Study of environmental management based on peri-karst community interaction pattern (case study: Long Lanuk Village, Sangkulirang-Mangkalihat karst area, East Kalimantan)

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Abstract. Peri-karst is an area located on the outside of karst formations but still the habitat of trogloxene and stygloxene. Long Lanuk village located on Peri-Karst zone of the Sangkulirang-Mangkalihat Karst area. The exploration of the natural resources in Long Lanuk village trigger changes in the pattern of community interaction. The research aims to discover (1) the factors that affect the sustainability of the environment caused by the interaction of behavioural pattern of Peri-Karst community; (2) analyse the level of sustainability of the Peri-Karst on society and (3) formulate management strategies related to the sustainability of Peri-Karst livelihood in the Karst area of Sangkulirang-Mangkalihat, East Kalimantan. The level of sustainability is analysed using the method of Multi-Dimensional Scaling which are categorized into four (4) dimensions, i.e. the dimension of environmental, economy, social and culture. The results of research regarding the level of sustainability of the Peri-Karst community in Long Lanuk Village based on the method of Multi-Dimensional Scaling shows: on the environmental dimension of attributes that have a high sensitivity value was the level of disruption of the industry has a value of 1,85. On the Economic Dimension, the attribute that has high sensitivity was the nest of the Swallow has a value of 2,4. The Attribute of Social Dimension which has high sensitivity was the potential for social conflict has a value of 2,3. The attribute of the cultural dimension that has a value of high sensitivity was the opportunity to make crafts has a value of 1,95.

Keyword: Peri-Karst, Multi Dimensional Scaling, Pattern of Community Interaction

1. Introduction
Karst is a unique area and fragile to degradation quality of its environment due to karst morphology that has characters of hard shape, thick of soil and rocky as well as limited water on the surface. In the other side, the karst area has essential resources for community livelihood. In the beginning era of human life, karst has been utilized for one of the oldest occupancies in history. Oldest occupancies in karst area reported in South Africa since two million years ago [1].
Evidence of hand painting in Sangkulirang-Mangkalihat Karst Area has proven that karst area in Kalimantan has been utilized since pre-history period. Certainly, Sangkulirang-Mangkalihat Karst Area had been one of the centre of population and capital of Kalimantan. In general, human occupancy will be left when humans have the technology and have the ability to build a settlement by themselves. [2] Next period, humans tend to choose a flat area to be cultivated as agriculture, however, in the modern age karst not utilizing for settlement, human beings are still utilizing karst in high intensity and impact damage thousand times worse [3]. Long Lanuk Village is one of the villages administratively located in Berau Regency which is located in Sangkulirang-Mangkalihat Karst Area. Appearances of the mining companies surround the village and karst area become a threat to the existence of Peri-Karst community in Long Lanuk Village.

Based on the phenomenon above, the need for comprehensive research of the karst area conditions, interaction patterns of community and karst area management strategies. Therefore, there is formulated the following research issues: (1) How the factors that affect the sustainability of the environmental community interaction pattern Peri-Karst; (2) how does the level of sustainability due to interaction patterns of Peri-Karst community; (3) how is the strategy of environmental management due to the interaction pattern of interaction Peri-Karst Community in Long Lanuk Village in Sangkulirang-Mangkalihat Karst Area, East Kalimantan.

The research aims to find factors that impact the sustain of environmental through Abiotic Aspect, Biotic Aspect and Culture Aspect due to the interaction of Peri-Karst Community; Define and formulate the level of environmental sustainability due to the interaction of Peri-Karst Community Interaction; Formulate environmental management strategies of environmental sustainability due to the interaction of Peri-Karst Community Interaction in Long Lanuk Village in Sangkulirang-Mangkalihat Karst Area, East Kalimantan.

2. Research Location
The research location was located in the administration area of Long Lanuk Village. Long Lanuk Village geographically located in between mT 202301 50N528681 mU. the large area of Long Lanuk approximately 427.11 km². Long Lanuk village located in a karst area Long Lanuk which is part of the Sangkulirang Mangkalihat Karst area. A research location map can be viewed below, in Figure 1.1

3. Research Method
The research obtained primary data through survey method. The result of the research will be outlined through quantitative descriptive. Tools were used for the research: GPS (Global Positioning System), Voice Recorder, UAV, camera, interviews guidelines, whereas component administrative village boundary map, Sangkulirang-Mangkalihat karst area map.

Data collecting in the research process established through direct observation, photos collected, questioner fulfillment, FGD Social Mapping, in-depth interview with key informants. Data collection then analyzed to discover the level of environmental sustainability from in-depth interviews with key informants as well as field observation

Analysis of the index and sustainability status was carried out using the Rap-Ressetlement ordination technique, a modification of the Rapfish [4] which places things in a measurable order using the MDS method. This method performs multi-dimensional transformations into lower dimensions. Rapid Appraisal Process (RAP) is a multi-disciplinary technique for setting comparative sustainability based on a number of attributes or indicators that are easy to score [5]. The data analysis was carried out in the following stages, namely (1) research descriptor attribute; (2) attribute research in ordinal scale; (3) Ordinal analysis of the sustainability of each dimension using a non-parametric multi-variable method called multidimensional scaling [5].

Each attribute in each dimension is given a score based on the scientific assessment of the score maker. The score ranges from 0-4 or depending on the state of each attribute that is interpreted from bad (0) to good (4), or vice versa. The score value of each attribute is analyzed in a multidimensional manner to determine one or more points that reflect the sustainability of the peri-karst community life under study relative to two reference points, namely the good (good) and bad (bad) points.

4. Result & Discussion
4.1 Factors that influence environmental sustainability due to the interaction pattern of Peri-Karst Community
Factors that influence environmental sustainability due to the interaction pattern of Peri-Karst Community in Long Lanuk Village Sangkulirang-Mangkalihat Karst Area East Kalimantan measured through Multi-Dimensional Scaling (MDS). The research divided into four dimensions, such as the Dimension of environmental, the dimension of the economy, the dimension of social and dimension of culture.

4.1.1 Dimension of environmental
The Dimension of environmental divided into nine attributes that influence environmental sustainability. Those attributes were settlement condition, public facility condition, distance to an industrial area, water source availability, level of pollution (water/air/soil), level of industrial disruption, Karst area condition and wildlife condition.

Forest has numerous of the commodity, which has precious value for indigenous people, besides forest have functioned as a popular home range that supply food and shelter, forest also source of money from forest product, for three generations at least there were three changes of commodities that have selling points. Started from rattan and agates resin to swallow’s nest and the latest was ornamental birds.
The changes in commodities not intervention by the indigenous people. Consumer’s trend either government regulations are the main driving factors of the commodity changes.

Ecological changes, land insistences and the degradation of value forest function economically for the indigenous community are impacts of mining companies expansion in the area of research. The establishment of the mining companies deliver a domino effect to changes in community livelihoods which are initially very dependent on forests and land, lately, it becomes very dependent on the existence of the company. With the lure of money to sell their land then become an area of coal mining activities. Currently, the understanding of land as capital is the result of a process of modernization (development). Hard to find people who are reluctant to sell their land for mining activities. Typically, the money is the result of the land of the acquisition is used to create a building swallow’s nest as an investment, or buy seedlings of palm oil and then planting on their land.

Starts by developing the area by many companies, it turns out that bringing growing impacts on indigenous communities in the area. After the expansion of the coal mining company and the road, infrastructure began to build, the village began to introduced by the various tribes of Sulawesi, Java or Sumatra.

Almost in most areas of the study are located in the area of mining, community economy at the moment is heavily dependent on the existence of a mining company. the arrival of the company has changed the condition of the natural environment, as well as the system of the social life of the community, including in the economic sustainability of communities. Changes in environmental conditions in the study area are significantly started since the existence of massive logging. In Long Lanuk, large logging has taken place since the 1980s, i.e. logging wild which then floated through the river when it floods. Logging in more massive at the time of the subsequent entry of the company made after the wood in the early 1980s up to the year 2000 which was later continued with the construction of logging roads through the forest. To search for forest products such as lumber, honey or hunted animal, people have to walk farther to a location that is still there because the area around the forest entirely settlement has become palm oil plantation or mining.

Long Lanuk village can be stated as the first ring Area of the mining company PT Berau Coal, the village is located approximately one kilometre from Block 7 and blocks 8 of the company. So it was very affected by the existence of mining activities. At some time still feels the impact of blasting activities result from the company. Very dusty village streets that are caused due to the density of the traffic potential of coal-loaded trucks to bring the kind of respiratory diseases (Acute Respiratory Infection).

The only indigenous knowledge on Karst area, namely as a place to find a bird’s nest swiftlet, but in some part of it is also known as a place to escape parents first from the assault by the other tribes and put lungun-lungun (coffin) of nautical people (ancestors). Indigenous peoples also relate that before many companies come in, people are still many forests are found in the mountain of rock (Karst).

4.1.2 Dimension of Economy
The dimension of economy divided into eight attributes that influence economically sustainable. Those attributes were family income, opportunity to increase income, support facility to increase income, accessibility to product market (plantation/forest), opportunity to increase family welfare, tourism and swallow nest.

Before 1980s, Sangkulirang-Mangkalihat karst area in the harmonious condition. The forest became popular home ranges at the time. Fish are plentiful in the rivers. The wood is easy to harvest. Caves in Karst hills have the potential of swallow nest and natural honey in abundance. Dayak Kenyah and Ga’ay communities in the area of Peri-Karst inhabiting this area are hereditary. The high dependence on the forest, especially in the Karst area drove human dependent to the forest resources in a very high level.

Even in 1970, the community in Suaran Karst area and Batu kulat such as Dayak Lebbo’ Inaran, Tumbit, Dayak and Malay, Long Lanuk and Pegat Bukur refused the entry and the existence of a marble quarry plan of PT Suaran Jaya. Disruption of swallow bird habitat and honey bees around the rock (Karst) that can interfere with a swallow bird nest harvesting for them, as well as the destruction of forest conditions
became the main reason for their rejection of the plan the influx of the Marble quarries. However, the hands of the capitalists could not stop bothering them.

Entered the mid-1980’s, the opening of the land became more. Trees cut down, Dayak Kenyah and Dayak Ga’ay communities scattered along Kelay river started shifting. The resource forest products had already been replaced by land od mining. Timber companies and mining started impacting community wildlife hunting areas in Dayak Ga’ay Long Lanuk Village. Even since the 1980s, Peri-Karst community start to difficult getting forest products like rattan, resin, sandalwood, swallow's nest and honey. Enter the period of the 1990s, the water of the river started silting by murky, the fish began to die because of the former lumber waste in waste in the river. Not to mention, noisy vehicles and coal blasting effect that reached the communities settlement. Palm oil plantations are also open space land conversion in a major way in the Peri-Karst community of Sangkulirang-Mangkalihat karst area

Before the 1990s, the swallow's nest has not become a source of livelihood for people in Long Lanuk. At that time, they have yet to recognize the economic value of swallow nest. Up to 70 years of the 2000s, the price of the bird's nest is still not too worth. Entering the year 1990, the territories which became area studies became a magnet for community newcomers who came to seek his fortune in Swallow nest harvesting in Gueng-gueng that existed in the area. From there, the Dayak community getting to know swallow nest and sell it. Eventually, the swallow nest is a large source of income for the region and communities. There are three types of swallow nest which are is known to the community, which are distinguished based on the type of nest are White Swallow nest, Moss Swallow nest and black swallow nest. White swallow nest is the best, the colour is white because it is not mixed with fur. Moss swallow nest coloured blackish because of the nest of feathers mingled with the swallow that sticky. While the black nest resembles a nest of moss, but rather more black as stickier by fur.

Around 1996, swallow nest price began to rise and reached its peak in about the early years 1998-2000an. Income from taking a swallow's nest at the time of harvesting can provide a very large income in spite of the risks are also great. Before the influx of national corporations, many indigenous communities participate in other villages to find a swallow nest. Typically, in harvesting the swallow nest, groups led by a leader of pickers. In Long Lanuk village, head of pickers is fully responsible for the process of picking, ranging from the installation of tools until the harvesting finished.

Around 1996, there was a policy of the local government to take ownership of the caves that produces more than 5 kg. Caves then obligated to be handed over to the government after the inventor was given the right to manage for two years. The caves are then auctioned off, one of the biggest auction winners in East Kutai and Berau is PT Walesta. This way around local people called as Phaktar. After the year 1996, swallow nest pickers began to diminish. The policies of the Government that acquire ownership of the nest by the Government which is then submitted to the company in corporate governance of swallow's nest utilization is considered to hand-over the ownership of swallow nest caves. This policy led to a decreased the pickers of swallow nest, swallow nest robberies had started rampantly and swallow nest productivity decreased in a few vertical caves because of the harvesting time was not on standard procedural. The high economic value of swallow nestled to Cave owners wants to get the biggest profit of without doing rejuvenation of the swallow. Swallow nest prices tend to be volatile depending on the quality of nest or more important depending on the condition of the US dollar at the time. Swallow nest price reached IDR 5 to 6 million for black swallow nest and even reached the price up to IDR 20 million to white swallow nest.
4.1.3 Dimension of Social

The dimension of social divided into seven attributes that influence socially sustainable. Those attributes were a guarantee of existing social governance, access to relatives, the potential for social conflict, the public perception against the industry, access to health facilities, access to education and access to entertainment/tourism facility.

![Social Conflict Matrix](image)

**Figure 1.2. Social Conflict Matrix**

Based on observation and research, in Long Lanuk village can be seen that some organization are involved in the conflict. Based on the source of the conflict can be divided three types of the conflict, the second one was community against private company (PT KJB) and the third one was private company (PT KJB) against government (Ministry of Environmental and Forestry).

The first one was occurred due to lack of status of Nyapa village as a newcomer, tribe difference was the main reason why newcomer with the tribe of Dayak Kenyah with the elder one tribe of Dayak Ga’ay. More confident the newcomers to living in then the desire for area administrative expansion began. As well as the village of entrants by the other kenyah a tribe as a new bloom of Bena Inaran and felt a Bloom of Long Lanuk. The second reason is the Division of grants from companies that cause uneven nyapa tribe had a "Deal" with the company in terms of the grant. In fact, the conflict was still potential, but if this condition could not be corrected would be a time bomb that could explode at any time. The conflict never happened is the existence of a different view against the entry of the mining company (KJB). Nyapa tribe at first refused the entry of mining company KJB, but with the intervention of the main Village as a major landlord, the company keeps running despite the distance between companies from the village not so far.

The second part of the first conflict is a conflict between the main village Long Lanuk with Newcomer villages (Inaran, Tumbit Dayak and Pana’an). This conflict caused due to the village boundary that is still indicative. The first one between the main village and Inaran Village, at the time, were price swallow's nest very expensive, occurred scramble of swallow's nest in Betan Area, the conflict ended when the Government took over the area in Betan Area, since that the area familiar with the name of Betan Government. Besides the existence of mutually recognizing the ownership of a cave nearby brackish skull was in Bud Bo' (mountain of Invisibility).
The second was the village boundary of tumbit Dayak, on lands where parking of DT (Dump Truck) of PT. Pama Persada (mining contractor company). And the last was boundary with pana’an a place that has been scrambled on was Tapak Kaki Ayam. Tapak Kaki Ayam was the river branched 4 which is the headwaters of major rivers. The river is Merok River, Keputek River (Lesan River Upstream), Inaran River and Nyapa River.

The second conflict (a society with PT KJB) driven by PT KJB did not meet aid promised to the citizens of the time of the acquisition of land. Until going on a demonstration conducted by the main village society seized the village of indigenous land has become a coal mining company of PT KJB. Until PT KJB promise by giving aid funds worth 600 thousand per family is given in each month.

The third conflict, namely the conflict between the Ministry of Environmental and Forestry (KLHK) with PT Kaltim Jaya Bara. The conflict caused by area permits overlapping (Mining Business License) PT KJB with areas for the implementation of programming from KLHK i.e. KHDTK (forest area with a special purpose). At this time the conflict still unresolved.

4.1.4 Dimension of Culture

The dimension of a culture divided into seven attributes that influence culturally sustainable. Those attributes were faith maintained (tradition), a relative relationship maintained, a social relationship maintained (among Dayak or even with not Dayak) Forest ownership maintained, fishing access, hunting access, honey harvesting access, Agarwood harvesting access, timber access, opportunity to make handicraft.

In East Kalimantan, native tribes are divided into two groups of tribes (according to the custom of the law environment) is a group of Malay Customary law (Kutai) and Dayak Customary Law. Kutai Malay ethnic tribe is native to East Kalimantan, which originally inhabited the coastal area of East Kalimantan. Based on the speech of local communities, for the tribes that inhabit Kutai is the area of the coastal city and then in the present process of assimilation had occurred with the settlers so it has begun to lose his trademark, in contrast to the Dayak tribe until by now still have to khasan Borneo in every aspect of their lives (dance, language, hunting, cultivation, rituals, etc.).

Dayak tribe is known to have had a complex craft, utterly Ga’ay and Dayak Kenyah. The village of Long Lanuk has many crafts such as seraung, anjat and kiba’. Seraung protective Cap is daily used by Dayak communities. This hat has a very wide size and fleeting resemblance to conical Asian hat. Seraung is made from the leaves of blue that are a kind of palm leaves that are widely found in forests of karst area. Kiba’ and anjat itself is a kind of bag that has a different function. Kiba’ is the usual backpacks in using the community to carry the weight of the goods at the time of gardening while the sling bag is anjat ordinary citizens use to bring goods and other goods minun on when cultivating. Anjat and kiba’ itself is made of rattan which many find in the forests of karst area [6].

Exclusion of the settlement in any area of study of a particular ethnicity movie tends to occur naturally. This one was caused by the kinship of the tribal entities. Typically, such kinship is causing tribal grouping in one place. Although there is no tribe alienated. Every other tribe mingled with the tribes. There are no certain tribes against the backdrop of the population or other criteria are intentionally kept away or distanced from the road of the village.

No question about it, newcomers have dominated almost every village in the region. The establishment of the mining companies and also logging companies became a magnet for newcomers to work and living in villages around mining sites. Long Lanuk Village itself is located in the first ring of the mining company. in this village, there are two large coal mines namely Berau Coal and Kaltim Jaya Bara. Additionally, the abundance of Swallow nest economical value also becomes driving force newcomers to come to East Kalimantan. The number of newcomers living in settled a prolonged period in the territory of the indigenous cause inequality and ethnicity in the composition of each village in the review. The intermingling of tribes through marriage between the natives and the newcomers have also been dissolved the identity of each tribe to become one unified identity of tribal residents where they live.
4.2 Environmental sustainability due to the interaction pattern of Peri-Karst Community

The results of the research on the level of sustainability to Peri-Karst community of Long Lanuk villages based on the Multi-dimensional Scaling method that was categorized in 4 dimensions. On the attribute of an environmental dimension that has a high sensitivity value was the level of industry disruption with a value of 1.85. On attribute of economic dimension that has a high sensitivity is the value of Swallow nest with 2.4. The attribute of social dimension which has high sensitivity was the potential for social conflict with the value of 2.3. On the attribute of cultural Dimension that has a value of high sensitivity is the opportunity to make handicrafts with a value of 1.95.

4.3 Environment Management Strategies due to interaction pattern of Peri-Karst Community

Environmental management strategies on the research were aimed at the types of variables used in analyzing the study data on the assessment of sustainability. Assessment of sustainability was based upon the granting of a score by the respondents for each of the attributes in each dimension of the sustainability the assessment of residents around the karst area. Dimensions of sustainability are assessed consist of dimensions environmental, economic, social and cultural. Each of the dimensions of sustainability provides a sensitivity analysis results on one of the attributes of each dimension. The design of the proposed management strategies based on the results of the social mapping at Long Lanuk Village.

There were several types of strategy formulation have been obtained based on process analysis of sustainability dimensions. The strategy formulation was divided into three sections based on the estimated time of the execution management plan, those are short term, medium term and long term.

Based on the results of the analysis, short-term management strategies can be applied to solve the problems identified in the environmental dimension, social dimension and culture dimension. These problems include the wildlife condition (2.2 categorized as high sensitivity), the community perception against the industry (2.4/high) and the opportunity to make handicrafts (1.95/high). The problem with the highest sensitivity level on short-term management strategies is the perception of the community against the industry with the highest sensitivity of 2.4. The condition occurred due to the company did not fulfill the agreement beyond the land acquisition process and recommendations for solving the problems by mediation and interviewing between company and community affected by the development of the industry.

Medium-term management strategies that can be used to solve the problems found on the environmental dimension, economic dimension and cultural dimension with the highest sensitivity such as level of pollution (2.25/high), access of forest wood and timber (2.45/high) and swallow nest (2.4/high). The main problems that must be faced with the medium-term management strategies is the limited access of local community to get forest products (wood and timber) which is have increasingly limited, one of the problems solving options for these problems is harvesting mechanism of forest product, especially for timber and non-timber product proposed by the community and local authority.

Long-term management strategies of Peri-Karst Area in Long Lanuk village that can be applied to solve problems related to the management process derived from the level of industrial disruption in environmental dimension and potential social conflicts in the social dimension. Those problems occurred due to village location of near the area that has been exploited for a mining company, the value of industrial disruption was 1.85 and territorial boundaries have not determined legally triggered social conflict for community, companies and the government has a value of 1.30 and classified as high sensitivity. Recommendations to solve these problems is to determine administrative boundaries in multi-level (village, district and regency, and review of regional spatial planning documents to evaluate settlements based on a function of the regional area.)
5. Conclusions and Recommendation

5.1. Conclusions

Factors that influence environmental sustainability due to the interaction pattern of Peri-Karst Community in Long Lanuk Village Sangkulirang-Mangkalihat Karst Area East Kalimantan as follows:

a. Factors that influence to the environmental sustainability due to the interaction pattern of Peri-Karst Community in Long Lanuk Village divided into 4 dimensions, there are an environmental dimension, Economy dimension, Social dimension, and culture dimension

b. Based on the result of in-depth interviews in Long Lanuk Village on the environmental dimension, attribute with the highest damage was level of industrial interruption

c. Based on the result of in-depth interviews in Long Lanuk Village on Economy dimension, attribute with the highest damage was swallow nest.

d. Based on the result of in-depth interviews in Long Lanuk Village on the social dimension, attribute with the highest damage was social conflict potential.

e. Based on the result of in-depth interviews in Long Lanuk Village on culture dimension, attribute with the highest damage was an opportunity to make handicraft.

Level of environmental sustainability due to interaction pattern based on multi-dimensional scaling shows that: classification of environmental dimension attribute of level of industrial interruption with value of 1.85, classification of economy dimension attribute of swallow nest with value of 2.4, classification of social dimension attribute of social conflict potential with value of 2.3, classification of culture dimension attribute of opportunity to make handicraft with value of 1.95.

Strategic of community environment management for Long Lanuk Village can be separated into dimension and time allocation aspects, there are:

a. Management strategy on environmental dimension attribute of the level of industrial interruption is needed to reviews of Mining Licence permit documents related to the research area.

b. Management strategy on economy dimension attribute of swallow nest is the relocation of swallow nest from a natural cave to manual nest in the communities settlement.

c. Management strategy on social dimension attribute of social conflict potential is the determination of administrative boundary among the villages in Berau Regency

d. Management strategy on culture dimension attribute of opportunity to make craft is counseling from the local authority about the important value of handicraft potential to the tourism development.

e. Management strategies divided into three parts of time-term based on the estimation of strategies can be applied, these are short-term, mid-term and long-term management strategies.

5.2. Recommendation

1. Policy strategy of management in Long Lanuk Village karst area through the renewal of spatial data to complete Governor decree of East Kalimantan No 67 the year 2012

2. Further study and research on management planning in Long Lanuk Village karst area become indigenous forest area.

3. The application of good management policy strategy based on territorial characteristics and should be done on sustainable planning.
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