Vietnam J. Agri. Sci. 2016, Vol. 14, No. 10: 1530 -1539 Tạp chí KH Nông nghiệp Việt Nam 2016, tập 14, số 10: 1530 - 1539
www.vnua.edu.vn

APPLYING LOGISTIC REGRESSION MODEL TO ANALYZE THE RELATIONSHIP BETWEEN LAND USE CHANGE AND NATURAL - SOCIAL FACTORS: A CASE STUDY IN TIEN YEN DISTRICT, QUANG NINH PROVINCE

Nguyen Thi Thu Hien*, Nguyen Khac Viet Ba

Falculty of Land Management, Vietnam National University of Agriculture (VNUA)

Email: ntthientnmt@vnua.edu.vn*

Received date: 22.03.2016 Accepted date: 20.10.2016

ABSTRACT

The objective of this research was to analyze the correlation between land use change and the social-natural factors in Tien Yen district using logistic regression model. The target variable was land use change and the dependent variables were elevation, slope, distance to the main road, distance to the secondary road, distance to river and stream, distance to village, ethnology, policies, population density, population growth rate, and average food per capita. The model was run in SPSS (Statistical Package for the Social Science) software version 20. The results showed different relationship between land use change and social-natural factors in different periods. From 2000 to 2005, the land use change of Tien Yen increased with the increase of elevation, distance to the secondary road and Dao ethnic minority, whereas slope, distance to stream and Kinh, Tay, San Chi ethnic minorities decreased. In the period of 2005 - 2010, the land use change in Tien Yen have positive correlation with slope, ethnology and Government policies while elevation and distance to the main roads showed reverse correlation.

Keywords: Land use change, logistic regression, natural - social factors, Tien Yen district.

Ứng dụng mô hình hồi quy logistic phân tích mối tương quan giữa biến động sử dụng đất và các yếu tố tự nhiên – xã hội: trường hợp nghiên cứu huyện Tiên Yên, tỉnh Quảng Ninh

TÓM TẮT

Mục tiêu của nghiên cứu là sử dụng mô hình hồi quy logistic phân tích mối tương quan giữa biến động sử dụng đất và các yếu tố tự nhiên - xã hội huyện Tiên Yên. Biến phụ thuộc là biến động sử dụng đất. Các biến độc lập bao gồm độ cao, độ dốc, khoảng cách tới đường giao thông chính, khoảng cách tới đường giao thông phụ, khoảng cách tới sông, suối, khoảng cách tới thôn bản, dân tộc, chính sách, mật độ dân số, tỷ lệ tăng dân số, bình quân lương thực đầu người. Mô hình được chạy trên phần mềm SPSS.20. Kết quả nghiên cứu chỉ ra rằng, ở các giai đoạn khác nhau ảnh hưởng của các biến độc lập đến biến động sử dụng là khác nhau. Từ năm 2000 đến 2005, biến động sử dụng đất tăng khi độ cao và khoảng cách đến đường giao thông phụ tăng và ở khu vực người Dao, còn yếu tố độ dốc, khoảng cách đến suối và khu vực người Kinh, Tày, Sán Chỉ thì biến động sử dụng đất giảm. Trong giai đoạn 2005 - 2010, biến động sử dụng đất của huyện Tiên Yên có mối tương quan thuận với độ dốc, dân tộc và chính sách, trong khi yếu tố độ cao, khoảng cách tới đường giao thông chính có tương quan nghịch với biến động sử dụng đất.

Từ khoá: Biến động sử dụng đất, hồi quy logistic, huyện Tiên Yên, yếu tố tự nhiên - xã hội.

1. INTRODUCTION

Land use change is defined as natural status change of land cover on the Earth's surface, as well as result of complex interaction between natural and social processes (Muller and Munroe, 2007). Land use change can lead to different changes in natural resource such as modifying physical characteristics of soil, changing in vegetation and animals and impacting on factors of the climate.

Briassoulis (2009) seperated the impact factors to land use change variable into 2 groups, including the natural factor and socio - economic factor. The natural factor consists of geographic location, topography, climate, pedology… and natural processes impacts directly on land use change variable or interelated to human decision which leads to land use change, while the socio - economic factor impacts land use change including population, technology, economic policy, institution and culture.

The previous researches about land use change only covered the changes of land use in certain area using remote sensing and GIS (Muller, 2003). The modeling method was used to explain reasons that led to land use change, as well as to assess the impacts of land use change (White and Engelen, 2000; Verburg and Veldkamp, 2001). According to Muller and Munroe (2007), besides using modelling and case studies to verify land use change, statistical analysis is a powerful tool to use due to its capacity in hypothesis testing, factor ranking and strict checking of hypotheses. Recently, statistical analysis method was used in many researches about land use change (Wang *et al.*, 2012; Qasim *et al.*, 2013; Nguyen, 2008).

Nguyen Thi Thu Hien (2015) affirmed that the causes and effects of land use change differed among regions. A certain cause impacts strongly in land use change in this sector, but does not necessarily affects other sector. In Vietnam, researches that identify the causes and factors influencing land use changes have not been quantified by the rigid statistical analysis.

Tien Yen with a total natural area of 64,789 ha, is a coastal mountainous district located in the eastern part of Quang Ninh province. The district has not only multiform topography and biodiversity but also diversity of ethnic minorities such as Kinh, Dao, Tay, San Chi and San Diu… Before 2000, the land use in the district has already undergone significant changes, notably lots of forest land were lost. Moreover, a large area of mangrove forest was converted to aquaculture. In contrast, the areas with milpa, shrub and grass increased significantly. In the last few years, due to the local authority and people's efforts, one can see a significant recovery of forest area. Thus, it is necessary to analyze the relationship between land use change and natural - social factors.

2. STUDY AREA, MATERIALS AND METHODS

2.1. Study area

Tien Yen district has geographical coordinates is from 21°11' to 21°33' Northern latitude and from 107°13' to 107°32' Eastern longitude. Tien Yen's topography is seperated into two zones, the mountainous zone located in the northwest and the alluvial coastal zone located in the south. The climate of Tien Yen district is characterized by its mountainous tropical monsoon. The annual rainfall average is 2,117 mm and annual humidity average is 84%. Although, the forestland accounts for 75% of the district's natural area, but the land cover reaches only 48.9%. According to the data of Statistic Office of Tien Yen district (2012), ethnic minorities account for 49.8% of total population in Tien Yen district including the Dao, Tay, San Chi, San Diu, Hoa and other ethnics. The complex topography, along with short and sloping streams, large precipitation significantly impacts land resource management and use. Besides, the residence of the ethnic minorities in hinterland, alpine zone is also a cause that leads to land use change in the present study.

According to Nguyen Thi Thu Hien (2015), both natural and socio-economic element have an impact on land-use and overlay change. However, due to the differences in natural conditions and socio-economic characteristics, as well as land-use features, factors that affect land-use change, also differ from each area.

In this study, we conducted preliminary process of data from the survey, which identified, natural factors such as elevation, slope andsocial factors, including access to infrastructure, ethnic, policy, population growth rate, and average food supply that affect land-use changes in Tien Yen. Other socio-economic

factors such as income, labor force, etc., do not affect land-use changes in the region of Tien Yen. Factors for accessing to infrastructure are quantified by variable distance from the main roads, secondary roads, distance to the river, and distance to the village.

2.2. Materials

This study adopted SPOT images acquired in three years, 2000, 2005 and 2010, including the following:

- SPOT4 images were acquired in November 2000 with 4 bands: Mono-spectral band with 10 m of spatial resolution, the spatial resolution is 20 m in Green, Red and Near infrared bands.

- SPOT5 images were acquired in October 2005 and 2010 with 2.5 m of spatial resolution in Panchromatic band, and 10 m in Green, Red and Near Infrared bands.

These satellite images were tuned spectrum and adjusted geometrically following National Geographic Coordinate System (VN2000).

In addition, this study also used different maps to enhance the accuracy of image classification, such as topographic map with 1:50,000 scale, Digital Elevation Model (DEM), Land use status map in 2010 in Tien Yen district.

2.3. Research methodology

2.3.1. Remote Sensing and GIS methods

Firstly, the SPOT images were classified by ENVI software with Maximum Likelihood algorithm. As a result, there were 9 land use types, which were created by classification image process. Secondly, the result of classification image process was exported to ArcGIS version 10.0 to create land use maps. Finally, using overlap function of ArcGIS to create land use change map and to analyze land use change in Tien Yen district.

2.3.2. Logistic regression in SPSS software

The logistic binary regression technique in the SPSS statistical package version 20 was used to investigate the relationship between natural and social factors and land use changes.

The binary logistic regression analysis pattern form (Hoang Trong and Chu Nguyen Mong Ngoc, 2008) is:

$$\log(p1/p0) = e^{B_0+B_1.X_1+B_2.X_2+...+B_nX_n} \quad (1)$$

Where:

X1, X2,.., Xn: are the independent variables

B1, B2,.., Bn is the coefficient of the independent variables, B0: the constant

With 95% of the reliability, the independent variables were considered as significant and correlated with the fluctuations of land-use when P-value <0.05.

10,000 points were chosen randomly in Tien Yen district, each point is commensurate with 1 pixel. The dependent variable is land use change in Tien Yen district, which were coded 1 if change and 0 if no change. While, the independent variables include distance to main road, distance to secondary road, distance to river, distance to stream, elevation, slope, ethnic, policy, population density, population growth rate, average food per capita.

The elevation, slope map and distance variables were created by Spatial Analyst Tools in Arc GIS 10.0. Especially, the ethnic variable was determined based on ethnical distribution by Thiessen – Voronoi algorithm. Finally, the population density, population growth rate and average food per capita were obtained from statistical yearbook of Tien Yen district.In this study, the policy variable was only used in period 2005- 2010, because in this period "The program of socioeconomic development in extremely poor communes and ethnic minority communities in period 2006 and 2010" (Program 135) supported significantly for local people of 5 per 10 extreme poor communes in district. Thus, this variable was used to detect the impact of policy on land use change in Tien Yen district. The policy variable exists in binary type. In specific, this variable is 0 if the policy is implemented in the village, otherwise this variable is 1.

In 10,000 points chosen randomly on map, the elevation variable varies from 0 to 900m, and the distance variables run from 0 to 5km. Meanwhile the slope variable varies from 0 to 46 degree. As a result, it is difficult to analysis and explain meaning the variable in this study. Thus,

these variables were encoded in value groups which will help to analyze clearly. For ethnic parameters, each ethnic was allocated to a number 1, 2, 3, 4. The coding table of variables for regression model is shown in table 1.

These encoded variables were exported to logistic regression model in statistical processing software SPSS.20 in order to identify the correlation between natural-socioeconomic factors and land use change. The analysis was followed by stepwise forward conditional interactions in SPSS.20. The model will stop until estimated parameter is less than 0.001.

3. RESULTS AND DISCUSSION

3.1. Land use change in the investigated region

Land use change in Tien Yen district was determined by the method of land use map overlaying applied for 2000, 2005 and 2010 in Arc GIS 10.0. Its results in land use change map and change data in the periods of 2000 - 2005 and 2005 - 2010 are presented in Figure 1, and table 2 and table 3, respectively.

3.1.1. The period 2000 - 2005

In the period of 2000-2005, the total area of land use change is 13,705.20 ha, accounting for 21.15 percent of total natural land area. The outcomes of lands change calculation are shown in table 2.

The forest land and milpa - shrub land had the most significant change. Forestland was converted to other lands and recovered from other lands. The increased in mangrove forest area to 625.27 ha showed local authority,s efforts in reforestation.

3.1.2. The period 2005 - 2010

In the period 2005 - 2010, the area of land use conversion was 8,613.12 ha accounting for 13.29 percent of total natural land (Table 3).

Table 1. The code of independent variables for regression model

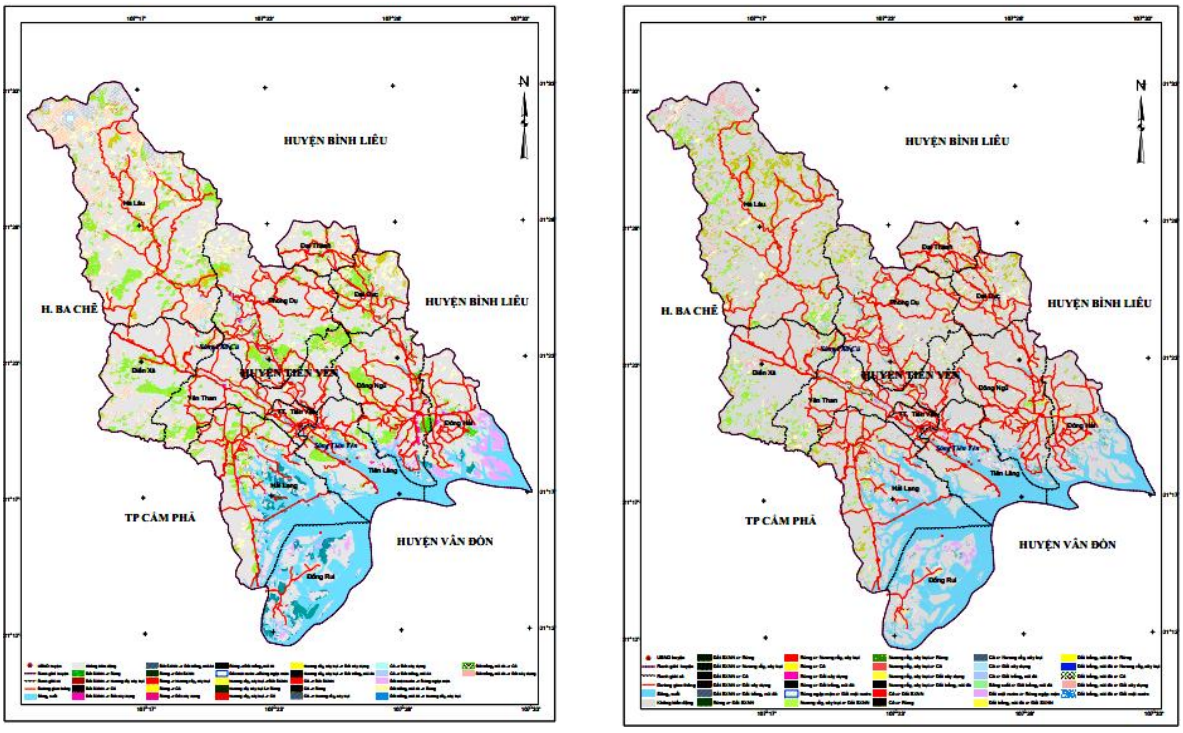
Variable	Unit	Code					
		1	2	3	4	5	6
Elevation	m	0-100	100-200	200-300	300-400	400-500	>500
Slope	degree	0-8	8-15	15-25	>25		
Distance to main road	km	0-1	1-2	2-3	3-4	>4	
Distance to secondary road	km	0-1	1-2	2-3	3-4	>4	
Distance to river	km	0-1	1-2	2-3	3-4	>4	
Distance to stream	km	0-0,5	0,5-1	1-1.5	1.5-2	>2	
Distance to village	km	0-1	1-2	2-3	>3		
Ethnic		Kinh	Tay	Dao	San Chi	Others	

Table 2. Land use change in the period 2000 - 2005 (Unit: ha)

Land use type	No change	Change	Conversion to other land	Conversion from other land
Paddy land	1,858.04	-354.12	515.56	161.43
Forest	29,958.04	2,374.34	3,863.39	6237.73
Mangrove forest	2,801.09	625.27	305.51	930.78
Milpa - shrub	2,760.21	-3,779.54	6,351.24	2,571.70
Grass	2,151.05	1,138.34	1,448.55	2,586.88
Built-up land	1,636.21	254.49	-	254.49
River	2,497.80	0.00	-	-
Water body	6,811.42	-625.27	930.78	305.51
Rocky mountain, bare land	610.68	366.50	290.16	656.66

Table 3. Land use change in 2005 - 2010 period (Unit: ha)

Land use type	No change	Change	Conversion to other land	Conversion from other land
Paddy land	1,847.44	117.75	172.04	289.79
Forest	34,066.84	1,542.57	2,128.93	3,671.50
Mangrove forest	3,618.56	1,095.30	113.32	1,208.62
Milpa - shrub	2,978.51	-420.62	2,353.40	1,932.77
Grass	2,352.08	-1,600.72	2,385.85	785.13
Built-up land	1,890.69	159.99	-	159.99
River	2,434.71	-63.09	63.09	-
Water body	5,908.31	-1,095.30	1,208.62	113.32
Rocky mountain, bare land	1,079.47	264.12	187.88	452.00



a) b)

Figure 1. Land use change map in Tien Yen district: (a) in 2005 - 2005 period and (b) in 2005 - 2010 period

Land use change in this period happened with forestland, mangrove forest, grass, built - up land, shrub and water surface land. Forest land area increased to 1,542.57 ha due to the conversion from milpa - shrub and grass land. Mangrove land went up to 1,095.30 ha since the conversion from water surface land. The rest of lands had insignificant change.

3.2. The correlation between natural-social factors and land use change in the investigated region.

Before passing variables to regression model, it is important to check multi – collinearity phenomenon, according to Gujarati and Porter (2008). If the Variance Inflation Factor (VIF) of variable is bigger than 10, that

variable is of a high multi – collinearity. Thus, this variable has to remove from the model. The multi – collinearity checking result of 12 independent variables in SPSS.20 showed that VIF of variables are from 1.203 to 2.252 and there existed no multi – collinearity phenomenon between independent variables. Therefore, all 12 independent variables passed to regression model.

3.2.1. The period of 2000 - 2005

With the data of the 2000-2005 period, the model stopped at the third step. The value of -2LL (-2 log likelihood) equal to 36.170 was not large, proving the validation of general model.

The values of significant parameters in the model are shown in table 4 with the confidence of 95%. Parameters are considered significant when P-value <0.05.

The parameters which showed significant correlation with land use change were slope, elevation, ethnic, distance to the secondary roads, distance to rivers and distance to streams. The distance to main road, distance to village, population growth rate, population density, average food per capita variables did not affect land use change.

With B coefficient determinated in model, the form of regresion equation is:

log (p1/p0) = 0.223 – 0.032 x Slope + 0.350 x Elevation +0.266 x Distance to secondary roads – 0.128x Distance to river - 0.136 x Distance to stream – 0.896 x Ethnic (1) – 0.348x Ethnic (2) +1.057x Ethnic (3) -0.742x Ethnic (4) (2)

Slope parameter has the value B of - 0.032, proving that it has a reverse correlation with land use change, meaning that if slope increases one level, the possibility of land use change shall decrease by $e^{-0,032}$= 0.969 time. In other words, if slope increases, the likelihood of change decreases.

The B coefficient of the Kinh, the Tay and the San Chi variables are -0.896, -0.348, -0.742, respectively. It means that the possibility of land use change in Kinh's zone, Tay's zone, San Chi's zone are 0.408, 0.706 and 0.476 time of the other zone, respectively.

The coefficient of Dao variable is 1.057, it means that the Dao affected strongly land use change. In the Dao's zone, the possibility of land use change increased 2.878 times as compared to other zones.

This could be explained as follows: the Dao ethnic group lives in locations far from traffic roads and relies mainly on slash-and-burn cultivation. Therefore, when local authority prohibits slash-and burn cultivation, implements sedentary and issue policies to support people in planting and caring of forest, the destroyed forest areas in the past are recovered. Hence, land use change in this location is mostly influenced by Dao ethnic group. Whereas, in the locations of Tay and San Chi minorities, since they concentrate in areas close to water resources, flat land and paddy rice cultivation, the forest area is less influenced by them. Moreover, in forestland allocation process, the area they received is not large, limited to 3 ha, and consequently, the land use change in San Chi's location is less than Dao's location.

For distance to the secondary roads and elevation parameters, the positive value of B means that the further distance to the secondary roads and the more elevated the locations are, the more probability of land use change. If the elevation rises 100 meter, the possibility of land use change would increase 1.42 times. If the distance to secondary road increases 0.5 kilometer, land use change variable would rise 1.305 times. This could be explained as follows: the delta and low hill mountain areas are place where people resided and cultivated for a long time. Hence, land use has less chance of change. Locations near the secondary roads, the land use change hardly takes place because the lands are managed tightly with high cultivation frequency, less abandoned land.

Table 4. The variables related to land use change from 2000 to 2005

Variable	(B)	S.E	Wald	P - value	Exp(B)
Slope	-0.032	0.003	86.196	0.000	0.969
Elevation	0.350	0.023	235.056	0.000	1.420
Distance to secondary road	0.266	0.035	59.283	0.000	1.305
Distance to river	-0.128	0.019	43.378	0.000	0.880
Distance to stream	-0.136	0.020	46.638	0.000	0.873
Ethnic (1)	-0.896	0.122	53.732	0.000	0.408
Ethnic (2)	-0.348	0.123	7.991	0.005	0.706
Ethnic (3)	1.057	0.134	62.138	0.000	2.878
Ethnic (4)	-0.742	0.127	33.967	0.000	0.476
Constant	0.223	0.143	2.426	0.119	1.250

Note: $\alpha = 0.05$; $R^2 = 0.77$; -2LL = 36.17

For distance to rivers and streams parameters, the negative value of B means that the further distance from rivers and streams the location is, the less chance of land use change. If the distance to river and to stream increases 0.5 kilometer, the land use change would decrease 0.880 and 0.873 time, respectively. In Tien Yen district, cultivation system mainly relies on natural water resource. Therefore, the further distance from water resource the location is, the more difficult the cultivation is. So the land in this area is less fluctuated.

Therefore, the land use change in the period 2000-2005 in Tien Yen district depends on slope, elevation, distance to rivers, streams, distance to the secondary roads and ethnic groups. The more elevated and further distance to the secondary the areas are, the more likely f land use change happens. If the locations are of much slope and far distance to water resources, the possibility of land use change will decrease. The area in which Dao ethnic group is living has more chance for land use change than the living areas of Kinh, Tay, San Chi ethnic groups.

3.2.2. The period 2005 - 2010

Applying stepwise regression, similar to data of 2005 - 2010, the running model stopped at step 5 with the value of -2LL = 50.22, proving the validation of model.

With the significance level of 0.05 ($\alpha = 0.05$), the parameters influencing the probability of land use change in this period are presented in table 5.

Table 5. The variable correlated with land use change in the period 2005 - 2010

Variable	B	S.E	Wald	P-value	Exp(B)
Elevation	-0.101	0.020	24.856	0.000	0.904
Slope	0.014	0.003	19.918	0.000	1.015
Distance to main roads	-0.119	0.023	26.965	0.000	0.887
Ethnic (1)	0.904	0.141	40.976	0.000	2.470
Ethnic (3)	0.501	0.152	10.823	0.001	1.650
Ethnic (4)	0.331	0.146	5.122	0.024	1.393
Policy	0.524	0.061	72.605	0.000	1.689
Constant	-1.235	0.134	84.409	0.000	0.291

Note: $\alpha = 0.05$; $R^2 = 0.73$; -2LL = 50.22

It can be seen clearly from the table 5 that the parameters influencing land use change were slope, elevation, distance to main roads, ethnic and policy. Slope, ethnic and policy parameter were proportional to land use change while elevation, distance to main roads were disproportionate to land use change.

The form of regression equation in period of 2005 – 2010 is expressed as:

log (p1/p0) = -1.235 – 0.101x Elevation + 0.014x Slope - 0.119x Distance to main roads + 0.904x Ethnic (1) + 0.501x Ethnic (3) + 0.331x Ethnic (4) + 0.524x Policy (3)

The coefficient of elevation variable was -0.101. It means that slope correlates positively with land use change. The result of regression model showed that if the elevation increases 100 meters, land use change would decrease 0.904 time. This can be explained as follows: in period of 2005 – 2010, the land use change occurred mainly in forestland due to afforestation. In the low contour/belt, forest was restored mainly due to afforestation, while in the protected forest, restoration of natural forest led to change in land use. Therefore, land use change in afforestation zone certainly was faster than that in restoration zone of natural forest.

The parameter of regression model showed that the B coefficient of slope variable was 0.014. Thus, slope factor affected rarely land use change in this period. If slope raises one level, the possibility of land use change would increase 1.015 times.

The parameters of model show that the more elevated and further distance to the main road the area is, the less likelihood of land use change takes place. This could be explained as below: in this period, the land use change is mainly the result of forest restoration area, which is lost in the past. Hence, the forest will be early recovered in the location where people are able to plant trees easily.

The calculated results indicates that the ethnic groups of Kinh, Dao, San Chi have impacts on land use change in which the change influence of Kinh, Dao and San Chi is ranked in descending order. In this period, people were aware of economic benefits from forest; hence, they were motivated to participate in planting, cultivating and protecting forest. Kinh ethnic lives in hill mountain areas, they are pioneers in accepting forest contracts from Tien Yen state forest enterprise. Meanwhile, Dao and San Chi people, who are supported by government, confidently receive land to cultivate forest of mainly acacia, pine and cinnamon trees.

The coefficient of policy variable was 0.524. It means that policy is one of the factors positively affecting land use change. In the policy implementation zone, land use change increases 1.689 times than other zone.

Hence, in the period 2005-2010, the factors concerning to land use change were slope, elevation and distance to main roads. For Kinh, Dao and San Chi ethnics, the more elevated and further distance to main roads districts is the less likelihood of land use change takes place. If slope increases, the possibility of change goes up. The change probability of Kinh, Dao and San Chi is in descending order. The outcomes of model also indicate policy factors positively impact on land use change.

4. DISCUSIONS

It is witnessed from the parameters used to determine the correlation with land use change that the influence of parameters varied in different periods. The results comparing the influence of parameters on land use change are illustrated in table 6.

Factors which correlate with land use change are elevation, slope, distance to roads, distance to river, stream, ethnic and policy. Factors which have no correlation with land use change in both investigated periods are distance to villages, population growth rate, population density and average food per capita.

Table 6. Impact of independent variables on land use change

Independent variable	Parameters B	
	2000 - 2005 period	2005 - 2010 period
Elevation	+0.350	-0.101
Slope	-0.032	0.014
Distance to main road	0	-0.119
Distance to secondary road	+0.266	0
Distance to river	-0.128	0
Distance to stream	-0.136	0
Distance to village	0	0
Ethnic 1 (Kinh)	-0.896	0.904
Ethnic 2 (Tay)	-0.348	0
Ethnic 3 (Dao)	1.057	0.501
Ethnic 4 (San Chi)	-0.742	0.331
Policy	*	0.524
Population growth rate	0	0
Population density	0	0
Average food per capita	0	0

Note: (+) positive correlation; (-) negative correlation; (0) no correlation; (*) don't exist in model

In the initial period from 2000 to 2005, the main roads in the district did not meet the demand, causing traffic inconvenience. Therefore, the main road factors did not affect the land use change. However, in the period 2005 - 2010 when national roads, i.e. 18A, 18C, 4C, were expanded and upgraded, main traffic factor had correlation with land use change. The further distance from main road the location is, the less the change likelihood is. If distance to main road increases 1 kilometer, the possibility shall decrease 0.887 time.

The ethnic variable, the Kinh, the Dao, the San Chi correlated with land use change in period of 2000 - 2005. The Kinh and the San Chi had negative correlation with land use change. In contrast, the Dao correlated positively with land use change. While, land use change increased in both of the Kinh's zone, the Dao's zone and the San Chi's zone in period 2005 - 2010.

The policy towards districts in Program 135showed positive correlation with land use change. In other words, the regions in Program 135 were more likely to experience land use change than others. This means that the location in which the people are supported by Program 135 has more recovered forest area than others.

Thus, regarding the conditions in Tien Yen district, the natural and social factors affect land use changes, but in different periods, such effects also vary in dimension and the level of impact. As such, in order for land use changes to take place in the uptrend of the forestland, there is a need to implement incorporated policies of sedentary farming and settlement, agriculture and forestry land allocation, and community support in reforestation. When implementing such policies, it is critical to consider natural geographic features of each region in line with the conditions and customs of the people, especially ethnic minorities such as Tay, Dao, San Chi.

5. CONCLUSION

This study applied successfully spatial analysis function of GIS and logistic regression to determine the correlation between natural –

social factors and land use change. The result of this study showed that each independent variable has different influence on land use change in each period.

In the 2000 - 2005 period, the variables correlated with land use change were elevation, slope, distance to the secondary road, distance to river, stream and ethnic. Particularly, negative correlations only occurred in Kinh, Tay, and San Chi ethnic. In contrast, positive correlation occurs in Dao ethnic.

In the 2005 - 2010 period, the variables correlated to land use change were elevation, slope, distance to the main road, ethnic groups (Kinh, Dao, and San Chi) and policy. The result of logistic regression model indicated that Program 135 impacted positively on land use change, meaning that it enhanced the capacity of forest restoration in comparison with other regions.

REFERENCES

Briassoulis, H. (2009). Factors influencing land use and land cover change. In: Land use, land cover and soil sciences, Vol 1, Verhey, W.H., Encyclopedia of Life Support Systems (EOLSS), Chapter 5, pp. 125 - 145.

Gujarati, D. N. and Porter, D. C. (2008). Basic Econometrics, Fifth Edition, Publisher McGraw-Hill Higher Education.

Hoang Trong and Chu Nguyen Mong Ngoc (2008). Research Data Analysis with SPSS. Hong Duc Publisher.

Muller, D. (2003). Land-use change in the Central Highlands of Vietnam, Institute of Rural Development Georg-August-University of Gottingen Germany.

Muller, D. and Munroe, D. K. (2007). Issues in spatially explicit statistical land use/cover change (LUCC) models: Examples from western Honduras and the Central Highlands of Vietnam. Land use Policy, 24: 521 - 530.

Nguyen, T. T. H. (2008). Driving forces of forest fover dynamics in the Ca River Basin in Vietnam, Journal of Science and Development, pp. 31 - 43.

Nguyen Thi Thu Hien (2015). Assessment of land use change and recommendation on the sustainable land use and management - Case study in Tien Yen District. Land management PhD Thesis. Viet Nam National University of Agriculture, p. 35.

Qasim, M., Hubacekb, K. and Termansen, M. (2013). Underlying and proximate driving causes of land use change in district Swat, Pakistan. Land Use Policy, 34: 146 - 157.

Statistic Office Tien Yen District (2012). Statistical Yearbook Tien Yen District 2011.

Verburg, P. H. and Veldkamp, A. (2001). The role of spatially explicit models in land-use change research: a case study for cropping patterns in China. Agriculture, Ecosystems and Environment, 85: 177 - 190.

Wang, J., Chen, Y., Shao, X., Zhang, Y. and Cao, Y. (2012). Land-use changes and policy dimension driving forces in China: Present, trend and future. Land Use Policy, 29: 737 - 749.

White, R. and Engelen, G. (2000). High-resolution integratedmodelling of the spatial dynamics of urban and regional systems, Computers Environmentand Urban Systems, 24: 383 - 400.