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APPLICATION OF GIS IN FOREST MANAGEMENT

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Abstract

This report deals with the Geographic information system (GIS) to provide general idea about GIS. Basically it is a system for storing, managing, and displaying geospatial data by conducting image processing. This study explores the potential application of GIS technology in forest management in general. The use of GIS has infested almost every field in the engineering, natural and social sciences, offering accurate, efficient, reproducible methods for collecting, viewing and analyzing spatial data. This study involved a combination of three approaches: review of global literature on GIS, use of GIS and related technologies, and participatory action research. A wide variety of spatial information was recognized through community groups as important for community forest planning and management. The findings of this study clearly indicate that GIS and related technologies have high potential for use in community-based forest management. The combination of GIS with participatory action research can help to identify community's requirements for information, collect and incorporate local knowledge into community-based GIS databases, and for local forest resource planning and management activities. GIS technologies are only a means to identify and solve problems, and need proper planning and basic resources to allow their potential to be realised.

Keywords: Global positioning system, GIS, Remote sensing.

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1 INTRODUCTION

1.1 General

Remote sensing technologies are used to collect information about the surface of the earth from a distant platform, usually a satellite or airborne sensor. Geographical information system (GIS) is a computer based system that enable user to collect, store, process (manage), analyse and present spatial data. As of February 2006, geospatial technology is listed by U. S. Department of Labor as one of the three emerging industries, along with nanotechnology and biotechnology. Geospatial technology covers a number of fields, including remote sensing, cartography, surveying, and photogrammetric. To integrate data from these different field in geospatial technology. Today many of us use GIS technology. Most recently GIS has been used for crime analysis, emergency of planning, land records management, market analysis, and transportation planning. The integration of GIS with other geospatial technologies such as global positioning system (GPS), remote sensing, and mobile devices has found applications in location-based services, in teractive mapping, in vehicle navigation system and precision farming. The use of GIS has flooded almost every field in the engineering, natural and social sciences, offering accurate, efficient, reproducible methods for collecting, viewing and analysing spatial data. Forests are important renewable natural resources and have a significant job in preserving an environment suitable for human life. In addition to timber, forests supply such resources as grazing land for animals, wildlife habitat, water resources and recreation areas. Forestry involves the management of a broad variety of natural resources within a forested area. Forest resource management in today's ever varying world is becoming more complex and demanding to forest managers.

The information that chains forest management is stored primarily in the form of forest inventory databases within a GIS environment. A forest inventory is a survey of the location, composition, and division of forest resources. Historically, forest management inventories were primarily for timber management and focused on capturing area and volume by species. In providing extra frequent information updates, remotely sensed data can improve the quality of forest inventory databases, thereby improving the resource management activities they support.

1.2 Problem Identification, Aim and Objectives

The emerging role of GIS and related technologies in forestry and the global trend toward Community-Based Forest Management (CBFM) have been mentioned. However, the potential benefits of GIS in CBFM have seldom been realized for a range of reasons.

a. Local communities have poor contact to computers and GIS software.
b. People trained in GIS and related technologies are not readily available.
c. There is need of trust by government authorities – in making data available.
d. Social scientists think GIS is too technical for use by local communities.
e. Minute is known by GIS technicians about ways to integrate GIS with needs of particular forest stakeholders.

2. Forest Management

2.1 General

Forest management is a branch of forestry concerned with overall administrative, economic, legal, and social aspect as well as scientific and technical such as silviculture, protection, and forest regulation. This include management for aesthetics, fish, recreation, urban values, water wilderness, wildlife, wood products, forest genetic resources and other forest value management can be based on conservation, economics, or a mixture of two techniques include timber extraction planting and replanting of various species, cutting roads and pathway through forest, and preventing fire.

2.2 Spatial technologies

2.2.1 The Global positioning system (GPS): Global Positioning System (GPS) technology has provided an essential tool for management of agricultural and natural resources. GPS is a satellite and ground based radio navigation and locational system that enables the user to determine very accurate locations on the surface of the Earth. Although GPS is a complex and difficult technology, user interfaces have evolved to become very accessible to the non-technical user. Simple and inexpensive GPS units are available with accuracies of 10 to 20 meters, and more sophisticated precision agriculture systems can obtain centimeter level accuracies. Reflected radiation in the infrared part of the electromagnetic spectrum, which is undetectable to the human eye, is of particular importance for vegetation studies.

2.2.2 Remote sensing: Remote sensing technologies are used to gather information about the surface of the earth from a distant platform, usually a satellite or airborne sensor. Most remotely sensed data used for mapping and spatial analysis is collected as reflected electromagnetic radiation, which is processed into a digital image that can be overlaidwith other spatial data Chuvieco and Congalton.

2.2.3 Geographic information systems: Geographic Information Systems applications enable the storage, management, and analysis of large quantities of spatially distributed data. These data are associated with their particular geographic features. For example, water quality data would be related with a sampling site, represented by a point. Data on crop yields might be associated with fields or experimental plots, represented on a map by polygons. A GIS can manage different data types occupying the same geographic space. For example, a biological control agent and its prey may be distributed in different abundances across a variety of plant types in an experimental plot. The power of a GIS lies in its ability to analyze relationships between features and their associated data. [Sonti, J Geogr Nat Disast 2015].

2.3 Relationship between GIS, GPS and Remote Sensing GIS and related technologies (e.g., remote sensing and the GPS) can be integrated with each other. The inter-organizational relationship and effectiveness concerning these three technologies have been greatly increased by utilizing modern computer systems and use friendly software (Star et al. 1997). Many forestry and natural resource manager are using remotely sensed and GPS data widely to provide input to new GIS databases, to update existing databases and for monitoring land-use/land-cover changes of various types (Hoffer 1994). GIS data can often be valuable in the analysis of remotely sensed data, enabling significant improvements in the classification accuracies achieved. The relationship between the three technologies is shown in Figure.[Himlal Baral August2004]

Figure 1 Reletionship Between GIS, GPS & RS

2.4 Organising Spatial Data

A GIS can be used to organise and store information as a collection of thematic Level that can be linked by geography. Each level contains features having similar attributes, like streets and cities that are located within the same geographic extent. This simple but extremely powerful and versatile concept (see example in Figure) has made GIS an invaluable means of solving many real-world problems related to forestry and natural resources management

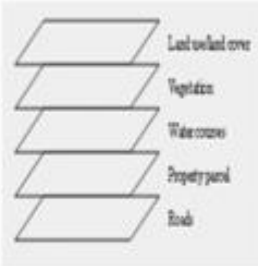

Figure 2- Layers In GIS-Use In Forest Management

2.5 GIS Application In Forest Management

2.5.1 GIS for strategic planning and modelling: Forest management planning involves making predictions about what the future forest will look like relative to alternative management activities. This ability is central to nearly all aspects of management forecasting, particularly long term wood and wildlife supply. According to Kane GIS stores both the geographic and numerical structure of the forest stands and links that spatial database to the planning models. It allows the supervisor to effectively add both the important temporal and spatial dimensions to the management planning process. The manager can then plan what the forest will look like in 5,10, 25, or 100 years in the future.

2.5.2 Map production: Forest managers require a large variety of maps to assist with their daily activities. Plantation maps are commonly used for location purposes and may contain additional useful information such as roads, rivers, compartment boundaries, planted species, and compartment size. Other features such as topographic types (contours), infrastructure, water points, fire breaks, neighbours and conservation areas may be also included in the map .

2.5.3 Fire management: The effect of fire on forest resources is another important management concern. Management activities include fire prevention, wildlife control, prescribed burning, and post fire recovery actions. The modelling capabilities of GIS have been fairly effective in this context. Forest fire managers have used GIS for fuel mapping, weather condition mapping, and fire danger rating. Forest fires have an important influence on the vegetation cover, soil, plants, animal, stream flow, air quality, microclimate, and even general climate . The failure of timber is obvious and so is the damage to life and property. The loss of exercise value of the forest and the destruction of wildlife habitat are also consequences of forest fires. The key to managing official burning activities was the ability to anticipate fire behaviour after ignition. Chuvieco et al. explained that fire behaviour models have been developed from fuel models to predict the fire intensity based on factors such as slope, elevation, site exposure, temperature, relative humidity, cloud cover, wind speed , and live and dead fuel moisture. These models are not spatial, however, and are typically used to predict fire behaviour for a fairly large area. To increase the understanding of the fire behaviour models to spatial variability within the park, fire behaviour models were fun with a raster based GIS. With input level stored in the GIS, its mathematical modelling capabilities, along with selected lookup tables, were then used to implement several fuel and fire intensity models. By compare the predicted fire behaviour with actual burn situation, Wells and McKinsey concluded that the GIS implementation of fire behaviour models was useful in locating potential control areas, planning ignition patterns, and accommodating sensitive areas that would be adversely affected by high fire intensities.

2.5.4 Harvest planning: Good forest management practice requires detailed planning of harvesting activities. Harvest planning activities contain the identification of felling directions, extraction routes, depots and sensitive zones such as wetlands. Maps constitute a basic planning tool for these activities. Other strategic harvest planning functions utilize maps to identify planned felling over a number of years, and to consolidate felling areas and extraction routes thereby permitting the efficient use of harvesting equipment and other resources.

2.5.5 Resource management: Wulder and Franklin mentioned that collecting forest inventory data and monitoring changes are critical to forest management activities. Yet, a GIS can build on these activities by incorporating models to guide, for example, timber harvesting, silviculture and fire management activities, or predict fuel wood and other resource supplies. Other priority, such as providing for wildlife habitat, ensuring recreation opportunities and minimizing visual impacts of harvesting, are also rising in importance. Some applications deal with single management issues, such as timber production, while others illustrate how a mix of management concerns can be integrated through the use of GIS, such as timber production combined with habitat protection.

Table 1; Status of Forest Cover in India (Based on Satellite Remote Sensing) Area in million Hectares within brackets

Forest Category	1972-75	1981-83	1985-87	1987-89	1989-91
Dense/ Closed	14.12 (46.45)	10.99 (36.14)	11.51 (37.84)	11.71 (38.50)	11.72 (38.55)
Open	7.38 (24.28)	8.41 (27.65)	7.83 (25.74)	7.60 (24.99)	7.61 (25.04)
Mangrove	0.10 (0.30)	0.12 (0.40)	0.13 (0.42)	0.13 (0.42)	0.13 (0.42)
Total%	21.60 (71.03)	19.52 (64.20)	19.47 (64.01)	19.44 (63.92)	19.47 (64.01)

The extended use inspection maps for the treatment area maps would must a serious consideration by all the state forest departments for prioritisation:

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a. CLOSED FORESTS (40% and above crown density) treatment area I for consideration to conservation zone.
b. OPEN FORESTS (less than 40% crown density) treatment area II for consideration as forest produce zone for careful management.
c. DEGRADED FORESTS (less than 10% crown density) treatmen area III for gap planting, JFM activities by peoples involvement.
d. Thus for the over treatment area maps the satellite based remote sensing especiallyusing the digital methods would prove to be an effecctive tool and in generation of information within a short span of ltime and a digital data base.

2.6 Uses of GIS in forest management

1. Location of forest resources in the earth in many ways such as a place name, post or zip code, or geographic references such as latitude and longitude.
2. Non forested land of certain size distance from road or river.
3. It helps to find out what has changed within study forest or land use an area over time.
4. Determine whether landslide in forest area.
5. Determine what happens, if a road network is added in a forest.

The figures below represent some of the uses of GIS in forest management:-

Fig. 3: Map Showing The Nordi North Forest Zone

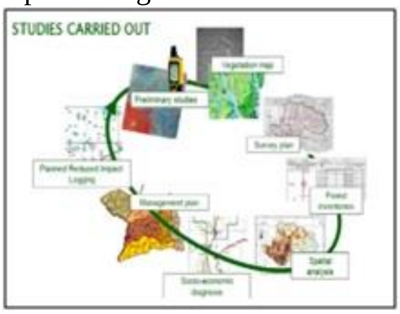

Fig. 4- Study Carried Out By Wachiye

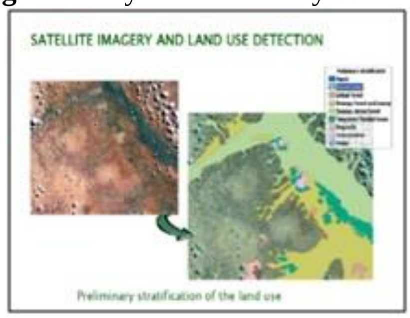

Fig. 5- Satellite Imagery And Land Detection

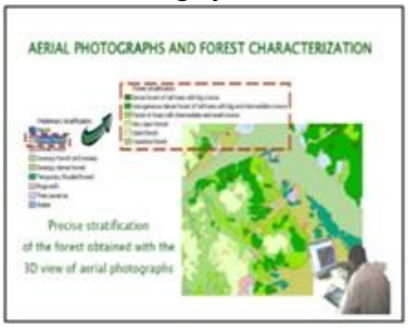

Fig. 6: Aerial Photographs And Forest Characterization

CONCLUSION

The variety of applications reviewed in this study is clear testament to the significant value of forests and the potential of GIS to aid in their management. GIS applications can strongly benefit from remote sensing and image processing technologies. Forests are complex assemblages of species that lend themselves well to broad-level inventory through remote sensing. It is clear that throughout the world, forests are matter to many demands. As a result, many forest management problems have the nature of multi-objective planning procedures. Unfortunately, GIS is not well developed for multi-objective planning. Stronger tools are necessary for the analytical resolution of conflicting suitabilities and choices in resource allocation. Thus, forestry applications embody the full scope of GIS technology. Thus its study provides an excellent overview of the state of the technology and its potential as a management tool for natural resource .

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