

A term paper on

Making GIS work in Forest management

*(A term paper has been submitted for the partial fulfillment of the requirement of the subject WME 806
Geoinformatics for Resource Mapping and analysis)*

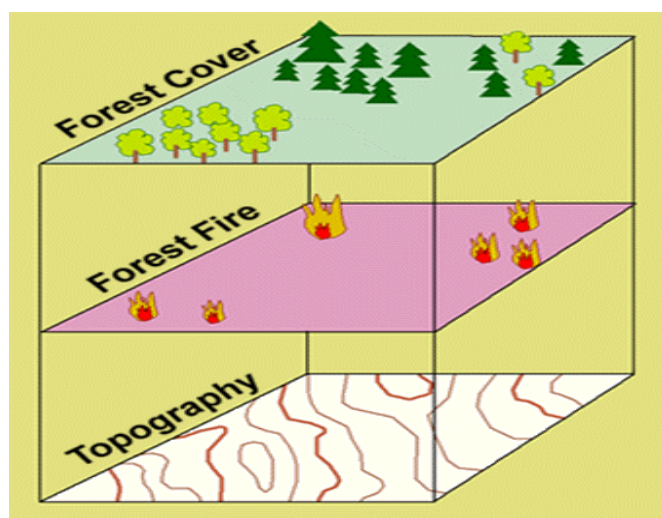
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Abstracts

The overall aim of this term paper was to explore the potential for the application of Geographic Information System (GIS) technology in forest management. Review of global literature on GIS applications showed high potential and growing use of GIS in Forest Management. GIS was successful in determining information, collecting and arrangement of data, mapping the area, finding the problem and decision-making. GIS technologies are only a means to identify and solve problems, and need proper planning and basic resources to allow their potential to be realized.

Key Words: GIS, Forest Management, Applications

1. Forest Management and GIS

Geographical Information Systems (GIS) is an information technology that has been used in public policy-making for environmental and forest planning and decision-making over the past two decades (Pradhan, 2008 and Bassole et al. 2001). GIS integrates hardware, software, and data for capturing, managing, analyzing, and displaying all forms of geographically referenced information (ESRI, 2008).

Forest management has become more complex as there are now multiple objectives to attain, as well as multiple criteria and constraints to address (Warnecke et al., 2002). This makes GIS an important tool in decision-making during policy formulation, planning, and management. It can be established to provide crucial information about resources and can make planning and management of resources easier, e.g., recording and updating resource inventories, harvest estimation and planning, ecosystem management, and landscape and habitat planning (ESRI, 2003). Nowadays, with improved access to computers and modern technologies, GIS is becoming increasingly popular for resource management (Baral, 2004).

Since foresters have to deal with numerous objectives from a single patch of forest (e.g., annual allowable cut, maintenance of biodiversity, conservation of soil and water) a wide variety of spatial information is required and sources of reliable data are a prerequisite for developing a GIS in forest management (Bettinger and Wing, 2004). The trend towards community based forest management has added new dimensions and potential to the use of GIS in forest management.

2. Use of GIS in Forest Management

GIS is a good tool of the Forest Management because it answers the following question that helps in Forest Management Activities.

- ☞ **Location** - What is at?: Location of forest resource in the earth in many ways such as a place name, post or zip code, or geographic references such as latitude and longitude.
- ☞ **Condition** - Where is it?: non forested land of certain size within certain distance from road or river etc.
- ☞ **Trends** - What has changed since?: It helps to find out what has changed within study forest/Land use an area over time.

☞ **Patterns** - What spatial patterns exist? Determine whether landslide in forest area.

☞ **Modeling** - What if ? Determine what happens, if a road net work is added in a forest.

3. Major application areas for GIS in forest management

Forest, can be categories into Private Forest, Community Forest, Leasehold Forest, Religious Forest, Protection Forest, and Production Forest and GIS is use as a management tools in these all kinds of the forest. The major areas of application of GIS in Forest Management are given below;

- i. **In Forest Resource Assessment and Monitoring:** As the primary objective of most forest resource assessment and monitoring is to know and map what exist in a forest area, it is not surprising that GIS has plenty of applications in this field ([Apan, 1999](#)). The use of GIS in this category is; a) Assessing Deforestation, Degradation and Land Use/Cover Change. b) Assessing Forest Types, Age Classes, and Successional Stages. c) Assessing Forest Resources at Various Spatial Scales
- ii. **In Forest Protection:** Forest protection, whether against fire, pests and diseases and human actions, requires sound spatial data in the design of plans and their actual implementation ([VDF, 2008](#)). For instance, to predict the occurrence, location, direction, rate of spread and intensity of forest fire, spatial data sets about the vegetation types, topography, natural features, etc., of the area are needed. GIS can be used more accurately, quickly and thoroughly present, analyse and interpret annual and historical records of forest pest conditions ([Vansickle 1989](#)).
- iii. **In Forest Harvesting:** Spatial forest modelling using GIS can substantially enhance the planning of harvesting strategies. Locations of forest stands, timber inventory data, ecologically sensitive areas, key attributes of the terrain, and other important factors, could be mapped and included for spatial analysis necessary in harvesting plan preparation ([Apan, 1999](#)). Spatial modelling tasks could help the forest manager and government officials see the economic, environmental and social impacts of the proposed harvest. GIS tools also help harvest planners to evaluate several road access alternatives – focusing on costs and their possible impacts ([Baral, 2004](#)).
- iv. **In Forest Rehabilitation:** Spatial information is crucial to effective forest rehabilitation. GIS could respond to solving major forest rehabilitation problems by providing an organized environment and analytical tool during site assessment and mapping, species-site matching, location of nursery and other infrastructures, and progress monitoring and evaluation ([Apan, 1999](#)).
- v. **In Community and Social Forestry:** A social/Community forestry program has to focus on socio-economic, Biophysical variables that affect local people's needs, priorities, and willingness to participate. Moreover, community forestry needs to promote adaptable and participatory approaches to problem identification and project design. The present use of GIS for community and social forestry is lacking. Only very few studies were formally reported in the literature ([Baral, 2004](#)).

- vi. **In Forest Conservation and Biodiversity:** Biodiversity conservation in tropical countries should begin with the collection of baseline information. GIS helps in preparation of conservation policies and plans, particularly in support of legislation, should be supported by information at appropriate levels and themes. Overall, the function of information is to assist the identification, selection, design and management of protected areas and nature reserves (SIC, 2009).
- vii. **On Climate Changes:** GIS has great potential in improving climate change studies. First, GIS can organize digital spatial datasets of different themes to form large global databases. Second, the powerful spatial analysis capabilities of GIS could strengthen the modelling tasks required. At present, however, applications of GIS to climate change studies are still in an early stage (Idurs et al. 2009).
- viii. **Spatial Databases for Forest Management:** The many perceived and realised benefits offered by GIS, as well as the on-going trend in the ‘digitalization’ of many thematic maps, will push for more creation, management, distribution and use of spatial databases. While spatial databases help to solve crucial forestry planning and management problems, there is also a problem of planning and managing the database itself. Particularly for large scale applications, it needs a systematic analysis, design, and implementation that will primarily focus on the needs of the users (Apan 1999). The users, managers, and information specialists have crucial roles in all aspects of the system development life cycle.
- ix. **In Preparing a Forest Working Plan:** Systematic forest management requires division of the forest area into blocks and compartments. A block is usually bounded by natural features and divided for administrative purposes into several compartments and GIS helps in these activities (Rao, 2006).
- x. **Wildlife habitat conservation and planning:** GIS is often used in habitat and vegetation mapping, monitoring, assessment and analysis of the progression of conservation activities, ecological patterns, encroachment of protected wildlife parks, monitoring of wildlife and marine populations and building management support systems by comparing images from different dates (Kushwaha, Undated).
- xi. **In conservation of soil and watersheds, and wetlands:** Watershed spatial databases from local to national scales are being maintained in many countries to serve the interests of multiple stakeholders in watershed management (Musinguzi et al. 2008).
- xii. **Participatory Forest Management planning:** A Public Participation GIS (PPGIS) was developed, applied and evaluated to determine its potential to assist village communities in the management of their communal forest resources in the mountains of Nepal. It was successful in involving the community in determining their information needs, collecting data, obtaining resource information and forest management decision-making (Jordan, 2001).

<u>Factors hindering GIS use in Forest Management, Nepal</u> Poor economic conditions Lack of trained personnel Poor information flow Restricted access to information Lack of operational applications of GIS Weak capacity for spatial data capture and database building Inadequate role in participatory planning and decision-making Lack of socio-economic data and applications Lack of Electricity for using Computer Source, Baral, 2004 and Apan, 1999.	<u>Data needs for forest Management</u> Forest cover Composition Structure Crown density Regeneration status Site quality Negative influences Sensitive spots Boundaries Topo features Soils Climatic data Moisture regime Biotic influences Markets (Source: Grewal, 2001)
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4. Conclusions

There have been a significant number of applications of GIS in forest management. GIS will maximize its benefits to forestry if it is used for operational decision-making aside from the research-saturated applications. There is an apparent lack of socio-economic data that could be used for GIS in forest management. As a recent trend of Community Forestry is to encourage participation, GIS therefore has to address some key issues to maximise its potential contribution. These include the need for customized, friendly user interfaces, better visualization and graphical display, the need to accommodate group decision-making.

As a data-dependent system, the use of GIS is severely hampered by weak forest inventory and related data gathering systems, including the building of digital spatial database. In addition, there is need to ensure the provision of GIS skilled personnel, at various levels and functions.

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