A PROJECT OF SUSTAINABLE UTILIZATION OF FOREST RESOURCES SUPPORTED BY GIS

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ABSTRACT: This paper, with the help of GIS, analyzes the structure characteristics, dynamic process and factors which result in failure of forest resources sustainable development in Tayuan Forest Farm, Da Hinggan Mountains, finds that there are big problems either in quantity or in planning for forest resource development, and puts forward a project for its forest resources sustainable utilization. From the analysis, this paper is going to find an available development project for forest resources sustainable utilization for the forest farm, and also provides the protection and management of forest resources and the strategy of sustainable forestry development with scientific foundation.
KEY WORDS: forest resources; sustainable utilization; project; GIS

1 INTRODUCTION

Resources are the foundation of economic development, and sustainable development is the inevitable trend of human development. The sustainable development of Chinese forestry is an important portion of Chinese sustainable development strategy, and forest resource is the key problem of sustainable forestry development. Therefore, exploring the reasonable forest resource management and utilization project has important significance for the realization of sustainable forestry development.

Da Hinggan Mountains forest district is one of the important wood production bases, and has very important position in Chinese economy. However, the forestry of this district was being in poor state of extensive management in its general situation in recent years, the forestry was developing at the cost of resource consumption, ecological condition and environment deteriorating, so that it led to the disadvantage situation of resources crisis, ecological quality declining and the difficulty of economic development in the district. Now, it is imperative to fully use its forestry resource, speed up the economic development of Da Hinggan Mountains forest district and guide it into a virtuous circle.

Scholars at home and abroad are paying more attention to the research of sustainable development of forest resources at present, but most of their studies were limited in conceptual explanation and problem description. The main problems are: 1) A complete, feasible theory on sustainable development of forest resource has not been formed, which can be used to instruct the theory and practice of forest resource management. 2) In addition to qualitative description in macro region, it is also necessary to establish the model of sustainable development of forest resource and spatial pattern for quantitative analysis. 3) How to fully use the investigated data and various specialized data and achievement made before has been a serious problem up to now.

GIS is a tool of information treatment, which can analyze, store, and display spatial data and attributive-

sizes quantitative analysis with qualitative analysis and consideration of various factors, establishes an optimum model of spatial pattern of forest sustainable utilization, so that provides sustainable development of forest resource with a feasible, efficient analysis method. Therefore, it is a powerful tool for sustainable management of forest resources. Using the technology in this paper, we preliminarily established the model of sustainable utilization of forest resources in Tayuan forest farm, and forecasted the dynamic process according to the model analysis on the relationship of forest resources, environment, man-made factors and so on.

2 STUDIED AREA

The studied area is located the south to Xinlin Forestry Bureau in the Da Hinggan Mountains forest district, Heilongjiang Province, 123°41' – 125°25' E and 51°20' – 52°10' N. Its area is 123 725 ha and the height is 580 – 1240 m above the sea level. It belongs to continental monsoon climate in cold-temperate zone. The average annual air temperature is from – 2℃ to – 4℃ , the annual rainfall is about 500 mm, which mainly concentrates on July and August. Its annual evaporation is 900 – 1000 mm and the frost-free season is only 90 days. The zonal soil is brown coniferous forest soil, being mainly distributed in the stands of *Larix gmelini, Pinus sylvestris* and secondary *Betula pltyphylla*. Because of the climatic influence, the kinds of plant species in the realm are relatively poor. The major species are *L. gmelini, P. sylvestris, Picea koraiensis, B. platyphylla, Populus davidixtna*. The main species of shrub are *Pinus pumila, Rhododendron dauricum, Alnus mandshuica*. And the groundcover are mainly *Pyrola rotundifilia, Leum palustre* and *Vaccinium vitis-idaea* and other wild economic plants.

The forest resources data of the studied area is reported in the topographic stock map (1: 50 000) made according to forest resources investigation in 1993, and relevant attribution database. Spatial data is collected from the Calcomp Drawing Board II serial digital instrument by the ARC/INFO 7. 02 vector GIS software configured in local NT network.

3 METHODS

Under the ARC/INFO and ARCVIEW environment we overlay each theme, which include soil, slope, aspect, age, diameter-class, forest resources and forest-line road special-subject maps. Display the suitability map of forest resources protection and utilization. Put forward an optimum programme for forest resources sustainable utilization through spatial iterative analysis and AVENUE language. Based on this program we can effectively protect and manage forest resources in time and space. Flow chart of a spatial analysis support model for forest resources utilization using GIS technique is shown in Fig. 1.
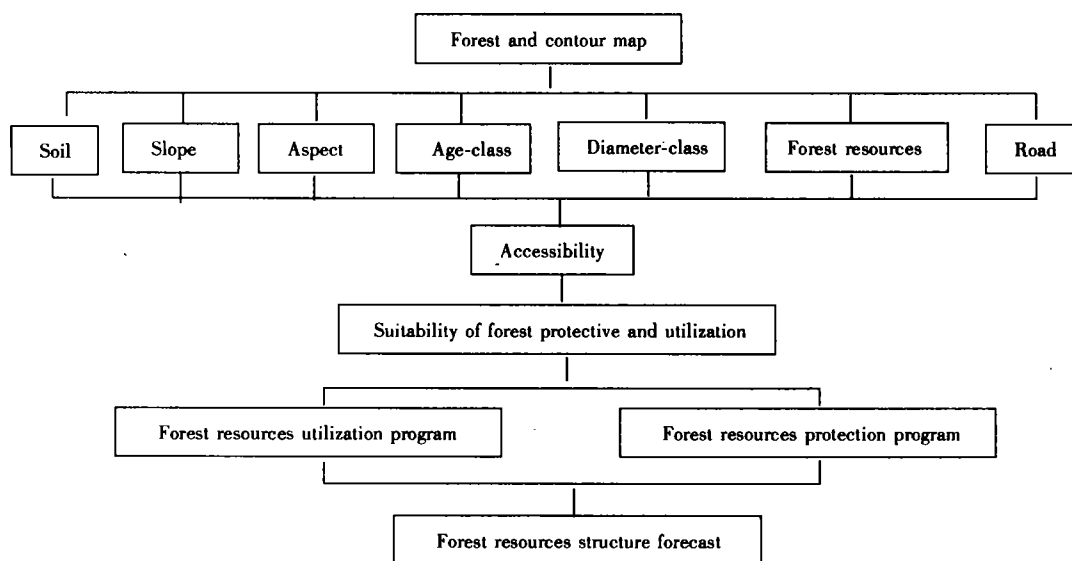

Fig. 1. Flow chart of a spatial analysis support model for forest resources utilization using GIS technique

4 RESULTS AND DISCUSSION

4.1 Dynamic Process of Forest Resources Structure

Table 1 and Table 2 show the dynamic process of forest resources structure in Tayuan Forest Farm from 1984 to 1993. We can see that the proportion of young growth, half-mature forest increased by a large margin, but the proportion of near-mature, mature, over-mature forest declined obviously. And the available resource has decreased. The proportion of conifer has relatively decreased, but that of the broadleaf forest has relatively increased. The forest volume consumption is larger than the growth.

From the dynamic process trends of forest resources structure we can find that the quantity of forest resources utilization has been greater than its growth. Together with the badly waste and short of planning for forest resources development forest resources can not be developed sustainably in Tayuan Forest Farm.

4.2 Sustainable Utilization Project of Forest Resources

It is very important for sustainable utilization of forest resources to calculate the annual allowable cuts (AAC). We compared eight kinds of the formula for calculating the AAC according to existing forest resources, forest growth rate, production and economic conditions, type of main cutting, and found the formula

Table1　The trend of varying of every age group in area and store

Item	1984			1993			Difference		
	Young	Half-mature	Mature	Young	Half-mature	Mature	Young	Half-mature	Mature
Area	7.3	21.9	70.9	17.8	56.6	25.7	+10.5	+34.7	−45.2
Cumulation	1.9	13.4	84.8	7.95	56.2	35.9	−6.05	−42.8	−48.9

Table 2　The trend of varying of dominant species in area and store

Species	1984		1993		Difference	
	Area	Cumulation	Area	Cumulation	Area	Cumulation
L. gemlini	80707	8334293	70781	5806411	−9926	−2527882
P. sylvestris	266	34503	310	1150	−44	−33353
B. platyphylla	14558	948994	33998	2318095	−19440	+1369101
P. davidixtna	260	22111	208	15537	−52	−6574
P. koraiensis	135	12244	308	37169	−173	−24925

of continuous cutting mature wood based tree volume is much better for calculating the AAC in Tayuan Forest Farm. After the AAC is given, the next step is how to collocate forest resources rationally in space-time in order to obtain maximum social benefits. Before space-time planning, the first step is to make forest resources evaluation, create suitability map for forest resources protection and utilization. Then rational arrangement of forest resources is made in space-time by using GIS model, that is to find the best location for forest resources development, and the AVENUE language in ARCVIEW is used to solve this problem. At last, the principle of sustainable development is con-

sidered to get an optimum program (Fig. 2).

4.3 Rationality Verification

If the present forest resources are managed in this structure of resources utilization and spatial distribution pattern we are going to control excessive and irrational forest resources development. By the end of this managerial period, the total forest volume will increase, and the distribution of every forest age group will become rational (Table 3). Therefore the forest resources can be sustainable utilized.
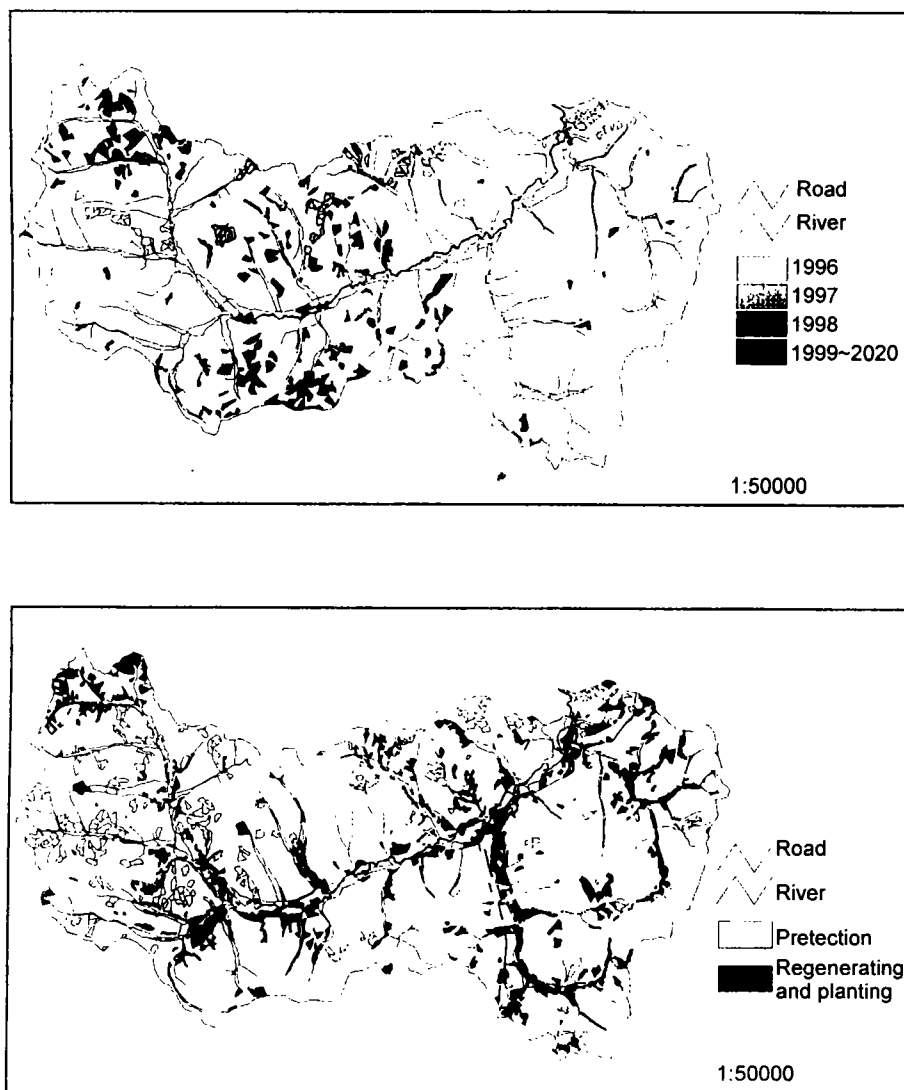
Fig. 2 Optimum programme of forest resources utilization in Tayuan Forest Farm

Table 3 Forecast of every age group and forest growing stock

Year	Young forest (%)	Middle forest (%)	Near mature forest (%)	Mature and over mature forest(%)	Growing stock (×10⁴ m³)
1995	17. 8	56. 6	12. 1	13. 6	823. 0
2005	22. 1	40. 7	21. 2	16. 1	844. 2
2015	23. 6	33. 1	18. 2	25. 2	872. 4
2025	27. 4	29. 0	14. 6	29. 0	868. 2
2035	31. 2	27. 5	12. 3	29. 0	857. 9
2045	33. 9	27. 8	11. 2	27. 1	847. 7
2055	35. 2	28. 6	11. 0	25. 2	843. 2
2065	35. 3	29. 7	11. 3	23. 8	843. 7
2075	34. 9	30. 2	11. 8	23. 1	848. 4

5 CONCLUSION AND DISCUSSION

From the spatial analysis of GIS model above, we have found that there are big problems either in quantity or in planning for forest resources development in Tayuan Forest Farm in recent year. Cutting goes beyond the limit of acceptable quantity. Using the analysis in this paper we can avoid unnecessary waste and reduce blindness. Meanwhile we find an available development project for sustainable utilization of forest resources, and also provide the auxiliary planning with scientific foundation for the government departments.

It is necessary to point out that sustainable utilization of forest resources deeply involve other factors. As a result of uncertainty for the most of these factors, it is very difficult and unreal to exactly simulate the process of resources development. That is also not avoiding in the process of resources planning. The aim of paper is to provide a kind of operational way of researching forest resources sustainable development.

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