# PROCEEDINGS

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## PREFACE

The 3rd International Symposium for Sustainable Humanosphere 2013 attracted the interest of scientists from Indonesia and Japan. The symposium covered the disciplines of community-based development and social economic science (climate change and society; ecosystem and community; the economical of natural resources; the role of traditional knowledge and values in managing ecosystems; women and natural resources), atmospheric science (airpollution; equatorial atmosphere; global climate change models; land-ocean weather systems; radar observations; solar activities; space environment; weather patterns), biosphere science (agricultural in changing world; animal ecology and animal husbandry; anthropological approach; bio-indicator; ethnobotany; food security; human development index), geosphere science (earth geological dynamics and natural disasters; earth carbon cycle dynamics; heat, water and CO; hydrology and water management system; land resource management), wood science and technology (biomass conversion; carbonized wood based composites; cellulose; chemical, physical and mechanical properties of wood; timber structure; wood for energy; wood cell formation; wood biochemistry; wood anatomy and plant physiology; wood deteriorating organisms; wood preservation; wooden construction; wood-based material; wood adhesive), wood and urban pest management (insect pest management, ecology and biology of urban pests, control of urban pest including biological, cultural, mechanical, physical and chemical controls), and forest science (biodiversity and society; biodiversity in tropical plantation forests; climate change and biodiversity; forest biomass dynamics; forest carbon accounting and monitoring; forest fire; invasive species; intensive silviculture; structure, growth and function; tree biotechnology). The technical program consisted of 38 oral presentations under 11 sessions and 19 poster presentations.

This publication is a compilation of presented papers. Every effort has been carried out to retain the original meaning and views of authors during the editing processes. All claims on trade products and processes and views expressed do not necessarily imply endorsement by the editors.

We believe that this publication will be a useful source of information and achieved its primary objective of disseminating new experiences and information to researchers, academics, policy makers and students.

The organization of this international gathering and compilation of the proceedings could not have been achieved without the combined effort of all members of the organizing committee and the supports of Research Institute for Sustainable Humanosphere (RISH), Center for South East Asian Studies (CSEAS) Kyoto University, International Center for Interdisciplinary and Advanced Research (ICIAR) – LIPI, University of Bengkulu (UNIB). The editors hereby wish to acknowledge the contributions of all parties.

Editors

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# POPULATION PRESSURE ON THE VILLAGES AROUND KERINCI SEBLAT NATIONAL PARK (TNKS) OF LEBONG DISTRICT, PROVINCE OF BENGKULU, INDONESIA

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**Abstract**

The sustainability of Kerinci Seblat National Park (TNKS), especially the forest located in the Lebon District, is largely determined by the carrying capacity of surrounding villages. The carrying capacity can be described by the index of population pressure. According to this calculation of the sample villages shows that the population pressures of villages around TNKS were already happening (the average population pressure index is 3.5). This was means that there had been an over population in the majority of the sample villages because of the numbers above 1.00. Population pressure occurs more due to underdeveloped non-farm activities, while the productivity of the farm activities were still relatively low. Based on these facts, the carrying capacity could be increased by improving the application of technology and the creation of the attraction to the area in order to increase the population dynamics.

**Keywords**: *Kerinci Seblat National Park, carrying capacity, population pressure, population dynamic*

## Introduction

Sustainable development was better understood as a form of natural resources use with respect to the availability and the ability to support any particular livelihood [1,2]. A simple depiction of sustainable development could be supposed to the drivers. They must consider the availability of fuel in the tank. How fast is the speed of oncoming vehicles depending on the vehicle capabilities. The ability of the resources that available in the nature can be described as the carrying capacity of land either physically or their biocapasity.

Starting from these understandings, sustainable development requires a natural resources management tools. The depiction described above indicate the importance of management tools that can reveal how much the capacity has been used by humans to support their life in achieving a certain level of prosperity. There was an old approach to analyze the human relationship with the environment proposed by Duncan by namely POET models [3]. POET models reveal any factors that determines the dynamics of the relationship between humans and the environment namely Population, Organization, Environment, and Technology. This model deals with the concept of carrying capacity where the ability of land to support a particular level of life was seen as direct and indirect impact of the four factors.

The carrying capacity can be determined by calculating the population pressure. Population pressure is a symptom of over population in the region, which are linked to the availability of resources, according to the desired standard of living in the area concerned. Population pressure occured when the population in the region has exceeded the carrying capacity [4].

The population pressure in the agrarian dominant areas were heavily influenced by farming system used. For example the wetland farming systems and the shifting cultivation systems will indicate population pressure levels different. If the pressure of population has occurred then it will most likely happen deterioration in the quality of wealth and the natural resources, population pressure to the villages around the forest could lead to forest clearing activities to the deepest location.

At the global level, the environmental degradation (i.e deforestation) are generated by the interaction of economic, demographic, cultural, and political causes [5]. There were two aspects, namely deforestation and the elements that are often cited as a cause, such as agricultural expansion as the tautological explanation [6]. An efforts to explain the destruction of forests by linking human activity as an independent variable will not find a comprehensive conclusion because it turns out their correlation are mutually influencing relationship. Environmental sustainability (forest) also determines the level of living of the population, vice versa [1]. The dynamic interaction of human and forest described as a reciprocal relationship between the demographic system, social system, and ecosystem [7].

For example, shifting cultivation activities. In general, the actors were small farmers who embrace the culture shifting cultivation in the forest areas. Sedentary activity was an agrarian culture reflection in order to sustain their life that contributed to the degradation of forests [8]. The destruction of forest on the other side also threaten the sustainability of the population livelihood because generally they also utilized either the forest timber and non-timber for various purposes of their life.

The phenomenon of deforestation and forest degradation in Indonesia, could be caused by the people's activities that settled around the forest. Forest Watch Indonesia suggested that the destruction of forests caused by several things such as timber extraction both by forest concession holders (HPH) and the activities of illegal logging, industrial timber opening (HTI), large-scale plantations of oil palm plantations, and small-scale agriculture [9].

Forest areas in Bengkulu Province were the threatened location sustainability due to people's activities. The rate of destruction of Kerinci Sebelat National Park (TNKS) in Bengkulu Province was very high, ie at the beginning of 2004 as much as 36.27% (123,534.58 ha) has been severely damaged (the condition of non-forest) area of 340 575 ha that are included in the administrative area of the Province of Bengkulu [10]. TNKS located in the Province of Bengkulu stretched in position 2 ° 16'36 .59 "S to 3 ° 27'2 .50" S and 101 ° 17'7 .76 "E to 102 ° 42'8 .52" E. Geaographically TNKS are in the District of Mukomuko, North Bengkulu, Rejang Lebong, and Lebong.

Kerinci Sebelat National Park (TNKS) established by the Decree of the Minister of Agriculture No. 736/Mentan/X/1982 then amplified by Decree of the Minister of Forestry and Plantations No. 901/kpts-II/1999 as conservation areas. The other areas were also confirmed as a Rimbo Pengadang Conservation Forest Areas Registers 42 and conservation areas Boven Lais that the first was designated as conservation forest by the Dutch Colonial Administration about 1927 known as the forest boundary Boszwezen [11].

The population and population density factors have to be recognition so we can know the demographic aspect contributing to the destruction of TNKS in Lebong district. Furthermore, it can be estimated also the impact on the sustainability of the livelihood system of people living around TNKS. So this study aimed to estimate the index of population pressure in the villages around TNKS.

**Materials and Methods**

The research was conducted in the district of Lebong, Province of Bengkulu. The early stage was identifying the villages that are directly contiguous to the forest. Data obtained from the sub-district office, there are 41 villages contiguous to the forest. Furthermore, the villages were randomly selected 20 of 41 villages directly contiguous to the TNKS.

The data collected consisted of the number of population, the annual rate of population growth, land use, land productivity, various of employment, and household income. Data collected by documenting the data available at the village office. If not available, conducted interviews with village heads and then loaded on the checklist provided. Especially revenue data was conducted by a survey of 15 households in each village randomly.

Population pressure index was calculated using the formula [12], namely:

$$PP_t = (1-\alpha_t)\frac{F_t\, P_0(1+r)^t}{L_t}$$

where:

$PP_t$ = Population indexat year t
t = Year
$L_t$ = Agricultural land area at year t
$Z_t$ = Average of agricultural land area required by each people at a needed standard of living
$P_0$ = Population at starting year
r = Annual rate of population growth at year t
$F_t$ = Proportion of farmer population
$\alpha_t$ = Proportion of non-farm to the farmer income

Population pressure indexes were calculated for each sample villages in 2012 and 2017. Here selected 2010 as a base year for determining population estimates for the year. In addition to productivity and agricultural land, use extrapolation techniques. The proportion of non-farm income was determined based on household surveys. While the standard of living used the World Bank poverty line of U.S. $ 2.00 (IDR 18,500) per capita per day; conversion of paddy into rice by 0.6, and rice productivity comparisons, dryland, and the estate was 10:5:6.

## Results and Discussion

### *Population and its growth*

Villages around TNKS have a different population (Table 1). Population minimum was the village of Talang Baru Sub-District of Rimbo Pengadang (370) and the maximum one was the village of Talang Leak 1 Sub-District of Lebong Selatan (1,833).

The annual population growth rate ranged from 0.67% to 6.73%. In general, these villages has had a population growth rate was quite high (more than 1:00%), except for the villages in the sub-district of Pinang Belapis (0.67%) and the Village Tambang Sawah and Air Kopras Sub-District of Lebong Tengah (0,67). There was a village with the highest growth in the village of Kota Baru Sub-District of Embong Uram.

The annual growth rate of population in these villages might be come from natural increases, the population growth was caused by the birth and death. There was no migration data making it difficult to quantitatively estimate the contribution of population movement to the total population. However, qualitatively it can be stated that the District of Lebong was a place that did not pass the road across the province so that the development of the region was relatively slow. Evens more not grown yet the industry that attracts people to come in and look for a job.

Tabel 1. Population and annual growth rate of villages around TNKS

| No. | Villages | Year | Population | Growth Rate 2000-2010 (%) |
|---|---|---|---|---|
| | Sub-District of Rimbo Pengadang | | | |
| 1. | Talang Ratu | 2010 | 1,086 | 1.19 |
| 2. | Air Dingin | 2010 | 1,323 | 1.19 |
| | Sub-District of Topos | | | |
| 3. | Talang Donok | 2010 | 442 | 1.53 |
| 4. | Talang Baru | 2010 | 370 | 1.53 |
| | Sub-District of Bingin Kuning | | | |
| 5. | Talang Leak 1 | 2010 | 1,833 | 1.62 |
| 6. | Kr. Dapo Atas | 2010 | 1,039 | 1.62 |
| 7. | Kr. Dapo Bawah | 2010 | 1,282 | 1.62 |
| 8. | Pl. Talang Leak | 2009 | 1,015 | 1.62 |
| | Sub-District of Lebong Atas | | | |
| 9. | Desa Baru | 2007 | 500 | 2.5 |
| 10. | Pelabi | 2007 | 740 | 2.5 |
| 11. | Atas Tebing | 2010 | 767 | 1.89 |
| 12. | Danau | 2007 | 938 | 1.89 |

| | | | | |
|---|---|---|---|---|
| | Sub-District of Pinang Belapis | | | |
| 13. | Ketenong 1 | 2009 | 568 | 0.67 |
| 14. | Ketenong 2 | 2009 | 478 | 0.67 |
| 15. | Sebelat Ulu | 2009 | 310 | 0.67 |
| | Sub-District of Embong Uram | | | |
| 16. | Kota Baru | 2010 | 672 | 6.73 |
| 17. | Talang Sakti | 2009 | 1,388 | 1.73 |
| 18. | Tambang Sawah | 2009 | 663 | 0.67 |
| 19. | Ujung Tanjung | 2009 | 1,800 | 1.73 |
| 20. | Air Kopras | 2010 | 666 | 0.67 |

Source: Villages Prophile and Monograph of Sub-District in District of Lebong 2007, 2009, 2010.

***Land use and agrarian density***

Land use was categorized based on the format issued by the Ministry of Home Affairs which was provided as a data base of every village, which consists of wetland, dryland, garden, swamp, yard, community forests, and state forests. Under the category then we classified in to two types of land namely arable land and non-arable land [4].

The villages around TNKS were generally more dominant arable land (Table 2). For example, the villages in the sub-district of Rimbo Pengadang, about 80% were arable land. In fact there were also villages where the amount of arable land close to 100%. There are two villages namely Talang Sakti and Tambang Sawah Sub-District of Embong Uram where 100% were arable land. The villages of this type means to the potential for agricultural development although not optimal cultivated, depending on the technology used and their capabilities.

The villages in the Sub-district of Lebong Atas were generally more dominant non-arable land (Table 2). Even the village of Atas Tebing nearly 100% was non-arable land, especially forests. The villages with a dominant type of non arable land indicates many lands that difficult to cultivate. Most of the non-arable land consists of swamps, community forests and state forests.

Real condition of arable lands in sustaining population was showed by agrarian density. According to the Table 2, generally were low agrarian density (below 3 people/ha). However, in some villages, especially in Sub-District of Embong Uram agrarian density was very high (above 6 people/ha). One even was reaching 11 people/ha, the Village Tambang Sawah.

Table 2. Land use and agrarian density of villages around TNKS

| No. | Villages | Year | Arable Land (hectare) | Non Arable Land (hectare) | Agrarian Density (people/ha) |
|---|---|---|---|---|---|
| | Sub-District of Rimbo Pengadang | | | | |
| 1. | Talang Ratu | 2010 | 678 (84.2) | 127 (15.8) | 1,49 |
| 2. | Air Dingin | 2010 | 611 (83.2) | 123 (16.8) | 2,01 |
| | Sub-District of Topos | | | | |
| 3. | Talang Donok | 2010 | 137 (48.2) | 147 (51.8) | 3,00 |
| 4. | Talang Baru | 2010 | 192 (60.6) | 125 (39.4) | 1,79 |
| | Sub-District of Bingin Kuning | | | | |
| 5. | Talang Leak 1 | 2010 | 812 (95.9) | 35 (4.1) | 2,10 |
| 6. | Kr. Dapo Atas | 2010 | 740 (98.0) | 15 (2.0) | 1,31 |
| 7. | Kr. Dapo Bawah | 2010 | 106 (79.1) | 28 (20.9) | 11,25 |
| 8. | Pl. Talang Leak | 2009 | 835 (78.8) | 225 (21.2) | 1,13 |
| | Sub-District of Lebong Atas | | | | |
| 9. | Desa Baru | 2007 | 100 (32.8) | 205 (67.2) | 3,85 |
| 10. | Pelabi | 2007 | 300 (31.6) | 650 (68.4) | 2,20 |
| 11. | Atas Tebing | 2010 | 145 (1.4) | 10,004 (98.6) | 4,50 |
| 12. | Danau | 2007 | 1,089 (67.1) | 535 (32.9) | 0,80 |

| | | | | | |
|---|---|---|---|---|---|
| | Sub-District of Pinang Belapis | | | | |
| 13. | Ketenong 1 | 2009 | 155 (31.0) | 345 (69.0) | 2,38 |
| 14. | Ketenong 2 | 2009 | 280 (73.7) | 100 (26.3) | 1,45 |
| 15. | Sebelat Ulu | 2009 | 380 (77.9) | 108 (22.1) | 0,73 |
| | Sub-District of Embong Uram | | | | |
| 16. | Kota Baru | 2010 | 78 (79.6) | 20 (20.4) | 8,01 |
| 17. | Talang Sakti | 2009 | 127 (100.0) | 0 (0.0) | 10,16 |
| 18. | Tambang Sawah | 2009 | 24 (100.0) | 0 (0.0) | 11,05 |
| 19. | Ujung Tanjung | 2009 | 260 (95.4) | 12.5(4.6) | 6,23 |
| 20. | Air Kopras | 2010 | 165 (39.3) | 255 (60.7) | 3,23 |

Source: Villages Prophile and Monograph of Sub-District in District of Lebong 2007, 2009, 2010. (Data processed)

Notes:

a. Arable land consists of wetland, dryland, and estate.
b. Non arable land consists of swamp, yard, community forest, and state forest.
c. Agrarian density is number of people who depend on agriculture per hectare of arable land.
d. Numbers in the parentheses indicate percentage.

### *Population Pressure Index*

The result of calculation of sample villages showed that the villages around TNKS, population pressure were already happened in 2012 (average of the population pressure index 3.21). This figure means that it has occurred over population in the sample villages (indexes above 1.00). Even there were some indexes very high, the Village Kr. Dapo Bawah, Kota Baru, Talang Sakti and Tambang Sawah. Contrary there were only 4 villages that have not experienced population pressure (population pressure indexes below 1.00), namely Talang Baru, Pelabi, Atas Tebing, and Danau. Population pressure will increase in 2017 (the average population pressure index 3.54). Completed results of the calculations are presented in Table 3.

Table 3. Population Pressure Index of Villages around TNKS, 2012 and 2017

| No. | Village | 2012 | 2017 |
|---|---|---|---|
| | Sub-District of Rimbo Pengadang | | |
| 1. | Talang Ratu | 1.28 | 1.36 |
| 2. | Air Dingin | 2.76 | 2.93 |
| | Sub-District of Topos | | |
| 3. | Talang Donok | 1.83 | 1.97 |
| 4. | Talang Baru | 0.26* | 0.28* |
| | Sub-District of Bingin Kuning | | |
| 5. | Talang Leak 1 | 2.00 | 2.16 |
| 6. | Kr. Dapo Atas | 1.01 | 1.10 |
| 7. | Kr. Dapo Bawah | 8.96 | 9.71 |
| 8. | Pl. Talang Leak | 1.32 | 1.43 |
| | Sub-District of Lebong Atas | | |
| 9. | Desa Baru | 1.41 | 1.59 |
| 10. | Pelabi | 0.59* | 0.67* |
| 11. | Atas Tebing | 0.89* | 0.98* |
| 12. | Danau | 0.22* | 0.24* |
| | Sub-District of Pinang Belapis | | |
| 13. | Ketenong 1 | 2.75 | 2.84 |
| 14. | Ketenong 2 | 1.29 | 1.33 |
| 15. | Sebelat Ulu | 4.73 | 4.89 |
| | Sub-District of Embong Uram | | |
| 16. | Kota Baru | 7.81 | 10.81 |
| 17. | Talang Sakti | 7.41 | 8.07 |

| | | | |
|---|---|---|---|
| 18. | Tambang Sawah | 10.68 | 11.04 |
| 19. | Ujung Tanjung | 2.7 | 2.98 |
| 20. | Air Kopras | 4.3 | 4.48 |
| | Average | 3.21 | 3.54 |

Notes: * In these villages population pressure have not occured.

Population pressure index was formed by several important components, especially population growth rate, land productivity, and the proportion of non-farm income. The population growth rate above 1:00%, even there was reaching 6:00% (Kota Baru) what meaning?, causing rapid increase in population. The population was generally accommodated in the agricultural sector, which indicated the large proportion of the farmer population in these villages. The farmer population was the peoples who identifies the main occupation as a farmer. In those conditions, have not been available employment outside agriculture. Consequently, the proportion of non-farm income becomes smaller, which is equal to 0.32.

In some villages, there are some villages that have non-farm income proportion was quite large (around 0.5), the village of Danau (0.59), Ketenong 1 (0.47), Ketenong 2 (0.49), and Ujung Tanjung 2 (0.49). However, non-farm income sources have not yet contributed to the improvement of living standards. At the level of agricultural technology that was used by the villagers, where rice productivity is still low (around 2 tonnes / ha) have not produced the desired welfare (standard World Bank spending 2 dollars per capita a day). The villages that have not occured population pressures, the agricultural productivity apparently was large around 5 tonnes/ha. Consequently, although the agrarian density was still low, agricultural land was not able to sustain its population lives.

The standar of living that considered in this study population was equivalent to 2:00 expenditure US dollars per capita a day (roughly IDR 18,500). This has led to be good income either the agricultural sector and outside the agricultural sector. The implication was we need more intensive in using of technology or the expansion of agricultural land. Up here, it can be concluded that in the villages around TNKS has been a decreasing of the carrying capacity as big as population pressure above 1.00. It means that the available natural resources, especially the agricultural sector was not able to support the entire population at the level of properity.

Livelihood strategies of villagers would run to diversify sources of income called multiple livelihood. In the setting of mountains forest ecology and shifting cultivation cultural setting [8], then the chances of forest degradation around settlements the population will increase. In the calculation of the index population pressure here, the income from the utilization of forest products were removed. Thus, the figures obtained could explain the symptoms of deforestation were increased caused by agricultural activities.

The estimated of the island of Sumatra population pressure has not happened (in 2006 amounted to 0.80, and 0.86 in 2010) [7]. With an average productivity of land 4.17 tonnes / ha, the ecology of Sumatra Island was able to sustain the population lives on the same level of prosperity with this research. Specifically in the Province of Bengkulu, the population pressure nearly occurred in 2010, which amounted to 0.99 [7]. If the condition of the people and the land did not change the population pressure was estimated would have occurred in the following year. Worse situation occurred in North Sumatra (1.06), West Sumatra (1.18), and Lampung (1.53). Java situation as the worst, ie the population pressure in 2006 amounted to 1.80 and 2010 amounted to 1.83 [13].

## Conclusion

Based on this study concluded that in 2012 the villages around TNKS has occurred population pressure (pressure index of 3.21 residents). Although agrarian density still quite low, but because of high population growth rate, of low agricultural productivity, and of proportion of non-farm income were also low, the population pressure has occurred. These conditions indicated the occurrence of overpopulation or the decreasing of carrying capacity of the environment.

To improve the environmental carrying capacity and sustainability of the population livelihood around TNKS required number of strategies. Multiple livelihood strategies by diversify the source of income was one of the solutions [1]. It's just that we need to take into account the population. The relatively small number of people have not been sufficient for the development of the secondary sector

(trade) and tertiary (services). Demographically, the factors that can be considered to be better for the population growth was in-migration. The factors of birth and death can be ruled out because of these two factors still require long periods of time as well as development of human resources. Therefore, the development of trade and services sector needs to be supported by the government program such as agro tourism, agroforestry, and industry (e.g. mining). These option would improve the proportion of non-farm income to increase the internal carrying capacity.

Another option was the intensification of agriculture. The intensification was done by apllying the modern agricultural technology. The goal was to improve the productivity of agricultural land. Rice fields and plantations were conserved and replanted. If the productivity of land improved sucessfully, it could reduce the population pressure. It means that the carrying capacity of the environment would increase.

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