Potentiality of Spatial Technology in Ecosystem Management

Dr. Surendra Kumar Yadav

Department of Environmental Studies, Jesus and Mary College, University of Delhi, Chanakyapuri, New Delhi, India

Abstract :- Spatial technology includes Geographical Information System (GIS), Remote Sensing (RS) and Global Positioning System (GPS) and is extremely important for ecosystem management issues at local, regional, National and international level. Ecosystem management is a complex issue as all the variables of biotic and abiotic components are inter-linked and related directly or indirectly with each other. Spatial technology analysis involving various parameters of air pollution, public health, conservation of natural resources, air quality parameters and toxic chemicals like heavy metals, polycyclic hydrocarbon (PAH), volatile organic compounds (VOC), ozone, carbon dioxide particulate matter (PM2.5 and PM10) etc can be monitored and provide effective planning, decision making and management of ecosystem. Remote sensing or satellite data due to synoptic coverage, repetitive data gathering capabilities, spatial information, economically cheaper & sustainable technology, real time data collection & computer compatibility, coupled with GIS are extremely useful in monitoring, assessment, evaluation & management of total environment. Remote sensing data or satellite data are extremely useful for monitoring, assessment & evaluation, planning and feedback mechanism and management of all components of ecosystems.

Keywords :- Ecosystem management, Remote sensing, Digital number, Pigmentation, GIS, Spatial analysis.

Introduction :- Satellites provide both spatial and temporal information needed to understand changes in resources for their distribution, qualitative & quantitative assessment (e.g. water quality parameters necessary for developing better management practices to improve water quality) & thus for environment management. Life is not possible on earth without services of ecosystems, as it provide all basic needs and requirements from medicines to habitat and food. Balanced ecosystems are more stable, viable and rich in biodiversity. Ecosystem functions are affected broadly due to all human activities. Remote Sensing Applications coupled with Geographic Information System (GIS) is extremely useful in

the decision and solution [1] for environments management. Spatial technology (Remote Sensing & GIS) is a potential area for management of all components of environments like soil, water, fauna & flora and other compositions. The application areas for remotely sensed data are both wide and varied [2]. Radiometric data potentially represent a very useful source of information in pedological research [3].

Remote sensing techniques because of synoptic coverage, repetitive data gathering capability, spatial information, real time data collection and computer compatibility are extremely useful in biodiversity assessment, environments management and sustainable development studies. Ready and timely availability of satellite observations of existing land use pattern from various remote sensing satellites now provide a most cost-effective means of identification of different forms of land, status of water resources, quantification of soil moisture content and soil degradation to enable all nations to take appropriate measures for maintaining productive use [4] of environments. Multi-date satellite data could be used effectively to find out the changes in the aerial extent of environments. False Color Composites (FCC) derived from the green, red, and infrared bands of satellite data can be virtually analyzed on 1:25000 or 1:50000 scale when information is required at the state/ national level.

An image interpretation key indicating the tone color, size, shape, texture pattern, location and association can be prepared for each category of vegetation including environments using ground truth information, topographical maps, aerial photographs, etc. The classification accuracy can be tested on a sample basis assuming binominal distribution for the probability of success/failure of sample tests. Sample size is decided using the Look Up Table (LUT), prepared by employing a binominal probability model. In Monitoring & role of effective communication for assessment, planning and management depends on the quality of satellite data. Remote sensing has important role for ecosystem management through groundwater conservation [5] and this is applicable urban as well as rural environment. Remote sensing has proved its potentiality in water resources management [6]. An environment may be related topologically with wastelands or forest ecosystems [7]; and may be affected by industrial pollution and consequently this may interfere indirectly with community people [8] living in nearby surrounding area and their economic status [9]. These aspects are advocating for ecosystem management and related issues through sustainable water resources management

[5]. The pollution of environment may affect whole ecosystem including the most important known medicinal plants [10].

Remote Sensing coupled with Geographical Information System (GIS) can be extremely useful [11] for environment management. The main advantage of satellite imagery is that the raw data are digital and can be analyzed using computer. The wavelengths that are widely used are visible & near infrared radiation in the waveband 0.4-3 um, infrared radiation in the waveband 3-14 um and microwave radiation in waveband 5-500 mm. Soil, basic requirement for maintenance of biodiversity, is supposed to have increased reflectance between 0.4 to 1.1 micrometer wavelengths [12]. GIS is computer-based powerful system [13] that provides the following four sets of capabilities to handle georeferenced data: (a) input; (b) data management (data storage and retrieval); (c) manipulation and analysis; and (d) output. GIS is able to query or analyze the attributes separately and to generate a map based on non-graphic values. Because of the arid climate, complex geological conditions, and human activities, environmental problems like lake of water resources, desertification, salinization, and biogeochemical endemic diseases etc. occur in fragile regions of the environment [14].

There is an urgent necessity of systematic inventory, mapping and monitoring of land resources [15-16] leading to an ecological balance in many areas. Ground survey is done to match digital data [17]. The spatial distribution and soil nature of these lands can serve as the base for the implementation of various reclamation measures and afforestation programmes [18]. Proper monitoring and planning through spatial technology leads to management of natural resources and ecosystem for sustainable development [19]. Spectral signatures of water, agricultural land, forest, wasteland etc. differ from each other distinctly [20]. Environmental protection and ecological balance are essential to ensure that development is sustainable in the long run [21]. The physiography, hydrology and chemical characteristics of soils are greatly responsible for the various kinds of land-degradation hazards [22]. Any major disaster affects a wide range of sectors of a society which can include political, social, cultural, environmental, physical, technological and economic aspects [23]. The characteristics of the pictures reflected on the remote sensing images are formed mainly by the difference in information of the tone and the form characteristics and spectral behaviour of each unit varies according to the nature and percent cover [24-25].

Methods of Investigation :- Primary and secondary data collection was done to use in this study. Methodology in ecosystem management using remote sensing & GIS is more or less same but many time variable and parameters are different and data set may vary from one place/ habitat to other and for different ecosystems. Methodology followed (an example of forest ecosystem in Sirsiya Block, Bharaich District, India was considered) include: (i) Preparation of base-map from Survey of India topographical sheet. (ii) Visual interpretation of Satellite data/ Imagery to study the various aspects of environment like biogeological aspects, vegetation, geology, urban-sprawl, hydromorphogeology, structural features and land use of the area. (iii) Digital enhancement of Remote sensing data for delineating vegetation, geomorphic and structural elements. (iv) Correlation of digital enhanced Remote sensing data with other data. (v) Preparation of vegetation anomaly map, hydromorphogeological & land-use maps from satellite imagery for study of vegetation aspects, land degradation aspects, groundwater potentiality and change in recharge capacity by changed land-use patterns. (vi) Imposition of interpreted Remote Sensing data on base-map. (vii) Soil samples' analysis to estimate fertility aspects. (viii) Field traverses for sample collection of soil, water & chlorophyll data using guide map. (ix) Analysis and modeling in GIS. (x) Application of GIS based approach for planning & management of ecosystem and environments.

GIS is able to query or analyse the attributes separately and to generate a map based on non-graphic values. The ability of GIS system to perform various analysis with graphic and non-graphic data play significant role in management of environments & natural resources like forest, soil and water etc. GIS uses spatio-temporal (space-time) location as the key index variable for all other information. Just as a relational database containing text or numbers can relate many different tables using common key index variables, GIS can relate otherwise unrelated information by using location as the key index variable. The key is the location and/or extent in space-time. Any variable that can be located spatially, and increasingly also temporally, can be referenced using a GIS. Locations or extents in Earth space–time may be recorded as dates/times of occurrence, and x, y, and z coordinates representing, longitude, latitude, and elevation, respectively.

Analysis in GIS :- GIS can handle huge data sets (spatial & non-spatial data). All the data (spatial & non-spatial) are integrated in GIS and analysis & modeling in GIS using satellite and other data is done for monitoring, planning & management plans and finally for decision making & sustainable development and therefore in ecosystem,

biodiversity and environment management. In Analysis/ modeling, for example, equation used in GIS for different overlays is :

Output = select{i1=1,1,0}+ select{i2=2,2,0}+select{i3=3,3,0}+ select{i4=4,4,0}+---N.

where i is input and 1,2,3,4, --- N represents number of layers overlayed. Analysis and overlaying steps for open degraded forest area were done in following steps: Step-1: Open forest map Vs. Ground water potential map; Step-2:Step 1 Vs. Soil texture map; Step-3:Step 2 Vs. Soil fertility map; Step-4:Step 1,2 and 3 repetition for various combinations. These are some of the steps for GIS modeling and analysis for various aspects of ecosystem. Various data (spatial and non-spatial can be used for management of any aspect of ecosystem, depending and requirement of data and output.

Conclusion :- Monitoring of various variable and parameters of biotic and abiotic components of ecosystem and biodiversity is extremely important for planning and management of ecosystem to take decision for sustainable development. Best available technologies like remote sensing & GIS have high potential and viability for any Nation for its biodiversity management. Productivity in terms of natural resources and functioning of each component of natural resources is monitored precisely through satellite data. Each substance or object absorbs certain energy and therefore reflect different energy that is captured by satellite imageries, because the reflected energy depends on the physical, chemical & biological properties of an object. Information captured on satellite imagery is true picture of the objects or substances present on ground or earth surface. Cartosat-2, an Indian satellite has resolution of 1 m. RS provides information upon which decisions on different management options and mitigation measures for specific wetlands or sections or components of ecosystems are made. Multi-spectral satellite data having specific utilities for vegetation mapping, classification, quantification, spatial analysis, temporal change detection, detection of diseased & stressed vegetation etc in addition to pigmentation, physiological structure, and architectural organization and water contents are attributes, which are responsible for vegetation reflectance in multi-spectral data.

Remote Sensing and GIS identifies and articulates current and emerging information needs of those involved with the management of forest ecosystems. Spatial technology explores the potential of spatial technology for further

development for legislative and judicial policymakers who do not have a technical background in either remote sensing or resource management but who are nonetheless called upon to make decisions regarding the protection and management of forest ecosystems. Remote sensing/ Satellite images help environment scientists to observe (land cover, boundaries, threats, damage, topography etc.), monitor (change in forest cover, range condition, land use etc.), classify (into vegetation and land use categories, habitats etc.), measure (areas, distances, height/elevation etc.), detect (fires, resource use violations) etc. for natural resources management. Because reflected electromagnetic radiations are different for different substance or object therefore digital number (DN) value is different for different objects, this DN value is useful for object identification & image interpretation which is done through involvement of shape, size, tone, shadow, pattern, texture, size (location), association and resolution of satellite imagery/ data.

Spatial information/ data & distribution pattern of each Parameter/ component of Natural Resources (NRs) & ecosystem is obtained through interpretation of satellite/ Remote sensing data with limited ground truth/ checks (field based). GIS can handle huge data sets (spatial & non-spatial data). All the data (spatial & non-spatial) are integrated in GIS and analysis & modeling in GIS using satellite and other data is done for monitoring, planning & management plans and finally for decision making & sustainable development and therefore in biodiversity, ecosystem and environment management.

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