Chapter 6
Efficacy of Advanced Remote Sensing (Hyperspectral and LIDAR) in Enhancing Forest Resources Management

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ABSTRACT

Sustainable management of natural forest resources is a vital requirement in the changing climatic conditions on Earth. Two advances techniques, hyperspectral remote sensing (HRS) and LIDAR (light detection and ranging) remote sensing (LRS), provide more enhanced and accurate measurements than that of conventional optical remote sensing (ORS). Hyperspectral sensor like AVIRIS, which has hundreds of narrow bands, have advantages over a broadband multispectral sensor. In addition, the fusion of HRS and LRS can play an essential role in assessing biophysical and biochemical variables of forest species. In this chapter, the authors reviewed the extant literature and tried to understand the position of HRS, LRS, and their integration with the machine and deep learning algorithms for the effective monitoring and management of natural forest resources. Further, scopes and challenges are also discussed to enhance the effectiveness of these techniques in natural forest resources management.

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1. INTRODUCTION

Sustainable management of natural forest resources is the inescapable demand in the present changing climatic scenarios. Recent developments in the remote sensing & Geographical Information system (GIS) offers improved methods to investigate and develop research approaches to manage natural forest resources. Moreover, the data and techniques offered by the remote sensing & GIS have gained much popularity in the monitoring and management of natural forest resources. Optical remote sensing (ORS) comes under conventional remote sensing which is widely used and has several application in forestry. Some application which is quickly evaluated with good accuracy using ORS includes assessment of area under forest cover, change detection, and forest health. However, species-level classification of forests, estimation of biophysical parameters, generation of tree inventory data is quite a non-satisfactorily with ORS (Wulder, 1998). Further, another issue in case of ORS is acquiring consistent cloud-free datasets over large areas (Avitabile et al., 2012). The accuracy of forest structural properties estimated in case of optical ORS typically decreases with increasing biomass and LAI (Foody et al., 2001; Hudak et al., 2002; Duncanson et al., 2010). According to Lefsky et al., 1998; Duncanson et al., 2010 the measurement of vertical vegetation structure using ORS data is constrained on the assumption that there is a predictable relationship between the two-dimensional structural properties of forests that can be sensed by ORS, and the three-dimensional structural properties of a forest that required for the estimation of forest volume and above-ground biomass (AGB). In general, ORS provide a promising opportunity to derive essential outputs which are very useful in forest monitoring and management; however, there is still some extents which cannot be addressed with ORS. To overcome these lacks, advanced remote sensing techniques such as LIDAR (Light Detection and Ranging) and hyperspectral offers a remarkable prospect in enhancing both the monitoring and management of natural forest resources.

Advancements in sensors technology have made it possible to collect the hundreds of spectral bands in remote sensing imagery. This technology is known as Hyperspectral remote sensing (HRS) or imaging spectroscopy. HRS is an advanced remote sensing technique, which comprises of hundreds of narrow and contiguous spectral bands covering the range from the visible to the infrared region of the electromagnetic spectrum (Chang, 2007). These spectral bands due to their narrow width and continuity provide ample scope to identify targets and extraction of information with high accuracy. Each spectral signature in hyperspectral data is based on the chemical and physical properties of specific objects. Therefore, the spectral signature is unique for every vegetation and because of this, HRS has the dynamic ability of monitoring and management of forest natural resources. HRS

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