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Adaptation of Hunting Activities to Forest Degradation: Comparison between the Indigenous Kenyah and the Punan in Kalimantan, Indonesia

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Abstract:

Traditionally the Kenyah and the Punan were forest dwellers in upriver areas of Borneo Island, depending highly on hunting and gathering as well as swidden agriculture. They were and are still skillful hunters with similarities and differences in some aspects such as hunting tools and hunting strategies. To maintain their stable income from hunting and gathering, the Kenyah and the Punan had been 'forest protectors.' This understanding was reasonable because primary forests had existed in their original villages even though they had lived there for hundreds of years before moving downriver. But their circumstances changed with the advent of logging concessions in the 1980s, forest fire in 1997-1998, 2005, enforced 'resettlement projects' from 1986 to 1996, coal mining since 1999 to present, and other human activities. The worsening forest degradation has declined sedentary population of wild pigs, which traditionally are the main source of meat and cooking oil. For their survival, the Kenyah and Punan started to change hunting strategies and livelihood to adapt to forest degradation. We conclude that the Kenyah dealt with the new situation better than the Punan.

Keywords: Borneo, east Kalimantan, Kenyah, punan, hunting, mufut

1. Introduction

Kalimantan Borneo is the world's third-biggest island and has one of the most important tropical rainforests. A portion of the northwestern part belongs to Brunei Darussalam, which is sandwiched between the Malaysian states of Sabah and Sarawak. The greater portion belongs to the four Indonesian provinces making up Kalimantan. East Kalimantan covers a land area of 200,395 km² with a low density of 12 persons/km². Around 140,000 km² (70%) of the area is covered by either primary or secondary forest (Dishut Kaltim, 2006).

Dayak (also called 'Dyak,' 'Daya,' and 'Dya') is used specifically to designate the non-Muslim, non-Malay natives of Borneo island (King, 1993; Coomans, 1987). They are the descendants of immigrants from Yunnan in southern China. Based on this definition, both of the Kenyah and the Punan might be categorized as Dayak. In East Kalimantan, the Kenyah and the Punan are two of 18 Dayak groups.

Explorer and naturalist Bock (1988, first published in 1881) described the Punan as "Wild People of the Woods" when he made a brief journey to the Mahakam River. This is one of the earliest descriptions of the Punan to appear in print (Hoffman, 1986). Hose and McDougall (1993, first published in 1912) described the Punan thus: "there are to be found hidden in the remotest recesses of the jungles small bands of homeless nomad hunters." We subscribe to the general understanding of the Punan as summarized by Hoffman (1986): "The Punan are hunters and gatherers, and this alone ought to be enough to move them considerably nearer to center stage." Sitorus et al (2004) observed that Punan population is 8,956 or 0.4% of East Kalimantan population. Their settlements spread up in 6 districts of which 55% living in Malinau District followed by Berau District (15%) and the rest of 30% scattered in small colony in other districts.

In the 1980s, a drastic change occurred in the Punan community. They tried to settle permanently in certain places or villages and to grow agricultural plants such as rice (Inoue et al, 1991). Basically, Punan has similar characteristic or imitating the Kenyah in term of shifting cultivation for instance the calendar of swidden activities, species of rice to grow, and the way to maintain. However, while the customary Kenyah resource management system including swidden agriculture can be regarded as sustainable (Inoue, 1998), agricultural activities by the Punan are not because sometimes they leave the village for mufut, which is the custom of living in the forest for several weeks. The purposes of mufut according to Kaskija (2000) are a break from routine village life, the excitement of hunting and the festive consumption of wild boar and fruit, a way to escapes diseases, and to be free in the forest. During the mufut, Punan families can survive by eating sago, meat, edible fruit, and palm and rattan shoots.

Since the 1960s, some of the Kenyah have moved from Apau Kayan to downstream of Mahakam River, and from the upper Bahau regions to downstream areas for closer access to the economy, health and educational facilities. Soriente (2003) describes 'Apau Kayan' as the native land of the Kenyah in the interior of Kalimantan, borders to Sarawak state Malaysia and covers area of 10,000 km². On the other hand, the Punan moved due to government resettlement projects that forced the people to move down to accessible areas. The project aimed to engage indigenous people in agriculture and the economy. Present subsistence activities of more than 95% households are swidden agriculture, fishing, and hunting. Even though it is very important for academics and governmental officials to clarify changes in ways of livelihood for the purpose of recommending effective resource management policy, they lack enough information on these peoples, especially their hunting activities. This study focused on their hunting activities and is intended to assess their adaptation to forest ecosystem degradation caused by forest fires, logging, mining, and agricultural activities.

2. Methods

2.1. Research Sites

Research was conducted in five villages in Malinau Districts, North Kalimantan in 2007-2010. The Punan residing three villages: Punan Tanjung Nanga, Bila Bekayuk, and Mabung Sembuak, established by a resettlement project in 1986, and the Kenyah occupy two villages, Tanjung Nanga and Long Loreh and have been inhabited since the 1960s. Research sites are scattered alongside the Malinau River with their distances to the capital of Malinau District being 120 km from Tanjung Nanga and Punan Tanjung Nanga villages, 80 km from Long Loreh and Bila Bekayuk villages, and 5 km from the Punan people resettlement of Mabung Sembuak.



Figure 1: Map of Research Site

2.2. Data Collection and Analysis

Data and information were collected by questioning all hunters in each village. The numbers of respondents were 25 Punan people and 21 Kenyah people. Village Chief and Customary Chief were also interviewed for general information related hunting, forests and swidden agriculture. Other people that considered had comprehensive experience related to hunting for example ex-hunters were also interviewed even though they were no longer active in hunting during the field survey.

Data gathered from the questionnaires are qualitative and quantitative data. Data is analyzed by classify the information base on queries that will be assessed in this article such as: hunting tools and activities, hunting techniques, economic and social values of pig, and adaptation to changes. For specific purpose, some qualitative information is converted to quantitative data.

3. Results and Discussion

Site and respondent characteristics Research was conducted in 5 villages that considered most suitable to compare hunting activities of the Kenyah and Punan ethnics. Two villages resided by the Kenyah and three villages resided by the Punan. The selected villages respectively from upper to down river are Punan Tanjung Nanga (Punan),

Tanjung Nanga (Kenyah), Long Loreh (Kenyah), Bila Bekayuk (Punan) and Sembuak (Punan). Characteristic of respondents and research sites is shown on Table 1 below.

Variables	Mabung	Bila	Long	Tanjung	Punan Tanjung
	Sembuak	Bekayuk	Loreh	Nanga	Nanga
Ethnicity	Punan	Punan	Kenyah	Kenyah	Punan
Number of households	23	58	45	104	26
Population (people)	89	224	160	456	101
Number of hunters (people)	6	9	10	11	10
Ratio number of hunters to number of households	1 : 4	1 : 6	1 : 5	1 : 9	1 : 3
Average age of hunter (year)	47	46	50	46	45
Village inhabited since (year)	1986	1982	1972	1974	1978

Table 1: Characteristic of Respondents and Site
Source: Respondents' Interview (2010)

Table 1 shows that number of hunters are respectively Tanjung Nanga (11 hunters), Punan Tanjung Nanga (10), Long Loreh (10), Bila Bekayuk (9) and Sembuak (6). The percentages of hunter to households are Punan Tanjung Nanga (38%), Mabung Sembuak (27%), Long Loreh (22%) and Bila Bekayuk (16%) and Tanjung Nanga 11%. The largest number of hunters respectively was in Tanjung Nanga, Punan Tanjung Nanga and Long Loreh villages. Geographically, the villages are the most remote villages therefore accessibility to hunting location relatively closer which makes them easier for hunting. Accumulatively 17% of Kenyah households are hunter, lower than the Punan of 27%.

Hunting Activities

Since Kenyah and Punan have been hunting for decades, the basic skills of Kenyah and Punan hunter are actually almost similar. However, they have also some differences in hunting during 'sedentary population' period. Alikodra (1989) defines 'sedentary population' as the average population of wild pig both in primary and secondary forests in whole year excluded of pig migration. Pig migration in this area occurred every 2-3 years, depending on forest fruits season. Such differences are shown on Table 2.

Variables	Kenyah	Punan
Hunting frequency per week (times)	1.73	1.01
Distance to hunting location (hours)	1.26	3.22
Hunting location in primary forest (%)	24.00	96.00
Hunting location in secondary forest (%)	52.40	4.00
'Effectivness' of each trip (%)	35.00	40.00
Meat to sell for cash (%)	30.00	0.00
Number of hunting dogs (dogs)	3.64	4.32
Number of group members per trip (people)	2.30	1.80
Family members of respondent (people)	4.60	4.80

Table 2: Hunting Activities of Kenyah and Punan
Source: Respondents' Interview (2010)

Table 2 shows average number related hunting by Kenyah and Punan. Hunting-frequency of Kenyah is 1.7 trips a week, higher than Punan of 1.01 trips because of some reasons: 50% of Kenyah hunters use shotgun that can be used both at day and nighttime in combination with dog, hunting locations of Kenyah are more flexible (both in secondary and primary forests). Another reason, Kenyah hunters consider that hunting is an alternative for cash, not simply for subsistence. Therefore, they try to hunt as many as possible in various locations. On average, Kenyah hunter sales 30% hunted pigs for cash. While, hunting frequency of Punan is 1.01 trips a week because the Punan maintain to hunting in primary forest which is relative far from the village.

Distances to hunting location of Kenyah and Punan are also different because of the difference on preferable 'hunting location'. For the Punan, primary forest is preferable because Punan's dogs used to hunt in primary forest. The reason is no much shrub and under grass in primary forest, so Punan's dogs are easier to pursue the pig. Kenyah hunters could in both primary and secondary forests. The average distance for Kenyah to reach hunting location is 1.3 hours and Punan 3.2 hours, more than double. Hunting location is certain area or route that has been selected to visit the day before or just prior leaving for hunting. Some common hunting locations are river, creek, mountain, salted water (Kenyah: sungan; Punan: paan) and other specific location in primary and secondary forest.

Base on calculation, the possibility of a Kenyah hunter to get pig at each trip is 0.35, a bit lower than Punan hunter of 0.4 due to some factors as follows: (a) 96% of Punan hunting location is primary forest. Both Punan and Kenyah hunters believe that food availability in primary forest usually more abundant than of secondary forest. On the other hand, 52% of Kenyah hunters are prefer go for hunting in secondary forest where as most of secondary forests located relatively nearby village area so that pigs not feel so secure to live and take rest in secondary forest, (b) every Punan hunter keeps 4.3 dogs while the Kenyah 3.6 dogs. Respondents believe that the more the dogs the higher the affectivity to

catch a pig. The skill and strategy of hunter, quality of hunting tools and lucky factor are also considered as important factors by hunters.

In terms of deciding hunting location, Table 3 below indicates that 33 % of Kenyah and 64 % of Punan hunter considered that the most important consideration to select hunting location is 'it has been long time not hunting in the area' followed by 'new pigs' tracks found in the location'. Kenyah and Punan hunter believe that the longer they not hunting in a certain area, the higher sedentary population in the location. Such considerations provided on Table 3.

Consideration	Kenyah		Punan	
	Resp.	%	Resp.	%
Location has not been hunted for a long time	7	33	16	64
Pigs' tracks found at the location	6	29	4	16
Location is easy to reach	3	14	1	4
Predicted availability of pigs at the location	3	14	1	4
Prior familiarization of the location	2	10	3	12
Total	21	100	25	100

Table 3: Consideration to Select Hunting Area
Source: Respondents' Interview (2010)

Beside rational considerations before going for hunting, Kenyah and Punan hunters have also some beliefs related hunting and still believed to present. We calculated that 24% of Kenyah and 32 % of Punan hunters believe that 'dreaming of pulling out a boat' is the clue to get a pig. Other important clue/dream for Kenyah and Punan to get pig when hunting is 'burying a death body'. We found that 33% of Kenyah and 12% of Punan still believe these dreams. Beside the beliefs, there're also prohibitions that should be considered by a group of hunters during in the forest as follows: a captured pig is not allowed to take home by any group member before the hunting trip ends, the pig is not allowed to share with other people before hunting ends, never refuse if another group would like to share their captured pig. The hunters believe that they will get nothing if they break the prohibitions.

3.1. Hunting Tools

When the Kenyah lived in original villages in Apau Kayan and Upper Bahau, their common hunting tools were spears, dogs, blowpipes, belatik (bamboo spiked booby traps), traps, and serung (bamboo spikes set around a garden's fence). It is compulsory by customary law (hukum adat) that those who set traps harmful to humans such as serung and belatik must post signs called 'atep' to indicate their presence in the area. Atep is made of wood or bamboo of 5 to 7 cm in diameter and 2 m high, which is stuck in the ground so that it points towards the prohibited area. A sharp piece of bamboo is also put on the top as a sign. Under customary law (hukum adat), an area is out of bounds once the sign is posted. Hukum adat are mostly un-written and drafted through consensus by some neighborhood villages every five years in a customary meeting (rapat adat).

After moving to populated areas in the Malinau basin, some hunting tools became ineffective and harmful to humans. Tools considered harmful to humans such as serung and belatik may no longer be used under customary law. Blowpipes also fell into disuse because of the difficulties of maintaining the poison. Hunting tools being used by Kenyah and Punan at present are shown in Table 4.

Hunting tools	Kenyah		Punan	
	n	%	n	%
Dogs + spear	5	24	15	60
Dogs + shotgun	5	24	0	0
Shotgun	11	52	0	0
Blowpipe	0	0	6	24
Dogs + blowpipe	0	0	4	16
Spear (only for <i>ngusiq</i>)	0	0	0	0
	21	100	25	100

Table 4: Hunting Tools by Ethnic
Source: Respondents' Interview (2010)

Table 4 shows that 76% of Kenyah hunters use shotgun. The users keep shotgun as the response to declining of sedentary population due to environmental changes caused by forest degradation and human activities. Other reasons to possess shotgun are its flexibility (easy to brought everywhere at any time), can be combined with dogs, effective at day and nighttime, free of disease, effective to kill monkeys and big mammals and even for prestige. This new tool needs much input. For instance, a 12 mm Malaysian-made bullet is worth Rp (Rupiah) 30,000 equal to US\$ 3.0 (1 US\$ = Rp 10,000). The bullet is a shell holds 60 small tin pellets each, usually used for shooting birds and monkeys, while shell used to shoot pigs

and deer or big mammals contain only nine bigger tin pellets each. Much cheaper hand-made shells are gradually replacing them. Anyway, this strategy has proven effective in killing wild pigs which eat agricultural crops at night. On the other hand, the Punan use only three types of hunting tools: spears, dogs, and blowpipes. Table 4 shows that 60% of Punan hunter use dogs and spear for hunting compared to Kenyah of 24%. Table 4 also shows that 40% of Punan hunters use blowpipe. They arguing, poison of blowpipe is 'silent gun' which can kill 2-5 monkeys of (*Presbytis spp*) simultaneously at almost the same time without any noise. The most important part taken of the monkey is bezoar stone. Bezoar locally called guliga is a round-shaped crystallized-bitter gall stone found inside the large intestine of *Presbytis spp*. The weight of one bezoar is ranged 10-100 gram. Bezoar is sold to middlemen of Rp. 400,000/gram equivalent US\$ 40/gram. As for comparison, gold's price is Rp. 100,000/gram.

The reasons why there's no Punan possess shotgun are the expensive price of the shotgun itself and the bullet, not really suitable to their nomadic habits. Legal aspect of shotgun is not considered, neither by Kenyah nor the Punan. Characteristic of their hunting tools is portability. Such tools do not need external inputs, and they suit the nomadic habits of the Punan hunters, especially when they go for mufut. For instance, they feeding dogs with hunted animals and they can make fresh poison while traveling in the forest.

Even though the Punan are administratively settled in villages, it nevertheless remains difficult for them to adjust to their new situation. As a result, Punan hunters maintained their old tools and strategy. The Punan are well-known as 'strong-walkers'. Even though prospective hunting locations in primary forest are relatively far (six hours one day roundtrip), they nevertheless hunt in primary forests. When opportunities arise, they leave the village and travel in the forest for several weeks for hunting and gathering.

3.2. Hunting Techniques

3.2.1. Ngusiq

Ngusiq (Kenyah), ngusik (Punan) is the local terms of the oldest hunting technique, both for the Kenyah and the Punan. Basically, this technique involves the hunter's camouflage skill. The hunter should skillfully imitate the voice or any habit of the pigtail macaque (*Macaca nemestrina*), so the hunter can approach the bearded pig as closely as possible. Such habits are voice, climbing and walking techniques, and the way the monkey rocking a tree of forest fruits. The pig's sense of smell is very sensitive and it is wary of human smell, so the hunter must smear his body with mud (Kenyah: tekina) to cover his skin pores, otherwise the pig cannot easily be approached. Once the bearded pig is within range, the hunter thrusts either a knife or a sword into the pig's armpit

In practice, however, the technique is only effectively used in old-growth forest and far from disturbances. In such places there is a symbiosis-mutualism between the monkey and bearded pig. Since 1980 when the first logging concession started to operate in Kenyah and Punan hunting areas, the hunting technique has no longer been effective.

3.2.2. Ngeleput

Ngeleput is hunting activity using blowpipe to kill both arboreal animals such as monkeys and on-ground animals such as pig, deer and even birds. According to Puri (1999), the blowpipe is the dominant symbol of hunter-gatherer culture in Kalimantan. The effectiveness of this technique depends highly on two main factors: proximity of blowpipe to target (pig) and the strength (quality) of the poison. Blowpipe poison is made from the latex of the upas tree (*Antiaris toxicaria*). In order to increase poison potency and deadlier, this poison is mixed with venom of brown cobra (*Ophiophagus hannah*) or king cobra (*Naja sumatrana*). The best quality poison can kill an adult bearded pig within five to 10 minutes.

However, once the poison's quality declines because of improper treatment, this technique becomes ineffective. Kenyah and Punan hunters have unique ways and beliefs in keeping the poison for instance: never keep poison at home particularly near perfumes (it is recommended to keep it outside home), never puts garlic or onion when cooking hunted animals, never fry the meat of animals killed by blowpipe's poison. Hunters say this myth has been believed for decades. At present, however, it is difficult to keep poison properly because most Kenyah and Punan live in villages.

For this reason, the number of blowpipe users declined, especially among the Kenyah. Blowpipes have not been used by the Kenyah since the 1990s because they have been replaced by shotguns, while 25% of Punan hunters still use blowpipes. Mufut is an opportunity for the Punan to maintain the effectiveness of blowpipe's poison, which is made just prior to or during the mufut, making it highly effective or deadly poison. For the same purpose, any animal killed by poison during the mufut just simply boiled or baked without any spice.

3.2.3. Nganup

Nganup (Kenyah), ngusa (Punan) is the local term for hunting with dog. The Kenyah and Punan treat their hunting dogs very differently before leaving for hunting. The Kenyah feed their dogs well in order to make them stronger. Conversely, the Punan never feed their dogs. Another treatment by the Punan is to throw their dogs in water to invigorate them and make them more vicious in their pursuit of bearded pigs. Punan hunters usually leave their villages for hunting at 7 o'clock, earlier than Kenyah hunter; some dogs are still sluggish as they have just awakened. That is why hunters throw them into water to invigorate them rather than to make them cleaner.

The average number of hunting dog kept by a Kenyah hunter is 3.6 and for the Punan is 4.3. Hunting dogs are rigorously selected by an expert when dogs are around two weeks old. Selection is based on criteria such as the relative

position of the breasts to genital organs, and some typical colors. Kenyah and Punan hunters usually ask expert to select dogs to be raised for hunting dogs. Only selected dogs are raised as hunting dogs.

3.24. Nyerapang

Nyerapang means going for hunting with shotgun. While the Kenyah started to use shotguns in the 1960s, nyerapang has become more popular since the 1990s in response to forest degradation that caused bearded pigs to stay away from villages in daytime, and to approach village area at night to look for food in villagers' gardens. This hunting activity can be done at day and night time. A flash light is needed when hunting at night time. The most innovative hunting practiced by some Kenyah hunters is the combination of shotgun and trained dog. Trained dogs can pursue pigs even at night, while most dogs are only effective in the daytime. The Kenyah hunters admit that this strategy has proven effective in catching pigs. The Punan, however, never use this strategy.

3.3. Economic and Social Values of Pig in the Sedentary Population

3.3.1. Economic Values

'Sedentary population' is described by Alikodra (1989) as the average population of wild pig both in primary and secondary forests in whole year excluded of pig season during the migration. Provided the weight of an adult bearded pig on average is 53 kg (average weight of pigs recorded from respondents) and data from Table 2, we calculate captured pig for a month and a year period and also per capita consumption as follows:

No		Value	
		Kenyah	Punan
1	Pig captured per month	2.4	1.7
2	Pig captured per year	29	20
3	Per capita consumption	146	125

Table 5: Economic Value of Wild Pig
Source: Respondents Interview (2010)

3.3.2. Calculation

3.3.2.1. Kenyah

- Pig captured per month (4 weeks x 1.73 x 0.35) = 2.4 pigs
- Pig captured per year (12 months x 2.4) = 29 pigs
- Per capita consumption (29 pigs x 53 kg / 2.3 hunters / 4.6 persons = 146 kg

3.3.2.2. Punan

- Pig killed per month (4 weeks x 1.01 x 0.4) = 1.7
- Pig killed per year (12 months x 1.7) = 20
- Per capita consumption (20 pigs x 53 kg / 1.8 hunters / 4.8 persons = 125 kg

As mentioned earlier, only a few households' own dogs that had qualification for hunting. Therefore, a Kenyah dog-owner or other hunting tools goes hunting usually accompanied by 2.3 persons on average; a Punan hunter is accompanied by 1.8 persons. Therefore, the captured pig must be shared fairly among hunting party members. Based on calculations, every member of a Kenyah hunter's group gets this share: 1,537/2.3 = 668 kg; for the Punan it is 1,007/1.8 = 559 kg per person. Because household member of Kenyah in average is 4.6 and that of the Punan is 4.8, per capita consumption of Kenyah is 146 kg, and that of the Punan is 125 kg. Overall average consumption of the two ethnic groups is 135 kg, which is almost equal to the figure indicated by Puri (1999), who revealed that per capita consumption of pig by the Kenyah and the Punan is 134 kg. Table 5 also shows that captured pig by Kenyah and Punan every year period is 29 and 20. As for comparison, the Kenyah hunter in Apau Kayan bags of 32 pigs every year on average (Colfer et al, 1997). To make it easier to compare the economic value between the Kenyah and Punan, we summarize above calculations and put it on Table 6.

Calculations	Kenyah	Punan
Hunting frequency per week	1.73	1.01
'Productivity' of each trip	0.35	0.40
Accompanied hunter per trip (people)	2.30	1.80
Family members per hunter (people)	4.60	4.80
Number of pigs killed per hunter per month (4 weeks x 1.73 x 0.35)	2.42	1.70
Number of pigs killed per hunter annually (12 months x 2.42 pigs)	29.00	20.00
Per capita consumption	146.00	125.00

Table 6: Comparison of Economic Value by Ethnic
Source: Field Survey (2006)

3.3.3. Social Value of Pig

For the Kenyah people, pig's meat is regarded as 'personal goods', means that they have the rights on how to utilize the meat by themselves. Therefore, Kenyah hunter usually allocate around 30% of the meat to sell at the price of Rp. 7,000 to 10,000/kg. During one-year period, a Kenyah hunter gets Rp. 1.4 million, equivalent US\$ 140.

While the Kenyah can make cash income by selling bearded pigs that is difficult for the Punan, who regard pig meat as 'communal goods.' If a hunter bags a pig, the neighbors think they have the right to share the meat with the hunter. Therefore, the hunter cannot sell any part of the meat for cash income because nothing remains after sharing among the villagers. They have been practicing this unique custom since living in small groups in the remote forest to present.

3.4. Forest and Environmental Changes

Environmental changes at study sites are described from some aspects such as agricultural activities, logging and mining, drought and fire, and the expansion of oil palm plantation as well as new settlement.

3.4.1. Agricultural Activities

The main subsistence of the Kenyah and the Punan is swidden agriculture. Swiddens are scattered around the village and alongside the Malinau river, and are all at most a two-hour walk (or about 6 km) away. As swidden agriculture has a rotational cycle in connection with social organization (Inoue and Lahjie, 1990), the clearing of primary forest for swiddens is not regarded as significant. Even recently, Yuana (2005) states that in 2004 there's no Kenyah cleared primary forest for swidden agriculture in this area. Instead, they cleared old and young secondary forest. Therefore, it is believed that agricultural activities itself do not significantly degrade the forest.

3.4.2. Logging and Mining Activities

From 1980 to 1985, a timber company PT. Sumber Mas operated in Tanjung Nanga and some Punan village territories. From 1998 to 2003, two other logging companies operated near Merap Village (downstream from Tanjung Nanga). In 10 years of operation the companies degraded thousands ha of primary forest and constructed hundreds of kilometers of logging roads in the heart of the primary forest. In East Kalimantan, only floating species including the Dipterocarpaceae were cut and rafted downstream. The decrease of Dipterocarpaceae especially *Shorea* spp caused by such activities and the thunderous noise of heavy equipment such as trucks, tractors, and chainsaws are considered to be important factors inducing the decline in the bearded pig sedentary population.

An Australian coal mining company PT. BDMS (Bara Dinamika Muda Sukses) also exploited resources in this area started in 1999, continue today. Coal is carried every day by around 30 dump trucks over an 80 -km gravel road from the mining area in the forest to the coastal embarkation port of Malinau. Truck noise has also been affecting the bearded pig sedentary population particularly for hunters in Long Loreh. Hunters complaining that distant to hunting location became longer than before the advent of this mining company.

3.4.3. Drought and Forest Fires

During the past 20 years there were two big forest fires in East Kalimantan. The first one occurred in 1982 and 1983 due to 11 months of prolonged drought. Mori (1999) estimated that the fire destroyed 5 million ha throughout Kalimantan and 3.6 million ha in East Kalimantan. The second forest fire occurred in 1997 and 1998, and severely spread throughout three districts of East Kalimantan: East Kutai, Kutai Kertanegara, and West Kutai.

According to Mori (2000), more than 85% of the lowlands and hills in East Kalimantan had been covered by dense primary forest dominated by dipterocarps before large-scale exploitation and forest fire. Forest fires seriously degraded the forest constitution and structure. As a result, primary forest disappeared from almost all lowlands and some areas up to 500 meters above sea level. Of course, some parts of the forested areas dominated by dipterocarps survived the fires, but the long drought also killed large dipterocarp trees, and some that had survived the fires succumbed to underground and surface heat. According to Mori (2000), *Shorea smithiana*, *S. seminis*, *Dryobalanops beccarii*, and other species are very sensitive to water deficits. Kiyono and Hastaniah (2000) concur that many dipterocarps are rather sensitive to drought. Furthermore, Mori (2000) revealed that severe drought itself weakens large dipterocarp trees and often kills them.

Though the fires were occurred only in neighborhood districts and were not directly affecting hunting location, degradation of the forest ecosystem mentioned above reduced food for bearded pigs. Kenyah and Punan explain that some species of dipterocarps are the important forest fruits for pigs' food. Degradation of dipterocarp trees at lowland area also resulting in pig migration became infrequent and has shifted to up river which is unreachable for one day return trip.

3.5. Adaptation of Hunting Tools to Environmental Changes

In the early years living in the existing villages, there was no much human activity in forest, there was no logging and mining activities, hunting tools such as spear for *ngusiq*, *serung* and *belatik* were still effective to use. Blowpipe was also popular among hunters because it was the gun to kill mammals, arboreal animals, birds and even for self defense. We try to trace the change on hunting tools from 1990-2007 as provided on Table 7.

Hunting tools	Kenyah		Punan	
	1990-1997	2007	1990-1997	2007
Spear for ngusiq	0	0	0	0
Serung and belatik	0	0	0	0
Shotgun	10	11	0	0
Dog	9	5	18	15
Shotgun + dog	2	5	0	0
Blowpipe	0	0	4	6
Blowpipe + dog	0	0	3	4
Total	21	21	25	25

Table 7: Changes of Hunting Tools by Ethnic

Source: Field Survey (2007)

Table 7 shows that the number shotgun user by Kenyah increased from 12 to 16, specifically in Long Loreh where the combination of shotgun and trained dogs is practiced. Conversely, dog owners decreased from 9 to 5 due to dog diseases such as rabies in 2000 and 2005, and some hunters changed hunting tools to shotgun. Likely the Kenyah, dog owner of Punan also decreased from 18 to 15 hunters due to similar reason, while blowpipes user increased from 7 to 10 hunters.

3.5.1. Adaptation by the Kenyah

In the early years living in the village, Kenyah could set up serung and belatik as long as they put properly sign called 'atep' to avoid everyone bounding the area except the hunter (owner). However, since many human activities in this area either by villagers or outsiders, some hunting tools become less effective and even dangerous. Table 4 shows that serung and belatik were no longer practiced by both Kenyah and Punan. According to Village Head of Tanjung Nanga, hunting tools that harmful to human were no longer allowed by Customary Law (hukum adat) since the 1990s. At present condition where most of Kenyah households consuming spices (onion and garlic), it is difficult to keep the poison properly. In the past, when they quite isolated and were not consume such spices, it was easy to keep the quality of poison. Such condition has caused the user of blowpipe declined, especially for Kenyah. Since 1980s, blowpipe has no longer used by Kenyah as it replaced by shotgun. Another reason was they realized the bad side-effect of poison to health, specifically to teeth and lung.

As mentioned earlier, human activities and forest degradation declined sedentary population of pig in the hunting locations. Forests disturbance caused pig stay far away from village area which is unreachable for the hunters. At night time, some pigs from remote forests approaching village area to look for agricultural crops. In this case, using only shotgun or 'conventional' hunting dogs is not so effective to catch the pig at late night. Most of dogs are only effective to hunt at daytime.

Therefore, one important finding of hunting strategy practiced by Kenyah is the combination of shotgun and trained dog. The trained dogs can pursue wild pig at both day and nighttime and never bark before ordered by trainer/owner, while conventional dog can only hunt at daytime. It takes around two months to train the dogs for hunting at nighttime in combination with shotgun. This strategy is practiced as follows: if wild pigs found (predicted) eating crops or hiding in shrub or young secondary forest at nighttime, a group of hunters with shotgun and trained dog encircle the position of the pigs. After all possible escape-patches of pig have been watched over by hunters, the hunter releasing dogs to look for the pigs in the shrub or young secondary forest. Every hunter ready with gun to kill the pigs when the pigs coming out to escape. This strategy was introduced and practiced by Kenyah in Long Loreh since 1999 followed by Tanjung Nanga. The hunters admitted that this strategy proven effective to catch wild pigs that preying agricultural crops late night.

3.5.2. Adaptation by the Punan

Punan is relatively fixed with traditional tools: dog and blowpipe. Table 4 shows that there was no shotgun, number of hunters using dog before 1997 and 2003 decreased from 16 to 15, while blowpipe users increased from 4 to 6 hunters. The decreasing of hunters keeping dog was due to some problems among other disease (rabies), so some hunter replaced dog with blowpipe for hunting. Another reason was because blowpipe is the most suitable and effective gun for Punan to kill monkeys (*Presbytis spp*) to take its bezoar. The Punan also travel in the forest (mufut) together with hunting dogs to keep them fresh. During the mufut, they enjoying sago, meats, fruits, and also collecting Aloe wood. Aloe wood was also sold to middlemen or directly to Chinese trader for the best quality of Rp. 8 million/kg equivalent to US\$ 800/kg.

3.6. Changes in Livelihoods

Environmental changes by human activities, living in the existing settlements, forest fires and the presence of new comers is responded by Kenyah and Punan on different ways. Responses of Kenyah and Punan people to such changes are described from livelihood and daily activities as follows:

3.6.1. The Kenyah

The pressure to environment was responded positively by Kenyah. Main livelihood of all households of Kenyah Loreh and Tanjung Nanga remain swidden agriculture. If a husband working as a civil servant or labor, the wife and or

children will run swidden agriculture. Kenyah benefits from the presence of logging and mining companies by selling meat, fish and crops to company workers, comers and villagers, running small shop or trading and services. As sedentary population of pigs declined, the Kenyah people improved tools and strategy of hunting and fresh water fishing. They also raise domestic pigs and chicken for sale as well as to fulfill the need of meat and to anticipate wild pig scarcity during the lean period.

3.6.2. The Punan

Livelihoods and daily activities of Punan people are basically similar to Kenyah i.e. swidden agriculture, hunting, gathering and fishing. The difference is on time allocation. The change on forest environment caused wild pig stay far away from village, so it takes more than 3 hours to reach hunting location. Due to long distant from village to hunting locations for one-day return trip some Punan family prefer to travel for 3-4 weeks even more in the forest, so agricultural activities are often ignored.

Response of Punan to environmental changes was assessed from the advantages and disadvantages of living in the present villages and the upper Malinau and Tubu rivers. From the Punan point of view, advantages of living in native land of upper Malinau and Tubu are as follows: it is easy to get pig because sedentary population relatively higher, hunting and gathering location are relatively close, no dog disease because less contact with outside dogs, they could protect their pristine forests from exploitative activity, they could survive by extractive products such as sago and shoots and sustain traditional way of life, easy to keep the quality of blowpipe's poison, and the most important thing is 'pig migration' always passing by the village area.

'Pig migration' is a phenomenal and important moment that always expected by Punan and Kenyah because they could collect big amount of meat and fat for cooking oil. Respondents explain that in the past, pig migration usually occurred regularly every 3-8 years. During the migration, Pffefer and Caldecott (1985) observed that a group of 100 or more pigs move slowly of around 2 km per hour to eat the fallen fruits on the ground. Meijaard (2000) describes pig migration of East Kalimantan in 1983 involves around one million pigs. Furthermore, Uluk et. al (2001) added that number of pigs in a group is 30.

Beside the advantages of living in existing villages, the Punan also experience some disadvantages from their point of view as follows: it takes long time to reach hunting location, sedentary population is relatively low, pig migration become infrequent (migration route at upper rivers unreachable for a-one day roundtrip), human and dog diseases. Instead of prolonged experience such problems, some Punan people are preferable to get back to their native land in upriver Tubu and Malinau.

4. Conclusions

Before severe pressures to forest ecosystem i.e. logging, forest fires and other human activities, all hunting tools and strategies of Kenyah and the Punan in Malinau were effective and it was easy to get pig. Since the 1980s, a series of exploitative activities in the forest (logging) and mining have significantly degraded forest ecology, particularly the hunting location of Kenyah and Punan that declined sedentary population.

Responding the environmental changes and the different situation at new settlements, Kenyah hunters changed and modified tools and strategy of hunting properly. For instance, the combination shotgun and trained dogs is proven effective to catch pig. Beside subsistence (swidden agriculture), Kenyah people benefits the advent of logging, mining and new road by selling pig, fish and crops to company workers.

On the other hand, the Punan hunter responding the environmental changes rather different to Kenyah. Some Punan hunters changed hunting tools but no improvement on strategy of hunting. Instead, the Punan keep their traditional way of hunting and gathering by traveling in the forest for several weeks for survive. Agricultural activities are not as sustainable as the Kenyah. Due to declining of pig population, long distance to hunting location, the infrequent of pig, and to sustain their traditional way of life, some Punan people considered to move back to their native lands in upper land of Tubu and Malinau. They complained that hunting area in them

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