Role of remote sensing and geographic information system in natural resources management

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Abstract
Remote sensing is a powerful tool for generating large amount of data related to nature and its resources in a relatively short time, and can be prominent source of information for a GIS. Space technologies have been successfully utilized world wide in natural resources management with the availability of high resolution remote sensing data, monitoring of land, coastal and water resources at local scales has become possible to resource managers as a way to create timely and reliable assessments.

Keywords: remote sensing, GIS, natural resources

Introduction
Natural resource management involves manipulation of the resource to preserve or supply products on a sustained basis (Knight and Bates, 1995). In most of the countries , development is increased significantly in recent times which results in major problems such as depletion of forest, ground water level, mineral resources, fishery resources, degradation of natural inland and coastal ecosystems, coastal erosion, safe disposal of liquid and solid wastes, land abuse and population explosion etc. These problems create environmental issues. Over exploitation of available natural resources for meeting the growing demand for food, fuel and shelter of an ever increasing population has led to serious environmental degradation. Remote sensing and geographic information system [GIS] offer potential to solve many of these problems by providing valuable information useful in assessment, monitoring and management of natural resources. Remote sensing is the measurement of object properties on earth’s surface without physically coming in contact with them. This process involves making observations using sensors like cameras, scanners, radiometer, radar etc. mounted on platforms like satellites and aircrafts which are at a considerable height from the earth surface and recording the observations on a suitable medium like photographic films, video tapes or digital data on magnetic tapes. Geographical information system (GIS) is an analytical tool capable to perform storing, spatial operations, spatial queries, data linkages, data matching and output generation. Remote sensing technology is a powerful tool for generating large amount of data related to nature and its resources in a short time and can be prominent source of information for GIS. GIS utilize remote sensed data and also enhances the effectiveness of this data through correlation of remote sensing inputs with data already stored in GIS.

Remote sensing systems particularly those deployed on satellites provide a repetitive and consistent view of earth facilitating and ability to monitor the earth system. There are many electromagnetic band-length ranges earth’s atmosphere absorbs. Among the electromagnetic spectrum Gamma rays, X rays and UV are not employed for remote sensing , as these rays are completely absorbed by the atmosphere, where as visual blue ray [0.45 – 0.52 um] provide the best data for mapping depth details of water covered area, soil
vegetation discrimination, forest mapping etc. Visual green region [0.50-0.60 um] is used for mapping details such as depth or sediment in water bodies. Visual red [0.60-0.70 um] is useful for distinguishing plant species, soil and geological boundaries. Near Infra Red [NIR] region of the spectrum (0.70-1.10 um) is sensitive to varying vegetation biomass and used for vegetation discrimination, penetrating haze and water-land boundaries. Mid Infra Red (1.55-3.95 um) region is useful for the studies of vegetation health and also used for distinguishing clouds, snow ice, mapping geologic formations and soil boundaries snow ice discrimination, soil moisture content and forest fire detection. Thermal Infra Red [10.40-12.50 um] of the spectrum helps in crop stress detection, heat intensity, insecticide application, thermal pollution and geothermal mapping and water surface temperature measurement. Microwave radar [0.10-100cm] can penetrate clouds fog and rain (Gleason et al., 1994; Schonwengerdt, 1997; Sabins, 1997; Lillesand et al., 2004).

Applications of remote sensing

The applications of remote sensing include land use / land cover study, mapping of vegetation, soil, geology and hydrogeology mapping, groundwater potential etc.,

Land

The Indian remote sensing satellites [IRS] are providing timely information from regional to farm level studies through a variety of sensors. Land use planning involves the inventory of the land resources and taking stock of the present scenario. The IRS LISS sensor with spatial resolution of 23.5 m is used to obtain information on land use two seasons. Townshend and Justice (1988) provide a useful example of space time interactions in remote sensing in the context of monitoring changes in land cover over large regions. They note that most landscapes undergo a wide variety of changes through space and time at many different characteristic scales. The changes of land use / land cover pattern over a time period control the pressure on land. The remote sensing technology along with GIS is an ideal tool to identify, locate and map various types of lands associated with different land farm units Prasad and Sinha (2002), described image characteristics and visual interpretation techniques of various land cover and land use categories. Settlements appear light grey clustering with particular patterns.

Forest

Forests protecting the hill environment and preserving the natural resources. The recent researches show that the overwhelming population pressure, practicing of unscientific agricultural methods and the lack of awareness about the importance of forests among the population in general and tribal folk in particular are the prime causes for deforestation. Many researchers have carried out the change analysis through remote sensing. Forest cover change detection has been done, through visual interpretation of satellite data by Luque (2000), Young et al. (2001), Boyd et al. (2002), Bouma and Kobryn, (2004), Camacho-De-Coca (2004), Ingram, (2005) Le Hegarat Mascle et al. (2006), Reis and Yomralioglu (2006), Panigrany et al. (2010). The main reason for forest cover decrease may be due to illegal felling and forest fire and shifting cultivation (Amon et al., 2010). Satellite remote sensing has been found to be a very valuable application tool in forest management including mangroves, not only in monitoring, but also carrying out relevant observations, which can bring out the impact of deforestation on global climate (Ramachandran et al., 1998).

Some analysis relative to forest are overlaying forested areas and logging areas to see what percentage of forest area is in danger of degradation. Dense forests are identified by dark red colour patterns. In the case of degraded forest the dark red colour patterns contains small brown or white patches. The blanks in the forest show creamy patches in the dark red background. Forest plantations are identified by dark red colour sign of particular pattern.
Coastal area management

India has a wide range of coastal ecosystem like mangroves, coral reefs, lagoons, estuary etc. Because of the increasing human population along the coastal area, anthropogenic impacts on the coastal zone have become severe over the past few decades. Storms, cyclones and tsunami also causes major damage to reefs. A careful assessment of changes that occur in the coastal ecosystem provide effective coastal ecosystem management and leads to sustainable utilization of coastal resources. Remote sensing technology in recent years has proved to be of great importance in acquiring data for effective resources management and hence could also be applied to coastal environmental monitoring and management (Ramachandran et al., 1997, 1998).

Based on remote sensing a variety of data pertaining to the coastal zone like, identification of plant community, biomass estimation, short time changes, delineation of coastal landforms and total boundary, qualitative estimation of suspended sediment concentration, bathymetry of shallow waters etc., can be collected and all these data will help in effective coastal ecosystem management. Preliminary analysis of remote sensing data indicates that coral reef zonation, identification of tree and shrub mangroves, mudflats, beach, dune vegetation, saline areas etc., as well as better understanding of suspended sediment patterns are now possible (Ramachandran et al., 1997, 1998). Muddy water logging occurs as blackish or deep blue spots while clear water logging area is identified by dark / bright blue patches. Marshy area is recognized as a sign of vegetation [red / pink spots] in the water logged (blackish blue / bright blue] area . Gullied land occurs as white / grey spot. The image of land with scrub contains white patches in the land area. Sandy area is classified as bright white coloration along the course of river (Prasad and Sinha, 2002).

Inland waters

River / stream is identified as long non-linear path coloured with dark blue / bright blue line in white background. Canals are identified as live line segments sign of water bodies. Lake and reservoirs are identified as patterns along the rivers. Embankment occurs as light grey structure along the river (Prasad and Sinha, 2002).

Soil management

Soil erosion an important soil degradation process can influence soil spectra. The potential utility of remotely reused data in the form of aerial photographs and satellite sensed data has been well recognized in mapping and assessing landscape attributes controlling soil erosion pattern (Pande et al., 1992). Remote sensing can facilitate studying the factor’s enhancing the process such as soil type slope gradient, drainage, geology and land cover. GIS technology is used as an aid to the soil erosion inventory with reference to soil erosion modeling and erosion risk assessment.

Conclusion

The remote sensing and GIS technologies can be used to get a spatial and non-spatial data on natural sources and environment. It provides synoptic view of a fairly large at regular intervals and have been used for generating base line information on mineral resources, soils, ground water and surface water, land use, landcover and forest etc.

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