Detecting Urbanization using Remotely Sensed Data for evaluating urban planning

Kyohei Sugino*,Masataka,Takagi* Yuta Takahashi*
Kochi University Of Technology*

***ABSTRACT*:** The satellite image is used in various fields such as the updating the map, understanding of the urban development. The objectives of this study are new buildings are detected in urban planning area using change of land cover and change of elevation, and urban planning is evaluated using result of the detection. In this study, change of land cover was detected using land cover map from 2002 and 2010. And, difference of elevation was calculated using elevation data 2003 and 2010.

New building was detected by the suggested algorithm using land cover change and elevation change. The correct percentage showed 81.9%.

Some buildings could not be detected because the accuracy of change detection of land cover was low. Therefore, improving the accuracy of land cover maps would be required.

Urban planning area was evaluated from building detection result , road , land prices and population density. Almost building was increased in urban planning area where are depending on land price, density of population and easily accessibility by transportation.

KEYWORD: satellite image, change detection, urban planning

1. INTRODUCTION

The satellite image was used in various fields such as the updating the map, understanding of the urban development. Surface elevation data can be made from satellite image[1)] therefore change of building and change of ground height can be detected using temporal elevation data.

Land cover map could be also made from satellite image[2)] therefore change of land cover could be detected using temporal land cover map. Therefore, Change of city can be checked using both data.

The objectives of this study was new buildings will be detected in urban planning area using change of land cover and change of elevation, and urban planning is evaluated using result of the detection.

2. TEST AREA

Test area was selected Tosayamada, Kochi, Japan. The Kochi University of Technology is located on Tosayamada. The test area had many apartments for students. The new apartments were build up along new wide road, Figure 1 shows test area.

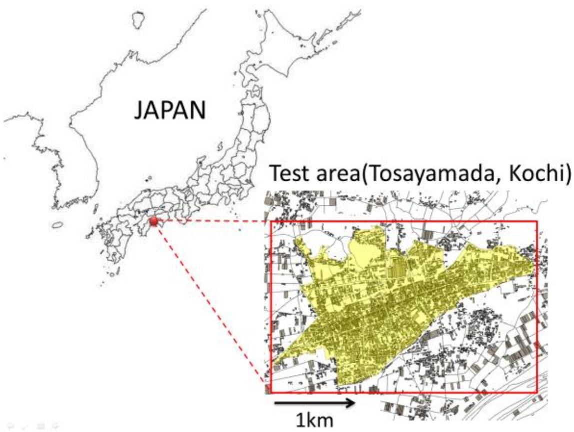

Figure 1 Test area

3. CHANGE DETECTION

3.1 Change detection of land cover

In this study, land cover map 2002 from satellite IKONOS and Land cover map 2010 from satellite GeoEye-1 were used. Satellite image IKONOS was 1.0m ground sampling distance. Also, satellite image Geoeye-1 was 0.5m ground sampling distance.

The categories of land cover was shown in Figure 2. The land cover map was shown by Figure 3 and Figure 4 in 2002 and 2010 respectively. Ground sampling distance of Geoeye-1 was higher than IKONOS therefore, accuracy of land cover map 2010 was higher than land cover 2002.

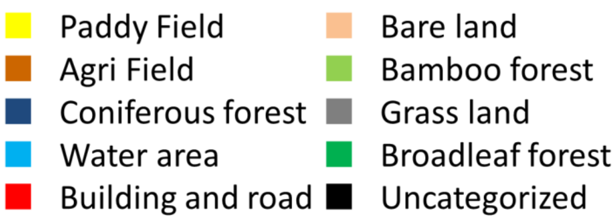

Figure 2 Categories of land cover

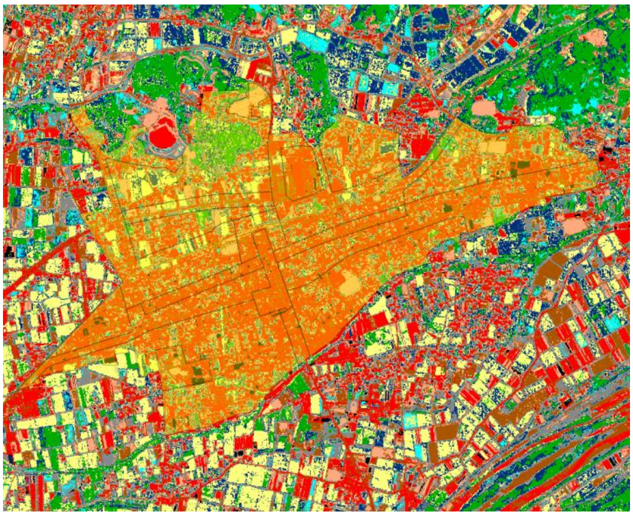

Figure 3 Land cover map(2002)

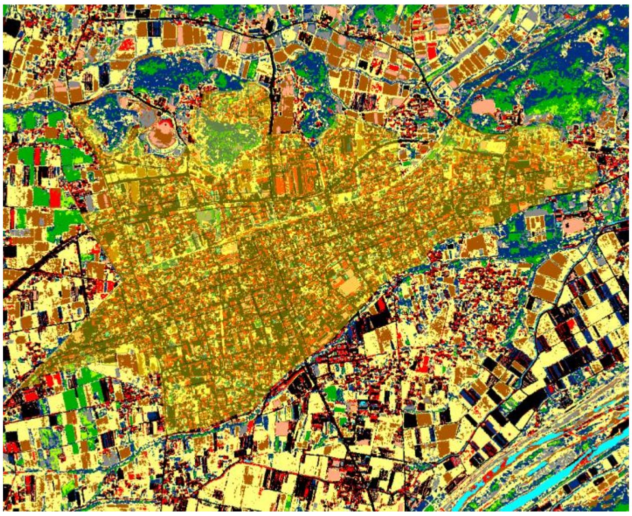

Figure 4 Land cover map(2010)

Change of land cover was defined using land cover map 2002 and 2010. New category set up from change of land cover, as “Change to building and road” ”Change to paddy field” ”Change to bamboo” “Denudation” “Deciduous field”. The change detection was shown in Table 1 categories according and Figure 5 by result of change detection of land cover.

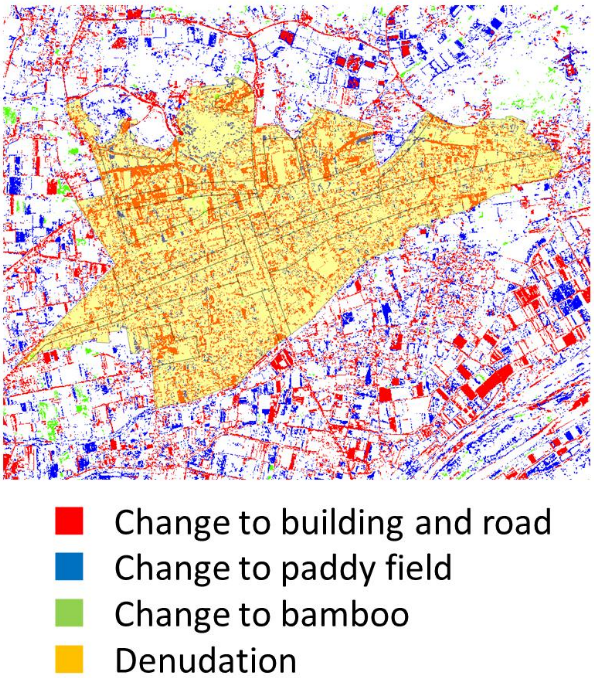

Figure 5 Result of change detection of land cover

Table 1 New categories according to result of change detection of land cove

		2010								
		Paddy field field	**Bamboo forest**	**Water area**	**Bare land**	**Coniferous forest**	**Broadleaf forest**	**Agri field**	**Grass land**	**Building and road**
2002	**Paddy field field**	Paddy field	Change to bamboo	Water area	Bare land	Coniferous forest	Broadleaf forest	Agri field	Grass land	Change to building and road
	Bamboo forest	Paddy field	Bamboo forest	Water area	Bare land	Bamboo forest	Bamboo forest	Agri field	Grass land	Change to building and road
	Water area	Change to Paddy field field	Change to bamboo	Water area	Water area	Water area	Water area	Water area	Water area	Change to building and road
	Bare land	Change to Paddy field field	Change to bamboo	Water area	Bare land	Bare land	Bare Land	Agri field	Grass land	Change to building and road
	Coniferous forest	Change to Paddy field field	Change to bamboo	Water area	Bare land	Coniferous forest	Coniferous forest	Agri field	Grass land	Change to building and road
	Broadleaf forest	Change to Paddy field field	Change to bamboo	Water area	Bare land	Deciduous forest	Broadleaf forest	Agri field	Grass land	Change to building and road
	Agri field	Paddy field	Change to bamboo	Water area	Field	Agri field	Agri field	Agri field	Agri field	Change to building and road
	Grass land	Grass	Change to bamboo	Water area	Bare Land	Grass land	Grass land	Agri field	Grass land	Change to building and road
	Building and road	Paddy field	Change to bamboo	Water area	Denudation	Building and road	Building and road	Agri field	Grass land	Building and road

The change detection of land cover result is checked by visual interpretation.

Correct percentage was shown in Table 2. Change of building and road showed approximately 80%. However, accuracy of other new category was low, the test area had various building and road.

Table 2 Correct percentage

Categories	Correct percentage
Change to building and road	79.9%
Change to paddy field	33.2%
Change to bamboo	53.9%
Denudation	51.5%

3.2 Change detection of elevation

In this study, elevation data 2003 from aerial LIDAR and elevation data 2010 from satellite GeoEye-1 were used. This data was observed surface of building and forest was shown by Figure 6 and Figure 7 in 2003 and 2010 respectively. Aerial LIDAR could be made elevation data in high accuracy. Accuracy of elevation data 2003 and 2010 were approximately 1 m.

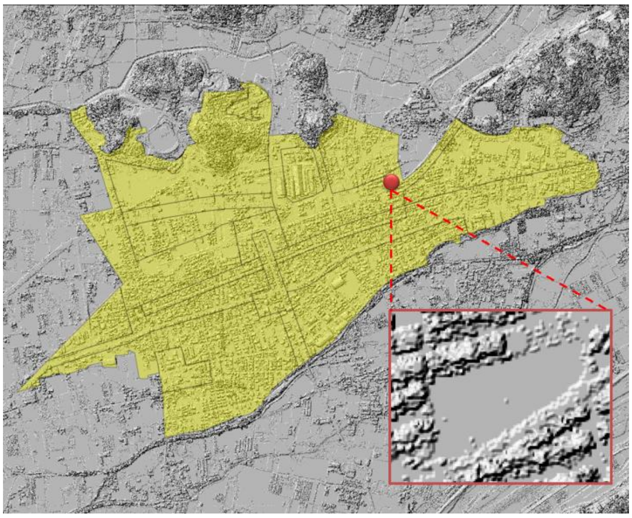

Figure 6 Elevation data (2003)

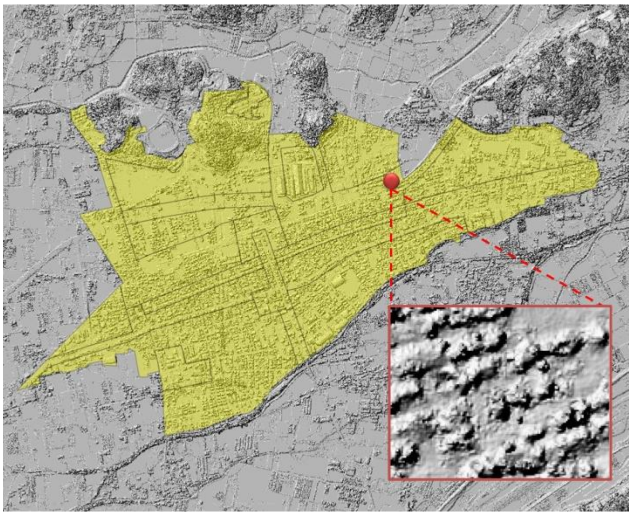

Figure 7 Elevation data (2010)

Difference of each elevation data was calculated using GIS. In this study, difference of more than 5m was defined as change. Because, at least 5 m rise up when house or building is built. In this difference of elevation was shown in Figure 8. Red is represented rise up of height . Blue is represented drop down of height.

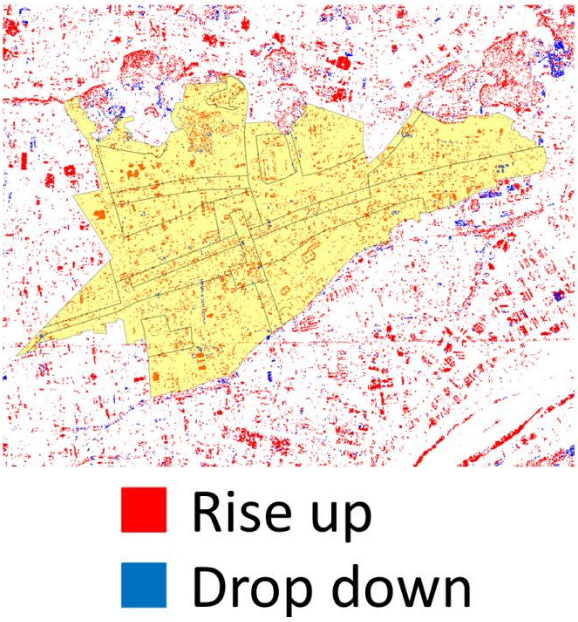

Figure 8 Result of difference of elevation

4 DETECTION Of NEW BUILDINGS

Difference of elevation was included change of building, change of ground height and change of vegetation. Thus, the change cannot be judged only building using elevation change. In this study, detection of new buildings should be achieved with land cover change. The algorithm was shown in Figure 9. The area where was detecting new building "rise up" of elevation change and
"change to building and road" in land cover change were assumed as new building if the area had enough size. Next, this data was changed to polygon. This polygons were various size polygons. Small polygons was possibility of noise. As a result , area of polygons were removed less than 30 ㎡. Finally, Polygon data was converted to point data using centroid was shown in Figure 10 by detected new buildings.

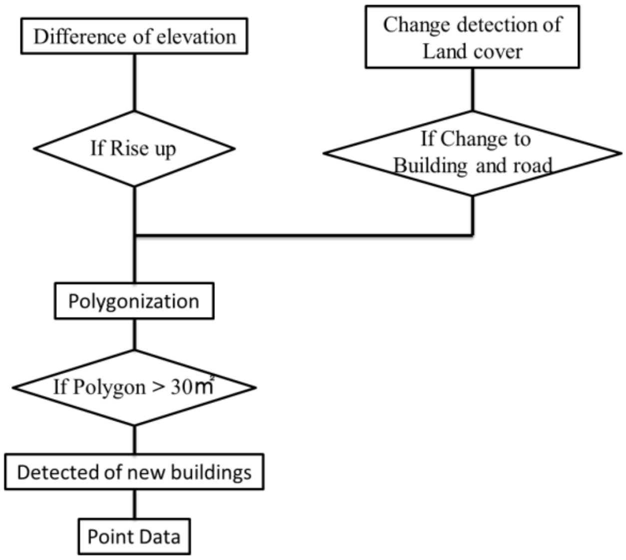

Figure 9 Algorithm

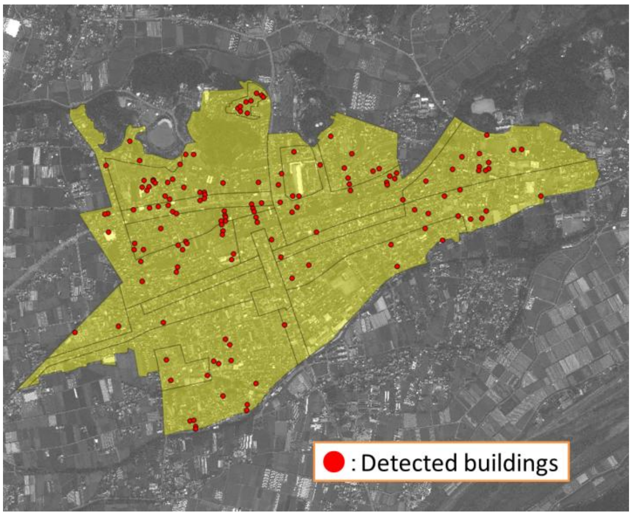

Figure 10 Detected buildings

Red point shows 114 buildings which was detected from the algorithm. The detection of building was checked by visual interpretation. Blue point shows actual new buildings. The actual buildings were 118 points. Correct percentage was 81.9% was shown in Figure 11 by number of correction and correct percentage was shown in Table 3. Urban planning was evaluated using this data.

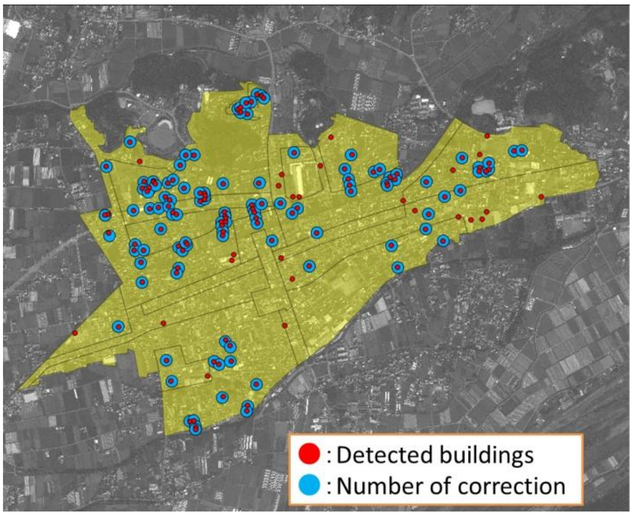

Figure 11 Number of correction

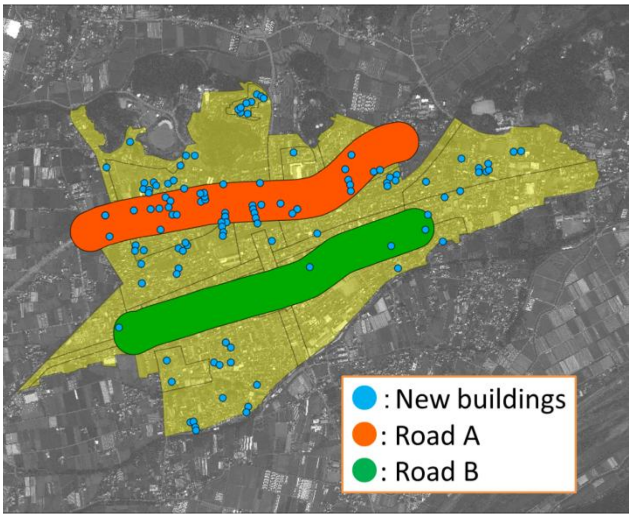

Figure 12 Result of buffering

Table 3 Correct percentage

Detection results	144 point (Red)
Number of correction	118 point (Blue)
Correct percentage	81.9%

Table 4 Number of new buildings

Road A (Orange)	39 point
Road B (Green)	5 point

5 EVALUATION USING URBAN PLANNING

5.1 Evaluation by road

Two main road was evaluated in urban planning area. Around the each road had the various buildings. Road A was made about 20 years ago and Road B was made about 60 years ago. In the future, Road A will connect directly to the big city therefore , public transport can be anticipated easily accessible. Number of new buildings were counted using buffering of GIS. Buffering could be analyzed spatial of within a certain distance from target was shown in Figure 12 by result of buffering and Table 4 by number of new buildings in within 100m radius buffer of road. Many of new buildings were increased in the vicinity of Road A.

5.2 Evaluation by Land prices

Distribution of new buildings were evaluated with difference of land prices was shown in Figure 13 by new buildings on land prices. Data of land prices were produced by National Land Numerical Information in 2010. The data of land prices were added to polygon data of each district. Data of land prices were displayed using GIS. Red area was land prices expensive. New building was increasing in cheap place of land prices. The vicinity of Road A was land prices cheap therefore , many of new buildings might be increased in vicinity of Road A.

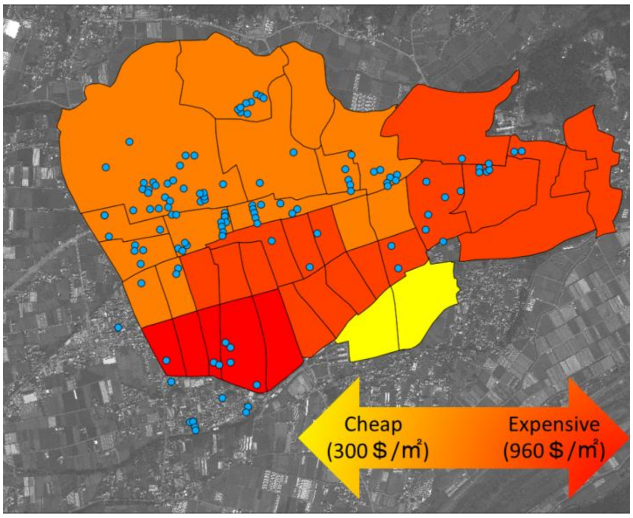

Figure 13 New buildings on land prices

5.3 Evaluation by population density

Distribution of new buildings were evaluated population density was shown in Figure 14. Data of population density were produced by national census in 2006. The data of population density were added to polygon data of each district. Data of population density were displayed using GIS. There is many vacant land on low population density. New buildings were increased in vacant land of vicinity of the Road A.

Therefore, many of new buildings were increased in vicinity of the Road A.

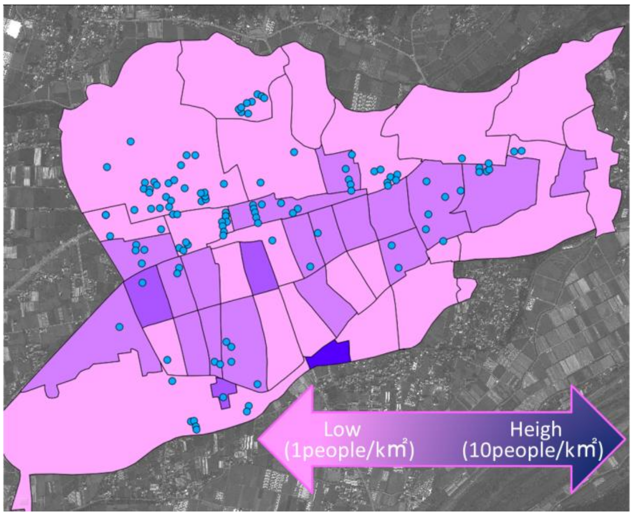

Figure 14 New buildings on population density

6 CONCLUSIONS

In this study, change of land cover was detected using land cover map from 2002 and 2010. And, difference of elevation was calculated using elevation data 2003 and 2010.

New buildings were detected by the suggested algorithm using land cover change and elevation change. The correct percentage showed 81.9%.

Some buildings could not be detected. Because, the accuracy of change detection of land cover was low. Therefore, improving the accuracy of land cover maps will be required.

Urban planning area was evaluated from building detection result, road, land prices and population density. Almost building was increased in urban planning area where were depending on land price, density of population and easily accessibility by transportation.

Currently, GIS data is used in various fields. Therefore, latest GIS data is required. Updating of GIS data was effective using satellite data.

REFERENCES

1) K Sugino, M Takagi, Change detection from 3D Measurement using satellite Geoeye-1 and aerial LIDAR data, Takagi Laboratory, Kochi University of Technology, 2012 (In Japanese).

2) T Yuta, M Takagi, Change detection of land cover in downstream area of Monobe river using satellite image, Takagi Laboratory, Kochi University of Technology, 2012(In Japanese).

3) M Masataka, Basis of technology for measurement national land(In Japanese)