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Short Communication

Evaluation of the MODIS Fire-Detection Product in Neka-Zalemroud Fire-Prone Forests in Northern Iran

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Abstract

The timely detection of forest fires using proper satellite imagery is necessary to prevent the spread of fires. The aim of this study is to detect active fires (fire pixels) in District Three of Neka Zalemroud forests using the MODIS fire-detection sensor. One fire in District Three of Neka Zalemroud Forests started in December 2010 and lasted to January 2011. The MODIS fire product was prepared from the given area within 30 days. Then, HDF view software was used to detect the active fire areas. Thus, fire products were imported to the HDF view software and the positions (e.g. latitude and longitude) of fire pixels were detected. The location of the fire pixels was identified using GIS. The necessary maps were prepared in GIS. Then, the accuracy of the MODIS fire product was examined using the reference data from 2010 to 2011. Results show that MODIS fire products could successfully detect and identify the three active fire areas in the study area. In addition, there isn't any false alarm of fire detection when using MODIS as it indicates the desired accuracy of the MODIS fire product in identification and detection of active fires.

Keywords: accuracy, active fire, District Tree of Neka Zalemroud forests, MODIS sensor

Introduction

Fire has increased in forests and natural resource lands in recent years. Many forest fires have annually occurred in northern forests of Iran and have destroyed a great amount of forests [1, 2]. Thus it is essential that fires be detected in time [1] to prevent destruction of wide swaths of forests and natural resources [2].

A moderate resolution imaging spectroradiometer (MODIS) is one of the sensors that been applied to detect the active fire areas in forests and natural resources in recent years. This sensor started its mission in space from 1992 and 2002 on Terra and Aqua platforms, respectively. One of the products of this sensor is that it presents the active fire areas with 1×1 km resolution. This sensor can be used as an efficient tool for fire management in forests [3]. The Giglio et al. [4] fire detection algorithm has been used to identify fire areas in MODIS products. The main structure of this algorithm is fire detection based on absolute and relative limits of temperature in the most sensitive bands. In MODIS imagery, 3.9 microns is the most sensitive band to change in temperature [2].

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Many researchers have studied fire detection in forests using MODIS regarding the importance of in-time detection and prevention of forest fires around the world. Many researchers have used satellite imagery to analyze the spatial and temporal patterns of fire [5-7].

Sarkargar Ardakani and Valedanzodj [8] investigated the spatial and temporal analysis of the occurred fires in Golestan, Mazandaran, and Gilan provinces in Iran using MODIS. Then the relationship between fire occurrence and rainfall, elevation, and NDVI was investigated.

Maeda et al. [9] identified the past fires using satellite imagery as the high-risk areas in a part of Amazon forests in Brazil. Then active fires were identified using MODIS in the study area. Results showed that there is a 0.84 correlation between past fires and active fires.

Akhoundzadeh et al. [10] evaluated modeling of fire spread using MODIS imagery in Iran. The trends of fire spreading were analyzed using DEM, land cover, fuel maps, wind speed, and direction data. Results showed that the presented system can be used as a supporting decision system in fire occurrence time, if a database is available.

Poorshakoori Allahdeh et al. [1] investigated the possibility of fire detection in Golestan National Park using MODIS. The actual 57-hectare fire area was tracked by GPS. MODIS imageries of Terra and Aqua in days before, during, and after the fire were provided and analyzed using a global algorithm of fire detection. The results showed that the past fire can be identified with aqua – not terra – satellite imagery.

Sarkargar Ardakani et al. [11] used MODIS and ETM+ satellite images in order to detect and determine the extent of the fire areas in Khor, in Isfahan, Iran. Potential fire areas were detected by appropriate threshold limits. In these areas, fire potential pixels were identified with brightness temperature less than 293 degrees Kelvin in band 22, spectral reflectance less than 0.3 in band 2, and temperature difference between band 22 and 31 – less than 10 degrees Kelvin.

Zohari et al. [2] evaluated the accuracy of MODIS fire product using field data in Golestan forests. The results showed that 29 fire alarms of 42 fires were identified by the fire algorithm. There are only three false alarms in MODIS fire products that can show good accuracy of MODIS fire products.

Eskandari et al. [12] evaluated the reliability of MODIS fire products in detection of active fires in a part of Mazandaran forests in Iran. Results showed that the false alarms of MODIS fire products in fire detection are very low.

Adab et al. [13] studied modeling forest fire risk in the northeastern forests of Iran using remote sensing and GIS techniques. Hot-spot data derived from the MODIS satellite sensor were used to validate the indices. Results of a part of this research indicated that MODIS fire products have good readability in fire detection.

The aim of this research is detection of active fires in District Three of Neka Zalemroud forests using MODIS fire product regarding the importance of in-time detection of forest fires. In the final part of this, the accuracy of the MODIS fire product is investigated by actual fire data from 2010 and 2011.

Materials and Methods

Study Area

District Three of Neka-Zalemroud Forests is located between 36º 30’ to 36º 40’ N latitude, and 53º 15’ to 53º 26’ E longitude in southern Neka and Behshahr counties of Mazandaran Province in Iran. It covers an area of 153.07 km^2 and is bound by the Neka-Behshahr road in the north, Chakhani and Souterabad in the east, Zarandin Khoramchamaz in the south, and Ablou in the west. Minimum and maximum altitudes from sea level are 90 and 820 meters, respectively. DTNZ forests include 103.4 km of forest roads, 27 km of rural roads, and 21 km of asphalt roads (Fig. 1).

Forests of the study area have uneven-aged and mixed structures. Plant species include tree species (*Fagus orientalis, Carpinus betulus, Quercus castaneifolia, Alnus subcordata, Parrotia persica, Zelcova carpinifolia, Acer* sp., etc.), shrub species (*Buxus hyrcanus, Mespilus germanica, Crataegus pentagyna, Prunus caspica,* etc.), and herb species (*Asperula odorata, Ruscus hyrcanus, Siclaman* sp., *Carex* sp., *Rubus* sp., etc.). DTNZ forests have high potential for fire, as the wide areas of these forests have been burned by fires in recent years [14].

Data

Fire in District Three of Neka-Zalemroud Forests began in 2010/12/3 and lasted to 2011/1/3 based on a report from the Nekachoob Corporation. Thus, MODIS fire products in these 30 days were provided directly by MODIS (https://earthdata.nasa.gov/data/near-real-time-data/firms/active-fire-data).

In addition, the actual fire data from 2010 to 2011 in the study area was provided by the Nekachoob Corporation.

HDF View software was used to detect active fire pixels. Actual fires and active fires maps were provided by GIS.

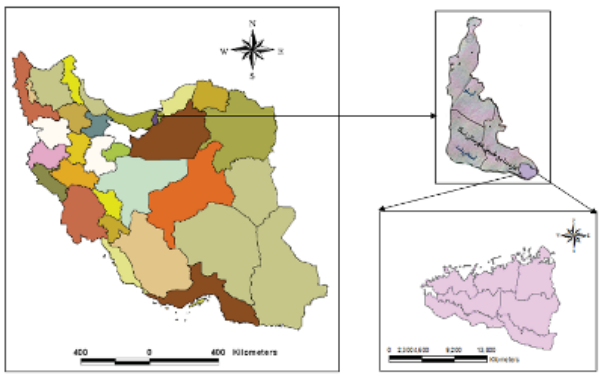

Fig. 1. Study area.

Research Method

Detection of Active Fires in District Three of Neka Zalemroud Forests using MODIS

In this research HDF View software was used to detect fire pixels after providing the MODIS fire products for 30 fire days. The fire products were imported to the HDF view software and the positions (e.g. latitude and longitude) of fire pixels were detected. The locations of the fire pixels ware identified using GIS. The necessary maps were prepared in GIS.

Investigation of Accuracy of MODIS Fire Products

The accuracy of MODIS fire products was examined using the reference fires data. The active fires map was overlaid on the actual fires map (from 2010 to 2011) in the study area to check the accordance of these maps. Then the number of the correct and false alarms of MODIS fire products was controlled.

Results

Active Fires Map

Three active fire pixels of MODIS fire products were detected in the study area within the fire days. Fig. 2 shows the location of the detected active fires in District Three of Neka-Zalemroud Forest.

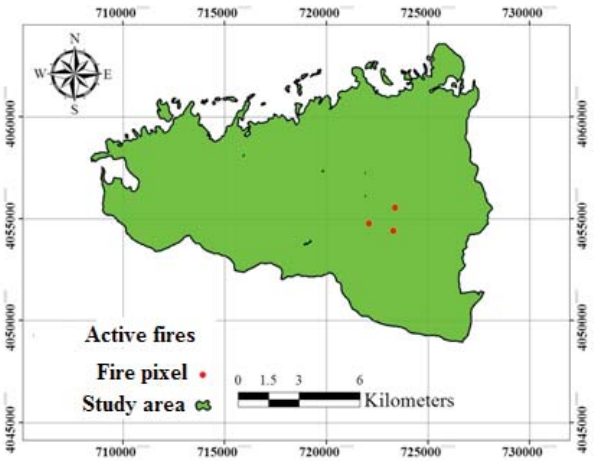

Fig. 2. Locations of the active fires in District Three of Neka-Zalemroud Forest.

Actual 2010-11 Fire Map and Investigation of the Accuracy of MODIS

The newest fires in Neka-Zalemroud Forest occurred in December 2010 to January 2011. Fig. 3 shows the locations of these fires.

The active fires map was overlaid on the actual fires map in the study area to check the accuracy of MODIS fire products (Fig. 4).

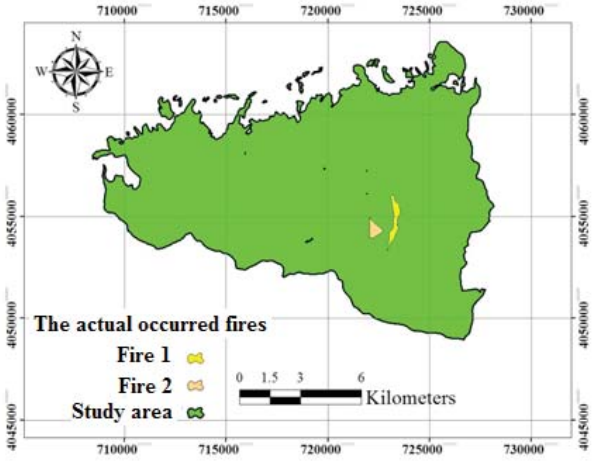

Fig. 3. Location of the actual fires from 2010-11 in District Three of Neka-Zalemroud Forest.

Discussion

Fire is one of the main causes of forests destruction in northern Iran due to environmental and human conditions. Fires are mostly detected in these forests when fire-fighting requires great cost and time. Thus early fire detection is essential [2].

This research was done to detect the active fires in District Three of Neka Zalemroud Forests using the MODIS fire-detection product. Then the accuracy of this product was investigated using actual fire data from 2010 to 2011. Results of analysis of MODIS within 30 days of the aforementioned 2010-11 fire showed that three fire pixels are detectable in the actual fire areas. Thus MODIS shows few false alarms. Results of this research in

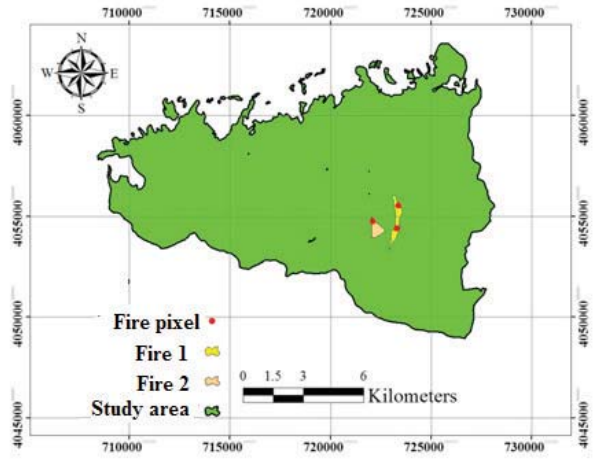

Fig. 4. Overlay of the active fires map on the actual fires map in District Three of Neka-Zalemroud Forest.

accordance with Zohari et al. [2] show that the number of MODIS false alarms is very low. Results of similar studies in Golestan and Mazandaran forests of Iran also showed that MODIS has good readability in fire detection [12, 13]. Furthermore, these results are according to results of other research that showed that there is a 0.84 correlation coefficient between active fires and past fires [9]. MODIS fire products have been identified by many researchers as a proxy of fire occurrence [9, 13, 15-17].

This can show the high accuracy of MODIS fire products in fire detection. Thus, this product can be useful in forest fire management. It can develop a fire alarm system to inform about time and location of fire occurrence. As Akhoundzadeh et al. [10] research results also showed, if a database is available, the presented system using MODIS can be used as a supporting decision system in fire occurrence.

Regarding the lack of identification of all fire pixels, we should note that the identification of fire pixels in fire days depends on fire time [1]. If fire temperature is low in some hours during the day, then fire can't be identified because all methods in the global algorithm of fire detection have a direct relationship with the produced temperature of fire [4, 18].

Conclusions

The final results of this research show that all the detected fire pixels using MODIS are located in the actual fire areas. In addition, there isn't any false alarm of MODIS fire product in fire days. This can show the high accuracy and capability of MODIS in forest fire detection. Thus it is suggested that the current MODIS fire-detection product would also be used to detect current fires in our study area. These products can be used to manage and quench forest fires at the proper time.

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