

A case study on land use and cover change in the near urban area of China from the 1960's to the 1990's using DMSP/OLS data

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KEY WORDS : land use and cover change, remote sensing, GIS, China, DMSP/OLS

ABSTRACT

Due to the economic development and its land demands, remarkable changes have occurred in land use and cover structure near urban area all over China in recent decades. In this study, using GIS (Geographic Information System) existing data including RS (Remote Sensing) data, such as LUC (Land Use and Cover) data and DMSP(Defense Meteorological Satellite Programs)/OLS(Operational Line scan System) data are used for detecting the trend of LUCC (Land Use and Cove Change) near urban area in whole China. From 1960's to 1990's, the area of forestland had significantly increased, while the area of grassland, arable land, and paddy field had remarkably decreased. The area of farmland mainly concentrates in the near urban area, with its decrease along its distance from city-central area, while the area of forestland and grassland increase contrarily.

1 INTRODUCTION

Since the foundation in 1949, the People's Republic of China has made great progress in economic development, especially from 1950 to 1960 and after 1980. Due to remarkable socio-economic development, urbanization has greatly changed land use and cover structure near urban area. Wu et al. (1994) and Feng (1999) engaged in LUCC study in China, respectively. Their research can offer the important data. But for understanding the trend of the relationship between LUCC and soil degradation near urban in China, another approach is needed.

This study is preliminary for characterizing the relationships between soil degradation and LUCC resulted from human impact. Using GIS and existing data including RS data was applied to derive quantitative and statistical data to reflect LUCC near urban area in China. For this object, GIS and existing data were applied to derive the quantitative and the statistical trend reflected LUCC near urban area in China. DMSP/OLS data was utilized to detect urban area in China.

2 USED DATA

2.1 DMSP/OLS calibrated radiance image data

The primary mission of DMSP/OLS is to observe nighttime-moonlit-cloud cover, in order to provide global meteorological forecasting service for U.S. Air Force. Since such remote sensing image data also contains spatial information of urban-oriented city lights, Imhoff et al. (1997) put forward image threshold technique to acquire urban area's spatial information. In order to remove blooming noise of city light in image data, Imhoff et al. selected the 88% of maximum pixel value (100) in DMSP as the threshold value, taking pixels with the value 88% to 100% as the real city lights. In our study, the same threshold values were chosen, but the derived city area was larger than actual data. Finally the value of 93% was selected as the threshold value for China's case. Firstly DMSP/OLS image of China area was extracted by GIS. Secondly using this image data, buffered zones with distance of 50km, 100km, 150km, and 200km from the center of each city, were made respectively (Fig.2), as the mask

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Fig. 1 City lights in China in DMSP/OLS image data

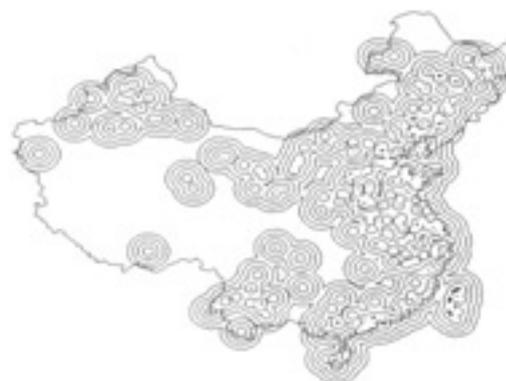


Fig. 2 Buffered zones of "City", "City-50km", "City-100km", "City-150km", "City-200km" ("City-Xkm" means the buffered zones with distance of Xkm from cities' center.)

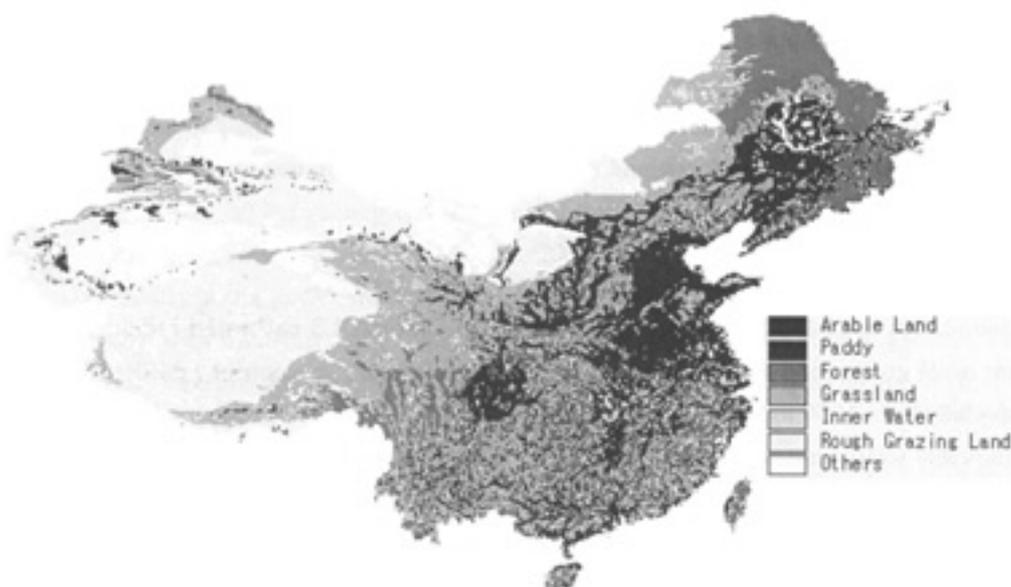


Fig. 3 Agricultural lands classification of China in 1960's of China appeared in Word Atlas of Agriculture(1969)

Table 1 Definition of land cover types in WAA original and digitized data

LUC Types in Original Data	LUC Types in Digitized Data
Arable land	Arable
Rough grazing land with arable land	Grassland
Permanent grassland with scattered arable land	Grassland
Wood and forest	Forest
Rice field	Paddy field
Sea, Inland water	Inner Water
Permanent grassland for grazing	Grassland
Non-agricultural land	Others
Non-agricultural land and rough grazing land	Others and Grassland

data for extracting LUC information near urban area. In Fig.2, "City-Xkm" means the buffered zones with distance of Xkm from cities' center.

2.2 Digitized World Atlas of Agriculture in 1960's

Agricultural land of China in the world atlas of agriculture (WAA), compiled by the International Association of Agricultural Economists in 1969 which reflected LUC status in whole China in 1960's (Table 1) was used as an exclusive and comprehensive data source.

2.3 Land Cover Data of Asia in 1992

The Land Cover Data of Asia (AARS Asia 30-second Land Cover Data set) was compiled by Land Cover Working Group of AARS (1999), using NOAA/AVHRR NDVI image data acquired from 1992 to 1993. Land cover classification system contains 39 categories. For comparability with other source data, its land cover classification system was merged into 6 types (Fig.4 and Table 2).

3 METHODOLOGY

Framework of research is demonstrated in figure 5, and data processing was supported by GIS. In this study we used ArcView 3.1.

4 DATA ANALYSIS

4.1 LUCC in China

By analyzing the World Atlas of Agriculture and Land Cover of Asia in 1992, we derived the LUCC information of China from 1960's to 1990's. Figures 6 and 7 show the main characteristic of LUCC. From 1969 to 1992, arable land and paddy field had significantly decreased. Most of disappeared parts of both were converted to construction and traffic area, which could be taken as main indication of urbanization process in China. Forestland had increased due to reforestation. Grassland had significantly decreased. A Part of disappeared grassland was converted to arable land and paddy field, while the other part of its decrease was mainly caused by desertification and soil salinization.

4.2 LUCC in Provincial level

Table 1 shows China provincial LUCC information. In most provinces, arable land and paddy field had decreased, except that in some northern provinces paddy field increased which was converted from grassland and forestland. In southern provinces, paddy field had significantly decreased and was converted to construction area due to regional high-speed economic development. In most provinces, forestland had increased, while grassland decreased except in some southern provinces (Table 3).

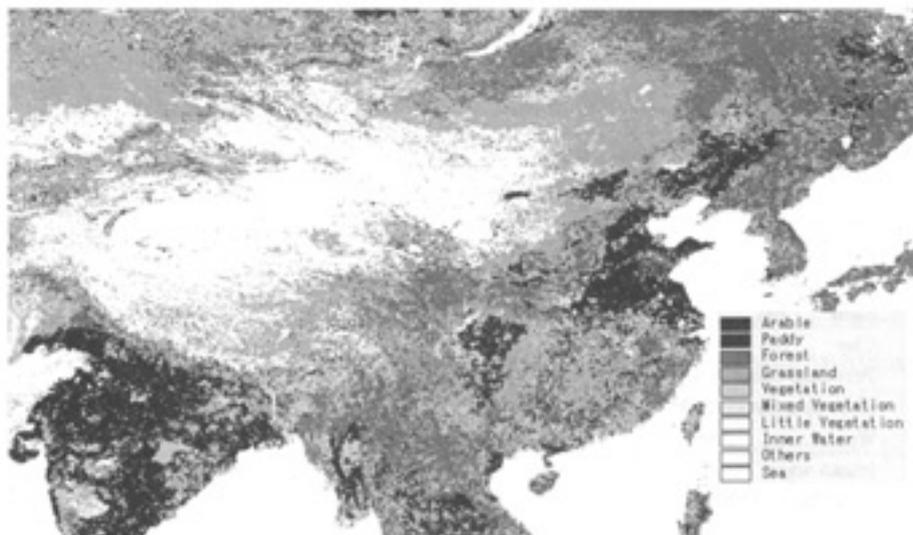


Fig. 4 Agricultural lands classification of China in 1960's of China appeared in Word Atlas of Agriculture(1969)

4.3 LUCC caused by urbanization

To meet land demands resulted from economic development, urbanization process has caused main portion of LUCC phenomenon in China. In order to study on LUCC structure within near urban area, similar multi-temporal data analysis work like above was performed within near urban area in China, with various buffering distances considered. As shown in Fig.8, within "City-50km" zone, the percentage of arable land increased outwardly, but from "City-50km" zone to "City-200km" zone decreased. Paddy field significantly

decreased within "City-200km" zone outwardly, which indicates that agricultural activities mainly concentrated within "City-50km" zone, and city expansion mostly occurred in paddy field and arable land. Within "City-50km" zone, arable land and paddy field held main share of land. Within "City-200km" zone, forestland gradually increased outwardly while grassland significantly decreased. Other categories decreased within "City-50km" zone and increased from "City-50km" zone to "City-200km" zone. Obviously, this is due to construction in near urban area.

Table 2 Definition of LUC Types in AARS-Land Cover Data Set and LUC Types in this Study

LUC Types in Original Data		LUC Types in Our Study
Sea	0*	
Vegetation	10	Forest
Evergreen	14	
Forest	16	
Broadleaf	18	
Needleleaf	36	
Natural	44	
Deciduous	70	
Forest	72	
Broadleaf	74	
Natural	76	
Tree crops	78	
Needleleaf	90	
Natural	94	
Forest and shrubland	110	
Grassland	130	Grassland
Natural grassland / pasture	132	
Grass crops	140	Arable land
Paddy field	141	Paddy field
Wheat	142	Arable land
Mixed vegetation	160	Forest, Grassland, Arable and Paddy field
Swamp	174	
Tundra	182	Others
Others	184	
Non vegetation	190	Others and Grassland
Bare ground	191	
Rock	192	
Stones or gravel	193	
Sand	194	
Clay	195	
Perennial snow or ice	200	
Built-up area	210	Others
Water	220	
Inland water	222	
Tidal flat	226	
		Inner Water

* Classification code in the original data

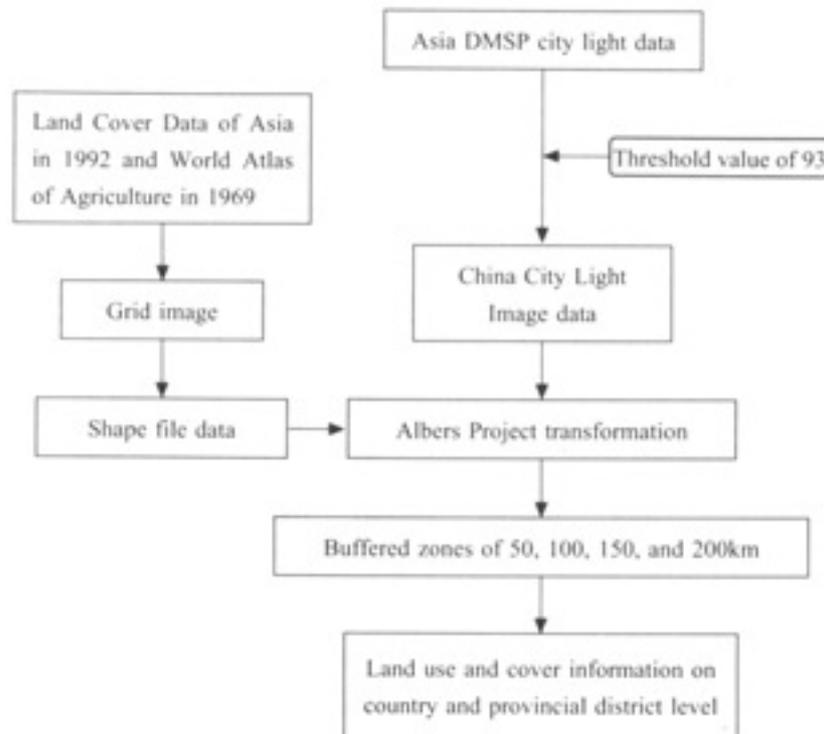


Fig. 5 Diagrams of analysis procedure

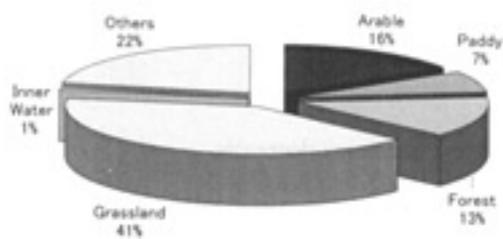


Fig. 6 Land uses and covers of China in 1969

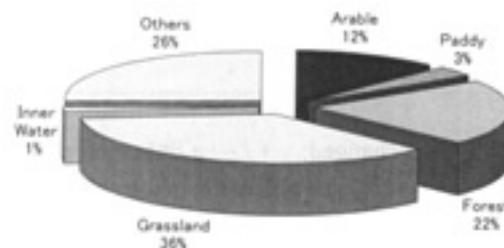


Fig. 7 Land uses and covers of China in 1992

In Fig.9, arable land and paddy field significantly increased within "City-50km" zone outwardly, and decreased from "City-50km" zone to "City-200km" zone. It indicates that city expansion generally occurred in arable land and paddy field. Forestland increased within "City-200km" zone outwardly. Grassland area decreased within "City-50km" zone and increased from "City-50km" zone to "City-200km" zone.

Comparing Fig.8 with Fig.9, we can see that urbanized area was mainly converted from arable land and later paddy field. Since 1990s, similar LUCC feature has been kept, while in future grassland would become another main source.

5 CONCLUSIONS

From 1960's to 1990's, significant changes in LUCC occurred in China. Forestland had significantly increased, while grassland, arable land and paddy field significantly decreased. In north China, arable land and paddy field had increased, but in south China these area decreased significantly.

Urbanized area was mainly converted from paddy field and arable land since 1960's, indicating that human activities were mainly within "City-50km" zone.

Data mismatch occurs with World Atlas of Agriculture map, especially about arable land and paddy field in China, which was overestimated. In fact, arable land was significantly increased in Northeast and Northwest China due to large-scaled reclamation. Thus, data calibration is necessary by introducing other historical databases, such as statistic materials.

Table 3 Land use and cover changes in every province from 1969 to 1992

	Heilongjiang	Jilin	Liaoning	Inner Mongolia	Hebei	Beijing	Tianjin	Shandong
Arable	-	----	----	*	----	----	--	----
Paddy field	-	--	-	*	++	++	--	+++
Forest	++	+++	+++	+	+++	+++	++	+++
Grassland	+++	++	--	--	*	--	+++	--
	Xinjiang	Gansu	Qinghai	Ningxia	Shaanxi	Shanxi	Henan	Hubei
Arable	-	--	*	--	----	----	----	*
Paddy field	-	--	*	--	+	+	+++	----
Forest	*	++	++	+	+++	+++	++	++
Grassland	----	--	----	----	--	++	++	+
	Jiangsu	Anhui	Shanghai	Zhejiang	Jiangxi	Hunan	Fujian	Hainan
Arable	--	--	--	+	+	*	+	+
Paddy field	--	--	-	----	----	----	----	----
Forest	++	++	++	+++	*	*	+++	++
Grassland	++	++	++	--	++	+++	----	-
	Guangdong	Taiwan	Guangxi	Guizhou	Sichuan	Yunnan	Tibet	
Arable	+	+	+	+	+	*	+	
Paddy field	----	----	----	--	--	--	+	
Forest	++	----	++	--	++	+++	*	
Grassland	*	++	*	*	--	----	--	

* : little changed; + / - : a little increase / decrease; ++ / -- : increase / decrease; +++ / --- : significant increase / decrease

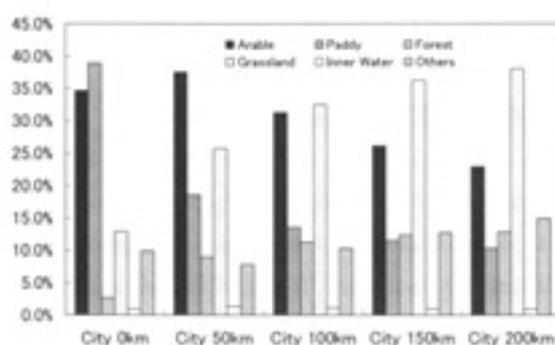


Fig. 8 Land use and cover structure within "City" zone to "City-200km" zone in 1969

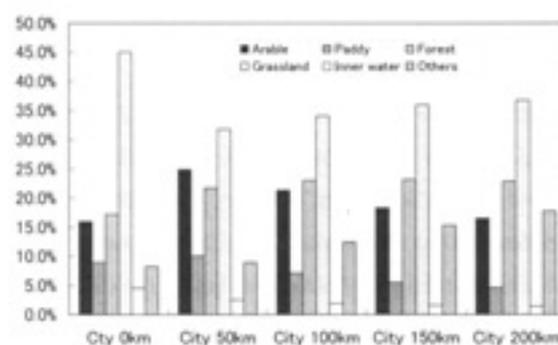


Fig. 9 Land use and cover structure within "City" zone to "City-200km" zone in 1992

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