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Landscape structure and land use on county level in northeastern Yunnan Province of China—a case study of Huize County

WANG Jin-liang, NI Shao-xiang

(College of Geographical Science, Nanjing Normal University, Nanjing 210097, China)

Abstract: Taking Huize County as an example, the paper analyzed the landscape structure (landscape element structure, landscape type structure, landscape spatial structure, landscape succession structure) and the relations between landscape structure and land use. It was pointed out that the agriculture should be developed in harmony with the landscape structure in the study area.

Key words: landscape structure; land use; agriculture; Yunnan Province; China

1 Landscape structure analysis

1.1 The elements structure

The study area (Huize County) is located at 25°48'34"—27°03'19"N and 103°03'47"—103°54'27"E. It belongs to the Zhaotong and Xuanwei mountain-plateau region with semi-humid evergreen broad-leaved forest and red earth of northern subtropical Yunnan Plateau (Chen, 1993). The most important factors which causing the differentiation of landscape and land use of this area are landforms and human activities. The large vertical variation in topography as high as 3322 meters and various kinds of landform and surface material components have given rise to the differentiation of the landscape factors (including moisture, heat, vegetation and soil), thus influenced the degree and pattern of the land use. Besides, the human activities, such as cultivation, fertilization, drainage and irrigation, reclaim, deforestation, pasturing and tree planting, have accelerated or slowed down the succession process of landscapes (Fig. 1).

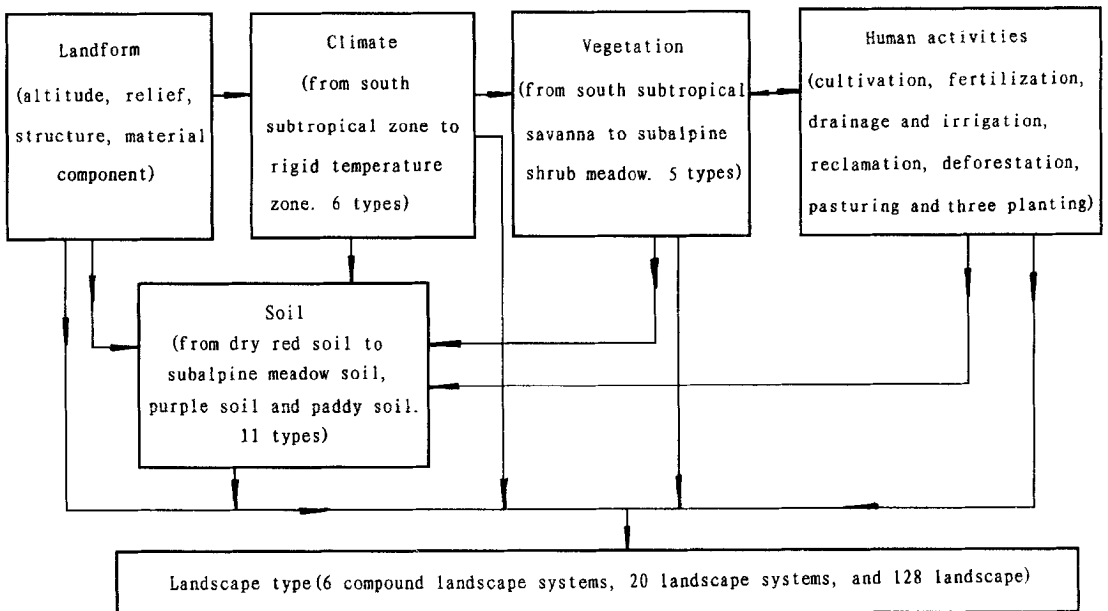


Fig. 1 Landscape element differentiation of the mountain-plateau region on northeastern Yunnan Province

1.2 Landscape type structure

In study area, the landscape types are divided into 6 compound landscape systems (severe frigid landscape, frigid landscape, cold landscape, cool landscape, warm landscape and very warm landscape), 20 landscape system (Table 1) and 128 landscape units. About 1.81% of the total area belongs to very warm landscape system, 13.32% warm landscape systems, 18.20% cool landscape system, 51.88% cold landscape, 13.05% frigid landscape systems and 1.46% severe frigid landscape. The cool and frigid landscape systems are the main types in the study area. And the mountainous landscape is dominant both in types and in quantities. Therefore, we must take forestry as the key industry and develop a diversified economy in this area.

1.3 Landscape spatial pattern structure

There are material and energy relations between adjacent landscape types. The spatial distributions and organizations of landscape demonstrate both on horizontal organization pattern and a vertical zone variation (Cai, 1992; Xu, 1997; Liu, 1996; Chen, 1992). In study area, the vertical variations of relief, soil and plant community are large; the landscape varies obviously in layer. From the low altitude to the high altitude, the first class landscape types (land compound systems) are: very warm landscape—warm landscape—cool landscape—cold landscape—frigid landscape—severe frigid landscape. The second class landscape types are (taking the mountainous landscape as an example): savanna and dry red soil very warm mountain landscape—semi-humid evergreen broad-leaved forest or *Pinus Yunnanensis* forest and red loam warm mountain landscape—semi-humid evergreen broad-leaved forest of *Pinus Yunnanensis* and red loam cool mountain landscape—moderate mountain humid evergreen broad-leaved forest or *Pinus armandii* mountain and yellow-brown earth cold mountain landscape—moderate humid evergreen broad-leaved forest or *Pinus armandii* forest and mountain brown soil frigid mountain landscape—subalpine meadow soil severe frigid mountain landscape.

The horizontal landscape structure can be summarized as follows: (1) Mountain alternates with basin and valley. It is the most popular landscape structure. It appears as basin and valley—mountain—basin and valley—mountain. positive landform strip alternate with negative landform strips, and most of the strips stretch from northeast to southwest and some of them almost stretch from north to south. (2) Strips and dendritic stretch. The same landscape type is formed in valley, the mainstreams and branches stretch across the mountain zone of different altitude in dendritic pattern, and form different landscapes: Savanna and dry red soil very warm valley landscape—semi-humid evergreen broad-leaved forest and red loam warm valley landscape—semi-humid evergreen broad-leaved forest red loam cool valley landscape—humid evergreen broad-level forest mountain and yellow-brown earth cold valley landscape—humid evergreen broad-leaved forest and mountain brown earth frigid valley landscape. (3) Concentric circles. In this structure, energy and materials flow together to the center of basin or depart from point (peak) to outside in a mountain, which links different landscapes to form one unity. In the basin area, basin landscape, hillside landscape, low mountain landscape, and moderate mountain landscape appear in proper order in circle from basin center to outside. In a mountain area, from the center (peak) to the outside, there are several landscape zones (severe frigid landscape, frigid landscape, cold landscape, cool landscape, warm landscape, very warm landscape) in proper order in strips zone. Every landscape zone is composed of mountain (or hillside) or basin and valley which has the similar heat condition.

1.4 The landscape succession structure

Landscape type has succession stage, process and regular pattern. Without human interference, landscape type succession is in self-adjusted, self-maintained and self-developed process, characterized by reversibility, gradual changes, and slow and long succession. But, once human activities are involved in, the landscape succession process will be accelerated or restrained

(Cai, 1990; 1992; Xu, 1997; Liu, 1996; Ni, 1990).

The primitive landscapes of this area are moderate humid evergreen broad-leaved forest and mountain brown earth (mountain yellow-brown earth) mountain (hillside) landscape and semi-humid evergreen broad-leaved forest and red soil (purple soil, calcareous soil) mountain (hillside) landscape (Yang, 1991). They are the relative stable landscapes and the consequence of long time evolution. With the involving and reinforcement of human activities (especially unreasonable activities), the landscape pattern has been greatly changed. In the basin, valley and on party of gentle slope mountain and hillside, natural vegetation has been replaced by field crops, soil characteristics have been changed and the original land has been developed into cultivated land. In the other steep mountain and hillside area, landscape appears in a negative succession (Fig. 2). But, this degenerated succession is reversible. If the unreasonable interference is prohibited, or

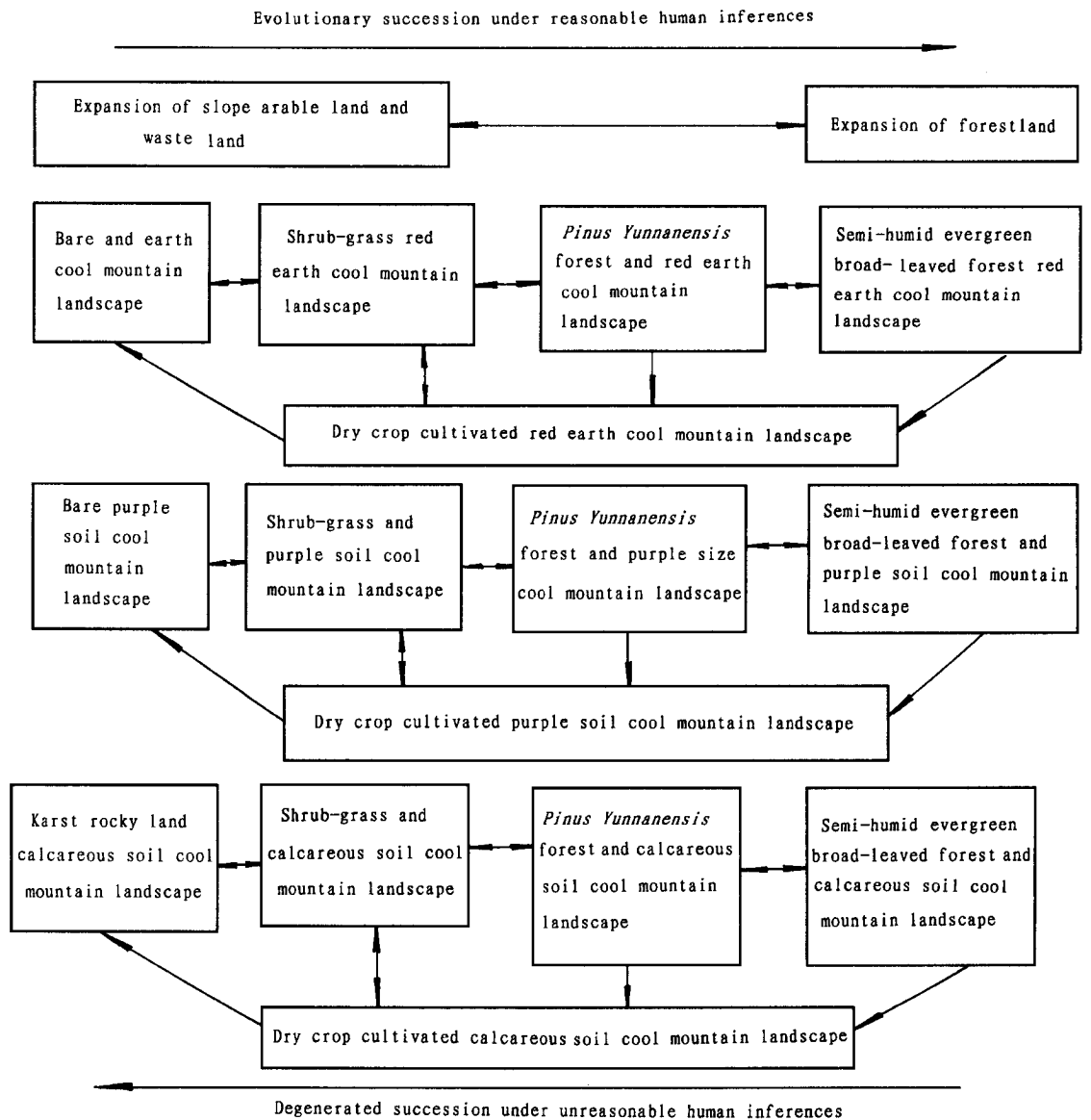


Fig. 2 The succession model of mountainous landscape types in Huize County (taking cool mountain landscape as an example)

construction and protection measures (for example, shelter forest in upper reaches and middle reaches of Yangtze River which is being carried out at present) are put into effect, this degenerated landscape will be recovered and developed gradually into primitive natural landscape. Thus, the activities scope and degree of mankind should be adjusted in agriculture process in order to promote the evolutionary succession of landscape.

2 Landscape structure and land use

2.1 Landscape type structure and land use type structure

Among the 589116.20 hm² in total, cultivated land is about 24.43% with the characteristics of high reclamation ration and low yield per capita; 0.08% garden crops; 45.20% forestland; 0.50% pastureland; 1.68% town village and mining land, 0.48% traffic lands; 1.63% water; and 26.00% waste land. The area ratio of arable land: forestland: garden land: grassland: water: the other land (including town village and mining land and waste lands) is 1:1.85:0.00033:0.01965:0.06672:1.15268. This land use structure reflects the landscape structure dominated by mountain landscape.

2.2 Landscape spatial pattern structure and land use spatial pattern

With respect to the landscape spatial structure, the land use spatial structure also can be summarized as follows in horizontal: (1) The strips of the forestland and grassland alternate with the strips of the water and cultivated lands. It appears as the follows pattern: arable land and water (basin and valley)—forestland and grassland (mountain)—arable land and water (basin and valley)—forestland and grassland (mountain). Most strips stretch from northeast to southeast, some of them almost from north to south. This kind of land utilization pattern is the most popular in the study area. (2) "String beads" structure. The arable land mainly distributes in basin and wide valley. Basin (paddy field) and wide valley (non-irrigated land) have being stung by streams and irrigated land that distributed in both sides of streams. For example, cultivated land which distributed in Zehai Basin, Nuna Basin, Shangchun wide valley and Tianba Basin are being strung by the upper reach and tributaries of Niulanjiang River and arable land of their side. (3) Concentric circles. In the basins, paddy field, irrigated land, garden plot and forestland appear in circle from the center to outside in proper order. In the mountainous area, there are forestland or grassland, arable land, and water in circle from the point (peak) to mountain foot in proper order.

Vertically, the land use types varies according to the altitude (Table 1). These variations include distribution of arable land, the proportion of paddy field to non-irrigated land, cropping systems, crop combination pattern, land use pattern, the proportion of used land to total land: (1) Cultivated land. From the severe frigid landscape to very warm landscape, the reclamation ratios are 9.8%, 18.9%, 22.5%, 23.4%, 16.1% and 9.3% respectively. The arable land distributes mainly in cold landscape (24.5%) and cool landscape (37.4%). From this area to high area and low area, the reclamation ratio decreases sharply. Among the cultivated lands, the paddy field mainly distributes in cool landscape (51%). From this landscape, the paddy field becomes less and less both up to point and down to valley bottom. And nonirrigated land distributes mainly in the cool landscape (30.29%), cold landscape (23.59%) and frigid landscape (19.6%). From the severe frigid landscape to very warm landscape, the ratio of paddy field to non-irrigated arable lands is 0:1, 0:1, 1:2, 1:4, 2:7 and 1:4. (2) Cropping system and main crops. From the severe frigid landscape to very warm landscape, the cropping system turns from "one crop a year" to "two crops a year" step by step. The crop combination pattern also changes coincided with the cropping system (Table 1). The highest multiple crop index is in cool landscape. From the cool landscape, multiple crop indexes decreases both up to high altitude and down to low area. (3) Land use pattern. From the severe frigid landscape to very warm landscape, the main land use types changed: pasture land — foreland — cultivated land — garden field and forestland. The land use ratios increase

Table 1 The land structure and land exploitation of Huize County

S	S1	Area ratio	Ratio	Arable land		Reclamation ratio	Multiple crop index	Cropping system and main crops	Main land use	Exploitation and utilization suggestion
				Among total arable land	Dry crop land ratio					
A	Severe frigid mountain	1.5	0.20	100.0	0.0	9.8	Lowest	One crop a year. Oats, buch-wheat	Nature and artificial pasture land	Husbandry
B	Frigid mountain	13.5	19.6	100.0	0.0	18.9	Lower	One crop a year Potato, oats, buch-wheat	Forestland and pasture land	Forestry and husbandry
	Frigid hillside								Forestland, non-irrigated arable land	Protection and exploration of forestry
	Frigid basin							Non-irrigated arable land	Food production	
	Frigid valley							Forestland	Potato, oats, buch-wheat Forestry	
C	Cold mountain	51.9	24.5	96.2	3.8	22.5	Higher	Two crops a year Potato, corn, horsebean, rape, paddy	Forestland	Protection and forestry construction, gardening on gentle slope
	Cold hillside								shrub and grassland, non-irrigated arable land	Protection and forestry or agro-forestry on gentle hillside
	Cold basin								Non-irrigated arable land, paddy field	Agriculture, gardening Corn, potato, rice, wheat
	Cold valley								Shrub, non-irrigated arable land	Protection and forestry
D	Cool mountain	18.1	37.4	81.0	19.0	23.4	Highest	Two crops a year Paddy, corn, horsebean, rape, tobacco	Forestland, shrub, non-irrigated arable land	Protection and forestry. Forestland or agro-forestry on gentle slope
	Cool hillside								Shrub, non-irrigated arable land, paddy field	Protection and forestry, terracing cultivation on gentle slope
	Cool basin								Paddy field, non-irrigated land	Agriculture. Rice, corn, rape
	Cool valley								Forestland, Shrub, non-irrigated arable land	Forestry
E	Warm mountain	13.2	15.3	77.6	22.4	16.1	Higher	Two crops a year. Paddy, corn, wheat, horsebean, rape	Forestland, shrub, non-irrigated arable land	Protection and forestry, gardening on gentle slope, or agro-forestry
	Warm hillside								Shrub, non-irrigated arable land	Protection and forestry, gardening and terrace on gentle hillside.
	Warm basin								Paddy field, non-irrigated arable land	Agriculture, gardening and dry crops. Wheat, horsebean.
	Warm valley								Shrub, non-irrigated arable land	Forestry

Table 1 (continued)

S	SI	Area ratio	Ratio	Arable land		Reclamation ratio	Multiple crop index	Cropping system and main crops	Main land use	Exploitation and utilization suggestion
				Among total arable land	Dry crop land ratio					
F	Very warm mountain	1.8	3.0	79.2	20.8	9.3	Lower	Two crops a year. Paddy, corn, wheat, horsebean, rape	Shrub, non-irrigated arable land, gardening	Protection and forestry construction, gardening
	Very warm hillside								Shrub, non-irrigated arable land, gardening.	Protection and forestry, cash forest on gentle slope
	Very warm valley								Shrub, non-irrigated arable land, rice land	Protection and forestry

Notes: S—landscape compound system; SI—landscape system; A—severe frigid landscape; B—frigid landscape; C—cold landscape; D—cool landscape; E—warm landscape; F—very warm landscape

gradually from severe frigid landscape to cold landscape, and decrease from the cold landscape to very warm landscape.

2.3 Landscape succession structure and change of land use

There is the interaction between landscape succession and land use change. In the study area, the much more important is the impact of land use (especially unreasonable land use) change which result in the degenerated succession of landscape. The study area is located in the upper reach of Yangtze River, with intensive mountains, very steep slope land with thin soil layer. Therefore the stability of landscape is very low. In addition, deforestation and over grazing is very popular, which has caused the degenerated landscape succession not only in this area, but also in the middle and low reaches of the Yangtze River. Therefore, in order to promote the positive landscape succession, the protection of forest and grassland must be reinforced.

3 Conclusion

The landform and human activities are main factors causing landscape differentiation in mountainous area. The former determines landscape type structure and landscape spatial pattern, and the later has effect on landscape change with time.

Landscape structure determines spatial and temporal variation in the land use structure. The land use should be based on landscape structure. The agriculture layout and structure must be harmonized with the landscape structure. In the study area, mountainous potential should be brought into full play, such as taking the forestry as the key enterprise. Besides agriculture production, husbandry, and gardening should also be emphasized and a diversified economy should be developed. As to the spatial structure, forestry should be developed mainly in mountains and valleys, agriculture in basins and wide valleys, and gardening on hillsides and valleys.

Finally it is vary important and urgent to regulate the human behavior and reinforce the landscape protection.

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