

GRADATION AND ASSESSMENT OF DAMAGE DEGREE OF NATURAL LANDSCAPE IN XING'AN COUNTY, GUANGXI

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ABSTRACT: A new technique designed to help quantify the degree of damage to the landscape from one area to another shows a close relationship between population density and the degree of landscape damage. The technique establishes a scale of damage from 0 to 5 (zero = no damage; 5 = severe damage) using data from aerial photographs, land-use maps, and field data. The related formula allows one to compare the relative degree of damage across regions using a combination of an absolute index, a theoretical index, a relative index, and population density. Xing'an County is used to demonstrate the technique.

KEY WORDS: landscape gradation, landscape assessment, damage degree index, population density

Landscape is a general term used to describe land scenery. Land degradation caused by human activities often is visible on the landscape. From this viewpoint, this paper presents a new way of evaluating the degraded degree of land by the gradation of the damage degree, which is simple and practicable, and could be applied in whole hilly regions of southern China.

I. GRADATION OF THE DAMAGE DEGREE OF THE NATURAL LANDSCAPE

The study was conducted in Xing'an County of the Guangxi Zhuang Autonomous Region. The area lies from 25° 18' N to 25° 55' N, and 110° 14' E to 110° 56' E, and belongs to the subtropic landscape zone. Theoretically, red earth with broad-leaved evergreen forest should cover much of the land if man had not interfered. But with the population growth and the excessive agricultural exploitation, the forest cover has been declining

and the natural landscape has been seriously damaged.

Micro-regional sections of the landscape were selected for the measurement of the damage degrees of the natural landscape. The damage degree of each section is distinguished and described in "The Gradation Map of the Damage Degree of the Natural Landscape". According to the law of geographic distribution of the natural landscape, the theory of landscape succession, the intensity of manmade interference, and our research experiences, the damage degree was divided into six grades. Table 1 shows the criteria for the gradation.

Table 1 Summary of the gradation mapping units

Grade (Map unit)	Degree of the damage	Stage of the succession	Characteristics of landscape
0	No damage	Native landscape	Broadleaved evergreen forest; Forest-cover-degree > 90%; No soil erosion
1	Slight damage	Quasinatural landscape	Dense healthy mixed forest; Forest-cover-degree > 80%; No appreciable erosion
2	Minor damage	Quasiartificial landscape	Appreciable manmade interference; Secondary jungle; Forest-cover-degree > 70%; Fertile cultivated land; Very minor sheet erosion
3	Moderate damage	Good artificial landscape	Evident manmade interference; Sparse coniferous forest or abundant brushwood; Forest-cover-degree > 50% Healthy economic forest; Field on gentle slope; Appreciable erosion
4	Severe damage	Artificial landscape with some problems	Grassland or glade; Sparse shrub; Forest-cover-degree < 50%; Farmland on the slopes; Severe erosion
5	Most severe damage	Wretched landscape	Bare land or barren; Farmland on steep slope; Very severe erosion; The regeneration of vegetation is very difficult

According to criteria, the gradation map of Xing'an County at a scale of 1:50,000 was compiled from aerial photographs, land-use maps, and other information collected during field survey. By using this gradation map, the areas of each grade in Xing'an County and its communes were measured. Then the percentages of each grade throughout the total area in the hilly region (P_n) were determined (Table 2).

Table 2 The percentage of the area of each grade to the total area in the hilly region in Xing'an County and its communes

District	% of the total area					
	P_0	P_1	P_2	P_3	P_4	P_5
Xing'an County	1.68	17.79	9.32	31.30	34.68	5.32
Hucheng				33.82	50.04	16.14
Jaishou				39.33	44.80	5.87
Xiangli				33.53	64.28	2.19
Chuijia			1.04	52.19	31.49	15.28
Beishi			0.11	38.88	53.57	7.44
Gaosheng			0.43	39.90	53.32	6.35
Muochuan		2.38	3.38	32.15	56.89	4.75
Nianguan		0.85	2.04	49.86	39.35	7.90
Rongjiang		9.55	12.90	44.98	30.59	1.98
Huajiang		47.98	27.52	17.47	6.75	0.28
Jinshi	1.28	65.68	16.54	14.57	1.84	0.09
The Natural Reserve	84.52	5.37	2.74	5.58	1.79	0.00

II. ASSESSMENT OF THE DAMAGE DEGREE OF THE NATURAL LANDSCAPE

Drawing the gradation map can help to judge qualitatively what degree of damage for each mapping cell. Table 2 provides data for the quantitative analysis of the damage degree of the landscape in the study area. The method described in this paper could be used to improve traditional assessment methods and can facilitate the integrated assessment of the damage degree of the natural landscape.

The "Index of the Damage Degree of the Natural Landscape" consists of absolute index (AJ), theoretical index (TJ), and relative index (RJ). Table 3 shows a diagrammatic rep-

resentation of the absolute index (*AI*). The district where P_0 is 100% has *AI* of 0. And the district where P_5 is 100% has *AI* of 100%. Thus, the greater the *AI* value, the more serious the damage degree of the natural landscape.

Table 3 Relationship between the absolute index (*AI*) and the grade and the damage degree of natural landscape

<i>AI</i> (%)	The damage degree of natural landscape	Grade (n)	(P_n) $P_5 = 100\%$
100	Most severe damage	5	
80	Severe damage	4	
60	Moderate damage	3	
40	Minor damage	2	
20	Slight damage	1	
0	No damage (Native landscape)	0	$P_0 = 100\%$

AI is obtained from the following formula:

$$AI = 1 / 5 \sum_{n=0}^5 n \cdot P_n \quad (1)$$

where n = the grade number; P_n = the percentage of the area of grade n to the total area. The *AI* of Xing'an County and its communes are shown in Table 4.

Table 4 provides an overall quantitative assessment of the damage degree of the natural landscape in the study area. For example, Hucheng's *AI* is 76.46, indicating that the landscape is severely damaged. Jinshi's *AI* is 30.06, indicating minor damage, and the *AI* of 6.95 for the Natural Reserve indicates very slight damage.

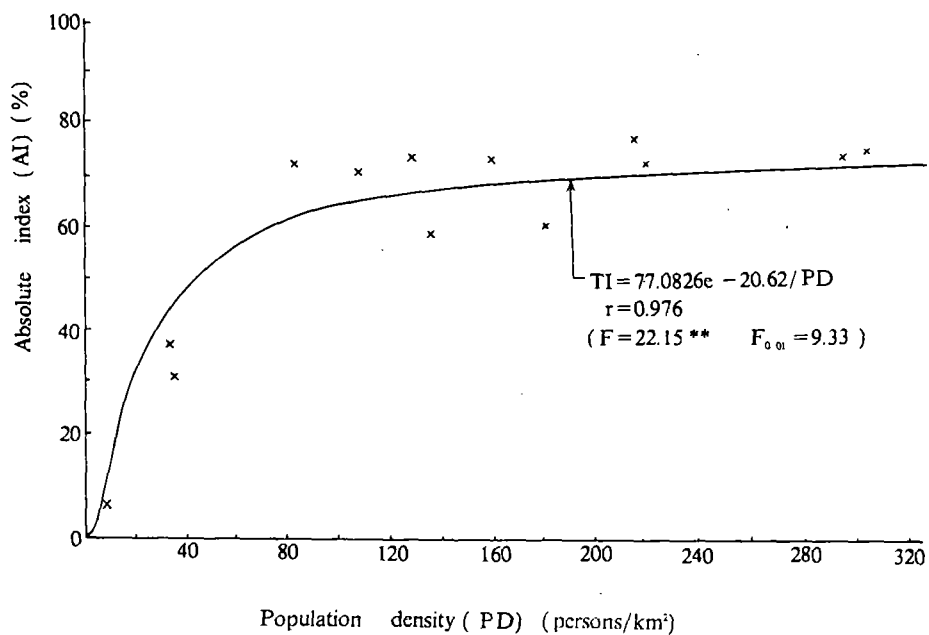
The damage degree of the natural landscape, however, is closely related to population density. It is evident from regression analysis that *AI* varies with population density (*PD*) exponentially (Fig.1)

The derived model is:

$$TI = 77.0826e^{-20.621 PD} \quad (2)$$

**Table 4 Index of the damage degree of the natural landscape in the hilly region
in Xing'an County and its communes**

District	AI (%)	TI (%)	RI (%)
Xing'an County	59.04		
Hucheng	76.46	70.00	6.46
Jaishou	75.31	72.02	3.29
Xiangli	73.73	71.84	-1.89
Chuijia	72.20	70.12	2.08
Beishi	73.67	65.70	7.97
Gaosheng	73.12	67.74	5.38
Muochuan	71.56	59.84	11.72
Nianguan	70.28	63.73	6.55
Rongjiang	60.51	68.76	-8.25
Huajiang	36.77	42.14	-5.37
Jinshi	30.06	43.21	-13.15
The Natural Reserve	6.95	6.37	0.58



**Fig.1 Relationship between the damage degree of the natural landscape
and the population density**

where PD = population density (persons/ km^2). The difference between AI and TI is RI , thereafter:

$$RI = AI - TI \quad (3)$$

The TI and RI of Xing'an County and its communes are shown in Table 4. The overall damage degree of the natural landscape of various districts with different populations can be compared relatively. For instance, Xiangli's RI is 1.89 and Muochan's is 11.72. Consequently, the damage degree of the natural landscape in the hilly region of Muochan is far more serious than that in Xiangli even though they have similar AI . Similarly, the damage degree of the natural landscape in the hilly area of the Natural Reserve is, relatively speaking, more serious than in Rongjing, Huajiang, and Jinshi when the population factor is considered.