Spatial Analysis of Fire Potential in Iran Using RS and GIS

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Extended Abstract

According to reports of forest range and watershed management organization of Iran, hundreds of forest fires take place in our country every year. Due to destroying forest and grass land in different parts of Iran, especially in Zagross and Alborz Mountain, it is necessary to develop new methods to reduce fire effects in these places. There are many parameters that increase probability of fire occurrence. Without considering these parameters, environmental and biomass impacts are very critical problems. As fire could be occur in many grass lands and forests, fire monitoring of fire in vegetation regions is impossible. Using Remote Sensing technology and geographic information system (GIS) modeling is a basic way to monitor and prevent from this national disaster. In this study, spatial distribution of fires which occurred in the last 8 years in Iran and were detected by Moderate Resolution Imaging Spectro-radiometer (MODIS) satellite images was used. Then, by using NDVI index and considering repetitive fires, permanent fires were distinguished from random fires. Finally, density function and spatial autocorrelation in GIS were employed as statistical parameters to detect potential regions to fire. The results show a correlation coefficient of 0.9 between the fires and NDVI mean.

Data source

For this study, 300 MODIS image of Iran were obtained during the years 2000 – 2007 and 216 NDVI images captured and images of maximum 10 days were used. ENVI 4.5 and ARCGIS 9.2 were used for the readiness, spatial analysis and production of needed maps.

Methodology

Spatial autocorrelation is a mathematical model which is suitable for the study of change of spatial models during times. The result of the above analysis presents a complete knowledge of the manner of change of spatial models from past to present and present to future. The results obtained from these methods help me to known effective factors which change spatial models.

There are two methods for calculation of the spatial autocorrelation of spots distribution, Jerry and Moran index, both of the above indexes calculated spatial autocorrelation of rank of ratio attribute data. In general, SAC is a proportion of attribute data which is represented through the following formula:

$$SAC \approx \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} CijWij}{\sum_{i=1}^{n}\sum_{j=1}^{n} Wij}$$

Where Cij is the similarity of attribute information of i and j; Wij is the distance between i and j, and n is the number of spots in distribution.

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So far different types of vegetation index are presented which each of them have their particular features, weakness and ability. NDVI which is the simplest and the most famous vegetation index is defined in terms of red bands and infrared. NDVI= (NIR-IR) / (NIR+IR)

Data analysis

As mentioned before, MODIS sensor images were used for the calculation of fire frequency during the years which are studied. Since some of the detected fires in the images are related to the regions with permanent fires, such as oil well and refinery. The separation of this kind of fires is done by modeling in GIS based on determining suitable threshold for NDVI in order to wild fire arisen from the humanistic and natural factors are entered into the calculations.

Maximum images of 10 days vegetation index for preparing annual NDVI maps of country. Usually for preparing this kind of NDVI images, each of the existence images are calculated for the duration of 10 days and then maximum NDVI image was produced by combining those images.

Produced images show the maximum of the vegetation degree for the duration of 10 days. 36 image frame of NDVI for each year were provided for this study. The total number of used images which are related to the years during 2000-2007 is 216 frames. For the production of annual vegetation index, NDVI images of annual maximum for all of the studied years are produced by the combination of the images of 10 days of each year.

For Studying and analyzing the relationship between NDVI and fire frequency in Iran, annual NDVI mean of country for the studied years is calculated. Also the fire frequency for these years is obtained. The least amount of NDVI mean of country is in 2000 and 2001, while the fire frequency in these two years is less than the other years. By visual comparison of Graphs (Fig. 1), it can be easily deduced that there is a meaningful relationship between NDVI and fire frequency. Correlation coefficient between them is about. 0.9, so it is expected that in case of increasing drought in country, fire will be decreased.

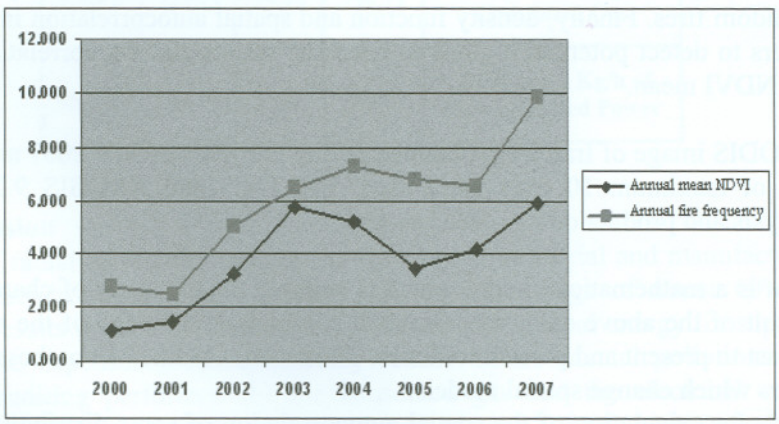

Fig. 1: Iran annual average NDVI and fire frequency on yearly based during 2000-2007

To investigate the fire spatial models and the degree of change of this model during the years 2000-2005, Moran index was calculated by MODIS images in terms of the number of wild fire. As mentioned before the closer the value of Moran index to +1, the more clustering distribution the phenomenon will have. Also the closer the value of Moran index to –1, the more distribution the phenomenon will have. The results of the spatial autocorrelation for the fire spots show that during the studied years, the Moran index it positive and the value of s Z score is also high. So fire spots have clustering spatial distribution with 99 percent confidence level. In other words, fire occurrence is dependent on spatial factors, as the result the region of fire distribution has more fire potential than other regions, so by using fire distribution map of studied years, fire potential map area of country can be provided.

In addition to the above results, the correlation between Moran index and fire frequency is -/93. This index shows that in the years in which there is a little NDVI or drought(such as 2000 and 2001), clustering models of fire spots are more than other years, in other words, distributed fires are less than other years and this is because of the little fuel material.

Conclusion

The results of the present study show that there is a relationship between the fires which happen in Iran during the recent years and vegetation. The results show a correlation coefficient of 0.90 between the fires and NDVI mean. Also, fires have a high spatial autocorrelation, so that during the study years, Moran index is positive and z-score is also high, which show clustering spatial pattern with significance level 99 percent. In other words, fire occurrence is dependent on spatial factors. By using fires that occurred in the last years, fire potential maps of Iran can be produced, as shown in Figure 2.

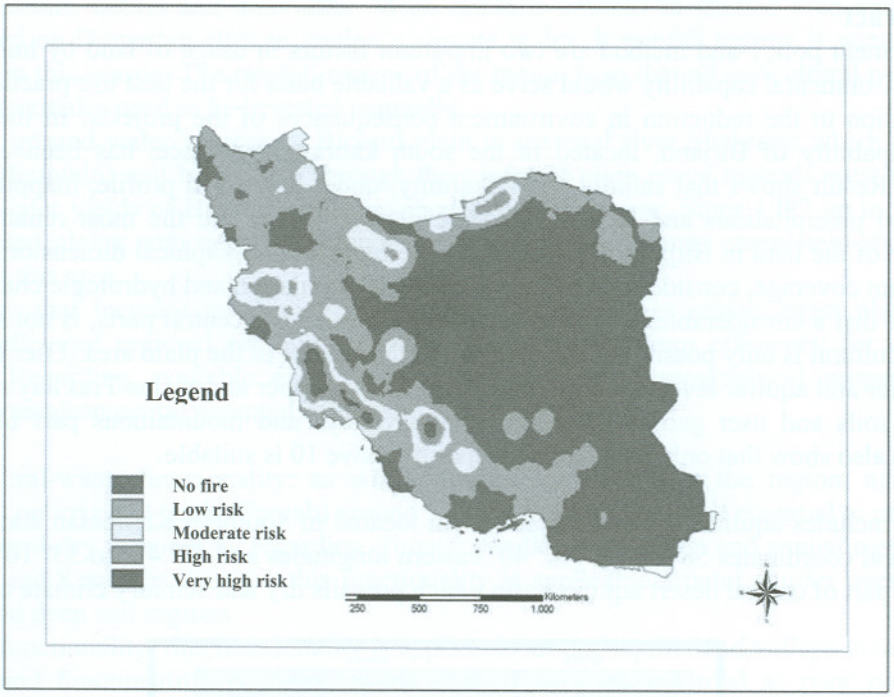

Fig. 2: Iran fire risk map

This is shown by the result that the region of fire has more fire potential than other regions. This study was done for the whole country. If this study is done in local and regional scales, it will present more accurate result which can be used for future research.

Key words
Fire regime, Spatial Autocorrelation, NDVI, Satellite images