium and weak) which took place between 1910-1993 has been done (Rukieh, 1996). This led to discover relationship between faults and lineaments identified on space images and epicenters as shown in Figure 5.

The historical data have three thousand years in BELAD ACHAM (Previously called Great Syria and consisted of Syria, Lebanon, Jordan, and Palestine) give 287 med, and strong earthquakes, which had happened on many secondary faults rift zone (Hakim, 1988). Some of the destroyed earthquakes in Damascus in years- 565-1202-1284-1640-1756. In Homs 846, in Aleppo 565, 1139,1344,1822. in Lattakia 53,1273,1408. in Antakia 37,528, 859, 1092, 1139, 1408. Figure 6 shows some historical earthquakes, which happened along this rift faults in previous time (Ambrsays and Barazagi, 1989). By comparing the historical earthquakes with major active tectonic units in Syria which contains the palmerdie fold belt, Syrian Lebanese fault rift zone, the east Anatolian fault system near the northern Syrian border (the Torous, Zagarous belt).

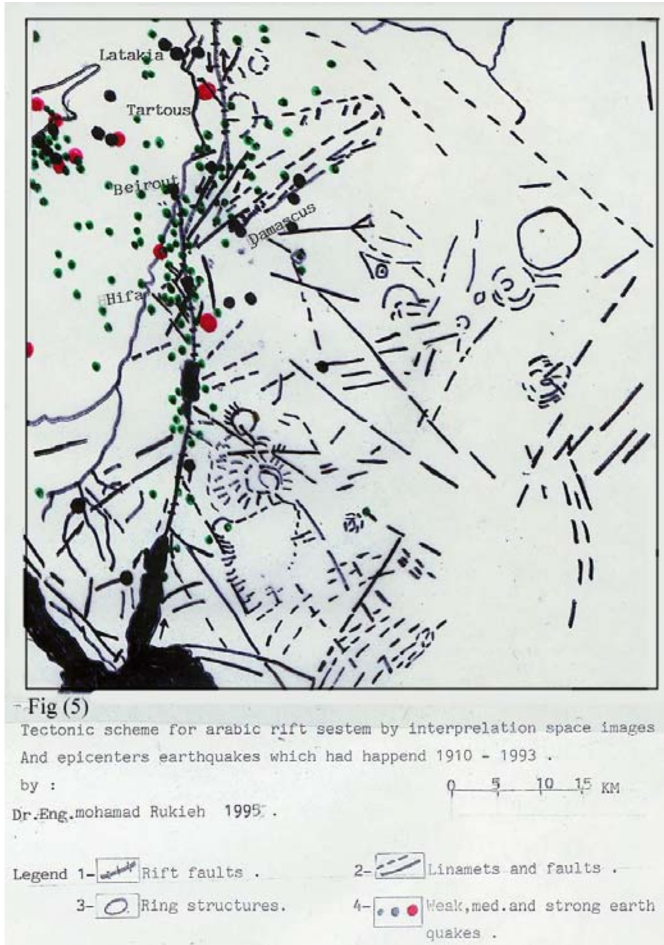

Figure 5. Tectonic scheme for Arabic Rift Zone by interpretation space images and epicenters earthquakes which had happened 1910-1993 (Rukieh, 1995).

Complete correspondence between them were shown in Figure 7. This map provides vital information about this region for strategic planning for major project and constructions. In case of building any big project or settlement, all the seismic information in west Syria must be considered to avoid all the earthquake disasters.

SPATIAL PLANNING

Today's society becomes ever more rapidly vulnerable to natural disasters due to the concentration of populations the cities. Additionally, changes in the global environment threaten the human life with the possibility of severe disaster (e.g., flood and earthquake, etc). Considering these rapid changes of ambient conditions, vulnerability has increased due to growing urban populations and a lack of planning and land management. The prevention of catastrophes in general is a consideration of spatial planning and land management on the regional and local level. Therefore a more active role of planning and land management is necessary. They have to support a sustainable settlement development and a sustainable land use on consideration of the different public and private interests because of there important influences on environmental disasters. The analyse of the interrelation between environmental catastrophes and regional development will enable to point out the strategies and instruments of spatial planning and land management to support the prevention hazards. The guiding principles for future planning activities should focus on preventive measures that include risk awareness (vulnerability), as adverse impacts of hazards can be prevented by appropriate planning, in other words land use, and other timely implemented measures.

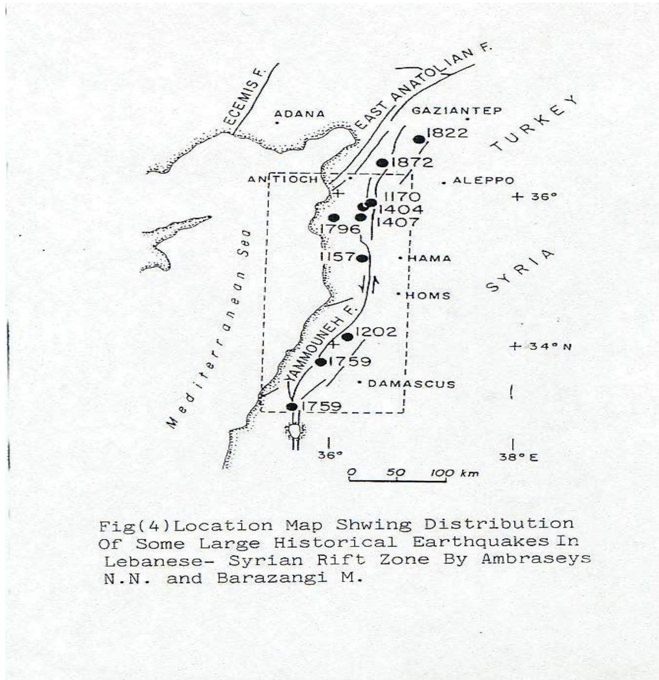

Figure 6. Location map showing the distribution of some large historical earthquakes in Lebanese-Syrian Rift Zone (Ambraseys and Barazangi, 1989)

As can be seen from Figure 7, which represents the historical earthquakes map of Syria and neighbouring countries, that the zones that are subjected to strong earthquakes are the faults zones located along the costal line starting from Hyfia (Palestine) in the south till Tripoli (Lebanon) in the north, and in Syria from Lattaqie zone till Iskenderun in the north and the zones of Damascus and Palmyra and in addition to some areas in Turkey. The southern and northern areas in Syria which are close to boundaries of Turkey are subjected to medium earthquakes. The rest of Syrian areas can be considered as calm or are subjected to weak earthquakes. Therefore, it is highly important to carry out detailed studies when establishing dams or important and large constructions in the southern part of Syria for resisting the earthquakes with 6-7 degrees. Also the Syrian Code for Earthquakes must be considered when constructing houses and other buildings in this part especially in these areas that are close to the Levant zone and strike-slip faults such as Baalbaak, Talkalakh, Misyaf, Gisr Alshogur, Serghaya, Damascus, Bayreuth, Lattaqie Iskenderun.

CONCLUSION

The paper describes the development of a framework with the index of seismic risk, vulnerability and response ability for earthquake effect assessment at urban areas, and then assesses the earthquake effect in urban areas in Syria. All of the material would be useful in understanding the relative earthquake effect of the cities, and the framework offers a way to bring the many components of earthquake effect assessment together. Furthermore, the straightforwardness of the development, evaluation and interpretation of the earthquake effect assessment index makes the information easily explicit and accessible to the government and public. According to assess the earthquake effect at urban areas in Syria, several procedures can be suggested.

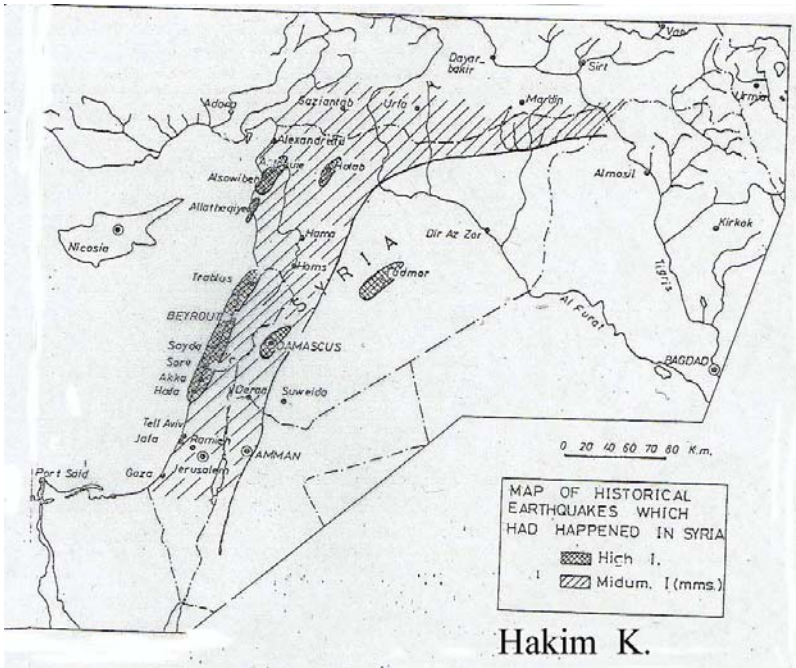

Figure 7. Map of the historical earthquakes in Syria (Hakim, 1988)

Strengthen governmental capability for urban earthquake prevention and reduction, put the emphasis on consummating emergency monitoring, share network system of disaster information, and strengthen civil quake proof emergency education to improve the public earthquake prevention consciousness. As shown from the study presented in this paper, remote sensing data also establish geologic bases: for a long term earthquake prediction by discovering the covered or deep active tectonic zones, and knowing their relation with seismic structures, and for identifying the collision zone among the different plant tectonics, which form important zones of frequent earthquakes. The knowledge of these faults and the epicenters will help in the regional planning for any region in case of disaster prevention. With regards to the spatial planning for risk reduction in Syria, the scheme seismic zoning for the strategic project, construction and settlement building in the western part of Syria must be considered.

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