LAND COVER CHANGE IN NATURAL RESERVE OF THE YELLOW RIVER DELTA, CHINA, 1999-2008
ABSTRACTS

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1. INTRODUCTION

Land is a dynamic canvas through which human and natural systems interact. Land cover is an expression of human activities and, as such, changes with changes in land use and management [1], and land cover change could be regarded as change in biotic diversity, actual and potential productivity, soil quality, run-off, and sedimentation rates [2]. Land cover change has caused and will continue to cause dramatic changes in the structure and function of ecosystems [3]. The Yellow River Delta (YRD) lies between multi-ecotones of dynamic interactions of Bohai Sea, land, atmosphere and the Yellow River [4], which is one of the most rapidly changed regions in the world. Concerns about land cover changes in the YRD have increased during the past decade [4-11]. The cultivated land and construction area increased rapidly, along with the virgin soil being reclaimed and oilfield development were regards as the key driving forces. With given an official approval for highly efficient eco-economy's development on the YRD by state department of China in 2009, land cover change in the YRD must be faster, and need be better studied for guiding land use development and protect the wetland ecosystems, which are the habitats for the rare and endangered birds in the world, such as Red-crowned crane [12]. All of the above researches on land cover change in the YRD used transition matrix method. Transition matrix method has been used extensively for analysis and stochastic modeling of land use and land cover change since the 1960s [13, 14]. These researches generally focused on calculation of transition probability matrix between the beginning time and end time, and hereby analyzed land use change trends and driving forces, but few detailed analysis on land use succession processes from the beginning time to the end time were made. The main objective of this paper is to monitor the land cover change in the natural reserve of the YRD using Markov chain transition matrix method, especially changes of natural vegetation communities in the recent ten years.

2. DATA AND METHODOLOGY

DATA: Four images of Landsat satellite acquired on 25th June, 1999 and 9th August, 2001 and 28th October, 2004 and 2nd October, 2006, and one image of HJ-1B satellite acquired on 2nd October, 2008 were classified using visual interpretation method. The average accuracy of classification results was 91%.

METHODOLOGY: This paper assumed land cover change from time T1 to T2 is a Markov chain with stationary transition probabilities, and different categories of land covers were the state of a chain. Transition probability equation ($P_{ij} = n_{ij} / \sum_{j=1}^{m} n_{ij} \times 100\%$) was used. P_{ij} is transition probabilities where land is changed from sate i to sate j at given time period. n_{ij} is transition area or number where land is changed from sate i to sate j at given time period. In this paper, ArcMap software was used, and firstly the transition polygons where land was changed from Suaeda meadow to Suaeda meadow between the years 1999 and 2001 were extracted, and transition probability was calculated. Then these transition polygons were intersected on land cover map of 2004, and the polygons which were still Suaeda meadow in 2004 were extracted, which were used to intersect on the land cover map of 2006, and the polygons which were still Suaeda meadow in 2006 were extracted, and which were used to intersect on the land cover map of 2008, and the polygons which were still Suaeda meadow in 2008 were extracted. The rest may be deduced by analogy, the transition areas and probabilities of the other three main natural vegetation communities such as Chinese tamarisk shrubs, Reed swamp and Reed meadow were gotten.

3. RESULTS AND CONCLUSIONS

RESULTS: Fig.1 (A to E) presents the land use and land cover patterns in the natural reserve of the YRD from 1999 to 2008. The tidal flat cover was the biggest, the second was farmland, and the areas of Salterns and breeding aquatics increased from 0.9% to 4.8% of total areas, and on the whole, the areas of farmland were decreased, and the areas of forest land, Chinese tamarisk and Reed swamp was increased. But the landscape fragmentation increased, which went against protecting ecosystems and habitats for the rare and endangered birds. Tab.1 shows the transition areas and probabilities of four natural vegetation community changes, which were relatively unchanged regions of them. The lower row in Column Area of Tab.1, which were percentage of the area in 1999, indicates that Suaeda meadow and Reed meadow were relatively unstable, which were susceptible to environmental disturbances. Fig.1 (F) shows that only 14.95% of Suaeda meadow and 3.77% of Reed meadow had kept no change. The UN and ATP and UTP of Tab.1 show that the landscape fragmentation increased, especially from 2001 to 2004. If the dynamic succession processes of vegetation community were not taken into account, the relatively changed regions in the YRD could be easily extracted through intersecting between 1999 and 2008. The progressive succession in the YRD was evolved from Suaeda meadow to Chinese tamarisk shrub, Reed swamp and Reed meadow, and the inverse succession was evolved contrariwise. In the recent ten years, the regions in which the inverse succession (83638064.77m^2) happened were 2.07-fold that of progressive succession (40356798.46m^2), which reflected ecological fragility of YRD.

CONCLUSIONS: From 1999 to 2008, only 14.95% of Suaeda meadow, 39.96% of Chinese tamarisk shrubs, 22.21% of Reed swamp and 3.77% of Reed meadow had kept no change, and the regions in which the inverse succession happened were 2.07-fold that of progressive succession, which reflected ecological fragility of YRD. The integration of satellite remote sensing, GIS and Markov chain transition probability matrices provided a means to study the dynamic succession processes of natural vegetation community.

Tab.1 Natural vegetation community change from 1999 to 2008

Years		1999	2001	2004	2006	2008
Suaeda meadow	Area(m^2)	97012174.48	67464397.76 *69.53%*	26936814.83 *27.77%*	14789005.24 *15.24%*	14502314.35 *14.95%*
	UN	15	57（12）	44（3）	18（6）	21（8）
	ATP		69.53%	39.93%	54.90%	98.06%
	UTP		21.05%	6.82%	33.33%	38.10%
Chinese tamarisk shrubs	Area(m^2)	44221388.49	34399386.36 *77.79%*	19639771.29 *44.41%*	17690043.38 *40.00%*	17668718.35 *39.96%*
	UN	6	25（5）	19（4）	15（5）	13（5）
	ATP		77.79%	57.09%	90.07%	99.88%
	UTP		20.00%	21.05%	33.33%	38.46%
Reed swamp	Area(m^2)	11510739.07	9338341.27 *81.13%*	2855470.14 *24.81%*	2556980.24 *22.21%*	2556217.44 *22.21%*
	UN	7	20（6）	20（7）	17（9）	15（11）
	ATP		81.13%	30.58%	89.55%	99.97%
	UTP		30.00%	35.00%	52.94%	73.33%
Reed meadow	Area(m^2)	84409850.57	53218031.63 *63.05%*	15479787.58 *18.34%*	3178444.05 *3.77%*	3178223.57 *3.77%*
	UN	13	59（15）	52（9）	22（4）	5（2）
	ATP		63.05%	29.09%	20.53%	99.99%
	UTP		25.42%	17.31%	18.18%	40.00%

UN-Unit Number; ATP-Area Transition Probability; UTP-Unit Transition Probability

4. REFERENCES

[1] Louisa, J.M.J., Antonio, D.G., "Parametric Land Cover and Land Use Classifications as Tools for Environmental Change Detection," *Agriculture, Ecosystems and Environment*, 91, pp. 89-100, 2001.

[2] Steffen, W.L., Walker, B.H., Ingram, J.S., et al, *Global Change and Terrestrial Ecosystems: The Operational Plan IGBP Report No. 21*, International Geosphere-Biosphere Program, Stockholm, 1992.

[3] Meyer, W.B., and B.L. Turner, *Changes in Land Use and Land Cover: A Global Perspective*, Cambridge University Press, New York, N.Y., 1994.

[4] Ye Qinghua, Liu Gaohuan, Tian Guoliang, et al, Liu Qingsheng, Chang Jun, Shi yanan, "Geospatial-temporal Analysis of Land-use Changes in the Yellow River Delta During the last 40 years," *Science in China Ser. D Earth Sciences,* Vol.47, No.11, pp.1008-1024, 2004.

[5] Mu Congru, Yang Linsheng, Wang Jinghua, et al, "Wetland ecosystems formation and its protection in Yellow River Delta," Chinese Journal of Applied Ecology, Vol.11, No.1 pp. 123-126, 2000. (In Chinese)

[6] Li Jing, Zhao Gengxing, Fan Ruibin, "Analysis of Driving Forces of the Land Use and Land Cover Change at the Yellow River Delta," *Jour. of Northwest Sci-Tech Univ. of Agri. and For. (Nat. Sci. Ed.)*, Vol.31 No.3, pp. 117-122, 2003. (In Chinese)

[6] Ye Qinghua, Liu Gaohuan, Yao Yiming, et al, "Tupu Analysis of Land Use Changes in the New-born Wetland of the Yellow River Delta (YRD)," *Progress in Geography*, Vol. 22, No.2, pp.141-150, 2003. (In Chinese)

[7] Ye Qinghua, Tian Guoliang, Liu Gaohuan, et al, "Tupu Analysis on the Land Cover Evolving Patterns in the New-born Wetland of the Yellow River Delta," *Geographical Research,* Vol. 23, No.2, pp. 257-264, 2004. (In Chinese)

[8] Wang Xiaoqin, Wang Qinmin, Liu Gaohuan, et al, "Analysis of Land Use and Land Cover Change in Yellow River Delta," *Journal of Soil and Water Conservation*, Vol.20. No.5, pp.158-161, 2006. (In Chinese)

[9] Wang Xiaoqin, Wang Qinmin, Li Huiguo, et al, "Driving Forces of Land Use Change/Cover in the Yellow River Delta," *Resources Science*, Vol. 29, No. 5, pp.175-181, 2007. (In Chinese)

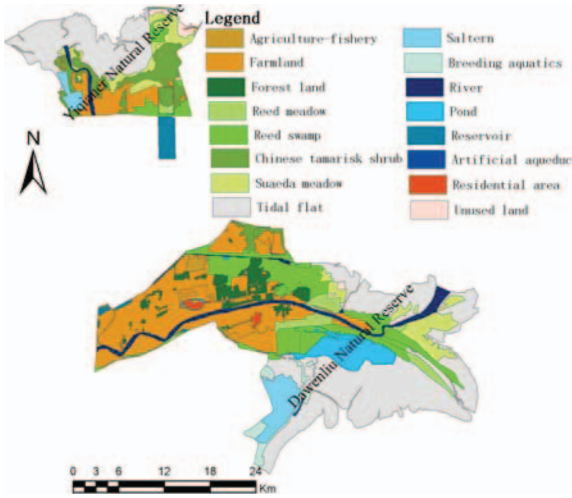
[10] Li Jing, Zhao Gengxing, Yang Peiguo, et al, "Temporal-Spatial Characteristic of the Land Use and Land Cover Change in the Yellow River Delta," *Areal Research and Development*, Vol. 27, No. 6, pp.110-114, 2008. (In Chinese)

[11] Zong Xiuying, Liu Gaohuan, Qiao Yuliang, et al, "Study on Dynamic Changes of Wetland Landscape Pattern in Yellow River Delta," Journal of Geo-information Science, Vol.11, No.1, pp.91-97, 2009. (In Chinese)

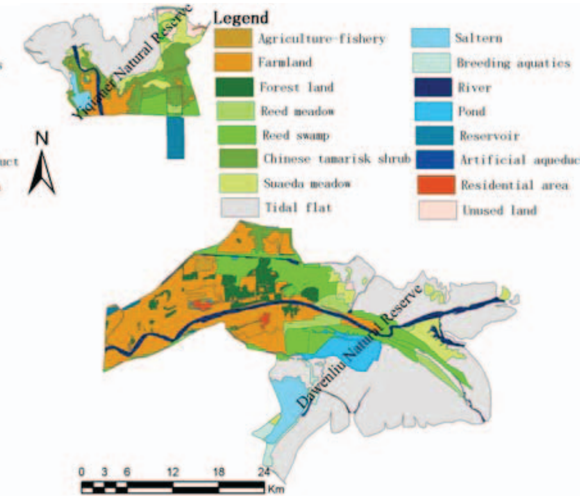
[12] Liu Gaohuan, Drost, H. J., *Atlas of the Yellow River Delta*, Publishing House of Surveying and Mapping, Beijing, 1997.

[13] Daniel G. Brown, Pierre Goovaerts, Amy Burnicki, et al, "Stochastic Simulation of Land-Cover Change Using Geostatistics and Generalized Additive Models," *Photogrammetric Engineering & Remote Sensing*, Vol.68, No.10, pp.1051-1061, 2002.

[14] Wu Qiong, Wang Rusong, Li Hongqing, et al, "Statistical Properties of Markov Chain in Land Use and Landscape Study," Chinese Journal of Applied Ecology, Vol.17, No.3, pp.434-437, 2006. (In Chinese)



A, on 2th Oct., 2008



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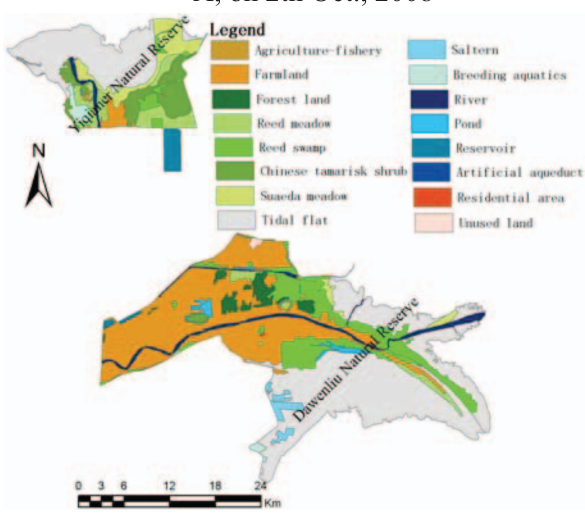

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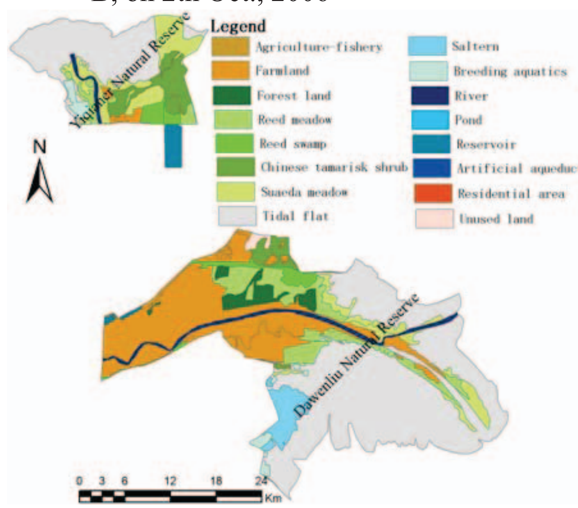

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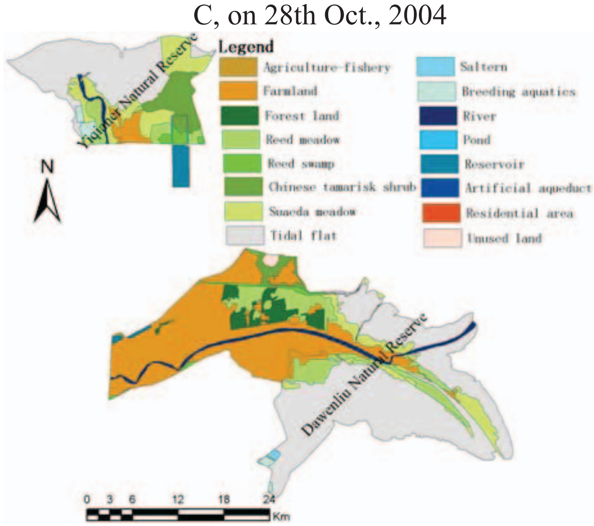

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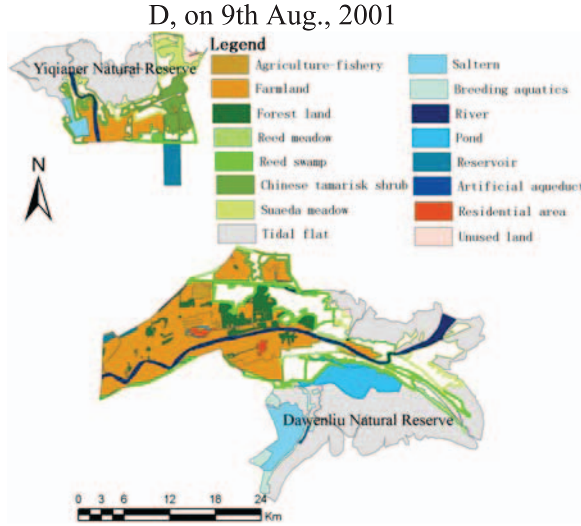

F, unchanged regions of four natural vegetation communities from 1999 to 2008

Fig.1 Land use/land cover maps from 1999 to 2008 in nature reserve of Yellow River Delta