

Developing Forest Fire Danger index using NASA MODIS TERRA Near Real Time satellite datasets

Suresh Babu K V¹, Arijit Roy², and Ramachandra Prasad P³

¹Indian Institute of Remote Sensing

²Scientist SF

³Assistant Professor

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Abstract

Forest fire is a major ecological disaster, which has economic, social and environmental impacts on humans and also causes the loss of biodiversity. Forest officials issue the warnings to the public on the basis of forest fire danger index classes. There is no operational forest fire danger index for the country India due to the sparsely distributed meteorological stations. The Fire Danger Rating System (FDRS) is a Decision Support System, which takes into consideration of all the factors affecting the fire danger such as fuel type, weather parameters and terrain characteristics and indexing into different classes of fire danger for the purpose of issuing warnings to the public, implementing the mitigation measures for controlling fires. The Static Fire Danger Index (SFDI) is a constant over the study area, computed from the MODIS Land cover type yearly L3 global 500 m SIN grid (MCD12Q1) and ASTER GDEM datasets. In this study, we used the Near Real Time datasets and these Near Real time datasets are available within 3 hours of the observation time of satellite overpass, downloaded through an FTP site. Dynamic Fire Danger Index has been calculated from the Near Real Time (NRT) Level 2 MODIS Terra Land Surface Temperature datasets (MOD11.L2) and MODIS TERRA NRT surface reflectance dataset MOD09 by using three parameters, i.e. Potential surface temperature, Perpendicular Moisture Index (PMI) and Modified Normalized Difference Fire Index (MNDFI). Forest Fire Danger Index (FFDI) has been computed by integrating the static fire danger index and individual dynamic forest fire danger index on each day during the major fire episode of Uttarakhand in 2016. The FFDI has been categorized into 5 fire danger classes such as Very high, High, Moderate, Low and No fire danger and MODIS active fire product MOD14 has been used for the validation. Estimated accuracy was ranging from 72% to 91% and the overall accuracy was around 81.27%. Therefore, the developed Forest Fire Danger Index will be useful for the disseminating the danger maps daily in near real time basis using the MODIS TERRA Near Real Time datasets so that the fire officials to take necessary actions to control the spreading of forest fires.

Suresh Babu K V¹, Arijit Roy² and Ramachandra Prasad P³
 1 PhD researcher, Indian Institute of Remote Sensing, Dehradun, India
 2 Scientist SF, Indian Institute of Remote Sensing, Dehradun, India
 3 Assistant Professor, International Institute of Information Technology, Hyderabad, India

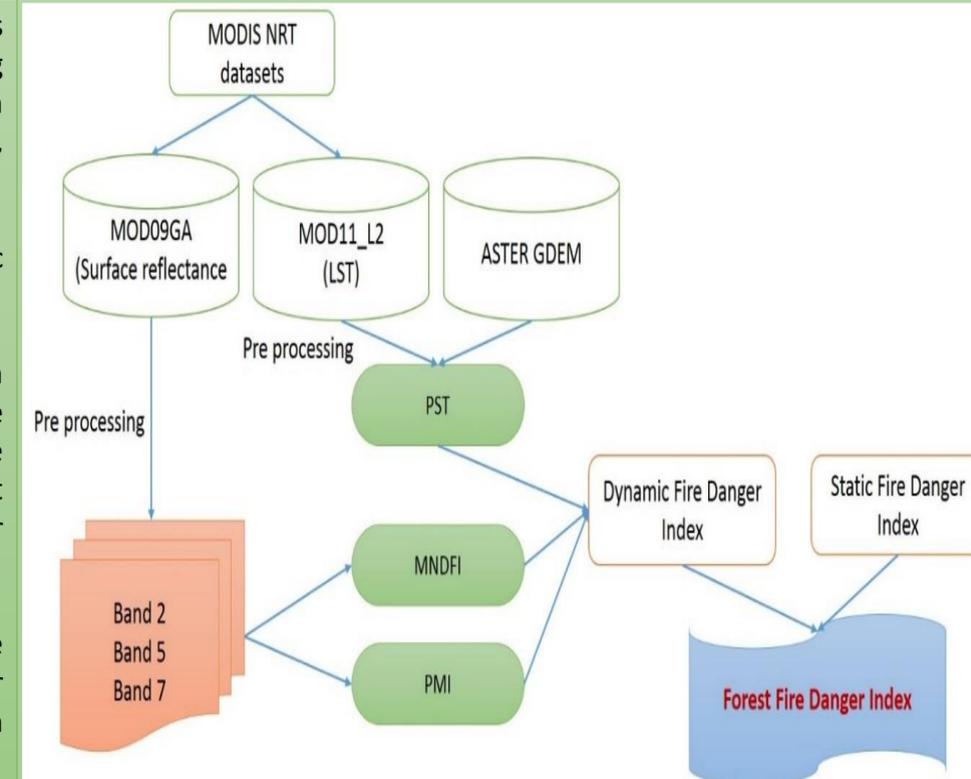
Introduction

Forest fire is one of the major causes of degradation of forests in India. According to the State of Forests Report 2011, the forest cover in India is 78.29 million ha, constituting 23.81 % of its geographical area (SFR, 2011). Forest fire has been regarded as one of the major causes of degradation of forests in Uttarakhand. Forest fires occur annually in more than 50% of Himalayan forests in Uttarakhand state mostly due to anthropogenic activities either intentional or accidental. Fire danger indices are important tools for the effective management of forest fires. In India, forest fire danger rating system has not been developed till now, except zonation of risk areas. The Fire Danger Rating System (FDRS) is a Decision Support System, which takes into consideration of all the factors affecting the fire danger such as fuel type, weather parameters and terrain characteristics and indexing into different classes of fire danger for the purpose of issuing warnings to the public, implementing the mitigation measures for controlling fires.

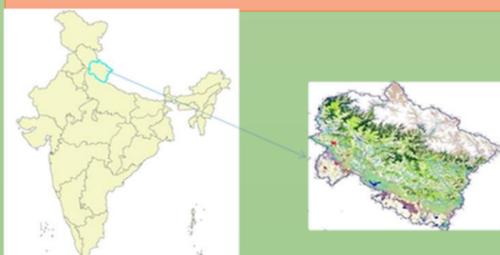
In this study, an attempt has been made to develop the Forest Fire Danger Index (FFDI) by using the remote sensing based datasets. The Dynamic Fire Danger Index (DFDI) has been calculated by using the Near Real Time (NRT) MODIS TERRA satellite datasets that can be available after half an hour of the satellite overpass. The Integrated FFDI maps can be disseminated in near real time to the fire managers, take necessary action to control the forest fires.

Methodology

- The Fire Danger Rating System is a Decision Support System, which takes into consideration of all the factors affecting the fire danger and indexing into different classes of fire danger viz. No danger, Low, Moderate, High and very High for the purpose of issuing warnings to the public, implementing the mitigation measures for controlling fires.
- The Forest Fire Danger Index (FFDI) is computed by integrating the Static Fire Danger Index (SFDI) and Dynamic Fire Danger Index (DFDI).
- The SFDI is useful to understand the spatial pattern of fire occurrence in the study area and used to determine areas of high fire danger due to the fundamental conditions that leads to fire occurrence and can be computed from the fuel type danger index, slope danger index, aspect danger index, elevation danger index and terrain ruggedness danger index.
- Dynamic forest fire danger index has been developed from three parameters such as potential surface temperature, Perpendicular Moisture Index and Modified Normalized Difference Fire Index, which were derived from the MODIS TERRA and ASTER DEM satellite datasets.



Study area

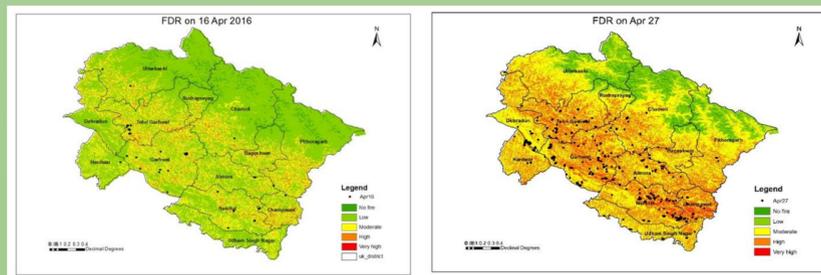


The state of Uttarakhand is one of the northern states of India. It shares international boundary with China in the north and Nepal in the east. It has an area of 53,483 Km² and lies between 28°43' N to 31°27' N latitude and 77°34' E to 81°02' E longitude.



| Name of Datasets | Product ID | Spatial Resolution | Temporal Resolution |
|----------------------------|-------------|--------------------|---------------------|
| Land Surface Temperature | MOD11NRT | 1 km | Daily |
| Surface Reflectance | MOD09GA NRT | 500 m | Daily |
| Geolocation fields | MOD03 | 1 km | Daily |
| Land cover type | MCD12Q1 | 500 m | Yearly |
| Digital Elevation Model | ASTER | 30 m | - |
| Fire and Thermal Anomalies | MOD14 | 1 km | Daily |

Results



Accuracy was estimated based on the number of fire incidents in different fire danger classes. FFDI was tested during the major fire episode of 2016, the calculated accuracy was ranging from 72% to 91% and the overall accuracy was around 81.27%. Therefore, the developed Forest Fire Danger Index will be useful for the disseminating the danger maps daily in near real time basis using the MODIS TERRA Near Real Time datasets.

Conclusions

- ❑ In this study, Forest Fire Danger Index (FFDI) has been developed from the static fire danger index and dynamic danger index using the Near Real Time MODIS TERRA datasets. The Forest Fire Danger Index has been developed by integrating the static fire danger index and dynamic fire danger indices. Thus, the developed index has the potential for predicting the forest fires using the satellite derived products.
- ❑ FFDI has been computed from the near real time datasets, which can be downloaded from the NASA FTP server after the satellite overpass. The entire procedure is automated sequentially i.e. downloading, preprocessing, generating the intermediate parameters and finally computing the Forest Fire Danger Index. Then it will be useful for disseminating the forest fire danger maps to the users for the control activities of forest fires during the fire season.