REMOTE SENSING

Remote sensing is defined as the art and science of gathering information about objects or areas from a distance without having physical contact with objects area being investigated.

Uses: Remote sensing techniques are used in agricultural and allied fields.

1. Collection of basic data for monitoring of crop growth
2. Estimating the cropped area
3. Forecasting the crop production
4. Mapping of wastelands
5. Drought monitoring and its assessment
6. Flood mapping and damage assessment
7. Land use/cover mapping and area under forest coverage
8. Soil mapping
9. Assessing soil moisture condition, irrigation, drainage
10. Assessing outbreak of pest and disease
11. Ground water exploration

Remote Sensing platforms:

Three platforms are generally used for remote sensing techniques. They are ground based, air based and satellite based. Infrared thermometer, Spectral radiometer, Pilot-Balloons and Radars are some of the ground based remote sensing tools while aircrafts air based remote sensing tools. Since the ground based and air based platforms are very costly and have limited use, space based satellite technology has become handy for wider application of remote sensing techniques. The digital image processing, using powerful computers, is the key tool for analyzing and interpretation of remotely sensed data. The advantages of satellite remote sensing are:

Synoptic view - Wide area can be covered by a single image/photo (One scene of Indian Remote Sensing Satellite IRS series cover about 148 x 178 sq.km area).

Receptivity - Can get the data of any area repeatedly (IRS series cover the same area every 16- 22 days).

Coverage - Inaccessible areas like mountains, swampy areas and thick forests are easily covered. Space based remote sensing is the process of obtaining information about the earth from the instruments mounted on the Earth Observation Satellites. The satellites are subdivided into two classes and the types of satellite are as follows:

Polar orbiting satellites

These satellites operate at an altitude between 550 and 1,600 km along an inclined circular plane over the poles. These satellites are used for remote sensing purposes. LANDSAT (USA), SPOT (FRANCE), and IRS (INDIA) are some of the Remote Sensing Satellites.

Geostationary satellite

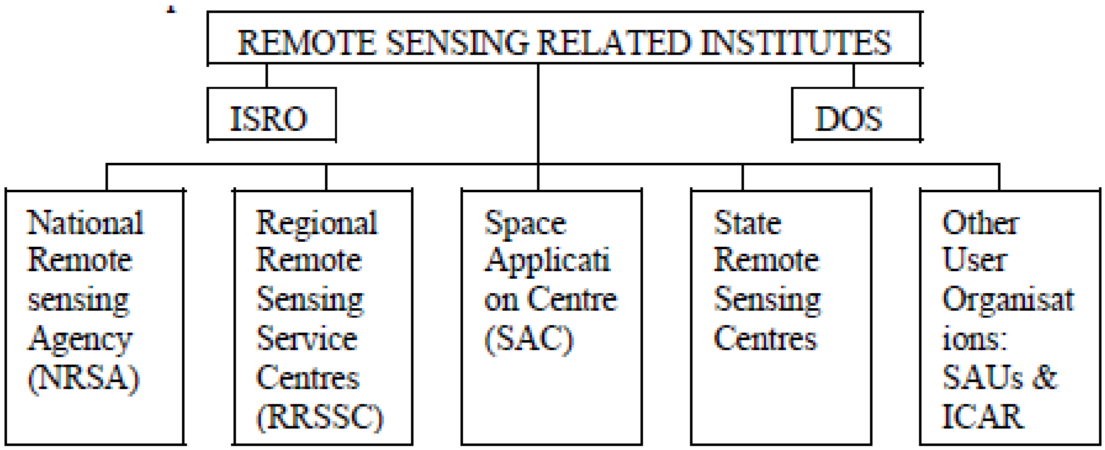
These have orbits around the equator at an altitude of 36,000 km and move with the same speed as the earth so as to view the same area on the earth continuously. They are used for telecommunication and weather forecasting purposes. INSAT series are launched from India for the above purposes. All these satellites have sensors on board operating in the visible and near infrared regions of the electromagnetic spectrum. INSAT-3A was launched on 10th April, 2003.

Role of Remote Sensing in agriculture

Agricultural resources are important renewable dynamic natural resources. In India, agriculture sector alone sustains the livelihood of around 70 percent of the population and contributes nearly 35 percent of the net national product. Increasing agricultural productivity has been the main concern since scope for increasing area under agriculture is rather limited. This demands judicious and optimal management of both land and water resources. Hence, comprehensive and reliable information on land use/cover, forest area, soils, geological information, extent of wastelands, agricultural crops, water resources both surface and underground and hazards/natural calamities like drought and floods is required. Season-wise information on crops, their acreage, vigour and production enables the country to adopt suitable measures to meet shortages, if any, and implement proper support and procurement policies. Remote Sensing systems, having capability of providing regular, synoptic, multi-temporal and multi-spectral coverage of the country, are playing an important role in providing such information. A large number of experiments have been carried out in developing techniques for extracting agriculture related information from ground borne, air borne and space borne data.

Indian Remote Sensing programme:

India, with the experience gained from its experimental remote sensing satellite missions BHASKARA-I and II, has now established satellite based operational remote sensing system in the country with the launch of Indian Remote Sensing Satellite IRS-IA in 1988, followed by IRS-IB (1992), IRS-IC (1995) and IRS-ID (1997). The Department of Space (DOS) / Indian Space Research Organisation (ISRO) as the nodal agency for establishing an operation remote sensing system in the country initiated efforts in the early 1970s for assessing the potentials of remotely sensed data through several means. In order to meet the user requirement of remote sensing data analysis and interpretation, ISRO/DOS has set up a system to launch remote sensing satellites once in three or four years to maintain the continuity in data collection. The remote sensing and some of its related institutes are depicted.



Crop weather modeling

Crop model

It is a representation of a crop through mathematical equations explaining the crops interaction with both above ground and below ground environment. The increase in dry matter of the crop is referred to as growth. The rate of growth of a healthy crop depends on the rate at which radiation is intercepted by foliage and / or on the rate at which water and nutrients are captured by root systems and therefore on the distribution of water and nutrients in the soil profile. The crop development is described in terms of various phenophases through which the crop completes its lifecycle. That is the progress of the crop from seeding or primordial initiation to maturity. Finally the yield of crop stand is expresses as a product of three components, viz., the period over which dry matter is accumulated (the length of the growing period), the mean rate at which dry matter is accumulated and the fraction of dry matter treated as yield when the crop is harvested. It is understood that the crop growth, development and yield depend upon the mean daily temperature (DTT), the length of the day and the amount of solar radiation (PAR) received by the crop.

$$DTT = \frac{\text{Max daily temperature} + \text{Min daily temperature}}{2} - \text{base temperature}$$

Where, DTT = Daily thermal time accumulation.

The time needed for the crop to reach a development stage depends upon temperature measured above a base value (DTT) and for photo periodically sensitive phases such as flowering, the day length above a fixed base. In the absence of stress, the harvest index does not vary much from year to year for a specified cultivar / variety. Therefore, crop weather modeling is based on the principles that govern the development of crop and its growing period based on temperature and / or day length. They are used to quantify the rate of crop growth in terms of radiation interception, water use and nutrient supply which moderate harvest index when the crops experience stress condition. The basic information required to be generated for crop weather modeling includes.

a) Crop phonology in relation to the temperature and day length

b) Water use by the crop during different phenophases of crop growth

c) The relationship between radiation interception, crop water use and total dry matter production

d) Partitioning of dry matter into various plant components as influenced by water and nutrient availability, and

e) The effect of weather parameters on biotic interference to crop growth.

Types of models

a) Statistical models

These models express the relationship between the yield or yield components and the weather parameters. The relationships are measured in a system using statistical techniques. Simple regression techniques explaining weather crop relationships are also considered as models.

b) Mechanistic model

These models explain not only the relationships between the weather parameters and the yield, but explain the relationship of influencing dependent variables.

c) Deterministic models

These models estimate the exact value of the yield or dependent variable. These models also have defined co-efficient.

d) Stochastic models

A probability element is attached to each output. For each set of inputs different outputs are given along with probabilities. These models define the yield or state of dependent variable at a given rate.

e) Dynamic models

Time is included as a variable. Both dependent and independent variables are having values which remain constant over a given period of time. Over a period of time these variables are changing due to change in rate of increment.

f) Static models

Time is not included as a variable. The dependent and independent variables having values remain constant over a given period of time.

g) Simulation models

Computer models in general, are a mathematical representation of a real world system. One of the main goals of crop simulation models is to estimate agricultural production as a function of weather and soil conditions as well as crop management. These models use one or more sets of differential equations over time, normally from planting until harvest maturity or final harvest.

h) Descriptive models

A descriptive model defines the behaviour of a system in a simple manner. The model reflects little or none of the mechanisms that are the causes of phenomena but consists of one or more mathematical equations. An example of such an equation is the one derived from successively measured weights quickly the weight of the crop where no observation was made.

i) Explanatory models

This model consists of quantitative description of the mechanisms and process that cause the behaviour of the system. To create this model, a system is analyzed and its process and mechanisms are quantified separately. The model is built by integrating these descriptions for the entire system. It contains descriptions of distinct processes such as leaf area expansion, tiller production etc. Crop growth is a consequence of these processes.

Climate change and variability

Climate change

Any permanent change in weather phenomena from the normals of a long period average is referred as climate change. Eg. The global temperature has increased by 2.0 to 3.0 C and increase in CO_2 from 180ppm to 350ppm.

Climate variability

The temporal changes in weather phenomena which is part of general circulation of atmosphere and occurs on a yearly basis on a global scale. Climate change and climate variability are the concern of human kind in recent decades all over the world. The recurrent drought and desertification seriously threaten the livelihood of over 1-2 billion people who depend on the land for most of their needs. The weather related disasters viz. drought and floods, ice storms, dust storms, land slides, thunder clouds associated with lightening and forest fires are uncommon over one or other region of the world. The year 1998 was one of the recent weather related disaster years, which caused hurricane house in Central America and floods in China, India and Bangladesh. Canada and New England in the U.S. suffered heavily due to ice storm in January while Turkey, Argentina and Paraguay with floods in June 1998. Vast fires in Siberia burned over three million acres of forests. Human and crop losses are the worst phenomena in such weather disasters, affecting global economy to a considerable extent. The 1997-

’98 El-Nino events, the strongest of the last century is estimated to have affected 110 million people and cost the global economy nearly US $ 100 billion. Statistics compiled from insurance companies for the period 1950-1999. Show that major natural catastrophes which are mainly weather and climate related caused estimated economic losses of US $ 960 billion. Most of the losses were recorded in recent decades. Increase in aerosols due to emission of green house gases including black carbon and chlorofluorocarbons (CFCS), ozone depletion, UV-B filtered radiation, cold and heat waves, global cooling and warming and "human hand" in the form of deforestation and loss of wetlands in the process of imbalanced development for betterment of human kind may be caused factors for climate variability and climate change.

Causes of climatic variability

A. External causes

i) Solar output: An increase in solar output by 0.3%when compared to 1650 -1700AD data.

ii) Orbital variation:

1. Earth orbit varies form almost a complete circle to marked ellipse (Eccentricity).
2. Wobble of earth’s axis (Precession of equinox) 3. Tilt of the earth’s axis of rotation relative to the plane of the orbit varies between 21.8^{o} and 24.4^{o}.

B. Internal causes

i) Changes in the atmospheric composition. Change in the green house gases especially CO2

ii) Land surface changes particularly the afforestation and deforestation

iii) The internal dynamics of southern oscillation – changes in the sea surface temperature in western tropical Pacific (El-Nino/La-Nina) coupled with Southern

Oscillation Index, the Tahiti minus Darwin normalized pressure index leading to the ENSO phenomena

iv) Anthropogenic causes of climate variation in green house gases and aerosols.

Effects of climate change

1. The increase concentration of CO_2 and other green house gases are expected to increase the temperature of the earth.

2. Crop production is weather dependant and any change will have major effects on crop production and productivity.

3. Elevated CO_2 and temperature affects the biological process like respiration, photosynthesis, plant growth, reproduction, water use etc. Depending on the latitude the CO_2 may either offer beneficial effect or may behave otherwise also.

El-Nino and La-Nina

El-Nino is a Spanish word meaning “the boy child” (‘Child Christ’) because El-Nino occurs around Christmas time each year when the waters off the Peruvian coast warm slightly. In every three to six years, the waters become unusually warm. 'El Ni□' is now used more widely to refer to this abnormal warming of the ocean and the resulting effects on weather. 'El Nino' is often coupled with 'Southern Oscillation' as the acronym ENSO. 'La Nino' is used popularly to signify the opposite of El Nino occurring when the waters of the eastern Pacific are abnormally cold. La Nino episodes are associated with more rainfall over eastern Australia, and continuing drought in Peru. Peruvian meteorologists have objected to term La Nino-the Girl Child-because Christ is not known to have had a sister, and the term anti-ENSO is sometimes preferred. The El-Nino event is due to decrease in atmospheric pressure over the South East Pacific Ocean. At the same time, the atmospheric pressure over Indonesia and North Australia increases. Once the El-Nino event is over, the atmospheric pressure over the above regions swings back. This sea-saw pattern of atmospheric pressure is called Southern Oscillation. Since El-Nino and Southern Oscillation are linked they often termed as ENSO. It is most important one, which represents a tendency for high atmospheric pressure over the Pacific Ocean, represents to be associated with low pressure over the Indian Ocean and vice-versa. A measure of the monsoon low pressure is the Southern Oscillation Index (SOI) represented by the difference in sea level pressure over Tahiti, an Island in South central pacific and Darwin in North Australia, which represents the northern part of the Indian Ocean. The positive SOI denotes high pressure over the central pacific and low over Indonesia, North Australia and Northern Indian Ocean. Above average rainfall is expected over India, India and Indonesia and North Australia if the SOI is positive. Drought or deficit rainfall is expected in the above countries if the SOI is negative, indicating high atmospheric pressure over Indonesia and low in the central pacific.