

ASSESSING ZONOTIC POTENTIAL: A STUDY ON COMMUNITY ACCESS TO NATURAL RESOURCES IN SEBANGAU NATIONAL PARK, INDONESIA

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ASSESSING ZONOTIC POTENTIAL: A STUDY ON COMMUNITY ACCESS TO NATURAL RESOURCES IN SEBANGAU NATIONAL PARK, INDONESIA. The community surrounding Sebangau National Park (SNP) play a key role in comprehending the epidemiological triad. Peat forests have experienced illegal logging and concessions practises from the early 1970s to 2005. The disturbed forest habitat offers the perfect setting for the inter-species transmission of pathogenic agents. The purpose of this study was to identify any possible zoonotic concerns based on the typical community activities across SNP. Community access data were collected using questionnaires and interview in Kereng Bangkirai (Sebangau River), Asem Kumbang, Baun Bango, Tumbang Ronen, Jahanjang, and Karuing (Katingan River) as the representatives' villages. These settlements are close to the locations used for field sampling (n:102 individuals). The prediction model was developed using CART® Classification for categorical data using MINITAB v. 20.3. We discovered that the model categorised five out of seven factors as important factors. The number of days spent becomes the most crucial predictor (100%), followed by access (95.3%), mode of stay (42.1%), followed by activities (16.8%) and defecation (8.3%), respectively. It was concluded that the longer and deeper they accessed the natural resources; the higher the zoonotic potential would be. The Indonesian Government has established a wildlife health information system, referred to as SehatSatLi, which is designed to protect wildlife genetic resources and reduce the likelihood of zoonotic diseases emerging. It is recommended that stakeholders at all level engaged in coordination, collaboration, and communication as a preventive strategy to inhibit the possible transmission of zoonotic diseases between wildlife and humans, vice versa.

Keywords: Epidemiology, zoonotic, human-wildlife interface, community, classification and regression tree (CART®)

MENILAI POTENSI ZONOSIS: STUDI TENTANG AKSES MASYARAKAT TERHADAP SUMBER DAYA ALAM DI TAMAN NASIONAL SEBANGAU, INDONESIA. Masyarakat di sekitar Taman Nasional Sebangau (TNS) merupakan kunci di dalam memahami segitiga epidemiologis. Hutan gambut di Sebangau telah mengalami praktik penebangan liar dan konsesi penebangan dari awal 1970-an hingga tahun 2005. Hal tersebut merupakan kondisi yang ideal terhadap transmisi agen patogen antar spesies. Tujuan penelitian adalah untuk mengidentifikasi kemungkinan masalah zoonosis berdasarkan kegiatan masyarakat di beberapa desa yang berbatasan dengan TNS. Data akses masyarakat dikumpulkan menggunakan kuesioner dan wawancara di desa yakni Kereng Bangkirai (Sungai Sebangau), Asem Kumbang, Baun Bango, Tumbang Ronen, Jahanjang, dan Karuing (Sungai Katingan). Permukiman ini dekat dengan lokasi yang digunakan untuk pengambilan sampel lapangan (n:102 individu). Konstruksi model prediksi menggunakan *Pohon Klasifikasi Classification and Regression Tree (CART®)* untuk data kategorik menggunakan MINITAB v. 20.3 (64-Bit). Hasil menunjukkan bahwa model mengkategorikan lima dari tujuh prediktor sebagai faktor penting. Jumlah hari

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yang dihabiskan menjadi prediktor paling penting (100%), diikuti oleh akses (81,8%), mode menginap (36,3%), aktivitas (15,5%), dan sanitasi (4%) masing-masing. Semakin lama dan jauh akses masyarakat terhadap sumber daya alam; semakin tinggi potensi zoonosisnya. Pemerintah Indonesia telah meluncurkan sistem informasi kesehatan satwa liar, SehatSatLi, sebagai upaya perlindungan terhadap materi genetik satwa liar dan pencegahan terhadap potensi zoonosis yang ditimbulkan. Kami merekomendasikan koordinasi, kolaborasi dan komunikasi dari pelbagai pihak sebagai upaya pencegahan potensi zoonosis dari satwa liar ke manusia dan sebaliknya.

Kata kunci: Epidemiologi, zoonosis, antarmuka manusia-satwaluar, masyarakat, classification and regression tree (CART®)

I. INTRODUCTION

Sebangau Forest experienced logging concessions during the 1970–2000 period. Then, most forest areas were affected by illegal logging until early 2005, before the government took law enforcement actions. Both logging practices have resulted in the loss and fragmentation of Sebangau, one of the strongholds for orangutan habitat in the tropical lowland peat forest ecosystem. The estimated orangutan population in Sebangau (513,500 ha) in 2002–2003 was 6919 individuals (Morrogh-Bernard et al., 2003). Then, in 2014–2015, a population of 5825 individuals in 486,800 ha was discovered using the same nest count technique (Utami-Atmoko et al., 2017). These numbers indicate a population loss of 15.6%.

During illegal logging practices, many canals have been dug. This was a fast and cheap method to transport logs from the forest to the river. However, canals accelerated peat drainage, lost their capability to maintain the water table and became susceptible to forest fires. The estimated 44,607 ha of peatland burned in Sebangau National Park between 2000 and 2012 (RSS GmBH, 2019). Additionally, these canals will become community access points to the forest interior afterward. There are at least three categories regarding high disturbance over the Sebangau peat ecosystem (Husson & Morrogh-Bernard, 2004) which are: 1) forest near the ex-logging camp, through tree removal for camp materials; 2) forest near the settlement and major rivers; related to fast removal of timber species and frequent return visits to log secondary species, and 3) Forest

containing a high proportion of commercially valuable individuals; by means that almost every canopy tree is removed and secondary damage is extensive.

The fragmentation of forests has shifted the interactions between intra and inter-species in the area. As a result of being exposed to different factors outside the forest fragment, and due to the edge effects (Fagan et al., 1999; Foley et al., 2005; Murcia, 1995), the orangutan is easily exposed to the transmission of intestinal parasites from humans and other species, and vice-versa. The disturbed forest habitat provides ideal conditions for inter-species intestinal parasite transmission (Gillespie et al., 2005; Gillespie & Chapman, 2008; Martínez-Mota et al., 2017; Mul et al., 2007). Aside from logging and forest fires, little is known about the impact on community activity and access to natural resources for both orangutans and humans, and vice versa, especially for inter-species infectious diseases and parasite transmission, termed zoonotic diseases.

Research has revealed that logging activities have created a patchy mosaic, leading to the so-called compression effect (Cheyne et al., 2018; Husson & Morrogh-Bernard, 2004). These are ideal conditions for inter-species parasite transmission (Gillespie et al., 2008; Mul et al., 2007). Sources of parasite transmission in great apes were tourists, researchers, and the local community (Woodford et al., 2002), and orangutan releases (Kilbourn et al., 2003). The impact of transmission of intestinal parasites from humans to one of the great apes, Chimpanzee populations (*Pan troglodytes ellioti*)

was found in Western Cameroon and Nigeria (Fotang et al., 2021). Another studies(Gómez et al., 2013; Medkour et al., 2021) reported the spread of intestinal parasites to humans by populations of gorillas (*Gorilla gorilla*), chimpanzees (*Pan troglodytes*), bonobos (*Pan paniscus*). This showcases on how the pathogen transmission are reciprocal, especially among great apes.

So far there have been no reported deaths of orangutans in their natural habitat. However, at Orangutan Rehabilitation Centre Bahorok, North Sumaterera, studies have reported eight orangutan death cases. The infections were caused by the parasite *Mammomonogamus* spp. (Foitová et al., 2008; Lowenstine et al., 2018). Protozoa (such as *Entamoeba*, *Endolimax*, *Iodamoeba*, *Balantidium*, and *Giardia*) and nematodes (such as *Strongyloides*, *Trichuris*, *Ascaris*, *Enterobius*, *Trichostrongylus*, and hookworms) have been found in free-ranging and semi-captive Bornean orangutans(Labes et al., 2010; Nurcahyo et al., 2017; Philippa & Dench, 2018). Hence, we focus on examining zoonotic potentials through various human activities, their implications and recommendations towards biodiversity conservation in Sebangau National Park.

II. MATERIAL AND METHOD

A. Study Site/Location

A socio-questionnaire community access data collection method was used in Kereng Bangkirai (KB) the north-eastern part of the Sebangau National Park (SNP), the only adjacent village in Sebangau River. The representatives for Katingan River are Asem Kumbang (AK), Baun Bango (BB), Tumbang Ronen (TR), Jahanjang (JHJ) and Baun Bango (BB), lying in the western part of the park (Figure 1).

There were two considerations in determining villages' choices. First, Kereng Bangkirai is the only village neighboring ex. Setia Alam Jaya logging concession company is now known as the Natural Peat Laboratory, Centre for Information and Management of Tropical

Peatland (CIMTROP). Other remaining villages are adjacent to the Punggualas, the representatives of the logged-over forest, hit by illegal logging. The Sebangau National Park (SNP) has appointed this area as one of the eco-tourism sites, observing wildlife becoming the main attraction. Both areas are active orangutan and other wildlife study sites (Utami-Atmoko et al., 2017).

Since many of the communities surrounding the SNP have been involved in illegal logging practices in the past, we are aware that the populations are considered a hidden population. As a result, we used respondent-driven sampling (RDS), which is a type of non-probability sampling approach (Heckathorn, 1997; McCreech et al., 2013). It begins with a convenience sample of initial subjects, determined accidentally within each village. A free prior consent is signed if the subject agrees to be involved. Otherwise, there are no further discussion. Persons who agree will refer to another subject within their network. This means that not all the subjects are recommended to other persons not involved in specific activities.

A total of 102 individuals, who came from various occupations agreed to fill out the questionnaire. They are willing to share their daily activity and, with no hesitation, respond to any questions. With some adjustment, we used inclusion and exclusion criteria(Panda & Gunawan, 2018) regarding the study objectives. The inclusion criteria are as follows:

1. Person originated from the above-mentioned village and specifically willing to show the ID; notes: the persons are able to recall their experiences during logging activities (between 2000 and 2005)
2. Person actively conducts their activities in and out of the traditional zone of the SNP National Park. For this, the age range should be between 19 and 70 years old.
3. A Person can speak and write Bahasa; speaking in Dayak or Banjar Language is not an issue for those who cannot.

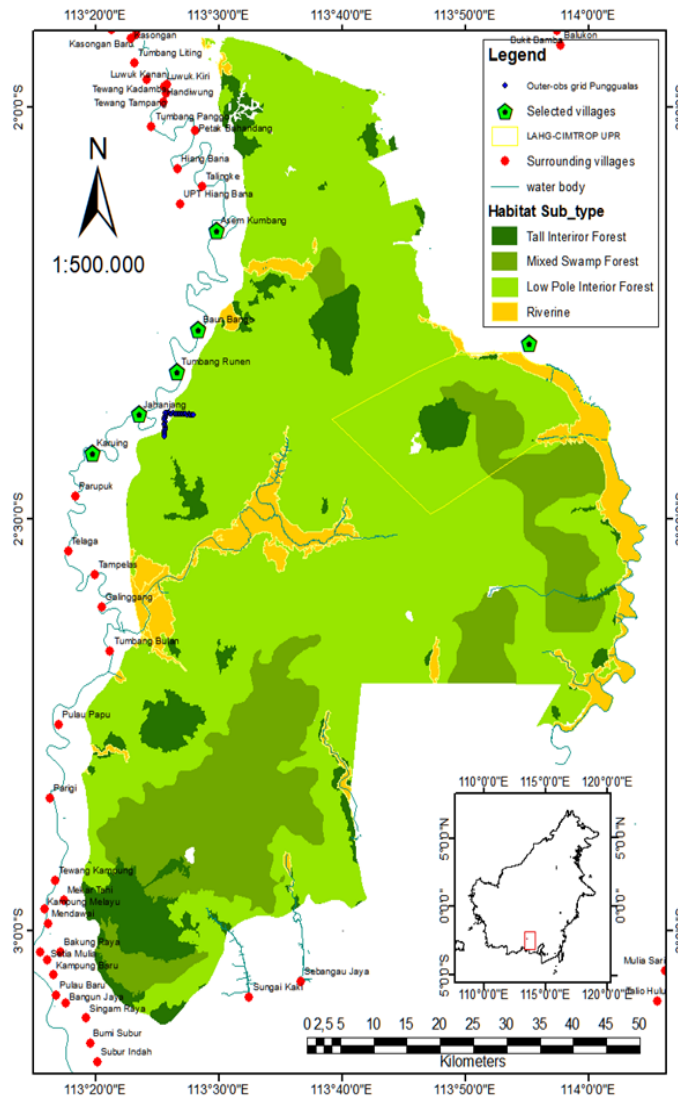


Figure 1. Map of the study area in targeted villages adjacent to Sebangau National Park.

4. Person willing to sign the Free Prior and Inform Consent (FPIC) form.

As for exclusion criteria, the participants are:

1. Not holding any positions in their villages, such as structural organization in the village office (so-called Perangkat Desa or Badan Perwakilan Desa – BPD)
2. Not a civil servant (Teacher, Nurses, Police, and Army).

B. Methods

The study was conducted from 01 February – May 2022. We used a validated questionnaire (Panda & Gunawan, 2018),

with some adjustments, on seven predictors, specifically as follows:

1. collector community activities, BRD: Bird hunt (for sale), FW: collect fire woods, GHR: collect gaharu, GEM: Gemor (*Alseodaphne coriocea*), JEL: Jelutong (*Dyera polyphylla*), FISH: fishing, GUI: Tourists Guide, HUN: Hunting, LOG: illegal logging, MED PLAN: medicinal plant and PTRL: Forest Ranger.
2. their access in distance: long; >5 km; med: 1-5 km; short: <1 km;
3. Number of days spent: long: > 3 days, med: 1-3 days, and short: <1 day;

4. mode of stay: flying camp, a roof over the boat, making hut, and other (morning – afternoon);
5. their sanitation mechanism during stayed in the forests: making holes, in the river/tributaries/canals, and others;
6. encounters with orangutan during activity, yes, no, and occasionally; and
7. mechanism for hindering or confronting the orangutan data: avoid and carry on the activities.

Along with those variables, another four (4) factors for data characteristics were also provided: respondents’ villages, ethnicity, religions and age distribution.

C. Analysis

Respondents’ characteristics and predictors, were summarized using RStudio 4.2.3, package ‘gtsummary’ and ‘huxtable’ library (R Core Team, 2022). Pearson’s chi square test (χ^2) were applied to categorical data, and Kruskal-Wallis test for continuous data, expressed as p-value. The Bonferroni correction for multiple testing, or adjusted p-value, is expressed as q-value. These statistical tests were used to examine the distribution frequency observed in sample is consistent with normal distribution. Classification and Regression Tree (CART)® Classification is a predictive modelling module that determines the following: 1) ideal classification tree, 2) relative variable importance, and 3) Receiver Operator Characteristic (ROC) Curve. Seven (7) predictors are included in this analysis. Statistical analyses were performed using Minitab® 20.3.

III. RESULT AND DISCUSSION

A. Result

Respondent characteristics – A total of 102 respondents agreed to participate as information sources. All questionnaires’ data have been analysed; thus, below are the results summary. Table 1 describes respondents’ characteristics by distance travelled (km) from their villages to the interior forests. The age distribution by their access apparently is not normally distributed (p-value: 0.4). The samples observed did not draw the actual age distribution in real population. However, given activities require physical activity, it reflects the age median ranging from 42 to 44 years by distance travelled.

Table 1 describes the activities that penetrates deeper (> 5 km) into the interior was fishing (32%), collecting gaharu *Gonystylus bancanus* (22%), and tourist guide (20%) out of 50 respondents. Furthermore, other activities such as logging, collecting raw material medicinal plants, gemor (*Alseodaphne coriocea* - raw materials for anti-mosquito products) and jelutong (*Dyera polyphylla* – raw material for chewing gum) latex were relatively had low percentage (<10%).

As the main activity, we observed that fisheries play a significant role in access and duration. It travels up to > 5 km travel using a small boat, through small tributaries or ex-logging channels, especially in wet seasons, in just one day. While in dry seasons, when water is insufficient to support back andforth travel, many local fishermen have made semi-permanent huts near fishing areas. This

Table 1. Subjects’ characteristics among targeted villages per access (distance travelled from village to the interior forest)

Characteristic	Deep (> 5 km); N = 50 ¹	Edge (<1 km); N = 28 ¹	Mid (1-5 km); N = 24 ¹	p-value ²	q-value ³
Age	43 (37, 50)	42 (34, 47)	44 (36, 51)	0,4	>0.9
Origins					
Asem Kumbang	11 (22%)	2 (7.1%)	0 (0%)		
Baun Bango	13 (26%)	3 (11%)	2 (8.3%)		
Jahanjang	1 (2.0%)	3 (11%)	4 (17%)		

Table 1. Continued

Characteristic	Deep (> 5 km); N = 50 ¹	Edge (<1 km); N = 28 ¹	Mid (1-5 km); N = 24 ¹	p-value ²	q-value ³
Karuing	11 (22%)	12 (43%)	6 (25%)		
Kereng Bangkirai	10 (20%)	3 (11%)	9 (38%)		
Tumbang Ronen	4 (8.0%)	5 (18%)	3 (12%)		
Activities					
Bird for sale	2 (4.0%)	0 (0%)	0 (0%)		
Firewood	3 (6.0%)	2 (7.1%)	2 (8.3%)		
Fishing	16 (32%)	13 (46%)	8 (33%)		
Gaharu (<i>Gonystylus bancanus</i>) collector	11 (22%)	6 (21%)	1 (4.2%)		
Gemor (<i>Alseodaphne coriacea</i>) bark collector	2 (4.0%)	0 (0%)	0 (0%)		
Guide	10 (20%)	3 (11%)	5 (21%)		
Hunting	3 (6.0%)	0 (0%)	0 (0%)		
Jelutong (<i>Dyera polyphylla</i>) sap collector	0 (0%)	0 (0%)	1 (4.2%)		
Logging	3 (6.0%)	0 (0%)	4 (17%)		
Medicinal plant	0 (0%)	3 (11%)	3 (12%)		
Ranger	0 (0%)	1 (3.6%)	0 (0%)		
No_of days				<0.001	<0.001
Long (>5 days)	24 (48%)	1 (3.6%)	9 (38%)		
Mid (1 – 5 days)	20 (40%)	4 (14%)	3 (12%)		
Short (< 1 day)	6 (12%)	23 (82%)	12 (50%)		
Mode of stay				<0.001	0,006
Flying camp	6 (12%)	4 (14%)	6 (25%)		
Making hut	38 (76%)	9 (32%)	12 (50%)		
roof on boat	2 (4.0%)	5 (18%)	4 (17%)		
others	4 (8.0%)	10 (36%)	2 (8.3%)		
Defecation at				0,015	0,1
(Making) hole	1 (2.0%)	1 (3.6%)	0 (0%)		
River/canals	48 (96%)	22 (79%)	24 (100%)		
others	1 (2.0%)	5 (18%)	0 (0%)		
Encounter w. orangutan				0,067	0,5
Yes	30 (60%)	9 (32%)	11 (46%)		
No	1 (2.0%)	0 (0%)	1 (4.2%)		
Occasional	19 (38%)	19 (68%)	12 (50%)		
Responds				0,5	>0.9
Away	26 (52%)	13 (46%)	9 (38%)		
Keep on	24 (48%)	15 (54%)	15 (62%)		
Potent				<0.001	<0.001
high	50 (100%)	5 (18%)	15 (62%)		
low	0 (0%)	23 (82%)	9 (38%)		

¹Median (IQR); n (%)

²Kruskal-Wallis rank sum test; Pearson's Chi-squared test; Fisher's exact test

³Bonferroni correction for multiple testing

was suggested that the sanitation mode was inadequate, by means of defecation in the river or tributaries or logging channels. Table 1 shows most of the defecation in the river/canals, either in long or short distances travelled.

Quantifying such predictors requires a multivariate approach. This was made possible using classification trees, which have the advantage to runs, either small or big datasets. Classification trees use an iterative algorithm, and select the training and test datasets. The objective is to find the best binary splits to construct the classification trees. As mentioned in the method section, seven (7) predictors are involved in the analysis.

The confusion matrix has revealed that the model can accurately predict proper classification. Moreover, from the model been

constructed, false-positive (type I error) was low for both training (4.3%) and test (4.3%) datasets. The model provided further notice: : the count of misclassification in the training (4.3%) and test (4.3%) datasets. The receiver operating characteristic (ROC) curve had supported this claim. As a rule of thumb, the more ROC curve away from the linear line, the more accurate the model was constructed. This means that the sensitivity of the constructed model was adequate. Furthermore, the false-positive rate or likelihood type-I error produced was very low, and given the area under the curve (AOC) was 0.9786 (training) and 0.9491 (test).

For the above classification, a tree was chosen as an optimal tree. An algorithm, iteratively splits nodes based on a confusion matrix (Table 2).

Table 2. The confusion and misclassification matrix for training and test datasets derived from seven predictors involved in the CART® analysis

Actual Class	Count	Predicted class (Training)			Predicted class (Test)		
		low	high	% Correct	low	high	% Correct
low (Event)	32	32	0	100.0	32	0	100.0
high	70	3	67	95.7	3	67	95.7
All	102	35	67	97.1	35	67	97.1
Statistics				Training (%)	Test (%)		
True positive rate (sensitivity or power)				100.0	100.0		
False positive rate (type I error)				4.3	4.3		
False negative rate (type II error)				0.0	0.0		
True negative rate (specificity)				95.7	95.7		

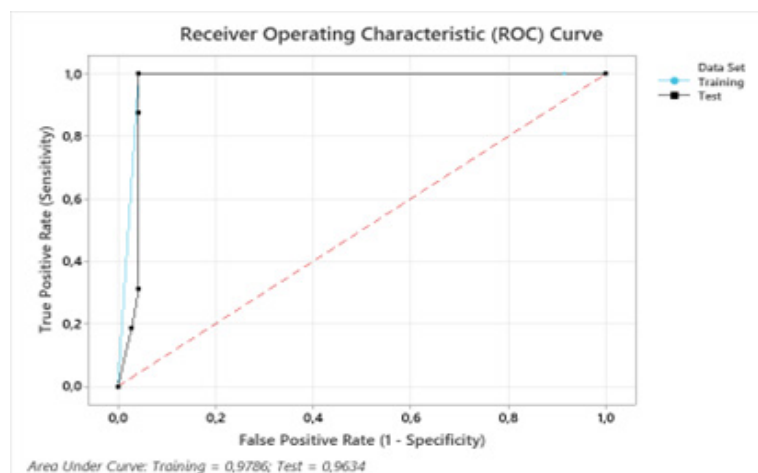


Figure 2. Receiver Operating Characteristic (ROC) curve for training and test data set, on which classification tree model have been constructed



Figure 3. The classification trees indicated the high potential from variable number of days (terminal node 1) and variable access (terminal node2)

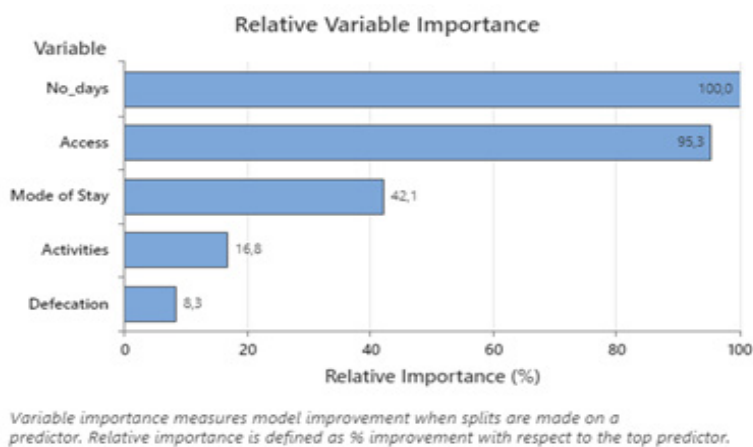


Figure 4. Relative variable importance (RIV) derived from the model

As the most relevant predictor, the variable no of days was classified to the right side, whereas long and mid categories (n: 61) were grouped as high. This is turn into a termination node. In contrast, a short day, classified to the left (n: 41), grouped as low. However, as revealed by the confusion matrix, the high event counted for 22%, within the particular node. Access, as a variable chosen by the model, is split to the right side to yield a 100% high event, following

the node termination. On other hand, on the left side, the low event has a count (n:32). Again, the high event accounted for 8,6%, on this particular node.

Finally, the model provided the relative variable importance (RIV) which were no of days (100%), access (95.3%), mode of stay (42.1%), followed by activities (16.8%) and defecation (8.3%), respectively. These variables also reflected in Pearson’s chi square (p-value:

<0.001), except for the activities and defecation (Table 1).

B. Discussion

Our perspectives construct several arguments for the research findings in the study area. As the main activity throughout the community surrounding Sebangau National Park, fishing plays a significant role in both the protein content of the fish and its economic value. The details of common community fishing practices and the trap equipment's dimensions and mesh size, especially in the Sebangau River, have been reported (Thornton et al., 2018) Several fish trap methods are available; however, the choice must be in line with conservation best practises. The authors imply that the fishing practises are intensive and can be destructive to the fish habitat. The traps used indeed have the advantages regarding the selectivity of fish species, depending on the mesh size. However, the trap placements are not only along the riversides, but also into the interior forest, on

which fisherman's hut being constructed near to the fishing areas.

Non-timber forest products, known for their aromatic fragrance, so-called gaharu, were mainly produced by the family Thymelaeaceae, especially *Aquilaria beccariana* van Tiegh and *Aquilaria filaria* (Oken.) Merr (Giesen, 2015; Paoli et al., 2001; Sitepu et al., 2011). It is harvested from the fungus-infected tree from the *Aquilaria* genus. However, this study has found and witnessed, that villagers (mostly from Karuing) were returning to the forest, collecting gaharu. In contrast, different methods. They brought a 1,20 m long iron stick, and push it down to the peat surface. They were familiar with a particular sound, as the stick hit gaharu beneath the peat surface. Suspected wood, then dig and lifted out of the surface. Returning to the village and weighted at the buyer, and bring the money home. Its aromatic essence was economically in raw materials and crafted as the bracelet and occasionally, a tasbih.



Figure 5. The flow-process in pseudo-gaharu starting from collect (a), processing raw-materials (b-d) and a tasbih as one of the final products (e); Source: Anonymous respondent, Karuing Village.

The products are coming from *Gonystylus bancanus* (Miq.) Kurz, of Thymelaeaceae. The wood is expensive and is the most sought-after during logging concessions in the Sebangau ecosystem. Verification has been made for a product claimed as gaharu (Nordahlia & Lim, 2017) and they concluded a product other than the plant genus *Aquilaria*, is called *pseudo-gaharu*. Although it has an aromatic, wood mechanical structure is not similar to the actual gaharu tree, *Aquilaria beccariana* van Tiegh and *Aquilaria filaria* (Oken.) Merr.

Pseudo-gaharu collecting activities, contribute to the orangutan ranging pattern, before and after COVID-19 Pandemic. The so-called compression effect has occurred in the orangutan as they are exposed to the disturbance in a portion of their range, e.g., mostly using those parts that have not been logged or so-called mosaic, and begin to use their home range differently. Furthermore, the study result implies that the flooding event during year 2021, followed by the pseudo-gaharu search activities in Punggualas, contributes to this high prevalence of *Ascaris lumbricoides* in all orangutan faecal samples collected from Punggualas forest (Panda et al., 2023) habitat.

As for hunting, although very little documented in this study, the hunting is still preserved. The villagers were often accompanied by their dogs, the so-called pig-hunting dog, Dayak Ngaju, one of the biggest tribes in Central Kalimantan, termed these activities as "Mandup". The study found that these dogs were at risk with regards to infectious diseases such as Leptospirosis, in the north of Queensland, Australia, and canine-heartworm infection, in the eastern part of Australia (Orr et al., 2020, 2022). On the contrary, the African swine fever was also taken into considerations, as showcase in North Sumatera (Dharmayanti et al., 2021; Primatika et al., 2022). No study was conducted on Sebangau orangutan regarding such infectious diseases in the Sebangau wildlife.

In the case of birds for sale, especially most of the Columbiformes Order, the pigeons. According to the respondents, the most

wanted are the Passeriformes, the songbirds as *Chloropsis sonnerati* and *Terpsiphone paradisi*. There is also little or no study ever conducted on Sebangau Aves regarding such infectious diseases. In case of bird hunting there was strong evidence for zoonotic, Australia cases. The avian metapneumoviruses; AMPV and human metapneumoviruses; HMPV were closely related viruses with a similar genomic organization and cause respiratory tract illnesses in birds and humans. Reviewed has suggested that HMPVs have evolved from AMPVs' (Jesse et al., 2022).

As for encounters with the orangutan and how the responses were given, implies that they just do not want to kill orangutans. They stated that the orangutans are like humans. This was perhaps, true in the Sebangau case. However, the study found that in Kalimantan, the killing was driven by the way villagers saw orangutans as food sources. Others have mentioned that killing is a self-defence mechanism (Davis et al., 2013; Meijaard et al., 2011). This suggested that consumption of bushmeat, especially non-human primates (NHPs) can be fatal. Many infectious diseases, with confirmed/ probable transmission routes e.g., body fluids, bite/saliva, organ/tissues, faeces/urine, including vector (indirect), have caused an outbreak in the Cameroon-Congo Basin. Such outbreaks as arboviruses, Ebola, monkeypox, HIV 1 & 2, anthrax, salmonellosis, and simian foamy viruses (Hay et al., 2013; Wolfe et al., 2001).

The results have provided a reliable classification model of community access to natural resources in Sebangau National Park. Meaning, that the predictors chosen were sufficiently tangible to describe the model. However, based on our findings, we did not want to accuse or extrapolate about any particular group of people. We wish to identify patterns and trends inherent within our dataset concerning various activities in and surround the SNP. We realize that the SNP authority strives to tighten partnerships with communities. This suggested a potentially serious situation for wildlife conservation that requires

conscientious effort and urgency to avoid an undesirable outcome from wildlife-associated health (Buttke et al., 2015; Cunningham et al., 2017; Milstein et al., 2020).

Management implication - The government of Republic of Indonesia through the Ministry of Environmental and Forestry has launched wildlife health information system, called **Sehat SatLi**. The information system was developed to further enhance regulation operationalization and the government program priorities to protect the Indonesian wildlife, specifically their genetic resources, as stated in Ministerial regulation such as the **Permenlhk-RI No. P.2/MENLHK/SETJEN/KUM.1/1/2018** and the Konservasi Keanekaragaman Hayati Directorates' strategic planning 2020-2024.

The results indicate that the imperative for enhanced communication and collaborative efforts among diverse institutions must be promptly instituted. This collaborative engagement should encompass not only foresters, ecologists, and conservation biologists, but also extend to veterinary practitioners, microbiologists, professionals in community health and community leaders (Ancrenaz et al., 2018; George et al., 2015; Schurer et al., 2016; Wich et al., 2012). Therefore, more field actions are needed to achieve government targets, such as raising community awareness on zoonotic potential originate from wildlife within the human-wildlife interface, specifically in SNP. Furthermore, One-health approach (Lebov et al., 2017; Mackenzie & Jeggo, 2019; Pieracci et al., 2016; Thompson, 2013) offers an advantage through their university network within National (e.g., Indonesia One-Health University network, INDOHUN) and Regional (e.g., South-East Asia One-Health University Network, SEAHOHUN) scales, in bridging the gap and collaboratively comprehending the emerging zoonotic diseases.

IV. CONCLUSION

The longer (> 5 days) and deeper (> 5 km) the community accessed the natural resources in the interior forests, especially for fishing, gaharu collection and as tourist guide, the zoonotic potential is getting higher. A potentially serious situation for wildlife conservation requires collaborative management to avoid undesirable outcomes from wildlife-associated health, one of which is the One-Health approach.

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