RESEARCH ON URBAN CHANGES IN A RELATIONSHIP WITH GEOGRAPHICAL FACTORS IN THE WESTERN REGION OF HANOI DURING THE PERIOD 2000-2014

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ABSTRACT

Hanoi, the capital of Viet Nam, has experienced three times of administrative boundary expansion (1980, 1991 and 2008). It becomes one of the 17 largest capitals in the world since the last change, facing the rapid urbanization speed in either developed or under-developed areas. However in accordance with the urbanization, various problems are rising. The population density in Hanoi (2059 people/km^2) likes fifty times as much as the standard number by United Nations (UN) and this number has concentrated in some west districts of Hanoi center. Urban population congestion has burdened on lack of settlement space, traffic jam and environmental pollution in central districts of Hanoi. In general, Hanoi likes an urban sprawl while in many sub-urban districts (Hoai Duc, Tu Liem, Thanh Tri, etc.) which several newly built settlement villas and blocks have been vacant. Based on this situation, this research has been conducted in order to identify the urbanization trend of Hanoi from 2000 to 2014 and find out the most effective element to these changes.

By regression multiple logistic methods, remote sensing and GIS, the research will obtain three following results: (1) presents the changing trends in construction land area in the period of 2000-2014; (2) shows the correlation between urban distribution and geographical factors; (3) and indicates the main factor affecting on transition of construction land in the western of Hanoi from 2000 to 2014, in order to contribute for the planning and urban development of Hanoi capital.

Keywords: Regression multiple logistic, remote sensing, GIS, urban, western region of Hanoi

1. Introduction

Hanoi is a civilization land thousands of years, is the heart of Viet Nam; the political - administrational center with the traditional culture, science, education and economy. Hanoi, the capital of Viet Nam, has experienced three times of administrative boundary expansion (1980, 1991 and 2008). It becomes one of the 17 largest capitals in the world since the last change, facing the rapid urbanization speed in either developed or under-developed areas. [3]

However in accordance with the urbanization, various problems are rising. The population density in Hanoi (2059 people/km^2) likes fifty times as much as the standard number by United Nations (UN) and this number has concentrated in some west districts of Hanoi center. Urban population congestion has burdened on lack of settlement space, traffic jam and environmental pollution in central districts of Hanoi. In general, Hanoi likes an urban sprawl while in many sub-urban districts (Hoai Duc, Tu Liem, Thanh Tri, etc.) which several newly built settlement villas and blocks have been vacant. Based on this situation, this research has been conducted in order to identify the urbanization trend of Hanoi from 2000 to 2014 and find out the most effective element to these changes. [4]

These elements have been relating to the urban-space expansion in Hanoi include both natural and socioeconomic factors. Most previous studies about the urbanization in Hanoi which just using satellite imagery to focus on land cover changes - associated with economic activities, policies and management plans, without regard to the natural elements. Assessment in the

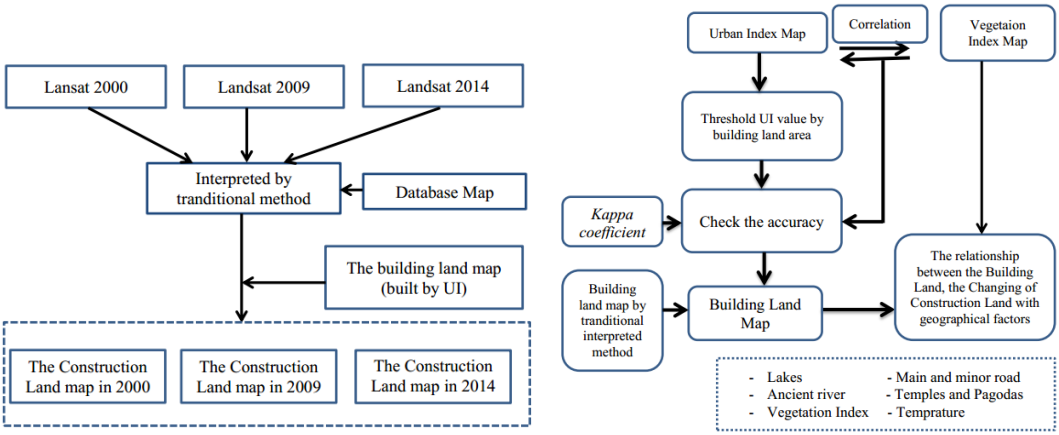
changing of building density in Hanoi from 2000 to 2009 aims to find out their advantage and disadvantage in the past, present and future, to meet the current needs and to forecast the rules of urban development. It serves as a basis for the land management, and for the sustainable development. [2]

2 Materials and Evaluation Model

2.1. Materials

• Landsat ETM + satellite image including 7 channel, 30m resolution were taken in 2000 and 2009 by Landsat 7 and 8 with 8 digital channels were taken on May 3/2014 is calibrated to the UTM coordinate system, projection WGS 84, zone 48N (excluded cloud and shadow noises). A land use map in the western of Hanoi in 2008; Topographic maps, database in research area; reports and statistical yearbooks of Hanoi in 2000, 2009, 2012.

2.2 Evaluation Model



Picture 1: Evaluation Model (Step 1: Left; Step 2: Right)

By regression multiple logistic methods, remote sensing and GIS, the research will obtain three following results: (1) presents the changing trends in construction land area in the period of 2000-2014; (2) shows the correlation between urban distribution and geographical factors; (3) and indicates the main factor affecting on transition of construction land in the western of Hanoi from 2000 to 2014, in order to contribute for the planning and urban development of Hanoi capital.

3. Results and discussion

3.1. Mapping building land in research area in period 2000 - 2014

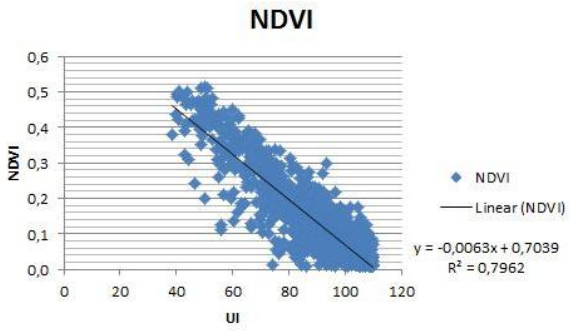
Normally, the land use or construction maps established by the traditional interpretation method, this study used UI (urban index) to establish the building land. Seventh channel and Fourth channel in Landsat image will be used to calculate this index. This index indicates the construction land area corresponding to the high pixel value with the formula: UI = [(B7 – B4) / (B7+B4) + 1] * 100; After calculating the Urban Index value in 2009 and 2014, study classified threshold UI value by building land area, accordingly UI > 80 in 2009 and UI > 97 in 2014 for the construction area. Because these results were the visual thresholds, they should check the accuracy by 2 methods used to verify that: Check Kappa coefficient and with vegetation index (NDVI).

Method 1: Check by Kappa coefficient

Based on the current population (point data) in 2010 and land use map in 2009 and 2014, they will be compared with the value of Urban Index in 2009 and 2014 has just created.

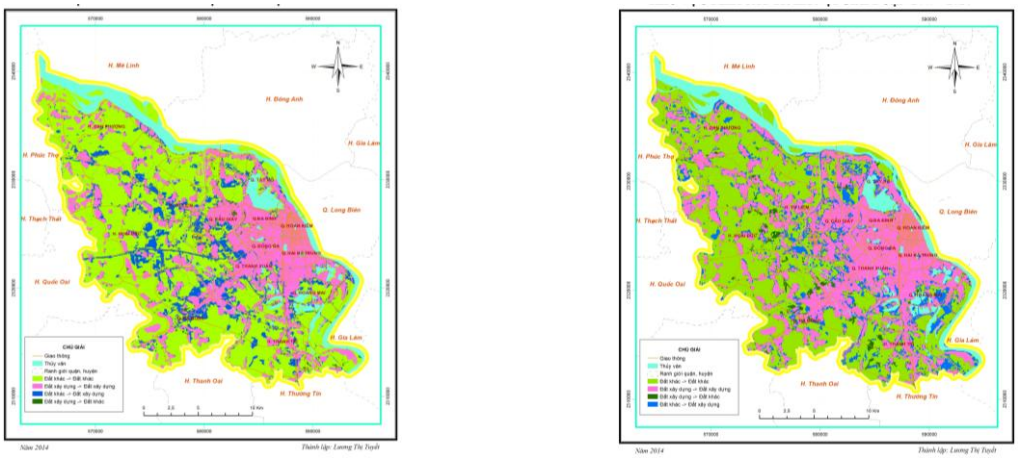
Calculate Kappa coefficients using the formula: K = A / B, Where: A = number of points classified correctly - Misclassification score; B = the total number of points are classified. The results of the Kappa coefficient are 0.62 and 0.61 for 2009 and 2014, respectively. With these numbers, it is ensure for threshold process relatively but it will be necessary to check with the vegetation index, in order to standardize input data for next steps.

Method 2: Assessment the relationship with vegetation index (NDVI)



The existence of construction and plant objects are two closely related conditions. Calculation of vegetation indices could show the urbanization rate of the study area. The relationship between UI and NDVI indices can check by testing them in the downtown area. Get 1400 points in the inner city of 7 districts of Hanoi as the study UI and NDVI indices relationships. Removing the points fall on the lakes and rivers, or putting UI and NDVI values at each point and then export to excel and draw a correlation diagram for assessment. The analysis results showed that the relationship between UI and NDVI index is represented by a linear function and building land density closely associated with the appearing of vegetation. It is easier when having the high UI value while the low NDVI in the urban area of Hanoi and the threshold value > 80 is the threshold of building land area can serve for research (2009)

3.2. Mapping construction land changing of two periods 2000-2009 and 2009-2014

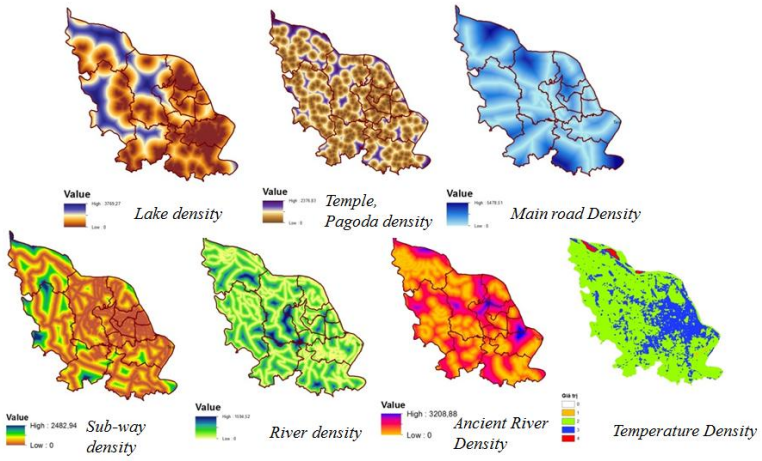


Picture 2: The construction land changing map in period 2000–2009 and 2009-2014

Based on the building land map has been established, the construction land changing map will be maken by overlay mapping building map in three years, serve for the assessment with geographical factors. Through construction period 2000 - 2009 shows the trend of the extending of construction, mainly in western and northwestern, especially along major roads such as Thang Long Highway, Highway 32, Highway 6 where appearing of the urbanization from agricultural land occurs mainly in Ha Dong, Tu Liem and Hoai Duc districts. The area of agricultural land decreased not only meet the needs of the land but also related to the services expansion and recreational amenities. Urbanization in this stage should mention to the giving of the agricultural land for road and highways.

The analytical results from the construction land in period 2009 - 2014 shows the development of the western disticts in Hanoi capital after six years of the expantion. But unchanging construction land have not many as period 2000 - 2009 but it has shown the speed of urbanization strongly suburbs. In six years, the construction land area increased by 3.209,3 ha (from 18.324,8 ha to 21.533,6 ha in period 2009-2014). The building land areas were mainly built in the following districts: Tu Liem, Hoang Mai and Thanh Tri.

3.3. Research the relationship between the Building Land, the Changing of Construction Land with geographical factors



Picture 3: Gegraphical factors maps

To examine the correlation between geographical factors, economic - social construction land and construction land changing, study has used Logistic Regression Analysis. This method should determine the independent variables (explanation variables) dependent variables (explanated variables). From the received datas have been taken into process by spatial data will determine the probability ranges from 0 - 1 at each point in the study area. This study will deeply research into the relationship between the construction land, the changing of construction land with natural-social factors. Such variables will be determined as follows: The dependent variable is the changing of building land was built by UI value and the current building land variable which built in 2009 and 2014. For the first data: The changing areas have number One and the unchange areas have number Zero. For the current building land in 2009 and 2014, the building areas have number One, other land is Zero. The independent variables included: distance to rivers, streams, lakes, ancient rivers; distance to main roads, secondary roads (minor); vegestation index and temperature. The distance variable is constructed from database map and spatial analyst tools (*Euclidean distance)*. The temperature variable is based on a calculation formula for sixth-channel satellite images in Landsat ETM +. These variations have existd in two types which are binary (0;1) and quantitative (continuing variables). Thus the binary variables are the building land variables in three years. The geographical factors variables are quantitative ones. All datas were included in the XLSTAT software to analysis the corelation for each other. According to the Logitical Regression Analysis results, it will be the significant variables when their values satisfy: (Pr <X2) <0:05, the other values on the principles of statistics are not meaningful and will be removed.

a, Logistical Regression Analysis for the current building land in 2009

Table 1: The correlation between construction land in 2009 with the geographical factors

	Value	Pr > X2	Sd	Rest

Distance to Temples and Pagodas	- 0.35	<0.0001	0.011	0.998
Distance to Rivers	0.088	0.004	0.01	1.000
Distance to Ancient rivers	0.136	<0.0001	0.01	1.000
Distance to Main roads	-0.212	<0.0001	0.01	1.000
Distance to Minor	-0.224	<0.0001	0.01	0.999
Temperature	0.059	<0.0001	0.04	0.875
Vegetation Index	-0.097	<0.0001	0.024	0.359

According to calculations above, based on positive and negative parameters of each variable, it can be inferred relationships each factor and construction land. In 2009, the correlation between building land and the distance to road, to temples and to pagodas are negative that mean: the further to these positions construction land with road, temples and pagodas is, the less to the number of the construction land. On the contrary, the correlations between this land-use type and the distance to river and the ancient River are positive. All of that are coincident with the fact. The area around pagodas, temples or main road is suitable to build houses but it is favorable for these around river or the ancient river for agriculture or fishery. Although with the development of technology the weak land is improved to increase the construction land and it needs to be interpreted carefully because of unexpected results.

b, Logistical Regression Analysis for changing of construction land in 2000 - 2009

Table 2: The correlation between the changing of construction land in period 2000-2009 with the geographical factors

	Value	Pr > X2	Sd	Rest
Distance to Ponds and Lakes	0.058	0.014	0.023	1.000
Distance to Main roads	0.069	0.013	0.027	1.000
Distance to Minor roads	0.115	<0.0001	0.025	1.000
Vegetation Index	-0.336	<0.0001	0.025	0.346
Temperature	-0.056	0.044	0.024	0.359

The table above showed that the distance to road; lakes and river is positive with the changing of construction land in this period. The facts indicated that the process of urbanlization is strong and stronger with the significant rising of population which lead to whole areas (from 1 to 2 km) placed surround the main and minor road will be used completly. In past, these areas were fields but now they become apartments and industries, etc. because of the increase in social demands.

c, Logistical Regression Analysis for the current building land in 2014

Table 3: The correlation between construction in 2014 with the geographical factors

	Value	Pr > X2	Sd.	Rest
Distance to Ponds and Lakes	0.071	0.014	0.02	1.000
Distance to Main roads	-0.109	<0.0001	0.02	1.000
Distance to Ancient rivers	0.040	0.038	0.019	1.000
Distance to Rivers	0.063	0.010	0.019	0.9
Distance to Temples and Pagodas	-0.164	<0.0001	0.02	1.000

The analysis results showed that the construction land in 2014 have been correlated with layers: Distance to lakes, distance from main roads, ancient river, current river and temples. The dependence upon negative and positive in this table have entirely the same results in the construction land in 2009. Expecially, the construction building areas in 2009 and 2014 have been correlated most strongly with the distance to temples.

d, Logistical Regression Analysis for changing of construction land in 2009 - 2014

Table 4: The correlation statistical between the changing of construction land in period 2009 - 2014 with the geographical factors

	Value	Pr > X2	Sd.	Rest
Distance to Ponds and Lakes	0.146	<0.0001	0.024	1.000
Distance to Main roads	0.14	<0.0001	0.023	1.000
Distance to Ancient rivers	0.05	0.034	0.023	1.000
Distance to Temples and Pagodas	0.203	<0.0001	0.022	1.000

The results showed that fluctuations in the construction land is not only dependent on factors distances to lakes, distance to main roads in the period 2000 - 2009 which depends on the other factors such as distance to the ancient river, distance to the temples. The correlation between the construction land and the distance to ancient rivers is 0.05 (positive) that means the changing is directly propotional to this type of variable. The more society develos the more demand increase then the widerning or renewing urban area are necessary and suitable with depvelopment rules.

4. Conclusion

After expanding of the administration boundaries, Hanoi has been changed incrediblly by horizontally and vertically. In the period 2000 – 2014, the building land density increased fastly, especially the main roads which have connected many downtowns, uptowns and the center area in Ha Noi. Combining spatial analysis in GIS and logistic regression models in statistical analysis, the report makes clearly the relationship between the natural – social factors and the changing of construction land.

Using UI index and Landsat image in calculating building area with high precision level (Kappa coefficients > 0.6). Through analysis process, study found that the changing of construction land in nearly 14 years is totally suitable with development rules. The national development inevitably leads to increased demand for infrastructure. Urban Architecture will vary by the variation of the infrastructure. With the research in building land subject, it will be necessary and helpfully for managers and planners in Ha Noi capital to find out the relationship between the geographical factors and construction land in period 2000 – 2014.

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