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THE ROLE OF GIS IN FOREST MANAGEMENT

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Abstract:

Forest management is a crucial aspect of environmental conservation, sustainable resource utilization, and biodiversity preservation. Geographic Information Systems (GIS) have revolutionized the way forests are managed and monitored. This abstract provides an overview of the pivotal role played by GIS in forest management, highlighting its contributions to data collection, analysis, planning, and decision-making processes. GIS technology facilitates the collection of spatial and attribute data related to forests, including tree species distribution, forest stand characteristics, soil properties, climate data, and more. This geospatial information is essential for creating comprehensive forest inventories and monitoring changes over time. GIS tools enable forest managers to gather data through remote sensing, ground surveys, and satellite imagery, providing a holistic understanding of forest ecosystems. In forest analysis, GIS aids in assessing forest health, identifying potential threats such as pests and diseases, and estimating timber volumes and growth rates. Through advanced spatial modeling and analysis, GIS helps predict the impact of various management scenarios, supporting evidence-based decision-making. Forest managers can use GIS to optimize harvesting operations, plan controlled burns, and designate protected areas based on ecological significance.GIS facilitates collaboration among stakeholders involved in forest management, including government agencies, non-governmental organizations, researchers, and local communities. By sharing spatial data and analysis results, GIS fosters transparent and participatory decision-making processes, ensuring that the diverse interests in forest management are considered. In the context of sustainable forestry practices, GIS contributes significantly to biodiversity conservation. It enables the identification of critical habitat areas, corridors for wildlife movement, and the assessment of the impacts of logging or infrastructure development on ecosystems. This information guides the development of forest management plans that prioritize conservation while permitting responsible resource extraction. GIS plays an indispensable role in forest management by providing valuable tools and data for informed decision-making. Its ability to integrate spatial and attribute information, analyze complex ecological processes, and support collaborative efforts makes it an essential technology in the pursuit of sustainable and ecologically sound forest management practices. As challenges related to climate change and environmental preservation continue to grow, GIS will remain a fundamental component of effective forest management strategies.

keywords: GIS, *Forest, Management*

Introduction

The use of Geographical Information Systems (GIS), which offer accurate, efficient, and reproducible techniques for gathering, visualizing, and analyzing geographical data, has swamped practically every sector in the engineering, natural, and social sciences. This is due to the fact that GIS is widely used. Forests are vital natural resources that are continually replenished and play a crucial part in the maintenance of an atmosphere that is hospitable to human life. In addition to timber, forests offer a variety of other resources to their surrounding communities, including grazing land for animals, habitat for wildlife, water resources, and recreation sites. Forestry is the management of a wide variety of natural resources that are found within an area that is covered in trees. The management of forest resources in today's ever-changing environment presents forest managers with an increasing number of challenges and complexities. In this essay, GIS is offered as a potential technique of coping with this complexity because of its versatility. According to Upadhyay, "Geographical Information Systems is an information technology that has been used in public policy making over the past two decades for environmental and forest planning and decision making.""Geographical Information Systems" Foresters have access to strong tools thanks to GIS and other associated technology, which they can use for record keeping, analysis, and decision making. GIS can be built to offer vital information about resources and can make it easier to plan for and manage resources, for example, recording and updating resource inventories, harvest estimation and planning, ecosystem management, and landscape and habitat planning. GIS can also be used to make planning and management of resources easier. The development of technologies like as Geographic Information Systems (GIS), the Global Positioning System (GPS), and Remote Sensing (RS) has made it possible to collect and analyze data from the field in ways that were not feasible before the invention of computers. GIS is becoming increasingly popular as a tool for resource management as there has been an increase in accessibility to contemporary technology and computers in recent years.

Types of Forest

The climate, make-up of the species population, and social organization of forest communities all differ. Within these bigger regions, there are a variety of forest kinds that are more particular:

Tropical Forest

Countries such as South America, Africa, and Southeast Asia are examples of places that contain tropical rain forests that are located around the equator. They contain millions of unique species, giving them the highest level of species variety found anywhere on the planet. Despite the fact that they only cover a small portion of the world, they serve as the primary habitat for around half of all species. The temperature rarely deviates from about 27 degrees Celsius throughout the year. The average annual rainfall in tropical forests is about 200 centimeters. In the majority of cases, tropical forests have both wet and dry seasons. A wide variety of plants are able to flourish thanks to the favorable growing conditions of high temperatures, adequate rains, and twelve hours of daylight each day. Rain forests are the perfect environment for the growth of broad-leaved trees, mosses, ferns, palms, and orchids. These woods are home to a wide variety of species that have evolved to a life in the trees, including monkeys, snakes, frogs, lizards, and other small mammals.

Various subcategories of tropical rain forests:

- Evergreen: rain around the year, no dry season
- Seasonal: vegetation evergreen, short dry season,
- Dry: long dry season in which trees shed leaves
- Montane: most precipitation from mist or fog (also called cloud forests), mostly conifers
- Tropical and subtropical coniferous: dry and warm climate with conifers adapted to variable weather
- Sub-tropical: north and south of tropical forests, trees adapted to resist summer drought

Temperate Forest

The next ring of latitude has temperate woods, which can be found in North America, Europe, and north-eastern Asia. The average annual precipitation in the forests is between 75 and 150 centimeters, while the temperature ranges from -30 degrees Celsius to 30 degrees Celsius. Oak, beech, maple, elm, birch, willow, and hickory are some of the more common types of trees. Squirrels, rabbits, birds, deer, wolves, foxes, and bears are some of the common animals that may be found dwelling in these forests. They are able to withstand both cold and hot conditions thanks to their adaptations. Due to the high quantity of precipitation that these woods experience on a yearly basis, they are sometimes referred to as temperate rain forests. In these particular woodlands, evergreen conifers predominate as the flora of choice. Trees such as cedar, cypress, pine, spruce, redwood, and fir are examples of common tree species. There are still some deciduous trees in these forests, such as maples, in addition to a great deal of mosses and ferns, which give them a Jurassic appearance. Deer, elk, bears, owls, and marmots are all common species that can be found walking around in the woods.

Problems of Forest:

Deforestation and the deterioration of forestland have been key concerns throughout the colonial period and continue to be so now. Even though the objectives of usage have shifted, forest resources are still being exploited as a result. It is predicted that the rate of deforestation was approximately 10 million hectares per year from 2015 to 2020, which is a significant decrease from the rate of 16 million hectares per year in the 1990s.

- Another key concern is the growth of the agricultural sector. The beginning of organized human society and the practice of agriculture has had a devastating impact on the surrounding woodlands. Between the years 2000 and 2010, large-scale commercial agriculture (mainly cattle ranching and the production of soya bean and oil palm) was responsible for forty percent of tropical deforestation, while local subsistence agriculture was responsible for thirty-three percent of this phenomenon.
- Natural reserves on their own are not enough to ensure the survival of biodiversity. They are typically too small, have the potential to operate as barriers in the migration of species, and are susceptible to variables such as changes in temperature. This indicates that there is a need to go beyond than protected areas and into traditional methods of biodiversity protection that are included into forest management practices.
- The collection of wood for use in building ships and dwellings led to the beginning of deforestation more than a thousand years ago. On the other hand, during the course of the past two decades, more than 300 million hectares of tropical forests have been cut down and cleared for use in plantations, agriculture, pasture, mining, urban development, and other purposes. The amount of land covered by trees at the time agriculture began is only half of what it is today. The destruction of fifty percent of the world's forests is already enough to throw off balance the global carbon cycle.

Forest Policy of India

Since the beginning of European colonial rule until the present day, numerous forest policies and laws have been enacted in an effort to make more efficient and effective use of the forest and the resources it contains. They are constructed by following a predetermined structure. The term "forestry" occurs in the "concurrent list" in the Indian constitution, which indicates that both the central government and the individual states have authority over the subject. In this section, we take a look at several significant policies that have been enacted at various times throughout history in India that have had a significant impact on the health and expansion of the country's forest ecosystems. An outline of the forestry acts and regulations that were in place in India during the colonial and post-colonial periods

Colonial Period

These are some important historical events that played a role in the development of forest policies and their subsequent execution in India. The following is a list of significant points along the process:

- In 1855, Lord Dalhousie promulgated his Forest Charter, marking the first time in Indian history that specific restrictions were established to safeguard India's forests. Laws of wasteland, or modern scientific forestry in its contemporary form.
- In 1864, the Imperial Forest Department was formally established.
- The Indian Forest Act of 1865 established the state's monopoly on the use of forest resources and established the foundation for scientific forest management.
- The 1878 Forest Act, which classified forests as reserved, protected, and village forests and denied locals their rights, was opposed by the people who lived in the forests at the time.
- The Indian Forest Act of 1927 It has been mentioned that this area is a RESERVE FOREST AREA, which limits the movement of people within it to ensure the protection of the natural ecology and the species that exists within it.
- In 1930, the Department of Forestry was first established at the state level.

Post – colonial period

- 1952 Indian Forest Policy, classification of protection, national, village forests and tree lands – aimed to bring 33% of geographical area under forest cover
- 1953 Nationalization of forests
- 1980 Forest Conservation Act intended to limit deforestation, conserve biodiversity and wildlife.

Fig .1 Types Of Forests -1

Role of GIS in forest management

In the context of the administration of natural resources, the function that contemporary technology plays is one that cannot be overstated. Among them are the prevention and management of flames through the development of early warning systems for regions that are prone to fire, the monitoring of fires in real time, and the evaluation of the severity of burn scars. Satellite-based remote sensing technology and GIS tools have been instrumental in improving the prevention and management of fires in recent years. This has been accomplished through the construction of early warning systems for regions that are prone to fire, the monitoring of flames on a real-time basis, and the compilation of data on burnt scars. The Geographic Information System, or GIS, is currently being used in virtually every industry, including engineering as well as the scientific and social sciences. It provides methods for the collecting and analysis of geographic data that are accurate as well as efficient. In order to make more informed judgments and to carry out effective forest management, it is necessary to have access to descriptive as well as locational inventory data. The application of GIS in forest management is important because it enables the forestry industry to derive the greatest possible advantage from its operations.

GIS tools:

- Remote sensor devices
- Satellite imagery
- Land detecting devices
- Aerial photography devices

Using GIS, foresters are able to generate databases that are necessary for the preparation of work plans. The use of technologies such as GIS, GPS (global positioning system), and RS (remote sensing) has given foresters the ability to explore beyond traditional ideas and has introduced novel approaches to the collecting and examination of data. Foresters are able to keep better records, assess situations more effectively, and make better decisions with the use of GIS and other associated technology. The Geographic Information System (GIS) provides responses to inquiries such as location, condition, trends, patterns, and modeling. In addition to this, Geographic Information Systems (GIS) can be quite helpful in the areas of forest resource assessment and monitoring, forest protection, forest harvesting, forest rehabilitation, conservation and biodiversity, climate change, preparation of the working plan for forest management, conservation of wildlife habitats, conservation of soil and watersheds, and so on. The application of GIS in forest management is an important factor that enables forestry sectors to derive the greatest possible advantages.

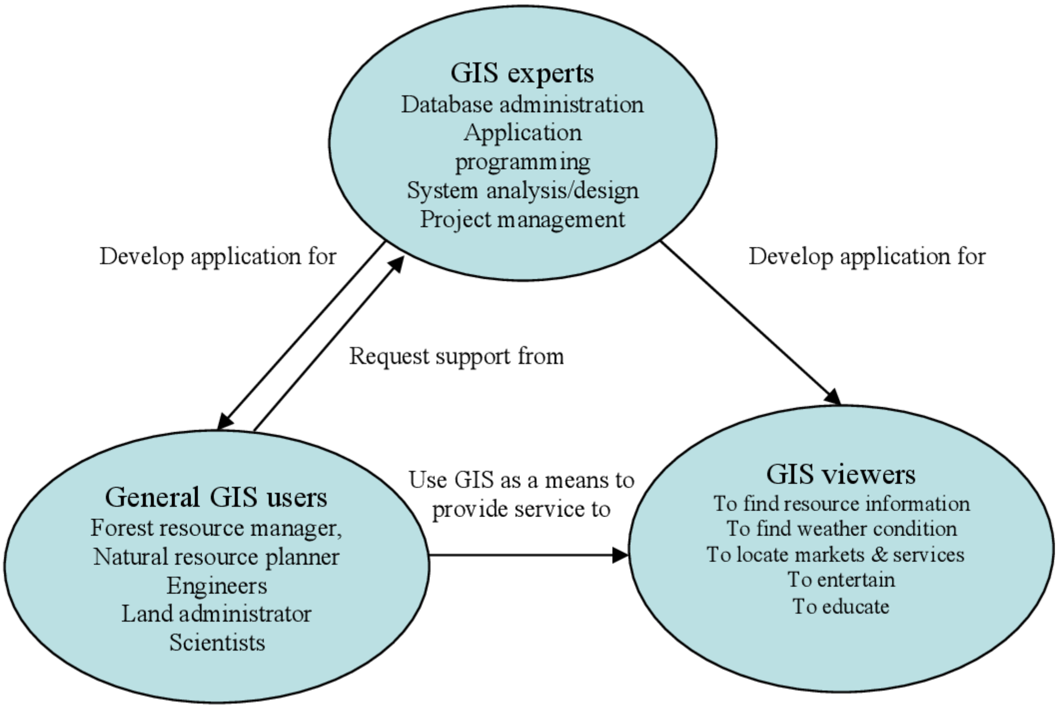

fig 2 Applications of GIS in community based forest management

GIS application in forest management

GIS for strategic planning and modeling: Part of the process of planning forest management involves developing projections about what the future appearance of the forest will be in relation to the various management actions that may be implemented. This capability is essential for virtually all elements of management forecasting, but especially for estimating the long-term supply of wood and animals. According to Kane, GIS saves both the geographical and numerical structure of the forest stands and relates that spatial information to the planning models. In addition, GIS is used to analyze the data. The process of management planning may be successfully expanded to include both the crucial temporal and geographical aspects as a result of this ability. Following the completion of the inventory and the development of the model, the manager will then be able to create a map depicting what the forest will look like in 5, 10, 25, or 100 years.

Production of Maps In order to assist them with their day-to-day tasks, forest managers require a broad array of different maps. Plantation maps are most frequently used to pinpoint specific locations, and they may also include other information that is important, such as roads, rivers, compartment boundaries, planted species, and compartment size. The map could also show additional elements, such as topography characteristics (contours), infrastructure, water spots, fire breaks, neighbors, and conservation areas.

The effects of fire on forest resources is another key management problem that must be addressed through fire management. Management tasks include preventing fires, controlling animal populations, conducting controlled burns, and assisting with post-fire recovery efforts. Within the scope of this project, the modeling capabilities of GIS have shown to be highly useful. GIS has been utilized by forest fire managers for mapping of fuel, mapping of meteorological conditions, and assessment of potential fire hazard. Forest fires have a significant impact on the vegetation cover, animals, and plants, as well as the soil, stream flow, air quality, microclimate, and even the climate overall. The devastation done to both people's lives and their property is abundantly clear, as is the loss of timber. Forest fires may have a number of negative effects, including the elimination of the forest's potential as a place for outdoor enjoyment and the destruction of habitat for local species.

The capacity to predict how a fire would behave once it was started was essential for the management of operations that involved burning. he indicated that models of fire behavior had been established using fuel models in order to forecast the severity of a fire based on characteristics such as slope, elevation, site exposure, wind speed, relative humidity, cloud cover, temperature, and the amount of moisture contained in living and dead fuel. However, these models do not take geographical context into account, and they are often employed to forecast how a fire would behave across a very big region. Fire behavior models were implemented utilizing a raster-based geographic information system (GIS) in order to maximize the sensitivity of the models to the spatial heterogeneity that exists inside the park. After the input layers had been saved in the GIS, its mathematical modeling capabilities and certain lookup tables were put to use in order to create a number of fuel and fire intensity models. Wells and McKinsey came to the conclusion 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 after comparing the predicted fire behavior with actual burn conditions. This was determined by comparing the predicted fire behavior with actual burn conditions.

The planning of harvesting activities is an essential component of good forest management practice, which mandates extensive advance preparation. Activities related to harvest planning include determining felling directions, extraction routes, depots, and sensitive zones like as wetlands. When it comes to the planning of these events, maps are an essential tool. Other features of strategic harvest planning include use of maps to identify anticipated felling across a number of years, as well as to consolidate felling areas and extraction routes, which enables more effective use of harvesting equipment and other resources.

Administration of resources: Both Wulder and Franklin emphasized how important it is for forest management efforts to include the collection of data on forest inventories as well as the monitoring of changes. Yet, a GIS may expand on these activities by including models to guide, for example, timber harvesting, silviculture, and fire control operations, or anticipate fuel wood and other resource supplies. This can be done by building on the activities that have already been completed. Other concerns, such as the provision of habitat for wildlife, the assurance of chances for leisure, and the minimization of the aesthetic consequences of harvesting, are also gaining in significance. Some examples deal with a single management worry, such as wood production, while others highlight how a mix of management concerns may be integrated through the use of GIS, such as timber production combined with habitat conservation. For example, some applications deal with single management concerns, such as timber production, while others deal with several management concerns at the same time.

Uses of GIS in forest management

Upadhyay [1] pointed out that GIS is a good tool for forest management because it answers the following question that helps in forest management activities.

• Location: What is at?

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.

• Condition: Where is it?

Non forested land of certain size distance from road or river.

- Trends: What has changed since?

It helps to find out what has changed within study forest or 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 network is added in a forest.

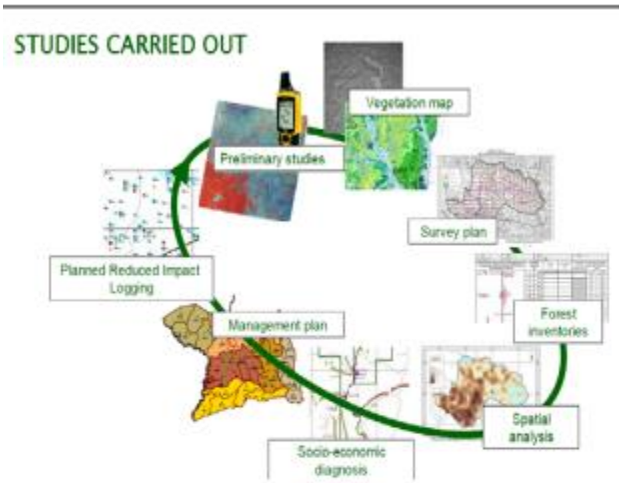

Figure 3: Studies carried out by Wachiye

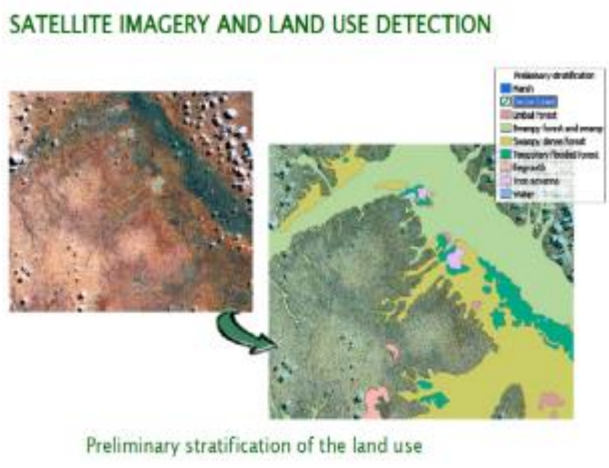

Figure 4: Satellite imagery and land detection.

Conclusion

Over the course of time, a greater emphasis has been placed on the requirement for improved spatial, spectral, and radiometric resolutions for woods types and species (associations). It is anticipated that the mapping and tracking situation would, in time, become far more accurate than in the past. Already, the spatial, spectral, and radiometric resolutions have all made significant strides forward. The majority of sensors on the market today provide spectral resolutions on the order of around 10 nanometers per band. It is anticipated that using continuous spectra for sensing will not only help in better species identification, association/formation mapping, and forest/vegetation type level mapping, but will also result in higher accuracy in timber volume and biomass estimations by highlighting the subtle differences in the physiognomy of the vegetation. This will be accomplished by highlighting the subtle differences in the physiognomy of the vegetation. In a way that has never been done before, the hyper spectral photography is shedding light on the current status of the biodiversity and the vegetation continuum throughout all of the ecosystems and the landscapes. Already, ground penetration radars are providing the scientific community with valuable assistance in determining the belowground biomass.

References:

[1] Ben, H.J. De Jong, Richard, Tipper and Guillermo, Montoya-Go´mez (2000), An economic analysis of role of forests in carbon sequestration,by forest: Evidence from Southern Mexico, Ecological Economics, 33,313- 327.

[2] Gupta, D. (2020 July 4), Forest Policies of India, https:// elsjnuals.wordpress.com/2020/07/04/forest-policies-in-india/ geographynotes.com

[3] Upadhyay M (2009) Making GIS work in forest management. Institute of Forestry, Pokhara, Nepal.

[4] Ayhan AA, Ametin TM, Bgurcan BG (2004) Spatial and Temporal Analysis of Forest Covers Change: Human Impacts and Natural Disturbances in Bartin Forests, NW of Turkey. Landscape Ecol 19: 631-646.

[5] Chuvieco E, Congalton RG (1989) Application of Remote Sensing and Geographic Information Systems to Forest Fire Hazard Mapping. Remote Sens Environ 29: 147-159.

[6] Anon (2015) Applications of GIS. Administration and finance. Mass GIS.

[7] Kane K (1997) GIS and Forestry.

[8] Wulder MA, Franklin SE (2007) Understanding forest disturbance and spatial pattern: Remote sensing and GIS approaches. CRC press, Boca Raton 1-246.

[9] Wachiye SA, Ndegwa DK, Musiega D (2013) GIS based forest cover change and vulnerability analysis: A case study of the Nandi North forest zone. Journal of Geography and Regional Planning 6: 159-171.

[10] Wulder MA (1998) Optical remote-sensing techniques for the assessment of forest inventory and biophysical parameters. Progress in Physical Geography 22: 449-476.

[11] Thompson MW, Whitehead K (1992) An overview of remote sensing in forestry and related activities its potential applications in South Africa. Southern African Forestry Journal 161: 59-68.

[12] McCall KM, Minang AP (2005) Assessing participatory GIS for communitybased natural resource management: claiming community forests in Cameroon. The Geographical Journal 171: 340-356.

[13] Mukeba A (2013) Eyes in the Sky Monitor Congo Basin Forests. USAID.

[14] World Resource Institute (2015) Congo Basin Forest Atlases.

[15] Zhang Q, Justice CO, Jiang M, Brunner J, Wilkie DS (2006) A GIS-based Assessment on the Vulnerability and Future Extent of the Tropical Forests of the Congo basin. Springer 114: 107-121.

[16] Anon (2007) Remote Sensing and GIS for Moist Tropical Forests' Sustainable Management FRM's expertise in the Congo basin.

[17] Esri (2015) Manage the forest better. Forestry