Mini Review

Environment and biodiversity conservation studies with remote sensing and GIS

Abstract

Remote sensing (RS) is used for identify, measure and analyze characteristics of objects of interest without direct contact; and Geographic Information System (GIS) facilitates storing, manipulating and retrieving spatially referenced data. Together RS and GIS offer the ability of rapid collection, process and integrate data and display results in geographic referenced maps and reports. Satellite remote sensing techniques may offer a proficient and cost-effective means of acquiring timely data for the advancement and management of natural resources. RS and GIS is the only technique that can provide holistic approach to study the environment and interrelationships that exist within the different biophysical components. Integrated RS and GIS technology offers incredible opportunities in agriculture for cost effective management of causes of crop stress. Its application is rapidly increasing in the area of hydrogeology and water resources development and can investigate urban landscape, physiognomy, lakes, plants, places of interest, land consumption, building and population distribution rapidly. In agriculture, it provides the solid technological foundation for agricultural statistics. Agriculturalists can measure growth rate changes caused by stress like salinity, drought, temperature, etc.

It can also be applied for coastal environment management and monitoring due to its effective data acquiring capacity and resource management. Satellite remote sensing is a promising tool for conservation issues and is instrumental in environment impact assessment. Plant disease detection due to environmental and epidemiological factors can be monitored in crop stands. Contribution to human health has been done by utilizing the intelligence on the distribution and abundance of cyanobacteria in internal water bodies thus aid risk assessment and management. It is now possible to synergistically combine lower resolution geostationary ocean color sensor with high resolution polar orbiting sensor to provide frequency with high special resolution. This article provides a survey of applications and recent theoretical developments in the context of remote sensing data analysis and GIS.

Keywords: remote sensing, geographic information system, disease, stress, health, agriculture

Volume 5 Issue 2 - 2017

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Received: October 25, 2016 | **Published:** February 20, 2017

Introduction

Remote sensing (RS) in recent years has proved to be of immense significance in acquiring information for effective resources management. Further, the application of Geographical Information System (GIS) in analyzing the trends and estimating the changes that have occurred in different themes helps in management decision making process. In particular, GIS and remote sensing technologies together offer the abilities of rapidly collecting data, processing and integrating data and information, and displaying results in geographic referenced maps and reports. Now-a-days the field of RS has become exhilarating and fascinating with quickly increasing opportunities. A GIS based integrated approach can be used for the risk management of natural hazards.[1] Nowadays, the remote sensing technology can be used to investigate urban terrain, physiognomy, lakes, plants, sights, traffic, land utilization, building and population distribution quickly.

In disease

Schistosomiasis and malaria are both water-related parasitic diseases which affects millions of people worldwide particularly in subtropical and tropical regions. Malaria is found in 72 out of 78 provinces in the Philippines, while schistosomiasis is prevalent in 24 provinces. The Oncomelania snail and Anopheles mosquito occupied in the transmission of these diseases rely on assured ecological determinants that sustain snail and mosquito. RS and GIS can be efficiently used in viewing how these environmental factors influence the spatial allocation of these two diseases. Geo referenced data facilitate revelation of predominance data in relation to physical maps thus facilitating measurement of disease circumstances. Closeness to irrigation networks, snail breeding sites and highly agricultural character of the barangays were recognized as the most prevalent factors that define the high predominance areas for schistosomiasis confirming the information that surroundings that support the snail populations will in turn favour the occurrence of the disease. The predictive models for malaria incorporated humidity, temperature, soil type, presence of cultivated areas, predominance of reproduction brush, distance from conventional water source and deep wells which consecutively inclined by the factor of elevation.[2]

In Thailand, papaya is an economically significant plant for household utilization and export. Nevertheless, papaya is tremendously at risk to disease caused by the papaya ring spot virus. Windborne-pollen dispersion of papaya was investigated using GIS and RS data. Pollen traps were placed around a papaya plot in eight geographic directions.[3]

Remote sensing and near-range techniques have demonstrated an elevated skill in detecting diseases and in observing crop stands for sub-areas with contaminated plants. The incidence of plant diseases relies on definite epidemiological and environmental diseases; therefore, frequently have erratic distribution in the field. Imaging systems are preferable for the monitoring and detection of plant diseases over non-imaging systems. To exploit the full potential of these highly advanced, pioneering technologies and high dimensional, complex data for precision crop protection, a multi-disciplinary approach including engineering, plant pathology and informatics is required. Besides precision crop protection, plant phenotyping for resistance breeding or fungicide selection can be optimized by these inventive technologies.[4]

Plant stress

Integrating remote sensing and geographic information systems (GIS) technologies offers tremendous opportunities for farmers to more cost effectively manage the causes of crop stress.[5] Salinity is one of the main limiting factors for agricultural production.[6] Nutrients and adequate water and are essential for flourishing crop production. Plants face adverse environmental stress such as salinity in the water and soil which inhibits growth, especially in arid and semi-arid regions of the world[7] Furthermore, plants showing symptoms of nutrient insufficiency vary from healthy ones as changes in cell structure changes the quantity of reflected radiation in the infrared part of the spectrum.[8]

Human health

In recreational waters, mass populations of toxic cyanobacteria can present a serious hazard to human health. Intelligence on the profusion and distribution of cyanobacteria is therefore required to assist management activities and risk assessment. It is argued the use of RS reconnaissance, in conjunction with *in situ* based monitoring approaches, would greatly support the assessment of cyanobacterial risks in inland waters and improve our ability to protect human health.[9] Mass populations of cyanobacteria are an increasingly global phenomenon in nutrient-polluted inland waters. These mass populations, which can occur as blooms, scums, or biofilms, can present serious risks to animal and human health because many species are capable of producing a number of highly potent toxins (so-called cyanotoxins).[10,11]

It has long been known that cholera outbreaks can be initiated when *Vibrio cholerae*, the bacterium that causes cholera, is present in drinking water in adequate numbers to comprise an infective dose, if ingested by humans. Outbreaks linked with bathing and drinking in contaminated river or brackish water may directly or indirectly depend on such conditions as nutrient concentration, water temperature, and plankton production that may be encouraging for growth and reproduction of the bacterium. Even though these environmental parameters have consistently been measured by using water samples collected aboard research ships, the available data sets are sparse and infrequent. Additionally, shipboard data attainment is both time-consuming and expensive. Interpolation to provincial scales can also be challenging. Even though the bacterium, *V. cholerae*, cannot be sensed directly, remotely sensed data can be utilized to infer its presence.[12]

Agriculture

Agriculture is the foundation of Indian financial system. The rapid development of RS technology serves as the solid technological base for the thorough application of Indian agricultural statistics. Satellite RS techniques can offer resource managers a proficient and economical means of acquiring well-timed data for the management and development of our natural wealth. RS data acquired frequently over agricultural land facilitate in identification and mapping of crops and also in assessing crop vitality.[13]

RS and its related image analysis technology afford access to spatial information on a planetary scale. New detectors and imaging technologies are escalating the potential of RS to obtain digital spatial information at very fine resolutions in proficient manner.[13] Advanced information of characteristics and phenomena on the earth can be derived in a short duration of time. Crop identification and forecast of yield are the major concern of remote sensing application in agriculture. Researchers have investigated different spectral bands for vegetation sensitivity. RS has potential in identifying crop classes, estimation of crop area and yield. The assessment of the relationships among yield and vegetation indices have been recurrently studied over the years and have been shown positive for yield prediction purposes.[13]

Conclusion

Remote sensing and GIS have wide applications and advantages in the field of environment and biodiversity conservation. Together RS and GIS present the facility of proficient and cost-effective means of acquiring timely data for the advancement and management of natural resources. It offers tremendous opportunities for farmers to cost effectively manage the crop stress including salinity and drought. Satellite remote sensing facilitates aid in conservation issues and environment impact assessment. To utilise the full potential of these highly sophisticated and innovative, a multi-disciplinary approach is required.

Acknowledgements

The authors are thankful to the authorities of Banasthali University for their support and encouragement to conduct this study.

Confluict of interest

The author declares no conflict of interest.

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Citation: Meshram A, Bhagyawant SS, Srivastava N. Environment and biodiversity conservation studies with remote sensing and GIS. *MOJ Proteomics Bioinform*. 2017;5(2):36–38. DOI: 10.15406/mojpb.2017.05.00151

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Citation: Meshram A, Bhagyawant SS, Srivastava N. Environment and biodiversity conservation studies with remote sensing and GIS. *MOJ Proteomics Bioinform.* 2017;5(2):36–38. DOI: 10.15406/mojpb.2017.05.00151