Analyse on Spatial-Temporal Features of Land Use /Land Cover under the Defferent Background of Soil Erosion[1]

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Abstract: The research of spatial-temporal features of land use and land cover is significantly important for better understanding land use/land cover change and environmental management for sustainable development. In order to study the spatial-temporal changes of land use and land cover, the technologies of Remote Sensing and Geographical Information System were used to analyze the spatial distribution of spatial-temporal feature of land use and land cover under the different soil erosion. It is shown that the main types of soil erosion are water soil erosion, wind soil erosion and frozen soil erosion in China. The maximum of percentage of types of water soil erosion and frozen soil erosion are slight water soil erosion and slight frozen soil erosion. The maximum of percentage of types of wind soil erosion is fierce wind soil erosion. So, The wind soil erosion is the most serious environment and socioeconomic problems in China, especially in the north China where sandy desertification is developing rapidly over large areas and receiving widespread attention.
Keywords: geographical information system, land erosion, land use, spatial-temporal feature

1 Foreword

With economy developing, China has different characters in many areas, such as the use-way of land resource, the structure of land use, the degree of land use, and so on. In order to understanding the process of land use change, we must study the space information of land use and its different in land use change. So, backed by the technologies of Remote Sensing and Geographical Information System, the spatial-temporal features distribution of land use/land cover under the background of different soil erosion were analyzed and the quantitative approach and track of study on land use/land cover change in China were given in this paper.

2 Study area and its database

The study-area includes whole of China.

The database include the land use database that represents the land use in middle of 90's, the database of land use that represents the land use in the end of 90's and the database of soil erosion, which represents the soil erosion in the end of 90's. The data of land use and soil erosion were all gotten from LANDSAT TM image by expert's interpretation. In the process of interpretation we use many assistant data such as the map of terrain and physiognomy, and reconnaissance on the spot. According to the rules of land use investigation in China and the characters of land use, We divided the land use types into six classes and twenty-four sub-classes from up to below: cultivated land, forestland, grassland, water region, built land and unused land. According to the rules of Soil erosion investigation technologies, and Considered of soil erosion environment, climate environment, vegetation and its physiognomy, we divided the soil erosion types into five classes and twelve sub-classes, that is water-power erosion, wind-power erosion, frozen erosion, gravity erosion and engineer erosion. At the same time we also divided the water erosion and wind erosion into 6 grades, that are weak, light, mid, intensity, more intensity and acute erosion, the frozen erosion into four grades, that is weak, light, mid and intensity erosion.

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All types of data are projected into uniform coordinates and projection system. The projection system is Albers projection, which parameters is: 1st standard parallel is 25.0000, 2nd standard parallel is 47.0000, the central meridian is105.0000, the ellipsoid is *KRASOVSKY* ellipsoid. Backed by ARC/INFO software, all types of data are turned into 100m×100m raster data.

The spatial distribution of land use/land cover in the end of 90's is shown in Figure 1. From this picture we can see: The cultivated land is mainly distributed in the east-north of China, the forestland is mainly distributed in the south and east-north of China, the grassland is mostly distributed in the middle and the west-south of China, unused land is mostly distributed in the middle of the west-north of China. Figure 2 is the spatial distribution of soil erosion in China. From this picture we can see: The water-power erosion is the main soil erosion types in China, mostly distributed in the east and the middle of China, the wind-power erosion distributed in the north-west of China and Inner-Mongolia Autonomous Region, the frozen erosion is mainly distributed in north-west of China.

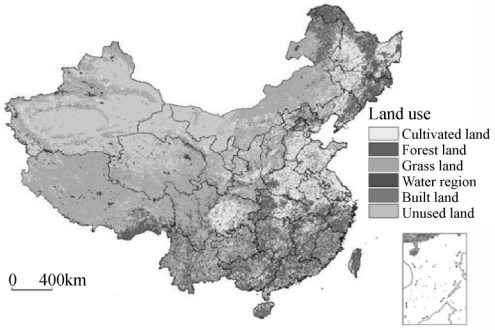

Fig. 1 The distribution of land use/land cover in China

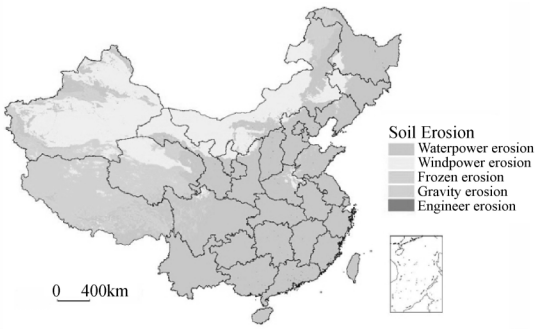

Fig. 2 The distribution of soil erosion in China

3 Analysis on spatial-temporal features of land use under different soil erosion backgroun

3.1 Analysis on spatial-temporal features of land use under different waterpower erosion

Backed by ARC/INFO software, we can get spatial distribution of land use under different waterpower erosion through overlay the land use map with waterpower erosion map. The Table one and two is the statistic result of distribution of land use under different waterpower erosion (% represents the area percentage of land use types under different waterpower erosion type). Considering the water area is changed more at different phase data of TM image, the spatial-temporal change of lake or river is not considered in this paper. From Table 2 we can see the land use status under different waterpower erosion: In China the weak waterpower erosion is the main waterpower erosion, and with the intensity of waterpower erosion increased, the area of erosion is decreased. In weak waterpower erosion region the area of forestland is largest, about 45.1% of total area in this region, the unused land area is smallest in all land use types. In the region that the grades of waterpower erosion is light, mid and more intensity erosion, the area of grassland is largest among all land use types, about 39.9%, 43.9% and 46.4% of total area in each region. In intensity waterpower erosion region and acute waterpower erosion region, the cultivated land area is largest, about 42.3% and 44.0% of total area in each region. Figure 3 is the statistical map of land use change under different water soil erosion. Comparing the two-phase statistic tables and this figure we can see that in weak waterpower erosion region the area of cultivated land, grassland and built land is increased, and the area of forestland and unused land is decreased, in all that the area of cultivated land had been increased mostly and the area of forestland had been decreased mostly, which area decreased from 45.4% to 45.1% of total area in this region. In light and mid waterpower erosion region the cultivated land area had been increased mostly, about 1% increased, next the area increased mostly is built land. However the both of forestland and grassland had been decreased. In intensity waterpower erosion region the area of cultivated land and grassland had been increased in some measure, and the area of forestland and unused land had been decreased. There is no obvious change of land use character in best intensity water erosion district. In acute waterpower erosion region

the area of forestland were increased and cultivated land and grassland were decreased, which the reason is probably the increase of manpower plantation leading to the increase of forestland area, but with the development of soil erosion, the area of cultivated land and grassland will decrease more and more.

Table 1 The distribution of land use under different water soil erosion in the middle of 90s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Weak	1,100,242	31.6	1,581,603	45.4	451,798	13.0	124,035	3.5	139,598	4.0	88,280	2.5	3,485,556
Light	213,968	24.2	274,929	31.1	358,061	40.4	3,759	0.4	6,540	0.7	27,983	3.2	885,240
Mid	180,701	28.3	151,132	23.6	284,470	44.5	3,301	0.5	3,245	0.5	16,571	2.6	639,420
Intensity	81,090	42.0	37,770	19.6	68,545	35.5	516	0.3	825	0.4	4,316	2.2	193,062
More Intensity	26,095	46.3	3,340	5.9	26,206	46.5	124	0.2	151	0.3	486	0.9	56,402
Acute	10,963	45.6	654	2.7	12,040	50.0	14	0.0	51	0.2	342	1.4	24,064

Table 2 The distribution of land use under different water soil erosion in the end of 90s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Weak	1,106,295	31.7	1,572,526	45.1	457,361	13.1	124,070	3.5	143,020	4.1	81,870	2.3	3,485,142
Light	222,310	25.1	270,128	30.5	353,039	39.9	5,158	0.6	7,096	0.8	27,476	3.1	885,207
Mid	186,507	29.1	148,848	23.3	280,450	43.9	3,384	0.5	3,521	0.6	16,696	2.6	639,406
Intensity	81,717	42.3	36,219	18.8	69,769	36.1	631	0.3	890	0.5	3,835	2.0	193,061
More Intensity	26,085	46.2	3,443	6.1	26,152	46.4	132	0.2	138	0.2	452	0.8	56,402
Acute	10,589	44.0	1,278	5.3	11,769	48.9	20	0.1	52	0.2	356	1.5	24,064

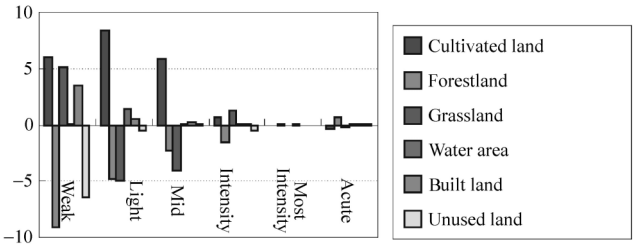

Fig. 3 The statistical map of land use change under different water soil erosion, area : $\times 10^3$ km^2

3.2 Analysis on spatial-temporal features of land use under different wind erosion

We can get spatial distribution of land use under different windpower erosion through overlay the land use map with windpower erosion map. The Table 3 and 4 is the statistic result of distribution of land use under different windpower erosion (% represents the area percentage of land use types under different windpower erosion type). We can see that the acute windpower erosion is the main windpower erosion type in China. With the increase of windpower erosion intensity, the erosion area is increased. In China the cultivated land, water area and built land distribute mainly in weak windpower erosion region, the forestland and grassland distribute mainly in light windpower erosion region, and unused land distribute mainly in acute wind erosion region.

Table 3 The distribution of land use under different windpower erosion in the middle of 90s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Weak	54,940	19.0	9,306	3.2	122,986	42.6	16,539	5.7	6,790	2.4	77,969	27.0	288,530
Light	29,048	8.4	10,840	3.1	259,084	75.2	2,224	0.6	2,662	0.8	40,796	11.8	344,654
Mid	26,602	7.1	5,041	1.3	243,255	64.6	1,489	0.4	1,376	0.4	98,962	26.3	376,725
Intensity	5,859	1.6	1,536	0.4	100,692	27.1	427	0.1	362	0.1	263,116	70.7	371,992
More Intensity	2,701	0.7	147	0.0	12,548	3.2	222	0.0	138	0.0	373,173	95.9	388,929
Acute	204	0.0	236	0.0	10,233	2.0	123	0.0	23	0.0	507,390	97.9	518,209

Table 4 The distribution of land use under different windpower erosion in the end of 1990s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Weak	54,679	19.0	9,444	3.3	120,394	41.7	15,213	5.3	6,960	2.4	81,835	28.4	288,525
Light	31,664	9.2	10,559	3.1	248,533	72.1	3,651	1.1	2,775	0.8	47,462	13.8	344,644
Mid	28,816	7.6	6,861	1.8	216,629	57.5	2,669	0.7	1,560	0.4	120,189	31.9	376,724
Intensity	6,512	1.8	2,027	0.5	82,184	22.1	843	0.2	425	0.1	280,001	75.3	371,992
More Intensity	3,049	0.8	274	0.0	14,092	3.6	1,087	0.3	157	0.0	370,270	95.2	388,929
Acute	1,161	0.2	483	0.1	14,730	2.8	123	0.0	364	0.0	500,728	96.6	518,205

Figure 4 is the statistical map of land use change under different windpower erosion. From this figure and Table 3, Table 4 we can see that: The area of grassland is decreased and unused land is increased in weak windpower erosion region in five years; In the region that the grades of windpower erosion is light, mid and intensity erosion, the area of cultivated land, forestland and unused land is increased and the area of unused land is largest among all land use types. The area percentage of unused land were increased from 11.8%, 26.3% and 70.7% in the mid of 90's to 13.8%, 31.9%, and 75.3% in the end of 90's. However, the area of grassland area were decreased, from 75.2%, 64.6% and 27.1% in the mid of 90's to 72.1%, 57.5% and 22.1% in the end of 90's. In more intensity and acute windpower erosion region the area of grassland and cultivated land are increased and unused land is decreased. Because of the result of wind erosion in meadow, the useful components such as some tiny fertilizers were run out and the meadow have been lost the carrying capacity to vegetation at last. So this region is the most sensitive area to be deserted, which is also the top-priority considered region. We can pick up this region as the most sensitive region to desert. Figure 5 is the desertification danger zone of meadow in China. Comparing the land use data in five years we can see that meadow dangerous area is continue decreased and desert area is continue increased, so that the tend of desertification will continue develop. How to prevent meadow from desertification and manage the desert, it is a core task that is worth for we to study.

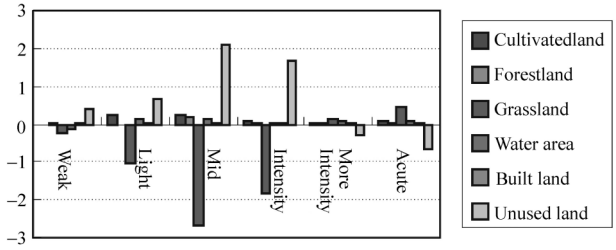

Fig. 4 The statistical map of land use change under different wind erosion, area : $\times 10^4$ km^2

Fig. 5 The desertification danger zone of meadow in China

3.3 Analysis on spatial-temporal features of land use under different frozen erosion

We can get spatial distribution of land use under different frozen erosion through overlay the land use map with frozen erosion map. The Table 5 and 6 is the statistic result of distribution of land use under different frozen erosion (% represents the area percentage of land use types under different frozen erosion type). We can see that the weak frozen erosion is the main frozen erosion type in China. With the increase of frozen erosion intensity, the erosion area is decreased.

Table 5 The distribution of land use under different frozen erosion in the middle of 90s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Weak	3,012	0.3	91,981	10.6	406,971	46.7	96,403	11.1	304	0.0	273,037	31.3	871,708
Light	1,882	0.3	55,539	9.6	359,959	62.1	4,707	0.8	131	0.0	157,690	27.2	579,908
Mid	54	0.0	2,771	0.9	202,653	68.6	3,220	1.1	0	0.0	86,683	29.3	295,381
Intensity	29	0.0	1,347	1.4	66,833	67.1	1,053	1.1	0	0.0	30,310	30.4	99,572

Table 6 The distribution of land use under different frozen erosion in the end of 90s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Weak	3,211	0.4	82,864	9.5	391,865	45.0	103,692	11.9	314	0.0	289,708	33.2	871,654
Light	2,092	0.4	56,653	9.8	390,680	67.4	3,438	0.6	129	0.0	126,900	21.9	579,892
Mid	84	0.0	1,707	0.6	237,588	80.4	1,850	0.6	0	0.0	54,141	18.3	295,370
Intensity	49	0.0	1,501	1.5	84,235	84.6	591	0.6	1	0.0	13,193	13.3	99,570

Fig. 6 is The statistical map of land use change under different frozen erosion. From this figure and table 5, 6 we can see that: The area of forestland and grassland is decreased and unused land is increased in weak frozen erosion region in five years. The area percentage of unused land were increased from 31.3% in the mid of 90's to 33.2% in the end of 90's. In the region that the grades of frozen erosion is light, mid and intensity erosion, the area of grassland is increased markedly and the area percentage of grassland were increased from 62.1%, 68.6% and 67.1% in the mid of 90's to 67.4%, 80.4%, and 84.6% in the end of 90's. However, the area of unused land is decreased and the area percentage of unused land were increased from 27.2%, 29.3.6% and 30.4% in the mid of 90's to 21.9%, 18.3%, and 13.3% in the end of 90's. In a word, in the frozen erosion region, the area of grassland is increased and unused land is decreased in five years.

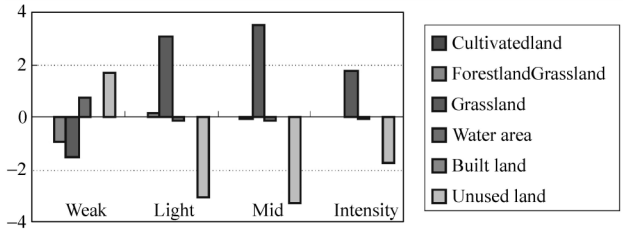

Fig. 6 The statistical map of land use change under different frozen erosion, area: $\times 10^4\,km^2$

3.4 Analysis on spatial-temporal features of land use under gravity and engineer erosion

We can get spatial-temporal features of land use under different gravity erosion and engineer erosion through overlay the land use map with gravity erosion map and engineer erosion map. The Table 7 and 8 is the statistic result of distribution of land use under different gravity erosion and engineer erosion. From these Table we can see that the intensity of gravity erosion and engineer erosion is very weak in China, and its area is also little and distribution is disperse. In gravity erosion region, forestland and cultivated land are main land use types, and its change are not obvious in five years; In engineer erosion region, built land is main land use types, and its area is decreased a little in five years.

Table 7 The distribution of land use under gravity and engineer erosion in the middle of 90s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Gravity erosion	196	33.2	319	54.0	56	9.5	1	0.2	19	3.2	177	29.9	768
Engineer erosion	795	18.2	320	7.3	197	4.5	51	1.2	2,937	67.2	69	1.6	4,369

Table 8 The distribution of land use under gravity and engineer erosion in the end of 90s, unit: km^2

ID	Cultivated land	%	Forestland	%	Grassland	%	Water area	%	Builtland	%	Unusedland	%	Total area
Gravity erosion	193	25.1	340	44.3	76	9.9	2	0.3	13	1.7	144	18.7	768
Engineer erosion	947	21.7	344	7.9	176	4.0	71	1.6	2,729	62.5	97	2.2	4,364

4 Conclusion and discussion

RS and GIS is an effective tool in researching and investigating our country resource. It can not only save financial and material resource but also monitor the spatial-temporal feature change of land use/land cover quickly, so we can understand the distribution of spatial-temporal feature of land use/land cover as a whole. This paper quantitative analyzed the spatial-temporal feature of land use/land cover under different background of soil erosion between the middle of 90's and the end of 90's in China backed by technology of RS and GIS. The result indicates that wind erosion is the most serious environment and socioeconomic problems in China, especially in the north China where sandy desertification is developing rapidly, so at present how to keep dry soil from wind soil erosion and keep soil away desert is the most pressing task for us to study.

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