The presentation of sample and quick model for the Preparation of the risk fire map in forest area

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Abstract

Human life was always on the verge of natural disasters which most of them are due to climate processes. One of these disasters is conflagration. In this article we try to estimate the conflagration risk by satellite images and DEM of specific region .In according to these factors, slope, aspect and NDVI, we want to formulize the conflagration risk on the satellite images.

Key words: Remote sensing, satellite images, DEM, slope, aspect.

1. Introduction

Increasing the earth's population in the previous century is the main reason of immeasurable and immethodical using of the earth's resources. Doubtless, the forest is one of the main natural resources which is important in two point of view .First is economical and second is bioenvironmental the fire is an important factor to form different types of existents and so impressive on ecologic system.

Certainly there is no phenomena like conflagration which threaten the forest's life, because if it happens will wipe out more than hundreds of hectare of forest in a day so that a waning system for preventing it's occurrence and advancing seems so necessary. There are so many natural and international organizations working out on this case.

As mentioned we want to estimate the region which are at risk by satellite Images. The most important specification of satellite images is vast temporal and spatial coverage .Also some satellites can take images from the specific region several times in a day. Of course it depends on which circuit they are in. By these Images and processing them, although combining them with DEM, we will achieve a good permission for preventing against these disasters's advancement. One of the best project that have been done in this field is, monitoring the conflagration in the united state of America by some great organization such as NOAA, NDMC and USDA in mentioned project the conflagration's situation.

There is another investigation have done by Walsh in the United State of America. In this investigation, the AVHHR images from NOAA were used to evaluate the conflagration in 1980.

In Iran, Mr. Khorasani nezhad have investigated about the regions which are sensible to fire and determine some factors, that so important when the conflagration occurred. Some factors are as following. Slope, aspect, texture type , number of flammable material, humidity of flammable material, precipitation percentage, average temperature.

2. Suggested Method For Providing The Fire Risk Method

In so many cases, spread of conflagration is along with warm winds and the slopes which are formed in those winds direction. The steep regions have so much risk than the others, because the fire can move towards faster. In this case we can consider three following factors as the most important one.

1. Slope (derived from DEM)
2. Aspect (derived from DEM)
3. Vegetarian Coverage (Derived from satellite images NDVI index)

Every region has their own fire risk that depends on slope, aspect and density of Vegetarian Coverage. We can model the fire risk with a logical fuzzy form between zero and one. The one means maximum fire risk and zero means minimum fire risk. In this model we assume that the direction of warm wind is horizontal, constant and has a specific azimuth. About the impression of slope in fire risk, we will consider that the vertical slope (90 degree) has the most fire risks and the horizontal slope (zero degree) is completely vice versa. Like the following figure. We consider that the fire risk is relative to sin (Slope).

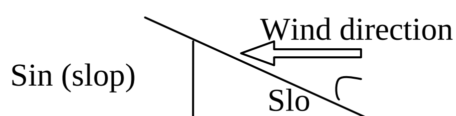

Fig 1: impression of slope in fire risk

$$\text{Sin (slop)} \propto \text{Risk} \qquad (1)$$

Also, if the slope direction alters in relative to wind direction, the fire risk will change. For example, the slopes which are opposite to the wind direction have the most fire risk and the slopes that perpendicular to the wind are completely vice versa. The Eq. 2 indicates the impression of aspect in fire risk.

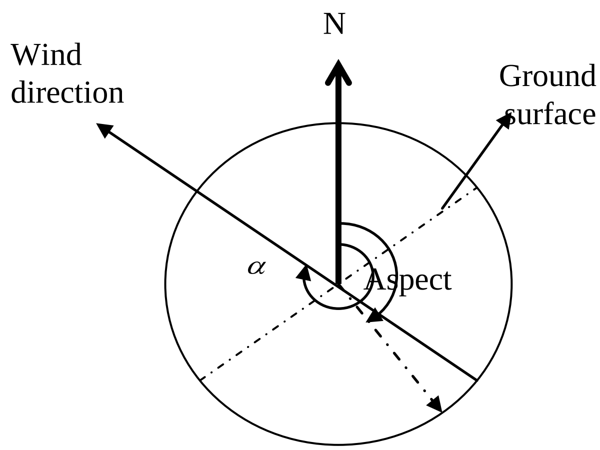

Fig 2: impression of aspect in fire risk

$$Risk \propto \begin{cases} -t & t \le 0 \\ 0 & t > 0 \end{cases} \qquad t = \cos(\alpha - Aspect) \tag{2}$$

In this formula (α) denotes for wind devotion. Finally for the plants, NDVI index is a suitable factor for consideration of vegetarian coverage in this calculation. The NDVI factor is in the interval of [-1/1]. Like the other factors the NDVI index is a number between zero and one.

$$\text{NDVI} = ((\text{NIR} - \text{R})/(\text{NIR}+\text{R})) \qquad \text{Risk} \propto ((\text{NDVI}+1)/2) \tag{3}$$

With consideration of these three items, slope, aspect, plant factor and fuzzy combination of them with fuzzy AND operator we will achieve to Eq. 4.

$$\text{Risk} = -\sin(slop) \times \cos(\alpha - Aspect) \times ((NDVI+1)/2) \tag{4}$$

In the above formula, the following condition must confirm. Other wise the fire risk equals to zero. After achieving these three layers (slope, aspect, NDVI), we will apply the above formula on all of them. Then we will achieve to a fire risk layer as an output. In this layer we have numbers in the range of zero to one. If the number equals to one, it means the maximum fire risk and if equals to zero it would be completely vice versa.

Also, we can overlay the fire risk layer with the DEM of region. After this we can see the processed conclusion in three dimensions. As well we can classify the fire risk layer and find out the regions which have more than 80 percent risk. After this classification, we can provide this classified layer as an input for GIS system. Notice that before using this layer as an input we have to convert it to a vector.

For eliminating the negligible region in the layer, it's better to apply a median filter. This filter will remove the small and non important region.

3. Practical Test

In fig. 3, we have a LANDSAT satellite image with a DEM from Japan in 2006. This image has four spectral bands (Blue, Green, Red, and Near Infra Red) and spatial resolution of 28.5 m.

We gain the layer of slope and aspect from the DEM of region with usual remote sensing application (ERDAS). Although NDVI index would gain from the Red and Near Infra Red band. If we apply the proposed fire risk model on the layers will gain the final fire risk layer. This layer is in Black-White and colorful mode.

In the Black-White mode the bright regions determine the higher risk and the dark region determine the lower risk. In the colorful mode, we use Red, Yellow and Green. The regions which are red determine the higher risk. The region which are yellow determine the medium risk, the region which are green determine the lower risk.

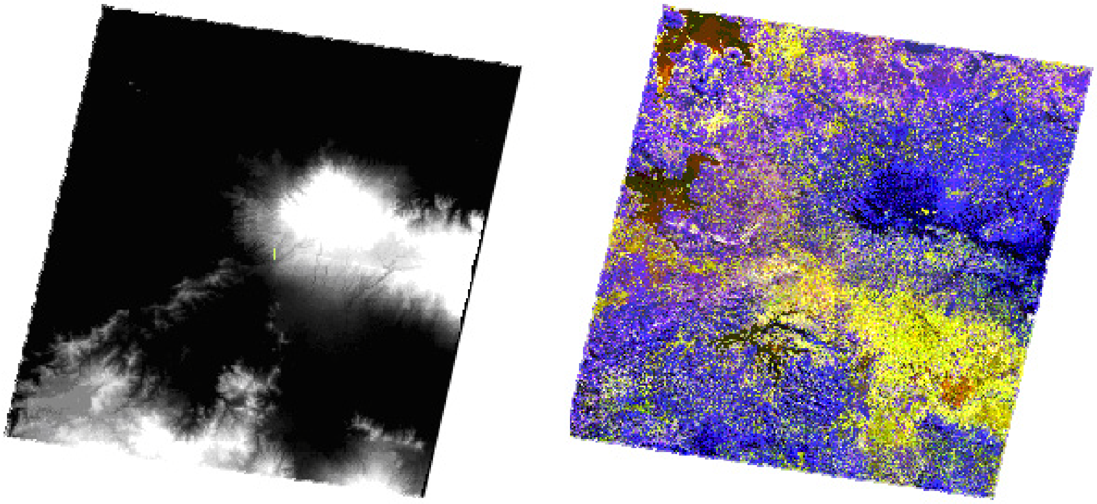

Fig 3: satellite image with a DEM

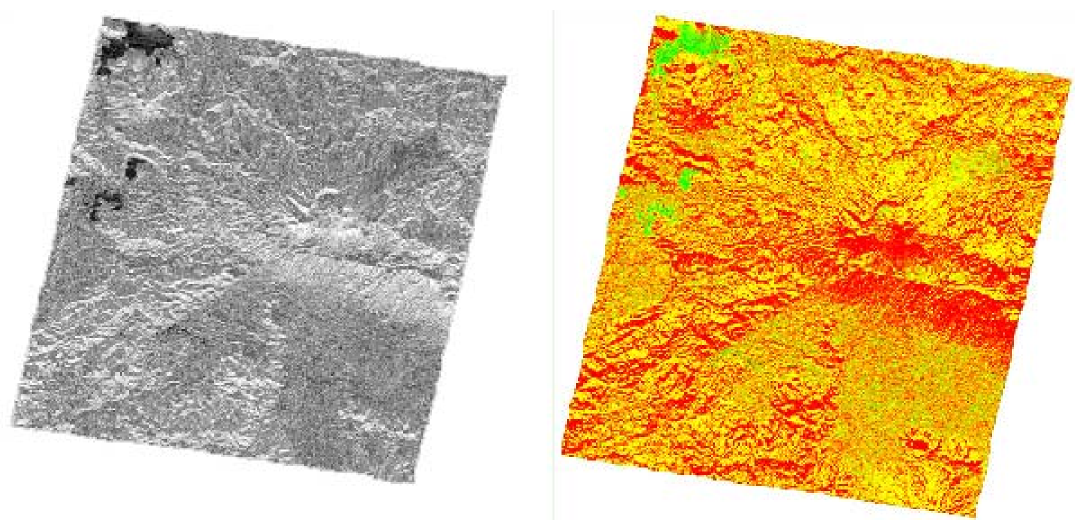

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Fig 4: fire layer in two modes 1-Black-White (bright is higher risk and dark is lower risk) 2-colorful (red color is higher risk and yellow color is medium risk and green color is lower risk)

4. Conclusion And Suggestion

This method is so fast and economic for determining the region's fire risk.

In the future research we suggest add some other factors as well the slope aspect and NDVI index.

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