Progress and Land-Use Characteristics of Urban Sprawl in Busan Metropolitan City using Remote sensing and GIS

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ABSTRACT

Satellite image is very usefully practiced to predict and analyze physical expansion and change of city. Physical expansion and change of city is closely related to the use of land, and continuous growth management focused on the use of land is essential for sustainable city growth. In this research, the change of land cover and land-use were analyzed with basic input data from 1985 to 2000 according to artificial satellite. Moreover, the land-use turnover rate was understood and expansion trend of urban sprawl in Busan metropolitan city and land-use characteristics of the expansion area. The results are, first, the area for urban region was expanded continuously but areas for agriculture area, forest area, and water area had different changes due to administrative district reform of Busan by each year. Second, the urbanization area in Busan was increased by 3.8% from 92.5㎢ in 1985 to 167.5㎢ in 2000. Third, the result of analysis on land-use turnover rate showed that agriculture area was turned into urbanized area the most, and forest area was followed by. Fourth, the result of analysis on database and overlay of buildings in Busan established in 2001 showed that agriculture area are had type 1 and 2 neighborhood living facilities (45.63%), apartment house in forest area (18.49%), and factory in water area (31.84%) with high ratio.

Keywords : Geographic Information System, Remote Sensing, Satellite Image, Landsat TM, Land-Use

1. Introduction

Satellite image is very usefully practiced to predict and analyze physical expansion and change of city. The physical expansion and change of city is closely related to land-use, and continues growth management focused on land-use is essential for sustainable urban growth.

Currently, researches on geography information system and remote sensing are being developed continuously, and social demands on application of this field are also being increased more and more. Furthermore, they are widely used in governmental policy research and administration area as well as military and environment areas. However, continued information about urban growth and change is essential as well as current information for effective and sustainable urban management and to predict quality demand of related activities.

Therefore, in this research, remote sensing data (LANDSAT TM;1985,1989,1995,2000) from satellite are used as basic input data and ERDAS and ArcGIS Ver.9.2 which are computer software for image data process, are used to analyze changes of land cover and land-use by each year from 1985 to 2000. Moreover, the land-use turnover rate is understood in order to review expansion trend of urbanization area and characteristics of land-use in diffusion area in Busan.

Moreover, this research could be used as basic data for research and evaluation on government policy.

For spatial range, 16 guns in Busan City were taken as subject as in [FIGURE 1], and LANDSAT TM data of year 1985, 1989, 1995, and 2000 were used to understand the urbanization process of Busan from 1985 to 2000.

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FIGURE 1. Study area

2. Classification of Land Cover

2.1 Preprocessor of Satellite Image

Geometric correction was conducted in order to eliminate geometric distortion in far sight satellite image data of Busan area. The ground control point for geometric correction was done with far sight satellite image data using digital map first. With such method, digital map was used for geometric correction with image-to-image method using four images as the same ground control point based on the satellite image which had geometric correction. Moreover, administrative boundary extracted from the digital map of 1:25,000 was used for masking process in order to make range of Busan area identified(FIGURE 2).

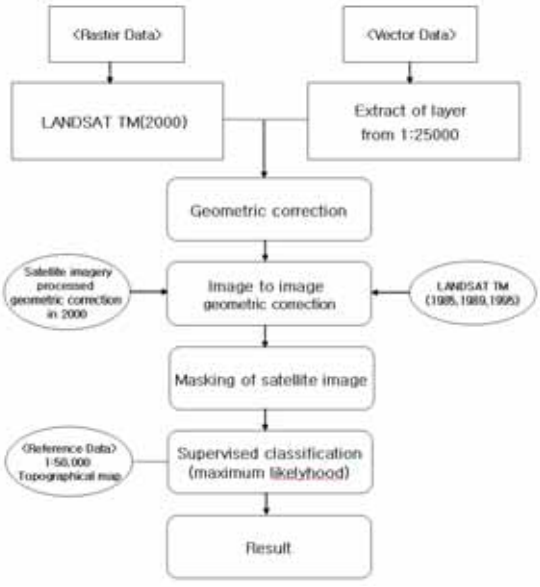

FIGURE 2. Preprocessor of satellite image

2.2 Classification of Land Cover

Land cover classification shows physical status on the surface of land that it clearly reflects the condition of land surface. In particular, land cover classification made from artificial satellite image data for remote sensing use area shows land-use status, and presents cover condition of the national land. Thus, it made time series analysis of land cover change available as well as to understand actual status of spatial structure and predict further changes.

The purpose of this research is to understand land cover change in urbanization region in Busan with time series. Therefore, the classification applied on the research subject area are categorized by four items such as city, agriculture area, forest area, and water area among land cover categorization suggested by the Ministry of Environment.

TABLE 1. Classification of land cover

Classification of land cover	contents	color
City area	Residential area, Commercial area, Industrial area, Public faculity	
Agriculture area	Rice field, Open space	
Forest area	Mountain forest	
Water area	River, Lake, Sea	

2.3 Result of Classification

Supervised classification among image classification was conducted for land cover categorization (FIGURE 3). Supervised classification needs a process to input class spectral characteristics beforehand by selecting training data. Therefore, 1:50,000 paper topographical map suitable with the shooting year of each satellite image was used to select training data. The selected training data was analyzed using maximum likelihood to conduct supervised classification in ERDAS 8.7. Under the assumption that the maximum likelihood calculated covariance and scattering of the image, and this makes normal distribution, probability density function of each item is calculated to classify as the highest class of probability.

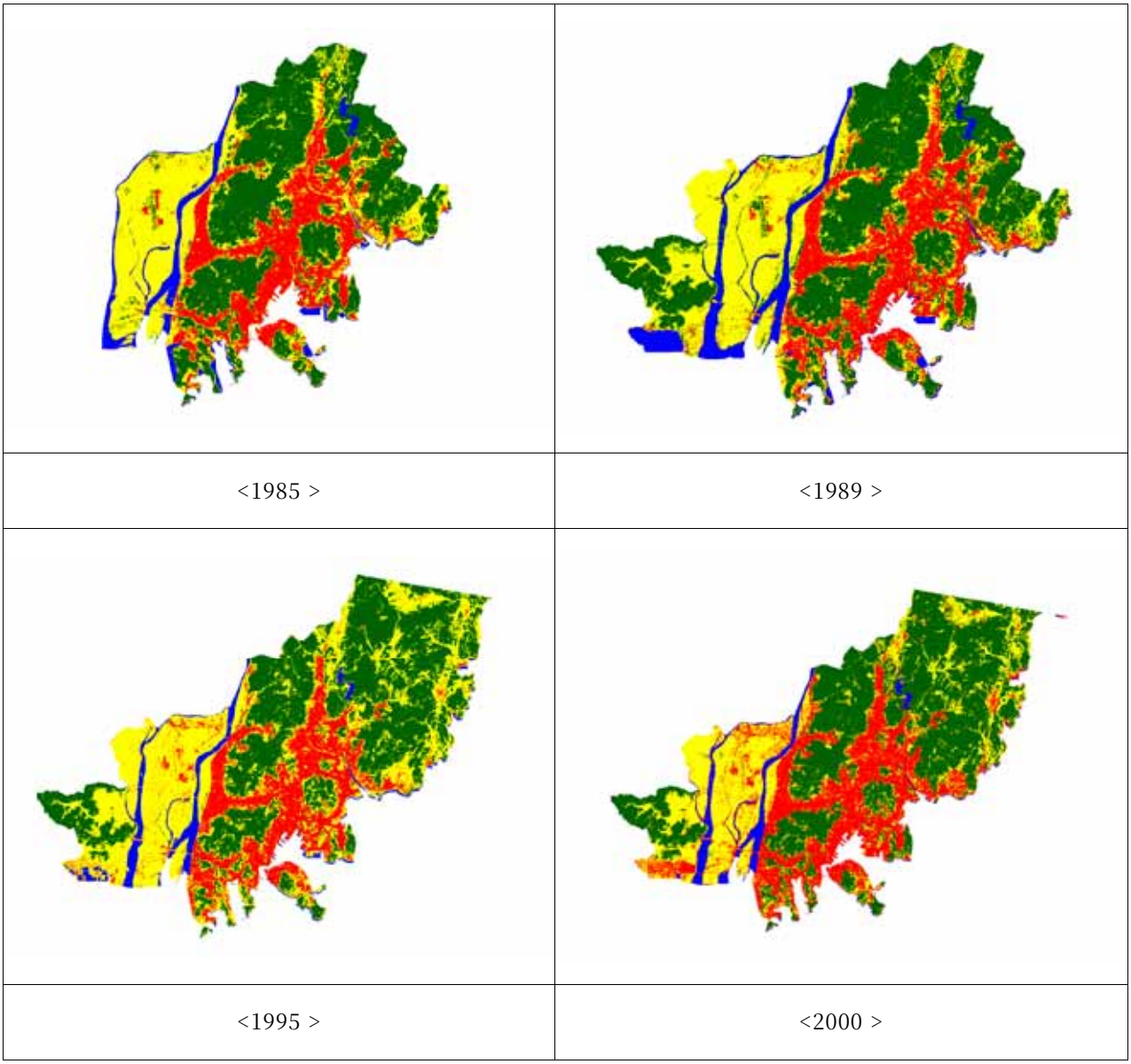

FIGURE 3. Result of land cover classification

3. Characteristics of Land-Use and Urbanization Area of Busan Metropolitan City

3.1 Change of Land-Use

TABLE 2, FIGURE 4 show land-use changes in Busan for 15 years from 1985 to 2000. The area of urban region had expanded continuously, but agriculture area, forest area, and water area had different change of area in accordance with administrative district reform in Busan by each year.

TABLE 2. Characteristics of land-use (Unit : ㎢, %)

year (total area)	City area	Agriculture area	Forest area	Water area
1985 (449.1)	92.5 (20.6)	147.9 (32.9)	186.3 (41.5)	22.4 (5.0)
1989 (534.3)	106.3 (19.9)	170.6 (31.9)	217 (40.6)	40.4 (7.6)
1995 (689.3)	119.8 (17.4)	266.3 (38.6)	271.9 (39.4)	31.3 (4.5)
2000 (691.7)	167.5 (24.2)	199.0 (28.8)	297.7 (43.0)	27.5 (4.0)

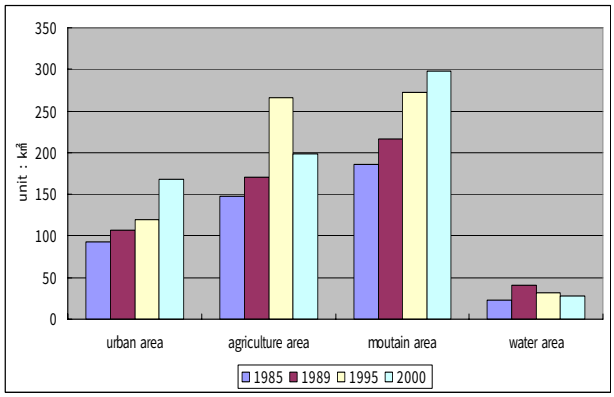

FIGURE 4. Change of land-use in Busan city

As in TABLE 2, the change of land-use for urban region was 20.6% in 1985 as total area but increased up to 24.2% in 2000. The reason of increased urban region area was thought to be because of large-scale development such as the New Port area, reclamation in Dadaepo, and new town in Haeundae, and urbanization on forest area to solve housing problem.

Meanwhile, the reason of rapid increase in agriculture area in 1985 was because of development with reclamation and different size of satellite image by each year that showed different area in masking process. Moreover, the masking was processed based on administration boundary in order to estimate land cover area by each year, thus, there was no difference with water area.

3.2 Change of Urbanization Area in Busan Metropolitan City

Among the results of land cover classification of Busan, layer of urbanization region of each year was extracted using ERDAS 8.7 and ArcGIS 9.2 on urbanization region in Busan for 15 years from 1985 to 2000. As in FIGURE 5, the area of urbanization region in Busan was 92.5㎢ in 1985, but it was increased by 3.8% for 15 years and became 167.5㎢ in 2000

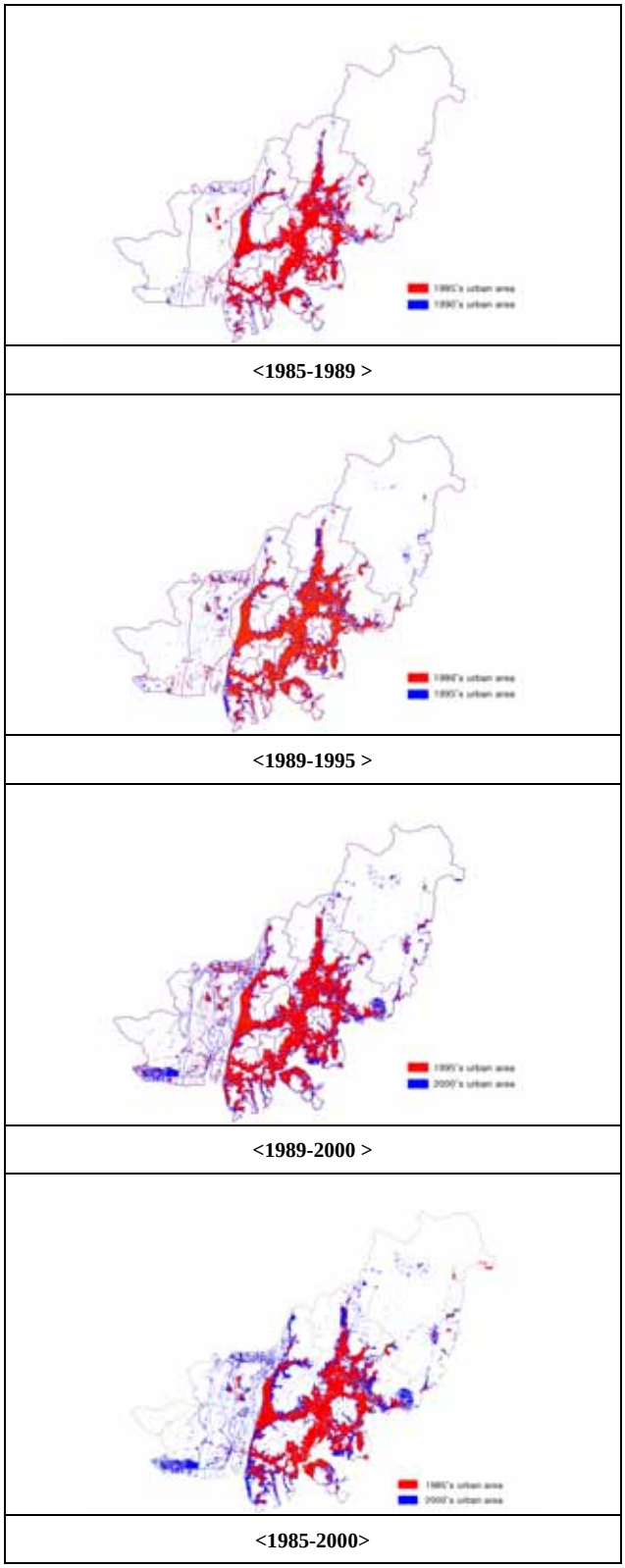

FIGURE 5. Change of urbanization area

TABLE 3. Increase rate in urbanization area

year	Increase area (㎢)	Rate of increase (%)
1985~1989	13.8	3.5
1989~1995	13.5	2.4
1995~2000	47.7	6.9

3.3 Turnover Rate of Urbanization Area

The visible situation of urbanization comes out as non-urban land-use is turned into urban land-use. In Busan, average annul rate of turning from non-urban land-use into urban land-use was 3.8% from 1985 to 2000. The change of urban land-use from non-urban land-use by each year in Busan was analyzed using ArcGIS 9.2 (TABLE 4). Agriculture area were turned into urban region the most and forest area was followed by in each year.

TABLE 4 Turnover rate of urbanization area

(unit : ㎢,%)

	Agriculture area	Forest area	Water area	Total
1985-1989	21.9 (88.7)	1.8 (7.3)	1 (4)	24.7 (100)
1989-1995	26 (77.4)	6 (17.8)	1.6 (4.8)	33.6 (100)
1995-2000	52.6 (84.3)	4.2 (6.7)	5.6 (9)	62.4 (100)

3.4 Characteristics of Land-Use

In order to analyze characteristics of land-use in accordance with urbanization of Busan, the satellite images of year 1985 were classified as city area, forest area, agriculture area, and water area, and urbanized building use and area are calculated with database and overlay of building use in Busan established in 2001. Building database in Busan established in 2001 had use of the buildings and number of floors with attributes of 18 type.

As a result in TABLE 5, the area of building use in urbanized region showed, type 1 and 2 neighborhood living facilities (45.63%) on agriculture area, apartment house on forest area (18.49%), and factory on water area (31.84%) with high ratio.

TABLE 5. Characteristic of land-use (unit : ㎢,%)

	City area	Agriculture area	Forest area	Water area
Individual house	15,516,348 (23.82)	3,419,068 (10.11)	778,675 (10.29)	10,105 (2.57)
Row houses	5,919,951 (9.09)	2,866,794 (8.47)	13,99,072 (18.49)	21,208 (5.40)
Category1 neighborhood	6,723,730 (10.32)	6,285,862 (18.58)	345,388 (4.56)	11,446 (2.91)
Category2 neighborhood	860,722 (1.32)	9,152,656 (27.05)	46,190 (0.61)	4,426 (1.13)
Cultural	351,024 (0.54)	130,342 (0.39)	113,147 (1.50)	-
Sales and operating	573,510 (0.88)	74,954 (0.22)	52,940 (0.70)	1,562 (0.40)
Hospital	247,781 (0.38)	18,827 (0.06)	33,617 (0.44)	-
Education and research	1,609,165 (2.47)	742,406 (2.19)	423,263 (5.59)	166 (0.04)
Sports	96,825 (0.15)	58,203 (0.17)	7,250 (0.10)	2,753 (0.70)
Business	2,041,322 (3.13)	265,267 (0.78)	55,025 (0.73)	12,380 (3.15)
Sleeping accommodation	669,497 (1.03)	143,296 (0.42)	5,265 (0.07)	10,739 (2.73)
Leisure	435,308 (0.67)	29,117 (0.09)	1,348 (0.02)	1,676 (0.43)
Factory	4,853,173 (7.45)	960,663 (2.84)	219,505 (2.90)	125,068 (31.84)
Warehouse	1,332,361 (2.05)	254,868 (0.75)	53,680 (0.71)	12,621 (3.21)
Fuel and gas station	210,704 (0.32)	77,422 (0.23)	11,340 (0.15)	-
Motor vehicle	501,988 (0.77)	74,151 (0.22)	37,353 (0.49)	59 (0.02)
Animal and vegetable	12,410 (0.02)	31,790 (0.09)	5,086 (0.07)	455 (0.12)
Waste treatment	153,643 (0.24)	105,941 (0.31)	1,481 (0.02)	805 (0.20)
Public facility	480,496 (0.74)	145,852 (0.43)	99,590 (1.32)	630 (0.16)
Cemetery	776 (0.00)	59 (0.00)	231 (0.00)	-
Sightseeing and rest	10,769 (0.02)	8,082 (0.02)	7,417 (0.10)	1,003 (0.26)
Individual house / Neighborhood	1,387 (0.00)	209 (0.00)	68 (0.00)	-
Religious	-	-	-	-
Etc	22,531,896 (34.59)	8,988,083 (26.56)	3,870,443 (51.15)	175,697 (44.73)
Total	65,134,885 (100.00)	33,833,911 (100.00)	7,567,377 (100.00)	392,799 (100.00)

5. Conclusions

In this research, land cover changes in Busan were analyzed using remote sensing and GIS to understand urbanization process and characteristics of land-use changes. First, the land cover map was made for time series analysis on images of 1985, 1989, 1995, and 2000. The land cover map was re-classified for each image with four items such as urban area, agriculture area, forest area, and water area among the land cover classification standard suggested by the Ministry of Environment.

The summary of research result is as follows.

First, land-use changes in Busan for 15 years from 1985 to 2000 were understood using the result of land cover classification. The area of land region was expanded continuously, but the area changes on agriculture area, forest area, and water area were different in accordance with administrative district reform of Busan by each year.

Second, the result of comparison on land cover classifications of each year using ERDAS 8.7 showed that area of urbanization region was increased by 3.8% from 92.5 ㎢ in 1985 to 167.5 ㎢ in 2000.

Third, the turnover rate of land-use was analyzed using ArcGIS. In general, agriculture areas were turned in urbanization area the most, and forest area was followed by.

Fourth, in order to analyze characteristics of land-use change in Busan, satellite images of 1985 was classified with city area, forest area, agriculture area, and water area using ArcGIS 9.2. The buildings database and overlay in Busan established in 2001 were analyzed to calculate building use and area in urbanized area. As a result, agriculture area had type 1 and 2 neighborhood living facilities (45.63%), apartment houses in forest area (18.49%), and factories in water area (31.84%) with high ratio. Therefore, agriculture area were turned into urban region with the highest ratio, and neighborhood living facilities took 45.63% of it. Moreover, 29% of forest area was turned into building area. Water area had large-scale development with reclamation on the New Port and Daedaepo regions.

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