Bio Capacity Approach in Land Use at Border Indonesia Malaysia

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Abstract. Entikong located in Sanggau regency is one of the areas directly adjacent to the state of Malaysia (Sarawak) and is the first and oldest cross-border entrance in Indonesia. The overlapping of unclear land use, causing the development of border areas seem unplanned with the implications of degradation of natural resources and environmental quality, and not achieving improved community welfare, dehumanization process, and deculturization, as well as macro leads to regional disintegration. The high population growth in this area resulted in the increasing use of natural resources without regard to the environmental balance either from supply or demand from human activities, one indication of this is seen from the change in land use is not appropriate. The purpose of this study identifies the extent and type of land use change and analyzes biocapacity as part of the bioecological carrying capacity. The results of this study indicate that the massive increase in area comes from the use of mixed plantation land in 2017 increased by 60.6% of the Entikong area and the degradation of the primary forest variables is only 18.6% of the Entikong area by 2017. This indicates that the protected forests are experiencing degradation of land use change towards mixed gardens where in this mixed plantation there are oil palm, rubber and pepper. While the highest percentage of biocapacity in a mixed plantation land type of 2.585 Ha/capita. This is not proportional to the biocapacity of primary forest land of 1.03 Ha/capita. Surely this indicates that the condition of imbalance of the bioecological carrying capacity. Supply from the forest is unable to absorb waste material from plantation land use. These results indicate that proper optimization and revitalization of land use is required by applying various development-related policies in the Entikong border region. In addition, it is necessary to supervise and control both from the elements of society, private, and government.

1. Introduction

Entikong is located in Sanggau District and is one of the areas directly adjacent to Malaysia (Sarawak) and is the first and oldest cross-border entrance in Indonesia. Different characteristics from other regions (factor production immobility, transaction costs and delay, different economic systems, institutional issues, zoning, and the role of the informal sector) encourage the region's economic functioning internally and externally. Economic perspectives in the border region tend to increase. With the above background, Entikong is the border region with the highest economic activity along the land border (West Kalimantan-Sarawak). The overlapping of unclear land uses, causing the development of border areas to be improperly planned with the implications of natural resource degradation and environmental
quality, and not achieving improved community welfare, dehumanization and deculturization processes, and macro leads to regional disintegration (especially economically).

High population growth and development rates have a negative impact on the quality of the environment, especially the decline in the quality and quantity of natural resources. One effort is to minimize the impact that may arise through a fairly comprehensive assessment of the effect of an activity with environmental quality parameters.

Conversion of forest land to plantations, agriculture, settlements, tourism and mining, conducted without regard to the principle of sustainability, will affect the environmental balance.

As a physical representation, plantations increase and land conversion takes place that deviates from the designated land allocation resulting in conflicts of land use interest. The emergence of oil palm plantations, rubber, pepper will have an impact on the emergence of several environmental problems such as crisis condition of raw water source discharge.

Overall, in this border area, natural resource utilization has exceeded the carrying capacity of the environment, thus indicated to influence the sustainability of protected forest area. One approach to assessing the bio-ecological carrying capacity as a sustainable ecosystem is biocapacity.

Guidebook to the nation footprint accounts (2008), states that the bioecological carrying capacity is a description of the ecological capacity of the region to meet the needs of the population in accordance with the pattern of life of the population. The bioecological carrying capacity is calculated based on the biocapacity approach. Biocapacity is the capacity of ecosystems to produce natural materials and absorb the material of human waste (supply-side).

Based on the background that has been described then can be formulated problems as follows:
1. What is the extent and type of land use change that exists in the border area between 2011 - 2017?
2. How to calculate the biocapacity of each land use variable in the border region?

From the introduction and problem formulation, the purpose of this study aims:
1. Identify the extent and type of land use change
2. Analyze the magnitude of the biocapacity of each land use variable

2. Research Methods

This research was conducted in Entikong border area. The data used are grouped into primary data in 2011-2017. Primary data consists of Landsat Image in 2011 and 2017. Besides secondary data in the form of maps consisting of the administrative map Entikong District obtained from the Regional Development Planning Agency District Sanggau. Equipment used Global Positioning System (GPS), a set of computers with ArcView GIS software, and Office 2007.

A. Map and Image Analysis (Overlay)

The process of remote sensing data analysis starts from geometric correction of image with topographic map scale 1: 25,000. Furthermore, land use is delineated manually by visual interpretation techniques. The characteristics of the objects depicted in the image are used to recognize objects called image interpretation (Sutanto, 1994). The elements of interpretation include hue, shape, texture, pattern, size, shadow, situ, and association. Interpretations combined with field observations are used to identify the types of land use described for primary forests, secondary forests, mixed gardens, rice fields, settlements, shrubs and water bodies.

The analysis of land use change is done by comparing land use map 2011 with land use map in 2017. This is done to know land use change that happened in 2011 until 2017. Landsat and Earth Map interpretation results in 2011 and 2017 were then overlaid to produce land use change maps.

B. Analysis of Land Use Change

The rate of land use change is presented in percent form with the following equation:

\[ V = \frac{N_2 - N_1}{N} \]
Information:
\( V \) = The pace of land use change
\( N_2 \) = The area of land use in the second year
\( N \) = Total Area (Hamidy, 2013)

C. Biocapacity Analysis
Biocapacity is the ability of the ecosystem to provide and produce natural ingredients and to absorb waste material produced by humans \textit{(supply side)}.

\[
BK_i = \left( 0.88 \times LPL_i \times FP_i \right) / JP
\]

Information:
\( BK_i \) = Bio Capacity of land used \( i \) (Ha/kapita)
\( LPL_i \) = Land use area \( i \) (Ha)
0.88 = Constants (12% used to ensure the continuity of biodiversity (WCED, 1987; WWF, ZSL, dan GFN, 2006; Habert, Krausmann, 2001, Weckemagel, et al, 1997)
\( FP_i \) = Factor Production \( i \) (Ferguson, 1998)
\( JP \) = Total population (soul)

Table 1. Equivalent Factor, Production Factor According to Land Use

| No | Land Use                           | K \(_{FE} \) | EF | FP |
|----|-----------------------------------|-------------|----|----|
| 1  | Agricultural Land / Plantation     | 0.29        | 0.94 | 0.94 |
| 2  | Primary Forest                    | 0.14        | 1.71 | 1.71 |
| 3  | Grassland / Farm / Field / Bush / Mixed Garden | 0.02 | 1.31 | 1.31 |
| 4  | Waters                            | 0.18        | 0.35 | 0.81 |
| 5  | Land built / Settlement           | 0.06        | 1.02 | 1.02 |
| 6  | Secondary Forest                  | 0.05        | 1.89 | 1.71 |

Source: WWF, SL, & GFN (2006) and Ferguson (1998) with modifications

D. Research variable
The classification system used is based on SNI cover classification and land use in 2010 from Badan Standarisisasi Nasional (BSN) ICS 07.040 number which is as follows:

Table 2. Land use classification

| No | Classification          | Information                                                                 |
|----|-------------------------|-----------------------------------------------------------------------------|
| 1  | Primary Forest          | Forests that have a dense crown structure so that the sun can not be a good forest floor. |
| 2  | Secondary Forest        | Forests that have experienced succession                                     |
| 3  | Plantation              | Land used for agriculture without crop turnover for two years                |
| 4  | Mixed Plantation        | Types that have crown strata overgrown by various types of forestry crops (timber) and agricultural crops include moor. |
| 5  | Settlement              | Land used as a residence                                                     |
| 6  | Shrubs                  | Dry land overgrown with heterogeneous natural vegetation is dominated by shrubs and grasses whose existence is not managed by humans. |

(Source: SNI Year 2010 with modification)

3. Result and Discussion
A. Land Use Year 2011
The interpretation activities carried out on Landsat image in 2011 resulted in the use of land in Entikong Sub-district into 6 types of land use, namely: primary forest, secondary forest, mixed plantation,
plantation, settlement, shrub / bushland. Data on the wide range of land use types in 2011 resulting from the Landsat image clarification process in 2011 are as follows:

**Table 3. Tabel Land Use year 2011**

| Land Use       | Large (Ha) | Percent (%) |
|----------------|------------|-------------|
| Primary Forest | 17433,44   | 27,72       |
| Secondary Forest| 6445,43 | 10,25       |
| Mixed Plantation| 35956,4   | 57,17       |
| Plantation     | 878,67     | 1,40        |
| Settlement     | 352,69     | 0,56        |
| Shrubs         | 1824,42    | 2,90        |
| Total          | 6289,1     | 100,00      |

Source : Analysis Results

Based on Landsat imagery data in 2011, the type of land use that has the most extensive area is mixed gardens. The mixed garden has an area of 35,956 ha which occupies 57.17% of the total area. Primary forest has an area of 17,433 hectares which occupy 27.72% of the total area. Furthermore, the type of land use that has the third largest area is the secondary forest of 6,445 Ha or 10.23% of the total area. The next type of bush land use has a total area of 1,824 Ha or 2.90% of the total area. Type of land use of plantation is 878,67 Ha or 1.40% of total area. The next type is Settlement where the area of 352,69 Ha or 0.56% of the total area.

Map of Entikong sub district land use in 2011 can be seen on the following map:

**Figure 1. Map of Land Use in 2011**

B. Land Use Year 2017

The interpretation activities carried out on Landsat image in 2017 resulted in the use of land in Entikong Sub-district into 6 types of land use, namely: primary forest, secondary forest, mixed plantation, plantation, settlement, shrub / bushland. Data on the wide range of land use types in 2017 resulting from the Landsat image clarification process in 2017 are as follows:

**Table 4. Tabel Land use year 2017**

| Land Use     | Large (Ha) | Percent (%) |
|--------------|------------|-------------|
| Primary Forest| 11787,32   | 18,6        |
| Secondary Forest| 5061,79  | 8,04        |
| Mixed Plantation| 38396,63 | 61,05       |
| Plantation   | 1359,17    | 2,16        |
| Settlement   | 1110,829   | 1,76        |
Based on Landsat imagery data in 2017, the type of land use that has the most extensive area is mixed gardens. The mixed garden has an area of 38,396.63 ha which occupies 61.05% of the total area. Primary forest has an area of 11,787.32 hectares which occupy 18.6% of the total area. Furthermore, the type of land use that has the third largest area is the secondary forest of 5,061.79 Ha or 8.04% of the total area. The next type of bush land use has a total area of 5,175.44 Ha or 8.22% of the total area. Type of land use of plantation is 1,359.17 Ha or 2.16% of total area. The next type is Settlement where the area of 1,110.82 Ha or 1.76% of the total area.

Map of Entikong sub district land use in 2017 can be seen on the following map:

**Figure 2. Map of Land Use in 2017**

C. Land Use Change in 2011 and 2017
Based on the interpretation results of landsat satellite imagery and google earth in 2007, 2011, and 2013 forest area has undergone a change of land use. Land use has shown both an increase and a decrease in land area. Massive land changes are on plantations where forest land is used by communities for oil palm, rubber and pepper plantations.

| Land Use         | 2011 (Ha)    | 2017 (Ha)    | Change (Ha) |
|------------------|--------------|--------------|-------------|
| Primary Forest   | 17433,44301  | 11787,32     | - 5646,12301|
| Secondary Forest | 6445,431444  | 5061,79      | - 1383,64   |
| Mixed Plantation | 35956,43574  | 38396.63     | + 2440,2    |
| Plantation       | 878,678556   | 1359,17      | + 480,5     |
| Settlement       | 352,697393   | 1110,82      | + 758,13    |
| Shrub            | 1824,42026   | 5175,44      | + 3351,02   |

From the results of the analysis, the dominant land use in the border areas is directed to mixed gardens where mixed garden types such as moor, fields, and rice fields.

D. Supply Condition (Availability) Land Use Types at Border
One of the factors needed to calculate the bio-ecological carrying capacity is to approach the bio-capacity. Here is the condition of supply (land availability) of each type of land use in 2017.
Table 6. Biocapacity of Land Use in 2011 and 2017

| Land Use       | Biocapacity Year 2011 (Ha/capita) | Biocapacity Year 2017 (Ha/capita) |
|----------------|-----------------------------------|-----------------------------------|
| Primary Forest | 1,810604254                       | 1,035951357                       |
| Secondary Forest | 0,669410259                    | 0,444865179                       |
| Mixed Plantation | 2,860830915                    | 2,585190694                       |
| Plantation     | 0,050165153                      | 0,065664375                       |
| Settlement     | 0,021849761                      | 0,058233879                       |
| Shrubs         | 0,145157822                      | 0,348455042                       |

Source: Analysis Results

4. Conclusion

Biocapacity is one approach to look at the bioecological carrying capacity. The value of bioecological carrying capacity is influenced by several factors such as population size, area of land use change, and type of land use variation. Based on the analysis of land use change from 2011 to 2017 it was found that the largest land use was for mixed garden sectors where the conversion of plantation land increased by 2440 Ha. By 2017 primary forests are degraded enormously where forest area is reduced by 5646 Ha. This is certainly not good for the environment because the forest has been transformed into a plantation. This is quite worrying because in the period of 6 years development in the plantation sector increased sharply. This is because demand for palm, rubber, and pepper is high enough in recent years that some residents open land for gardening. This is caused by several factors, namely the rapidly growing population which has an impact on the increasing of varying land requirement and biocapacity value decreasing consequence of ecological balance of Entikong border area will be disrupted.

In this vast study, population, type of change, and factors of production play a role in the approach of biocapacity. Since the development in Entikong which is not spread evenly makes the primary forest area as protected forest has changed its function into a land that has high economic value.

The biocapacity value of forest variables has a deficit of availability, which means that the availability of ecosystems in absorbing waste material produced by humans decreases. Therefore this indicates that Entikong border area has bad supply to keep balance of ecological bio-carrying capacity to waste, it can be seen in table 6 where the biocapacity of primary and secondary forest as environmental buffer is reduced by 1 Ha/capita. However, the biocapacity of mixed gardens is not balanced with the biocapacity of primary forest so that the ecosystem's ability to absorb the waste generated from the mixed garden, and the settlements is very small and will certainly have an impact on the environment.

Direction of land use to the plantation sector has changed the environmental conscious paradigm into a welfare paradigm, especially related to the economy of the community. This is because the location of the Entikong area is on the border and very strategic because it is passed by cross country road Malaysia. But behind it all will have the worst impact if the availability (supply) of forests deficit from year to year. There will be natural disasters resulting from unsustainable and environmentally sound development.

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