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Agriculture and Remote Sensing Technologies

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Abstract

Every country's economy is extremely dependent on agriculture. It represents a sizable trading sector for a nation with a robust economy. In order to evaluate and visualize agricultural surroundings, remote sensing and geographic information systems have proven to be very useful for both industry and the farming community. For the sustainability of agriculture and natural resources, applications of various remote sensing techniques are crucial for crop monitoring, crop condition assessment, and yield estimation. The spectral data is a crucial component of remote sensing data for crop modelling, and it is closely related to canopy characteristics, which serve as indicators of the health and stage of growth of a crop. Analyzing land usage and land cover, as well as estimating damage from drought, floods, and other extreme weather events, are other areas where remote sensing and GIS can be utilized very well. The two most crucial inputs for agricultural meteorology are data on vegetation and meteorological. Applications of remote sensing technologies are crucial and a useful way to spot illness and insect infestations. It is one of the most useful instruments for evaluating and keeping track of water resources.

Keywords: Crop inventory, Geographic Information System (GIS), Pest infestation, Remote Sensing

Introduction

Agriculture has always been the backbone of various civilizations and continues to steer the present population. The production of food efficiently and effectively is the desire of every farmer or an organization. Remote sensing and Geographic Information System (GIS) find its way to analyze and visualize agricultural environments in order to predict the management strategies that would benefit the farming community. In other words, remote sensing can be defined as an art and science of gathering information about the object of

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interest without coming in direct contact. It is a technique that employs the use of electromagnetic spectrum *viz.*, visible, infrared and microwaves in order to monitor earth's resources or condition. Since the response varies from object to object, therefore these are rapidly used for distinguishing earth's features *i.e.*, vegetation cover, soil, water bodies, etc. In the field of agriculture, remote sensing is being increasingly used in crop growth monitoring, land use pattern and land cover changes, water resources mapping and water status under field condition, diseases and pest forecasting, yield estimation, precision farming and weather forecasting (Wang *et al.*, 2020). Remote sensing inputs combined with crop simulation models are very useful in crop yield forecasting. The other methods employed to collect data in real-time are time consuming and difficult to achieve the desired result. Hence, the remote sensing is gaining more importance for acquiring spatio-temporal meteorological and crop status information for complementing the traditional methods. Farmers have improved decision-making skills for scheduling their cultivation to maximize yields by using data gathered from remote sensors and sensors put directly on farm gear. The right preparation for accurate farming includes consideration of previous crop yields, topography features and the amount of organic matter in the soil, its pH, moisture content, and nutrient levels. Remote sensing and GIS technologies are quickly becoming important tools for monitoring crop growth, identifying and managing various pressures, estimating regional yields, and maintaining natural resources and agricultural production.

Crop Inventory

In order to identify crops and places where cropping patterns are changing, remote sensing (RS) and geographic information systems (GIS) are essential tools. They are also important for conducting crop surveys and mapping. For a government of a country with an agricultural economy, accurate and timely information about the types of crops planted, their area, and estimated output is crucial. The spectral data is a crucial component of remote sensing data for crop modelling, and it is closely related to canopy characteristics, which serve as indicators of the health and stage of growth of a crop. Crop-specific maps, which are useful to agribusinesses like seed and fertilizer companies, are produced by combining satellite images, survey data, and information on the layout of the land and its owners (farmers) (Kingra *et al*., 2016).

Nutrient and water stress

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For healthy growth and vitality, plants require sufficient amounts of nutrients, sunlight, and water. Macro-nutrients are more important than micro-nutrients as key components in the formation of plant cell and tissue. Nutrient and water stress management is one of the most significant domains where we can choose to apply remote sensing and GIS through the application of precision farming. It is crucial for site-specific nutrient management to identify nutrient challenges thereby lowering cultivation costs and improving the fertilizer use efficiency. By using precise technologies, it is possible to use water wisely in arid areas. Nutrient deficit is identified by using multi-spectral and hyper-spectral image analysis. Measurements of spectral reflectance that is responsive to various forms of nutrition and water stress. Crop water stress detection is essential for effective irrigation water management and in order to assure that crops won't suffer from water stress and will produce yield under limited water conditions, precision agriculture must monitor vegetation water stress using satellite technology. The regional and temporal dynamics of crop development under water stress and its effects on production may be provided through satellite data (Mee*et al.*, 2017).

Agro-meteorological application

Climate and meteorological events have a big impact on agriculture. The meteorological data are gathered using various point station observation networks in space. The ability of conventional agro-metrological techniques to utilize their data for forecasting yields and real-time agricultural monitoring is severely constrained. Several fundamental agro-metrological parameters, such as surface albedo, surface temperature, evapo-transpiration, solar radiation, and rainfall, have been made possible thanks to satellite meteorology. Significant rainfall at fortnightly intervals, minimum and maximum temperatures, and other factors that would be included in a correlation-weighted regression model were the main agro-meteorological inputs.The use of geostationary satellites for weather and climate remote sensing is recognized as the single most important development in the past years for tracking the Earth's vegetation, weather, and climate. These satellites measure ocean temperatures and terrestrial vegetation. Vegetation data and meteorological information are two of the most crucial inputs for agricultural meteorology (Wang *et al.*, 2020).

Pest infestation

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Applications of remote sensing technologies are a crucial and efficient way to spot diseased, infested, and invader-infested areas. Although spatial variability makes it difficult to investigate biological invasion trends, remote sensing has the potential to provide the necessary data because of its comprehensive perspective. Applications of remote sensing give data that is crucial for identifying and mapping defoliation, characterizing pattern disruptions, and more. If these changes can be connected, categorized, and interpreted, the remote sensing application in monitoring and analyzing insect defoliation has been utilized to relate variation in spectral responses to chlorosis, yellowing of leaves, and foliage decrease during a specific time period. Varying flying altitudes can produce different spatial resolutions for airborne remote sensing. Ground-based platforms are frequently used for weed infestation, crop disease, insect damage detection, and pest control. They also give important data for management planning and decision-making. Aerial color infrared photography using a normal camera has been used successfully to identify damage caused by a number of harmful pests (Huang *et al*., 2008).

Water management

At both the global and regional levels, there is a shortage of water resources, which necessitates cautious management of cutting-edge technologies. One of the efficient methods for evaluating and keeping track of water resources is remote sensing. In order to provide more precise estimates of the information needed for applications involving water resources, hyper-spectral remote sensing is emerging as a more thorough method of examining spatial, spectral, and temporal variations. The capacity to determine the availability of soil moisture using distant sensing data has been made possible by the development of microwave remote sensing. Groundwater is one of the most important natural resources because it promotes economic growth, ecological diversity, and human health. Our ecosystems and the survival of future generations are in danger due to the excessive use of this essential resource. The use of remote sensing (RS) and geographic information system (GIS) technology in groundwater hydrology has received less attention. Water management requires a thorough understanding of the physical world and the spatial data that surrounds it, such as watersheds, watershed sources, terrain surfaces, land uses, land covers, rainfall, temperature, humidity, soil conditions and composition, geology, atmospheric conditions, human activities, environmental data, etc. Remote sensing (RS) and geographic information system (GIS)

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technologies are also used to describe the issues, importance, and sustainable management of freshwater and groundwater (Welch and Re millard, 1991). As long as careful consideration is given to source materials and database building, the integration of geographic information systems and remote sensing techniques has permitted assessments of aquatic vegetation growth, salt marsh quality, and floodplain disturbances throughout time.

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