Soil Loss Risk Assessment Based GIS
—In Case of Jiangxi Province

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Abstract: Soil loss is one of an important reason for land degradation, which causes many disasters. There is 367 million km^2 soil loss in China, accounting for 38% whole national land, losing 6.7 km^2 cultivate land, and soil 50t each year. That the soil loss brings about land degradation makes the character of land cover changed, so it leads to disasters, such as Yangtze river flood, Beijing sand storm. Soil loss is made by many factors both human actives and nature. But few study in soil loss risk assessment. In case of Jiangxi province, this paper chooses eco-environment factors for soil loss in reason. All of factors are calculated based on multi-year mean values. There are slope, aridity, precipitation, NDVI, mean temperature and land use. All of factors are changed into 100 m×100 m grid under ARC/INFO. Then we give each factor a value according to soil erosion formula, and each value represents the degree of soil loss risk assessment. Thus we adopt PCA (principal component analysis) to get weights of each factor. With these factors weights, we multiply each factor coverage by its weight. So we get the soil loss risk assessment. Under the ARCVIEW, we make risk degree. Final, we analyze the results. The results show: in generation, soil loss risk is not serious. But the risk degree 2 and 3 cover main. Although there is little heavy soil loss risk, it distributes in hills that is the source of Ganjiang river. It will lead to Ganjiang river environment change, final cause disasters. The distribution of soil loss risk is coincidence to topographty.
Keywords: GIS, Soil Loss Eco-environment Risk, Assessment

One of important reasons to cause land degradation is soil erosion, which brings about tremendous disaster. There is about 367 million km^2 soil erosion, covering 38% national area, losing soil 6.7 million km^2 /a. That soil erosion causes land degradation makes characters of land change, and leads to natural diseases, such as Yangtze flood in 1998, Beijing sand storm in 2000. The soil erosion is function of many factors. However, little researches in it. Where does it happen? This paper assesses the risk of soil erosion based on GIS in case of Jiangxi province and make some science suggests for treating soil erosion and protecting environment.

1 Study area

Jiangxi Province, covering a total area of more than 166,900 square kilometers, lies to the south of the middle and lower reaches of the Yangtze River. It is at 113°34' E to 118°28' East Longitude and 24°29' N to 30°04' North Latitude. Jiangxi Province is adjacent to Fujian and Zhejiang Province in the east and neighboring to Hunan in the west; to the south of Jiangxi is Guangdong and it is adjoined with Hubei and Anhui Province in the north. Starting from the Yangtze River in the north, Jiangxi Province is the front hinterland of developed area, Yue, Ming, Hu and Zhe. Stretching about 615 km south to north and 480 kilometers east to west, Jiangxi Province covers the area of 166,900 km^2. It is abundant in natural resources. The Ganjiang River starts from the south of Jiangxi, where is characterized by undulation hills, and enters into the Boyang Lake which is the biggest freshwater lake, adjoined River, forming a uniquely mountain-river-lake landscape. The area is more developed economically in Jiangxi Province. It is far-reaching to evaluate the risk of water loss and soil erosion.

2 Study method and data base

Principle component analysis puts P relative variables xi（i=1, 2, 3…P）into p independence variables Yi（i =1, 2, 3…P）by line combination. It makes the sum deviation of p independence variables equal total deviation P relative variables, and order from small to big in line with its deviation. Then p independence variables can instead of p relative variables. So p variables, x becomes m independence variables that named principle components. In this paper, ensure the numbers of principle components lies in the balance between $\alpha_i = \lambda_i \Big/ \sum_{i=1}^{m} \lambda_i$ and $\alpha(t) = \sum_{i=1}^{t} \lambda_i \Big/ \sum_{j=1}^{m} \lambda_j$. In general, when M >3, $\alpha(m)$ > 60%, the result is sound. The total risk assessment can be expressed as: $Y = \alpha_1 Y_1 + \alpha_m Y_2 + \cdots \alpha_m Y_m$, We order assessment units in line with value y.

All of eco-environment factors are mean value of many years. We get land use coverage through visual interpret based TM images which processed by geometric correction. We adopt nation land classification system to get land use classification. The degree of each eco-environment as fellow:

Table 1 The degree of each eco — environment

ID	aridity（K）	precipitation	Slope	Temperature (*10)	NDVI
1	≤0.5	–60	0—5	–150 — –50	0.1 — 0.2
2	0.5 — 1.00	–60 — –30	5—8	–50 — 0	0.2 — 0.3
3	1.00 — 1.49	–30 — –15	8—15	0 — 50	0.3 — 0.4
4	1.50 — 2.00	–15 — 0	15—25	50 — 100	0.4 — 0.5
5	2.00 — 4.00	0 — 40	25—35	100 — 150	0.5 — 0.6
6	>4.00	40 — 80	35—90	150 — 200	0.6 — 1.0
7		80		200 — 300	

where: NDVI : normalized different vegetation index

All types of data are projected into uniform coordinates and projection system. The projection system is Albers projection, the parameters is : 1st standard parallel: 25.0000,2nd standard parallel: 47.0000, the central meridian: 105.0000, the ellipsoid is KRASOVSKY ellipsoid. All types of data are changed into 100m×100m grid format in ARC/INFO.

3 Soil erosion eco-environment risk assessment

3.1 Factor choose and degree

That the soil erosion happens is closely relation to its eco-environment. According to principle of science, system, region etc, we choose mean temperature, slope, precipitation, land use, NDVI, aridity as environment factors. We degree each factor in line with value calculated by soil erosion formula as fellow:

$$INDEX = \sum_{i=1}^{n} \sum_{j=1}^{m} W_{ij} A_{ij} \tag{1}$$

Where: W_{ij} as the degree value of i class j degree ; A_{ij} as proportion of i class j degree

Different intensity of different soil erosion type can be divided as fellow: 1 stands for water soil erosion, the intensity divided into very light, light, moderate, heavy, very heavy, most heavy, its value as 0, 2, 4, 6, 8, 10 correspond; 2 stands for wind soil erosion, the intensity divided into very light, light, moderate, heavy, very heavy, most heavy, its value as 0, 2, 4, 6, 8, 10 correspond; 3 stands for frozen erosion, the intensity divided into very light, light, moderate, heavy, its value as 2, 4, 6, 8 correspond; 4 stands for gravity erosion, its value is 8; 5 stands for engineer erosion, its value is 4. The high soil erosion index is, the heavier soil erosion. We divide soil erosion risk degree into 5 which ranks from small to big.

Table 2 The results of each factor degree

degree	aridity	precipitation	NDVI	slope	temperature	landuse
1	1, 2	6	1, 6	1	1, 2, 10, 11	41, 46, 51, 52, 53
2	6	5	5	5, 6	3, 9	22 , 24
3	3, 5	4, 1	4	4	4, 5, 8	23, 31, 12
4	–9	3	2	3	6	32, 64, 65, 66
5	4	2	3	2	7	33

3.2 Principle component analysis

We get weights and principle components by using PRINCOMP( ) in ARC/INFO. The results as fellow:

Table 3 Eigenvalues of each component

layer	1	2	3	4	5	6
Eigenvalues	0.0157	0.00705	0.00262	0.000745	0.0000183	0.000000018

according to eigenvalues, we choose three principle components , it can be expressed:

$$P = JXZC1 \times 0.6 + JXZC2 \times 0.27 + JXZC3 \times 0.1 \quad (2)$$

where: p as the assessment result, $JXZC1$ as first principle component, $JXZC2$ as second principle component, $JXZC3$ as third principle component.

From the results, the main principle components account for 97%, only 3% losing. It shows high reliability. By using proportion of each component accounting for total EIGENVALUES as its weight, we have the results by three principle component multiplying its weight.

3.3 Result analysis

We have the results, Tables 4 and Figure 1. We divide environment risk into four degrees, that is: very light, moderate, heavy and very heavy. What the environment causes soil erosion in jiangxi province is not serious in whole, but it need treating. The distribution of risk is about a round whose intensity decreases from south to north in consistency with jiangxi topographty with south high and north low. The very light risk accounts for 54% whole area, main distribution in ganfu plain, jitai basin, and areas which gan, fu, rao, xiu,xin river passes. This shows that the environment causes soil erosion in jiangxi province is not serious in whole. This area is main farm zone, so it is very little influence to agriculture produce. Here environment can ensure agriculture produce. The very heavy risk accounts for 2%, with small proportion and scatter distribution. The main distribution is in mountain, especially in source of ganjiang. Soil erosion brings about danger to ganjiang which carries sands down the river, so it make diseases to poyang lake which is the most largest fresh water lake in china. It is very significant to monitor. The risk two and three degrees account for 44% that moderate accounts for 19% and heavy accounts for 25%. The distribution of 2 and 3 risk degree is blend. The main distribution of two degrees is mountain of Jiangxi and some plain. Compared with north, the south distribution area is large, this indicates latent danger. The main topographty in south of Jiangxi is hills where productivity is poor and agriculture produce is main. If we develop the hills incorrectly, it will lead to soil erosion. The environment risk to soil erosion should be taken into account when we develop hills. In Jiangxi province, the topographty factor is the most influence of all factors. What we analysis can direct to agriculture produce.

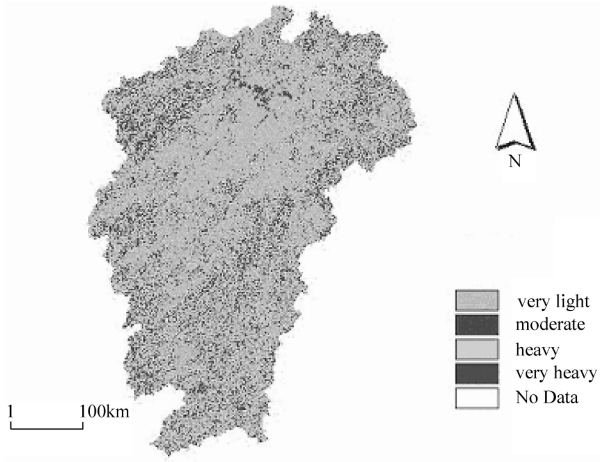

Fig. 1 Soil loss eco-environment risk assessment in Jiangxi province

Table 4 The Result of eco-environment risk assessment

the risk degree	Area（km^2）	percent（%）	count
1	90,761.63	54	9,076,163
2	32,298.08	19	3,229,808
3	40,903.16	25	4,090,316
4	28,273.3	2	282,733

4 Conclusions

This paper chooses several environment factors from soil erosion, and assessing soil erosion risk by using principle component. What the paper gets results is coordinate to real situation. Choosing environment factors is relative to soil erosion, the most influence is topographty which closely relates with distribution of soil erosion risk. In generate, for soil erosion, the influence of environment factors is not serious, but it needs treating. Using principle component, we overcome human influence, combing quality and quantity, so it is reliability, even losing information.

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