Study on the Variation Characteristics of Land Desertification in Ebinur Lake Basin

L. S. Sun[1], **Y. T. Ma**[1, 2], **and H. Ding**[1]

[1]School of Civil Engineering, Shenyang Jianzhu University, Shenyang, China
[2]School of Resource & Civil Engineering, Northeastern University, Shenyang, China

Abstract— Desertification is one of the most serious problems of environment and social economy in the world today, which threats to human survival safety directly. In this paper, based on MODIS-NDVI data and dimidiate pixel model, we analyzed space distribution and change characteristics of desertification in Ebinur Lake Basin. Study results indicated the sandy desertification in most parts of Ebinur Lake Basin was mild and moderate desertifications which were always over the 60 percent of total area, the area of micro and non-desertification had been still transforming to the area of the severe, moderate and mild desertification.

1. INTRODUCE

Desertification refers to the land degradation in the arid, semi-arid and dry sub-humid areas due to various factors, including climatic variations and human activities. It has potentially impacted on 40% of global land area and 32% of population (United Nations Environment Agency, 1997), traveled over more than 100 countries on six continents in Asia, Africa, Australia, Europe, North America and South America. Global desertification area has added up to $3.56 \times 109\,\mathrm{km}^2$ and the economic losses due to desertification every year have amounted to $42.308 billion (Lixian Wang, 1994) [1]. This showed that the monitoring and control of desertification has become a pressing problem. Desertification monitoring using satellite remote sensing research abroad began in 1970s, when people mostly adopted soil salinization and land retirement represented by the NVDI to indicate desertification [2–5]. For instance, the status of land desertification was evaluated by remote sensing method in Argentina. In the early 80s, China has started to do a survey of resource on land desertification by using remote sensing technology. Zhu et al. did a research on the dynamics desertification in Khorchin region by the aerial photo in 1975 and the TM images of 1987–1988 [6]. During 1984–1986, the Ministry of Water Resources Center organized a national survey of soil erosion by remote sensing. Based on MODIS-NDVI data in August 2006, 2009 and 2012 and dimidiate pixel model [7], the vegetation coverage was estimated in this paper. Furthermore, the land sandy desertification in Ebinur Lake Basin was also processed to reflect the dynamic changes of desertification in last 6 years, which offered decision support for regional ecological environment assessment and sustainable development.

2. DATA AND PROCESSING

2.1. Investigation Area

Xinjiang Ebinur Lake wetland is located in the border between China and kazakhstan, nest to the international port of ala mountain running from east longitude $79^\circ 53'$ to $85^\circ 02'$ and north latitude $43^\circ 37'$ to $45^\circ 55'$. It covers 2800 square kilometers of wetland around Ebinur. Ebinur Lake wetland is the lowest bottomland depressions of southwestern margin of the Junggar Basin and salt water collection center, is the largest salt water lake in Xinjiang. Because of particular geographical location and characteristics of topography various types of desertification exist in the region. Taking into account the specific characteristics of desertification, the integrity of the study area and the resolution of image, we determined that the scope of the study area covers the entire Bortala Mongol Autonomous Prefecture including Jing he, Bole and Wenquan counties.

2.2. Data

In this paper, the data of NDVI (MOD13A3) come from NASA Earth Observation System (EOS) at a time resolution of the month and a space resolution of 1 km. The time was respectively in August in 2006, 2009 and 2012. The range was from east longitude $79^\circ 53'$ to $85^\circ 02'$ and north latitude $43^\circ 37'$ to $45^\circ 55'$.

2.3. Data Processing

Through image projection conversion, subsetting, mosaicing, stacking and other steps, NDVI data were acquired. Then we calculated the vegetation coverage by the following formula:

$$f_g = (\mathrm{NDVI} - \mathrm{NDVI}_{\min}) / (\mathrm{NDVI}_{\max} - \mathrm{NDVI}_{\min})$$

Among them: f_g is vegetation coverage, NDVI is Normalized Difference Vegetation Index, $\mathrm{NDVI}_{\min}$ is the smallest vegetation index in images, generally which is the minimum value of bare land pixels. $\mathrm{NDVI}_{\max}$ is the maximum vegetation index in images, generally which is the maximum value of pure vegetation cover pixels.

3. RESEARCH RESULT

3.1. Spatial Distribution of Land Desertification

According to the standard of soil erosion and desertification indicator developed by Z. D. Zhu and others, the study area in this paper was in line with the prerequisite of standard developed by them, so we applied the desertification indicator to classify land in Ebinur areas (Table 1).

According to the indicator of desertification, the desertification thematic figures were shown in Figure 1 and percents of desertification level were listed in Table 2 in 2006, 2009 and 2012 respectively.

It could be seen that from the figure and table, the desertification in the study area mainly were mild, moderate and not desertification. During 2006 and 2012, moderate and micro desertification land area were in a case of reduction followed by increase. There was a larger proportion of moderate

Table 1: Remote monitoring indicators of desertification in Ebinur Lake area (Bole).

Table 1 Remote monitoring indicators of desertification in Ebinur Lake area (Bole)

Desertification grades [legend]	Not [ ]	Micro-degree [ ]	Mild [ ]	Moderate [ ]	Serious [ ]
Vegetation coverage	Water or vegetation cover > 80%	60%–80%	30%–60%	10%–30%	10%

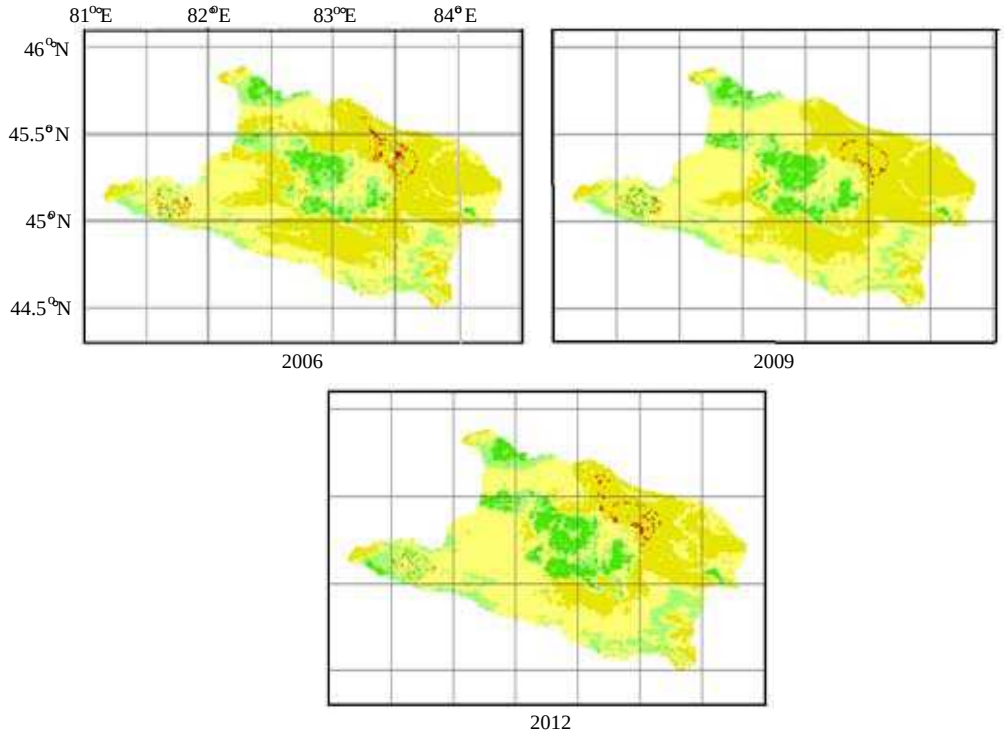

Figure 1: Spatial distribution of land desertification (legend in Table 1).

and mild desertification land in the research area indicating that the difficulty of desertification control in the Ebinur Lake region was still very great.

3.2. Land Desertification Type Transformation

In order to study the construction of land desertification transformation in Ebinur Lake (Bole) region, two phases of RS classification diagram were performed the operation of subtract in ERDAS, generating the distribution figure of desertification type changes and desertification conversion degree tables. Because of limited space, only statistics of desertification conversion types in 2006 and 2009 was listed in Table 3.

It could be perceived from Table 3 that between 2006 and 2009 there were 51.358% of the land turning from micro-desertification to not desertification, 4.3011% converting from micro-desertification into mild desertification, 1.5697% transforming from mild desertification to moderate desertification, 1.0119% truning from mild desertification to micro-desertification, 1.358% switching from moderate desertification to serious desertification, 15.4541%, 17.6742%, 4.1512% and 1.9026% of the land respectively remaining the original micro, mild, moderate and serious desertification degree with no change.

3.3. Annual Variation Rate of Land Desertification Change

This study described the rate of change of land desertification in the Ebinur region on the method of calculating the variation rate of land use and compute the variation and the annual variation

Table 2: Statistics of desertification grades.

Desertification grades	2006		2009		2012	
	Pixel numbers	Percentage	Pixel numbers	Percentage	Pixel numbers	Percentage
Severe Desertification	1090	2.4060	680	1.4991	990	2.1846
Moderate Desertification	23402	51.5917	20592	45.3965	17453	38.4771
Mild Desertification	10937	24.1116	9252	20.3968	10282	22.6675
Micro-degree Desertification	2827	6.2302	1555	3.4281	1905	4.1977
Not Desertification	7104	15.6605	13281	29.2795	14730	32.4731

Table 3: Statistics of desertification conversion types from 2006 to 2009.

Conversion types	Pixel gray value	Pixel numbers	Percentage	Desertification types	Pixel gray value	Pixel numbers	Percentage
Severe-Not	16	1	0.0022	Micro-degree -Mild	126	1951	4.3011
Moderate-Not	24	5	0.011	Severe- Moderate	240	91	0.2006
Mild-Not	28	11	0.0243	Moderate	248	1883	4.1512
Micro-degree-Not	30	23296	51.358	Mild-Moderate	252	712	1.5697
Moderate-Micro-degree	56	15	0.0331	Micro-degree-Moderate	254	40	0.0882
Mild-Micro-degree	60	459	1.0119	Severe	496	863	1.9026
Micro-degree	62	7010	15.4541	Moderate-Severe	504	616	1.358
Severe-Mild	112	7	0.0154	Mild-Severe	508	53	0.1168
Moderate-Mild	120	307	0.6768	Micro-degree-Severe	510	23	0.0507
Mild	124	8017	17.6742				

Table 4: Comparison of desertification area in different grades.

Desertification grades	2006 (km^2)	2012 (km^2)	Variation (km^2)	Annual Rate (%)
Not Desertification	12844.270	12815.739	−28.531	−0.037%
Micro-degree Desertification	4894.678	3108.166	−1786.512	−6.083%
Mild Desertification	5077.987	6002.824	924.837	3.035%
Moderate Desertification	1551.071	1922.220	365.149	3.924%
Severe Desertification	527.994	1045.059	517.065	16.322%
Total	24896	24894.008	−1.992	

rate of different desertification area amount in different study periods from 2006 to 2012, a positive value indicating the level of desertification area increase and a negative value indicating decrease. Results as shown in Table 4.

As was very clear from Table 4 that compared with 2006, in 2012, severe, moderate and mild desertification area was increasing while micro-desertification and not desertification was decreasing, of which serious desertification area was the most significant change that the area added 517.065 square kilometers in six years in an annual rate of 16.332%. In the meantime, micro-desertification area decreased 1786.512 square kilometers in the annual rate of −6.083% and the not desertification area had slight decrease. These showed that not desertification and micro-desertification was developing in the direction of mild, moderate and serious desertification. So from an overall point of view, the degree of desertification in the Ebinur Lake region was increasing.

4. CONCLUSIONS

In this thesis, during the process of desertification monitoring in the Ebinur Lake region, we found that the land desertification of Ebinur Lake region (Bole) region mainly dominated by moderate and mild desertification whose sum is always more than 60% of the total land area per year. More than 50% land converted from micro-desertification to not desertification from 2006 to 2009 and 2009 to 2012. Comparing with 2006, in 2012, serious, moderate and mild desertification area is increasing while micro-desertification and not desertification is decreasing, of which serious desertification area is the most significant change that the area added 517.065 square kilometers in six years in an annual rate of 16.332%. In the meantime, micro-desertification area decreased 1786.512 square kilometers in the annual rate of −6.083% and the not desertification area had slight decrease. These show that not desertification and micro-desertification is developing in the direction of mild, moderate and serious desertification. Overall study results indicate that the area of desertification land is on the decline but the type conversion structure shows that the strength of desertification is in the constant development stages. Thus, these prevention and treatment recommendations are provided in this thesis as follows: 1. Ensure the Ebinur Lake area of the waters. 2. Comprehensive management of Ebinur Lake wetland nature reserve. 3. Firm control the blind expansion of arable land and mining digging. 4. Reasonable irrigation and water conservation.

REFERENCES

1. Wang, L. X., "The state of control and tendency of development of the global desertification," *World Forestry Research*, Vol. 1, 10–17, 1994.
2. Li, X. Y., B. Zhang, and Z. B. Jin, "Dynamic monitoring of vegetation coverage based on MODIS-NDVI in Hedong area of Gansu Province," *Research of Soil and Water Conservation*, Vol. 20, No. 1, 16–58, 2013.
3. Tian, J. Q. and X. J. He, "Progress vegetation index advances in earth science," *Advances in Earth Science*, Vol. 13, No. 4, 327–333, 1998.
4. Sheng, Y. W., W. Y. Chen, and Q. G. Xiao, "Macroscopic classification of vegetation in China by vegetation index from weather satellite," *Chinese Science Bulletin*, Vol. 40, No. 1, 68–71, 1995.
5. Xiong, L., K. Q. Yan, L. Wu, and W. J. Huang, "Vegetation cover variation analysis of NDVI sequence image in growing season of Urumqi region," *Desert and Oasis Meteorology*, Vol. 5, No. 6, 54–58, 2011.
6. Zhu, Z. D., "The concept, causes and prevention of desertification in China," *Quaternary Sciences*, Vol. 2, No. 6, 145–155, 1998.
7. Lin, Z. R., Y. G. Feng, and G. J. Yang, "Estimation method commentary of vegetation coverage based on remote sensing," *Remote Sensing Technology and Application*, Vol. 24, No. 6, 233–258, 2009.