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ORIGINAL ARTICLE – Conservation of Nature

The Human and Tapanuli Orangutan (*Pongo tapanuliensis*) Conflict in the Tropical Mountain Rainforest Ecosystem, Indonesia

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Abstract

Threats must be eliminated from the tropical mountain forest habitat of Dolok Sipirok Natural Reserve, which is home to the Tapanuli Orangutan (*Pongo tapanuliensis*). The threat arises from human-orangutan conflict resulting from the occupation of agricultural land and the opening of accessibility. The aim of this research is to identify areas and patterns of conflict between orangutans and humans in the vicinity of the Dolok Sipirok Nature Reserve. Data was gathered through community interviews and direct observation of the Tapanuli orangutan. The magnitude of community losses was determined by analyzing economic losses and crop destruction. The majority of conflicts were discovered in community fields that were about to be harvested. The main attraction for orangutans is fruit plants in those areas. These fruit trees are located in a roaming area and animal corridor. A buffer zone must be managed effectively to provide for the orangutan's sustenance and nesting requirements.

Keywords: Batang Toru ecosystem, Community fields, Dolok Sipirok natural reserve, Wildlife corridor.

1. INTRODUCTION

Land clearing for farming areas and public access always happens after development. It also causes people to move into a particular location. Human settlements in forest reserves can be a serious concern, especially in areas where the areas are poorly maintained. (Yang et al., 2019). Land clearing for agricultural production (De Moraes et al., 2017), deforestation (De Oliveira et al., 2017), and human settlements expansion (Bailey et al., 2016) leads to destruction and degradation of wildlife habitat. Expansion of human settlements inside nature reserves causes habitat loss and fragmentation (He et al., 2014; Samsuri et al., 2014) and enhanced negative human influences (Yang et al., 2019).

A newly constructed road prompted foreigners to come and remove the remaining forest, transforming it into a vast tract of intensively managed rubber, coffee, and oil palm plantations. It demonstrates that the severe impact altered biodiversity and wildlife distributions, as well as a decrease in species richness when compared to agriculture and natural forests (Fitzherbert et al., 2008; Barnes et al., 2017; Mendes-Oliveira et al., 2017). It has an impact in the form of diminished habitat area as a result of new land removal. Human-inhabited areas along the borders of protected zones may be in conflict with wildlife. It is a serious threat to the survival of endangered species (Nyhus & Tilson, 2004). Conflicts between wildlife and humans deconstruct their mutual well-being and increasingly threaten the conservation of many wildlife species (Shilongo et al., 2018).

Human-wildlife conflict is widespread where human-inhabited areas and wildlife habitat overlap. It has also happened with the forest reserve as an orangutan habitat within the forest ecosystem. Human population growth has a direct impact on the Tapanuli Orangutan's habitat (Kuswanda, 2014). It devastated orangutan habitat, causing the species to decline. Meanwhile, the current state of orangutans has declined significantly during the previous 30 years (Directorate General of Forest Protection and Conservation, 2006). However, despite concerted efforts, the rate of forest degradation as a habitat for orangutans continues to advance without success. Due to this condition, orangutans are classified as critically endangered species on a global scale.

Several scientists were motivated to conduct investigations on human-orangutan conflict and interpersonal dynamics due to deplorable habitat conditions and orangutan populations. A small number of Asian researchers have conducted comparable investigations into human-primate conflict (e.g. Johnson et al., 2018; Nekaris et al., 2013) and in both Africa and Asia (Priston & McLennan, 2013). Many studies have also been carried out in the context of Africa; Guinea-Bissau (Hockings & Sousa, 2013), Madagascar (Freed, 2012), Rwanda (McGuinness & Taylor, 2014), South Africa (Findlay, 2016), and Uganda (Aharikundira & Tweheyo, 2011; Hill, 2000; Naughton-Treves, 1998; Tweheyo et al., 2005; Wallace & Hill, 2012).

In Sumatra, Indonesia, observations have been made in villages around the Dolok Sibual-Buali forest reserve area by Pasaribu & Harahap (2017), who found a conflict between humans and the Sumatran Orangutan. It proves that the existence of orangutans and their habitats are threatened.

Another threatened habitat for the orangutan is the Dolok Sipirok Nature Reserve. The habitat provides a good food source for orangutan. In 2017 (Nater et al., 2017), research found new species of orangutan, named Tapanuli orangutan. However, the Tapanuli orangutan habitat threat has increased. This threat is triggered by the increasingly limited living space of the orangutan due to farmland expansion into orangutan habitats (Kuswanda, 2014).

These threats are the cause of conflict between orangutans and humans. As a measure to handle and anticipate future conflicts, research has been conducted by Siregar et al., (2015). The research mapped areas prone to conflict between orangutans and humans in the Dolok Sipirok Nature Reserve; then conflict spot distribution and data compilation affect conflict incidents.

It is necessary to conduct research on orangutan conflicts, particularly those between orangutans and humans in the villages surrounding the reserve, in order to implement post-conflict management of orangutans and humans and prevent future conflict incidents. Additionally, information regarding regions susceptible to orangutan-human conflicts facilitates policy formulation by governing bodies, which takes into account the long-term viability of orangutans and their habitats as well as the prevention of conflicts.

The objective of this research is to ascertain regions susceptible to conflict between the village community and the Tapanuli orangutan (Pongo tapanuliensis) residing in the vicinity of the reserve. Additionally, it seeks to analyze the underlying factors that contribute to this conflict.

2. METHOD

2.1. Research location

This research was conducted in villages around Dolok Sipirok Nature Reserve. The villages are Ramba Sihosur, Luat Lombang, Aek Batang Paya, Nanggarjati, Lancat, and Arse Nauli. The Nature Reserve is part of the Batang Toru forest ecosystem with a mountainous tropical rainforest type with an altitude ranging from 600-1,200 meters above sea level. Data analysis was conducted at the Forest Management Laboratory, Department of Forest Management, Faculty of Forestry, Universitas Sumatera Utara. The location of the six villages, which are the focus of the research area, can be seen in Fig. 1.

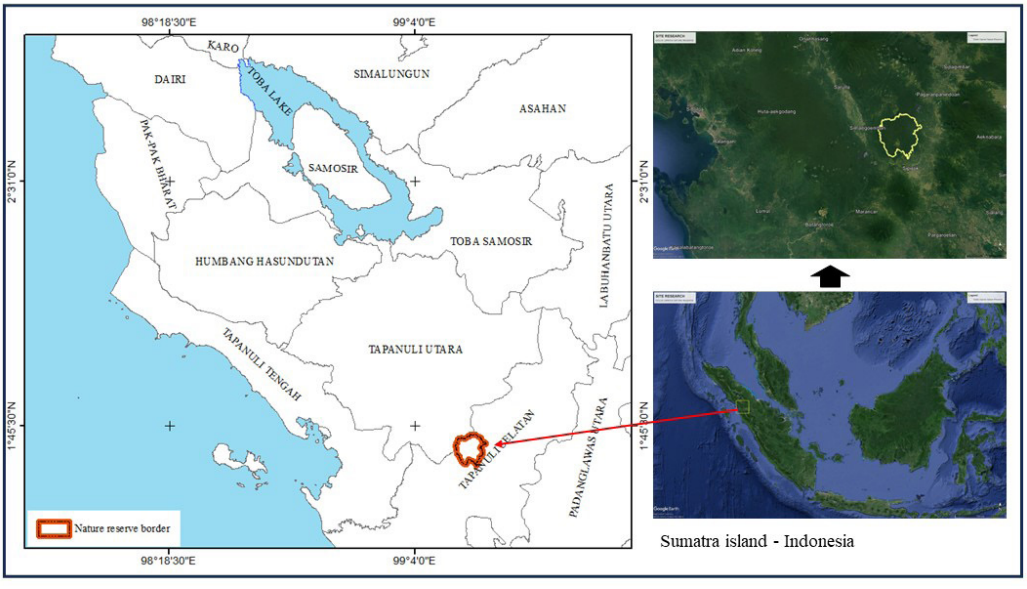

Figure 1. Research location map.

2.2. Tool and material

The research used ArcGIS 10.3 software, Geographical Positioning System (GPS), digital camera, SPSS ver. 25, stationery, and questionnaires. The data used in this study are administrative maps of Tapanuli Utara and Tapanuli Selatan districts, village administration maps, land cover maps, and maps of the Dolok Sipirok Nature Reserve. In addition to data sourced from secondary data, data from field data or primary data were data on conflicts between orangutans and humans in the research area and ground checks for human-orangutan conflict.

2.3. Data collecting

Conflicts between humans and primates are mainly about the crop-raiding, so there are three main types of research approach dominated (Siljander 2020): (i) Farmers interview their perceptions of crop damage (Hill & Webber 2010; Saj et al., 2001; Tweheyo et al., 2005); (ii) assessment the crop damage and loss economics during a specific period (Hill 2000), and (iii) observing wildlife behavior in farmer lands (Priston et al., 2011).

The data collected are data on conflict occurrence spots and questionnaires. Field data types are occurrence spots of conflicts between orangutans and humans. The number of crop damage due to conflicts in the research area was obtained from the ground check results of human orangutan conflict points. Criteria for conflict spots are where the conflict between orangutans and humans occurs by looking at the authentic disturbance in the field.

2.4. Community interview

The main data collection consists of two types of information: (1) the type and degree of crop damage in conflict hotspots and (b) community knowledge and response to Human and Orangutan Conflict (HOC). In addition, the research uses a set of questionnaires for chosen respondents. Several questions were posed to the community in order to obtain information regarding (1) the location of the conflict, (2) the time of crop destruction, (3) the frequency of disturbances to community land or plants, (4) the types of plants damaged by HOC, (5) the volume or number of damaged plants or fruit, and (6) techniques for controlling or preventing conflict by the community.

The respondents were chosen through purposive sampling. Individuals or communities living in conflict areas were interviewed. Individuals or communities whose agricultural land has been damaged by orangutan habitats have also been included on the list of respondents. Questionnaires were distributed in the six municipalities designated as the primary area of focus. The questionnaire instrument furnishes participants with a fundamental comprehension of the distinctive attributes of orangutans as well as the manner in which the community navigates conflicts.

2.5. Verification of human orangutan conflict spots

The quantification of agricultural damage in the study area attributable to conflicts was obtained from the findings of ground checks conducted at human orangutan conflict locations. The selection of conflict sites is determined by a predetermined set of criteria; in this case, the location of the orangutan-human conflict is ascertained by observing the conspicuous disruption in the area. Furthermore, the research validates the HOC location ascertained through community interviews and ascertains the type of crop injury present on farmland. The HOC verification gains data, i.e., what part of the crop, crop species, and fruit were destroyed or eaten by orangutan. The location verified is marked and mapped using ArcMap.

3. DATA ANALYSIS

3.1. HOC intensity

The HOC spot map is overlaid with the village bordered map. It produces composite maps with attribute data regarding the intensity of HOC in each village.

3.2. Economics loss analysis

Economic loss (EL) is the potential loss of income to farmers due to HOC. The analysis of economic losses arising from damage uses data on the damage to plants obtained from primary data. The economic value of the crop types damaged is calculated by Calculating losses based on economic aspects due to HOC using the following approach (Siregar et al. 2015):

a. Multiply the amount or volume of damage (V) by the market price (P); using the formula $EL = V \times P$
b. Market prices are determined by interviewing sellers in the local market. It means the market price is valid only at the research site. The market price approach for each commodity can be seen in Tab.1.

Table 1. Commodity prices and crop production.

No	Local name	Scientific name	Unit	Rate (IDR)	Volume
1	Aren	*Arenga pinnata*	liter	2.000	1500 l / tree
2	Bambu	*Bambuseae*	stem	10.000	Ten stem/clump
3	Nangka	*Artocarpus heterophyllus*	unit	50.000	30 unit/tree
4	Durian	*Durio zibethinus*	unit	20.000	100 unit/tree
5	Jambu bol	*Syzygium malaccens*	kilogram	10.000	25 Kg/tree
6	Jengkol	*Archidendron pauciflorum*	kilogram	100.000	10 Kg/tree
7	Jipang	*Secium edule*	kilogram	3.000	10 Kg/plant
8	Petai	*Parkia speciosa*	bunches	10.000	100 bunches/tree
9	Pisang	*Musa paradisiaca*	bunches	100.000	1 bunches/tree

4. RESULTS AND DISCUSSION

4.1. Human and orangutan conflict cases

The interviews of communities around Dolok Sipirok Nature Reserve show that the orangutan entered the community lands in the first period from December to January, and the second period from July to September. This period is the fruit season for several important agricultural commodities, such as *Durio Zibethinus*, *Parkia speciosa,* and *Archidendron pauciflorum*. The orangutan would enter community fields, eat *Durio Zhibetinus, Parkia speciosa* and *Archidendron pauciflorum*, make nests in community fields, and stay temporarily for approximately 1-2 weeks in these locations. Identifying the conflict between the orangutan and the village community around the nature reserve was based on the number of plants damaged by the orangutans and the value of the economic loss caused by the orangutan.

Geographically, the location of these villages directly adjacent to the reserve makes it easier for the orangutan to move into one village and another. The location of the orangutan conflict is a corridor for the orangutan; hence some orangutans still pass through the corridor to this day. In addition, this fact is supported by Wich et al., (2019), which states that female orangutans are philopatric and tend not to move when they lose a part of their home range. Loss of such home range and subsequent dispersal can also lead to orangutan compression in adjacent areas. The density of orangutans can exceed their carrying capacity and lead to food shortages and future density reductions.

The orangutan is a new species (Nater et al., 2017) that has entered the community lands in six villages around the nature reserve. The distribution of HOC spots in the nature reserve villages is evenly distributed in the western and eastern regions, encompassing 20 villages bordering the nature reserve area. Four conflicts occurred in Ramba Sihosur, Luat Lombang, Aek Batang Paya, Nanggarjati, Lancat, and Arse Nauli villages. People of the HOC villages reported that orangutans throng their farmlands and destroy and eat livelihood crops. The distribution map of the HOC has been illustrated in Fig. 2.

Most disturbed villages have plantation lands, including fruit trees, such as *Durio zibethinus* and *Parkia speciosa*, which are the orangutans' food. It is revealed that orangutans lack food in their habitat, so the animals look towards the community lands located in the reserve buffer zone. The community has handled orangutans' ridden farmland with preventive measures, such as protecting their fields. Farmers use it most effectively on several Aek Batang Paya village incidents. The orangutans prefer to avoid the presence of farmers in their lands. Studies of Asia and African human-wildlife conflict revealed that farmers have damage costs during the conflict. Hence, farmers try to reduce damage costs through the collective action of guarding system. The practice of traditional guarding strategies and the effectiveness of fences were recommended (Gross et al., 2019).

Before discovering the proper method to expel the orangutan, i.e., preventive measures and protecting the fields, people usually expelled the orangutan by several other methods, such as using smoke and loud noises and throwing objects at the orangutans. In other countries, farmers also prevent crop-raiding by guarding the field (Warren et al., 2007), having a guard dog, shouting and scaring wildlife, and growing unattractive crops. At first, this method worked effectively, but with the constant use of the same method, the orangutan became immune to it, and it was no longer effective.

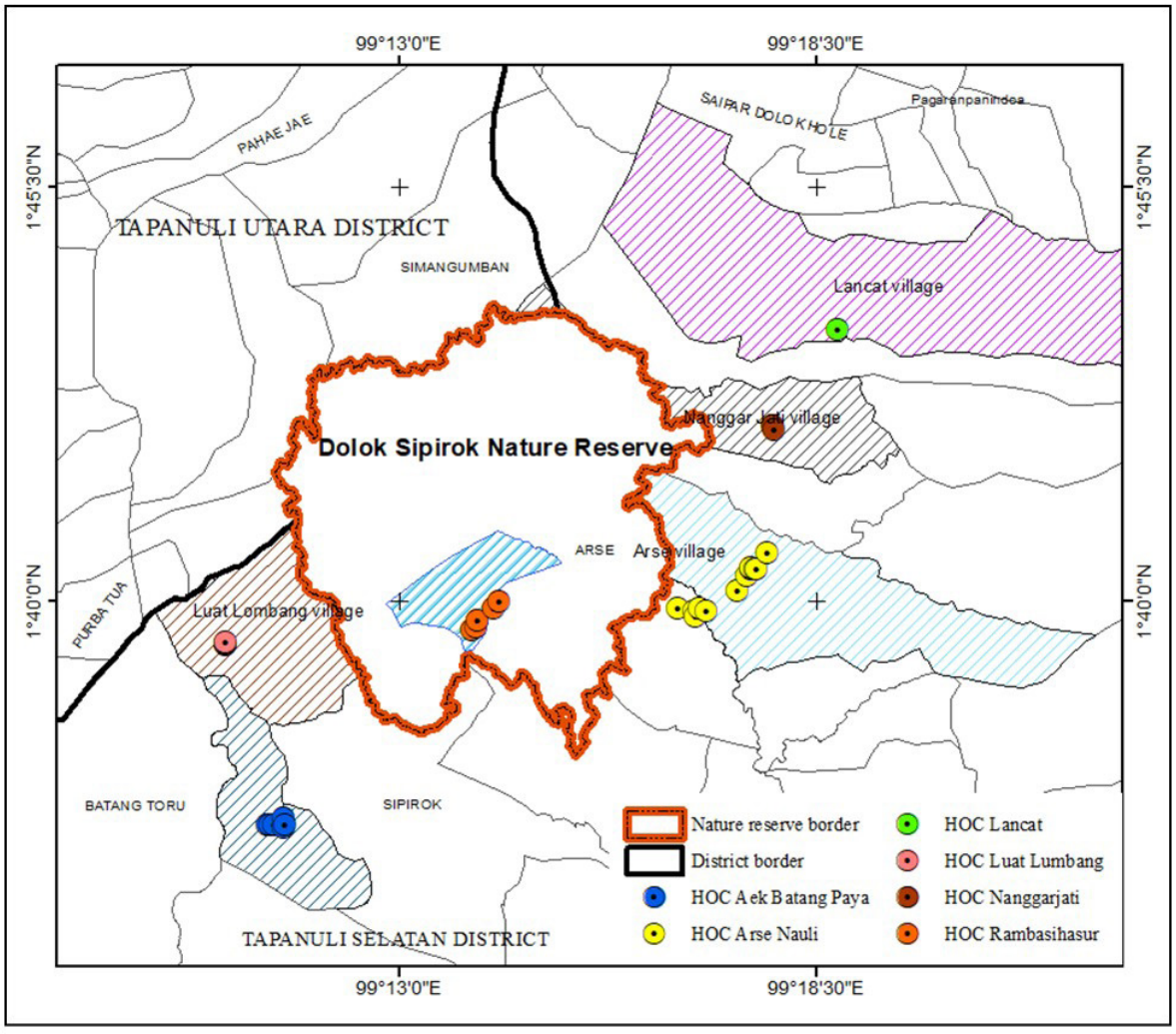

Figure 2. Spots distribution map of human and orangutans conflict (HOC).

Based on the distribution of HOCs overlaid with village boundaries, the distance between villages is close to each other. It proves that the HOC location is a corridor for orangutans. The distribution of HOC spots can be seen in Fig. 3. The distribution of conflict spots is mainly located in Arse Nauli village, with the number of HOC reaching 12. Thus, it can be said that the eastern area of the reserve is the area most prone to conflict with orangutans. Meanwhile, the western part area, directly adjacent to Tapanuli Utara district, has no conflict with orangutans. Due to the type of land cover, which is still covered by secondary dryland forest, the habitat condition is classified as a preserved ecosystem.

Notes: Ramba Sihosur (RS), Luat Lombang (LL), Aek Batang Paya (BP), Nanggarjati (NJ), Lancat (LC), and Arse Nauli (AN)

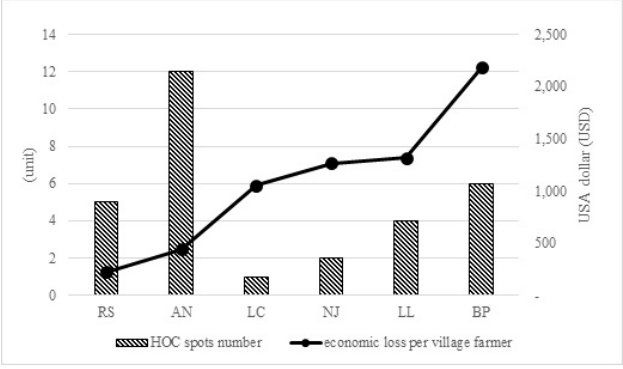

Figure 3. Distribution diagram of HOC dan economic losses based on the village border.

Based on the data presented in Fig. 3, the highest distribution of HOC is located in Arse Nauli village, with 12 HOC spots, with the most damaged plant being *Durio zibethinus*. Arse Nauli sub-district comes first in the vulnerability of HOC, and the distance between the HOC spots is very close to residential areas. The second most prone to conflict is Aek Batang Paya village, with 6 HOC spots. *Durio zibethinus* and *Parkia speciosa* were the area's most damaged species by orangutan. While finding orangutans in Aek Batang Paya village farmland found an orangutan nest and *Durio zibethinus* fruit dropped by orangutans. People said orangutan eat the ripe fruits and drop unripe fruits. Nests and fruit dropped by orangutan are illustrated in Fig. 4.

Figure 4. (A) Orangutan nest in farming area, Aek Batang Paya village (B) *Durio zibethinus* fruit dropped by the orangutan.

Orangutans occupy community lands during the start of fruit season, especially *Durio zibethinus* fruit. Meanwhile, the fruit is one of the primary commodities for farmers in the villages. Orangutan build nests where they can feed on plants and fruit, such as *Durio zibethinus*, *Parkie speciosa,* and other forage plants. Generally, no more than two individuals come into the farmland within groups. It follows the idea presented by Ashbury et al., (2015), which states that in orangutan-disturbed areas, a part of the orangutan home range is lost, and orangutan will use the remaining parts of their home range more intensively than before.

Along with *Durio Zibethinus*, another commodity damaged is *Parkia speciosa*. *Parkia speciosa* is another source of the farmers income besides *Durio Zibethinus*. It follows the research results by Kuswanda & Sugiarti (2003), which stated that orangutan are usually solitary; thus, they look for food alone and rarely form groups. However, orangutan may gather together around abundant food sources. Fig. 5 illustrates an orangutan picking up *Parkia speciosa* fruit in the community land of Aek Batang Paya village.

Figure 5. Orangutan was taking *Parkia speciosa* fruit, Aek Batang Paya village.

In third place, the level of HOC conflict vulnerability is Ramba Sihosur village. In this village, five HOC spots are located in the community lands. The Ramba Sihosur village is in an enclaved area of nature reserve. Most HOC spots are in community lands planted with *Coffea sp*, *Durio zibethinus,* and *Parkia speciosa*.

The Luat Lombang village is adjacent to the east of the nature reserve area. This village is directly adjacent to the nature reserve, making it vulnerable for orangutan to enter the community's lands. The Luat Lombang village has four HOC spots; one of the HOCs is the largest area, about ten hectares.

In the fifth rank of conflict vulnerability is Nanggar Jati village, where orangutan disturbance is infrequent. The villagers are dominated by farmers who grow rubber (*Hevea brasiliensis*) and plant sugar palms. A mixed rubber and *Durio zibethinus* garden in this village has two HOC spots. This village is quite far from the nature reserve. In addition, the farmland located close to community settlements prevents orangutan from entering the farmlands. Most farmers plant rice, while others plant palm sugar and *Durio zibethinus*. It follows the statement given by Kuswanda (2014), which states that the livelihoods of the people in nature reserve are almost the same as those around nature reserve, who are farmers, plantation owners, and palm sugar makers.

The last sequence is the Lancat community. Geographically, the village is far from the nature reserve boundaries, and based on the community report, HOC is not frequent. The disturbance frequency of farmlands can be categorized as very rare. Only one HOC was located on the community's land, although the farmers also grew *Durio Zibethinus*.

4.2. The economic loss of farmer

Based on field observations, most of the *Durio zibethinus* plants belonging to the community are inherited from generation to generation. The villages have *Durio zibethinus* trees, most of which are almost 50-70 years old. The *Durio zibethinus* fruit production reaches 100 grains each season. The durian tree in the community's fields is a legacy plant from the elders. Besides *Durio zibethinus, Parkia speciosa* plants are also in the agricultural field. *Parkia speciosa* is also a source of income for village farmers around the nature reserve. The price of one *Parkia speciosa* bunch reaches IDR 10,000, and one *Parkia speciosa* tree can produce up to 100 bunches. Based on a survey of the *Parkia speciosa* market price, it can be estimated that the loss for one *Parkia speciosa* tree has a potential loss of IDR 1,000,000. Damaged plant affects people living adjacent to protected areas or buffer zones (Treves et al., 2006) where natural wildlife habitat and agriculture are overlayed or due to a forest conversion area (Distefano, 2005). Severe conflict occurs when subsistence farming is the only income source, so crop damage can directly affect survival (Taylor et al., 2016). The human-orangutan conflict drastically impacts the livelihoods of rural households, mainly subsistence farmers. It causes them to be highly dependent on their agricultural production, but crop-raiding by wildlife, such as the orangutan, can threaten local food security (Siljander et al. 2020).

Meanwhile, losses for durian fruit are estimated at IDR 2,000,000 at a durian price of IDR 10,000/unit. One durian tree, which is 30-50 years old, can produce 200 fruits per season. Based on this calculation, farmers around the nature reserve are at a loss when orangutan enter the farmlands. The average cost of damage per incident per farmer in Africa and Asia ranges from [USD] 47.51-4.21 (Gross et al. 2019). This cost is smaller than the economic loss of farmers around nature reserve. Different commodity and price markets may cause it.

In the farmer interview of the six HOC locations, orangutan entered community lands long ago because these villages were adjacent to the nature reserve area. This area is an enclave for the orangutan population. The average number of orangutan entering the farmlands is 1-2 individuals. Orangutan get into the farmland to search for food. In line with Siljander et al. (2020), the closer a farm is to the forest boundary, the more vulnerable it is to HOC. The area of land ownership is also increased every year. It has triggered orangutan corridor change into community land. In addition, the food quantity of orangutan has started to decrease. Orangutans usually enter community lands in the morning or evening, as Putro et al. (2019) stated that orangutans are generally active during the day. It is also stated by Kuswanda (2014) that behavioral changes or adaptations have also occurred on orangutan having home ranges around cultivated lands. Orangutans visit it in the late afternoon or early evening to make sleeping nests.

Orangutans prefer to eat *Durio zibethinus, Parkia speciosa* and *Arenga Pinnata* more frequently. However, other planted commodities were disturbed, i.e., *Sechium edule*, *Syzygium malaccense,* and *Bambusoideae sp* (Tab. 2). One of the HOC locations shows that orangutans will move to other trees when they are satisfied with what they have eaten.

Table 2. The number of crops damaged by orangutan raiding.

Crop species	Crop damage number (unit)					
	AN	BP	LC	LL	NJ	RS
Arenga pinata	3	20	-	3	1	2
Arthocarpus integer	6	-	-	3	-	3
Artocrpus heterophyllus	-	-	-	3	-	-
Bamboo	-	-	-		-	1
Durio zibethinus	21	55	-	21	5	-
Musa parasidiaca	2	-	-	2	-	-
Parkia speciosa	14	21	15	14	20	5
Sechium edule	3	-	-	3	-	-
Syxygium malaccensis	-	-	-	-	-	1
Total	49	96	15	49	26	12

Orangutans enter the lands, then build nests as resting places near the trees for several weeks. It follows Kuswanda (2014) statement that orangutan eating activity in the morning is allocated the most time (34.31%), followed by moving activity (31.39%), social activity (23.61%), and finally, resting (10.69%). During the day, orangutans build nests for naps with a time allocation of 4.45%. At least once a day, orangutans make nests made of fresh branches and leaves. Nesting is relatively fast, ranging from 9 –12 minutes. Adult males make the fastest nest within nine minutes. Besides eating *Durio zibethinus* fruit, orangutans also break branches of *Parkia speciosa*. Orangutans breaking *Parkia speciosa* branches is illustrated in Fig. 5. Orangutans eat *Parkia speciosa* fruit and move trees when they run out of fruit. The activity of orangutans who actively move branches of the *Parkia speciosa* tree follows Kuswanda's (2014) statement, which states that mobile activities consist of moving from one tree to another in search of food and looking for other individuals around the home range. Several studies on human-wildlife conflicts have shown that planting a crop that attracts wildlife triggers crop-raiding by wildlife (Tweheyo et al. 2005).

5. CONCLUSION

Research found several factors causing orangutan conflict with humans as follows:

1. The HOC site is situated within the orangutan's home range; alternatively, it may be referred to as an animal corridor.

2. The habitat and living space of the orangutan have decreased as a result of the expansion of community fields that are becoming wider with the commodity crops, including coffee, *Arenga pinnata, Durio zibethinus, Parkia speciosa,* and *Hevea brasiliensis*. Food crops for orangutans have declined in the vicinity of the buffer zone and animal corridors as a result of this activity.

3. The farmers have reported that the expansion of orangutans during the fruit seasons has resulted in a reduction in the economic value of their fields of commodities.

A buffer zone must be managed effectively in order to provide for the orangutan's sustenance and nesting requirements. Research on food and nest trees is necessary in specific areas to ensure that their requirements are met. Active cultivation should be prohibited within the buffer zone and home range of orangutans.

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Wanda Kuswanda: Writing original draft (supporting), writing review and editing (Supporting).

Riyan Hari Ashari: data collecting (Lead), Data curation (Supporting), Visualization (Equal), Writing original draft (Supporting).

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