Urban Growth of Chuncheon City Observed by Landsat Satellite Images

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ABSTRACT:

In this study, 8 Landsat(TM/ETM+) satellite images acquired from 1984 to 2002 were used to investigate the growth of Chuncheon city, Kangwon-do, Korea. The images were geocoded and classified using training set collected from field survey. Four land-use types were classified such as urban area, green zone, agricultural land and water body. It also showed rapid increase of urban area in the past two decades from 1166ha in 1984 to 3358ha in 2002. About 2182ha of agricultural land and green zone have been changed to urban area. Agricultural land was newly formed from the green zone.

KEY WORDS: Landsat, Chuncheon, urban, growth, minimum distance method

1. INTRODUCTION

1.1 Background

Remote sensing is a useful tool for urban growth monitoring. Archived data preserves the history of changes in the past. Urban in Korea had experienced many changes. Much natural or rural area have been urbanized as a result economic development, and Chuncheon city is not an exception. Urban areas of Chuncheon have shown a great increase over the last 20 years. Also, many changes have occurred in agricultural and natural land accordingly. We used a series of satellite images of Landsat-5 TM and Landsat-7 ETM+ to quantify the change of land-use in Chuncheon city.

1.2 Study Area

Study area is a part of Chuncheon city which include major city area (Fig. 1). It has geographic position of 127° 37´E ~ 127° 50´E in longitude, 37° 58´ N ~ 37° 48´N in latitude. Chuncheon city is 1166.43km^2 and have population of 252,019 in 2002. The Chuncheon is located inside a geological basin with many artificial lakes such as Lake Euiam, Lake Chuncheon, and Lake Soyang. The seasonal temperature shows high variation, which is a typical continental climate. Average temperature is -5.2°C in January, 24.4°C in August. The average temperature of the year is 10.6°C. Annual mean precipitation is 1296.4mm.

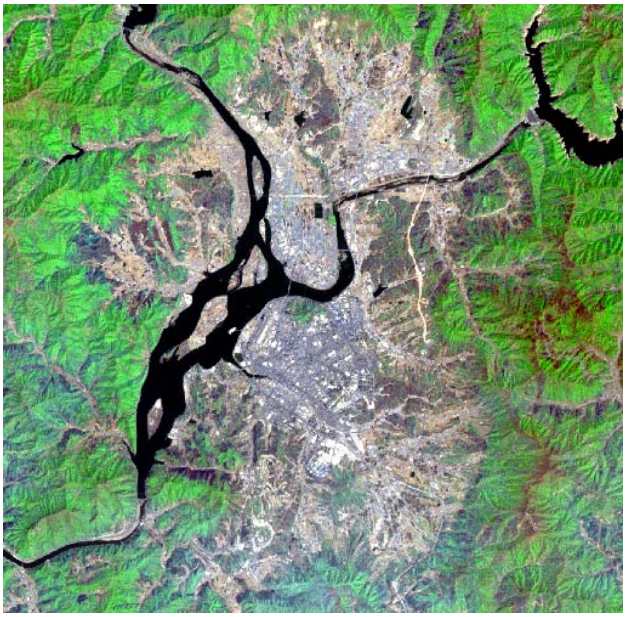

Figure 1. Chuncheon city image(Landsat-7 2002.04.28).

Acquisition time	Sensor	Path	Row
1984-11-12	TM	115	34
1987-04-27	TM	115	34
1989-06-03	TM	115	34
1994-06-01	TM	115	34
1997-06-16	TM	116	34
1999-03-27	TM	115	34
2000-09-29	ETM+	115	34
2002-04-28	ETM+	115	34

Table 1. Landsat images used in this study.

2. DATA PROCESSING

In this study, 8 Landsat (TM/ETM+) images, acquired from 1984 to 2002 were used (Table 1). The whole scene were initially geo-referenced to 1:50,000 digital topographic map, and then the study area was geocoded again using ground controlling points (GCPs) obtained from several field survey to meet the accuracy requirement for this study. Using 22 refined GCP points, we obtained 0.8 pixel RMS error over the study area.

The images were then classified by using the minimum distance method for supervised classification. Training sets were also obtained from the field survey. The training set were initially divided into 13 detailed types

and then rejoined to 4 major groups: urban, agricultural land, green zone, water body. (Table 2 and Fig. 2).

Urban	Urban low	Urban, low-story building
	Blue roof	Factory with blue roof
	Apt	High-story apartment
	Soil	Ground soil, work site
Agricultural land	Paddy 1	Farmland, low vegetation
	Paddy 2	Farmland, high vegetation
	Vinyl house	Vinyl ceiling
Green zone	Bright	Bright green area
	Medium	Medium green area
	Dark	Dark green area
	Fallen	Fallen leaves area
Water body	Water 1	Euiam lake
	Water 2	Soyang lake

Table 2. Training set for supervised classification.

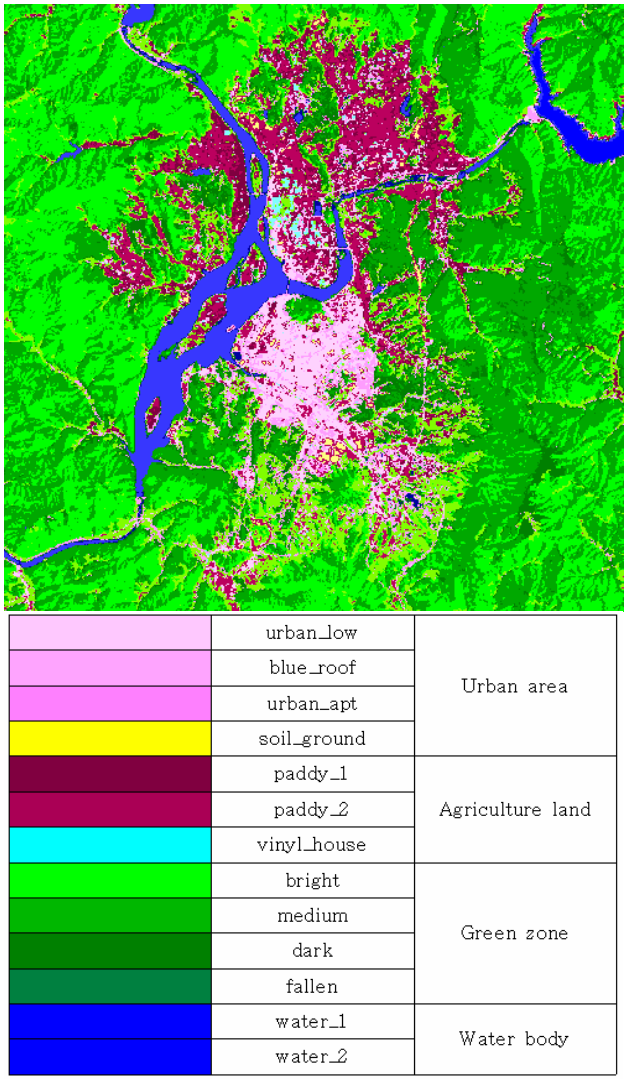

Figure 2. An example of classified image and color setting table.

3. CHANGE ANALYSIS

3.1 Urban Growth

Acquisition time	Urban area	Agricultural land	Green zone	Water body	Total
1984.11.12	1166	7965	26588	2018	33733
1987.04.27	1445	8354	25947	1991	33733
1989.06.03	1458	7305	27151	1823	33733
1994.06.01	2412	6929	26574	1822	33733
1997.06.16	2520	8373	24902	1942	33733
1999.03.27	2625	6098	27117	1897	33733
2000.09.29	2819	5998	26984	1936	33733
2002.04.28	3358	7973	24471	1935	33733

Table 3. Result of classification(unit : ha).

Total area of Urban has expanded nearly three times from 1166ha in 1984 to 3358ha in 2002 (Table 3). We here describe image-to-image change of city area and compare it with the record from apartment construction data (www.kbstar.com) to validate and investigate the regional change in more detail.

Urban was increased by 277ha from 1984 to 1989. This is mainly due to the development of Hupyung-dong(Fig. 3).

During 1989 and 1994, we have witnessed great urban growth by 954ha. At this time, we observed major construction of apartment in Toigye-dong(Fig. 4).

Between 1994 and 1997, urban was increased by 108ha. Such changes are the result of red polygon area in Toegye-dong (Fig. 5) and Suksa-dong(Fig. 6).

Between 1997 and 1999, urban area increased by 105ha caused by many high-story apartment construction at Suksa-dong (Fig. 7).

Between 1999 and 2002, urban area has increased greatly by 733ha. Major changes were due to urbanization of agricultural area in Dongnae-myeon (Fig. 8).

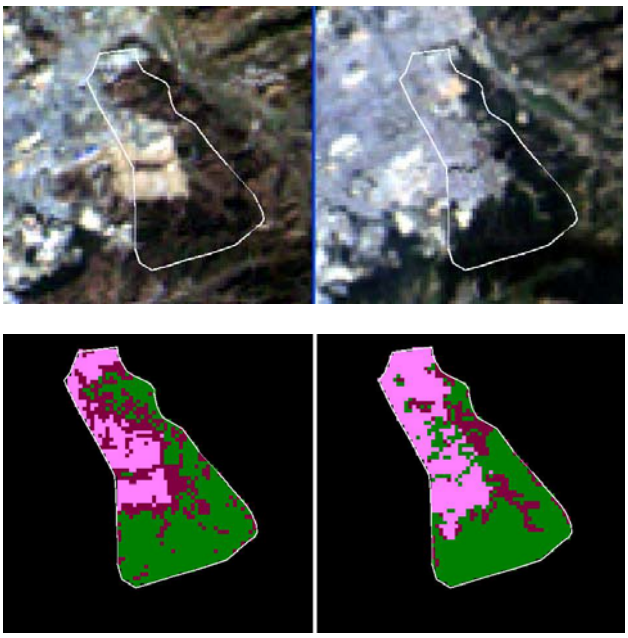

Figure 3. Change of Hupyung-dong from 1984(left) to 1989(right). Bottom images are the classification results.

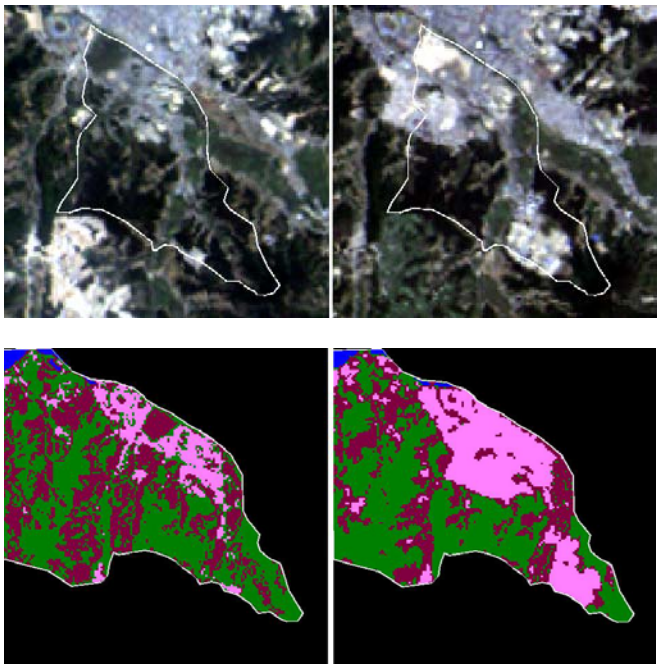

Figure 4. Change of Toigye-dong from 1989(left) to 1994(right) by apartment construction. Bottom images are the classification results.

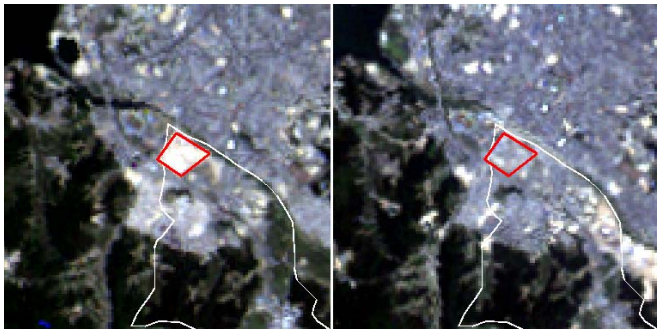

Figure 5. Change of Toigye-dong from 1994 to 1997

Figure 6. Change of Suksa-dong from 1994 to 1997.

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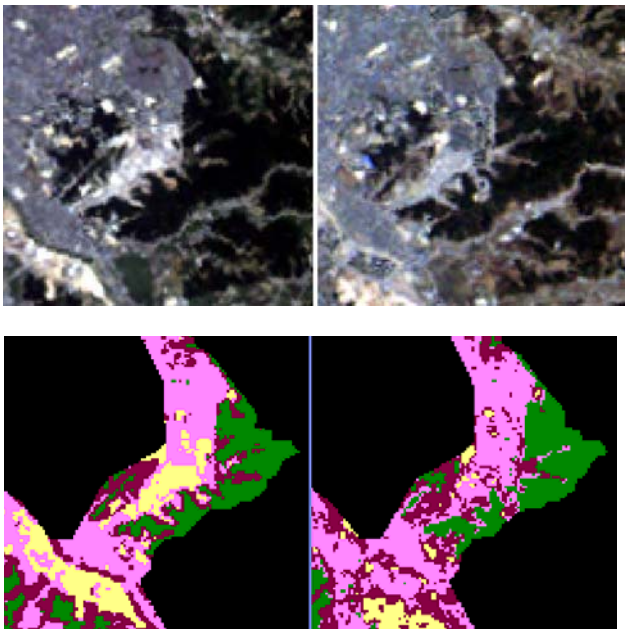

Figure 7. Change of Suksa-dong from 1997(left) to 1999(right). Bottom images are classification result with yellow as bare soil).

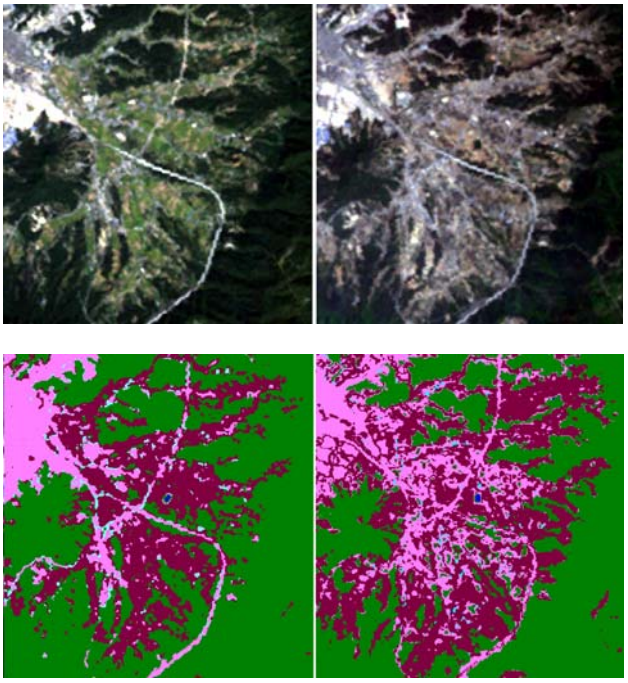

Fig 8. Change of Dongnae-myeon from 1999 to 2002. Bottom images are classification result.

3.2 Change of Agricultural Land and Natural Green Zone

From the classified image we can observe the change of agricultural land and natural green zone. It is found that harvested agricultural land and leaf-fallen green zone during winter time is very difficult to discriminate. Therefore, we used summer-time images only for this purpose.

Acquisition time	Paddy 1	Paddy 2	Vinyl house	Total
1989-06-03	1751	5457	96	7304
1994-06-01	1462	4587	879	6928
1997-06-16	1433	4986	1954	8373

Table 4. Change of Agricultural land obtained from summer images only (unit: ha).

Acquisition Time	Bright	Med	dark	etc	Total
1989-06-03	8356	2560	9980	6237	27133
1994-06-01	7912	14400	695	3547	26554
1997-06-16	1948	7956	1535	13496	24935

Table 5. Natural green zone of summer image (unit: ha).

Total agricultural land was 7304ha in 1989, and decreased by 336ha due to rapid urban growth (Table 4). It increased again in 1997 to 8373ha. Vinyl house was 96ha in 1987 and increased to 879ha in 1994, and rapidly increased to 1954ha in 1997. Natural green zone were decreased as shown in Table 5. This is mainly due to the change of natural green zone to agricultural and urban area.

4. CONCLUSION

We could see the urban growth of Chuncheon city using Landsat images acquired over the last two decades. Total urban was increased by three times from 1166ha in 1984 to 3358ha in 2002 mainly due to construction of apartment complex over the last twenty years.

Agricultural land and green zone were 7304ha and 27133ha respectively in 1989. However they became 8343ha and 24935ha respectively in 1997. The rapid growth of horticultural vinyl house was typical to this region. We can see that many natural green zone has been changed to agricultural or urban land, and agricultural land has been also changed to urban area.

Collection of high resolution data such as Kompsat-1, -2, and Ikonos will provided much more useful information to monitor the urban changes.

4. REFERENCES

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Real estimate from Kukmin bank, http://www.kbstar.com/

5. ACKNOWLEDGEMENT

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