Analysis of Soil Erosion Environment Background in China Hills

Zhao Xiaoli, Zou Yarong, Zhang Zengxiang, Zhou Quanbin and ***Tan Wenbin***

Institute of Remote Sensing Applications, CAS Beijing,100101
E-mail**:** zhaoxiaoli@21cn.com

Abstract: There is more than 70% mountain area in China, and these mountains are the resources of rivers, such as Changjiang river, Huanghe river. Moreover, these hills are resources of branches of main rivers. Soil erosion in these areas will lead to river environment change, and causes more disasters, such as flood. With RS and GIS supported, this paper analyses features of soil erosion environment background in these hill areas, then we suggest some points for treating soil erosion. The steps as fellow: first, we extract hill coverage from DEM with the elevation less than 1,000m according to traditional method, second, we set hill coverage as a mask in ARC/INFO to get environment background coverage, that is we have slope coverage, NDVI coverage, etc. Third, we combine these coverages with soil erosion coverage in ARC/INFO. Soil erosion is made by multi-factor. This paper discusses soil erosion of hill under different eco-environment background. All of soil erosion type and intensity takes place in china hills. With the temperature, rainfall, NDVI, etc changing, the soil erosion changes in zone. From results, for the eco-environment background zone law, the intensity of water soil erosion decreases from east to west, which shows some treatments are taken in east China. However, the change direction of the intensity of wind erosion is contrary to water erosion'. The intensity of water erosion is great than wind erosion' in interchange of water and wind erosion. So we suggest some treatments for controlling soil erosion.
Keywords: RS, GIS, hill soil erosion, environment background

1 Introduction

Soil resource is one kind of natural resources which have the closest relations with humankind. China has the largest population but the very limited farming soils, so there is a strain relation between population and soil resources in China. Modern society is a highly developed society, a negative result of modernization is the serious problem of soil degradedness. The reasons for soil degradedness is multiple. Nature causes the problems, but the most important reason is human activities. Soil erosion is an important reason for soil degradation, not only could it causes soil degradation, but also lead to serious ecological disasters, thus posing threat to human survival. In China, the soil erosion area is 3.67 ten thousand km^2， accounting for 38% of the total territory. That is to say that each year 67,000 km^2 farming soils and 50t soils are lost. The main landform in China is moutain. Especially in east China, hills occupy most territory.These areas have a high soil utility rate.So soil degradedness caused by soil erosion will has a bad effect on economic development of this region.Soil erosion only occurrs in given environment backgrounds involving vegetation index,soil utility,slope,etc.But different environmental factor has different effect. All environmental factors in this paper are extracted from hill with the elevation less than 1,000 m.

2 Data based and study method

The datum are extracted from LANDSAT TM image. From these data, the type of soil utilization is decided on basis of the interactive MGE environment. To diminish the geometry error of the image,we adopt the processing method of Least-Square. As for pixel sampling method, we adopt the method of Nearest Neighbour Interpolation or Bilinear Interpolation. After the image processing, the maximum geometry error are 2—3 pixels. The task of image classification is mainly taken on by experts with the

help of relief map, navigation photo etc, thus soil erosion coverage could be acquired. According to [1], we extract hill coverage from DEM with the elevation less than 1,000m according to traditional method.

Then we set hill coverage as a mask in ARC/INFO to combine with ecological environmental background, and finally the different styles and intensity of soil erosion data are acquired. The ecological background data are the result of the integration of many years data. All data are converted to 100m×100m grid graphic data under the same coordination.

Table 1 Index of each environment background coverage

ID	aridity(K)	ID	IM(mm)	ID	slope	ID	> 0 ℃	ID	> 0 ℃
1	≤0.5	1	250	1	0—5	1	0—5,000	8	55,000—57,000
2	0.5—1.00	2	250—400	2	5—8	2	5,000—15,000	9	57,000—60,000
3	1.00—1.49	3	400—800(1)	3	8—15	3	15,000—21,000	10	60,000—61,000
4	1.50—2.00		400—800(2)	4	15—25	4	21,000—30,000	11	61,000—70,000
5	2.00—4.00	4	800—1,000	5	25—35	5	30,000—39,000	12	70,000—82,000
6	>4.00	5	1,000—1,600	6	>35	6	39,000—40,000	13	82,000—90,000
-9		6	>1,600			7	40,000—55,000	14	90,000—100,000
								15	100,000—104,600

Where:> 0° accumulate temperature，DEM revise ≥0℃ accumulate temperature（*10）

3 Analysis of eco-environment background

3.1 Aridity analysis

There is 33.87 ten thousand hm^2 on the aridity -9. The erosion types are wind erosion, water erosion, froze erosion and its area accounts for 98%，1.2%，0.2% respectively. The main erosion type is water erosion. There is 196.86 ten thousand hm^2 on the aridity 1 degree. The main erosion type is water erosion, and accounts for 99%. The main intensity is very light. There is 2,407.33 ten thousand hm^2 on the aridity 2 degree. The main erosion types are water erosion, wind erosion, froze erosion, and water erosion area accounts for 94.5%. The main intensity is very light and light. There is 10,079.95 ten thousand hm^2 on the aridity 3 degree. The main erosion type is water erosion, wind erosion, and water erosion area accounts for 81%. The main intensity are very light and light. There is 1,442 ten thousand hm^2 soil erosion on the aridity four degree and the erosion types are water erosion, wind erosion, etc. The area of water erosion accounts for 54%, wind erosion account for 45%. The intensity of soil erosion is very light, light, moderate, heavy. There is 724 ten thousand hm^2 on the aridity five degree and the erosion types are water erosion, wind erosion, etc. Wind erosion accounts for 84%, especially very light, moderate, heavy. There is 4,580 ten thousand hm^2 on the aridity five degree and the erosion types are water erosion, wind erosion, etc. Wind erosion accounts for 92%, especially heavy, most intensity. With the value of aridity increasing, the water erosion type is giving away into wind erosion whose area increase. The main soil erosion intensity is very light, light, which indicates the water erosion is light.

Table 2 Situation of soil erosion under different aridity in China hills units: hm^2

aridity	area	type	aridity	area	type	aridity	area	type	aridity	area	type
-9	873	31	5	852, 170	21	2	53, 187	40	4	2, 012, 834	21
-9	330, 371	11	5	1, 622, 071	23	2	4, 192	33	4	556, 074	24
-9	1, 336	13	5	995, 378	22	3	57, 215, 997	11	4	47, 680	25
-9	1, 332	12	5	1, 162, 515	24	3	12, 394, 462	12	4	484, 008	13

−9	4, 211	25	5	580, 262	11	3	8, 425, 770	13	4	6, 419, 632	11
−9	542	15	5	1, 423, 377	26	3	177, 985	31	4	158, 298	14
−9	39	33	5	257, 932	13	3	45, 596	32	4	4, 910	50
1	1, 531, 740	11	5	283, 951	12	3	2, 561, 329	23	4	8, 551	26
1	178, 853	13	5	16	33	3	8, 206, 510	21	4	146, 333	15
1	213, 001	12	5	3, 244	50	3	7, 165, 682	22	4	142, 641	16
1	34, 709	14	5	8, 603	14	3	949, 794	24	4	816	31
1	3, 413	15	5	53, 292	25	3	615, 806	15	4	199	33
1	1, 035	16	5	1, 004	31	3	343, 878	25	4	5	32
1	535	50	5	205	15	3	64, 815	50	2	905, 231	15
1	5, 340	31	5	3	32	3	2, 302, 763	14	2	88, 292	23
2	177, 791, 805	11	6	2, 330, 053	11	3	328, 246	16	2	1, 471	24
2	6, 929, 669	31	6	2, 502, 282	22	3	169	26	2	38	25
2	17, 001, 508	13	6	795, 071	12	3	21	33	2	181, 756	16
2	5, 721, 700	32	6	6, 179, 596	23	3	654	40	6	373	32
2	27, 846, 016	12	6	403, 484	13	4	1, 036, 241	23	6	82	33
2	262, 250	50	6	4, 096, 520	21	4	2, 955, 916	22	6	374	14
2	4, 922, 723	14	6	9, 710, 086	24	6	4, 053, 283	25	6	1, 153	31
2	110, 109	22	6	15, 708, 811	26	2	181, 756	16	6	4, 053, 283	25
2	253, 401	21	6	25, 680	50	2	1, 471	24	6	374	14
2	905, 231	15	6	373	32	2	38	25	6	1, 153	31
2	88, 292	23	6	82	33	4	448, 561	12			

3.2 IM factor

In the view point of im factor, soil erosion shows obvious zone. From 1 to 7 degree, wind erosion becomes great, and water erosion becomes ebb gradually. The area of wind erosion accounts for 99% at above light and its intensity is very intensity, most intensity. But The area of water erosion accounts for 0.32%. The area of wind erosion changes as 62%，61%，30%，0.22% respectively，0.1% from 2 to 7 degree. At the interleaving of water erosion and wind erosion, the intensity of water erosion is great than wind erosion's. The area of water erosion above light changes 0.5%，38%，67%，74%，99% respectively from 2 to 7 degree. What the water erosion changes in line with rainfall distribution, which shows the rainfall factor is main eco-environment factor.

Table 3 Situation of soil erosion under different rainfall in china hills units: hm^2

IM	area	type	IM	area	type	IM	area	type	IM	Area	type
1	3, 029	13	2	2, 457, 953	11	6	72, 620, 533	11	5	96, 450, 975	11
1	8, 317, 276	26	2	2, 865, 050	22	6	8, 095, 198	12	5	9, 693, 292	13
1	1, 652, 143	23	2	784, 976	12	6	6, 139, 602	13	5	5, 697, 549	31
1	2, 095, 761	21	2	5, 378, 780	23	6	2, 009, 270	14	5	4, 470, 302	32
1	5, 037, 228	24	2	474, 312	13	6	353, 664	15	5	16, 855, 287	12
1	110, 036	11	2	2, 486, 933	21	6	107, 576	16	5	83, 979	50

1	500, 849	22	2	5, 186, 318	24	6	147, 194	50	5	2, 805, 849	14
1	8445	50	2	8, 303, 475	26	6	43, 958	40	5	561, 616	15
1	55, 016	12	2	17, 518	50	6	4, 104	22	5	150, 705	21
1	2, 142, 950	25	2	370	32	6	181	23	5	81, 764	22
3	8, 127, 622	21	2	57	33	4	39	33	5	6, 309	23
3	8, 413, 468	22	2	411	14	4	159, 556	16	5	47, 191	16
3	1, 998, 988	24	2	1, 963, 116	25	4	4, 841	26	5	238	24
3	359, 870	15	2	826	31	4	179	25	5	4, 229	25
3	1, 944	31	7	17, 447, 518	11	4	285, 589	15	5	8, 306	40
3	814, 780	14	7	2, 100, 655	12	3	3, 418, 833	13	5	4, 192	33
3	261	33	7	1, 300, 586	13	4	5, 733, 804	13	3	300, 046	16
3	22, 631, 708	11	7	531, 722	14	4	59, 748	50	3	8	32
3	4, 490, 788	12	7	110, 871	15	4	1, 860, 197	22	4	34, 837, 435	11
3	3, 756, 580	23	7	39, 333	16	4	689, 084	23	4	1, 416, 951	31
3	391, 422	25	7	11, 788	50	4	2, 554, 174	21	4	1, 297, 203	32
3	33, 573	50	7	1, 587	40	4	1, 266, 977	14	4	9, 614, 226	12
3	515, 273	26	7	10	22	4	154, 825	24			

3.3 NDVI factor

All of soil erosion exist from 1 to 8 degree. The main erosion is water erosion and wind erosion. With NDVI change, water erosion and wind erosion show zone law. Water erosion change s from southeast to northwest with the NDVI changing at 1 to 8 degree, the proportion of water erosion is 0.3%，3.3%，45%，70%，76%，74%，68%，81% respectively, and at 2 ,3 degree getting max value. But the wind erosion change is country to water erosion's, the proportion of wind erosion is 90%，97%，54%，29%，20%，11%，3.3%，1.5% respectively. From Table 4, we can see the interleaving of water erosion and wind erosion. In interleaving zone, the water erosion is great than wind erosion. Where the NDVI is high, the soil erosion is less.

Table 4 Situation of soil erosion under different NDVI in china hills units: $10^4 hm^2$

ndvi	type	area	ndvi	type	area	ndvi	type	area	ndvi	type	area	ndvi	type	area	ndvi	type	area
1	11	208.2	7	11	5,758	5	11	5,880	3	23	157.5	3	12	125.4	8	25	0.015
1	13	1.329	7	31	275	5	13	844.7	3	24	48.72	3	31	0.368	8	26	0.464
1	21	287.6	7	13	370.1	5	31	70.92	3	25	10.65	3	32	0.136	8	33	0.038
1	22	58.89	7	32	263.6	5	32	61.47	3	50	3.616	3	13	97.71	8	15	5.085
1	25	326.6	7	12	744.7	5	12	1,206	3	26	33.34	3	14	41.63	8	16	1.179
1	23	240.3	7	50	2.256	5	50	11.09	3	33	0.014	3	21	176.2	8	40	0.165
1	24	614	7	14	112.5	5	14	222.5	3	15	31.44	3	22	146.7	2	1	63.19
1	26	1,174	7	22	46.65	5	22	408.8	3	16	34.06	6	21	318.5	2	40	0.003
1	12	5.332	7	23	13	5	21	332.1	3	40	0.043	6	24	16.76	3	11	467.9
1	50	2.044	7	21	50.8	5	23	126	4	11	1,742	6	15	49.19	2	33	0.011

1	31	0.01	7	15	21.52	5	15	39.89	4	13	332.4	6	25	1.241	4	26	8.261
1	32	0.004	7	24	1.35	5	25	3.692	4	31	2.429	6	26	1.326	4	33	0.009
1	14	0.267	7	25	0.08	5	24	45.49	4	32	3.415	6	16	7.911	4	15	17.98
1	16	0.001	7	26	0.305	5	26	3.548	4	12	486.7	6	40	1.933	4	16	7.41
1	15	0.143	7	33	0.224	5	16	6.572	4	50	7.767	6	33	0.159	4	40	0.329
1	33	7E-04	7	16	5.048	5	40	1.82	4	14	80.65	8	24	0.019	2	14	2.06
2	11	178.1	7	40	1.098	5	33	3E-04	4	22	200	8	14	23.23	2	31	0.138
2	12	33.17	8	11	953.2	6	11	9,589	4	21	257.2	2	50	1.592	2	15	1.906
2	13	16.78	8	31	24.96	6	31	338.1	4	23	128.6	6	23	81.06	2	26	494.2
2	21	118.1	8	13	62.65	6	13	951.8	4	24	44.14	2	32	0.017	8	22	3.034
2	23	402.4	8	32	23.17	6	32	225	4	25	4.323	8	23	0.805	6	22	309.6
2	22	201.4	8	12	135.7	6	12	1,465	2	24	467.9	8	21	3.028	6	14	260.1
2	25	103.6	8	50	0.434	6	50	7.856									

3.4 Slope factor

There exists different type and intensity erosion at different slope. The most area is at 1 degree with 29,856.17 ten thousand hm^2, and wind erosion accounts for 51%,water erosion 41%, which indicates the intensity of wind erosion is great than water's in flat zone. With the slope increasing, the intensity of water erosion becomes great and wind erosion decreases. From 1 to 6 degree, the areas of water erosion are 41%，58%，78%，94%，98%，98% respectively. The obvious increasing is at 2 and 3 degree. The areas of wind erosion are 51%，12%，4.1%，1%，0.3%，0.6% respectively. The most decreasing happens at 1 or 2 degree. The influence of slope to water erosion is great than wind erosion's.

Table 5 Situation of soil erosion under different slope in china hills units: 10^4hm^2

slope	area	type	slope	area	type	slope	area	type	slope	area	type	slope	area	type	slope	area	type
1	17,145	11	5	1.766	31	3	8.334	24	2	0.01	33	6	0.118	24	6	0.153	23
1	1,538	13	5	121.3	13	3	23.96	15	3	2,645	11	6	0.02	26	2	103	32
1	409.7	31	5	1.809	32	3	1.615	25	3	134.1	31	6	13.58	14	2	1.968	16
1	311.7	32	5	174.6	12	3	36.65	26	3	419.8	13	6	0.036	50	2	0.337	40
1	2,635	12	5	46.26	14	3	0.041	33	3	127.7	32	6	5.346	15	2	259.1	12
1	31.85	50	5	0.658	23	3	9.239	16	3	563.9	12	6	1.114	16	2	1.401	50
1	377.4	14	5	0.275	21	3	1.086	40	3	2.081	50	6	0.026	40	2	42.61	14
1	1,359	22	5	0.216	22	4	2873	11	3	125.3	14	6	0.054	33	2	9.639	22
1	1,120	23	5	0.029	25	4	21.24	31	3	4.411	22	2	13.59	23	6	0.495	21
1	1,534	21	5	0.271	24	4	386.2	13	3	10.48	23	2	4.353	21	6	0.308	25
1	1,212	24	5	0.141	26	4	32.03	32	3	2.34	21	2	15.1	24	6	0.105	22
1	83.87	15	5	0.198	50	4	515.1	12	5	956.1	11	2	6.259	15	6	33.64	13
1	444.2	25	5	14.17	15	4	1.096	50	4	0.106	33	2	3.383	25	4	1.866	24
1	1,613	26	5	3.698	16	4	137	14	4	0.76	40	2	59.25	26	4	0.147	25
1	0.16	33	5	0.132	40	4	0.915	22	4	10.93	16	6	50.53	12	6	0.134	32
1	38.25	16	5	0.084	33	4	0.724	21	4	5.47	26	2	175.9	13	2	144.1	31
1	3.04	40	6	0.48	31	4	33.34	15	2	872	11	6	270.5	11	4	3.66	23

3.5 More than 0 degree temperature factor

Froze erosion is relation with temperature factor. From 1 to 3 degree, froze erosion accounts for its soil erosion 100%，88%，73% respectively. With accumulate temperature increasing, froze erosion decreases rapidly from 73% to 4.6%, which shows temperature has impact on froze erosion. At 5,6,7 degree, the area of froze ersion is small. The proportion of water erosion and wind erosion is about same at 5,7 degree. The area of water erosion becomes great with the accumulate temperature increasing, also its proportion, and decreasing after 11 degree, its values are 7%, 4.8%, 61%, 46%, 46%, 97%, 97%, 88%, 93%, 83%, 73% respectively. The area of wind erosion reaches max value at 5,6,7 degree, its proportion are 53%, 79%, 51% respectively, decreasing from middle degree to both of sides. Where the accumulate temperature great, the wind erosion is small compared with other erosions. From 9 to 13 degree, the proportion of wind erosion is less than 2%. From intensity, every intensity exists all degrees,also engineer erosion with little area.

3.6 Land use factor analysis

Incorrect land use is an important factor to cause soil erosion. From water soil erosion, the proportion of farmland erosion becomes great with the erosion intensity increasing, and decrease s at 16, the proportion is 36%, which shows human-being reclaims is great. The area of above light of farmland is 39%，41%，53%，64%，36% respectively. The area of forest erosion decreases with the intensity increasing, The area of above light of forest is 38%，32%，24%，9.7%，5% respectively. The area of grassland erosion changes between 20% and 25% and reaching 56% at most intensity. The area of other land use type erosion is relatively small. For wind erosion, grassland is the most erosion. The area of above light of grassland is 69%，60%，20%，2.7%，2% respectively. With the proportion of other land use erosion increasing, The area of other land use type erosion is 12%，19%，76%，97%，99% respectively. Urban is main Engineer erosion. Forest and farmland are main gravity erosion, its proportion is 51%，38% respectively.

4 Conclusion

Soil erosion is made by multi-factor. This paper discusses soil erosion of hill under different eco-environment background. All of soil erosion type and intensity takes place in china hills. With the temperature, rainfall, NDVI, etc changing, the soil erosion changes in zone. From results, for the eco-environment background zone law, the intensity of water soil erosion decreases from east to west, which shows some treatments are taken in east china. However, the change direction of the intensity of wind erosion is contrary to water erosion'. The intensity of water erosion is great than wind erosion' in interchange of water and wind erosion.

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