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Spatial pattern and compositive structure of forests in Guizhou

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Remote-sensing and field data of Guizhou forest resources in 2000 are processed using ArcGIS, with the production of forest resource distribution map, forest age class structure map, and forest canopy distribution map. Analysis of the se data shows that: (1) though there are multiple types of forest resources, forest coverage is low (only 25.27%, exc luding sparse woodland, shrub and underage-forest); (2) the geographical distribution of forests is quite uneven, mai nly in the southeast of the province and in Zunyi prefecture; (3) the zonal evergreen broad-leaved forests have been seriously destroyed, with striking secondary features, i.e., coniferous forest and shrubbery account for the greates t proportion of Guizhou forests; (4) the timber-forest is much larger in area than shelter-forest and economic fores t; (5) young-and-middle aged forests are more widely distributed than near-and-over matured forest; and (6) the fores t of Guizhou is not enough to effectively protect the environment of karst mountain areas of the province.

YAO Yonghui1, ZHANG Baiping1, ZHOU Chenghu1, LUO Yang2, ZHU Jun2, QIN Gang2, LI Baolin1, CHEN Xiaodong1 (1. Inst. of Geographic Sciences and Natural Resources Research, CAS, Beijing 100101, China; 2. Inst. of Forestry Survey and Desig n of Guizhou Province, Guiyang 550003, China) 1 Introduction Guizhou Province is characterized by wide distribution o f karst areas, which cover about 70% of the total area of the province. The environment in karst areas is dynamicall y fragile (May et al., 1982) i.e., only in the strict limit of environment threshold can the ecological system remain s steadily. It would easily crash when the environment threshold is overstepped or the genus communities are seriousl y disturbed. The fragility of the environment of Guizhou can be shown by the followings: low environmental capacity, few species of suitable trees, simple community structure and small biomass; as a result, Guizhou´s environment is ea sy to destroy and difficult to recover, and disasters such as drought, waterlog and rock desertification are serious (Huang et al., 1988; FDG, 2001; He et al., 1996; Yang and Zhu, 2000; Zhou, 2001). Forests and rock desertification ar e closely related to each other, but their significance is completely different to the environment. Their mutual acti on determines the state of the whole environment of Guizhou. Therefore, studying the spatial pattern and the componen t structure of forests is the key to understand rock desertification and the whole environment of Guizhou. It is als o significant for attaining sustainable development of the province. Mountainous and hilly regions account for 97% o f Guizhou province´s total area. The province averages 1,100 m above sea level, with the highest point of about 2,90 0 m in the west and the lowest point of only 137 m in the east. With a sub-tropical monsoon climate, it has an annua l mean temperature of 15 oC and an annual mean precipitation of 1,100-1,300 mm. The non-frost period totals about 27 0 days. The relative humidity is above 70%. The zonal vegetation is evergreen broad-leaved forest, while monsoon fore sts and evergreen broad-leaved forests with tropic features grow in the river valleys in the south of Guizhou. In kar st areas are calcium-soil vegetation. Most parts of the province are distributed with kinds of secondary forests and man-planted vegetations. Furthermore, Guizhou is one of the provinces with high biodiversity in China, with about 700 0 species of high plants and 1000 kinds of wild vertebrates (FDG, 1996). There are many types of agrotypes in Guizho u, including crimson soil, red soil, yellow soil, brown soil, montane shrubbery-meadow soil, calcareous soil, purple soil and ripe soil. There are 984 rivers longer than 10 km, and most of them are tributaries of the Yangtze and the Z hujiang rivers. The data used in this paper are interpreted from TM images obtained in 1998 and some in 1999. The kil ometer grids of 1:50,000 relief maps were overlapped with remote sensing images, then samples for interpretation are collected on a basis of 2 km×2 km grid and interpreted on 3×3 pixels. Features include land-cover type, the structu re of forest age, canopy coverage of forest, etc. About 5% of the samples are extracted randomly along the traffic li

nes in different images to be validated in the field. Processing the above data using ArcGIS produces such maps as forest resource distribution map, forest age class structure, and the distribution map of forest canopy (Zang and Zu, 1999). Also based on field investigation, this paper deals with the spatial pattern and compositive structure of forests of Guizhou province. 2 Spatial pattern of Guizhou forests 2.1 The general pattern of forests The spatial distribution of Guizhou forests is shown in Figure 1. Forests are mainly distributed in the southeast of the province and northern Zunyi prefecture (Chishui and Xishui counties), with little forest in the northwest and the centre of Guizhou. Of the nine prefectures and cities of Guizhou, the Miao and Dong autonomous prefecture in the southeast has the largest forest area, about 12,480 km2 accounting for 28.11% of the total forest area of the province and with a forest coverage of 41.22%; Zunyi city is covered with 8,208 km2 of forests with forest coverage of 26.73%; its forest area accounts for 18.48% of the total province. Liupanshui city holds the least forest area, only 1,252 km2, accounting for 2.82% of the total forest area of Guizhou with forest coverage of only 12.71% (Table 1). The accumulated stock of the province is 2.1×108 m3. The average forest coverage is 25.27%. 2.2 The spatial distribution of different types of forests The spatial distribution of different types of forests is shown in Figure 2 and Table 2. It can be seen that coniferous forests are mainly distributed in the eastern part of Guizhou; shrubbery is everywhere except the eastern part. Broad-leaved forests are mainly distributed in Zunyi prefecture and in the southeast of Guizhou. Coniferous and broad-leaved mixed forests are mainly distributed in Zunyi prefecture and in the southeastern part of Guizhou. Economic forests grow almost in every part of Guizhou, with large area in the southwest and the east. Bamboo forests mainly appear in Chishui county of Zunyi prefecture; sparse and underage forests are very sparsely distributed but almost everywhere. Bare land suitable for forest is mainly distributed in the northwest and the south of Guizhou. 2.3 The spatial distribution of forests with different ages The spatial distribution of forests with different ages is shown in Figure 3. Young and middle aged forests are mostly distributed in the Miao and Dong Zu autonomous prefecture, Zunyi prefecture, the Buyi and Miao Zu autonomous prefecture, and Tongren prefecture. Near-and-over matured forests mainly occur in the Miao and Dong Zu autonomous prefecture, also in Zunyi prefecture and Buyi and Miao Zu autonomous prefecture. Most of the near-and-over matured forests are broad-leaved forests (Figures 1 and 3) 2.4 The spatial distribution of forests with different canopy coverage According to canopy coverage, Guizhou forests can be divided into three grades: low (canopy coverage 0.20-0.39), medium (0.40-0.69) and high (0.70-1.00). Their distribution is shown in Figure 4. High canopy forests only appear in Chishui and Xishui counties, in the Fanjingshan Mountains and in the southeast of Guizhou. In the centre and west of Guizhou, forest canopy is low, and most forests are sparse forest. Most parts of Guizhou are covered with medium-grade canopy forests. 3 The component structure of forests 3.1 The component structure of forest area The area of different types of forests can be calculated from the distribution map of forest. The result are as follows: coniferous forest totals 25,420 km2 and accounts for 44.22% of the forest area of Guizhou, ranking first in area; shrubbery ranks the second, about 13,036 km2 and accounting for 22.68% of the province´s forest area; and broad-leaved forest is almost the same as shrubbery, about 13,024 km2 and accounting for 22.66% of the total forest area. Other types of forests are quite limited, e.g., coniferous and broad-leaved mixed forest is 1,512 km2, economic forest 3,960 km2, bamboo 488 km2, sparse wood 1,740 km2, and underage forest 1,624 km2. The barren land suitable for forest is widespread, about 16,264 km2, which shows that there is a great potential for forest development (Figure 4). 3.2 The component structure of standing forest According to ground survey in 2000, among standing forests, timber forest accounts for 44.82%, shelter forest 27.67%, fire wood 6.48%, special forest 2.97%, economic forest 15.78%, and bamboo about 2.29%. 3.3 The component structure of natural forest and man-planted forest The area of man-planted forest accounts for 44.50% and natural forest 55.50%. The accumulated stock of man-planted forest accounts for 31.23% and that of natural forest 68.77%. 3.4 The structure of forest age The structure of forest age is shown in Figure 3 and Table 3. Young and middle aged forests total 38,596 km2 and account for 82.11% of the forest, while near-and-over matured forest covers only 8,408 km2, about 17.89% of the total. Moreover, the accumulated stock (AS) of young forests is 6.65864×107 m3, or 37.42% of the total stock; the AS of middle forest is 7.06581×107 m3 and 39.71% of the total; and the AS of near-and-over matured forest is about 4.07127×107 m3, or 22.88% of the total. Figure 7 shows the structure of different ages of forests in prefectures and cities of Guizhou. 3.5 The structure of canopy coverage of forests Low canopy forest amounts to 9,284 km2, or 18.47% of the total; the medium canopy forest is 36,724 km2 or 73.04% of the total; and the high canopy forest is about 4,268 km2, or 8.49% of the total (Figure 4). 4 Conclusions The characteristics of Guizhou forests can be generalized as follows: (1) Guizhou forests are mainly distributed in the southeast of the province and in Zunyi prefecture (mainly in Chishui and Xishui counties) and few patches of forests can be found in the northwestern and central parts of Guizhou. This uneven distribution of Guizhou forests is due to the imbalanced distribution of water and heat conditions. The low mountains and highlands along the Qingshuiji

ang River and along the middle and lower reaches of the Duniujiang River in the southeast of Guizhou are rich in water, heat and soil resources, and the condition is suitable for forest growth and development. These areas are distributed with vastness of coniferous forests and coniferous and broad-leaved mixed forests, and the productivity of forests is very high. The forest coverage is as high as 41.22%. The lower and middle mountains and valleys in Chishui and Xishui counties in the northwest of Guizhou have a mild and wet climate with sufficient water and heat resources, there broad-leaved forest, bamboo and coniferous forests are widespread, and the forest coverage reaches about 26.73%. Other areas are relatively inadequancy in water and heat resources with very low forest coverage. Especially, the natural vegetations of the Miaoling Range were seriously destroyed, and most of them have been replaced with coniferous forests and shrubbery. (2) There are multiple types of forests, but the coverage is low, only about 25.27% on an average (excluding sparse wood, shrubbery and underage forest). In the history, Guizhou abounded in forest resources; however, due to years of war, population pressure, cultivation, over-logging and denudation, the forest resources have decreased enormously, with the forest coverage dropping from 30% in the 1950s to 13.7% in the 1980s. Since the early 1990s, thanks to the re-orientation of national forest policy, the forest coverage has gradually been increased. However, the increase is mainly in man-planted forests, and their stability and function for protecting ecology are much poorer than those of natural forests. (3) The zonal evergreen broad-leaved forests have been seriously destroyed, and the forest has obvious secondary features, in other words, coniferous forests and shrubbery serve as the main body of Guizhou forest. Generally, when the zonal evergreen broad-leaved forests were destroyed, they were often replaced with coniferous forests or shrubberies. In the eastern part of Guizhou, the distribution of coniferous forests is negatively correlated with the distribution of shrubbery. (4) The structure of forest age is unreasonable. There are more young-and-middle aged forests than near-and-over matured forests. As a result, the productivity of forest is low. The general pattern is that the area of coniferous forest is greater than the area of shrubbery, which, in turn, is greater than the area of broad-leaved forest. (5) According to the regulations of China forest law, forest coverage in mountain regions should be as high as 40% or more and the forests are distributed evenly, then the forest may play the role of protecting the ecological environment sufficiently (He et al., 1996; Su, 2000). However, the forest coverage of Guizhou is only 25.27%, its spatial distribution is uneven, and the component structure is not reasonable; so, the quality of forests is not low, and it can not effectively protect Guizhou´s environment. On the basis of the analysis above, it can be drawn that, in order to attain sustainable development of forest resources, Guizhou province should greatly promote tree planting and forestation, fence mountain slopes to cultivate forests, and adjust the component structure of forests to make it reasonable. In the meantime, rock desertification management should be well planned for the rehabilitation of degraded Karst landscape. Economic forests should be actively developed so as to enhance the protection of forest resources. In addition, there are many national and provincial nature reserves in Guizhou, which should be well planned and managed for the good of the ecology of the province.

关键词： forest resources; spatial pattern; compositive structure; Guizhou

