Spatial Analysis for Mitigation the Environmental impacts of Ho Chi Minh Road

TUAN Vu Anh, Vietnam

Key words: GIS, spatial analysis, environment, Ho Chi Minh road

SUMMARY

Ho Chi Minh Road is an important complementary for the existing trans-Vietnam road network. However, it has caused serious environment impacts through its negative effects to the forest corridor of the middle of Truong Son (Trung Truong Son). In such circumstance, the restoration of the forest corridor along Ho Chi Minh Road is one of the most important measures for mitigation of the environmental impacts of Ho Chi Minh Road. The healthy forest corridor will reduce the soil erosion, land slide and maintain the habitat of wildlife. The forest corridor restoration process depends strongly on the present situation of the forest cover. Accordingly, the key sites for forest corridor restoration should be implemented in the most vulnerable places where the negative impacts of Ho Chi Minh Road are detected.

To point out the area where forest need to be restored and how to restore it, the spatial analysis of GIS has been used. We calculated the map of stability index; the map of road bisect and habitat breakages. The results show the key sites for forest restoration as well as suggested intervention method.

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1. INTRODUCTION

The Ho Chi Minh road runs through much of the western edge of the Central Truong Son area which is the significant biodiversity importance in Vietnam, being identified by WWF as one of the most important eco-regions in a global assessment. The area is home to unique and endangered species such as the saola, doucs, tiger and elephant. The landscape also has immense cultural importance for numerous indigenous people, who lead a lifestyle closely associated with natural resources.

This road has had impacts during its construction and will inevitably have longer term impacts as areas of forest become more accessible and the cumulative impacts of long-term erosion on aquatic resources, soil loss and the physical impact on the road itself take hold.
To identify the environmental impacts of the road in term of landscape ecology, the study used the spatial analysis to the landscape accessment: Identification of areas where the road bisects forest areas (remote sensing and spatial analysis); District level quantification of habitat breakages caused by road construction; Identification of key sites for forest corridor restoration (plantation on bare slopes caused by construction or landslides); Recommendations for the restoration of forest corridors bisected by the road.
The models had been build and used for as much as possible qualitatively spatial analysis. We used a model for habitat breakages analysis, model for key sites specification and model for pointing out the recommendations for the restoration of forest corridors.
The result shows the role of remote sensing data as well as the spatial analysis in application of the large area.

2. SPATIAL ANALYSIS APPLIED AND RESULT

2.1 The study area

The study area is three provinces of Viet Nam, where the Ho Chi Minh road runs on the Truong Son mountain: Quang Tri; Thua Thien – Hue ; Quang Nam and Kon Tum which is shown on figure 1.

However, because of the study aims to get the analysis at district level, all and only districts of the provinces where the road display has been chosen.

2.2 Data used

Most important of data used is the information collected from two field trips and other data. Totally, data at 78 points have been collected. Parallel to the observation point information collection, all the residential area is quickly marked by GPS points. Any site there is more than 3 houses will be marked as a residential point. There are more than 200 residential point has been marked.

Beside the field data, we also used the auxiliary data for GIS analysis of erosion impact assessment and landscape ecology analysis. The data used are:

- Topographic data: The DEM of the study area is used to calculate the slope map; elevation map; analysis the stability index; analysis the topographic condition;
- Satellite image: The satellite image is used to classify the present land cove;
- Administrative map;
- Hydrology map

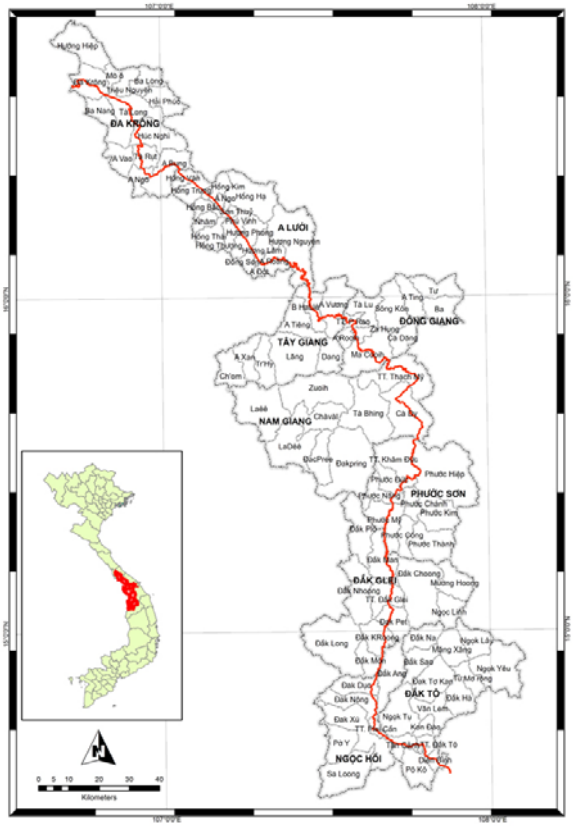


Figure 1: The study area

2.3 GIS analysis for identifying areas where the road bisects forest areas

The Ho Chi Minh road bisects many forest areas in the study area. This is can be recognized when we go along the road and see the bisect area. However, the effects of the road to the forest are difference due to the distance. It means that we need to count the size of the forest in estimation the bisect area.
Based on the field observation, we take size of forest along the bisect area as: smaller than 50m - the bisect is true, but the road effects to forest can be considered as low level; from 50m to 100m - the bisect is true, and the effect is considered as moderate level; more than 100m - the bisect is completely true

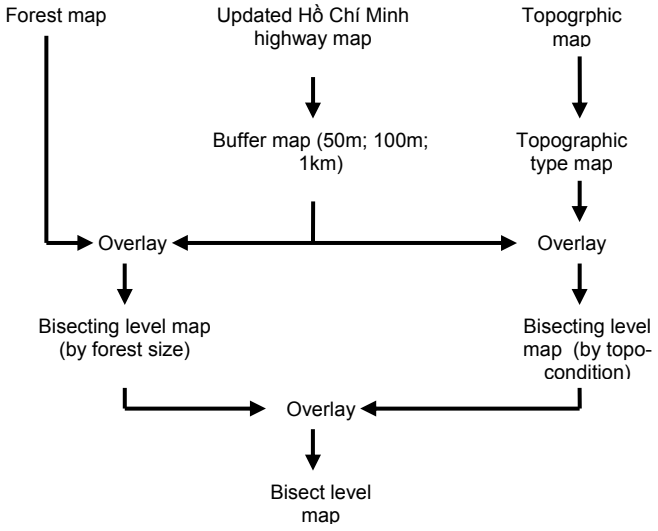


Figure 2: Steps for "bisect level" mapping

and effect is considered as high level.

Another aspect need to be considered in the bisect forest of the Ho Chi Minh road is the topography type. During the field trip, we considered that the effect of the topography types to bisect of the Ho Chi Minh road to forest as:

- Type 1: the Ho Chi Minh road is on slope: The bisect will be exaggerated in term of erosion due to it concentrate water and create bigger flow.
- Type 2: the Ho Chi Minh road is on pass. In this case, the HCM makes decreasing of the land cover in the pass and nearby area and it is reason to increase the soil erosion.
- Type 3: the Ho Chi Minh road is on narrow valley (with river). This types is not countable effected to the bisect due to it effect only in one side of the road beside the river can be considered as a natural bisection.
- Type 4: the Ho Chi Minh road is on wide valley (with/without river). In this case, the soil erosion is not strong in general. Hence, the bisection of the forest from HCM is considered as moderate level.
- Type 5: the Ho Chi Minh road is on flat area (or highland). This type of topography has effect to the bisection similar the above case.

From the analysis effect of the topography types and size of forest bisected, to estimate the area where and how much the Ho Chi Minh road bisects forest area, we use the model as follows:

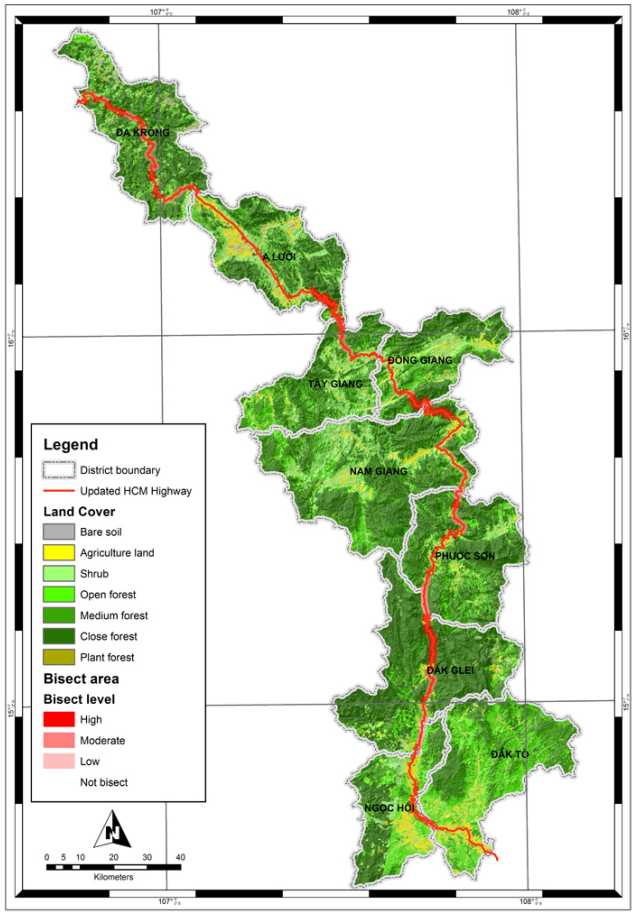


Figure 3: Bisect level map

Bisecting level	*Conditions*							
	Forest buffer			*Topography*				
	50m	100m	1km	Type 1	Type 2	Type 3	Type 4	Type 5
Low	x					x		
Moderate		x					x	x
High			x	x	x			

To point out where the Ho Chi Minh road bisects forest and how critical it is, we used spatial analysis in GIS. The steps are described in figure 2 and the result is shown in figure 3.

2.4 Quantification of habitat breakages

It is clear that the existing of the Ho Chi Minh road makes the habitat breakages because it bisects forest area – the habitat in this case. Where the road comes, the people concentrates and the habitat breakages. In other way, habitat breakages is consequence of human actions which is because of the existing of road. The habitat breakages of Ho Chi Minh road can be considered through the factors as:

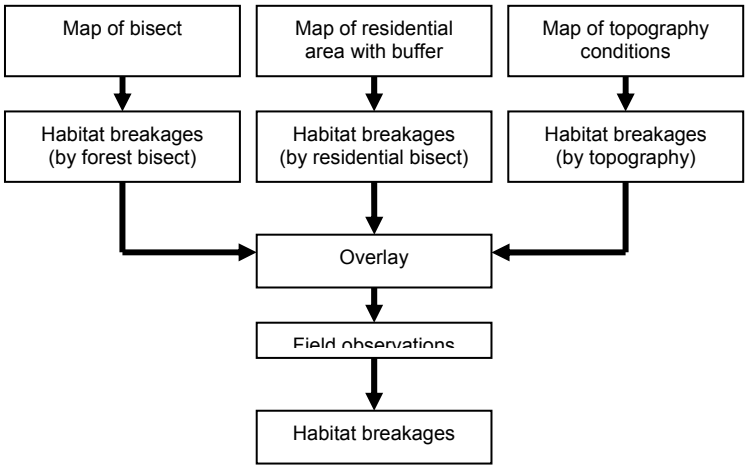


Figure 3: Steps for "habitat breakages" mapping

Deforestation - Ho Chi Minh road create a better condition for forest exploitation and accordingly, the forest can be destroyed; Shifting cultivation or agriculture land expanding; Hunting; Building actions; Other actions.

All that factors (human activities factors) is not similar everywhere along the road. It depends on the natural and social conditions. The natural conditions can be : land cover condition ; topographic condition ; water system condition etc, ; the social conditions can be : residential area ; population density ; education conditions ; income etc.

Based on the data collected from field survey and available data mentioned above, the quantification of habitat breakages is determined as:

- Quantification habitat breakages analysis of land cover. The relation of land cover and Ho Chi Minh road is analyzed in the section 2.3. That is clear that the bisecting level of Ho Chi Minh road to the forest is also describing the habitat breakages level of the road to land cover. It is described as:

Bisects level	*Habitat breakages level*
Low	Low
Moderate	Moderate
High	High

- Quantification habitat breakages by human activities. The human activities are plenty and almost all of those effected to the habitat. However, the effects of the human activities to habitat are depends on the distance from the residential area. The activities can be listed in the study area are: hunting; exploitation forest production; clear cut forest for agriculture land. The effect of the human activities can be spatially displayed as:

Distance from residential area	*Habitat breakages level*
100m	Very high
1km	High
2km	Moderate
5km	Low
More than 5 km	Not habitat breakages

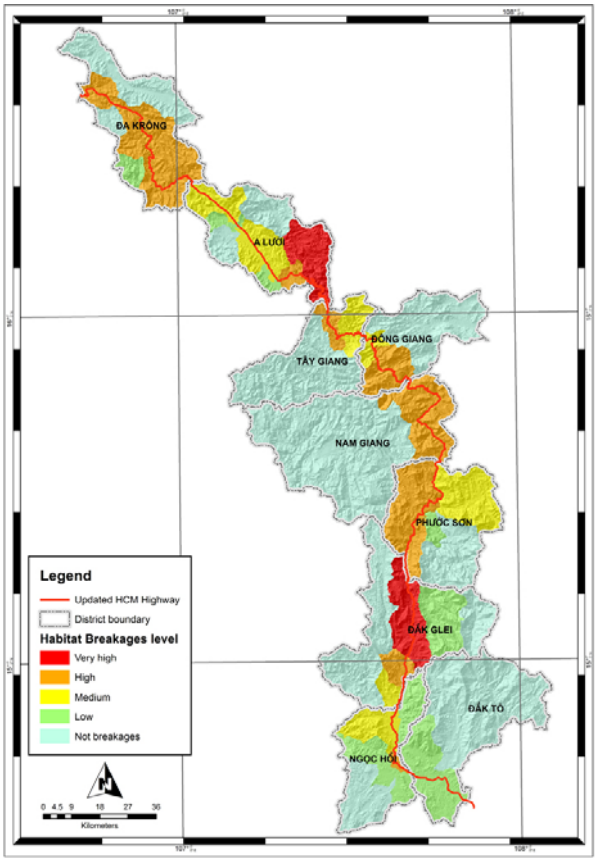


Figure 4: Habitat breakages level map

- Quantification habitat breakages by topography is complicated and depends on the distribution environment of certain species. In this study, we do not have detail studies in this field. Geographically, we assumed that the effect of topography condition along the Ho Chi Minh road to habitat breakages as:

Slope	*Elevation*			
	<300	300-700	700-1000	>1000
<8	Low	Low	Moderate	Moderate
8-15	Low	Moderate	High	High
15-25	Moderate	Moderate	High	Very high
25-35	Moderate	High	Very high	Very high

The result is shown in figure 5.

2.5 Key sites for forest corridor restoration

The forest corridor restoration, as mentioned in the section above, has the aim to:

- Mitigation the impact of Ho Chi Minhroad on erosion (include land slide)
- Mitigation the impact of Ho Chi Minhroad on habitat breakages

And its strongly depends on the present situation of the forest cover. Accordingly, the key sites for forest corridor restoration should be where:

- Present situation of land cover is not forest

- The habitat breakages occur
- Landslide/erosion strongly impact.

To point out area where all three conditions are satisfied, we used the data as:

- Map of road bisect and habitat breakages
- Road road, with buffer
- Land cover map
- Map of stability index

The key sites for forest corridor restoration are determined by these conditions as bellowed.

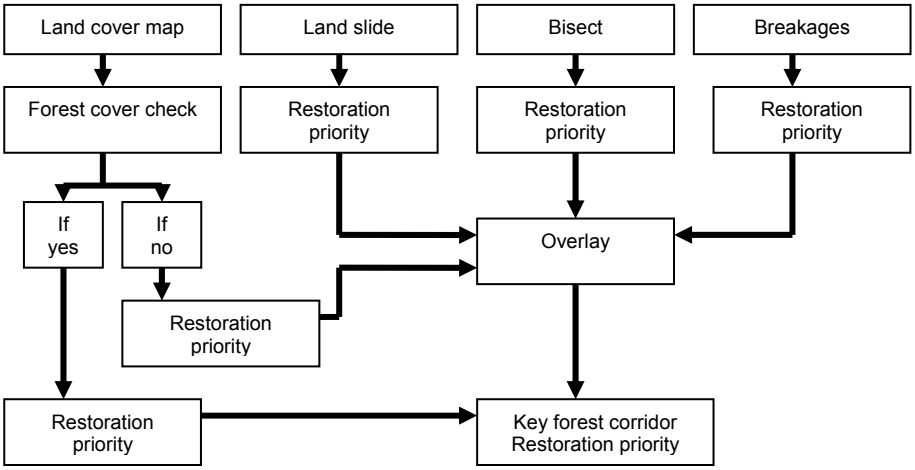


Figure 5: Steps for "keys sites" mapping

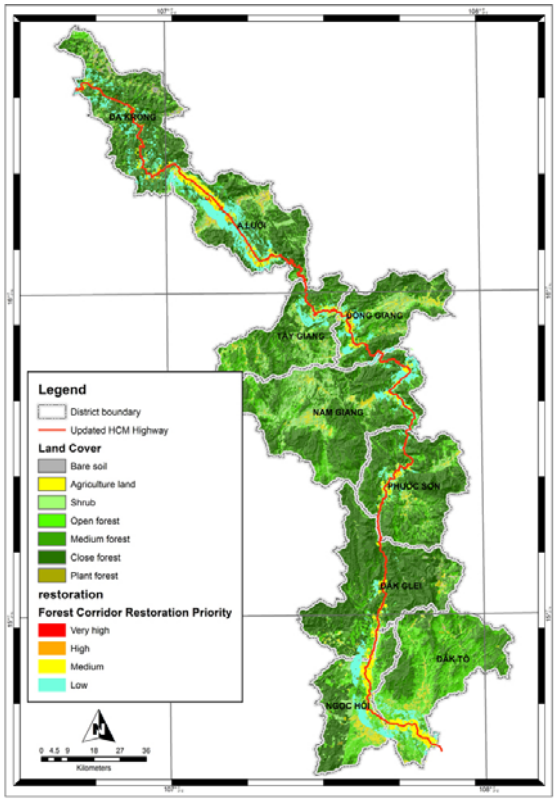
Figure 6: Key sites map

Land cover type and restoration priority

Land cover type	*Restoration priority*
Dense forest	Not priority
Medium dense forest	Not priority
Open forest	Not priority
Shrub	Low Priority
Agriculture land	Medium Priority
Bare soil	High Priority

Land slide/erosion and restoration priority

Landslide/erosion	*Restoration priority*
Stable	Not Priority
Moderately stable	Low Priority
Quasi stable	Medium Priority
Lower threshold	High Priority
Upper threshold	Very high Priority



Habitat breakages and restoration priority

Habitat Breakages	*Restoration priority*
Low	Low Priority
Moderate	Medium Priority
High	High Priority
Very high	Very high Priority

3. DISCUSSION

In the spatial analysis above, the accuracy of the model is directly affecting to the accuracy of results. Models made in this study based mainly on the evaluation/accessment of experts based on observation in the field. However, the calculated parameters for quantitative models is entirely feasible.

Beside the natural factors, the human activities factor is not similar everywhere along the road. It depends on the natural and social conditions. The natural conditions can be : land cover condition ; topographic condition ; water system condition etc, ; the social conditions can be : residential area ; population density ; education conditions ; income etc. In the specific case of Ho Chi Minh road, we can display the human activities factor as: *Human activities = f (natural condition)f(social condition)*

However, to specify the functions *f(social condition)* above is complicate and it is not the aim of this study. Accordingly, the *f(social condition)* is assumed equal a constant. We recommend that this *f* need to be count in order to make clearer the effect of the human activities along the road.

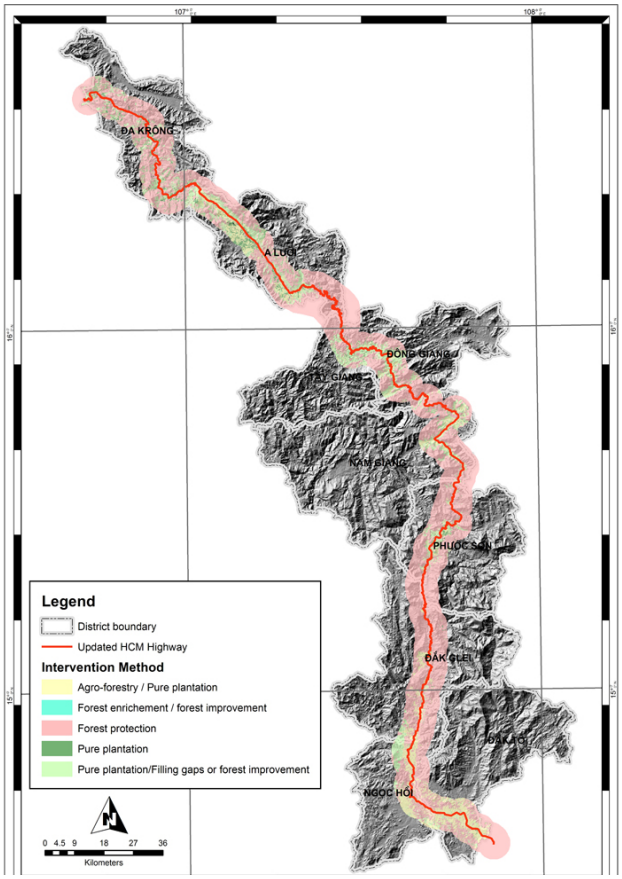


Figure 7: Intervention method map

Identifying key sites is the first important step for the investigation, planning and establishment of the projects which aim to mitigate environmental impacts by Ho Chi Minh road to land scape ecology.

Results of the spatial analysis are maps which can be input data for further spatial analysis in the next stage. In addition of direct using result such as the key sites map, each component map , although is not the results map, can be used. The example below using the map key sites and maps of the forest to evaluate and map out intervention methods.

Land cover types and intervention methods

Land cover type	*Intervention method*
Dense forest	Forest protection
Medium dense forest	Forest protection/Natural growing
Open forest	Forest enrichment/Forest improvement
Shrub	Pure plantation/Filling gaps or forest improvement
Agriculture land	Agro-forestry/Pure plantation
Bare soil	Pure plantation

Applied table (model) above to the map of present land cover and map of key sites for forest restoration, the recommendation of forest corridor restoration map is calculated as figure 6

4. CONCLUSION AND RECOMMENDATION

Results of calculation showed that in all the studied part of the Ho Chi Minh road, *protect* the forest should be strict compliance. The conduct in each forest is only necessary in some sector (where the road passing the Thua Thien - Hue and Quang Nam provinces).
The results of this study can be used as the initial investigation, allowing efforts to focus the investigation on a specific area - the area is *"sensitive"* in the habitat map breakage.

ACKNOWLEDGEMENT
We would like to express our gratitude to WWF Viet Nam who provides us necessary document, data and funds the field trip.

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CONTACTS

Dr. Vu Anh Tuan
Institution: Space Technology Institute - VAST
Address: 18 Hoang Quoc Viet
City: Ha Noi
VIETNAM
Tel: + 84 98 909 6171
Email: vu.a.tuan@gmail.com