STUDY ON LANDUSE CHANGE DETECTION AND ITS TRENDS USING ALOS AND LANDSAT DATA IN BINH DUONG PROVINCE, VIETNAM

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ABSTRACT

Landuse change detection is necessary for planning and strategies of sustainable development. Multi-temporal images from remotely-sensed data of Alos Avnir-2 and Landsat ETM+7, which cover the whole Binh Duong province, were used to detect landuse change. These data have been used to classify landuse with maximum likelihood, as well as being assessed trends of change in a period from 2005 to 2010 and being pedicted for a next 5 year period Markov Chain. The results showed the significant changes of landuse over a 5 year period, especially Bare soil and Built-up areas. They also present different trends of landuse change in next 5 years in the study area. Namely, there could be a steady increase in Built-up and Agriculture, but a sharp drop in Bare soil at the same time.

Keywords. Landuse change, Markov Chain

1. INTRODUCTION

Nowaday, development of economy and urbanization lead to the constant changes of landuse purposes. A massive conversion of forestry areas into agriculture and built-up areas has happened, and this leads to an unbalance between utilization of natural resources and environment protection. Therefore, it is important to study on landuse changes and trends for planning and strategies of sustainable development.

The method that combined Remote Sensing and Geographic Information Systems (GIS) is effective to observe and study landuse changes. This method is popular to observe and manage natural resources, especially assessment of current landuse. Besides, multi-temporal remote sensing databases enable the users to study landuse change in a long time quickly, and effectively when incorporated with probabilistic models such as the Markov Chain.

2. MATERIALS AND METHODS

2.1 Materials

In this study, the multi-temporal images from remotely-sensed data of Alos Avnir-2 (JAXA – Japan, PI-504 resourced by Ho Dinh Duan) and Landsat ETM+7 (USGS – USA) as well as the vector layers of terrain and geology were used to classificate and study about landuse changes in Binh Duong in the period from 2005 to 2010.

2.2 Methods

2.2.1 *Classification and Change Detection*

The maximum likelihood method has been applied for landuse classification. Then, each landuse images were compared to detect the landuse changes in the study area.

2.2.2 *Interpretation Practise*

First, the visual interpretation method was realised in order to define landuse types by our experience and knowledge about this area. This result then, associated with information of GPS points on landuse types, can be used to sample, build interpretation key and apply the supervised classification for performing processed images. These images were supposed to show the result of landuse classification through years in the study area.

2.2.3 *Markov Chain Modeling and Markov Cellular Automata (MCA)*

Temporal landuse changes in somewhere, that it is interested in a set of certain landuse states, is defined as a Markov Chain, so it is able to predict current at some point in the future. Assuming, landuse types in 2005 was used as the initial state S_0 , and S_1, S_2 were states in 2010 and 2015 in turn in Markov Chain. Thence, S_2 was found by the following formula:

$$S_2 = S_0 \times P^2 \quad (1)$$

This is a simple MCA that is calculated without spatial section. In which, P is a transition probability that the probability of moving from one state i to another state j. It can be represented in the form of a transition matrix, P, as shown below:

$$P = \begin{bmatrix} p_{11} & p_{12} & \cdots & p_{1n} \\ p_{21} & p_{22} & \cdots & p_{2n} \\ \cdots & \cdots & \cdots & \\ p_{n1} & p_{n2} & \cdots & p_{nn} \end{bmatrix} \quad (2)$$

3. RESULTS AND DISCUSSION

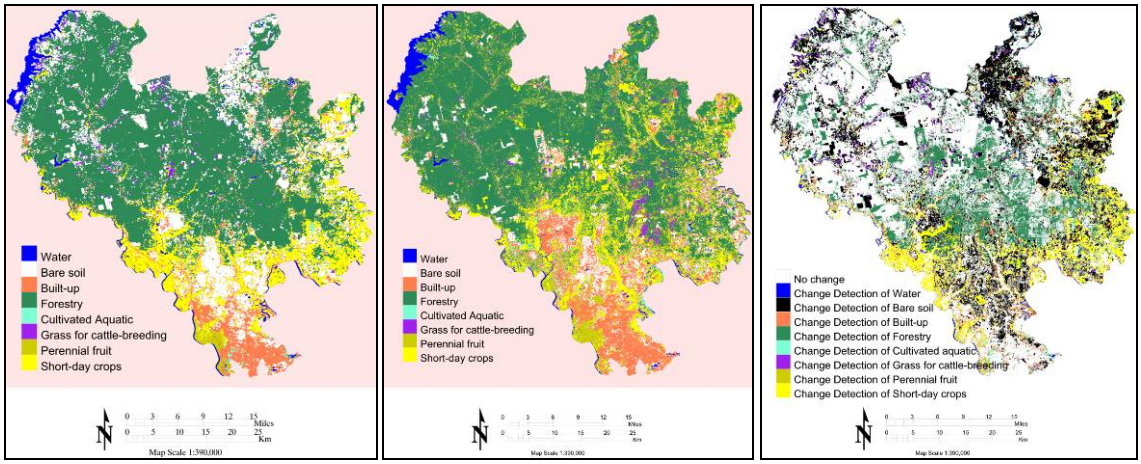
3.1 Landuse changes in the period from 2005 to 2010

The result showed that the total area of Binh Duong province which has been observed with from the remotely-sensed data is 269,554.05 hecta. This study area could be mainly classified into 8 categories: Water, Bare soil, Built-up, Forestry, Cultivated aquatic areas, Grass for cattle-breeding, Perennial fruit, and Short-day crops (shown in Table 1 and Figure 1a, 1b). In which, Forestry areas are over 50% of the total and widely distribute. Short-day crops, mainly are Rice, are the second largest area and distribute near rivers (Sai Gon, Dong Nai river) and residential areas. Built-up areas, which are the third, concentrate in the line of communication, particularly the southern of province.

Table 1. Landuse classification in 2005 and 2010.

Landuse	Area (ha)			Rate	
	2005	2010	Change	2005	2010
Water	7,115	7,655	540	0.0264	0.0284
Bare soil	55,172	22,694	-32,478	0.2046	0.0842
Built-up	19,648	28,758	9,110	0.0729	0.1067

Forestry	143,981	139,560	-4,421	0.5341	0.5178
Cultivated aquatic	1,428	4,393	2,965	0.0053	0.0163
Grass	4,016	7,520	3,504	0.0149	0.0279
Perennial fruit	2,237	12,829	10,592	0.0083	0.0476
Short-time crops	35,928	46,116	10,188	0.1333	0.1711
Total	269,525	269,525		1.0000	1.0000



(a) (b) (c)

Figure 1. Current landuse in 2005 (a), 2010 (b) and landuse change detection images (c)

In the period from 2005 to 2010, landuse change detection in Binh Duong showed that Short-day crops, Perennial fruit and Built-up areas were on the increase; otherwise, Bare soil areas had a sharp drop and Forestry decreased lightly (shown in Table 2 and Figure 1c).

Table 2. Transition Matrix of landuse in the period 2005-2010, %

States	Water	Bare soil	Built-up	Forestry	Cultivated aquatic	Grass	Perennial fruit	Short-day crops
Water	60.77	1.89	1.01	0.31	7.87	6.23	4.63	3.25
Bare soil	1.19	15.98	7.14	5.50	10.59	11.53	3.01	10.87
Built-up	2.86	17.95	51.82	2.64	23.62	5.22	9.80	10.87
Forestry	15.62	40.60	18.18	70.54	18.42	57.01	2.69	22.45
Cultivated aquatic	3.00	1.43	2.35	1.05	4.69	0.99	4.93	3.34

Grass	0.71	2.17	1.18	3.39	2.12	4.30	0.63	2.74
Perennial fruit	3.08	3.38	4.10	3.00	7.61	1.92	50.57	12.03
Short-time crops	12.77	16.59	14.23	13.58	25.10	12.80	23.74	34.45

Table 2 showed transition of landuse types from 2005 (shown in columm) into 2010 (shown in row) by percent. The landuse change detection mostly found in Bare soil that transfer into Forestry and Built-up areas.

3.2 An analysis of urbanization trend in the period from 2005 to 2010

Built-up areas had a sharp increase in the period from 2005 to 2010, particularly southern of province belong to Thuan An district and Thu Dau Mot town. In a five year period, area of built-up grew 9,110 ha (1.46 times) that were mostly transferred from Bare soil, Cultivated aquatic and Agricuture (includes Grass, Perennial fruit and Short-day crops) (shown in Table 2).

The main line of communication played a important role in the spatial development of Built-up, such as 13 highway, 742 and 743 street. Besides, what a significant section for urbanization here were a plain topography and a near source of water (Sai Gon – Dong Nai river system).

3.3 An analysis of landuse change based on Markov statistical models

Applying the formula (2) to copy landuse changes, we found that matrix P was a transposition of transition matrix in Table 2, as shown below:

Table 3. Results of transition probability P, %

States	Water	Bare soil	Built-up	Forestry	Cultivated aquatic	Grass	Perennial fruit	Short-day crops
Water	0.677	0.0119	0.0286	0.1562	0.03	0.0071	0.0308	0.1277
Bare soil	0.0189	0.1598	0.1795	0.406	0.0143	0.0217	0.0338	0.1659
Built-up	0.0101	0.0714	0.5182	0.1818	0.0235	0.0118	0.041	0.1423
Forestry	0.0031	0.055	0.0264	0.7054	0.0105	0.0339	0.03	0.1358
Cultivated aquatic	0.0787	0.1059	0.2362	0.1842	0.0469	0.0212	0.0761	0.251
Grass	0.0623	0.1153	0.0522	0.5701	0.0099	0.043	0.0192	0.128
Perennial fruit	0.0463	0.0301	0.098	0.0269	0.0493	0.0063	0.5057	0.2374
Short-time crops	0.0325	0.1087	0.1087	0.2245	0.0334	0.0274	0.1203	0.3445

With S_0, S_2 are the rate of landuse in 2005 in Table 1 and in 2015 respectively, applying the formula (1), we had a result of landuse types area in 2015 as shown below:

Table 4. Results of Markov Chain

Landuse	Rate		Area (ha) 2015
	S_0 (2005)	S_2 (2015)	
Water	0.0264	0.033543	9,041
Bare soil	0.2046	0.077182	20,803
Built-up	0.0729	0.114563	30,878
Forestry	0.5341	0.492666	132,786
Cultivated aquatic	0.0053	0.019304	5,203
Grass	0.0149	0.028207	7,602
Perennial fruit	0.0083	0.070484	18,997
Short-time crops	0.1333	0.183561	49,474
Total	1.000	1.000	274,784

4. CONCLUSION

The resulst indicate that the medium spatial resolution of Alos Avnir-2 and Landsat ETM+7 data can be used for landuse change detection. Moreover, these data can also be used to predict the trends of landuse changes in a next period by Markov Chain.

5. REFERENCES

[1] Lieu Van An, 2006. *Adjustment of planning in Binh Duong province up to 2010 and vision 2020: Introduction about development of farmhouse planning*.

[2] *Report of current environment in Binh Duong in 2005*. Department of Natural resources and Environment in Binh Duong.

[3] *Summary report of Agriculture and Rural Development Department in Binh Duong in 2006*.

[4] Helen Briasoulis, 2000. *Analysis of Land Use Change: Theoretical and Modeling Approaches*. Regional Research Institute, West Virginia University. 2000.

[5] Eastman, J. R., 2006. *IDRISI Andes Guide to GIS and Image Processing*. Massachusetts, USA: Clark Labs, Clark University.