Land Use Change Analysis Using Regional Numerical Land Information

Mitsunori Yoshimura
Remote Sensing Technology Center of Japan

Sumio Muraoka and Koji Imabayashi
Ohba Co. LTD

Commission IV, Working Group 1

KEY WORDS: Geomatics/GIS, Land Use, Change Detection

ABSTRACT:

The regional numerical land information has constructed in Japanese three largest urbanized areas, Tokyo, Nagoya and Osaka and their suburbs. Its information is more effective for detail and microscopic investigation than the use of national land information. In this study, in order to discuss the potential of its land information, land use trends and change analyses were performed. The land use ratio, mixture and continuity with unit of 1 km mesh area was used for both analyses. As the results, land use ratio was proved to be used effectively for the regional land use trend investigation. The land use mixture and continuity were useful for detail land use change consideration. Furthermore land developing pattern and its transition could estimate by multi-temporal analysis.

1.Introduction

1.1 Regional Numerical Land Information

Both national and regional numerical land informations are known to be published and used as the common land use data base in Japan.
The national numerical land information has constructed as nationwide information data base and can be used effectively for the macroscopic land use, change investigation.
On the other hand, the regional numerical land information has constructed in Japanese three largest urbanized areas, Tokyo, Nagoya and Osaka and their suburbs. Its information is more effective for detailed and microscopic investigation than the use of national land information.
In this study, in order to discuss application fields using regional land information, the authors conducted the experimental study of investigations for data characteristics, regional land use trend and detailed land use change.

1.2 Test Site and Used Data

The test area of this study is west part of metropolitan Tokyo with 28kmX21km area. The used regional numerical land information consists of four temporal land use data with 10m mesh size.
This information was generated based on '74 housing investigation as the first period, '79 as the second, '84 as the third and '89 as the fourth respectively.
Further following four sub-test sites with 2kmX2km area were selected in order to execute our experimental study more detail.

1) Area-A (existing urban area)
2) Area-B (Housing development in agricultural area)
3) Area-C (Development area by Governmental authorities)
4) Area-D (Development area by private companies)

2.Characteristics of Regional Numerical Land Information

2.1 How to generate Regional Land Information ?

Basically this regional numerical land use information generates or updates using base map(1/10,000), aerial photograph, resident map, change detection map (1/10,000).
Processing procedure is as follows:
a) change detection by aerial photograph interpretation
b) vectorization changed area
c) coding land use number
d) vector-raster conversion

2.2 Verification/Comparison

It is necessary to understand quality and characteristics of used land use data for discussing application fields.
Every city, town and village have established own land use information by urban planning related projects.
In order to verify used data, comparing of some land use data analysis results and existing statistical materials was carried out.
Following two existing statistical materials used:
1) Land use Tama city (1987)
Area measurement based on 1/2500 land use map
2) Land use Tokyo (1987)
Area Measurement from 1/2500 Land Use Map

2.3 Data Error and Noise

Most of data error and noise are estimated to be caused on either a) change detection or d)vector-raster conversion.
As the comparison results, following error or noise were identified:
1) Noises at boundary of huge or line shape changed area.
2) Misunderstanding about land use item
3) Noises at connected area of maps
4) Error depend on the generated date

2.4 Characteristics of Information

Main purpose of establishment regional land information land is to investigate trend of housing area at the largest urbanized regions so that it is necessary to take care for its data classification standard, details and accuracy.
It is more effective for the larger area than local city, town, village unit.

As the result of this examination, obvious data error was recognized in some part and noises were found in other part. However almost of these data errors was proved to be no effective for its data analysis.

4.Land Use Trend Analysis

The land use ratio, mixture and continuity with unit of 1km mesh area in each sub-test site were used for investigating of the regional land use trend.

4.1 Land Use Ratio

The land use ratio was used for understanding the resent status for mentioned four target areas.
Fig.1 shows the land use ratio in each sub-test site. Area-A Ratio of natural land use such as forest, paddy, etc., is extremely low because of existing urbanized area. On the other hand, the ratio of residential and commercial items is comparably high. Trunk road network is not completed because of low road ratio.
In Area-B, Agricultural residential, commercial items have the same ratio as each together other land use area was equally occupied because there are many housing developments in agricultural area.
In Area-C, under constructing trunk road networks as the typical planned development area.
The residential items, park, public utilities are mostly occupied.

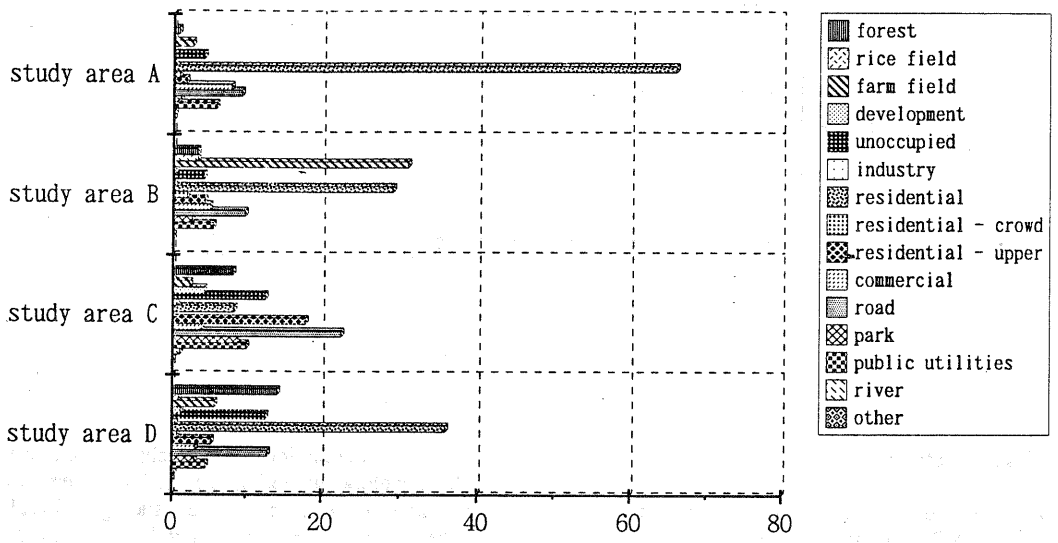

Fig.1 Land Use Ratio in Each Sub-test Site (1989)

Table.1 Land Use Mixture Matrix in Sub-test Site A (1989)

LAND USE	forest	rice field	farm field	develop -ment	unoccu- pied	industry	residential	residential - crowd	residential - upper	commer- cial	road	park	public utilities	river	other
forest	310	0	15	0	27	0	196	6	21	18	84	8	10	1	0
rice field		0	0	0	0	0	0	0	0	0	0	0	0	0	0
farm field			1439	0	104	4	641	5	1	126	147	7	28	0	0
development				0	0	0	0	0	0	0	0	0	0	0	0
unoccupied					1592	14	2213	5	75	282	506	30	99	20	0
industry						86	59	0	0	4	37	0	6	0	0
residential							45400	147	288	2068	7371	202	945	142	0
residential - crowd								437	30	19	109	10	24	3	0
residential - upper									926	108	213	10	50	8	0
commercial										4214	1165	58	325	7	0
road											2189	162	629	20	0
park												468	37	3	0
public utilities													3571	0	0
river														16	0
other															0

Table.2 Basic Statistics of Each Land Use Aggregation in Sub-test Site A (1989)

LAND USE	forest	rice field	farm field	develop -ment	unoccu- pied	industry	residential	residential - crowd	residential - upper	commer- cial	road	park	public utilities	river	other
continuity	23	0	47	0	276	9	42	11	50	9	526	32	81	9	0
maximum	38	0	131	0	44	30	13654	124	85	697	237	44	501	19	0
minimum	2	0	2	0	2	2	2	2	2	2	2	2	2	2	0
average	10.6	0.0	21.1	0.0	5.7	8.1	628.3	27.0	13.3	15.0	5.8	11.4	28.3	5.6	0
covariance	81.5	0.0	682.6	0.0	35.8	69.9	5438902	1173.3	366.3	2874.4	229	109	5377	27.8	0
standard dev	9.0	0.0	26.1	0.0	6.0	8.4	2332.2	34.3	19.1	53.6	15.1	10.5	73.3	5.3	0

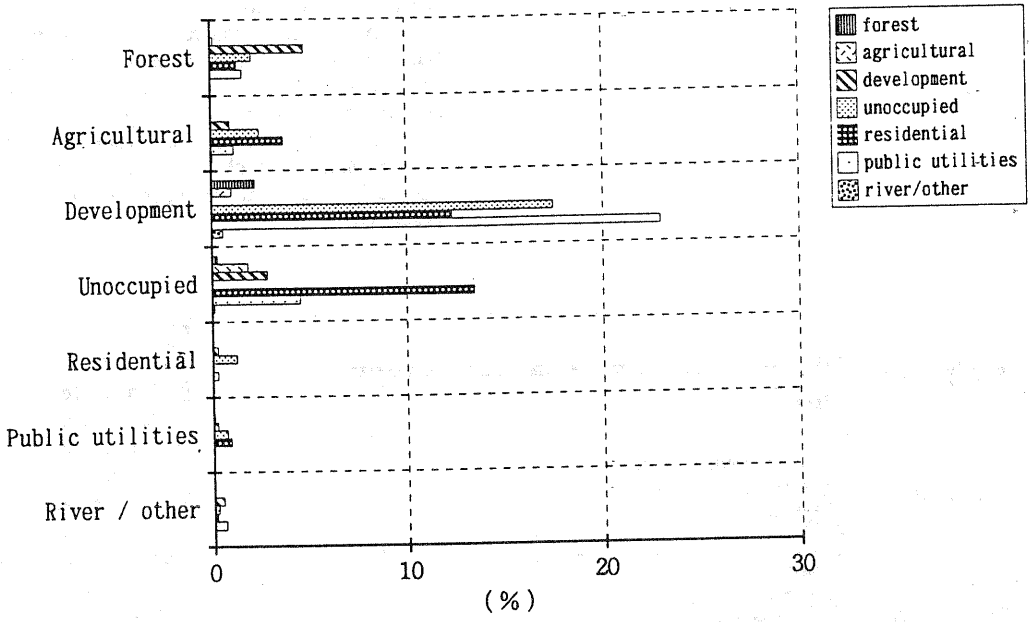

Fig.2 Land Use Change Pattern (1984 - 1989)

4.2 land Use Mixture

The join index is one of the methods how to explain about the land use mixture. The mixture matrix of land use is explained using what kinds of land use items connect to some concerned mesh and how many meshes they are. Table-1 shows the mixture matrix of land use at sub-test site A in '89. This mixture matrix of land use is used as the context index.

4.3 Land Use Continuity

This land use continuity is calculated by how many pixels some concerned land use is connected to the same land use in horizontal and perpendicular directions. This index is used for express the land use aggregation.
Table-2 shows the continuity for each land use in sub-test site A.

5.Land Use Change Analysis

It is possible to discuss about land use trend using the result of land use change analysis. Here land use change in the term from '84 to '89, was detected.

Fig.2 shows detailed land use change pattern in test site. The development and unoccupied area were proved to be mainly derived from the forest and agricultural area. On the other hand, the development and unoccupied area were mainly changed to the unoccupied, residential and public utilities area.

6.Conclusion

As the results of this study, land use ratio was proved to be used effectively for the regional land use trend investigation for an existing and new urbanized area. The estimation of land use pattern was recognized to be possible using land use mixture and continuity indices. The land use ratio, mixture and continuity indices were also possible to apply to the classification of target area urbanization. The development pattern and its transition were estimated through multi-temporal analysis.