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Dinsar Analysis of Land Subsidence in Themahyar Plain, Central Iran

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ABSTRACT

Land subsidence and ground fissure activities have been a serious geo-hazard in internal plain of Iran. The D-InSAR technique has been widely applied and deeply researched in the field of the land deformation monitoring. In this study, we use SAR interferometer study to investigate earth subsidence in the northern Mahyar plain, located in the south of Isfahan, Iran. The results of the survey based on SAR interferometry reveals that subsidence occurs with the uplift in the adjacent hills, simultaneously called duality in geomorphology. In Duality, a phenomenon with another one is dual. Although each of these phenomena are independent in nature, but there is a relationship between them. So, we will analyze the behavior of phenomena in relation to other ones.
KEYWORDS: Differential SAR interferometer, duality, Land subsidence, up lift, Mahyar plain.

INTRODUCTION

Land subsidence and ground fissure activities have been a serious geo-hazard in internal plain of Iran.

According to researches that were conducted the cause of subsidence in the plains of Iran is irregular exploitation of water resources. For example, both studies of SHemshaki and Entezamsoltani(2004) and Lashkari pour et al (2008) were conducted about land subsidence in Tehran andKashmar, respectively. But some of researchers aren't sure that cause of subsidence is irregular exploitation of water resource. Fore example, Eslamizadeh and Samanirad(2010: 84) studied Land Subsidence and Fissuring in Yazd- Ardakan basin and reported increasing in exploitation of water resources with water table decline in the study area has decreased the hydraulic pressure and increased the total tension which created land subsidence and fissuring. Land subsidence is greater in central part of the basin where more wells there are. Radial fractures in wells within the area have mostly extension type. These fractures have been formed due over withdrawal and decreasing of water table. Considering that all these fractures have a distinct trend, it is impossible that subsidence created all of them. Generally the fractures have been created by two main factors: subsidence and tectonic agents resulting from active faults.

Generally, the ground fissures associated with the land subsidence have caused damages to alarge number of buildings, bridges and other structures (Zhao et al, 2008:12). Earth subsidence has become one of the most important studies among geomorphologies. There are different theories to explain the reasons behind the earth subsidence such as the shortage of underground water resources, emerge of lava from underground, mining operations, melting the ices, oil refinery operations, etc. The primary outcome of all these operations is to see a number of cracks on the surface of lands. During the past few three decades, there have been tremendous operations for using underground water resources. Many people believe that these operations are important reasons for having so many cracks in the lands in Iran. During the past two decades, the weather condition in Iran has been dry; there were shortage of water resources and there has been an increase on using underground water resources. However, there have been many arguments that there is not a strong scientific proof to blame shortage of water resources as the only reason for such incidents. During the past few years, there have been different attempts to investigate such incidents (Jonathan, 2001, Gutiérrez, 2004).

Keller et al. (2007) investigated the geomorphology of the western sector of the Mid-Channel Anticline (MCA), Santa Barbara, and Southern California and reported that the actively growing fold is laterally propagating to the west. The presence of fold scarps and cross faults that segment the structure recommends that buried faults, which are producing the folding, are present at shallow depths. According to their studies, evidence for presence of the island indicates terrestrial erosion and the assumption of sea level change and

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rates of uplift and subsidence. Guccione et al. (2001) studied stream response to repeated coseismic folding, Tiptonville dome, New Madrid seismic zone. Malik and Mohanty (2002) studied active tectonic influence on the evolution of drainage and landscape geomorphic signatures from frontal and hinter land areas along the North western Himalya, India.

Generally, the land subsidence has been a global disastrous problem, and conventional geodetic technique is highly incompetent for the large-scale and serious land deformation monitoring. However, the new and developing radar interferometrytechnique exactly provides an effective method that can be applied to large coverage areas, high spatial and temporal resolution, for monitoring.Based on SAR (Synthetic Aperture Radar), the developing D-InSAR is the most effective method. Conventional D-InSAR methods, including two-pass method, three-pass method, and four-pass method, have good effect on the land deformation monitoring, especially on deformation caused by the earthquake or large tectonic movement, and the centimeter accuracy in radar line-of-sight direction can be obtained. However, the urban land subsidence is continuing that so the shortcomings are evident when the D-InSAR is applied to it. It is essential to find out the better way to resolve it.

The proposed study of this work use Synthetic aperture radar to measure the land subsidence in Mahyar plain in central Iran.

Study area

Mahyarplain is located 25 kilometers south of city of Esfahan, Iran. The region is cover withcalcareous rocks of cretaceous and there are many Rocky Mountains. Many sediment erosions coverthe areas of desert and there are various faults. It is located in a semiarid region of Iran with an unconfined aquifer with an area of 158km2. Development of surface fissures is one of the critical ground problems in the area. Fissuring has caused considerable damage to buildings and roads and agricultural activities have become redundant.

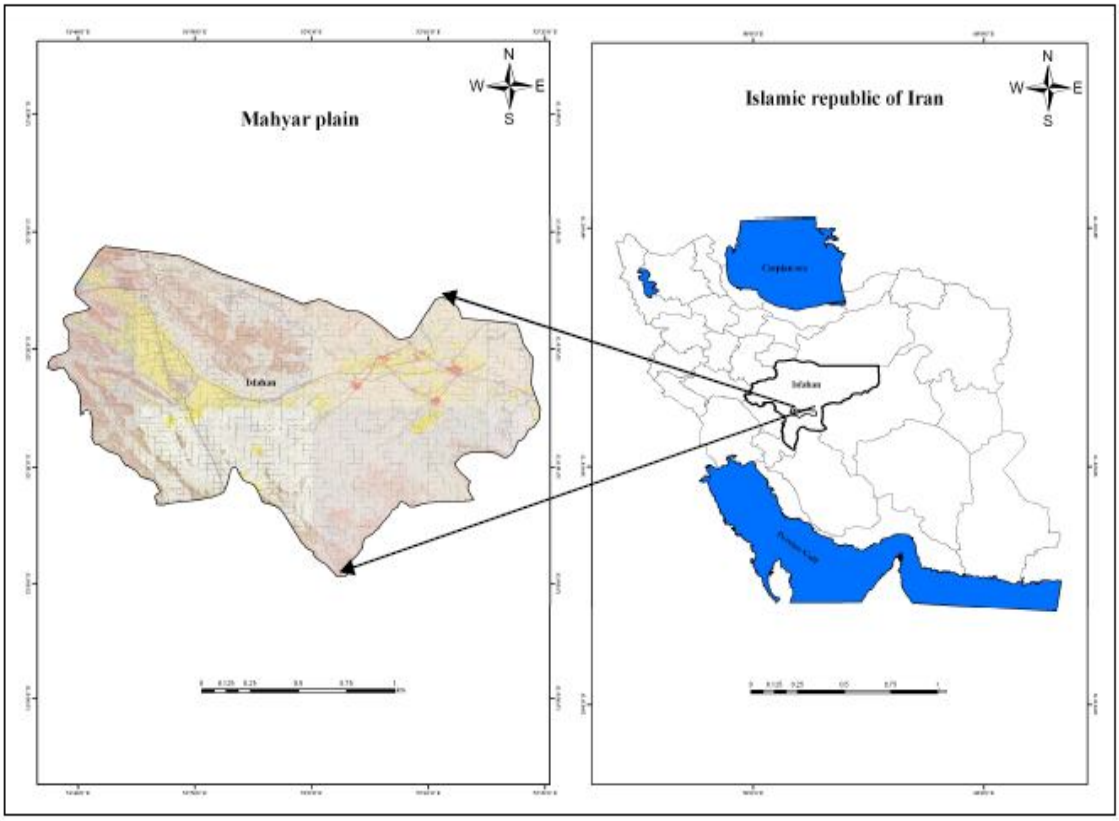

Fig. 1. Geography of the region of Mahyar

THE METHOD

InSAR is a technique for extracting information about changes in the surface of the Earth using the phase contents of the radar signal. The use of the interferometric technique for the retrieval of terrain deformations requires the SAR images to be taken from exactly the same position in space at two different

times. Reliable interference between SAR images in the same area is possible only after meeting all relevant conditions. A major limitation is that image pairs yield interference only when the base length is less than the critical value. The sensitivity of InSAR depends upon the observed geometric relationship, while the base length affects the magnitude of noise. When the baseline is too short, the sensitivity to detect changes in terrain may be lost. Otherwise, the de-correlation of the baseline yields phase errors (Zebker and Villasenor 1992). DInSAR uses two InSAR interference patterns from different times, one named as topographic pair indicating the elevation of the Earth's surface and the other named as deformation pair containing both terrain effects and surface deformation. The two interference patterns are then differentiated to remove the terrain effect, and the ultimate result represents the phase difference caused by deformation of the earth surface. This technology provides relatively good accuracy at the centimeter scale (Gabriel et al. 1989).

The processing of SAR interferometric data is a complex procedure. Based on the quality of the data sets, the performance of each processing step is crucial. To summarise, the interferometric processing consists of the following steps: (1) image registration, (2) calculation of modulate phase difference, (3) phase unwrapping and geocoding (Gens and Genderen 1996; Klees and Massonnet 1998; Rosen et al. 2000).

We have gathered the necessary SAR information from Envisat satellite for the region of Mahyar is gathered from European aerospace organization. The proposed study of this research first examines some important characteristics of the data such as normal baseline and Doppler to make sure that sufficient information are available on the data. Geomorphological analyses help us investigate on the modifications that affect hydrographic basins, more specifically modifications because of active tectonics, and the quantitative descriptions of landforms. The study of geomorphic indices is normally used to appraise the influence of active faults on the hydrographic network. Table 1 shows details of the information.

Table 1: The summary of the necessary information of Baseline and Doppler for years of 2008 and 2009

Parameter	Value
Normal Base line (m)	2074.449
Critical Base line (m)	6529.615
Ambiguity height (m)	30.869
Range shift (pixels)	151.983
Azimuth shift (pixels)	-127.420
Doppler centroid	0.054
Critical Doppler	2159. 827

As we can observe from the results of Table 1, all parameters such as Doppler centroid, Normalbaseline and Critical baseline are statistically meaningful and we can analyze the results.

THE RESULTS

Results of date analysis ofEnvisat Satellite(Alospalsar) in tables 2 and 3 presentthe picture of Mahyar plain in October of 2008 and 2009, also July 2009- 2010 Analysis of maps in Mahyar plain shows the subsidence of plain land has been synchronized withoccurred uplift in the mountains of adjacent plains,. The results show that most uplift is in the Kolah Ghazi Mountain. And the rate of subsidence is increasing towards the center of plain.

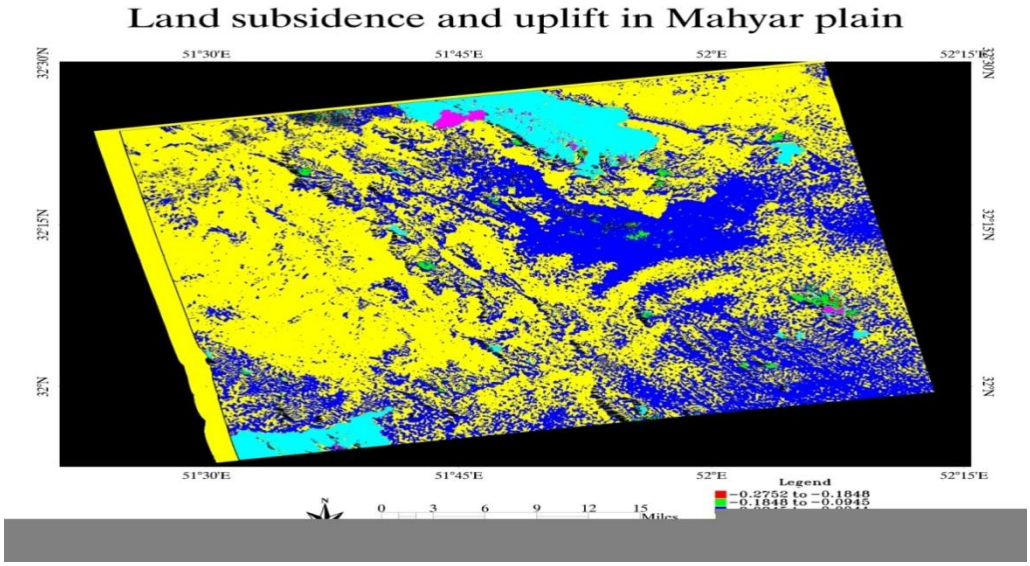

Fig. 2. Displacement map in Mahyarplain (October, 2008-2009

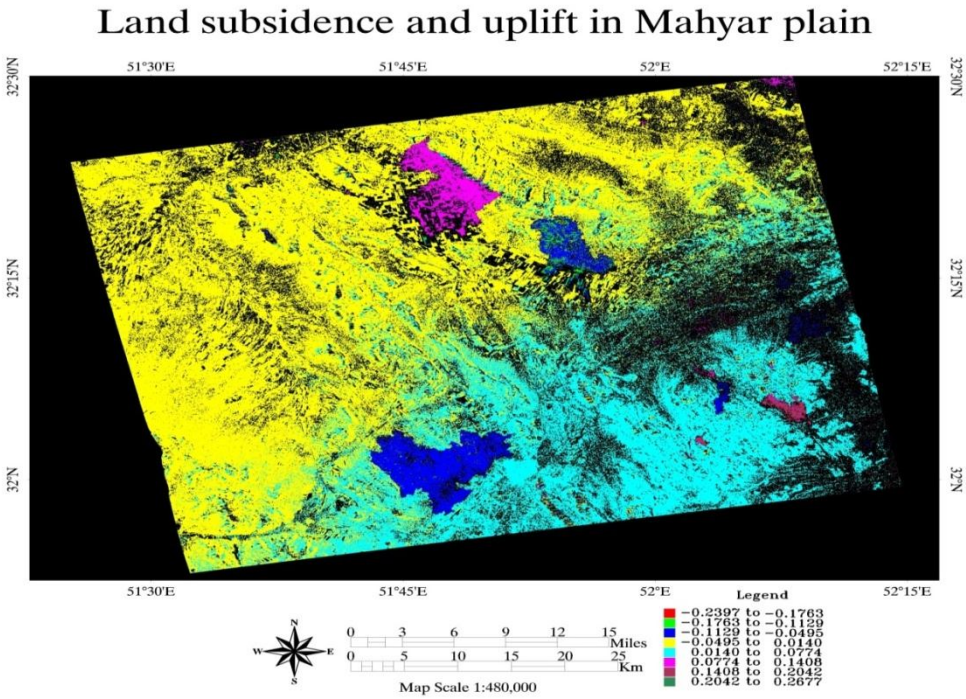

Fig.3. Displacement map in Mahyarplain (July, 2009-2010)

Conclusion

Although the effectof irregular exploitation of water resource can be denied to increase the amount of land subsidence, the main cause of land subsidence in the plains of Iran is the simultaneousnessof raisingthe subsidence in the floor of plains and adjacent mountains. These processes as a series act doubly together and coordinate in reverse order. This is called Duality in geomorphology. In Duality, a phenomenon with another one is dual. Although each one of these phenomena is independent in nature, there is a relationship between them. So, we will analyze the behavior of phenomena in relation to others.

In this paper, we have presented an empirical investigation on Mahyar plains to determine the land subsidence in these regions. We have gathered some reliable data gathered by satellite and analyzed the results using SAR method. The results indicated that this region had some significant up lift and subsidence.

Based on the preliminary results of this survey we would like to support the theory of duality defined as the balanced coordinate Movements between the plains and mountains surrounding them. These operations occur for years, which could cause the up lift and subsidence in the region. We hope the results of this study could help understand the nature of up lift and subsidence, which could help us prevent any damages on different constructions such as bridges, railways, etc.

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