

INTEGRATION OF CLUE-S MODEL AND GLOBIO3 MODEL TO ASSESS BIODIVERSITY IN CAT TIEN DISTRICT, VIETNAM

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ABSTRACT

There are heavy pressure threatening many species' life as well as entire ecosystem. Accordingly, many potential solutions have been developed to conserve and recover environmental ecology for sustainable use of biodiversity in terms of genetic resources, species and ecosystem. The land-use types directly affect wildlife habitats, thereby causing the impacts on local and global biodiversity. The Conversion of Land-use and its Effects at Small regional extent (CLUE-s) model has been used to simulate the land-use change. Meanwhile, Global Biodiversity Model Framework (GLOBIO3) model has been used to estimate the Mean Species Abundance (MSA) index to assess the global biodiversity based on many factors such as infrastructure, climate etc, especially land-use change. In this research, we have used the integrated model from CLUE-s and GLOBIO3 to estimate the MSA indexes for representing the biodiversity maps of Cat Tien District, Lam Dong Province for the period of 2015-2020. Therefore, the development of economy and infrastructure are required to be put in environmental context to reduce the loss of biodiversity.

Keywords: loss of biodiversity; MSA; CLUE-s model; GLOBIO3 model; land-use change

1. INTRODUCTION

The loss of biodiversity causes the decrease (or loss) of ecosystem functions such as water control, erosion prevention, the self-cleaning capability of environment, mitigation of catastrophes, etc It also causes the decline of economic growth which holds an important role to prevent the loss of value of environment and natural resources. Biodiversity secures the stability of biosphere. The present habitats of specific species would be occupied by the others in case they disappeared or became extinct. The elimination of a part of food chain might lead to adversely unpredictable consequences endangering the entire ecosystem. Thus, biodiversity conservation is not only the pressing problem but also the benefits for the next generations.

The term biodiversity generally describes the variety of biological lives on the Earth including plants, animals, fungi, microorganisms, the other communities and their habitats. Biodiversity consists of three basic types: genetic diversity, species diversity, and ecosystem diversity. Biodiversity tends to decline dramatically due to natural negative impacts and human impacts which are the major reasons.

In the period of 2016-2020, Vietnam have 46 biodiversity conservation areas with total area of 567.000 ha. Vietnam is the country having high biodiversity level in the world recording many types of ecosystem. In particular, a portion of the Cat Tien National Park in Cat Tien District, Lam Dong Province, is regarded as the Natural Treasure of Vietnam containing many types of rare animals and plants. In this research, the change of biodiversity and land-use are studied and assessed in Cat Tien District according to land-use planning established by the local district administration.

2. MATERIALS AND METHODS

2.1 Materials

Current land use map in 2015 and the planning land use in 2020 were provided by the Sub-National Institute of Agricultural Planning and Projection (Sub-NIAPP). Index biology for each land use were based on the experimental expert in agriculture. CLUE-s and GLOBIO3 model were provided by Dr. Wilbert van Rooij at the workshop "Land use and biodiversity modeling to support land use planning in Vietnam" was held in NIAPP, Hanoi on 5 - 14 March 2013.

2.2 Methods

2.2.1 CLUE-s model

In this research, CLUE-s model was applied to simulate the land-use allocation for the land-use planning for year 2020. The land-use planning was constructed on the basis of land-use requirements and demand tables of governmental agencies and departments, organization and stakeholder in Cat Tien District. The outcomes from CLUE-s model are inputted into GLOBIO3 model to analyze and simulate the change of biodiversity at the study area. The outputs from the CLUE-s model are the future land-use maps established in the stage of simulation script. This model has been extensively applied into many specific fields such as agriculture, forestry, urbanization etc. The findings from the process of running the simulation are the information tables and maps that annually present and illustrate the land-use changes directly influencing the scale of biodiversity.

2.2.2 Definitions and the appropriate index

In this study, MSA index is selected from GLOBIO3 model to simulate the land-use planning in consecutive years and then observed the local biodiversity changes in detail to investigate the current trends in biodiversity change compared to that in the previous years.

2.2.3 Mean Species Abundance (MSA)

Mean Species Abundance (MSA) is the index representing specifically the biological diversity in study periods, ranging from 0 to 1. The average MSA index can be calculated as follows:

$$MSA = MSA_{LU} * MSA_{CC} * MSA_N * MSA_I * MSA_F \quad (1)$$

where MSA_{LU} , MSA_N , MSA_{CC} , MSA_I and MSA_F are the MSA variable values affected by the factors regarding land-use, nitrogen deposition, climate change, infrastructures and fractions respectively, calculated as follows:

$$MSA_i = \sum (S_i \times index) / \sum S_i \quad (2)$$

S_i is the area of allocation of each factors

3. RESULTS AND DISCUSSION

In the resulted maps, the validation of the model over the years in the planning notice period calculation model with very small deviations from the listed land use needs of each Land Use Type (LUT) for each year, test results of the LUT: vegetables (double the area in 2020) in the areas with vegetable-flower arrangement having entirely new possibilities for very high suitability region are located along the Dong Nai River.

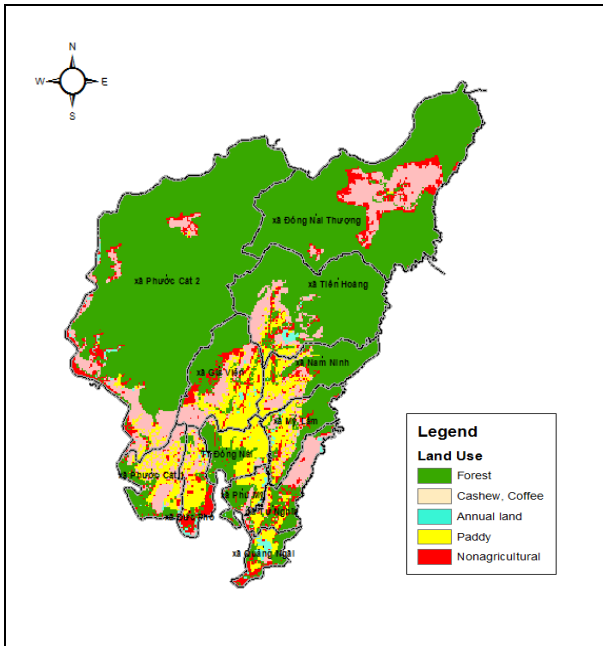


Figure 1. Current Land use map (2015).

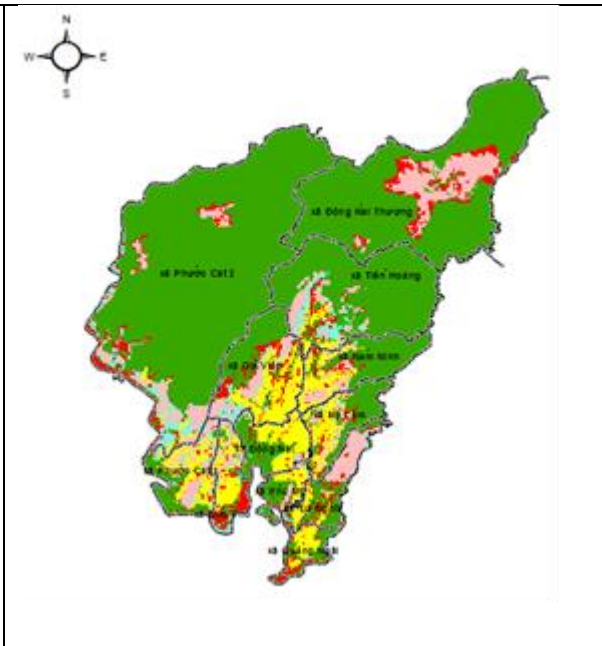


Figure 2. Land use Planning map (2020).

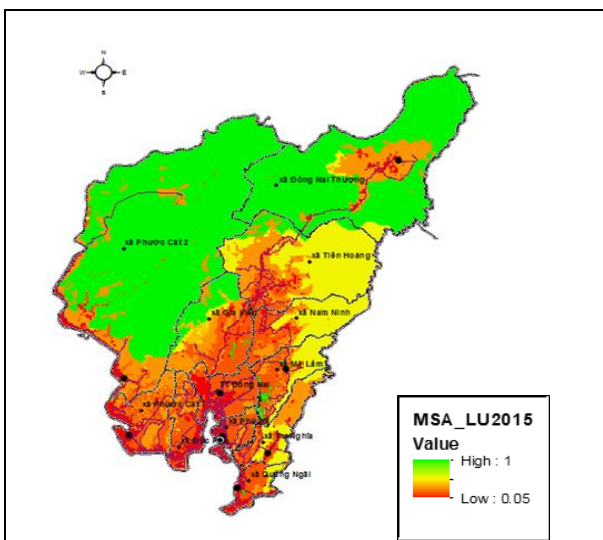


Figure 3. Loss of biodiversity by Land use (2015).

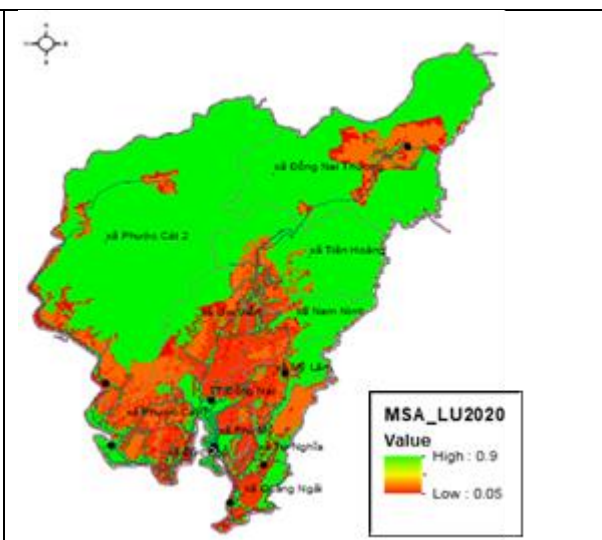


Figure 4. Loss of biodiversity by Land use (2020).

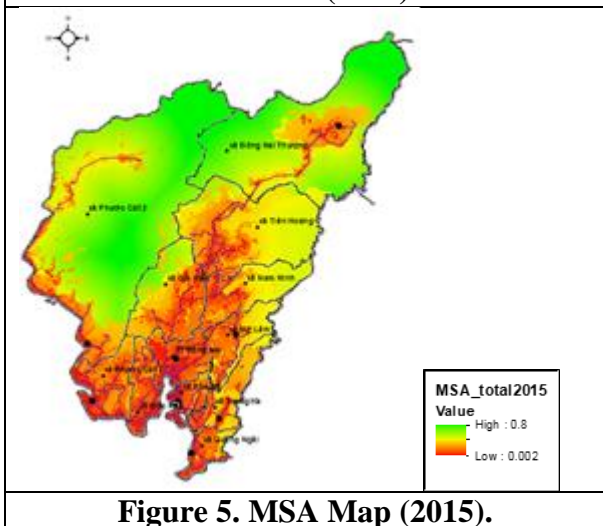


Figure 5. MSA Map (2015).

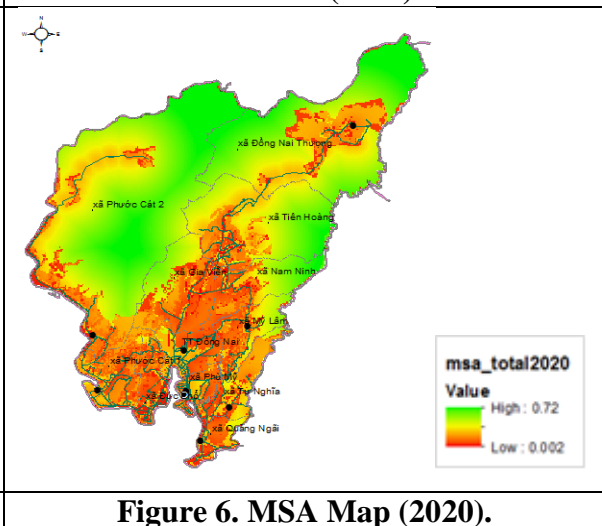


Figure 6. MSA Map (2020).

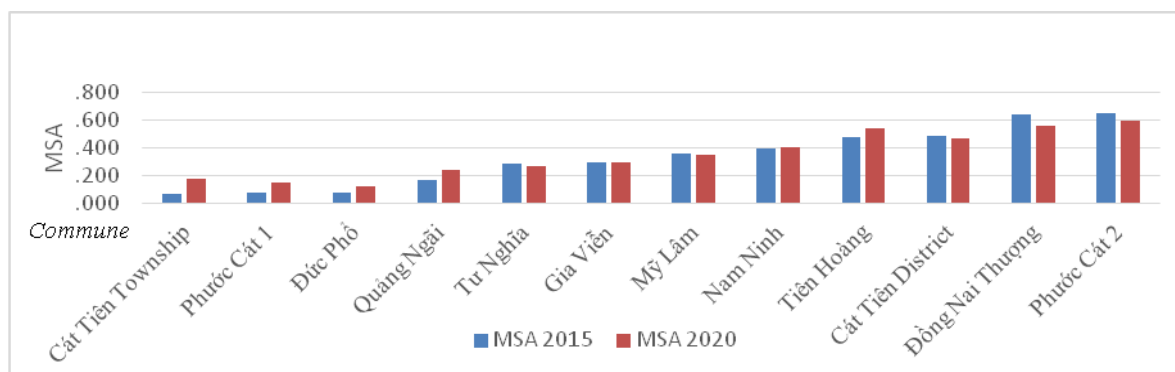


Figure 7. The bar chart to represent the biodiversity of the communes and Cat Tien district.

In the period 2015-2020, based on the data of the MSA index provided by the GLOBIO3 model from the planning of resource use and environment in Cat Tien District, it represents that:

Communes with high biodiversity ($MSA > 0.50$) and higher than the biodiversity of the Cat Tien district are: Phuoc Cat 2 and Dong Nai Thuong Commune. However, it is important to note that in the period 2015-2020, biodiversity (based on MSA indicator) tends to decrease (Phuoc Cat 2: -0.05 (↓), Dong Nai Thuong -0.08 (↓)). Therefore, it is necessary to pay close attention to the implementation of the selected planning schemes to minimize the loss of biodiversity in those two communes. Especially, it is not allowed to intervene or exploit in special use of forest (a part of the Cat Tien National Park) in Phuoc Cat 2 Commune.

- Tien Hoang Commune has an average level of biodiversity and tends to increase ($+0.06$ (↑)) if implemented according to the selected plan to 2020.

- Communes: Nam Ninh, Phuoc Cat 1, Duc Pho, Quang Ngai, Tu Nghia, Gia Vien, My Lam and Cat Tien have low biodiversity. However, the level of biodiversity in these communes will be improved by 2020 compared to the current situation in 2015.

$MSA_{2020} < MSA_{2015}$ ($0,47 < 0,49$) is negligible, thereby showing the status of biodiversity protection is ensured by:

- Identify land-use demand harmoniously.

- Choose the alternative project layout for land use planning based on environmental protection policies.

- Optimize by applying the results of the intergrated model of CLUE-s model and GLOBIO3 model.

5. CONCLUSION

MSA index in the integrated model from CLUE-s and GLOBIO3 and the maps enable us to observe visually and assess generally the loss of biodiversity due to many issues. This paper indicates two main causes which are land use and infrastructures instead of considering other perspectives due to some limitations. As a result, appropriate planning and distribution of land use and infrastructures helps balance and maintain environmental factors. The development of local economy also contributes to biodiversity conservation. All of indexes and formulas were implemented in this research derived from many studies of ecologists and professional experts. In future, Multi-criteria decision analysis (MCDA/MCDM) will be applied to calculate the index of environmental factors in order to mitigate subjective assessment.

6. REFERENCES

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