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Structural Model Of Land Use Change In Protected Area:
Case Study at Kerinci Seblat National Park

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ABSTRACT

This research aims to identify the driving forces of land-use change to estimate deforestation level and its impact on land-cover of the buffer zone of Kerinci Seblat National Park (KSNP) area, in central Sumatra. Econometric model for land use change bloc using the Discrete Choice Model, while Triangular System Model for deforestation and degradation bloc used the estimation technique of Seemingly Unrelated Regression. The results indicate that commodity conversion was significantly influenced by micro variables such as output and input prices, while macro variables especially demographic factors significantly determined land use change. Decline in deforestation has a negative impact on buffer zone land-cover and positive impact on national park land-cover. The tradeoff between these two needs a determination of an ideal proportion of buffer zone land-cover of national park area. This research concludes that the management of the national park should consider the socioeconomic progress including regional land-use and land cover change of buffer zone.

Keywords: Land-use, land cover, micro and macro variables

1. Introduction

National Park is a protected area for the purposes of ecosystem conservation and recreation or in a broader definition, an integrated system of natural conservation management, tourism park, sea park, and management of production forest with integrated management. Kerinci Seblat National Park is the largest national park in Sumatera (1375 million Ha) and was launched by the Decree of Minister of Forestry No. 901/Kpts-II/95 on 14 October 1995. The fast-growing regional economy has increased pressures on the park. Moreover, different perceptions among regional governments about the national park and its buffer zone have triggered economic development competition among provinces. West Sumatra and Bengkulu provinces intend to develop plantation in the areas surrounding the park by building road infrastructure across and around the park. However, Jambi Province relies on the park for protecting water storage area.

Scriecu (2001) says that land use change or land expansion can be a proxy for deforestation level of an area. Deforestation refers to tree cutting of forest area and conversion for other purposes, mainly agriculture (van Kooten, 2000 in Briassoulis, 2003). According to FWI and GWI (2001), deforestation is the cutting of forest cover and permanent land conversion for other purposes. They further define forest degradation as the decrease in tree density and/or the increased degradation in forest resulting in the loss of forest products and ecological services of forest. Andersen (1996) states that there is no consensus on macro-level explanatory variables an empirical model should cover. Literature on household-level economic theory uses expansion of agricultural land as a proxy of deforestation and a parameter in the driving forces of deforestation decision change (Scriecu, 2001). Interaction among deforestation agents has often been a constraint in identifying deforestation driving forces. Therefore, Angelsen et al. (1999) classifies the forces into three specific factors: (1) deforestation sources (such as small-scale farmers, collectors of forest products - wood in particular, livestock owners, and those dealing with forest encroachment), (2) local-level deforestation forces (related to decision parameter and agent characteristics) and (3) macro-level forces (policy and trend or structural factors).

Conceptual framework to design the process and approach to deforestation model according to Angelsen and Kaimowitz (1999) includes 5 variables: (1) magnitude and (2) location of deforestation as dependent variables, (3) agents of deforestation that include individuals, households or companies involved in land use change, (4) choice (decision on land allocation that determines deforestation level of

main agents and groups), and (5) agents' decision parameters (variables directly influence agents' decision but are coming from external factors).

The broad objectives of the present study is to find out the impact of socioeconomic development on changes in land cover of the buffer zone of KSNP. While specific objectives are to identify: (1) the driving forces of land use change and inter-commodity conversion pattern and land use surrounding KSNP; and (2) the regional socioeconomic impact and agricultural land expansion on land cover change in the buffer zone and KSNP area.

2. Model Specipication

The model consists of three blocs: commodity selection, dynamics of land use and deforestation and degradation of the national park. The model of land use change is a modified discrete choice model that is able to represent general situation choice (McFadden, 1978; Hensher, 1981; Anas, 1982 in Briassoulis, 2003). Discrete statistic model was modified to estimate land use change by the following Seemingly Unrelated Equation (SUE):

2.1. Commodity choice bloc (1-12)

$$PLAKi = \alpha_{0.i} + \alpha_1 ROIKi + \alpha_{2.i} PVKTi + \alpha_{3.i} PUSEi + \alpha_{4.i} SKBD + \alpha_{5.i} RAWTN + \alpha_{6.i} PAGC + \alpha_{7.i} PAGE + \alpha_{8.i} PWRE + \alpha_{9.i} PTRE + \alpha_{10.i} DKAW1 + \alpha_{11.i} DKAW2 + \alpha_{12.i} DESE + \alpha_{13.i} KRIS + \alpha_{14.i} YEAR + e_{1-12}$$

2.2. Land use dynamics bloc (13-22)

$$PUSEi = \beta_{0.i} + \beta_1 ECOG + \beta_{2.i} POPG + \beta_{3.i} POPD + \beta_{4.i} SSPTi + \beta_{5.i} RAGWA + \beta_{6.i} RPFER + \beta_{7.i} PAGE + \beta_{8.i} PTRE + \beta_{9.i} PAGC + \beta_{10.i} DESE + \beta_{11.i} KRIS + \beta_{12.i} YEAR + e_{13-21}$$

$$PFOR = 100 - \Sigma PUSEi$$

To explain the relationship between economic growth, deforestation, land cover change, and degradation of KSNP, recursive Triangular System was employed.

2.3. National park deforestation and degradation bloc (23 – 27)

$$ECOG = \delta_{1.00} + \delta_{1.01} ECOS + \delta_{1.02} LABS + \delta_{1.03} GEXS + \delta_{1.04} GRES + \delta_{1.05} PUKC + \delta_{1.06} CRES + \delta_{1.07} PSRE + \delta_{1.08} PTRE + \delta_{1.09} PRDE + \delta_{1.10} ECOGR + \delta_{1.11} DESE + \delta_{1.12} KRIS + \delta_{1.13} YEAR + e_{22}$$

$$DEFO = \delta_{2.00} + \delta_{2.01} ECOG + \delta_{2.02} ECOS + \delta_{2.03} POPD + \delta_{2.04} UNEM + \delta_{2.05} RWIND + \delta_{2.06} RPFER + \delta_{2.07} PAGE + \delta_{2.08} PTRE + \delta_{2.09} PAGC + \delta_{2.10} PTEM + \delta_{2.11} DESE + \delta_{2.12} KRIS + \delta_{2.13} YEAR + e_{23}$$

$$DEGHS = \delta_{3.00} + \delta_{3.01} DEFO + \delta_{3.02} ECOG + \delta_{3.03} ECOS + \delta_{3.04} RHTLU + \delta_{3.05} INCP + \delta_{3.06} RKBMT + \delta_{3.07} LHPHS + \delta_{3.08} PEVE + \delta_{3.09} PERS + \delta_{3.10} DESE + \delta_{3.11} KRIS + \delta_{3.12} YEAR + e_{24}$$

$$RHSTN = \delta_{4.00} + \delta_{4.01} DEFO + \delta_{4.02} DEGHS + \delta_{4.03} ECOG + \delta_{4.04} ECOS + \delta_{4.05} INCP + \delta_{4.06} RKBMT + \delta_{4.07} LHPHS + \delta_{4.08} PEVE + \delta_{4.09} PERS + \delta_{4.10} DESE + \delta_{4.11} KRIS + \delta_{4.12} YEAR + e_{25}$$

$$DEGTN = \delta_{5.00} + \delta_{5.01} DEFO + \delta_{5.02} DEGHS + \delta_{5.03} ECOG + \delta_{5.04} ECOS + \delta_{5.05} RHSTN + \delta_{5.06} INCP + \delta_{5.07} RKBMT + \delta_{5.08} EXHKS + \delta_{5.09} PEVE + \delta_{5.10} AGRE + \delta_{5.11} DESE + \delta_{5.12} KRIS + \delta_{5.13} YEAR + e_{26}$$

The model was estimated by Seemingly Unrelated Regression (SUR) with SAS 6.12 program.

3. Results and Discussion

3.1. Driving Forces of Agricultural Commodity Production

Factors affecting demand for land to produce food and plantation crops are presented at Table 1 and Table 2.

3.2. Food Crop Commodities

The increased ratio of food price and fertilizer price indicates the expected profit of food crops by farm households. This will be responded positively by expanding agricultural land. Due to land limitation, unproductive and low-priced commodities will be converted to food crops. This could be the source of the significantly decreasing area of cassava and soybean. On the contrary, land for maize production increases due to increased productivity. Increased productivity was also performed by dry land paddy, peanut, cassava, and sweet potato. In the cases of wetland paddy and soybean, the increase in productivity was responded by reducing land for these crops. Therefore, the development of these crops can be used to reduce pressure on land.

The area of wetland paddy increases along with the increase in wetland area. However, the increase in dry land area reduces the area of dry land paddy. This could be due to the fact that dry land is mainly used for other crops such as vegetables and fruits (horticulture). The increase in input prices such as capital (interest rate) and labor wage in general was responded negatively by reducing input-intensive crops and converting it to less input-intensive crops such as cassava. Cassava can produce without intensive inputs such as fertilizer and labor.

Development financing through public sector (development expenditure) as well as private sector (agricultural credit) generally do not give significant impact on the area of commodity production, but is responded differently by each commodity. The insignificant impact of the change in agricultural credit allocation on crop pattern indicates the low intensity of the use of agricultural credit for food crop production. The increase in development expenditure has significant negative impact on peanut production. The quite significant impact of development expenditure is shown by expenditure in water resource and irrigation that is able to expand the area of peanut and soybean production. The increased accessibility to land has significant impact on the expanded wetland area.

Table 1. Estimation Results of the Driving Forces of Food Crops Land Use

Variable	Area of Food Crops						
	Wetland paddy	Dry land paddy	Maize	Peanut	Soybean	Sweet Potato	Cassava
Intercept	-4187.399	-3037.422	-2800.996	-356.5970	117.4663	-361.9376	507.9200
Price Ratio	0.8151	1.0276	1.6892	0.0449	-0.1658	0.6619	***-4.8772***
Productivity	-1.6104	0.0025	***0.4741***	0.2868	-0.5967	0.0343	0.1735
Ratio of wet to dry land	2.6050	-0.2321	***-0.1622***	***-0.0736***	-0.0847	***-0.1776***	-0.1429
Interest rate	-0.1729	***-0.1363***	***-0.0986***	***-0.0194***	-0.0029	-0.0140	0.0112
Planting Wage	-1.0761	-1.1314	***-1.0878***	***-0.1893***	0.0006	-0.1302	0.0782
Agricultural Credit	0.1326	0.0221	0.0144	0.0004	0.0128	-0.0003	-0.0215
Agricultural Costs	-0.4750	-0.1193	-0.0826	***-0.0508***	-0.0781	-0.0386	-0.1820
Water Expenditure	0.1528	-0.2380	0.0029	***0.0644***	***0.1077***	0.0598	0.1231
Transportation Expend.	***0.2223***	0.0606	0.0537	0.0120	0.0214	0.0244	-0.0455
Dummy West Sumatra	***16.6346***	***-5.7178***	***-5.2980***	***-1.2086***	***-0.8954***	***-2.6651***	***-1.3913***
Dummy Jambi	3.1261	0.6648	***-3.2210***	***-1.1154***	***-1.0233***	***-1.9427***	-0.1423
Decentralization	-1.6914	-0.5206	***-1.6524***	***-0.3258***	-0.3276	-0.3809	0.1640
Crisis	-0.5341	***-2.1622***	-0.3010	0.2245	0.0146	0.2935	-0.5861
Year	2.0968	1.5258	***1.4065***	0.1797	-0.0576	0.1829	-0.2510

Note: Bold and italic letters indicate significance at significance level of 90% ($P < 0.10$)

Regional difference in the area of commodity production is generally significant and indicates the tendency of regional food production. Wetland paddy is mainly grown by farm smallholders in West Sumatera and Jambi. This is revealed by two regencies in West Sumatera (Solok) and Jambi (Kerinci) that serve as provincial rice bowls. Bengkulu is dominant in dry land food crop production such as dry land paddy, maize, peanut, soybean, and sweet potato. Its difference with other provinces is highly significant.

Economic crisis and the implementation of regional autonomy generally give negative impact on land use change for food crop production. The significant decrease in the cultivation area due to crises is observed for dry land paddy, while decentralization leads to significant decrease in the cultivation area of maize and peanut. This could be due to conversion of food crops to horticulture crops (vegetables and fruits). The negative impact of crisis and decentralization does not considerably influence changes in food cropping pattern because the areas of most crops increase every year; maize area increases significantly. The unsuitability of land for soybean production and the low value of cassava lead to decreased area of these crops during 1994 - 2003.

3.3. Plantation Commodities

The area of plantation commodities in general increases as the price ratio of output to fertilizer increases. However, only coffee shows significant increase. By contrast, cinnamon shows a significant decrease due to increased price ratio. This could be due to its characteristics of whole-tree cutting. Higher price encourages production; however, the exploitation of cinnamon is not followed by replanting; this results in significant decrease.

The increased productivity of plantation area helps inhibit expansion because increased productivity is followed by decreased area of all commodities. The significant increase in plantation area is not accompanied by increased area of individual commodities; the significant decrease in the area of rubber indicates that the area development of this commodity has been very slow and even decreasing as compared to other plantation commodities. The increased interest rate and agricultural wage have negative impact on labor-intensive crops such as coffee, palm oil, while the use of agricultural credit for commercial plantation such as palm oil boosts significant increase in palm oil plantation area resulting in the decreased area of other crops. Financing through development expenditure in agriculture, water resource and transportation do not give significant impact on changing commodity production pattern.

Based on the significant regional difference, competitive plantation commodity (dominant commodity cultivated by farm households) of individual provinces can be identified. Rubber, palm oil, and cinnamon are superior commodities in Jambi, coffee in Bengkulu and coconut in West Sumatera. The economic crises triggers output price increase, but is not accompanied by input price increase. Therefore, it does not lead to significant decrease in the cultivation area of individual commodities. Conversely, after decentralization, the area increased again but cinnamon. The significant increase in the cultivation area of palm oil after decentralization could be the main driver of increased commodity cultivation area.

Table 2. Estimation Results of the Driving Forces of Plantation Commodity Land Use

Variable	Area of Plantation				
	Rubber	Palm Oil	Coconut	Coffee	Cinnamon
Intercept	95.7429	1022.8152	-9313.4160	-6343.5437	-5625.7038
Ratio of I-O Prices	1.7494	0.4636	2.2497	***1.5555***	***-0.5764***
Productivity	-0.8469	-0.7153	***-1.7319***	***-42.5392***	***-15.5669***
Area of Plantation	***-3.2904***	-0.0820	-0.7140	-0.1749	***-1.2697***
Interest Rate	0.7829	0.0447	-0.2267	-0.1856	-0.0886
Wage of Farm Laborer	1.8643	0.3472	-1.8064	-1.1006	***-2.0021***
Agricultural Credit	-0.2344	-0.0455	***0.4815***	-0.0324	0.0057
Agricultural Costs	0.0986	-0.1386	-0.2393	0.0478	-0.2735
Water Expenditure	-0.4819	-0.1104	0.3766	0.7870	***1.0679***
Transportation Expend.	0.4633	0.0222	0.1099	-0.2135	0.0344
Dummy West Sumatra	***-34.4811***	***7.8605***	3.3891	***-16.9153***	4.6941
Dummy Jambi	***52.4250***	***-1.6922***	***11.3441***	***-38.0022***	***25.6453***
Decentralization	2.7503	1.1603	***6.6791***	3.7399	-0.3969
Crisis	-1.8778	-0.1379	-0.8420	-2.7142	-3.2465
Year	-0.0262	-0.5092	***4.6542***	3.2054	***2.8351***

Note: Bold and italic letters indicate significance at significance level of 90% (P < 0.10)

3.4. Land Use Change

The driving forces to land use change in the areas surrounding the park can be seen at Table 3. Land use change is influenced by macro factors (economic growth and structure and demography), micro factors mainly input price (fertilizer and labor), financing policy (credit and development expenditure) and time (crisis, decentralization and year). Even though economic growth does not significantly influence land use, but it is responded differently by land use. The impact of increased population can be seen at the significant increase of land use for plantation and ponds, and increased use of wetland, pasture and fallow land due to increased population density. The significant increase in plantation area triggered

by increased demand for land due to population pressure is not only converted from forest but also from other land, particularly wood plants area. This could be the source of significant decrease in wood plants area. Significant increase in ponds mainly comes from similar land that is easier to convert such as wetland and swamp area. For non-agricultural purposes (housing and settlement), significant increase is due to increased number of households.

Significant land use change occurred due to changing role of agricultural sub sectors such as increased dry land and plantation by the increased share of food crops and plantation in regional Gross Domestic Product. Significant decrease of pasture due to increased share of livestock production implies the degradation of pasture as the consequence of increased ruminant livestock population such as cows, buffalos, and sheep. A quite worrying finding is that the increased share of agriculture in GDP is accompanied by significant increase in fallow land. This could be due to fact that the increased share of forestry sub-sector is achieved through forest exploitation and the degraded forest area is left fallow.

Increase in input prices such as labor wage and fertilizer is responded differently but in general decreases cultivation area. Increase in labor wage significantly reduces wetland cultivation and the magnitude of households converting to dry land crops encourages the extensive use of dry land particularly for crops that do not require a lot of family labor. On the contrary, increase in fertilizer price encourages high-value and high productivity food crops such as wetland paddy. Hence, wetland paddy increases significantly, while dry land paddy decreases. Changes in the allocation of development expenditure and agricultural credit, though not significant, but in general promotes land expansion by increasing area of individual crops and reduces fallow land. Negative impact is also observed on the increased fallow land as allocation of development expenditure increases.

Table 3. Estimation Results of the Driving Forces of Land Use

Variable	Land Use								
	Wetland	Dry land	Garden	Pond	Pasture	Wood plant	Fallow	Swamp	Settlement
Intercept	-718.1	2199.8	-1061.1	-17.468	-10.373	-917.284	-722.3	77.661	-33.231
Economic Growth	0.104	-0.239	0.037	0.001	0.038	0.260	0.177	-0.033	-0.031
Population Growth	-0.109	0.096	***1.717***	***0.045***	-0.025	***-1.214***	**0.257**	-0.097	0.044
Population Density	*0.097*	0.027	0.024	0.003	***0.015***	0.075	***0.193***	-0.011	-0.007
Num of Households	-	-	-	-	-	-	-	-	***0.060***
Share of sectors	-0.059	***0.550***	***1.336***	0.003	***-0.467***	-0.489	***0.652***	***0.090***	-
Wage of Labor	***-0.521***	***1.195***	-0.547	-0.019	-0.040	-0.496	-0.147	0.175	-0.038
Fertilizer Price	*1.409*	-3.356	1.910	0.079	-0.175	0.593	-0.399	-0.795	-
Semen Price	-	-	-	-	-	-	-	-	2.668
Wood Price	-	-	-	-	-	-	-	-	*-0.116*
Agricultural Costs	0.075	0.257	0.623	0.004	0.038	0.276	-0.142	***0.134***	
Transportation Costs	0.046	*-0.232*	-0.060	0.000	-0.001	0.131	***0.082***	0.002	-0.008
Reg. Dev. Expend.	-	-	-	-	-	-	-	-	0.001
Agricultural Credit	0.009	-0.030	0.023	0.000	0.005	0.034	0.033	-0.007	
Decentralization	-0.201	1.118	-1.906	-0.030	-0.076	-0.713	0.602	-0.367	0.561
Crisis	0.351	-1.310	-0.940	-0.049	0.349	3.490	1.465	0.359	-0.500
Year	0.358	-1.099	0.530	0.009	0.006	0.458	0.342	-0.040	0.013

Note: Bold and italic letters indicate significance at significance level of 90% ($P < 0.10$)

Crisis and decentralization do not have significant impact on cultivation land use, but in general individual cultivation area decreases. This could be the root of unobserved significant land use change during the research period. In general, land use for agriculture, housing and settlement increases implying that forest conversion increases from year to year.

3.5. Economic Growth, Deforestation, and Degradation

The relationship between economic growth as an impact of socioeconomic development with the rate of deforestation and degradation of national park can be seen at Annex 4. The increase in economic growth encourages land use by converting forest and degrading national park, but is able to reduce the park degradation. This indicates 'trade-off" in development particularly between economic and environmental aspects where efforts to improve welfare leads to increasing pressure on environment. Economic growth leading to increased degradation of buffer zone will endanger the park itself. The relationship between deforestation and degradation of buffer zone and degradation of the national park indicates that accessibility constraint to public resource, in this case national park, will increase deforestation in non protected area. Another cause could be that the decrease in public land such as open access forest and buffer zone will encourage people to shift resource use to state property. This condition leads to the need for a certain ratio of forest cover in buffer zone with an ideal area of national park that can provide positive impact on economic growth and national park conservation.

Whether the relationship among these variables has significant impact and other factors that may influence them are presented at Table 8. Economic growth that is measured from production approach at constant price shows that it is significantly affected by economic structure, labor force structure, and regional economic growth. The higher the contribution of agricultural sector in regional GDP, the lower the regional economic growth. Nevertheless, the increased number of labor force in this sector significantly increases output growth. This implies a dilemma in economic development where increase in agricultural output will lower economic growth, but if it is constrained, it will decrease labor absorption. A possible solution is to develop agro industry that has forward and backward linkage to other sectors, thus increased agricultural value added and employment creation. Provincial economic growth has significant impact on regional economic growth as increased economic growth in provinces is followed by regional economic growth.

Another factor that needs more concern to foster regional economic growth is the structure of government expenditure and income. The increased proportion of routine expenditure during decentralization - as an effort to increase the proportion of regional original income through various retributions, decelerates economic growth. The indication of ineffective regional autonomy in fostering

economic growth is that growth after decentralization is lower than that in the period before liberalization. Another explanation could be that the impact of crisis significantly decreases economic growth. Allocation of sectoral development expenditure such as increased allocation for knowledge and technology and transportation has positive impact on economic growth, but increased allocation for regional development sector has negative impact. The financing allocation of private sector should also be taken into account because increased credit allocation for small and medium enterprises and the use of credit for productive purposes (investment and working capital) are able to promote economic growth. In general, though not significant, output growth has increased during the research period.

Economic and population growth, increased share of agricultural sector and allocation of agricultural development expenditure have significant impact on regional deforestation. The same thing applies as the impact of economic crisis where transformation of non-agricultural labor to agricultural labor leads to significantly increasing conversion from forest to other purposes, mainly agricultural cultivation. The increased demand for land will first be met by using fallow land rather than forest. This is indicated by the fact that increase in this type of land is able to significantly decrease regional deforestation. Increase in agricultural financing allocation (credit and development expenditure) and increased accessibility to land (transportation) also encourages forest conversion. The big number of significant factors causing forest conversion significantly increases deforestation from year to year.

Decrease in land cover area or regional degradation increases significantly as the share of agriculture in regional GDP increases. Differences in the perception of using the area also have significant impact. In West Sumatra and Bengkulu that prefer to utilize the area for economic purposes, the degradation of buffer zone is bigger than that in Jambi that perceives the park as a source of water supply. The increased awareness of environment by local government in particular, is an important issue to protect the increasing degradation of buffer zone, indicated by the allocation of environmental development expenditure. The increase in this expenditure will have significant impact on forest degradation of the park buffer zone. The economic crisis during which living costs and difficulty to get job enlarges brings about people to exploit the buffer zone to get forest resources. This could be the cause of significant degradation. Degradation can be significantly reduced after decentralization. The more dominant supporting rather than restraining factors to regional degradation leads to the significant increase in degradation during the research period.

The increased degradation of the national park leads to significant decrease in the ratio of forest cover of buffer zone to national park area and vice versa, decreased degradation will significantly decrease the ratio. This is the consequence of the decision of utilizing other areas and buffer zone; when the benefit of utilizing other areas is reduced, people will shift to the buffer zone. Decreasing resources in other areas will bring about people to use the buffer zone, which is highly important in natural conservation. Similarly, the increase of agricultural share will significantly decrease the ratio of forest cover of buffer zone to the national park in each region. The increased degradation of buffer zone decreases this ratio during the research period though not significant.

The imperative function of buffer zone is reflected by the fact that the increased ratio of buffer zone to the national park decreases the park degradation, though not significant. Regional deforestation and buffer zone degradation that do not match the park degradation again indicates a tradeoff in regional resource utilization. High awareness of the key function of protected forest is seen from the increased environmental development expenditure that is able to reduce the park degradation and the consensus among stakeholders, local governments in particular, to improve the park conservation in 2001 that significantly reduces the park degradation. Significant increase in the park degradation was observed during the economic crisis in the research period.

4. Conclusion and Policy Implication

4.1. Conclusion

a) Land use change among commodities and among different purposes represents a dynamic phenomenon due to regional socioeconomic development.
b) Land use change occurred in a dynamic way in terms that conversion was observed among commodities with conversion among food crops more dynamic than that among plantation commodities.
c) The largest land expansion including forest conversion was observed in plantation; therefore, plantation development has been the main source of regional deforestation.
d) There is a significant association between economic growth and regional deforestation with the degradation of the park and its buffer zone.

e) The conservation improvement of the park and its buffer zone should be integrated with the improvement in community welfare in order to reduce pressures on land.

4.2. Policy Implication

a) Increased farm productivity could be the solution to increase production and to reduce pressures on land because there is a negative correlation between productivity and cultivation area.

b) An important factor that needs concern in the national park conservation is the size of buffer zone forest cover, which is ideal to reduce pressures on the national park because there is a tradeoff among deforestation and degradation of buffer zone and the park.

References

[1] Andersen, L.E. 1996 "The Causes of Deforestation in the Brazilian Amazon", *Journal of Environment and Developmen*t, 5(3): 9-28.

[2] Angelsen , A and D. Kaimowitz, 1999. Rethinking the Causes of Deforestation: Lessons from Economic Models, *The World Bank Research Observer*, . 14(1): 73 – 98.

[3] Angelsen, A., E.F.K. Shitindi and J. Aarrestad 1999 "Why Do Farmers Expand Their Land Into Forests? Theories and Evidence from Tanzania", *Environment and Development Economics* 4 (03): 313-31.

[4] Briassoulis, H. 2003. Analysis of Land Use Change: Theoretical and Modeling Approaches, *The Web Book of Regional Science*, Regional Research Institute, West Virginia University.

[5] Bunasor, S., 2001. Reformulasi Kebijakan Otonomi dalam Sektor Kehutanan: *Tinjauan Ekonomi*. Makalah Reformulasi Kebijakan Otonomi Bidang Kehutanan, Departemen Kehutanan, 24 Oktober 2001, Bogor.

[6] CFAN (CIDA Forestry Advisers Network), 1999. Forestry Issues Deforestation: *Tropical Forests in Decline*, CIDA (Canadian International Development Agency) Canada.

[7] Dirjen PHPA (Direktorat Jenderal Perlindungan Hutan dan Pelestarian Alam), 2002. Daftar Taman Nasional di Indonesia Sampai dengan Agustus 2002, Departemen Kehutanan RI, Jakarta.

[8] FWI/GFW (Forest Watch Indonesia/Global Forest Watch), 2001. Potret Keadaan Hutan Indonesia, Bogor Indonesia: Forest Watch Indonesia dan Washington D.C, Globat Forest Watch, ISBN: 979-96730-0-3.

[9] GOI (Government of Indonesia), 1985. Forest Policies in Indonesia: *The Sustainable Development of Forest Land*, Government of Indonesia, Jakarta.

[10] ICDP (Integrated Conservation and Development Project), 2002. Aneka Ancaman Pada Taman Nasional, Goverment of Indonesia, World Bank and GEF (Global Environmental Fund).

[11] Koutsoyiannis, A., 1977. Theory of Econometrics. *An Introductory Exposition of Econometric Methods*. Second Edition. Harper and Row Publishers, Inc. New York.

[12] Scrieciu, S. S. 2001. Economic Causes of Tropical Deforestation: *A Global Empirical Application*, Institute for Development Policy and Management, University of Manchester, Harold Hankins Building, Oxford Road, Manchester.

Annex 1. Factors Affecting Economic Growth, Deforestation and Degradation of Buffer Zone and Kerinci Seblat National Park

Economic Growth /PDRB (ECOG)

No	Variable	Coefficient
1	Intercept	-884.5881
2	Economic structure	***-0.1846***
3	Structure of labor force	***0.1714***
4	Structure of development expenditure	0.0436
5	Income structure	0.0317
6	Credit allocation for small and medium enterprises	0.0008
7	Credit Structure	0.0656
8	Allocation of development expenditure, R&D	0.3303
9	Allocation of development expenditure, transportation expenditure	0.0232
10	Allocation of development expenditure, regional development expenditure	0.0006
11	Regional GDP growth	***0.5611***
12	Decentralization	-0.2027
13	Crisis	***-2.9491***
14	Year	0.4381

Regional Deforestation (DEFO)

No	Variable	Coefficient
1	Intercept	-2577.1603
2	Regional GDP growth	***0.7083***
3	Economic structure	***2.3435***
4	Population density	***0.6129***
5	Open employment rate	-0.9209
6	Sectoral wage ratio	-1.7695
7	Fertilizer real price	***-5.5874***
8	Allocation of agricultural development expenditure	***1.1917***
9	Allocation of transportation development expenditure	0.0836
10	Allocation of agricultural credit	0.1791
11	Fallow land area	-0.9627
12	Decentralization	0.0915
13	Crisis	***8.1457***
14	Year	***1.2403***

Degradation of Buffer Zone Forest of KSNP (DEGHS)

No	Variable	Coefficient
1	Intercept	-2190.8838
2	Regional deforestation rate	0.1690
3	Regional GDP growth	0.2161
4	Economic structure	***0.9131***
5	Ratio of forest to land use	0.0085

6	Income percapita	1.4766
7	Price ratio of firewood to kerosene	0.2152
8	Area of logging authority in buffer zone	0.0047
9	Allocation of environmental development expenditure	***-0.3896***
10	Perception of the functions of buffer zone	***10.3959***
11	Decentralization	***-3.0449***
12	Crisis	***8.5782***
13	Year	***1.0713***

Ratio of Surrounding Forest to KSNP (RHSTN)

No	Variable	Coefficient
1	Intercept	2599.7639
2	Regional deforestation rate	***1.2019***
3	Degradation of buffer zone forest	***-3.4862***
4	Regional GDP growth	-0.6772
5	Economic structure	***-6.1999***
6	Income percapita	7.5197
7	Price ratio of firewood to kerosene	-1.0478
8	Area of logging authority in buffer zone	-0.0414
9	Allocation of environmental development expenditure	1.2208
10	Perception of the functions of buffer zone	3.1028
11	Decentralization	1.7575
12	Crisis	13.5172
13	Year	-1.1466

Forest Degradation of Kerinci Seblat National Park (DEGTN)

No	Variable	Coefficient
1	Intercept	-1093.5624
2	Regional deforestation rate	-0.0141
3	Buffer zone forest degradation	***-0.3161***
4	Regional GDP growth	0.0647
5	Economic structure	-0.0807
6	Ratio of forest cover of KSNP	-0.0189
7	Income percapita	-2.5936
8	Price ratio of firewood to kerosene	-0.0880
9	Area of ex-logging authority surrounding KSNP	-0.0004
10	Allocation of environmental development expenditure	-0.1567
11	Stakeholder consensus	***-1.6389***
12	Decentralization	-1.0273
13	Crisis	***3.5944***
14	Year	***0.5560***

Note: *Bold and italic letters shows significance impact at* 90% significance level (P < 0.10)

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