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Remote Sensing and GIS in Environment Management and Sustainability - Uses of Modern Technology to Conserve Environment

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ABSTRACT

Environment as a whole consist of Land, Water, Air and all the physical features that are directly and indirectly related with it. Today our Environment is in dire state and is getting depleted day by day. The world has entered in a technical era and everyday scaling new heights in technology, but everything have "cause effect relationship" and in this phase the effect is on environment. Now every country is facing environmental problems and the experts are on their toes to mitigate the risk in every possible way, it is kind of emergency that whole world is going through and the role of Modern information and technology has increased in manifolds. The technical capabilities of the sensors, space platform, data communication, GPS, Digital image processing system are contributing in level playing role.

The success of many applications of remote sensing is improved considerably by taking a multiple view approach to data collection. In the multistage approach, satellite data may be analyzed in conjunction with high altitude data and ground observations. Each successive data may provide more detailed information over smaller geographic areas. It is so broad in its application that nobody owns the field. The remote sensing data is useful in monitoring, managing earth resources and us to understand the global ecosystem.

Keywords: Remote Sensing, GIS, Environment Management, Global Ecosystem, Modern Technology

I. INTRODUCTION

Remote sensing is the acquisition of information about an object or phenomenon without making physical contact with the object, in contrast to in situ or on-site observation. The term is applied especially to acquiring information about the Earth and other planets. Remote sensing makes it possible to collect data of dangerous or inaccessible areas.

II. OBJECTIVES OF THE STUDY

- To study the various technological development techniques used in agriculture, land use, forestry, ocean relief features, atmospheric constituents etc.
- To find out the use of mapping in environment management
- Identification of the remote sensing data acquisition procedures to be employed and referenced data needed.
- Use of radar and other sensors for mapping and environment sustainability.
- Use of digital elevation model for surveying.

III. METHODOLOGY ADOPTED

Secondary data was taken from various books, research papers and articles. In this paper primary

data is also used from Remote Sensing and GIS books. As map is the highest geographical tool for a geographer to study the earth surface features. In this paper I am concluding the various techniques and information gathered from the remote sensing data for environment management and sustainability.

IV. VARIOUS TECHNOLOGIES USED

4.1. Conventional radar is mostly associated with aerial traffic control, early warning, and certain large-scale meteorological data. **Doppler radar** is used by local law enforcements monitoring of speed limits and in enhanced meteorological collection such as wind speed and direction within weather systems in addition to precipitation location and intensity. Other types of active collection include plasmas in the ionosphere. Interferometric synthetic aperture radar is used to produce precise digital elevation models of large scale terrain.

4.2. Laser and radar altimeters on satellites have provided a wide range of data. By measuring the bulges of water caused by gravity, they map features on the seafloor to a resolution of a mile or so. By measuring the height and wavelength of ocean waves, the altimeters measure wind speeds and direction, and surface ocean currents and directions.

4.3. Ultrasound (acoustic) and **radar tide gauges** measure sea level, tides and wave direction in coastal and offshore tide gauges.

4.4. Light detection and ranging (LIDAR) is well known in examples of weapon ranging, laser illuminated homing of projectiles. LIDAR is used to detect and measure the concentration of various chemicals in the atmosphere, while airborne LIDAR can be used to measure the heights of objects and features on the ground more accurately than with radar technology. Vegetation remote sensing is a principal application of LIDAR.

4.5. Radiometers and photometers are the most common instrument in use, collecting reflected and emitted radiation in a wide range of frequencies. The most common are visible and infrared sensors, followed by microwave, gamma-ray, and rarely, ultraviolet. They may also be used to detect the emission spectra of various chemicals, providing data on chemical concentrations in the atmosphere.

4.6. Radiometers are also used at night, because artificial light emissions are a key signature of human activity. Applications include remote sensing of population, GDP, and damage to infrastructure from war or disasters.

4.7. Stereographic pairs of aerial photographs have often been used to make topographic maps by imagery and terrain analysts in trafficability and highway departments for potential routes, in addition to modelling terrestrial habitat features.

4.8. Simultaneous multi-spectral platforms such as **Landsat** have been in use since the 1970s. These **thematic mappers** take images in multiple wavelengths of electromagnetic radiation (multi-spectral) and are usually found on Earth observation satellites, including (for example) the Landsat program or the IKONOS satellite.

4.9. Maps of land cover and land use from thematic mapping can be used to prospect for minerals, detect or monitor land usage, detect invasive vegetation, deforestation, and examine the health of indigenous plants and crops (satellite crop monitoring), including entire farming regions or forests. **Weather satellites** are used in meteorology and climatology.

4.10. Within the scope of the combat against desertification, remote sensing allows researchers to follow up and monitor risk areas in the long term, to determine desertification factors, to support decision-makers in defining

relevant measures of environmental management, and to assess their impacts.

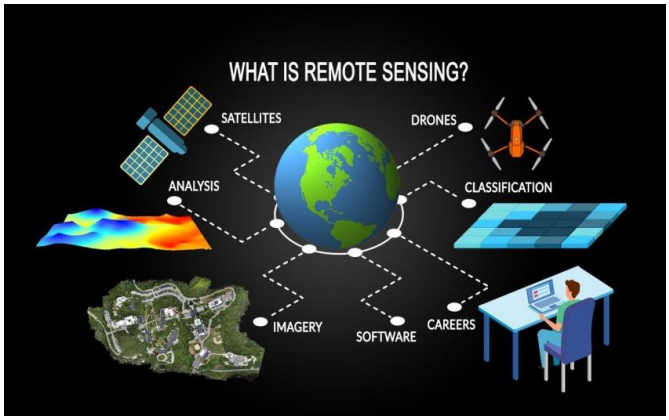


Fig.1: Remote Sensing
Source: EUMETSAT

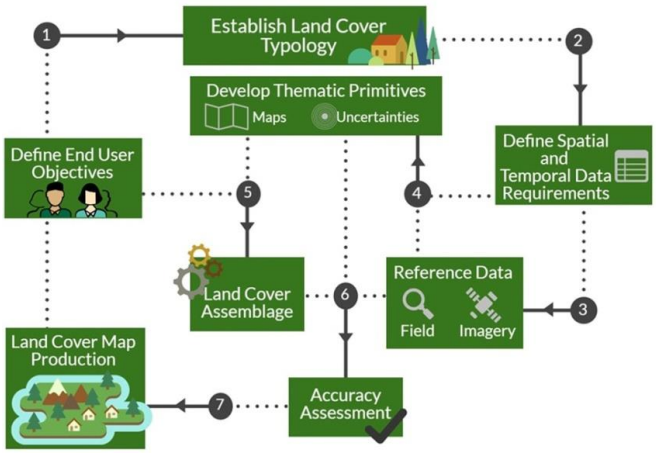
V. LAND COVER AND LAND USE

It refers to the surface cover on the ground, whether vegetation, urban infrastructure, water, bare soil or other. Identifying, delineating and mapping land cover is important for global monitoring studies, resource management, and planning activities. Identification of land cover establishes the baseline from which monitoring activities(change detection) can be performed, and provides the ground cover information for baseline thematic maps.

VI. LAND USE

It refers to the purpose the land serves e.g. recreation, wildlife habitat, or agriculture. Since timely information is required to know what current quantity of and is in what type of use changes from year to year. This knowledge will help develop strategies to balance conservation, conflicting uses and development pressures. Issues driving land use studies include the removal or disturbance of productive land, urban encroachment, and depletion of forests. Land use applications:-

- Natural resource management
- Urban expansion/encroachment
- Routing and logistics planning for seismic/ exploration/ resource extraction activities
- Target detection- identification of landing strips, roads, bridges, land/water interface



Source: EUMETSAT
Fig. 2 : Land Use

VII. LAND USE CHANGE (RURAL OR URBAN)

With multi temporal analysis, remote sensing gives a unique perspective of how cities evolve. The key element for mapping rural to urban land use change is the ability to discriminate between rural uses (farming, pasture forests) and urban use (residential, commercial, recreational). Remote sensing methods can be employed to classify types of land uses in practical, economical and repetitive fashion over large areas.

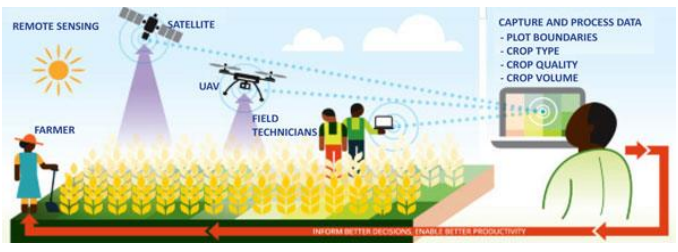
Radar sensors also have some use of all urban or rural delineation applications due to the ability to the imaging geometry to enhance anthropogenic features, such as building in the manner of corner reflections. The optimum geometric arrangement between the sensor and urban is an orientation of linear features parallel to the sensor movement, perpendicular to the incoming incident EM energy.

VIII. LAND COVER MAPPING

Regional land cover mapping is performed by almost anyone who is interested in the obtaining an inventory of land resources, to be used as a baseline map for future monitoring and land management. Biomass mapping provides quantifiable estimates of vegetation cover. Multi temporal data are preferred for capturing changes in phenology throughout the growing season. The information may be used in the classification process to more accurately discriminate vegetation type based on their growing characteristics. While optical data are best for land cover mapping, radar imagery is a good replacement in very cloudy areas.

IX. AGRICULTURE

The production of food is important to everyone and producing food is a cost effective manner is the goal of every farmer, large scale farm manager and regional agriculture agency. A farmer needs to be informed to be efficient and that includes having the knowledge and information products to forge a viable strategy for farming operations. These tools will help him understand the health of his crop, extent or infestation or stress damage, or potential yield and soil conditions. Satellite and airborne images are used for mapping tools to classify crops, examine their health and viability, and monitor farming practices. Through remote sensing, farmers can tell what water resources are available for use over a given land and whether the resources are adequate. Remote sensing technology is used in the estimation of air moisture which determines the humidity of the area. The level of humidity determines the type of crops to be grown within the area.



Source: EUMETSAT

Fig.3: Agriculture

9.1 Agriculture applications of remote sensing include the following

- Crop type classification
- Crop condition assessment
- Crop yield estimation
- Mapping of soil characteristics
- Mapping of soil management practices
- Compliance monitoring(farming practices)

X. CROP TYPE MAPPING

Traditional methods of obtaining this information are census and ground surveying. Remote sensing offers an efficient and reliable means of collecting the information required, in order to map crop type and acreage. Besides providing a symbolic view, remote sensing can provide structure information about the health of the vegetation. The spectral reflection of a field will vary with respect to changes in the phenology (growth), stage type, and crop health, and thus can be measured and monitored by multi spectral sensors. Radar is sensitive to the structure, alignment and moisture content of the crop and thus can provide complementary information to the optical data. Remote sensing technology can give accurate estimates of the expected crop yield in a planting season using various crop information such as the crop quality, the moisture level in the soil and in the crop and the crop cover of the land. When all of this data is combined it gives almost accurate estimates of the crop yield.

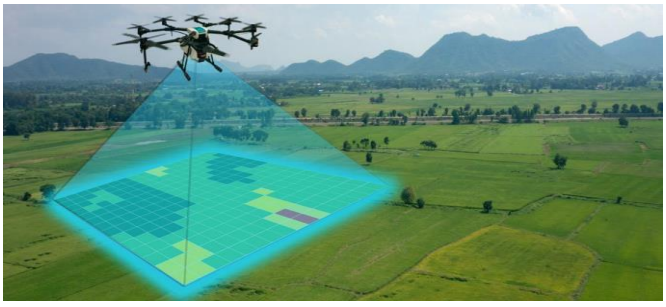


Fig.4: Crop Mapping
Source: EUMETSAT

Remote sensing technology has also helped farmers and other agricultural experts to determine the extent of crop nutrients deficiency and come up with remedies that would increase the nutrients level in crops hence increasing the overall crop yield. Remote sensing gives information on the moisture quantity of soils. This information is used to determine whether a particular soil is moisture deficient or not and helps in planning the irrigation needs of the soil. Remote sensing technology also plays a significant role in the identification of pests in farmland and gives data on the right pests control mechanism to be used to get rid of the pests and diseases on the farm.

XI. FORESTRY

Forests are a valuable resource providing food, shelter, wildlife habitat, fuel, and daily supplies such as medicinal ingredients and paper. Forests play an important role in balancing the EARTHS's CO2, supply and exchange, acting as a key link between the atmosphere, geosphere and hydrosphere. With increasing pressure to conserve native and virgin forests areas, and unsustainable forestry practices limiting the remaining areas of potential cutting, the companies involved in extracting wood supplies need to be more efficient, economical, and aware of sustainable forestry practices. Ensuring that there is a healthy regeneration of tress where forests are extracted will ensure a future for the commercial forestry time as well as adequate wood supplies to meet the demands of growing population. Forests are burned or clear cut to facilitate access to and use of the land. The practice offer occurs when the perceived need for long term sustainability is overwhelmed by short term sustenance goals. International and forestry applications where remote sensing can be utilized include sustainable development, biodiversity, land title and tenure(cadastre) monitoring deforestation, reforestation monitoring and managing, commercial logging operations, shoreline and watershed protection, biophysical monitoring (wildlife habitat assessment) and other environmental concerns.

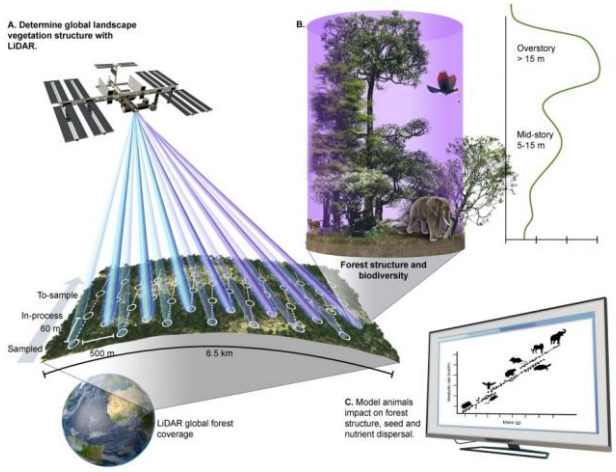


Fig. 5 : Forestry
Source: EUMETSAT

XII. GEOLOGY

It involves study of landforms, structure and the substances to understand physical processes creating and modifying the earth's crust. It is the most commonly understood as the exploration and exploitation of mineral and hydrocarbon resources, generally to improve the conditions and standards of living in society. Remote sensing is used as a tool to extract information about the land surfaces structure, composition or sub surfaces, but is often combined with other sources providing complementary measurements. Multi special data can provide information on lithology or rock composition based on special reflectance. Remote sensing is not limited to direct geology applications- it is also used to support logistics, such as route planning for access into a mining area, reclamation monitoring and generating base maps upon which geological data can

be referenced or superimposed. Geological applications of remote sensing are:-

- Lithological mapping
- Structural mapping
- Mineral exploration
- Baseline infrastructure
- Sedimentation mapping
- Geo hazard mapping

Fig. 6 : Geology
Source: EUMETSAT

XIII. FLOOD MANAGEMENT

Flooding conditions are relatively short term and generally occur during inclement weather, so optical sensors , although typically having high information content for this purpose, can not penetrate through the cloud cover to view the flooded region below. For these reasons, active SAR sensors are particularly valuable for flood monitoring. The SAR data is most useful when integrated with the flood image to highlight the flood effected areas and then presented in a GIS with cadastral and road network information. A sensor must be sensitive to moisture conditions, and radar satisfies this requirement better than optical sensors. Frequent and regular imaging is required during the growing season to follow the change in moisture conditions and a quick turn around is required for a farmer to respond to unsuitable conditions in a timely manner. Using high resolutions, images a farmer can target irrigation efforts more accurately. Using regional coverage allows an overview of soil and growing conditions of interest to agriculture agency and authority. This data can then be used to avert any flood disaster in future.

14. MAPPING

India is one of the world leaders in mapping technology. India's immense land area with a rich resource potential, coupled with a large population base has necessitate the development of thorough and efficient mechanism of investigation and land information. There is a growing demand of utilization of resources in map production since the following benefits may be provided stereo coverage, frequent revisits, timely delivery, wide area coverage, low labour intensity and storage in digital format to facilitate subsequent updating and compatibility with current GIS technology.

Developing countries are initiating mapping programs to cover large unsurvyed areas to increase their topographic and planimetric knowledge base. The derived information will be used to support territorial sovereignty issues, excess and monitor resource potential exploitation and encouraging economic opportunities.

XIV. OCEAN RELIEF FEATURES

Synthetic aperture (SAR) is sensitive to spatially varying surface roughness patterns caused by the interaction of the upper ocean with the atmosphere at the marine boundary and scanning radio meters and micro wave sounders collect sea surface data.

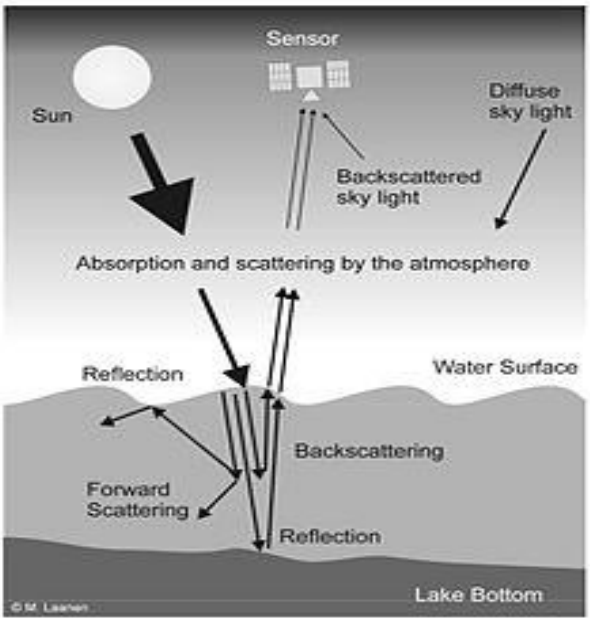


Fig. 7 : Ocean Relief
Source: EUMETSAT

XV. CONCLUSIONS

Remote sensing technologies are used in different fields of environment to enhance the management and sustainability. The agriculture, forestry, land use data are used to check the land, soil, irrigation, drought, flood with time. The year to year data is published by various agencies of remote sensing to enhance environment management. All the techniques or information are used in remote sensing data is helpful for the prediction of upcoming hazardous events e.g. floods and droughts.

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