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Geospatial Techniques and Their Natural Resources Roles

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ABSTRACT

Remote sensing and Geographical Information System (GIS) provides an ample chance to monitor and manage natural resources at multi-temporal, multi-spectral and multi-spatial resolution. It is an essential need to comprehend the specific capabilities of a ever-expanding variety of picture sources and analysis methods for natural resource management. In this study, we collect the different applications of remote sensing and GIS technologies that may be utilized for natural resource management (agricultural, water, forest, soil, natural hazards). The information is helpful for the natural resource managers to comprehend and more effectively work with remote sensing scientists to develop and use remote sensing research to accomplish monitoring goals.
Key words: Remote sensing, Island, Soil and water resources, Irrigation, Mapping.

Introduction

In recent years, remote sensing data has been extensively utilised in different natural resource management disciplines. With the availability of remote sensed data from multiple platform sensors with a broad variety of spatiotemporal, radiometric and spectral resolutions, remote sensing has become the greatest source of data for large-scale applications and research. Exhaustive data from remote sensing is currently used as input data for various environmental process models (Melesse et al., 2007).

The combined use of distant sensing data, GPS and GIS will allow consultants and natural resource managers and researchers in government agencies, conservation groups and industry to create management plans for a range of natural resource management applications (Philipson & Lindell, 2003). It is a possible tool for studying land cover change, forest density, coastal morphology, reef condition, and island biodiversity even if at remote area.

Application in Agriculture

Potential usefulness of utilising remote sensing platforms to get real-time agricultural landscape evaluations has been enhanced. Precision agriculture is a production method that, depending to site circumstances, supports varied management techniques within a field. This system is built on new technology tools and information sources (Walker *et al.*, 2019). These include global positioning (GPS), geographic information systems (GIS), yield monitoring devices, soil, plant and insect sensors, remote sensing and input variable technology (Seelan *et al.,* 2003).

Remote satellite sensing, in combination with geographic information systems (GIS), was extensively used and acknowledged as a strong and effective technique for identifying land use and land cover change (Walker *et al.,* 2018). It offers cost-effective multi-spectral and multi-temporal data, making them useful for understanding and monitoring trends of land development.

GIS technology offers a flexible environment to store, analyse and display digital data needed for change detection and database building. Satellite imagery was utilised to monitor discrete land cover types by spectral categorization or to estimate land surface biophysical parameters through linear correlations with spectral reflections or indices (Steininger, 1996). In Andaman Island, it was utilised to locate and map rice-growing regions and evaluate soil limitations.

Application in Soil Science

Natural soil characteristics are geographically varied, therefore better accuracy and broader applicability should be calculated as continuous variable rather than point values (Burrough 1993). Moreover, the conventional method of soil research and interpretation is tedious and time-consuming, making kriging and its variations generally acknowledged as an essential spatial interpolation tool in soil resource inventories (*Hengl et al.,* 2004).

In this context, with the development of GIS and remote sensing technologies, predictive soil mapping methods have been created. In situ point measurements of soil quality may be performed using comprehensive satellite derived indices and the correlation is scaled to wider geographical regions.

Space maps are also suitable for geographically dispersed models. Gopal Krishan *et al.,* (2009) utilised remote sensing plant cover, slope and erosion condition to define four main land degradation categories: undegraded, moderately degraded, degraded and severely degraded. Velmurugan and Carlos effectively utilised remote sensing and GIS for natural resource mapping and soil taxonomy research (2009).

Application in Crop-Irrigation Demand Monitoring

Agriculture is the major water user, using more than 70% of world freshwater. Thus, irrigation water's function plays a major role in improving land production. Land surface evapotranspiration (ET) is one of the major water balance components responsible for water loss (Michailidis *et al.,* 2009) and is of primary importance for environmental applications such as optimising water usage, irrigation system performance, crop water deficit, etc.

In many dry and semi-arid agricultural areas, inadequate irrigation timing and inadequate water applications are ubiquitous issues limiting agricultural output. Remote sensing technology has developed as an efficient tool in monitoring irrigated fields across a range of climatic conditions and locales during the last several decades. It helps to determine when and how much to irrigate by monitoring plant water status, measuring evapotranspiration rates, and calculating crop coefficients. Effective utilization of surface water and monitoring the use of water using remote sensing methods was a subject of considerable concern for water policy officials in irrigation.

Application in Crop Modelling

It is possible to integrate crop models with remote sensing to assess yield variables using remote sensed data at each time step in model simulations, thus remote sensing enables us to complete the missing model parameters during field scale recalibration (Batchelor *et al.,* 2002). Additionally, data from crop models may be transferred from the field scale to the regional size (Priya and Shibasaki, 2001). Multiple methods of combining remote sensing data with crop models were proposed (Wiegand *et al.,* 1986 and Dele colle *et al.,* 1992). One approach is to estimate LAI (leaf area index) values using remote sensing to calibrate crop models. Other approach is early predictions of final yield; however this technique requires numerous remote sensing data to be used in crop models throughout the growing season.

Integrated remote sensing data with crop models to assimilate stress measurement methods (*Baret et al.,* 2006). GIS crop and soil model may be used to identify methane emissions from fields (Matthews *et al.,* 2000), similarly used to predict global food production and global warming effects using GIS and crop model. Remote sensing has many methods to decrease crop model uncertainty. One option is that remote sensing pictures may be used to categories agricultural areas and crop kinds, thus crop models may be chosen to utilise soil input data with this classification. Remote sensing may also be utilised to estimate crop growth indicator coupled with agricultural models.

Application in Water Resource management

Water as a resource is essential to human life. Over the years, fresh water supply for human use has declined, while rising population demand is rising.

In this environment, there is an urgent need to monitor and get a better knowledge of its usage, providing knowledge that may help create efficient water management policies and infrastructures. This may be of vital significance, especially in areas where water is scarce. Understanding the complicated water system needs a comprehensive approach to combine water resource management concepts and ideas from various disciplines. A field-scale research provides initial insights to build a comprehensive knowledge of the water cycle mechanisms. (Biswas *et al.,* 2018)

Political choices are taken at regional to national level, however, and it is thus essential to rationally upgrade field-scale research at regional or national level. Hydrological models are commonly employed for this purpose, but frequently have data shortages or lack of quality input data. Remote sensing technologies would therefore be a potential tool for integrating data in data-scarce areas with the models. Launching numerous Earth Observation (EO) sensors from sophisticated satellites enables continuous measurements of different hydrological components worldwide, which are important input data for hydrological modelling. Data gaps owing to lack of on-the-ground monitoring of worldwide water resources are now accessible via satellite collection.

Thus, satellite products and advanced water management computing methods may play a significant role in current and future water resources. Remote sensing for hydrological purposes includes, but not limited to, rainfall (Global Precipitation Measures (GPM) and Tropical Rainfall Measuring Mission (TRMM); soil moisture (Soil Moisture Active Passive (SMAP) and Soil Moisture Ocean Salinity (SMOS); Evapotranspiration with Internalized Calibration (METRIC) and Surface Energy Balance Algorithm for Land (SEBAL); Gravity Recovery and Climate Experiment (GRACE) (Bastiaanssen et al., 1998; Liu, 2012; Sun, 2013). Using satellite data and GIS can map water bodies such as rivers, lakes, dams and reservoirs in 3D. Spatial availability maps may be produced. The authorities involved may utilise the information to identify sites or areas that require effective protection and management, and choices may be taken on sustainable water resource management in designated areas.

Application in Water Quality Monitoring

Frequent water quality monitoring is needed to maintain and enhance human consumption quality. Measurements and laboratory analysis of water samples are presently utilised to assess water quality (Kumar *et al.,* 2021). While such measures are correct at a point in time and place, they do not provide the spatial or temporal picture of water quality required for proper evaluation or management of water bodies. Moreover, they are costly and time-consuming and cannot meet the regional or national monitoring needs. (Maurya *et al.,* 2017)

Remote sensing may be used to monitor parameters of water quality (i.e. suspended sediments (turbidity), chlorophyll, and temperature). Optical and thermal sensors on boats, planes and satellites offer both geographical and temporal information required to monitor changes in water quality indicators to create water quality management strategies.

Remote sensing was also utilised to estimate chlorophyll concentrations geographically and temporarily based on empirical radiance or reflection correlations (Ritchie *et al.,* 1994). The empirical connections (algorithms) between the concentration of suspended sediments and radiance or reflectance for a particular date and location were established over many years to forecast water quality (Ritchie and Cooper, 1991).Forest management and wildlife analysis. Forest is a crucial organ of our ecology; it affects our life in many ways, but the global forest has declined at an alarming pace (Kumar *et al.,* 2015).

Sustainable management can restore forest cover as a renewable resource. Thus, utilising remote sensing data and GIS methods, a forest manager may produce information on forest coverage; forest kinds within an area of interest, human encroachment on forest land/protected areas, desert encroachment like circumstances, and so on. This information is important to the creation of forest management plans and decision-making processes to guarantee that appropriate policies are put in place to regulate and regulate how forest resources may be used. Using multicriteria analysis, the appropriateness and condition of sites/forest area for a certain animal species may also be evaluated using remote sensing data.

Application in Natural Disaster Management

Substantial multi-temporal spatial data is needed to handle natural catastrophes such as floods, earthquakes, volcanic eruptions and landslides. In this context, remote satellite sensing is an excellent instrument that provides information over vast regions and at short intervals that may be used in different stages of disaster management, such as prevention, preparation, relief, rebuilding, early warning and monitoring. In addition to remote sensing, GIS methods are needed to handle large geographical data sets and have gained significance in disaster management (Van Westen, 2000).

Conclusion

With rising strain on natural resources owing to growing human population, remote sensing and GIS may be utilised effectively and efficiently to manage these valuable finite resources. Geospatial information is helpful in identifying and analysing variables affecting the usage of these resources. Thus, with a thorough knowledge of these variables, appropriate choices may be made to guarantee the sustainable use of natural resources to satisfy current and future generations' requirements.

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