Properties of plants in the forest

Spectral properties of plants in the forest: (1 st ch)

Interaction of radiation with plant leaves is extremely complex. General features of this interaction have been studied but many spectral features are yet unexplained. Gates et al., (1965) are considered pioneers, who have studied spectral characteristics of leaf reflection, transmission and absorption. Optical properties of plants have been further studied to understand the mechanisms involved by Gausman and Allen (1973), Wooley (1971) and Allen et al., (1970).

It is the synthesis of the parameters like reflection of plant parts, reflection of plant canopies, nature and state of plant canopies and Structure and texture of plant canopies, which will be required to fully understand the remote sensing data collected from space borne and aerial platforms. They have been attempted for crop canopies through the development of models but not yet fully achieved. It will be initially required to discuss the electromagnetic spectrum and its interaction with vegetation canopies. Subsequent factors affecting the spectral reflectance of plant canopies with its possible applications in remote sensing technology would be discussed.

The vegetation reflectance is influenced by the reflectance characteristics of individual plant organs, canopy organization and type, growth stage of plants, structure and texture of the canopies. The synthesis of the above four aspects provides true reflectance characteristic. However, various authors without fully achieving models to determine vegetation reflectance characteristics have studied effect of individual parameters.

Nature of the Plant:

Numerous measurements have been performed to evaluate the spectral response of various categories of plants with a spectrophotometer (Fig. ***).

For a plant in its normal state i. e., typical and healthy the spectral reflectance is specific of the group, the species and even of the variety at a given stage in its phenological evolution. The general aspects of spectral reflectance of healthy plant in the range from 0. 4 to 2. 6 µm is shown in figure ****.

The very abrupt increase in reflectance near 0. 7 µm and the fairly abrupt decrease near 1. 5 µm are present for all mature, healthy green leaves. Very high; further in the far infrared > 3. 0 µm. Thus, the typical spectral curve of plant is divided into three prominent zones correlated with morphological characteristics of the leaves (Gates, 1971).

Pigment Absorption Zone:

The important pigments, *viz* . chlorophyll, xanthophylls and carotenoids absorb energy strongly in ultraviolet blue and red regions of the EMR. The reflectance and transmittance are weak. The absorbed energy of this part of this spectrum is utilized for the photosynthetic activity (Allen et al. 1970).

Multidioptric Reflectance Zone:

In this zone, the reflectance is high, while the absorbptance remains weak. All the unabsorbed energy (30 to 70% according to the type of plant) is transmitted. They reflectance is essentially due to the internal structure of the leaf and the radiation is able to penetrate. The reflectance from internal structure is of physical more than chemical nature. Apart front the contribution of the waxy cuticle, the magnitude of the reflectance depends primarily upon the amount of spongy mesophyll.

Hydric Zone:

Amount of water inside the leaf affect the pattern of spectral reflectance with water specific absorption bands at 1. 45 µm, 1. 95 µm and 2. 6 µm. Liquid water in a leaf causes strong absorption throughout middle infrared region. Beyond 2. 5 µm the reflectance becomes less than 5% due to atmospheric absorption and beyond 3 µm the vegetation starts acting as quasi blackbody (Gates *et al.,* 1965).

There are numerous factors either internal of the plant or external coming from the environmental conditions have an influence on the specific spectral reflectance. The above descriptions are true only for a normal, mature and healthy vegetation. The factors which affect the spectral reflectance of leaves are leaf structure, maturity, pigmentation, sun exposition, phyllotaxis, pubescene, turgidity (water content) nutritional status and, disease etc. Important factors are pigmentation, nutritional status, anatomy of leaves and water content. While, sun exposition and phyllotaxy affects the canopy reflectance, phenological state and disease are linked to the primary factors affecting the spectral reflectance (Wooley, 1971).

Spectral vegetation indices:

Radiant energy intercepted by a vegetative canopy is primarily scattered by leaves either away from the leaf surface or to the leaf interior. The scattered radiation is reflected, transmitted or absorbed by leaves. The partitioning of radiation a reflected, transmitted or absorbed energy depends on a number of factor including leaf cellular structures (Gates et al. 1965; Kfipling, 1970; Woolley, 1971), leaf pubescence and roughness (Gausman, 1977), leaf morphology and physiology (Gausman et al., 1969 a, b; Gausman and Allen, 1973; Gausman et al., 1971) and leaf surface characteristics (Breece and Hommes, 1971; Grant, 1985).

Leaves are not perfectly diffuse reflectors but have diffuse and specular characteristics. Leaf transmittance tends to have a non Lambertian distribution, while leaf reflectance is dependent on illumination and view angles. Knowledge of soils radiation interaction with individual leaves is necessary for several reasons like special to interpret and process remotely sensed data. Typical reflectance and transmittance spectrum of a individual plant leaf indicate three distinct wavelength regions in interaction: visible (0. 4-0. 7 µm), near infrared (NIR) (0. 7-1. 35 µm) and mid infrared (mid IR) (1. 35-2. 7 µm). Thus the typical spectral curve of plant is divided into three prominent zones correlated with morphological/anatomical/physiological characteristics of the leaves and these are Pigment Absorption Zone, Multi-Dioptric Reflectance Zone and Hydric Zone, etc.

The analysis of all remotely sensed data involves models of many processes wherein the EM radiation is transformed (the scene, atmosphere and sensor) and whereby inference is made about the scene from the image data. The most common strategy for relating remote sensing data to vegetation canopies has been via the correlation of vegetation indices with vegetation structure and functional variables. This simple empirical approach has yielded substantial understanding of the structure and dynamics of vegetation at all scales. These indices are capable of handling variation introduced in a scene due to atmosphere or sensor and vegetation background influence in low vegetation cover areas.

The capacity to assess and monitor the structure of terrestrial vegetation using spectral properties recorded by remote sensing is important because structure can be related to functioning, that is to ecosystem processes that are ultimately aggregated up to the functioning of the local-regional-global level of ecosystem. The categorization of the various spectral indices in to approximately five types. Such as Ratio Indices, Vegetation Indices, Orthogonal based Indices, Perpendicular Vegetation Indices and Tasseled Cap Transformation, etc.

Remote sensing of cropland, forest and grassland involves the measurement of reflected energy of component in the presence of each other. The development and usefulness of vegetation indices are dependent upon the degree to which the spectral contribution of non-vegetation component can be isolated from the measured canopy response. Although vegetation indices have been widely recognized a valuable tools in the measurement and interpretation of ‘ vegetation condition’ several limitation have also been identified. They are related to soil brightness effect and secondary soil spectral deviations. The use of site specific soil lines reduces soil background influence. In this context SAVI, GRABS and PVI holds greater promise in low vegetated areas.

The vegetation indices are simplified method to extract information about vegetation parameter from multispectral data however, their use in spectral modeling needs to be studied in context of spectral dynamics of earth surface components.

Resume

Forest cover is an important natural resource for the environment and socio-eco on the surface of the earth. It can bridge the gap between nature and human beings conflicts. Changes in the forest land increase the imbalance in the ecosystem, climatic conditions, temperature, land degradation, drought prone zones, soil erosion, depending manmade activities, etc. The living tribes in the mountain hill as well as foot hill area utilized forest material for their domestic usages. Therefore, the objectives of detection and delineation of the forest land by using ordinary classification methods have been outlined in the present study. The methodology has been outlined in this chapter. The Landsat-5 TM and Landsat-7 ETM+ dataset has been suggested as a source of information to achieve the objectives of the study. The basic knowledge regarding spectral properties of the forest and physiographic elements as well as spectral vegetation indices area has been proposed for the second chapter to make information base study for image analysis, classification and interpretation in the next chapters.