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Forest Fire Burnt Area Assessment in a Part of West Himalayan Region Using Spectral Unmixing Method and Assess the Extent and Severity of the Affected Area Using Neural Network Approach

Authors : Sunil Chandra, Triparna Barman, Vikas Gusain, Himanshu Rawat

Abstract : Forest fires are a recurrent phenomenon in the Himalayan region owing to the presence of vulnerable forest types, topographical gradients, climatic weather conditions, and anthropogenic pressure. The present study focuses on the identification of forest fire-affected areas in a small part of the West Himalayan region using a differential normalized burnt ratio method and spectral unmixing methods. The study area has a rugged terrain with the presence of sub-tropical pine forest, montane temperate forest, and sub-alpine forest and scrub. The major reason for fires in this region is anthropogenic in nature, with the practice of human-induced fires for getting fresh leaves, scaring wild animals to protect agricultural crops, grazing practices within the reserved forest, and igniting fires for cooking and other reasons. The fires caused by the above reasons affect a large area on the ground, necessitating its precise estimation for further management and policy making. In the present study, two approaches have been used for carrying out a burnt area analysis. The first approach followed for burnt area analysis uses a differential burnt normalized ratio index (dNBR) approach that uses the burnt ratio values generated using Short Wave Infra Red (SWIR) band and Near Infra Red (NIR) bands of the Sentinel-2A image. The results of the dNBR have been compared with the outputs of the spectral mixing methods. It has been found that the dNBR is able to create good results in fire-affected areas having homogenous forest stratum and with slope degree <5 degrees. However, in a rugged terrain where the landscape is largely influenced by the topographical variations, vegetation types, tree density, the results may be largely influenced by the effects of topography, complexity in tree composition, fuel load composition, and soil moisture. Hence, such variations in the factors influencing burnt area assessment may not be effectively carried out using a dNBR approach which is commonly followed for burnt area assessment over a large area. Hence, another approach that has been attempted in the present study utilizes a spectral mixing method where the individual pixel is tested before assigning an information class to it. The method uses a neural network approach utilizing Sentinel 2A bands. The training and testing data are generated from the sentinel-2A data and the national field inventory, which is further used for generating outputs using ML tools. The analysis of the results indicates that the fire-affected regions and their severity can be better estimated in rugged terrain using spectral unmixing methods which have the capability to resolve the noise in the data and can classify the individual pixel to the precise burnt/unburnt class.

Keywords : dNBR, spectral unmixing, neural network, forest stratum
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