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 1166.43km² 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.

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

Table 1. Landsat images used in this study.

<table>
<thead>
<tr>
<th>Acquisition time</th>
<th>Sensor</th>
<th>Path</th>
<th>Row</th>
</tr>
</thead>
<tbody>
<tr>
<td>1984-11-12</td>
<td>TM</td>
<td>115</td>
<td>34</td>
</tr>
<tr>
<td>1987-04-27</td>
<td>TM</td>
<td>115</td>
<td>34</td>
</tr>
<tr>
<td>1989-06-03</td>
<td>TM</td>
<td>115</td>
<td>34</td>
</tr>
<tr>
<td>1994-06-01</td>
<td>TM</td>
<td>115</td>
<td>34</td>
</tr>
<tr>
<td>1997-06-16</td>
<td>TM</td>
<td>116</td>
<td>34</td>
</tr>
<tr>
<td>1999-03-27</td>
<td>TM</td>
<td>115</td>
<td>34</td>
</tr>
<tr>
<td>2000-09-29</td>
<td>ETM+</td>
<td>115</td>
<td>34</td>
</tr>
<tr>
<td>2002-04-28</td>
<td>ETM+</td>
<td>115</td>
<td>34</td>
</tr>
</tbody>
</table>
and then rejoined to 4 major groups: urban, agricultural land, green zone, water body. (Table 2 and Fig. 2).

<table>
<thead>
<tr>
<th>Urban</th>
<th>Agriculural land</th>
<th>Green zone</th>
<th>Water body</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban low</td>
<td>Urban, low-story building</td>
<td>1166</td>
<td>7965</td>
<td>26588</td>
</tr>
<tr>
<td>Blue roof</td>
<td>Factory with blue roof</td>
<td>1445</td>
<td>8354</td>
<td>25947</td>
</tr>
<tr>
<td>Apt</td>
<td>High-story apartment</td>
<td>1458</td>
<td>7305</td>
<td>27151</td>
</tr>
<tr>
<td>Soil</td>
<td>Ground soil, work site</td>
<td>2412</td>
<td>6929</td>
<td>26574</td>
</tr>
<tr>
<td>Paddy 1</td>
<td>Farmland, low vegetation</td>
<td>2520</td>
<td>8373</td>
<td>24902</td>
</tr>
<tr>
<td>Paddy 2</td>
<td>Farmland, high vegetation</td>
<td>2625</td>
<td>6098</td>
<td>27117</td>
</tr>
<tr>
<td>Vinyl house</td>
<td>Vinyl ceiling</td>
<td>2819</td>
<td>5998</td>
<td>26984</td>
</tr>
<tr>
<td>Bright</td>
<td>Bright green area</td>
<td>3358</td>
<td>7973</td>
<td>24471</td>
</tr>
</tbody>
</table>

Table 2. Training set for supervised classification.

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).

3. CHANGE ANALYSIS

3.1 Urban Growth

![Figure 2. An example of classified image and color setting table.](image)

![Figure 3. Change of Hupyung-dong from 1984(left) to 1989(right). Bottom images are the classification results.](image)
3.2 Change of Agricultural Land and Natural Green Zone

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

<table>
<thead>
<tr>
<th>Acquisition Time</th>
<th>Paddy 1</th>
<th>Paddy 2</th>
<th>Vinyl house</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989-06-03</td>
<td>1751</td>
<td>5457</td>
<td>96</td>
<td>7304</td>
</tr>
<tr>
<td>1994-06-01</td>
<td>1462</td>
<td>4587</td>
<td>879</td>
<td>6928</td>
</tr>
<tr>
<td>1997-06-16</td>
<td>1433</td>
<td>4986</td>
<td>1954</td>
<td>8373</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Acquisition Time</th>
<th>Bright</th>
<th>Med</th>
<th>dark</th>
<th>etc</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>1989-06-03</td>
<td>8356</td>
<td>2560</td>
<td>9980</td>
<td>6237</td>
<td>27133</td>
</tr>
<tr>
<td>1994-06-01</td>
<td>7912</td>
<td>14400</td>
<td>695</td>
<td>3547</td>
<td>26554</td>
</tr>
<tr>
<td>1997-06-16</td>
<td>1948</td>
<td>7956</td>
<td>1535</td>
<td>13496</td>
<td>24935</td>
</tr>
</tbody>
</table>

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 1989 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


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

5. ACKNOWLEDGEMENT

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