

Driving factors of land use changes in Kathmandu Valley, Nepal

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Abstract: Kathmandu valley has been experiencing rapid land use changes since the last few decades. Residing in the bowl shaped topography, it forms the core of the Nepal's most populous metropolitan region. In this study, we investigated the driving factors of land use changes in the valley between the years 1991 and 2000. GIS and AHP techniques were applied for land use changes detection and driving factors evaluation. Three geographic tiers (city core, fringe and rural areas) were delineated. An extensive fieldwork including interviews with local people and experts was conducted. Seven types of land use change factors for the valley, physiographic, facilities, opportunities, land price, population growth, political situation and plan/policies were identified. The contribution of these factors to change the landscape is evaluated for each tier separately. Among the seven driving factors, opportunities followed by facilities played a key role to change the landscape of the city core and fringe areas during the study period. Whereas these factors played less role in rural area as compared to physiographic and land price factors. The plans/policies factor played a weak role to change the landscape in all tiers. We conclude that the different driving factors of land use changes play different roles at different forms of settlements.

Keywords: LULC, Land use, landscape evaluation, driving factors, AHP

1. Introduction

Kathmandu Valley, a river basin forms the core of the Nepal's most populous metropolitan region where it has been important economically, administratively, and politically for hundreds of years. Since the last few decades, the fringe and rural communities are dealing with rapid changes to their surrounding landscape, livelihoods and communities, all across the valley. Along with these new changes within the city fringes and rural villages, shifts in biophysical environment and newly developed socioeconomic strains between residents are emerging (Thapa et al., 2007; Thapa et al., 2008). The complex process of converting rural land uses to urban

uses causes various impacts on ecosystem structure, function, dynamics and livelihood of human being. Given these impacts, understanding the mechanisms that drive the changes is crucial in the valley.

The emphasis is on investigating and identifying the causes of land use change to help inform policy goals relating to urban ecosystem in the valley. Technological advancement in data acquisition and data analysis techniques in recent years made easy to analyze spatial patterns of land use changes and its driving factors. GIS incorporating with Analytical Hierarchical Process (AHP) has been recognized as an effective tool for analyzing spatial patterns and causes that drive the pattern changes over time at a relatively large geographical scale (Thapa and Murayama, 2008a). In this paper we aimed to investigate the driving factors of land use changes and their contribution scale in Kathmandu Valley using the GIS and AHP methods.

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2. Database and methodology

A case study was carried out in Kathmandu Valley (Figure 1). The physiographic boundary plays an important role to allocate development resources in complex topography. Therefore, Kathmandu valley is delineated based on watershed boundary derived from 20-meter Digital Elevation Model (DEM). The valley is situated in Bagmati river basin within the geographic coordinates 27°31'55" to 27°48'56" North latitudes and 85°11'11" to 85°31'52" East longitudes. The valley has a complex topography where the altitude ranges from 1100 to 2700 meters high. The study area extends over 685 km² of area and had a total population of 1.5 million in 2001 where 63% were urban dwellers.

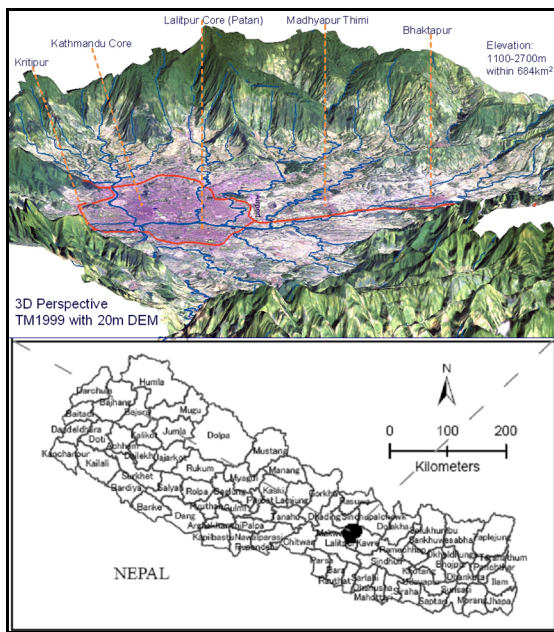


Figure 1: Study area: Kathmandu Valley, Nepal.

GIS and AHP techniques were used while assessing land use changes and its driving factors in the valley. A field survey equipped with global positioning system (GPS) and still camera was conducted to collect the location-based information. The GPS coordinates and photographs of each location were used for updating land use maps. Local experts meetings and focused group discussions were also accomplished during the field work. The information collected from the meetings and

discussions are used to determine the key driving factors of the land use changes.

Land use maps for the year 1991 and 2000 (Figure 2) as source data were used from the study of Thapa and Murayama (2008b). In contrast, five (road, airport, industrial area, government secretariat area and royal palace) of the twelve land uses have covered nominal geographic space at valley level analysis. Therefore, we merged these land uses into urban/builtup land use type making total six land uses for the change analysis.

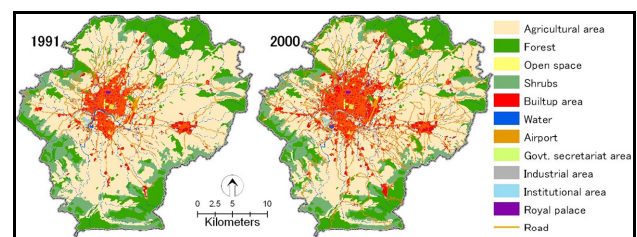


Figure 2: Land use maps of Kathmandu Valley (courtesy: Thapa and Murayama, 2008b).

The valley is further divided into three spatial tiers (city core area, fringe area and rural area) to identify the driving factors more in detail. Proximity distance from the ring road was computed to synthesize the tentative location of three tiers in the valley. This proximity map overlaid with changed area was used to visualize the study area for the respondents.

In this research, the AHP based fieldwork data modeling framework was developed to evaluate the driving factors of land use changes during the study period (Figure 3). This model evaluates the consistent weight of each factor through pair-wise comparison (Saaty, 1990; Thapa and Murayama, 2008a). A set of interview questionnaires for each study tier within the AHP framework was prepared. In the questionnaire, respondents can determine relative importance of each factor with respect to other, for example, importance of physiographic with respect to facilities, opportunities, land price, population growth, political situation and plan/policies and vice versa for each tier.

Total twenty-nine key respondents from various professional backgrounds (planners, researchers, professors and the people from civil society) were responded. A key criterion to select the respondent was he/she must have bachelor's degree of education and have long term residential experience in the valley. Furthermore, each key respondent was made aware about the tiers (urban core area, fringe area and rural area) through map (Figure 4). Then each respondent was able to evaluate the factors for these three study tiers simultaneously and independently. Altogether 29 matrices for each study tier were developed. An average matrix was computed from the 29 matrices for each tier. As per the AHP rule, reciprocal computation, value normalization, principal vector weights computation, consistency calculations were performed to the individual study tier, respectively (Figure 3).

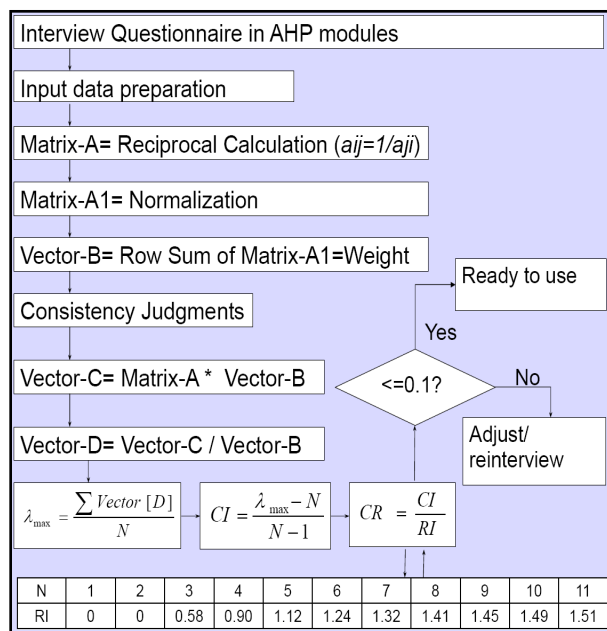


Figure 3: Field work information modeling in AHP framework.

3. Results and discussion

The urban/builtup area in the valley increased from 9% in 1991 to 13% in 2000 where the shrubs lands decreased from 12% to 9% and forest lands from 18% to 16% in the same periods. Agricultural land was the

dominated land uses as compared to others in the valley. However, the locations of agriculture lands have been changed significantly in urban rural fringe areas because of urbanization process in the past decade. In the valley floor (Figures 1 and 4); the agricultural land was changed to urban/builtup lands whereas in rural areas much of the shrubs and forest lands were transformed into agricultural uses. Interestingly, the open space was slightly increased in 2000 it was due to adding of new gulf courses, expansion of Gokarna Gulf Course at Rajnikunja and construction of Army Gulf Courses at Tribhuvan International Airport for example (for more detail see, Thapa and Murayama, 2008b).

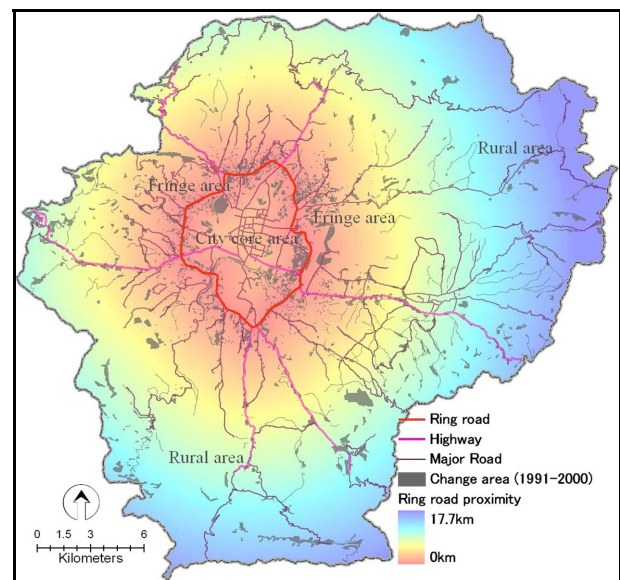


Figure 4: Three spatial tiers of valley landscape.

The Figure 4 shows the location of land use changes during the period of 1991-2000 and the proximity distance from the ring road as synthesis map of three tiers (city core, fringe and rural areas) of the valley. This map helped the key respondents to draw mind map of the landscape change locations and the study area while making decision in pair-wise comparison of the factors.

A schematic hierarchic relationship between the seven driving factors (physiographic, facilities, opportunities, land price, population growth, political situation and plan/policies) and the study tiers in the

valley is shown in Figure 5. The figure presents that there is a relationship among the factors and the three locations. Of course the degree of relationship and their contribution to land use changes can be different. Herein, the degree of relationship among the factors for each tier was evaluated by the key respondents. The information generated from the respondents was further modeled into AHP framework and measured in 1~100 scale.

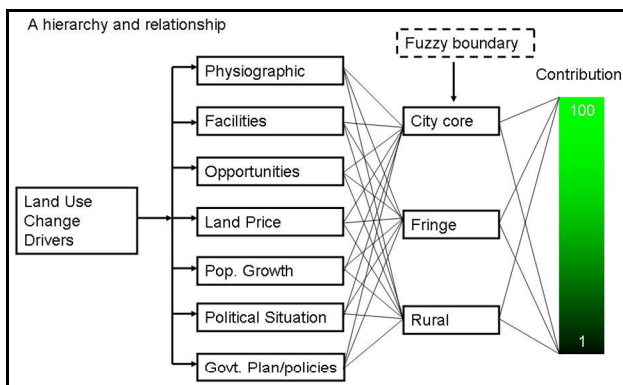


Figure 5: Hierarchical relationship between the seven driving factors and the three study areas.

The AHP modeling (Figure 3) enabled us to predict the contribution level of each factor to change the land use at different areas in the valley (Figure 6). The prediction results in all study zones are achieved within the acceptable sensitivity region of ≤ 0.1 . The opportunities factor is found prevalent to change the land in urban area. But the physiographic factor played key role to change the rural area. The land price factor exhibited greater role to change the rural landscape as compared to other areas. Lands in rural areas are being acquired at cheaper prices for new developments or land business. While in fringe area, population growth factor seems apparent to change the landscape as compared to the urban core and the rural area.

Government plan and policies seem less effective as compared to other factors in all study tiers. The decade long political conflicts in the country has also contributed to change the landscape as the sixth most factor. The result clarified that the political/conflicts factor contributed to change the rural landscape as compared to

the other areas.

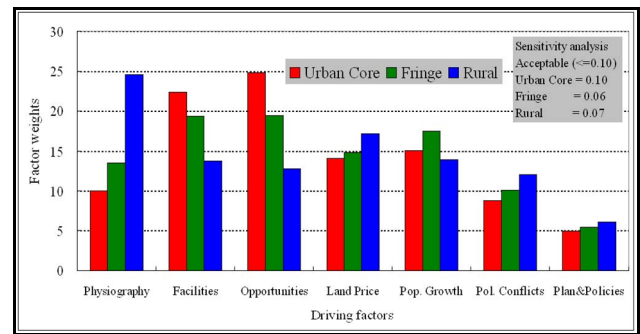


Figure 6: Driving factors and their relative contributions to change the valley landscape.

4. Conclusions

The integrated technique of GIS and AHP has enabled to reveal the driving factors of land use changes in the valley over the last decade. As we could see from the results; the different driving factors played different role at different landscape of the valley. People envision their surrounding environment and its change process as they interact with it in their daily life. Exploring and modeling of their views within modern geographic techniques to evaluate the land use changes leads this research results more empirical and original.

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