

Analysis Land-use Changes of the Suomo Basin Based on Remote Sensing Images

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Abstract: Three periods of land-use maps of the Suomo Basin were drawn from topographic maps (1970a) and Landsat TM/ETM images (1986a and 1999a). The area of each kind of land use was calculated from the three maps. From 1970 to 1999, the area of forestland decreased 17%, the area of sparse forestland increased 8%, and the area of grassland increased 10%. The transferring trend of the land-use is that forestland turned into sparse forestland and brush land, and the brush land degenerated into grassland based on the transferring matrixes from 1970 to 1986, and from 1986 to 1999. According to the local government record and statistical data, forest cover rate had been increasing from 1970 to 1998, but the amount of growing stock had been declining. From 1957 to 1998, the amount of growing stock declined from 423m³/ha to 177m³/ha.

Key words: Remote sense images; the Suomo Basin; land-use changes; transferring matrix

1 Introduction

The Suomo River is a tributary of the Dadu River, which is an important tributary of the Yangtze River. The Suomo Basin lies in the Northwestern Sichuan Province, on the east side of the Tibet Plateau. It has a total area of 2536km² and covers part of the Maerkang County and the Hongyuan County. It extends from latitude 31°40' to 32°21' north, and longitudes from 101°18' to 102°41' east.

The length of the Suomo River is 182.5km, flowing from the Hongyuan County into the Maerkang County. The mean runoff flow of the Suomo River is 50.9m³/s; mean runoff depth is 633.5mm. The elevation of the Suomo Basin ranges from 2700m to 5300m. This basin belongs to plateau monsoon climate, dried and cold in winter, wet and hot in summer. The Suomo Basin is a typical basin in the upper reach of the Yangtze River. Many human activities occurred from 1960 to present in this region, including cutting of almost all the accessible primitive forest. The reforestation rate is slower than the rate of cutting.

There are two main types of land-use in this region, forestland and grassland; both of them occupy 98% of the total basin's area. In the upper reaches of the Suomo Basin, grassland is the primary land-use. Forestland is the dominating land in the lower reaches of the Suomo Basin. Farmland scattered on the lower and flat valley.

2 Land-use changes in the Suomo Basin

According to the accessible maps of the Suomo Basin, three land-use maps were drawn from topographic maps (1970a) and Landsat TM/ETM images (1986a and 1999a).

The Land-use map of the 1970a derived from the 1:100000 topographic maps, which were drawn by the Mapping Bureau of the Chinese Peoples' Liberation

Army in 1970. The land-use types were defined by the indications on the topographic maps. There are eight types land-use in the 1970's map: forestland, brush land, grassland, sparse forestland, swampland, water, construction and cultivated land. The population density of the Suomo basin is low. Human beings dwell along the river valley. Expect that cities or towns had many people, which can be seen from the 1:100000 topographic maps, those scattered constructions merged into cultivated land. So, constriction and cultivated land was classified one type land-use on the 1970's land-use map.

The land-use map of the 1986 (time: Nov.2, 1986) and the 1999 (time: Apr.12, 1999) were drawn from Landsat TM/ETM images. Each pixel of the Landsat TM/ETM stands for 30*30m² surface land. GIS software, such as Arc/Info, ArcView and PCI, were used when drew the maps from that images. The coordinate of the maps is Albers. Images of No.5 (red), No.4 (green) and No.3 (blue) wave bands can compound a new color image. Several kinds of land-use can be drawn by ArcView 3.2 based on this image. According to land-use classify criterion, the second level land-use type in the Suomo Basin includes dry land, forestland, brush land, sparse forestland, grassland, lake, construction and swampland. Three land-use maps show as figure 2 and 3. Figure 1 shows the main kinds of land-use changes from 1970 to 1999.

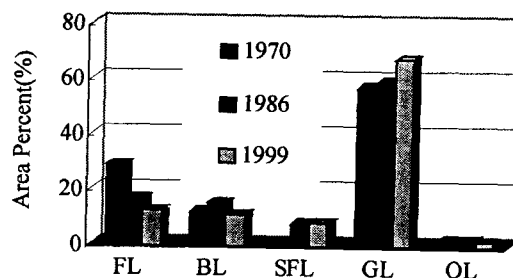


Fig.1 Land-use changes in the Suomo Basin

From 1970 to 1999, the area of forestland decreased 17% (40650ha), the area of sparse forestland increased 8% (19460ha), the area of grassland increased 10% (26850ha).

3 land-use changes by transferring matrix

3.1 1970-1986a

Use "Identity" command of the GIS software Arc/Info, land-use map of 1970 as the input coverage and the map of 1986 as the identity coverage, the area of changed polygons were calculated. The probability-transferring matrix shows in the table 1.

According to the above two tables, from 1970 to 1986, 60% forestland changed into other lands, among of them, 17%(12251ha) changed into brush land, 21%(15195ha) turned into sparse forestland and 23%(16561ha) turned into grassland. 40% brush land changed into grassland and 58% sparse forestland turned into grassland. The stability of the grassland is the best, only less than 20% turned into other lands. The stability of the sparse forestland is the lowest, only 16% didn't change.

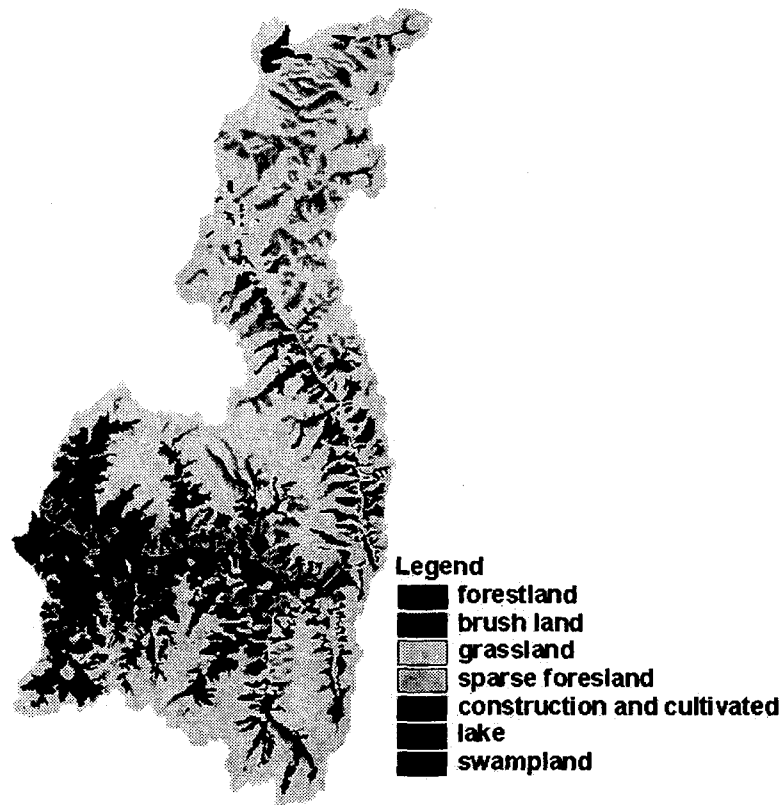


Fig.2 Land-use map of 1970a

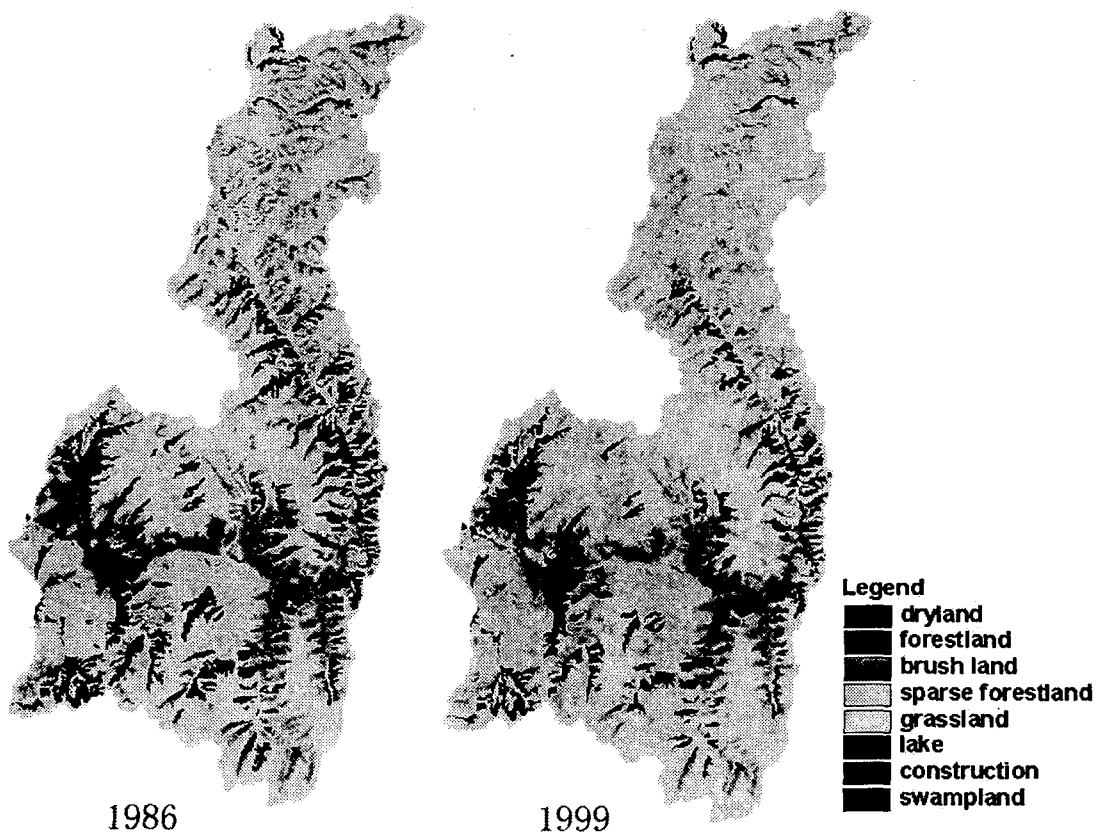


Fig.3 Land-use maps of 1986a and 1999a

Tab.1 Probability-transferring matrix from 1970 to 1986

	Forest land	Brush land	Sparse forestland	Grassland	Cultivated	Construction	Water	Swampland
Forestland	38.2	17.0	21.0	22.9	0.9	0	0	0
Brush land	8.9	44.1	4.5	40.3	2.0	0	0	0.2
Sparse forestland	9.1	17.3	15.8	57.8	0	0	0	0
Grassland	7.3	7.9	1.7	82.4	0.7	0	0	0
Cultivated & construction	7.3	17.7	11.1	13.9	50.0		0	0
Water	0	0	0	67.7	0	0	32.3	0
Swampland	0.8	7.3	0.5	63.7	0.9	0	0	26.8

3.2 1986-1999a

Tab.2 Probability-transferring matrix from 1986 to 1999

	Forestland	Brush land	Sparse forestland	Grassland	Cultivated	Construction	Water	Swampland
Forestland	68.5	4.7	6.8	19.8	0.2	0	0	0
Brush land	2.7	59.9	1.3	35.1	1.0	0	0	0
Sparse forestland	1.9	0.3	82.4	14.8	0.6	0	0	0
Grassland	1.2	1.1	0.9	96.6	0.2	0	0	0.1
Cultivated	5.4	5.5	3.2	26.4	59.4	0.1	0	0
Construction	0.6	0.7	2.0	7.2	28.2	61.3	0	0
Water	0	0.8	0	79.4	0	0	19.8	0
Swampland	0	0.3	0	17.3	0	0	0	82.4

Use the same method, land-use map of 1986 as the input coverage and the map of 1999 as the identity coverage, the area of changed polygons were calculated. The probability-transferring matrix shows in the Table 2.

From 1986a to 1999a, kinds of land-use changed a little except water. 69% forestland, 60% brush land, 80% sparse forestland and 97% grassland didn't change. 80% water turned into others.

According to the three land-use maps and the transferring matrixes analysis, it concludes that the

majority changing trend of the land-use in the Suomo Basin is that forestland changed into sparse forestland, brush land and grassland; brush land and sparse forestland turned into grassland.

4 Forestland changes analysis

There are three towns of the Maerkang County in the Suomo Basin, the Suomo Town, the Zhuokeji Town and part of the Maerkang Town. Much of the social and economic data collected by administrative regions in China. Forestland of the Suomo Basin concentrates in the Maerkang County. The whole basin's data can't available.

So, forestland changes of the Maerkang County can reflect the forestland changes of the whole basin to a certain extent.

The Maerkang Forest Bureau was founded in the September of 1956. Four times forest resources investigations had been conducted since 1957. The No.3 Forest Management Team of the former Forest Ministry surveyed the forest resources in the part of the Maerkang County in 1957. In 1974, the investigation area wasn't accordant with the last one, which made it impossible to compare with the 1957's investigation in the scale of whole basin. However, there are some comparable regions between the two investigations. According to these comparable regions, the area of forestland decreased much. In the informal cutting regions, forestland area decreased 25.6% and turned into sparse forestland. In the finished cutting regions, forestland area decreased 41.6%, sparse forestland area increased 151.3%. In the cutting regions, forestland area decreased 20.3%, sparse forestland area increased 980% from 1957 to 1974. In the comparable investigation area, the amount of growing stock decreased 61% from 423m³/ha in 1957 to 235m³/ha in 1974.

Twice forest resources investigations were conducted in the entire Maerkang County, the first one was done in 1984 and the second one was done in 1998(Table 3). During the fourteen years, the area of forestland changed much. Compared with the first investigation in 1984, forestland increased 14159ha, sparse forestland decreased 14158ha in 1998. This investigated data is inconsistent with the result based on the remote sensing images. The reason is that the criterion of the forestland and sparse forestland between two investigations is different. In the first investigation, the criterion was that when the canopy density was more than 0.4, it was defined as forestland; when the canopy density was between 0.1-0.3, it was defined as sparse forestland. In the second investigation, the criterion was that when the canopy density was more than 0.2, it was defined as forestland, when the canopy density was between 0.1-0.2, it was defined as sparse forestland. However, the forest cover rate increased in that the area of the brush land and the sparse forestland increased much. The quality of the forest crop was declining. The amount of growing stock declined from 248 m³/ha in 1984 to 177 m³/ha in 1998 (Fig.4).

Tab.3 Compare of forest area and amount of growing stock between twice forest resources investigations

	Forestry land-use (ha)							Non-forestry land-use (ha)	The amount of growing stock (m ³ /ha)
	Forest -land	Sparse forestland	Brush land	Green forestland	Nursery land	No forest land	Total		
1984	193665	14773	123364	6699	62	22132	360695	306364	49061923
1998	226489	614	119992	1676	33	14437	363242	299412	40290145

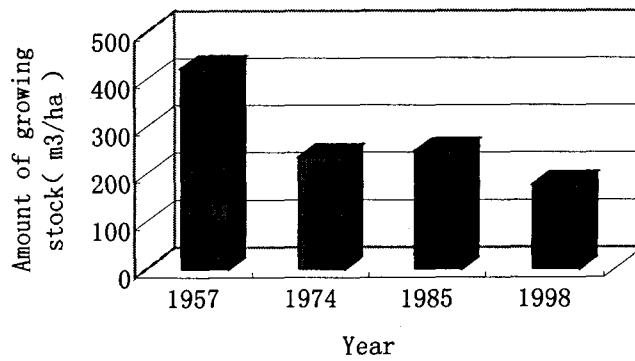


Fig.4 Amount of growing stock changes from 1957 to 1998

5 Conclusions

The majority of the land-use changes of the Suomo Basin are that the area of forestland decreased, the area of sparse forestland increased and the area of grassland increased. From 1970 to 1999, the area of the forestland decreased 17%, the area of sparse forestland increased 8% and the area of grassland increased 10%.

The majority of the land-use transferring trend is that forestland turned into sparse forestland, brush land and grassland; brush land and sparse forestland changed into grassland.

According to the recordation of the local government, the area of the forestland and the forest cover rate increased in the Maerkang County. But the quality of the forest crop had been declining. The amount of growing stock decreased 58% from 1957 to 1998.

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