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Fire Risk Potential Checking in Forests using Fire Risk Model

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Abstract: *Forests are one of the most valuable wealth on the earth planet and are living place for animals and plants, so protecting of them is an important and necessary order. One of the main reasons of forest annihilation is not controlled fires that destroy wide areas of forest and cause desertification. Remote sensing and GIS can be so much beneficial for studying Fire risk. In this research we investigated fire risk in protected forests in Central Alborz that has occurred every year and caused to plenty of damages. In this research Fire Risk method was used which included gradient environment factors, gradient direction and vegetation cover. Eventually area's fire risk maps were prepared which had weak relation with previous fire data and this point demonstrates low efficiency of presented model.*

Keywords: *Remote Sensing and GIS, Forest, Fire Risk Model, Fire Risk, Central Alborz's Forest.*

1. INTRODUCTION

Forest are the most beautiful natural source of our environment and play important role in physical and mental health of organisms. Health of forest in every place is indicator of ecological conditions in that area (Zhang & Chen; 2007). One of dangers that threatens forests is fire which causes to area ecology change by irreparable damages (Xu et al, 2005; Vakalis et al, 2004) and threatens these habitat makers permanently (Marozas et al., 2007) in the way that annual average of fire forests areas has been estimated six to fourteen million hectare in the world (Encinas et al., 2007). Actually forest's fire with either natural source or human source has harmful and destructive effects on human's life (Kazemi et al., 2005Podur et al., 2002). Increasing the number of times of fire occurrence in north of Iran's forests in recent years,confronts environment, forests, villages and their residents in wide range with damages and a lot of casualties. As a result of these fires not only forests of north has been damaged but also heavy financial damages has been imposed to country, whereas with necessary predictions and providing suitable technical solutions, ability to prevent of happening these incidents is easy and simple (Hoshyarkhah & JamshidiAlashti, 2007).Therefore, preventive proceedings about fire incident are unavoidable in forests to prevent from their irreparable damages. One of the ways to control these fires is identifying fire critical points in forests area. Lack of enough knowledge about these points causes to start and spread fire in forest, delay to restrain it and will incur hurt to life of animals and plants in forest (Jaiswal et al., 2002). Some studies have been done about fire function in Iran's forests and most of these researches are novel. In the same way Mohammadi and colleagues launched to provide areas maps which have danger of forest fire based on some factors such as vegetation cover, physiography, continental and human (distance from raods and rivers) in a part of Pave river. In this research, map of fire areas was prepared by field operation and using of global

positioning system. Then effective factors in fire incident and its spread were weighed by using Analytical Hierarchy process method (AHP) and action was taken to provide fire danger zoning map by using weighing layer and weighing coefficient that are related to each factor. Conclusions demonstrated that 90 percent of fire burned areas are in zones with high risk. (Mohammadi et al., 2010) used artificial neural network to predict fire risk of forests and pastures Izeh county. Conclusions demonstrated multilayerperceptron algorithm and hyperbolic function were efficient to create correlation between climatology data and fire incidence. Due to the importance of the issue of fire in forests and identification necessity of talented areas and sensitive to fire, different studies have been done as yet in this field in different parts of the world. Salvati and Ferrara (2015) have done validation of fire risk indicator MEDALUS, by using statistic methods based on multivariate analysis. This research has been done in Greece and set to occurrence fire rating in area and they calculated area of ignited surface in different users (Urban, grassland, forest, etcetera) by using different indicators. Arnett and colleagues in a research set to recognize vulnerability of forests by using remote sensing in different scales. In this research assessment of fire in forests of south of Canada has been done by using images of Rapid Eye and Lanset. In addition to mapping of fire danger, correlation between fire and type of cover has been obtained. It can be concluded that most of mentioned studies to evaluate of fire capability have emphasized about different environmental factors and assigning suitable weigh to them, by checking done researches. Also using of geographical information system tools capability could facilitate zoning and occurrence modeling and probability of fire danger (Chuvieco & Congalton, 1989; Jaiswal et al., 2002; Ertenet al., 2004; Salamatiet al., 2011) so that importance of remote sensing and geographical information systems use has been made clear in information development and fire prediction (Akpinar&Usul, 2003). Therefore, due to the importance of forests fire prevention by using of geographical information systems and due to the frequent of fire occurrence in forests of Central Alborz, this research intends to identify critical points of fire risk in forests of area by evaluating chosen models.

2. ZONE OF STUDY

Mazandaran province with about 23756.4 square kilometer extent, included nearly 1.46 of whole country's area that according to country divisions in year 1391 and public enumeration in year 1390, has 20 counties, 58 cities and 3073943 populations. Zone of study located in Noshahr city with 320 square kilometer area and has 58 degree and 29 minutes to 51 degrees and 40 minutes' east longitude and 36 degree and 15 minutes to 36 degrees and 37 minutes' north latitude. Location of study zone has been illustrated in figure(1). Central Alborz protected forests have plant species such as trees and have shrubs such as Alder, Oak, Zelkova, Honeylocust, Hornbeam, Jungle tomato, Warts,Fig, etcetera and have animal species such as Shchuka, Brown Bear, Tiger, Fox, Hog, Toad, Snake, etcetera (Tarzbanet al., 1392 page 26-29).

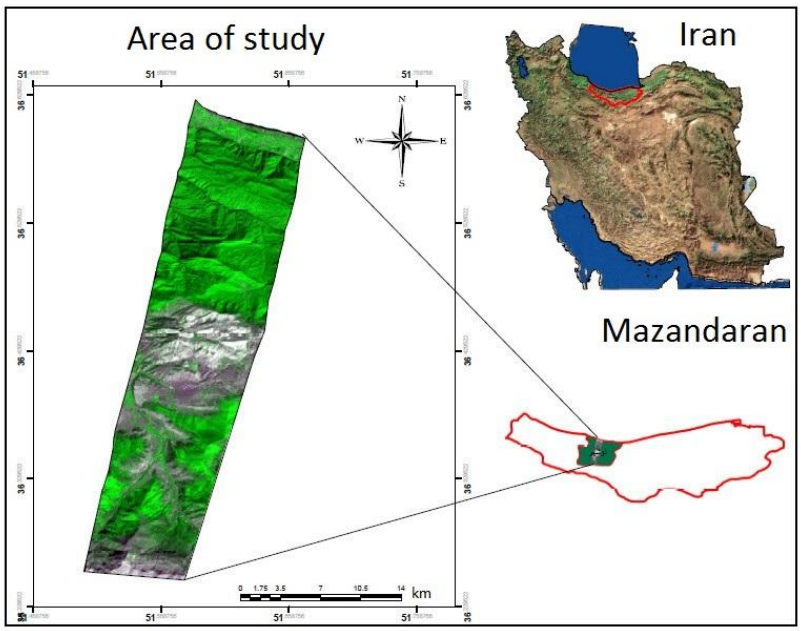


Figure1. *Geographical location of area of study*

3. MATERIAL AND METHOD

3.1. Using Data

1- Satellite's images of TM sensor Landsat 5 with 165-35 pass and row and 2010 date.

2- Digital elevation model (DEM) in dimensions of 30 meter of ASTER sensor.

3- Area fire data during 15 recent years that were prepared by Nature source and Mazandaran province forests protecting organization.

Table1. *Data of Fired Area*

Fired area (hectare)	Date of fire	Area	Area of forestry	Row
1	2000	Chiler	Kheiroudkenar	1
0.035	2001	Velerdeh	Marzanabad	2
0.2	2004	Ahakchal	Soleimanabad	3
1	2005	Katro	Kajour	4
0.15	2005	Aroush	Noshahr	5
0.02	2005	Ghalaben-Berken	Kajour	6
0.1	2008	Mukala	Peimoud	7
0.08	2008	Alichal	Kheiroudkenar	8
0.39	2008	Zanous-Tange	Kajour	9
0.075	2010	Si-Sangan	Salahe-din Kala	10

3.2. Using model

Using environmental factors to determine fire talented areas.

Fire occurrence is function of many conditions and factors that environmental factors affection is undeniable in their occurrence and spread. the most important and the most effective environmental factors that has a lot of affection in occurrence and spread of fire, are: gradient, direction of gradient, vegetation.

Affection of these factors can be defined as follows:

-Direction of dominated hot wind

-Comparative relation between surface gradient and hot wind direction.

-Vital vegetable mass rate (Biomass) that exists in gradients

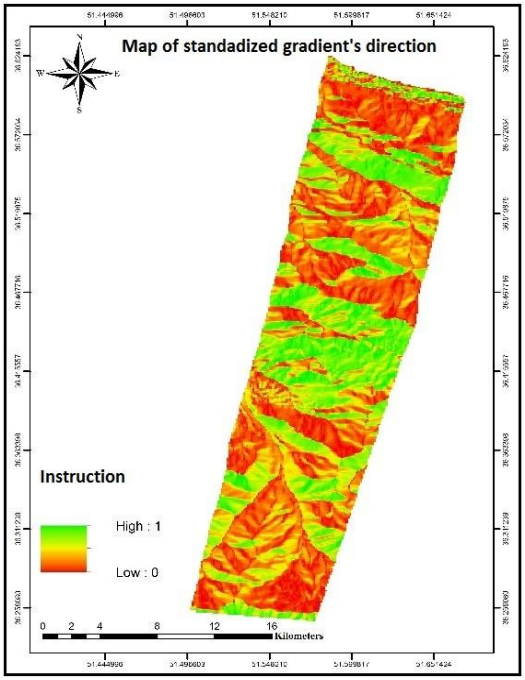
Gradients that faced to dominated hot wind and has more biomass, are in more fire risk. Also sharper gradients increase risk of fire spread. Because fire flames can be transferred upward quickly in sharper gradients and this causes to rapid spread of fire to amplitudes upper parts (NajarAzali, 1392. Page 20-22).

With considerate of any of these 3 factors, fire risk final formula as follows:

$$\text{Fire Risk} = \frac{\left(\frac{slope}{90}\right) + \left(1 - \frac{abs(180 - aspect)}{180}\right) + \left(\frac{NDVI + 1}{2}\right)}{3}$$

Fire risk layer has been prepared as amount between zero and one that zero indicates minimum risk and one indicates maximum risk.

In this method, after preparing area's digital elevation data via ENVI software, gradients layer and direction of gradient were extracted. Then on Lands at satellite's images that related to (35-164) zone, with the help of ENVI software, steps of preprocessing that included geometric and atmosphere correction were done and vegetation layer (NDVI), was extracted from image. In the following, gradient's layers, gradient's direction and vegetation were transferred by Arc GIS software. Used layers became standardization and are introduced as map according to any of (1-3) formula's part.



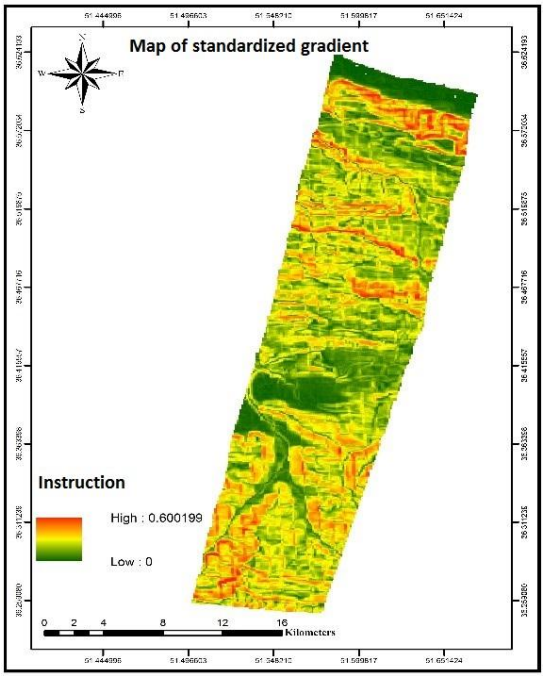


Figure2. *Map of Standardized Gradient's direction.* **Figure3.** *Map of standardized gradient*

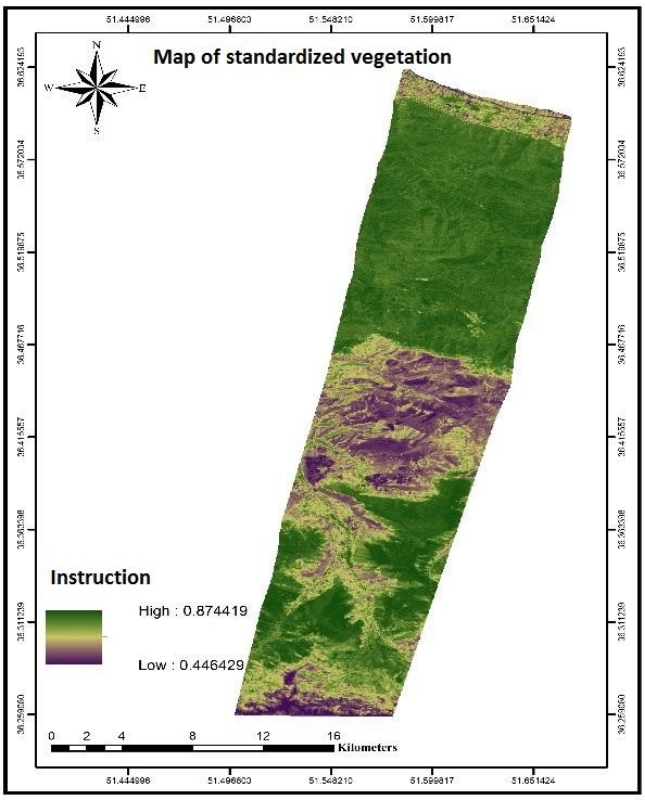


Figure4. *Map of Standardized Vegetation*

4. CONCLUSION AND DISCUSSION

The most important process of each research is, obtained conclusions from research which in that answer of a lot of questions is revealed. In this process, investigate of hypothesis became possible and also necessary preparation is provided for suggestions presentation and improvement of current condition.

Here, fire risk's map was obtained by combination of related layers and through formula (1). As it is being illustrating, numerical value is between zero and one that zero indicates minimum risk and one indicates maximum risk.

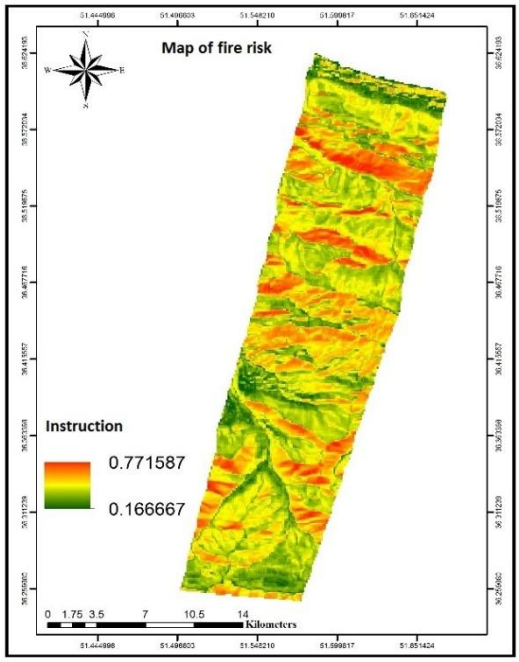


Figure5. *Map of Fire Risk with Fire Risk Model*

4.1. Investigation of Rate of Fire Risk Method's Correctitude and Precision

To check out the rate of fire risk method's correctitude and precision that is combination of environmental factors in estimation of fire risk's rate in area, information that is related to fire occurrence that happened before was used. Conclusions have been demonstrated in below map and table.

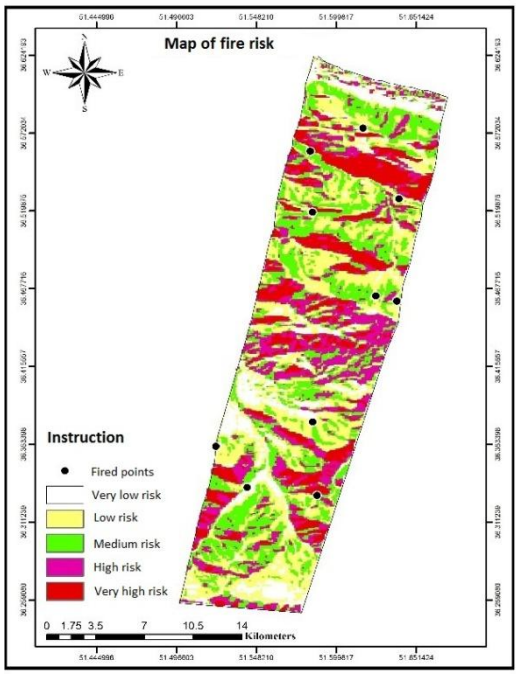


Figure6. *Combination Map of Risk and Occurred Fire in Area*

Table2. *Number of Fire Occurrence in Different Degrees of Fire Risk in Fire Risk Model*

Number of fire occurrence	Degrees of fire risk
2	Very low risk
5	Low risk
3	Medium risk
0	High risk
0	Very high risk

Also area of each risk's range, was calculated that has been demonstrated as below table and diagram.

Table3. *Area of risk's different ranges in using model in square kilometer*

VERY HIGH RISK	HIGH RISK	MEDIUM RISK	LOW RISK	VERY LOW RISK	DIFFERENT LEVELS OF RISK
43.21	59.94	86.29	90.75	38.57	AREA (FIRE RISK MODEL)

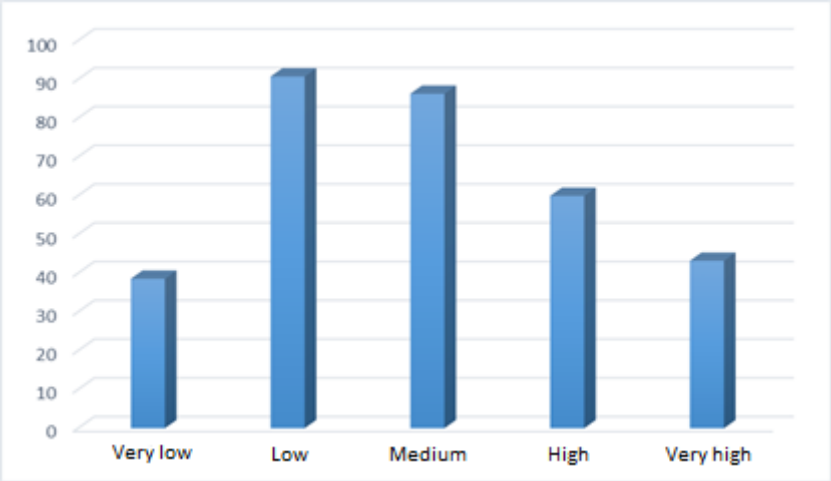


Figure7. *Diagram of fire occurrence risk of different ranges area in Fire Risk model*

5. CONCLUSION AND SUGGESTIONS

In this research, researcher tried to consider basic factors in fire occurrence and prepared fire risk map by using of Fire Risk model. In this model, environmental factors such as gradient, gradient direction and elevation is considered. Generally situating of most number of occurred fires point in the zone with low risk shows very low correlation between resulted map from this model and former occurred fires in zone. Obtained conclusion from this research can be used for further researches so that in fire map preparation, some models and scales are used that have more affection on zone's fire. Also according to heavy damages of fire in country, it is offered toorgans that related to protecting forest and pastures specially Nature Sources and Forestry Organization and also Environment Organization to prevent heavy damages imposition in forests and protect more practical from these valuable sources of our country with preparing up to date maps by experts in this field.

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