AGENGT-BASED MODEL ANALYSIS OF LANDOWNER'S MOTIVATION IN LAND USE CHANGE FROM HOME GARDEN AT KANDY CITY IN SRI LANKA

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ABSTRACT: Kandy was old capital of Kingdom of Kandy and is one of main cities in Sri Lanka. While this city is famous as a sacred place for Buddhist and a world heritage, it is an important point for traffic and economy. Therefore, land use of Kandy is drastically changing these days. In some case, home garden, multi-storied vegetation plot established by rural families, change to cash cropland or other type of land use as its economical growth. Our research's objective is to investigate the motivations and the causes of these land use change from the landowner's point of view in the economical growth. Firstly, we capture the land use change, especially home garden to other land cover, of Kandy from 1990s to now by Landsat satellite data. Secondly, we conduct a change detection analysis in images taken in 1992 and 2001. As a result, decreasing trend of home garden was captured in the suburb area along with the main roads that connect the Kandy city with other cities.

1. INTRODUCTION

1.1 Back ground

Home gardens, multi-stored vegetation plot established by rural families, are dynamic sustainable land management systems over centuries in Sri Lanka. The villagers derive a part of their subsistence requirements from the gardens, and also gather a variety of forest products for food, medicine, building construction, and other utilities from neighboring forest [1]. Local people live with home gardens for a long time, but the home gardens are subjected to shrinking and converted to other land cover type due to the rapid economic growth in Sri Lanka. Home gardens' shrinking can depress the sustainability of the local life or affect the quality of watershed around. Despite of the potential problem of shrinking home gardens, the real situation of home gardens (total area, quality) is not investigated, and specific motivation for landowners to change the home gardens to other land use.
We selected Kandy city as a study area, because Kandy city plays a important role of transport in the central of Sri Lanka and developed rapidly in this 20 years.

1.2 Objective

We have two objectives. First one is to capture the reality of shrinking home gardens. Second one is to investigate the hidden reason or parameter that influenced the land use change, especially why some home gardens has diminished and some remain.

2. METHODOLOGY

2.1 Flow of over all research

Figure 1 shows the flow chart of the over all research. There are 3 steps in the project. First one is a classification of Landsat satellite images. Second one is building up an agent-based model with the data of DEM, accessibility from the road, and cellular automaton system. Third one is to comparing the land cover changes between real one and estimated one by the model to explain the shortage or lack of the built model by the land owners' inner motivation that is gotten from field inquiry. In this paper, methodology and result of first is shown.

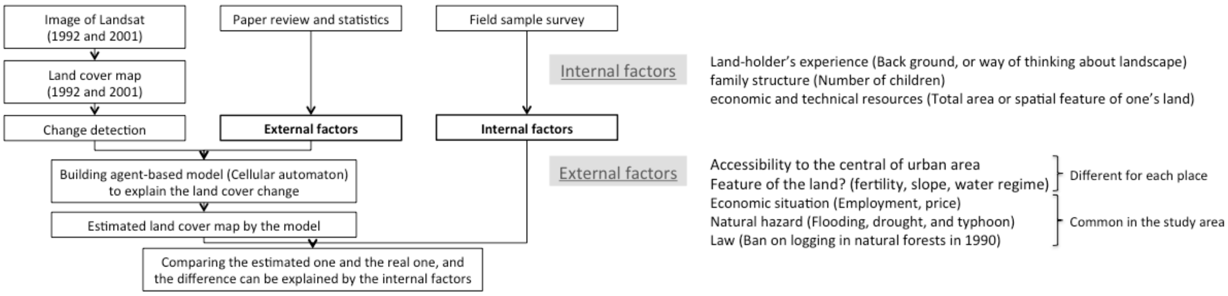

Figure 1. Flow chart of over all research.

2.2 Landsat image classification

To detect the reality of changing home gardens, we need satellite images in different times more than 10 years. So we select Landsat as a satellite used in this research, because this satellite observes the earth more than 40 years in almost same system. In this study, we use 3 Landsat images, an image in Feb. 1992 from Landsat 5, an image in Mar. 2001 from Landsat7. We use 6bands of the Landsat images for land cover classification, band1, band2, band3, band4, band5, and band7. 15 km square images are selected as a study area. Spatial resolution of Landsat image is 30m, so we have 500 pixels in one line of the image and 250000 pixels in one image.
Before the land cover classification, we apply the normalizing method for topographic and atmospheric effect [2]. In this method, by normalizing the apparent reflectances which are estimated from Landsat data using the sum of those 6 or 4 bands, inevitable topographic and atmospheric effects can be suppressed. The normalized reflectance is calculated by the equation below.

$$\mathrm{Re}(i) = \frac{re(i)}{\frac{1}{N}\sum re(i)} \qquad (1)$$

Re : Normalized reflectance
N : Number of bands (in this study 6)
Re : Raw reflectance at the ground surface

After the normalization we apply supervised classification with Mahanobis distance to classifying the images to 5 categories (forest, low vegetation, urban, soil, and water).

3. RESULT AND DISCUSSION

3.1 Satellite image classification

Figure 2 shows the natural color Landsat images before normalization and after normalization in 1992 and 2001. In the natural color images before normalization, image (a) and (b), mountain area can be seen around the bottom of the images. Brightness of either side of mountain's ridgeline is different in image (c). Image (d), (e), and (f) are images after normalization of image (a), (b), and (c). Image (f) shows the same point with image (c), and brightness difference between the ridgeline becomes almost zero in the image (f). So we can eliminate the shadow due to the geographical feature.
Figure 3 shows the result of supervised classification with Mahanobis distance of Landsat images after normalization. Most of urban area can be seen in the central of Kandy city, where many infrastructures including a train station exist. Small urban area can be seen along with the main roads that connect Kandy city with other cities. Table 1 shows the matrix of land cover change between 1992 and 2001. Because seasons in which images are taken are different, high vegetation, low vegetation, soil, and water pixels pass each other. Any way, number of urban pixels increase from 6981 to 10043 and increasing urban area can be seen.
Figure 4 shows the difference of the number of urban pixels in 1992 and 2001. Red or yellow pixels mean there is an increasing trend of urban pixels, and blue of green pixels mean there is a decreasing trend of urban pixels. Compare to the center of the city, suburb area near to main roads have more strong increasing trend. This is because the center of Kandy city already well developed.

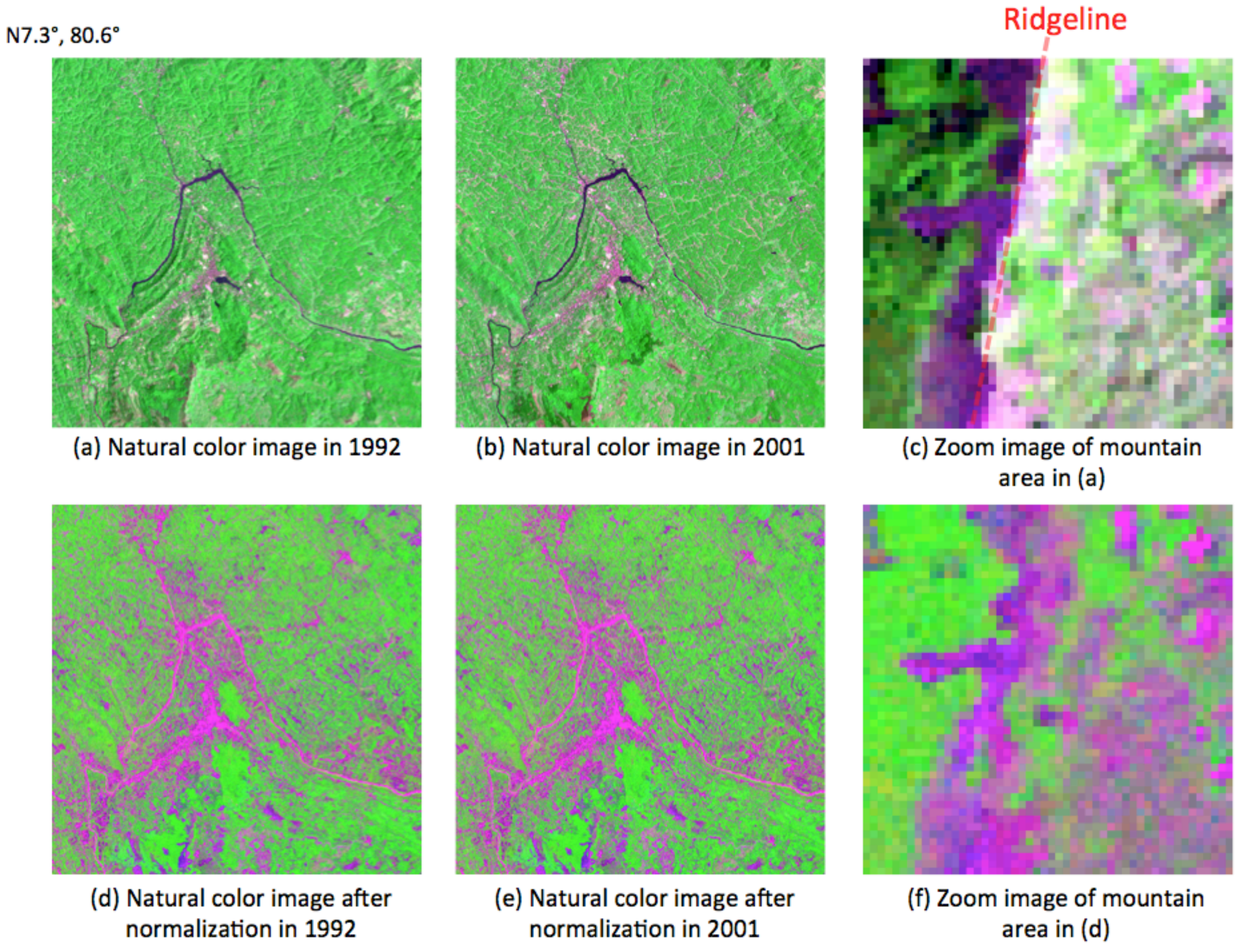

Figure 2. Landsat images before normalization and after normalization.

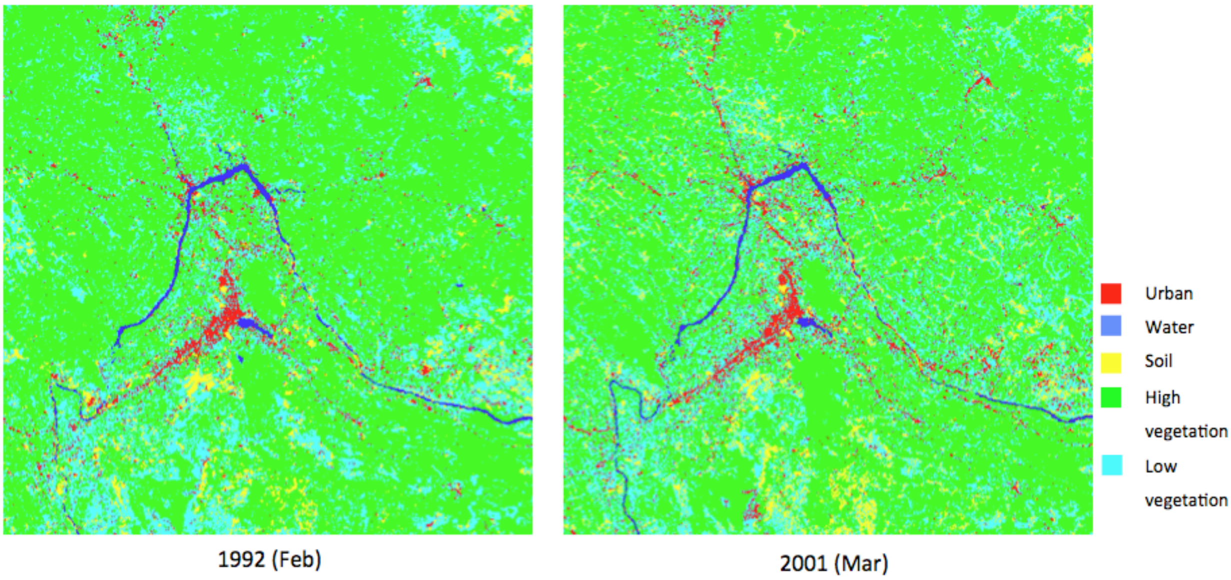

Figure 3. Classification result of the Landsat images.

Table 1. Matrix of land cover change between 1992 and 2001.

Land cover type in 1992 \ Land cover type in 2001	Urban	High vegetation	Water	Soil	Low vegetation	Total
Urban	2277	1369	79	515	2741	6981
High vegetation	3428	136673	266	7399	30235	178001
Water	136	545	1248	93	197	2219
Soil	639	2839	130	3111	3637	10356
Low vegetation	3563	22687	225	5005	20963	52443
Total	10043	164113	1948	16123	57773	250000

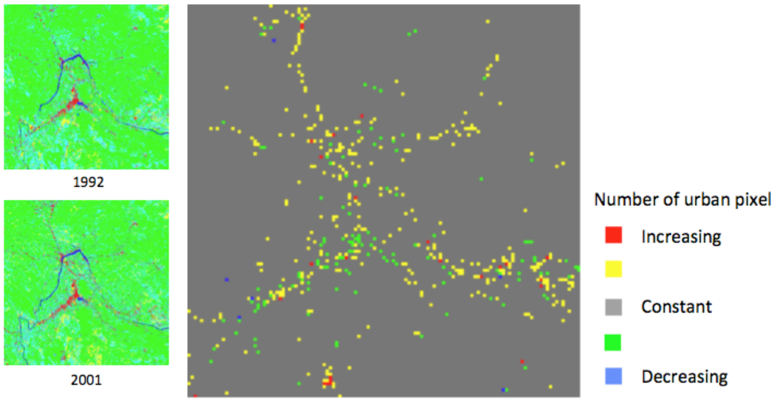

Figure 4. Difference of the number of urban pixel between 1992 and 2001.

4. CONCLUSION AND FUTERE WORK

By using Landsat images in 1992 and 2001, land cover classification of each year was done. Urban area around the Kandy city increased along with the main roads.
As a future work, combining the classification result with factors that influence the urbanizing is needed. As the factors, slope data deprived from DEM or accessibility with main road or commercial facilities.

5. REFFERENCE

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