APPLICATION OF RS-GIS-GPS TECHNOLOGY IN THE EVALUTAION OF CHANGING CULTIVATION INTO FORESTRY/GRASSLAND

—— A Case Study in the Upper Reach of Minjiang River

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ABSTRACT

In the investigation of the regional ecosystem status, the combination of Remote Sensing (RS), Global Positioning System (GPS) and Geographical Information System (GIS) technologies can provide the dynamic data timely and visually. A database of ecosystem can be built based on the data with these technologies, and used for relevant departments of the state government to make rational decisions and planning. This paper describes a case study in Wenchuan District of the RS-GIS-GPS technologies in the policy-making process of changing cultivated land to forestry and in the management of the ecosystem monitor. The accuracy of calculating the surface area with this method can satisfy the requirement of the class 2 of resources survey standards of China.

This paper mainly considers the effect of topographic variables in Changing Cultivation into Forestry/Grassland. Others such as the type of soil, hydrology and climate are not the main points in this paper.

KEY WORDS: Remote sensing, Geographical information system, Changing Cultivation into Forestry/Grassland, Ecosystem monitoring

1. BACKGROUND OF THE CASE STUDY

Western Region of China, hosting about 57% area and 23% population of China, has various terrain, physiognomy, climate and ecosystem. But the availability of the most land is so poor that it is an emergency to make the best use of land. Government proposes the aim of changing cultivation into forestry/grassland, which directs the regional construction of ecosystem, that is, it will be scheduled in the target.

Minjiang River origins from Gongga mountain, the Songpan county,Aba Zhou,Sichuan Province, at the altitude of 4,500m . As one of the main branchs of Yangtze Rive, Minjiang River wanders through 5 counties and one city such as Songpan,Wenchuan , Dujiangyan ,etc.. In the recent 50 years, the virgin forestry in both banks of Minjiang River have degenerated to be arid valley grassland, and the rapidly erosion of water and soil threatens the ecosystem of the lower reach and even the Yangtze Rive. This paper describes an application the GIS-RS-GPS technologies in the policy-making process of changing cultivated land to forestry and in the management of the ecosystem monitor in Wenchuan District.

Wenchuan District lies in the area of 103° 30′ ～ 104° 00′ E, and 31° 40′ ～31 ° 20′ N. The altitude ranges between 1240m and 4968m, and the average slope is 45. 53 °.It is the physiognomy of the high valley and middle-high land. Minjiang River goes through the region from the northeast to the southwest. The valley rains little with the characters of arid and warm climate. The average precipitation of it is 500～600 mm. The vegetation, which is mostly of grassland and shrub- grassland, is versatile and varies distinctly with the altitudes.

The area of cultivated lands in Wenchuan is no more than 5. 5% of total area, and because most of them distribute on the both banks of valley of Minjiang River and its branches, the phenomena of the erosion of water and soil are so severe that it gives the pressure to the construction of ecosystem in both banks of Minjiang. As the Rule of Water & Soil Conservation of China proposes, the slope of 25° is the threshold of forbidding the land to be cultivated. According to this standard and relevant calculation, 68.93 % of area of cultivated land in the region has to change its condition in 2000.

2. PREPARATIONS FOR DATA SET

The traditional method of measuring land is often carried out in field works, which is low in efficiency and requires long period of work. This can hardly meet the needs of rapid land surveying, such as the prediction of agriculture output, the pest calamity of forest, and so on. The functions in GIS, such as analyzing, identifying, can be utilized to calculate the area of land and monitor the change and the conditions of land, and the RS and GPS are also be used at the same time.

The necessary conditions of Changing Cultivation into Forestry/Grassland include: 1.the grade being more than 25° ; 2. distribution of cultivation ,that is, it depends on the local geographic and climatic conditions there whether to change cultivation into forestry/grassland.

Main steps of calculations are as following: 1.Generating Digital Earth Model (DEM) by digitalizing topographic maps; 2. Creating false color image through compounding the TM data of the band 4,3and 2, then making thematic cartography of various features by image interpolation; 3. Perfecting the result of image interpolation in order to improve the accuracy by Global Positioning System (GPS) ; 4. Compounding the image data and DEM to derive the terrain model of three dimensions; 5. Calculating the area and forming the map of the district that have to change to plant tree/grass based on GIS according to the formula of Changing Cultivation into Forestry/Grassland.

The data of database are derived into various layers as different themes: such as Digital Elevation Model, the Map of Classified Vegetation, the Map of Classified Soil and the Map of Water Resource. The file types of Digital Elevation Model are mostly Grid or Tin format, and the former is a raster type, which use discontinuous unit－pixel to depict the continuous surface, the later is a kind of Delaunay triangulation[7] . The thematic layers were put into vector layers of surface. Making a vector layer is through scanning terrain map, making an image whose file type is TIF, then vectorizing it and evaluating every line/surface. At last, interpolating method is used for transferring into a DEM file, and the file type is Tin or Grid. The results of scanning and vectorizing include the layers of water

system and regional mete.

False color image is obtained through compounding the image of the band 4,3and 2, and it is used to make thematic cartography of various features by image interpolation [8]; and the results include the Map of Vegetation, the Map of Soil and the Map of Water Resource, etc..

3. ANALYSIS OF THE CHANGE OF LAND COVER AND LAND USE

With the multi-temporal images the vegetable maps with different times can be obtained, and it is easy to monitor the change of vegetation, such as the fluctuation of forestry area, the distribution of felling forestry, and so on.

The application of the database: making the map of changing cultivation to forestry/grassland. The area of changing cultivation can be calculated with the data of the map of vegetation, the slope and the DEM in GIS. The land that has to change cultivation will be visually revealed in the last calculating map named the Map of Changing cultivation to Forestry/Grassland.

3.1 Dynamic monitoring land cover

Wenchuan hosts many high mountains , and the average slope of the region is 45.53° , and even that of cultivation is 48.21° . It is essential to calculate the spatial surface area instead of the plat surface area, because the error of that is 20% with the plat one to calculate area.

The class 2 of resources survey standards of China allows for the error ranging between 5 and 15%. With the model of Arcview GIS[5],the error of the calculation is 7% , so it completely meets the requirements of the standard.

Table 1. Changes of land cover and use during ten years (1999-2000) in Wenchuan district (km^2)

	Cultivation	Garden land	Natural forestry	Artificial forestry	Shrub-grassland	Felling forestry	Naked land
1990	88.184	14.294	150.179	354.865	799.968	0.1214	2.772
2000	78.376	28.416	124.961	357.394	816.549	1.112	2.772
Increase (%)	-9.808	14.122	-25.218	2.529	16.581	0.9906	0
The ratio of increase (%)	-11.12	98.80	-16.79	0.71	2.07	815.98	0

Table 1 shows that from 1990 to 2000, the area of the cultivation and the natural forestry in the region separately decreased by 11.12% and 16.79%, but that of the garden land, artificial forestry and shrub-grassland increase by 98. 80%、0.71% and 2.07% respectively. Especially, the area of felling forestry increased in a rapid rate of 815. 98%. All of these results illustrate that some of cultivation had changed; garden land, as a temporary type of land between cultivation and forestry, increased quickly; the decrease of natural forestry was not at the same speed of the increase of artificial forestry, so the felling forestry augmented obviously.

3.2 The calculation of the area of changing cultivation to forestry/grassland and the practical method

As the rule of changing cultivation, the first limited factor is the slope of 25°, the second one is the area of cultivation revealed in the map of cultivation distribution. With the function of identifying and calculating of spatial surface in Arcview GIS, the distribution map of changing calculation can be derived, and it is omitted in the paper. In the map, the cultivations that have to change mostly distributes along the steep banks of the rivers. Because of the rough climate, and the rarely proper kind of tree, it is better to change cultivation to grassland at first in the region [6], and then change to forestry step by step, at the same time, the motivation and economy of farmers there are two more important factors that have to think about.

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Overlaying features data with DEM can derive the data of changing cultivation to forestry/grassland and its distribution map, the accuracy of the curve surface can meet the requirement of the class 2 of resources survey standards of China. Through comparing the data of changing in land cover, concrete maps and data for that was obtained, and dynamic monitor of the change has been established primarily. Practically, it has an important sense to direct the policy-making and monitor the change of land cover and use.

REFERENCES

[1] Huang Binwei, etc.(1999) .*Modern Natural Geography*, Beijing : Science Publishment, 333-334

[2] Association of Japanese Remote Sensing(1993). *Precise Interpolation of Remote Sensing*, Surveying Publishment

[3]Du Haiping, etc.(1999) .*Modern Cadastral Theory and Practice*, Haitian Publishment,106

[4] Fen Zhongke, etc.(2000). *Application and Technique of RS-GIS-GPS*, Chinese Forestry Publishment, 23-24

[5]Jeff Jenness. Surface Areas and Ratios Extension :http:/ / www. jennessent. com/ arcview/ surface- areas-ratios. htm January 14,2001

[6] He Yurong, etc.(2000). *the Soid Degradation and Fertility Reconstruction in Region of Changning Cultivation into Tree Planting in Changjiang River Upstream* , Journal of Mountain Science ,18(6) ,526-527

[7] Arc DOC(ARC/ INFO8. 0 Help File)(1999). ESRI Company

[8]Yang Wunian, etc.(2000). *the Comprehensive Technique Report of Investigation and assessing of Remote Sensing of Ecosystem in Upper and Middle Minjiang River, Sichuan Province*, Chengdu University of Technology