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# Model of Agricultural Economic Development of the Cycloops Natural Reserve in Papua, Indonesia

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**Abstract**
The acceleration of human population growth around the Cycloops Natural Reserve (CNR) has resulted in land conversions for multiple purposes such as small-scale agriculture, minor mining operation, settlement, and infrastructure. Such conditions have deteriorated CNR and declined its quality periodically. In order to persist the sustainability of CNR function and quality, a real solution of problem-solving was needed through developed model toward regional management of which based on economic and agricultural management coupled with an environmental perspective. The main objective of this study was to develop an economic development model for the community through agricultural activities in the Cycloops Nature Reserve of Papua Island. This research was conducted in CNR using dynamic analysis schema. The result revealed that an intervention-based scenario was appropriate in addressing each agricultural activity around CNR and consider to be the best in terms of embodying the sustainable agricultural management with pertinent instructions and policies to be implemented. It was pivotal in order to link all stakeholders and provide a preferential collaboration for better management of CNR for the long-term of the sustainable way and contribute economically for the local people who live interdependently with the CNR.
**Keywords**: economic development, local community, nature reserve.

## 1. Introduction

The phenomenon of forested and natural disturbances in particular deforestation and forest degradation in the world occurred for a long time ago and until now the aftermath is huge with multiple devastating effects for human being (Foley et al 2005). Indonesia was known as one of the third largest tropical rainforest in the world also experienced massive conversion of lands and forests into agricultural and industrial needs. Along with the increasing of human population growth in Indonesia, land availabilities and spaces for settlements and other primary based activities are mandatory required which leads to massive land conversion (Benu et al 2013). In addition, forest-based industrial sectors such as oil palm, pulp and paper, and plantation forests are also play a key role in revolutionizing forested lands to other shapes (Contreras-Hermosilla and Fay 2005).

Forests in particular have been pivotal in terms of its contribution toward economic influences and incomes for people who live around it. In many places around Indonesian archipelago, forests contributions are very tangible and have been accounted for 2 percent of total national income. However, still a couple of problem found in regard to forest managements and its maximum benefits for communities and environmental balances. In addition, sharing benefit of forest itself is not well-managed in generating incomes and distributing equally among stakeholders. This, a better management in the forests by way of implementing strong sustainability paradigm through implementation of forest and natural management based on ecosystem approach is apparently needed.

The Cycloops Natural Reserve (CNR) is one of the richness natural ecosystems in Indonesia, located in the eastern part of Indonesia, known as Papua Island. This ecosystem is about 22,500 and managed under the Ministry of Forestry and Agriculture of the Republic of Indonesia through the regulation number of 56 and 365 in 1978. There are a couple of mandatory functions in conjunction with the preservation efforts such as keeping many of endemic plants and animal species i.e., *Ralina mayri* and *Paraleptomys refilatus*, and as a main nature reserve, it has been contributing toward natural ecosystem and providing water supply for urban settlements around the city. However, the increasing scale of land conversions surrounding the area of CNR is continually resulting a number of massive problems for the environment and accumulating a long-term imbalance of ecosystem services. Currently, the aftermath of it can be seen such as burning land for small-scale agriculture sectors, minor mining activities, and settlements as a major invasion for land accusation.

In general, the objective of this study is to build an economic development model that based on community through sustainable agricultural activity in the Cycloops Natural Reserve (CNR) in Papua.

 

## 2. Method

### 2.1. Study Area

This study was conducted around the Cycloops Natural Reserve (CNR) in the district of Jayapura, Papua Province, Indonesia.

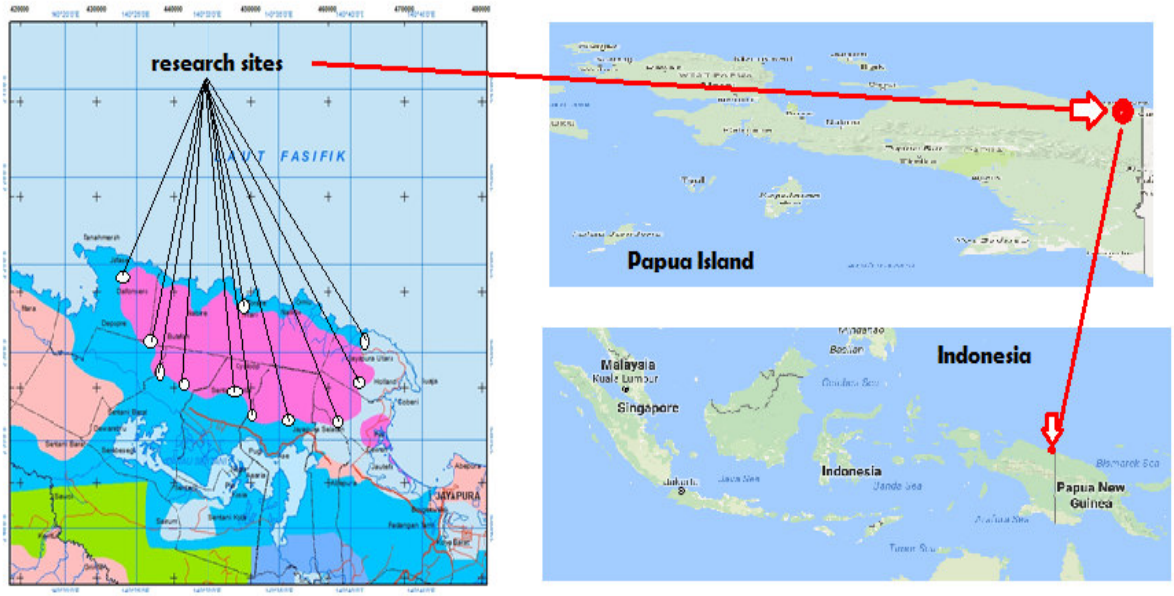


Figure 1. Study area of the Cycloops Natural Reserve (CNR)

### 2.2. Data analysis

Data of population were generated from both the provincial and district government of Jayapura. Both are mainly concerned about physical, social, and economic aspects which were analyzed using powersim software. Samples were taken purposively (purposive sampling) from 11 villages in six districts through interview among various stakeholders who have been involved.

### 2.3. Analysis of dynamic system

Dynamic system is used in this research to solve the problem begins with identifying the issues, objectives, and constraints and then formulating a model which is formed with the concept and ending with the operating system running effective and purposeful. This systematic approach has several elements, including the use of the methodology in the planning and management of agriculture, as well as the multidisciplinary nature of organized non quantitative thinking, can be simulated and achieve optimal point in management, and can be applied to the computer (Eriyatno 2012).

Figure 1 shows the alleged model in dynamical systems for the management and planning of agriculture in the CNR.

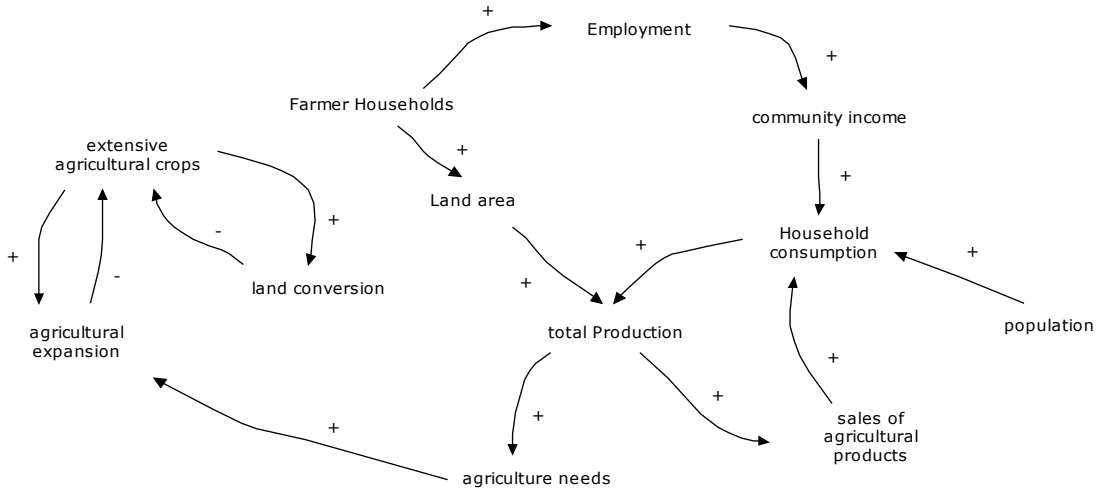


Figure 1. Alleged Chain Model of agriculture in the region CNR

 

### 2.4. Model Use

Dynamic system model analysis process management Cycloops Mountains Nature Reserve area was conducted to design and develop alternative management model of agricultural management policies in the region Cycloops Mountains Nature Reserve. Based on figure 1 above, the analysis is to design and develop dynamic system models of alternative agricultural development policy in the region Mountains Nature Reserve Cycloops sustainable by using simulation models.

### 2.5. Restrictions Models

This study uses a physical subsystem, economic subsystem and social subsystem and institutional. Physical subsystem consists of agricultural land consists of agricultural land, total conversion of land, plant area of agriculture, extension, need for agricultural products, agricultural expansion. Economic subsystem consists of public revenue, total production, private consumption, sale of the crop. Social and institutional subsystem consists of the sheer number of family farmers, population, total employment, employment.

### 2.6. Model Validation

Validation used in this study is the AME (Mean Absolute Error) and the AVE (Variation Absolute Error). AME is a deviation (difference) between the average value (mean) results of a simulation of the actual value. AVE is a deviation value variation (variance) of the actual simulation. Limits acceptable deviation is between 1 – 10 percent. (Dallen and Thissen 2001)

$$AME = [(\underline{Si} - \underline{Ai}) / \underline{Ai}\ ]$$

$\underline{Si}$ = Si N, where S = value simulation

Ai = Ai N, where A = the actual value

N = The time interval of observation

$$AVE = [(\underline{Ss} - \underline{Sa}) / \underline{Sa}\ ]$$

$$\underline{Ss} = [(\underline{Si} - \underline{Si})^2 / N\ ] = \text{deviation value simulation}$$

$$Sa = [(\underline{Ai} - \underline{Ai})^2 / N\ ] = \text{deviation of actual value}$$

### 2.7. Scenario Model

Scenario analysis for the model is the direction of agricultural policy as well as efforts to improve the local economy around the area of CNR. Based on the model scenario management and agricultural planning in the area of the Nature Reserve Mountains Cycloops Papua, Indonesia, a simulation model of the important factors that influenced or barrier system based on the use of land in conservation areas for agriculture.

Factors driving system or inputs controlled in this model is the rate of damage to the nature reserve, the government program for the rehabilitation of the region, and improving the local economy around the nature reserve area Cycloop Mountains. In this study, these three variables are driven through simulation with dynamic analysis (these three variables in percentage).

## 3. Results and Discussion

### 3.1. Dynamic Model of Agricultural Development Region CNR

#### a. Sub Model Population

The variable component of the population is an important element to be considered in the planning of development in a region. Considerations to incorporate population variables due to the ever-increasing population growth, thus increasing demand for residential areas (undeveloped land) as well as other activities is raise, while the land area of the region are limited.

Population density and building density increases as well as the vastarea that is open to economic activity as a result of increasingly vast and undeveloped land will lead to environmental degradation of the region. The number of people affected by births, deaths, migration and in-migration, so that the growth of population is the difference between the birth of inward migration coupled with deaths plus out-migration.

#### b. Sub Model Physical Environment

The population is growing will lead to the increased extent of undeveloped land (residential areas, agricultural areas, plantations), the increase in population density, an increase in clearing new land, encroachment. The opening of new land will continue to grow with limitations in its management, the frequency of the opening of agricultural land or plantations is increasingly being done to meet the needs of each community that are in the area around the CNR.

In order to overcome the decline in environmental quality conditions have rehabilitation needs to be done and the necessary commitment of local governments in terms of coordination, consistency and control of population growth and settlements in the area of CNR.

 

**c. Sub Model Community Economic Activity**

The amount of forest disturbance that causes more deterioration of environmental quality and natural resources in the CNR can not be separated from the socioeconomic conditions of society. Similarly, people around the area CNR should not be separated from each activity area management, especially for the customary communities before their local government. The indigenous people who were around the area has a high enough intensity in the interaction with the forest Cycloops Mountains Nature Reserve. This study illustrates how the interaction model CNR communities around the region with economic activity been running around the area.

In the dynamic model of economic activities around the area in the input CNR community income generating activities with a wide range of economic activities in each area of human settlements in the surrounding area, and the rate of harm as a barrier for activities undertaken by each people residing in the vicinity of CNR.

### 3.2. Testing Model

Test the validity of using statistical methods and AVE AME conducted on elements of the population around Cycloops Mountains Nature Reserve area. Results of testing the validity of performance for elements of the population show that among models with empirical data contained in conformity threshold allowed. AME results for 0021 and the RD of 0004, it is means the value is still within the limits of deviation of less than 0.05 (5 %). Thus, this model is capable of simulating the changes that occur in real-time in the field.

### 3.3. Scenario Simulation Model

Simulation models done with the intention to get the possibilities in the development of policies that do functionally that is fixed model, the parameters of the model functions are changed by the assumption that the system environment remain. Scenario aims to predict the possibilities that will occurred in the future for the policy. Scenarios developed by simulation intervene against each parameter model of assessment of the damage caused CNR area of some economic activities those are not environmentally friendly, and is still going on new land clearing, forest fires and other activities. Addition area rehabilitation policy indicators CNR with the utilization of environmentally sound regional and local regulatory enforcement area management through the rehabilitation of the region as a counterweight to the indicator of the rate of degradation of areas CNR, supported by indigenous peoples in the policies help local governments combat the destructive activity CNR region as an indicator of public control that burdens CNR region by land managers as agricultural land and plantations.

The scenario studied is through a variety of interventions that can be categorized as pessimistic scenario, the scenario of moderate and optimistic scenarios. The third scenario is accomplished by increasing the parameters of the existing condition to better conditions; increasing commitment of local governments and tribal governments (cooperation / coordination, consistency and control in spatial planning activities), increase the capacity of the region and controlling population growth (decline in the rate of in-migration). In the table below are presented interventions parameter value in each scenario.

Table 2. Scenario Intervention Model Parameters

| Parameters in intervention | Without Intervention (%) | Pessimistic Scenario (%) | Moderate Scenario (%) | Optimistic Scenario (%) |
|---|---|---|---|---|
| Damage rate of CNR region | 5,2 | 5 | 4 | 3 |
| Government Programs (CNR Regional Rehabilitation) | 40 | 65 | 85 | 100 |
| Improving the local economy | 0 | 0 | 25 | 20 |

The parameter rate of degradation of areas CNR in three scenarios of intervention on the rate of damage to the region, given the area of research is a complex ecosystem and has fairly high biodiversity value. The condition was done in order to restrain the rate of economic activity is not environmentally sound either by people who are not thinking about the sustainability of the natural reserve area Cycloop Mountains.

Policies that can be taken and implemented by policy area rehabilitation CNR and utilization programs of indigenous peoples who have used the land areas of the mountains Cycloop, so the pattern of life of the indigenous people themselves and society immigrants who reside in the surrounding nature reserve area Mountains Cycloops well ordered.

With the rehabilitation program and activity patterns of utilization of the indigenous peoples in the CNR , the total area of which is assumed to be damaged by 250 hectares , with the program of rehabilitation and utilization patterns assuming 12.50 ha per year , it will decrease the rate of destruction of Mountains Nature Reserve Cycloop up to 100 years in the future.

Conditions of local government commitment at the moment is 40% of the average value that includes coordination / cooperation,consistency and control relating to area management and spatial planning CNR. Possible changes to the conditions when it comes to local government commitment assumed is a) by 65 % for the pessimistic scenario b) by 85 % for moderate scenario and c) of 100% for an optimistic scenario. This

 

intervention by the consideration that efforts to encourage the commitment of local governments can be done through improvement efforts and fulfillment of each device area management and spatial planning CNR and implementation and control through every program better.

The output of the simulation results is an indicator of the management of nature reserve area Mountains Cycloops in the area of research that can improve the management and structuring nature reserve area in the study area, including the level of rehabilitation of the region, area utilization with customary rules in force as well, holding the rate of the total population, the ratio settlement areas and improving the quality of the physical environment. Expected results of the simulation is a decrease in the amount of land that is damaged, the repair of damaged forest areas, population control, the ratio of residential areas under control and the decline in physical environmental quality control.

**a. Scenario Without Intervention**

In the scenario without intervention, population growth is left as at present, namely the year 2016 where the parameters of the population in this case the rate of in-migration amounted to 5 %, the birth rate in the surrounding area is 1 % annually, with a total population around the area in 2016 was as much as 89.193 inhabitants. With the divider in this scenario is the rate of death and the rate of the number of people who come out each of 0.001 %. The condition has been no government intervention to limit the number of people living in the area of CNR.

The simulation results and 2030 showed an increase in population during the period of the simulation in the amount of 89.193 inhabitants in 2016 increased to 94.256 inhabitants in 2030. Increasing population growth is followed by an increase in residential areas when compared with the direction in which the availability of land for residential areas increased the ratio is large enough. This situation shows that in 2030 the study area will decrease the quality of the environment and degraded areas also loss of biodiversity value.

**b. Pessimistic Scenario**

In the pessimistic scenario assumed an increasing number of uncontrolled population caused by the high rate of in-migration together with the existing condition and there is no area management policy and land management and settlement, but the government's commitment is assumed to have been increased. The simulation results of the population and settlements resulting ratio are equal to the condition without intervention, namely the total population in 2030 was estimated at 94.256 inhabitants increased from the condition in 2016. Increasing population growth is accompanied by an agricultural area and settlements which, if compared with the direction of the availability of land for agriculture and settlement area ratio increased significantly. This situation is identical as the simulation results of existing conditions and it is going to continue as the population growth region CNR

**c. Moderate Scenario**

In the moderate scenario assumed population growth due to in-migration amounted to 4 % and decreased from the current 5%,while the rate of our people from around the region are due to the government policy for the residents around the area which is about 3 %. On the other hand support area management policy that the rehabilitation policy area had been damaged and the policy of settlements in the surrounding area organize CNR applied by 7%, and settlement arrangement with the government's commitment of 85%. Based on simulation results obtained results show an increase in population, which in 2016 amounted to 89.193 inhabitants increased to 91.707 inhabitants in 2030. These results, if observed, showing a decrease in the number of people living around the area of the rate of a population of approximately 5 %. Their intervention on population growth parameters and structuring area of farms and plantations with area utilization are managed by indigenous peoples by 5 % which should be managed by the community.

**d. Optimistic Scenario**

In the optimistic scenario assumed a decline in the population is controlled by in-migration growth rate of 3%. Increased local government commitment made through the intervention of the parameters of coordination, consistency and control is already running optimally and area management and residential development around the area of CNR assumed to be 20 % in accordance with the directives of the government. The simulation results show that the estimated population in 2030 to 90.445 inhabitants, and still there was an increase of the condition in 2015 as many as 89.193 people.

Because of the boost commitment of local governments that will raise the capacity of the region as well as a decrease in the rate of in-migration of population and the passage area rehabilitation program and decrease damage and be fixed and in line with the regional management of CNR.

### 3.4. Local Economic Scenario Analysis Model CNR

From a number of scenarios have been analyzed in the period up to 2030, both the linkage and the relationship between population and environmental degradation as well as the patterns of people's livelihood has been discussed, generate discussion of varying the model of the local economy to people who utilize the reserve area Nature mountains Cycloops. It is presented in the following table 3.

 

Table 3 shows that the three scenarios provide for conditions of use patterns Mountains Nature Reserve area in 2030 Cycloops different. This condition is affected by the increased number of people around the nature reserve area Mountains Cycloops. Through the optimistic scenario can be controlled at a population of 90.445 inhabitants by 2030. The difference is quite dominant compared to a scenario without intervention and other intervention scenarios. The optimistic scenario may also increase the economic acceptance of people living in the surrounding area Mountains Nature Reserve Cycloops be Rp.130.202.529, - by 2030. Models included the rehabilitation of a different value, for 2016 and the scenario without intervention rehabilitated land that does not exist, while the rate of the land use region is still relatively high at 85 %.

Table 3. Scenario Model Local Economic Area Utilization CNR

| Local Economic Indicators Region CNR | 2016 | Scenario 2030 | | | |
|---|---|---|---|---|---|
| | | without Intervention | Pessimistic | Moderate | Optimistic |
| 1. Population in the Neighbourhood region CNR | 89.193 | 96.839 | 91.707 | 86.712 | 81.854 |
| 2. CNR Regional Quality | 0 | 0,71 | 5,05 | 15,29 | 24,34 |
| 3. Community Economic Conditions ( Acceptance of Economic Activity ) by the rate of area utilization CNR | IDR.19.450.197,- | IDR.22.898.844,- | IDR.39.975.098,- | IDR.48.940.078,- | IDR.130.202.529,- |

In the pessimistic scenario, there is improving the local economy through the rehabilitation of an area of 5 ha by the government, whereas customs and economic activities outside the area of 3 ha respectively, and the rate of the land use region is reduced to 50 %. Moderate scenario can also increase revenue for the community, supported by their economic activity outside the area of 20 ha and 10 ha customary. In this scenario rehabilitation activity also increased to 20 ha, and the utilization rate is reduced to 40 %. In the optimistic scenario, the increase in economic income communities of economic activities outside the region, which built both by governments, indigenous and migrant communities.

Based on simulation results showed that the three scenarios in this study, the optimistic scenario is the scenario that is appropriate to be used as a strategy of the economic boom that was around and located within the nature reserve area Mountains Cycloops, it is given that the optimistic scenario has applied restrictions on the number of people who CNR will be settled in the area with government rules and customs rules which tightened the rules in the management of CNR region. In addition, the policy applied in the management of the area of the application area of the rehabilitation of the lands managed by the community as well as customary rules of any indigenous peoples who settled in the area CNR will be established either for the indigenous people themselves and society immigrants who have already settled in the area CNR. The pattern of the economy that is applied can also use government programs that have been planned in the form of activities that can stimulate community activities outside the region, whether it is as beekeeping, honey, gardening orchids, carving natural stone, carve bark, plant plaiting materials that are all done outside the region with the help of capital and operating tool of the government.

The activities undertaken as indigenous community-based forest management, agricultural management with Agrowisata pattern, development of tourist spots managed by indigenous people assisted by the local government. Utilization of the principle of economic management of local communities with the optimistic scenario, there should be strengthening local government commitment in the form of cooperation / coordination, consistency and control related to management rules the region with the involvement of the rule of indigenous peoples, as well as increased local government commitment to remain involved indigenous peoples in the area management CNR. As a comparison scenario in the model of economic management community in Cycloops Mountains Nature Reserve area is presented in appendix 1.

The process to realize the scenario chosen from the management model Nature Reserve area Mountains Cycloops that is the optimistic scenario, the necessary precondition that local governments should have the insight to forward the same to the indigenous owners of customary rights to cooperate and support each other for the realization of the management of residential areas better and sustained as instructed in government regulations regarding the environment.

Cooperation among local governments and indigenous peoples to strengthen coordination and consistency in managing the CNR and put the basis for better management again. Region CNR includes 5 large indigenous inhabiting the area and the two local governments, which will fundamentally require attention to establish areas which is recognized by indigenous peoples and local government. In the local regulations Jayapura regency in Papua province, said that in the form of local government authority in the management of the buffer zone Cycloops Mountains Nature Reserve covers the field of physical conditions, socioeconomic, cultural communities, the existence of indigenous communities, the potential for conflict, land, and the status of the buffer zone. Furthermore, that planning, the use of the buffer zone as intended, conducted with the involvement of indigenous landowners, community leaders, religious leaders, and youth leaders as representatives of the public settlers buffer zone CNR. Therefore, the process of cooperation that is built to be

 

implemented by upholding the values of togetherness and continue to jointly maintain Cycloops Mountains Nature Reserve area better.

## 4. Conclusions and Recommendations

### 4.1. Conclusions

From the simulation results overall with model scenarios offered consisting of a scenario without intervention and three scenarios through intervention, it was found that the model with the scenario through the intervention optimistic about the parameters of the model, is right option to do in order to realize the agricultural management in the area of nature reserve mountains Cycloop. Sustainable management is required in the area of research in the form of policy directions that can be implemented in the management process for the residential area and lifestyle. Due to government intervention and cooperation built between indigenous impact most greatly to the improvement of performance management Cycloops Mountains Nature Reserve area is ongoing and continuous.

### 4.2. Recommendations

Suggestions that can be presented in the management of conservation areas in economic Cycloop Mountains communities in the surrounding area include, the necessary formula for regulating the right to speak and manage the area based on the rules and knowledge of indigenous peoples who are the customary community's regional. Necessary to formulate spatial planning and development for the region CNR, which is the traditional institutions are partisipate integrally. Required strict formulation of the land transfer and severe social sanctions against damaging activities in the nature reserve area from both traditional sanctions as well as the government sanction and written and confirmed by local regulations. The local government needs to establish a mechanism of incentives in management of the nature reserve . Incentives given to customary institutions to organize and secure the area based on customary rights .

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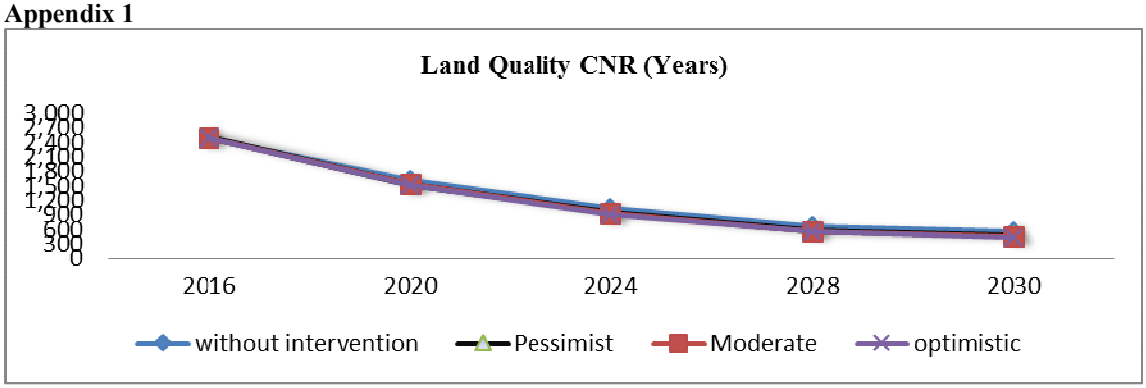
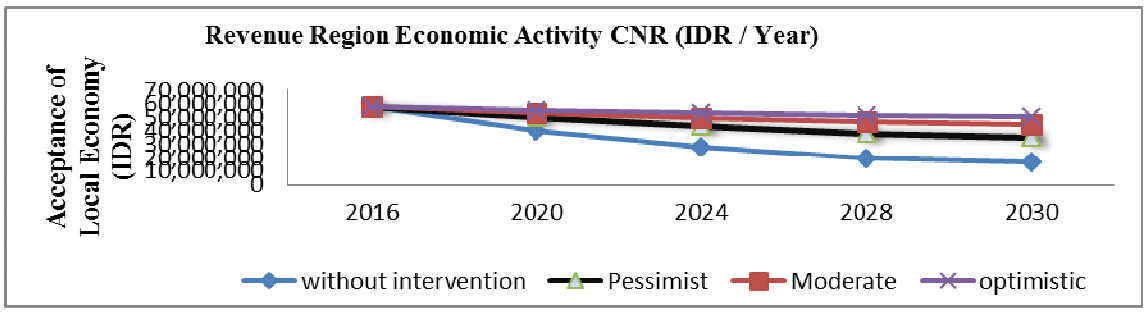
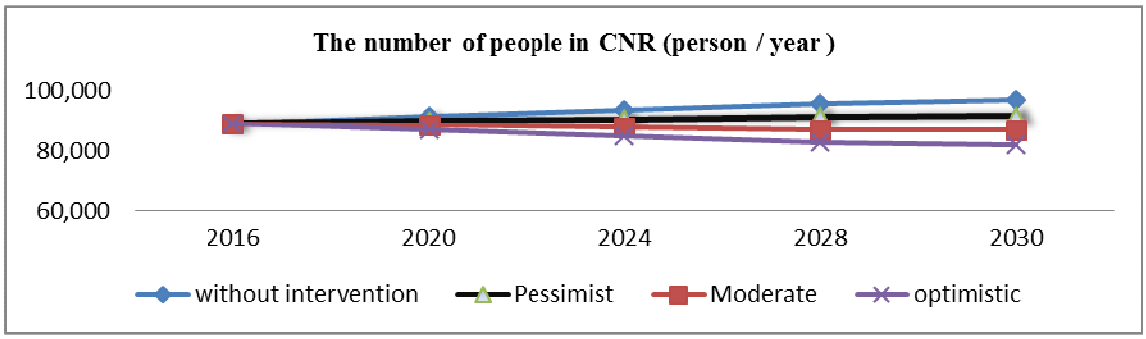
**Appendix 1**


Land Quality CNR (Years)
3,000
2,700
2,400
2,100
1,800
1,500
1,200
900
600
300
0
2016
2020
2024
2028
2030
without intervention
Pessimist
Moderate
optimistic


Revenue Region Economic Activity CNR (IDR / Year)
Acceptance of Local Economy (IDR)
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
0
2016
2020
2024
2028
2030
without intervention
Pessimist
Moderate
optimistic


The number of people in CNR (person / year )
100,000
80,000
60,000
2016
2020
2024
2028
2030
without intervention
Pessimist
Moderate
optimistic