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Remote Sensing and Geographic information Systems (GIS) for environmental and agricultural analysis: Worldwide.

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Abstract:

This article offers an overview of some current agricultural studies combining remote sensing and GIS. Biological land resources are very susceptible to regional differences in temperature, soil, and terrain and all of these aspects must be examined on a spatiotemporal basis for effective management and planning. Large swaths of land typically contain spatial differences in soil types, moisture content, nutrient availability, and other factors. Farmers may therefore more accurately identify what inputs to place exactly where and in what quantities by using remote sensing (RS), Geographical Information Systems (GIS), and global positioning systems (GPS). There are instances of use in urban studies, hydrological modelling such as land-cover and floodplain mapping, fractional vegetation cover and impervious surface area mapping, surface energy flux and micro-topography correlation investigations. Natural resource managers and academics will be able to construct management plans for a number of agriculture and forest resource management applications by combining remote sensing data, GPS, and GIS. Examples of remote sensing and GIS applications in agricultural and forest resource monitoring were examined in this chapter.

Keywords: Geographical Information Systems (GIS), Remote Sensing (RS), Environment, Agriculture.

Introduction:

Agriculture is the backbone of Indian economy and the pivotal sector for ensuring food security. Timely availability of information on agriculture is vital for taking informed decisions on food security issues. India is one of the few countries in the world that uses space technology and land-based observations for generating regular updates on crop production statistics and providing inputs to achieve sustainable agriculture. Satellite-based optical and radar imagery are used widely in monitoring agriculture. Radar imagery is especially used during monsoon season. Integrated use of geospatial tools with crop models and in-situ observation network enables timely crop production forecasts and drought assessment & monitoring. This is wise advice that sets the stage nicely for addressing commercial uses and research potential for geographic information systems (GIS). GIS are becoming more popular in business because they are strong tools that can be used to unlock the amount of information that is tied up in data that identifies location (e.g., addresses, zip codes, counties, latitude and longitude). GIS is a decision-making tool that enables users to combine geographical data (e.g., maps) with databases comprising attribute and other sorts of data (e.g., images or graphs). The geographical link between items may be included into studies, which is one of the major elements that separate GIS from other information systems.

Perhaps the most pressing worry for all of us now is the preservation of the environment in which we live and breathe. Climate change is wreaking havoc on the environment, with irregular weather patterns affecting everything from grain output to the premature melting of ice glaciers. There is a lot to be concerned about, and fast action is essential. It's not that the world hasn't prepared to take remedial measures, but we need to do more, and GIS can help us do so. GIS is an extremely useful tool. It enables every sector to function better, including the environment.

The concerns confronting humanity today are the preservation of the natural environment and the maintenance of a high quality of life. When carrying out development operations, the assimilative capacities of the environmental components, namely air, water, and land, are seldom considered. The unplanned and unpredictable nature of development activities leads to overuse, congestion, unsuitable landuse, and bad living circumstances. As a result, environmental contamination is becoming a contentious issue in a high-risk setting.

Remote Sensing:

In contrast to on-site observation, remote sensing is the collecting of information about an item or phenomena without establishing physical contact with the thing. Remote sensing is used in a wide range of fields, including geography, land surveying, and the majority of Earth Science disciplines (for example, hydrology, ecology, oceanography, glaciology, and geology); it also has military, intelligence, commercial, economic, planning, and humanitarian applications.

Remote Sensing: Overview

There are two types of remote sensing methods: passive remote sensing and active remote sensing. Passive sensors collect radiation produced or reflected by the item or its surroundings. The most prevalent source of radiation recorded by passive sensors is reflected sunlight. Film photography, infrared, charge-coupled devices, and radiometers are all examples of passive remote sensors. Active collection, on the other hand, produces energy to scan objects and spaces, after which a sensor detects and measures the reflected or backscattered radiation from the target. RADAR and LiDAR are instances of active remote sensing, in which the time delay between emission and return is monitored to determine an object's location, speed, and direction.

Geographical Information Systems (GIS):Overview

Geographical Information System (GIS) integrates location data with both quantitative and qualitative information about the area, allowing you to display, analyse, and present data via maps and charts.

You may use the technology to answer questions, run what-if scenarios, and display the outcomes. GIS is defined as a system used to manage infrastructural assets, natural resources, and any other things as needed. GIS-stored facility and asset data is easier to analyse and manage, making design, construction, and maintenance more efficient and lucrative.

Geographic information systems (GIS) are used in a variety of technologies, processes, approaches, and procedures. They are linked to a variety of activities and applications in engineering, planning, management, transportation/logistics, insurance, telecommunications, and business. As a result, geographic information systems (GIS) and location intelligence applications are at the heart of location-enabled services that rely on spatial analysis and visualisation.

GIS enables the linking of previously unconnected data by employing location as the "key index variable." Locations and extents observed in Earth's spacetime can be documented using the date and time of occurrence, as well as x, y, and z coordinates, which denote longitude (x), latitude (y), and elevation (z).

Geographical Information Systems and Agriculture:

The overall improvement of technology in the last few decades has aided GIS in agriculture.

GIS in agriculture is all about evaluating the land, displaying field data on a map, and putting that information to use. Precision farming, which is powered by GIS, helps farmers to make educated decisions and take action in order to get the most out of each acre while minimising environmental impact.

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In terms of equipment, satellites, aeroplanes, drones, and sensors are used in agricultural geospatial technology. These applications are used to create pictures and link them to maps and non-visualized data. As a consequence, you'll obtain a map with crop position and health status, topography, soil type, fertiliser, and other relevant data.

- **Crop yield forecasting**: Accurate yield prediction can assist governments in ensuring food security and companies in forecasting revenues and budgeting. The current advancement of technologies integrating satellites, sensors, big data, and artificial intelligence (AI) can enable those forecasts.
- **Crop health surveillance:**Manually inspecting crop health across numerous acres is the least efficient approach. This is where remote sensing mixed with GIS in agriculture comes in handy.Satellite photos and input data may be used to analyse environmental factors such as humidity, air temperature, surface conditions, and others across the field. Precision farming, which is based on GIS, may improve such an assessment and assist you in determining which crops require more care.
- **Livestock surveillance:**The tracking of particular animal movement is the most basic application of farm GIS software in animal husbandry. This allows farmers to locate them on a farm and track their health, fertility, and nutrition. GIS services that enable this include trackers mounted on animals and a mobile device that receives and visualizes data from the trackers.Here's an illustration. You want to keep an eye on the weight of your beef cattle. Each animal has a tracker attached to its ear or neck. When the animal steps on the digital scales, the scales scan its ID and apply a new value to that ID in the system.
- **Control of flooding, erosion, and drought:** Combining GIS with agriculture can aid in the prevention, assessment, and mitigation of natural disasters. Flood inventory mapping techniques can be used to detect flood-prone locations. Data such as previous floods, field studies, and satellite pictures must be gathered. Use the data to generate a dataset for training a neural network to detect and map flood hazards, and you'll have the ideal disaster management tool.
- **Irrigation management:**Keeping a watch on huge fields to ensure that each crop receives adequate water is a difficult chore, but one that geoinformatics in agriculture can readily handle.Aircraft and satellites outfitted with high-resolution

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cameras provide photos that AI systems may use to quantify water stress in each crop and identify visual patterns underlying water shortages.

- **Control of insects and pests:** Infestation, or the introduction of hazardous insects and pests, causes significant damage to agriculture. A bird's-eye view can offer precise, timely alarms to avert this. The alternative would be to employ artificial intelligence. You construct a neural network and train it with deep learning methods. During this training, you send photos of contaminated land to the neural network, and the network learns to detect samples that indicate infestation. Following that, you send it satellite photos of the terrain to be studied.

Geographical Information Systems and Environment: GIS is a great tool for analysing and planning environmental data. GIS is a computer mapping environment that contains spatial information (data). To visualise geographical information and relationships, a digital basemap can be layered with data or additional layers of information onto a map.Role of GIS in environment given below:

- **GIS applications in disaster management:** GIS can assist mitigate the risks of a catastrophe to a large level, whether it is modelling through early warning systems or utilising decision support systems to identify which disaster is likely to hit or is already affecting which region the most. Using GIS, preparations may be improved, efforts can be more targeted, and responses can be delivered more quickly. GIS allows response personnel to establish situational awareness, interact with the public, and comprehend the magnitude of the catastrophe. Recovery becomes easier and faster since GIS allows for improved identification of damaged regions and persons.
- **Environmental Impact Assessment:** Many human activities, such as the building and operation of roadways, rail tracks, pipelines, airports, radioactive waste disposal, and others, have the potential to have negative environmental consequences. Environmental impact statements are often required to include particular information on the size and features of the environmental effect. The EIA may be completed effectively with the use of GIS; by merging several GIS layers, natural aspects can be assessed.

- **The use of geographic information systems (GIS) in forest fire control:** Flora and animals suffer greatly as a result of wildfires. The first and most important technique for defending forests against wildfire is to avoid it. GIS has demonstrated its use in the control of forest fires. There are several GIS applications in forest fire management, the most prominent of which being danger map creation, forest fire modelling, and resource management. Simulation plays a significant part in forest fire management.
- **Volcanic Hazard Identification:** Hot avalanches, hot particulate gas clouds, lava flows, and flooding are all examples of volcanic hazards to human life and the environment. Potential volcanic hazard zones may be identified using historical records of volcanic activity, which can be integrated with GIS. As a result, an impact assessment research on volcanic risks addresses economic loss as well as loss of life and property in heavily populated regions.
- **Natural Resource Management:** Agricultural, water, and forest resources may be better maintained and managed with the use of GIS technology. Foresters can simply monitor the state of the forest. Crop yield management, crop rotation monitoring, and other tasks are all part of agricultural land management. Water is one of the most important components of the ecosystem. Spatial information systems (GIS) are used to examine the geographic distribution of water resources. They are interconnected, for example, forest cover minimizes storm water runoff and tree canopy stores roughly 215,000 tons of carbon. Afforestation also makes use of GIS.

Remote Sensing and Agriculture: The collecting of information about an object or phenomena without establishing direct touch with the thing is referred to as remote sensing. It is a phenomenon with multiple applications such as photography, surveying, geology, forestry, and many more. However, remote sensing has found widespread application in agriculture. Remote sensing has a wide range of uses in agriculture. A summary of these applications is provided below.

- **Crop production projections:** Remote sensing is used to anticipate agricultural output and yield across a certain region, as well as to calculate how much of the crop will be harvested under various conditions. Researchers can forecast the amount of crop that will be produced in a specific acreage during a certain time period.

- **Crop damage and crop progress evaluation:** In the case of crop damage or crop progress, remote sensing technology may be utilised to infiltrate fields and evaluate how much of a certain crop has been destroyed as well as the status of the remaining crop on the farm.
- **Identification of Crops:** Remote sensing has also played a significant role in crop identification, particularly when the crop under observation is strange or has certain unexplained traits. The crop data is gathered and sent to labs where many characteristics of the crop, including crop culture, are investigated.
- **Cropping Systems Analysis in Horticulture:** Remote sensing technology has also been used to analyse various agricultural planting strategies. This technique has mostly been used in the horticultural business, where flower development patterns may be examined and predictions produced.
- **Determination of the water content of field crops:** Aside from assessing the moisture level of the soil, remote sensing is also useful in estimating the water content of field crops.
- **Detection of crop nutrient deficiency:** Remote sensing technology has also assisted farmers and other agricultural professionals in determining the amount of crop nutrient insufficiency and developing therapies to boost nutrient levels in crops, hence enhancing crop production.
- **Drought monitoring:** Weather trends, especially drought patterns, are monitored using remote sensing equipment over a defined area. The data may be used to forecast rainfall patterns in a certain region, as well as to calculate the time difference between the present rainfall and the next rainfall, which aids in keeping track of the drought.
- **Estimation of soil moisture:** Without the assistance of remote sensing equipment, measuring soil moisture can be challenging. Remote sensing provides soil moisture data, which aids in assessing the amount of moisture in the soil and, as a result, the type of crop that may be cultivated in the soil.

Remote Sensing and Environment: In recent years, there has been a surge in the use of remotely sensed data in natural resource mapping and as a source of input data for environmental process modelling. With the availability of remotely sensed data from numerous sensors on multiple platforms with a wide variety of spatiotemporal, radiometric, and spectral resolutions, remote sensing has emerged as possibly the finest source of data for large scale applications and research. Role of remote sensing in Environmental study given below:

- **Weather statistics from the past and present:** Remote sensing technology is great for collecting and storing historical and current weather data for future decision making and prediction.
- **Monitoring of climate change:** Remote sensing technology is critical for monitoring climate change and keeping track of climatic conditions, which play a part in determining what crops may be cultivated where.
- **Estimation of air moisture:** The assessment of air moisture, which determines the humidity of the environment, is done using remote sensing technologies. The sort of crops that may be cultivated in the location is determined by the degree of humidity.
- **Natural resource management:** Natural resources are precious, and as such, they are vulnerable to theft and misappropriation; remote sensing techniques are employed to counteract these actions. The satellite sensor captures all ongoing activity on the site, which considerably aids in the reduction of incidents of abuse and theft.
- **Detecting physical properties:** Sensors can identify an area's physical qualities by measuring the reflected and emitted radiation. This aids in the documentation of a certain area's or region's history since scholars can foresee and detect things in that area.
- **Natural catastrophe management:** Natural disasters pose a significant hazard to the ecosystem, and as such, they must be mitigated and regulated. Remote sensing is a valuable tool for controlling and managing fires, fires, drought, desertification, and other natural disasters. Remote sensors, such as satellite sensors, are used to

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restrict the spread of fire during a forest fire outbreak, for example, since they can map a greater space, allowing rangers to observe the area impacted by the fire.

Conclusion:

Today, we face a variety of environmental concerns, ranging from the supply of fresh water to the deterioration of terrestrial and aquatic ecosystems, soil erosion, changes in atmospheric chemistry, the possibility of climate change, and so on. It is critical to leverage cutting-edge technology such as remote sensing and GIS to successfully implement these projects. With a single click, decision makers may view all of the farmlands, together with their associated information and present state. Traditional methods of production estimation and crop damage assessment take a month or two and a large amount of people to complete. Before acquiring a yield map, a farmer should determine the variation of elements within the fields that impact crop output. A yield map should only be used as verification data to quantify the effects of variance in a field. Other than yield maps, management methods and prescriptions will most likely be based on other sources.

To summarise, geographic information system (GIS) technology will continue to play an important role in environmental system management. When needed, GIS becomes the principal store of information that can be rapidly accessed and seen. GIS is becoming increasingly useful for emergency operations and is including capabilities that enable for real-time information presentation. The usage of GIS allows for faster access to information, increased safety, efficiency, and better resource management decisions.

You may discover papers and research on the use of GIS in agriculture dating back to the early 1990s. Agriculture's goals haven't altered much since then, nor have the problems that GIS is anticipated to answer.

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