Feature Extraction in Land Use Changes of the Gyeongan River basin Using High Resolution Aerial Photographs

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ABSTRACT

The goal of this study was to investigate the feature extraction in lad use change dynamics using high resolution aerial photographs and GIS (Geographical information system) in the Kyungan River Basin where there are rapid land use changes by recent reckless developments. A land use/land cover map was made using aerial orthophotography and land use change dynamics was analyzed using Arc/Info GRID. More precise information on land use was obtained employing high resolution aerial photographs instead of low resolution satellite imageries.

INTRODUCTION

Background and Purpose

Recently, rapidly changing land use has been resulted largely from rapid industrialization, unplanned development, and population clustering (Weng, 2003). For this reason, many investigators have studied the change for efficient land use. Most studies were performed using satellite imagery because of its usefulness such as periodicity. However, more detailed analysis is needed for more effective plan and regulation of land use. Therefore, we have studied the land use changes of the Kyungan River basin using high resolution aerial photographs instead of satellite imagery, which has lower resolution. Besides, we examined accuracy and encompassment of the results by evaluating current land use and land cover classification.

Study Range and Methodology

The studied area was Kyungan River basin. The Kyungan River is a tributary of the Han River and originated from Youngin-shi Idong-myun Eobi-ri. The river is then joined by Nungwon and Gonjiam Streams and flows into Paldang Reservoir. Being adjacent to Seoul Metropolitan Area, the Kyungan River is not only threatened by rapid and reckless developments, but also exposed to various sources of pollution from its surrounding streams. As a part of Paldang Water Quality Conservation Zone, considerable efforts to protect the quality of water are made (Kim 1995). The spatial range of this study was confined to the overlapping area of various aerial photographs, which are useful for land use change detection for the past two decades <Figure 1>. Thus, the total area is 471.5 ㎢ and includes Yongin-shi, Ichon-shi, Hanam-shi, Yangpyung-gun, and Yoju-gun.

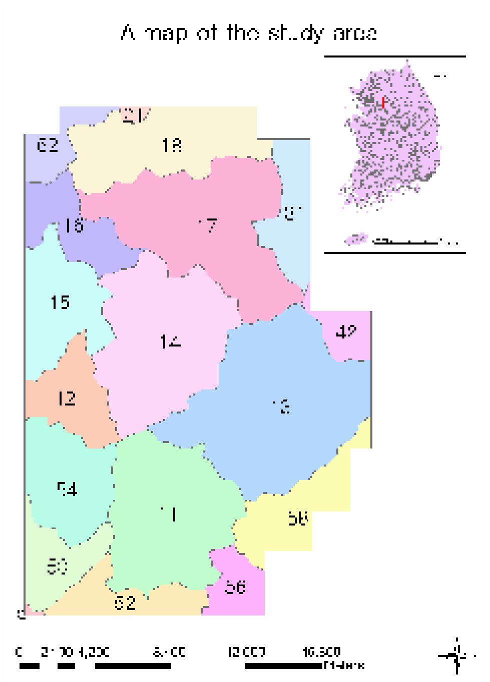

Figure 1. The study area in the Kyungan River basin

Classification			Area (㎢)
Kyeonggido			
Kwangju-shi(10)	Kwangju-eub	(11)	27.055
	Namjong-myeon	(12)	36.984
	Tochok-myeon	(13)	51.759
	Shilchon-myeon	(14)	75.900
	Opo-myeon	(15)	18.571
	Chungbu-myeon	(16)	18.751
	Chowol-myeon	(17)	55.544
	Toechon-myeon	(18)	59.928
Namyangju-shi(20)	Joan-myeon	(21)	1.277
Yangpuong-gun(30)	Kangha-myeon	(31)	16.980
Yoju-gun(40)	Sanbuk-myeon	(41)	8.122
Yongin-shi(50)	Mohyeon-myeon	(51)	27.299
	Yangji-myeon	(52)	14.938
	Yurim-dong	(53)	0.398
	Pogok-myeon	(54)	15.636
Ichon-shi(60)	Majang-myeon	(62)	10.315
	Shindun-myeon	(64)	22.296
Hanam-shi(70)	Chonhyon-dong	(71)	9.702
Total			471.457

Table 1. The total area.

The total number of aerial photographs used was 277 <Table 2>. Each aerial photograph was scanned using Epson 12000 at 1200 dpi resolution. The size of data per picture was about 180 MB and added up to 150 GB for all 277 pictures. Each file was scanned as TIFF format and each image was processed using ERDAS IMAGINE 8.2. Global Positioning System (GPS) and 1/5000 topographic map were used for Ground Control Point (GCP) survey. Both 1/5000 and 1/25000 topographic maps were created for Digital Elevation Model (DEM), which would be used for ortho projection. Land use/cover maps were then created using ortho-photos and change detection was performed through Arc/Info GRID according to each attribute.

Previous Studies

In many recent studies, land use change analysis was often performed using satellite images (Landsat TM, MSS, IKONOS, KOMPSAT) and GIS(Geographic Information System) (Yang *et al.*, 2002; Choi. *et al.*, 2002; Xia *et al.*, 2004). Methods such as Markov chain(Joo *et al.,* 2003; Weng, 2002), Cellular Automata(Monteiro, 2003), and Logistic Regression(Kim, 2002)) were used to efficiently analyze change of land use. As land use rapidly changes due to urbanization, remote sensing and GIS were incorporated for the analyses of and spatial distribution and urban sprawl direction of Seoul Metropolitan Region(Sakong, 2004). As high resolution satellite image develops, many investigators frequently use various types of satellite images. Using these images, there have been studies such as interpretation of terrestrial information(Jang, 2003) and a land cover classification method (Sakong, 2003; Kim, 2003)).

Year	Focal length	Scale	Picture	Camera
1981	152	1/25000 (12,500ft)	10	wild uag 404
	152.87	1/25000 (12,500ft)	93	wild uag two 308
1988	153.35	1/37500 (18,750ft)	7	wild 15/4 uag
1993	153.1	1/20000 (10,000ft)	82	Zeiss RMK
1995	152.85	1/20000 (10,000ft)	28	wild 15/4 uag-s
	153.4	1/20000 (10,000ft)	7	wild 15/4 uag-s
		1/20000 (10,000ft)	19	wild 15/4 uag-s
1997	153.59	1/25000 (12,500ft)	7	wild 15/4 uaga-f
2000	152.54	1/37500 (18,750ft)	10	Zeiss RMK
Total			277	

Table 2. An index of aerial photo

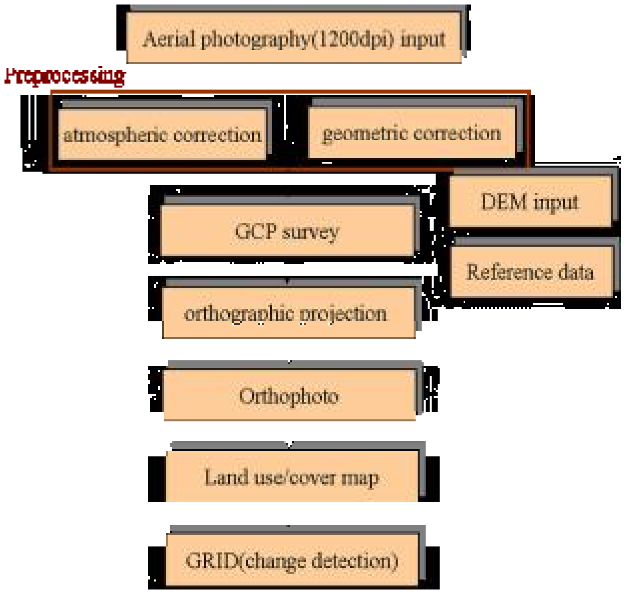

Figure 2. The study process

Data processing and Data Establishment

1. Geometric Rectification and Ortho Rectification

For GCP survey, coverage was produced by extracting topography information without contour lines from 1/5000 digital map. After coverage, geometric correction was made on aerial photography scanned with DEM at 1200 dpi. Orthographic projection of the corrected aerial photograph was conducted through the processes of interior orientation and exterior orientation.

2. Interior Orientation

2.1 Camera Calibration and Lens Distortion Correction

Interior orientation was performed by defining the relationship between image coordinate and fiducial marks based on indicated principle point (IPP). The lens distortion correction was a part of interior orie ntation process using information such as image coordinates of four fiducial marks and IPP of images.

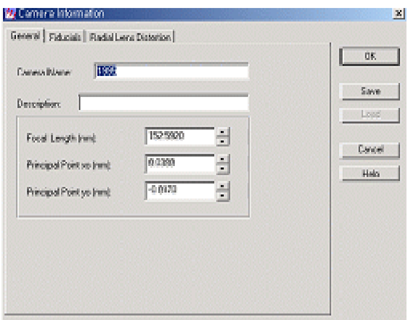

Figure 3. Camera calibration

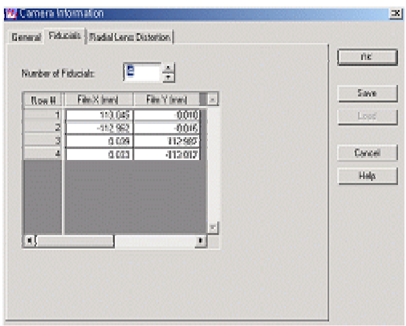

Figure 4. Fiducial marks input

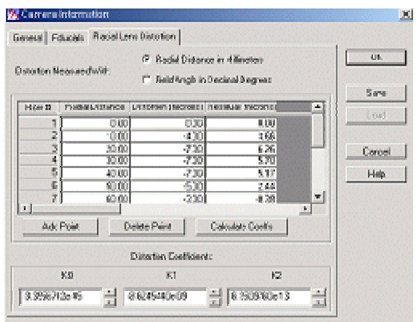

Figure 5. Lens distortion correction

3. Exterior Orientation

3.1 Relative Orientation

Relative orientation is defined as geometric relationship between two continuously taken aerial photos. In general, at least six relative orientation points were required for calculation.

3.2 Absolute Orientation

After all parallaxes of the two pictures are eliminated by relative orientation, the pictures do not have correct scales and are not on horizontal position. Thus, they do not accurately represent the actual topography. Thus, model space coordinate system should be converted to object space coordinate system and this process is called absolute orientation. At least two plane control points and three elevation control points were then required to obtain accurate actual space coordinate system.

4. Land Cover Change Detection and Analysis Result

Land use/cover map was created through several steps such as image processing, digitizing, structurized editing and attribute input of orthographically projected aerial photographs (Sag, 2003). Feature classification was made according to information given by both National Geographic Information Institute (high: 4, intermediate: 14, low: 36) and Ministry of Environment (high: 7, intermediate: 23, low: 47). Land use/cover map and area for high level category were made as in Fig 6 and Table 3.

Classification	UCB Code	1981		1993		2000	
		Area(㎢)	Ratio(%)	Area(㎢)	Ratio(%)	Area(㎢)	Ratio(%)
Cropland	1000	100.634	21.35	87.059	18.47	73.070	15.50
Forest	2000	335.465	71.15	330.757	70.16	327.335	69.43
Urban or Built-up	3000	16.568	3.51	34.724	7.37	51.866	11.00
Water	4000	18.790	3.99	18.918	4.01	19.187	4.07
Total		471.457	100.00	471.457	100.00	471.457	100.00

Table 3. Land use change matrix, 1981-2000

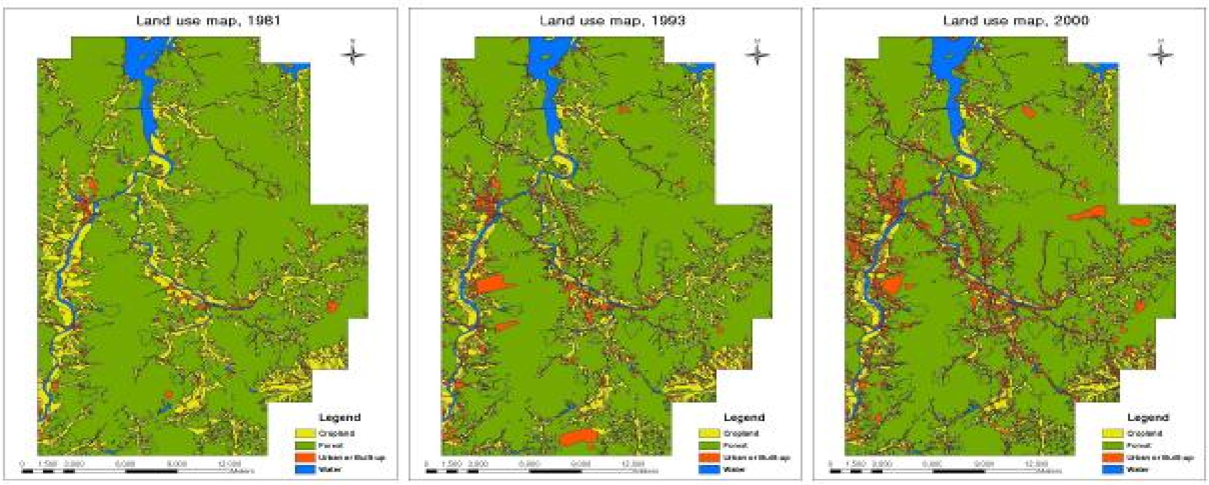

Figure 6. Land use map, 1981-2000

Classification	UCB Code	1981		1993		2001	
		Area(㎢)	Ratio(%)	Area(㎢)	Ratio(%)	Area(㎢)	Ratio(%)
Urban or Built-up	100	14.343	3.04%	30.029	6.37%	40.790	8.65%
Cropland	200	101.513	21.53%	88.975	18.87%	76.525	16.23%
Forest	300	331.423	70.30%	323.681	68.66%	316.902	67.22%
Greenland	400	3.667	0.78%	6.397	1.36%	8.881	1.88%
Barren	500	1.741	0.37%	3.485	0.74%	9.193	1.95%
Water	600	18.770	3.98%	18.890	4.01%	19.166	4.07%
Total		471.457	100.00%	471.457	100.00%	471.457	100.00%

Table 4. Land cover change matrix, 1981-2000

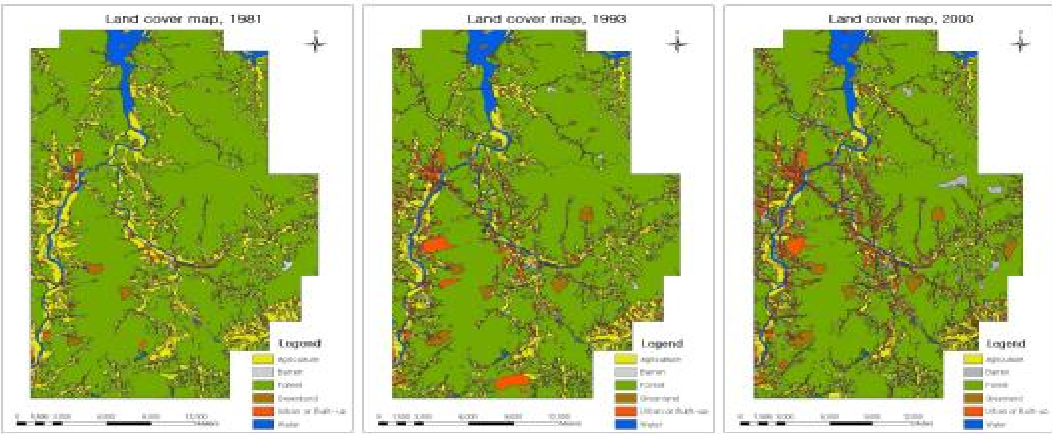

Figure 7. Land cover map, 1981-2000.

In order to study change dynamics of annual land use in the Kyungan River basin, land cover map for each year was converted to GRID and all maps were combined as GRID file. The attribute values of combined GRID were, in each class, assigned to years 1981, 1993, and 2000 in the form of 3-digit, 2-digit, and 1-digit numbers, respectively. Total number of 152 change information was extracted (Yang, 2002).

Attribute values	change			Pixel	Area (㎢)
	1981	1993	2000		
211	Cropland	Urban or Built-up	Urban or Built-up	103251	10.3251
221	Cropland	Cropland	Urban or Built-up	96165	9.6165
311	Forest	Urban or Built-up	Urban or Built-up	32854	3.2854
336	Forest	Forest	Barren	31863	3.1863
313	Forest	Urban or Built-up	Forest	30892	3.0892
344	Forest	Barren	Barren	26103	2.6103
233	Cropland	Forest	Forest	21638	2.1638
334	Forest	Forest	Barren	20910	2.091

Table 5. Land cover change detection, 1981-2000

For the past 20 years, crop land decreased by 5.3% from 21.53% to 16.23% and forest by 3.08% from 70.30% to 67.22%. On the contrary, both barren and urban or built-up increased by 1.58% and 8.65%, respectively.

As the results indicated, there has been a great loss of crop land and forest due to rapid urbanization. At the same time, the increased barren land indicated that it would more likely turn to urban area.

Conclusions

After careful examination of the data obtained from aerial photography, there has been profound urbanization in surrounding area of Kyungan River basin. The aerial photographs with geometric resolving power of 0.6 m shows its far better resolution than current satellite imagery such as Arirang (6.6 m), Landsat (6 m), and IKONOS (1 m). Due to its superior resolution, detailed analyses were possible in this study. As a result, more detailed and accurate information were able to be obtained and led to various analyses. These advantages can effectively be used for detailed analyses, planning, and regulation when small and confined areas such as streams and roads are studied. In addition, firm feature classification on land use/cover information, suitable for aerial photography, needs to be established in order to extract various and accurate results.

References

Qihao Weng, 2002, Land Use Change Analysis in the Zhujiang Delta of China Using Satellite Remote Sensing, GIS and Stochastic Medelling, Environmenal Management, pp. 273-284.

Sang-Wook Kim, 1995, A Study On The Temporal Change of Soil Loss of Kyungan River Basin with GIS, The master's thesis.

In-Tae Yang, Soung-man Han, Jae-Kook Park, A Study On Change Detection of Land Cover in The Incheon Coast Using Landsat Images and GIS Tool, Korean Society of Civil Engineers, pp. 1019-1027.

Yong-jin Joo, Soo-hong Park, Implementation of a Statistical Model for Land Use Change Prediction Using Temporal Satellite Imagery. The Korean Association Of Professional Geographers, pp. 373-385.

Hyun Choi, In-joon Kang, Jae-ha, Kwak, An Analysis for Change Detection of Urban Expansion Using Multispectral Image Data, Korean Society of Civil Engineers, pp. 121-130.

Xia Li, Anthony Gar-On Yeh, Analyzing Spatial Restructuring of Land Use Patterns in a Fast Growing Region Using Remote Sensing and GIS, Landscape and Urban Planning.

Almeida, C. M. Monteiro, A. M. V. Camara, G. Soares-Filho, B. S. Cerqueira, G. C. Araujo, W. L. Pantuzzo, A. E., Modeling the Urban Evolution of Land Use Transitions Using Cellular Automata and Logistic Regression , 2003, INTERNATIONAL GEOSCIENCE AND REMOTE SENSING SYMPOSIUM, Vol.3 No.344

Jung-hoon Kim, An Analysis of Land Use Change in the Urban Fringe Using GIS and Logistic Regression in Korea, Korea Research Institute For Human Settlements, pp.175-200.

Ho-Sang Sakong, Characteristics of Urban Sprawl in Seoul Metropolitan Region : An Integration of Remote Sensing and GIS Approach, 2004, Korea Research Institute For Human Settlements, pp. 53-69.

Dong-ho Jang, Man-kyu Kim, 2003, Improving of land-cover map using IKONOS image data, GIS Association of Korea, Vol. 11, No. 2, pp. 101-117.

Ho-sang Sakong, Jung-ho IM, An Empirical Study on the Land Cover Classification Method using IKONOS Image, 2003, The Korea Association of Geographic Information Studies, pp. 107-116.

Toun-soo Kim, Kwang-jae Lee, Ji-won Ryu, Jung-hwan Kim, 2003, Land use Clasification Nomenclature for Urban Growth Analysis using Satellite Imagery, The Korea Association of Geographic Information Studies, pp. 83-94.