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Abstract

Geographic Information System (GIS) is defined as an information system that is used to input, store, retrieve, manipulate, analyze and output geographically referenced data or geospatial data in order to support decision making for spatial planning and management of land use, natural resources, environment, transportation, urban facilities, and other administrative records. Responsible and successful environmental management is necessary for protecting, conserving and restoring the natural environment. A number of satellite systems have been invented and dedicated to monitoring the global environment. Probally the most commonly used for environmental management are the NOAA and AVHRR satellite images. The purpose of this work is, spatial planning and environmental management in the study region with the help of GIS and Remote Sensing techniques. In this paper, we concentrate on the role of GIS and Remote Sensing techniques to generate information about the resources, with an emphasis on how recent innovations in remote sensing fit with sustainable environmental management methods.

Keywords: Environmental Management, Spatial planning, GIS, RS, Satellite images.

Introduction

Many initiatives have been taken in the last decade in India to develop and disseminate the digital spatial data for use in GIS. For example, Singh (2005) reported on the National (Natural) Resources Information System (NRIS) (Department of Space), the Natural Resources Data Management System (NRDMS) program (Department of Science and Technology), the Geographical Information System initiative of the National Informatics Centre (GISNIC), and other initiatives such as the large-scale mapping project of the National Natural Resource Management System (NNRMS), the space-enabled Village Resources Centre (VRC) initiative, and the emerging National Spatial Data Infrastructure (NSDI). Other large-scale mapping initiatives also exist, such as the Utility Mapping Project of the National Informatics Centre (GOI 2007), as well as many more-focused projects such as inundation mapping spurred by the 2004 tsunami (Kumar et al. 2008).

Work on GIS began in late 1950s initiated by Canadian Forest Department. First GIS software came only in late 1970s from the lab of the ESRI. Canada was the pioneer in the development of GIS as a result of innovations dating back to early 1960s. First initiated by Canadian Forestry mapping in 1960s. There are two main company in abroad, first is “Intergraph co-operation of Huntsville, focused on efficient input and storage of GIS data and preparation of computer generated maps” and other one is “The Environmental Systems Research Institute (ESRI) of Redlands, California focused on providing “Tool Kits” of computer commands for the analysis of GIS data”. Many institute, agencies and companies working in India in the field of Remote Sensing and GIS to provide satellite data and products for natural resource management, agencies like NRSA in Hyderabad, ISRO in Bengluru, SAC in Ahmedabad.

Accurate geo-referencing is paramount or very important when creating reliable GIS related analysis with various geospatial data layers. When the original orthorectified Image data acquired by satellite or airborne sensors are used to display 3-D Terrain models, vegetation types, or urban and rural developments, every layer of geospatial data within a analysis must be referenced at common Geodetic reference system such as Global WGS-84 (for India and many other countries). The low cost of the imagery is an important advantage for environment and natural resource management, particularly in developing countries.

Spatial planning is the method, used to influence the distribution of people and activities in spaces of various scales. GIS can be associated with satellite based forest cover monitoring yet it is not only relatively easy to store and recall earlier satellite data sets for comparison with future datasets and to mask out those areas that are not relevant, but also the spatial changes can be associated quickly with other categories of field data such as climatic factors, soils, transportation routes, morphometric parameters and environmental parameters which in turn help in the generation of a change detection map of any area. Remote sensing is one of the excellent and advanced tools for inventory and analysis of environment and its resources, due to its unique ability of providing the synoptic overview of a large area of the earth’s surfaces and its capacity of repetitive coverage. Its multispectral capability provides appropriate contrast between
various natural features where its repetitive coverage provides information on the dynamic changes taking place over the earth surface and the natural environment.

There are two basic processes involved in data acquisition and analysis shown in (Fig. 1 & Fig. 2 shows relationship between GIS and RS).

**Fig. 1:** Electromagnetic Remote Sensing of the Earth (Thomas M. Lillesand, R. W. Kiefer and J. W. Chipman, 2011)

**Fig. 2:** Shows Relationship between Remote Sensing and GIS

**Remote Sensing Is Backbone of Planning**

The first Indian Remote Sensing Satellite, IRS -1A, was launched on March 17, 1988. Today the ISRO has 10 of its remote sensing satellites orbiting the earth and sending down imagery by the minute. According to ISRO Chairman (K. Radhakrishnan), from a camera resolution of 36 meters, IRS had graduated through a world best of 5.8 meters in the mid-1990s to a second best of 80cm mapping today, Remote Sensing has become backbone of planning in ministries and to monitor and manage natural resources. For the years about a quarter of farmers have used an agriculture forecast application called FASAL, which gives them information on weather, fertilizer and crop practices.

**Environmental Monitoring and Change Detection**

Remote Sensing Satellite and Airborne image/maps/data has become a most common tool in the analysis of different fields in Earth and Environmental sciences. This technology has the capability of acquiring information about the earth and its natural resources for global, regional and local assessments.

There is a growing interest in the application of remote sensing technologies to protect the global environment. Availability of satellite and aerial-based imagery can provide spatial resolutions of 0.6m or better for analysis of urban growth and transportation development for assessment and monitoring. Moreover, high-spectral images with multispectral bands, can provide increased spectral resolution that can be used to further analysis of environmental conditions, land cover and change detection.
tion, and how urban growth and associated transportation development impact these conditions.

Remote sensing for natural resource exploration activities for large areas requires airborne surveys to facilitate detailed geographical interpretations for subsurface features by utilizing 3D high resolution Digital Terrain Models (DTMs). The high resolution <1m Satellite imaging mosaics and 3m-5m DEMs provide operators with the appropriate planning tools to reduce the risk of environmental impact during operations and improve on safety procedures.

Use of RS and GIS in Natural Resources / Environmental Management

Agriculture
With the increasing population growth and pressure throughout the world and the need for increased agricultural production there is a definite need for improved management of the world's agricultural resources. For this it is first necessary step to obtain reliable data on not only the types, but also the quality, quantity and location of these resources. Satellites or aerial born remote sensing images and technology has been and always will continue to be a very important factor in the improvement of the present systems of acquiring and generating agricultural and resources data.

Vegetation Analysis
Vegetation images: Show crop growth and yield from planting through the harvest, changes as the season progresses and abnormalities such as weed patches, soil compaction, watering problems etc. A georeferenced and orthorectified image can locate these problem areas as well as the size of the area affected can be easily determined. This information can help the farmer to make decisions about the most feasible solution. Techniques commonly used including following method:

Classifications: Pixels of an image are sorted into different classes and each class is given a unique color defined by the spectral "signatures". A supervised classification requires pre-knowledge about the data as the analyst, selects pixels that correspond to known features (such as differences in the land cover). Unsupervised classifications are more computer automated and used Iso-data Cluster Algorithm method or cluster pixels which have similar spectral characteristics.

Vegetation Indices: By using the various spectral signature of vegetation with low reflectance in the visible (0.4 - 0.7 um) and very high reflectance in the near infrared region (0.7 - 1.2 um) of the electromagnetic spectrum, the spectral contrast can be used for identifying the presence of green vegetation and evaluating some characteristics through various vegetation indices, such as the Normalized Difference Vegetation Index (NDVI).

Forest Cover Change Detection and Mapping
Deforestation, desertification, global warming, pollution and natural resources depletion are now serious and major problems in the world, which threatens the survival of the living beings in the world. Forest change detection and monitoring has been mainly based on the comparing of two or more temporal sets of data or images, comparing old aerial photographs and present satellite imagery and comparing satellite imagery with existing old maps. Monitoring from satellite remote sensing system includes the detection and evaluation of sudden forest change or damage and continuous forest inventory.

These change detection studies can be completed by using visual image interpretation and digital image analysis techniques with the help of satellite data acquired on two different dates for the same ground area take on an identical scale. The digital analysis of the satellite images has the advantage of being fast and able to handle large amount of data whereas the visual image interpretation is based on the tonal variation of different features that is observed on satellite imagery. The major limitation in using satellite imagery for change detection of forest cover is the spatial and temporal resolution of the satellite sensors.

Wildlife Habitat Mapping
Habitat analysis is play most vital role in planning and management of protected areas. Wildlife habitat includes wide variety of factors, viz, vegetation cover characterization including human influence on all these, climate, soil, geomorphology, topography, physiography and water availability. Since each species needs a particular habitat to meet the fulfillment of space, food, cover and other needs of survival, the database with respect to above parameter can be used to identify the species needs for particular wildlife for Habitat suitability analysis.

Remote sensing and GIS has great potential in wildlife management because of its role in providing information about three most important parameters viz., cover and food value and water resources and the fourth physiography indirectly required for Habitat suitability analysis. The change in habitat, due to change in forest cover characteristics, degradation due to reduction in forest cover, fragmentation of forested areas, degradation due to fire, over grazing and cultivation can also be analyses.
Watershed Management

Watershed is defined as an area from which water drains to a given point or in other words watershed is an area from which runoff, resulting from precipitation, flows in a single point into a stream. Broadly, watershed management implies the proper use of all land and water resource of a watershed for optimum production with minimum hazard to natural resources.

There are many objectives of a watershed management programme:

a) To control damaging runoff and manage and utilize runoff for useful purposes,

b) To moderate floods in the downstream areas and to enhance ground water storage

c) To control erosion and to reduce sediment production

d) Appropriate use of the land resources in the watershed

Flood Management

Advancements in the remote sensing techniques and Geographic Information Systems (GIS) help in real time monitoring, early warning and quick damage assessment of flood disasters. With the help of GIS, geographical information is stored in a database that can be queried and graphically displayed for analysis. By overlaying or intersecting different geographical layers, flood prone areas can be identified and targeted for mitigation or stricter floodplain management practices by following way:

a) Detailed mapping for the production of hazard assessment maps and for input to various types of hydrological models.

b) Developing a larger scale view of the general flood situation within a river basin with the aim of identifying areas at higher risk and in the need of immediate assistance.

Conclusion

Remote sensing and Geographic Information Systems (GIS) have greatly expanded opportunities for data integration, data analysis, modeling, and map production. Apart from use in global models, the imagery is also effective in awareness building of the state of the earth’s environment, as well as policy development for government. Common uses for satellite images for environmental impact assessments are, accurate satellite imagery is the most cost-effective method of geological applications such as environmental management. These imageries help in evaluation and management of environment with the help of remote sensing and GIS by analysing change detection and vegetation analysis. Beside these other geologic applications are: Lithological and mineral mapping, structural geology, tectonics, geological hazards, mine waste, earthquakes, hydrogeology etc. Thus, the geo information derived from remote sensing data and tools like GIS provide excellent opportunities to measure the spatio-temporal changes in land and water productivity and to achieve sustainable management of irrigation systems. We can easily plan and manage to our environment by using high resolution satellite images.

References


