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Negative Interactions between Humans and Sumatran Elephants (*Elephas maximus sumatranus)* in the Gunung Raya Landscape, South Ogan Komering Ulu Regency, Indonesia

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Abstract

The Gunung Raya Wildlife Sanctuary is one of the elephant habitats in South Sumatra. Elephant movement from production forests to the sanctuary passes through villages and agricultural lands, triggering human–elephant conflict. However, studies addressing elephant populations, conflict patterns, and the roles and perceptions of communities and government remain limited. This study employed a descriptive design using quantitative and qualitative approaches, including questionnaire surveys, structured interviews, field observations, and Likert scale analysis. The results indicate that elephant habitat in the Gunung Raya landscape has experienced a significant decline in quality and quantity, reducing its carrying capacity. Community assessments showed that 83.33% of elephant incursions into plantations occur annually, while 16.67% occur every six months. The total damaged area reached 42.5 ha, consisting of 71% agricultural land and 29% plantation facilities. Of six perception indicators, five reflected negative perceptions, with an average score of 66.2%. Community responses varied, with 53.33% remaining passive, 30% actively attempting to repel elephants, and 16.66% reporting incidents to authorities. Mitigation measures implemented by village governments include deterrence using loud noises and community safety warnings. Forest managers have applied strategies such as providing deterrent tools, conducting conflict management outreach, collaborating with stakeholders, and herding elephants. This study recommends strengthening multi-stakeholder collaboration among forest managers, local governments, NGOs, and local communities. In addition, community education and habitat restoration are essential to improve habitat quality and reduce future human-elephant conflict.

Keywords: negative human-wildlife conflict, Sumatran elephants, public perceptions and actions

1. Introduction

Elephants are the largest land mammals alive today, requiring very large home ranges. Their home ranges range between 32.4 km^2 and 166.9 km^2 [1,2]. The roaming area of an elephant group in primary forest is twice as large as the roaming area in secondary forest, [3,4]. Elephants are large mammals that play an important ecological role as umbrella and keystone species, maintaining ecosystem balance by dispersing seeds and supporting habitat sustainability and food availability for their populations [5,6]. The population of Sumatran elephants is currently divided into 22 isolated habitat pockets distributed across several provinces, including Aceh, Riau, Jambi, Bengkulu, South Sumatra, and Lampung. In some regions, the number of elephant habitat pockets has declined significantly, and several habitats in Riau are reported to be empty. The decline in elephant populations is largely associated with habitat fragmentation and landscape changes that reduce the availability and connectivity of their natural habitats [7,8].

The Gunung Raya Wildlife Sanctuary in South Ogan Komering Ulu Regency is one of the elephant habitats in South Sumatra. According to the South Sumatra Natural Resources Conservation Agency, there are five elephants living in the Gunung Raya landscape elephant habitat. According to information from the Gunung Raya Conservation Forest Management Unit and the public, elephants frequently cause disturbances, including damage to agricultural crops. Elephants' roaming in the Gunung Raya landscape starts in production forests, extends into other land-use areas and permanent production forests, and terminates in the wildlife sanctuary.

The movement of Sumatran elephants from forests to other use areas through villages and agricultural land triggers negative interactions between elephants and humans [9]. As the research results of Abdullah et al. [6] stated that the types of disturbances caused by negative human-elephant interactions include destroying plantation land and eating planted crops, resulting in major losses. Almost every year elephants destroy settlements and plantations. They often leave their habitat to search for food in residential areas, plantations, and agricultural areas adjacent to these areas, due to disturbances by people in their habitat [10–13]. This problem can cause indirect harm to the community, leading to fear [8]. Meanwhile, research examining the presence of elephants and the negative interactions they have with them in the Gunung Raya landscape is still lacking.

The role and participation of the government have not been identified in detail, and community attitudes and participation have not been clearly recorded. This situation highlights the importance of conducting research to describe the negative interactions between humans and Sumatran elephants (*E. maximus sumatranus*) in the Gunung Raya Landscape. This research aims to (1) identify and characterize elephant-induced damage and the affected assets; (2) examine mitigation measures implemented by the community and local government; and (3) analyze community perceptions of elephant presence.

2. Materials and Methods

This research was a descriptive study using quantitative and qualitative approaches. The sample was determined purposively from the 30 people of Sumber Ringin Village who were directly affected by elephant disturbances or who interact with the presence of elephants. The selected community members who became respondents met the criteria of being the head of the family, father or mother, or someone who has reached adulthood (age >20 years). Information data was collected not only from respondents but also from informants with the criteria of being key community members or government officials who have roles and capacities in elephant disturbance issues or community leaders who understand the problem of elephant disturbances.

The data collection technique used in the study was triangulation technique, which combines questionnaire data, interviews, non-participatory observation and documentation. Questionnaires and interviews were conducted on respondents and informants with structured techniques using interview guides related to the problem of elephant disturbances to humans. Data analysis used descriptive and quantitative data analysis using a Likert scale using 5 scales strongly agree, agree, neutral, disagree and strongly disagree. Interpretation criteria are based on intervals with the lowest distance of 0 – <20% (strongly disagree), 20 – <40% (disagree), 40 – <60% (neutral), 60 – <80% (agree), 80–100% (strongly agree).

3. Results

The results of this study reveal several key aspects of negative human-elephant interactions in Sumber Ringin Village, Buay Pemaca District, particularly focusing on habitat degradation, elephant behavior, and community perceptions. The detailed findings are as follows.

3.1. Elephant Movement

the number of wild elephants disturbing plantations and agricultural land in Sumber Ringin Village ranges from 1 to 5. The elephants in the area originated in the Production Forest, which is currently the Industrial Plantation Forest business permit area, and then entered the non-forest area, namely Sinar Danau Village (104°13'35.904", 4°35'13.200") (104°12'0.277", 4°36'14.400") then to Sumber Ringin Village (104°12'18.367", 4°38'6.000") then to Durian Sembilang Village (104°10'16.367", 4°41'38.400") (104°10'3.605", 4°42'36.000") and then to Sidodadi Village. The movement from Durian Sembilang Village to Sidodai Village (104°6'28.642", 4°43'48.000") passes through a forest area with Limited Production Forest status which finally leads to the Gunung Raya Wildlife Reserve Conservation Forest (Figure 1a). Based on the 2024 land cover map interpretation, elephants predominantly roam in mixed dryland agricultural areas, while also passing through shrubland and secondary dryland forests (Figure 1b).

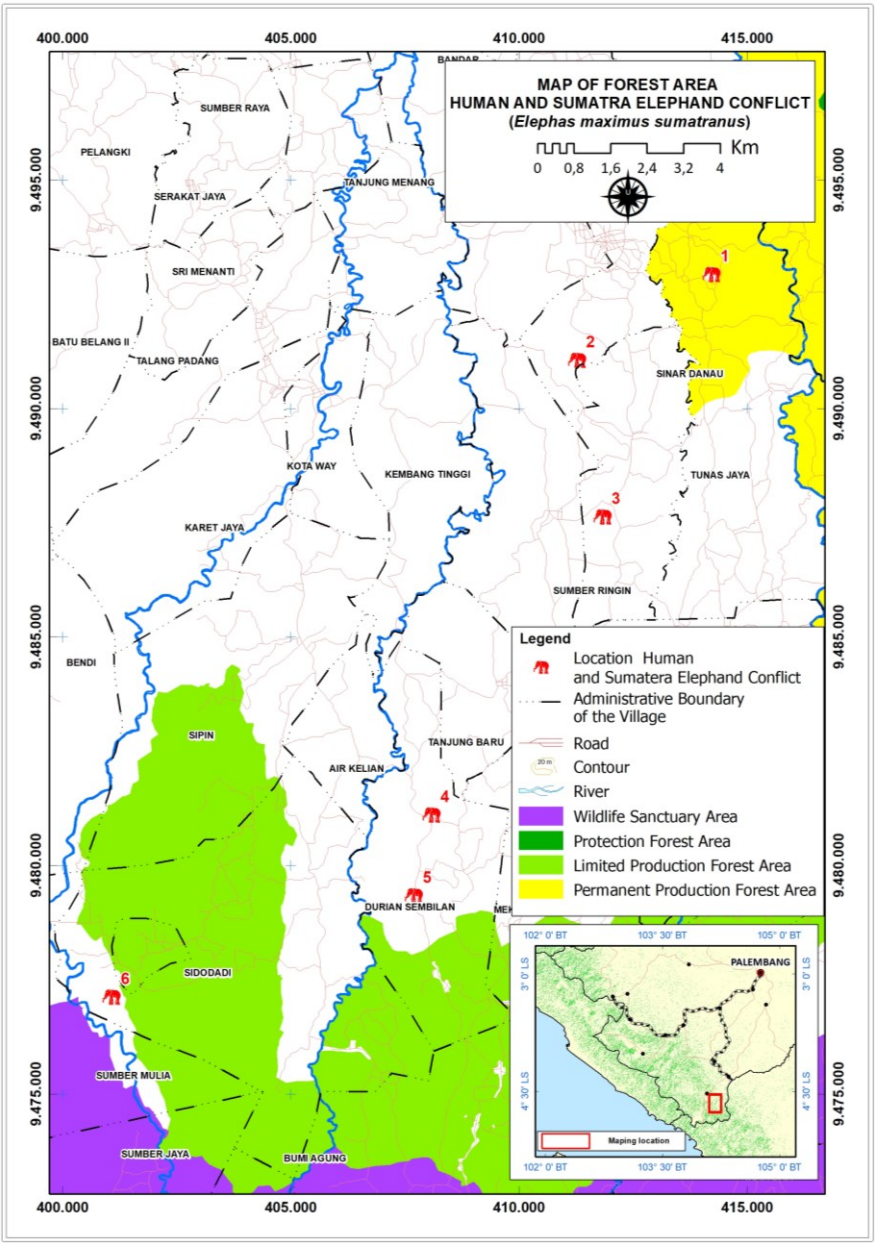

Figure 1a. The direction of elephant roaming based on forest and land functions, starting from the production forest area (yellow) then to the non-forest area (white) continuing to the limited production forest area (light green) and ending in the Gunung Raya Wildlife Reserve conservation forest area (purple) (Source: Department of Forestry).

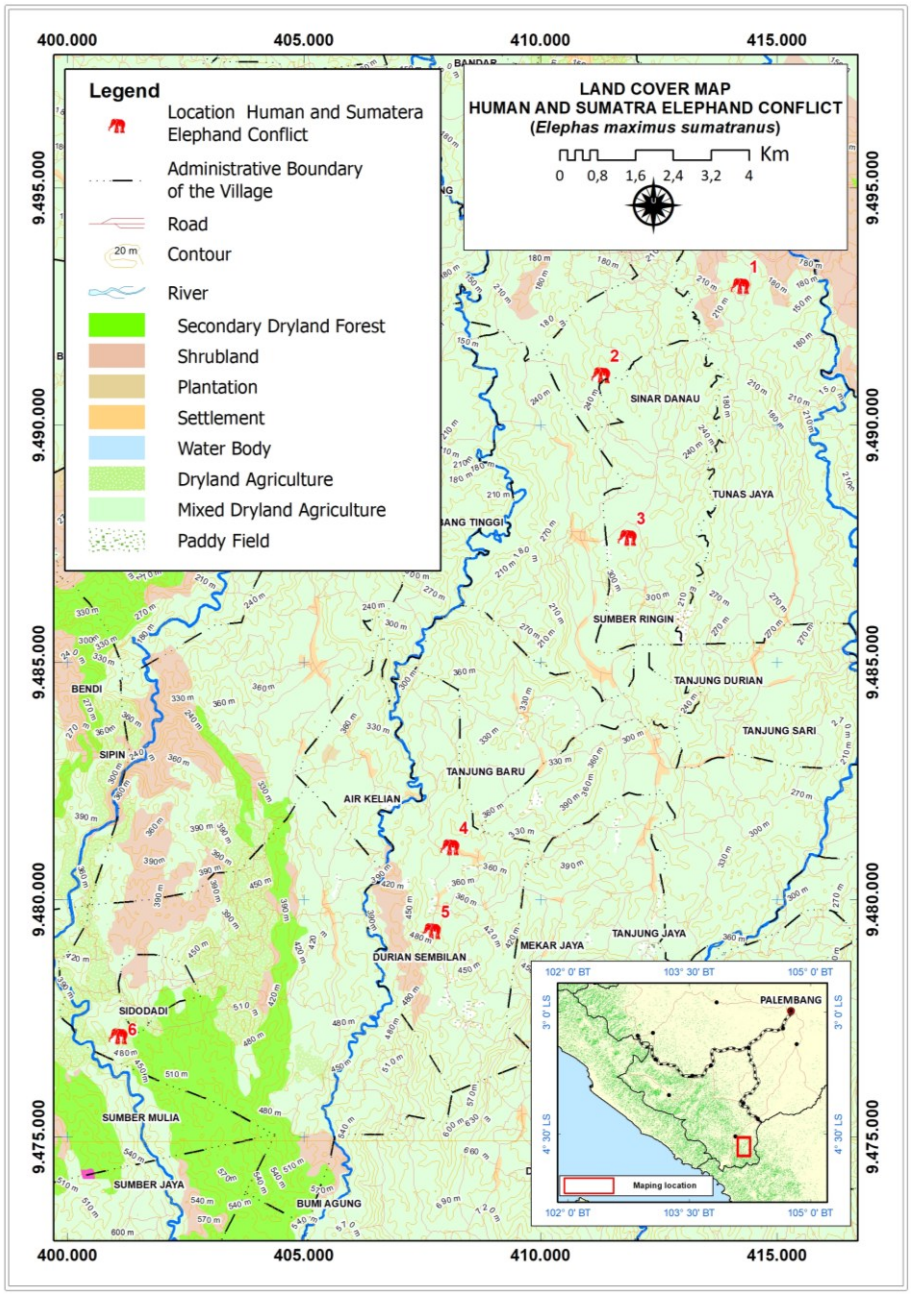

Figure 1b. Elephant roaming direction based on land cover type passes through mixed dryland agricultural land cover (light green), shrub land (pink), dryland secondary forest (green) (Source: Department of Forestry).

3.2. Object of Damage

When wild elephant cross residents' plantations, they don't stay long, simply passing through, but they still damage some of the community's agricultural land. Most residents (83.33%) stated that elephants cross their plantations once a year, while 16.67% reported irregular visits. Elephants damaged two types of land: agricultural land and buildings. The total area of agricultural land damaged reached 42.5 ha, or 71%, while only 29% of the damage to agricultural support buildings occurred. The agricultural commodities damaged included coffee, bananas, corn, rice, and rubber. The parts damaged/eaten of each type varied, with some consuming leaves, fruit, and stems. The area of each commodity and the plant parts damaged/eaten by elephants are presented in Table 1.

Table 1. The area of the plantation for each commodity and the type of commodity damaged/eaten by elephants.

No.	Commodity type	Garden area (ha)	Edible parts		
			Leaves	Fruit	Stems
1	Robusta coffee (*Coffea robusta*)	9	✓		✓
2	Banana (*Musa paradisiaca)*	5	✓	✓	✓
3	Corn (*Zea Mays*)	15	✓	✓	
4	Rice (*Oryza sativa*)	13	✓	✓	
5	Rubber (*Havea bresiliensis)*	0.5	✓		✓

3.2.1. Public Perception of Elephants

The research results show that overall, negative public perceptions outweigh positive ones. Of the six parameters used to determine public attitudes, five indicated negative perceptions and only one indicated positive perceptions (Table 2).

Table 2. Community perception values towards elephants, scale category values and perception category values.

No.	Public opinion	Percentage (%)	Category scale	Category of perception
1	Elephants are dangerous and detrimental animals	89	Strongly agree	Negative
2	Plantation and agricultural areas cultivated by the community must be clear of elephants	85	Strongly agree	Negative
3	All family members of the community do not want elephants in the village area	89	Strongly agree	Negative
4	Elephants are animals that have sacred value.	36	Strongly disagree	Negative
5	Elephants are protected animals	90	Strongly agree	Positive
6	The existence of elephants can be maintained at their current location	32	Don't agree	Negative

3.2.2. Community Interaction and Action Towards Elephant

Community efforts to mitigate human-elephant conflict include driving away elephants. However, some communities remain apathetic and remain silent, while others report the incident to government agencies responsible for elephant management. The diversity of community responses is presented in Table 3.

Table 3. The value of the diversity of community attitudes and actions towards elephant disturbances.

Actions taken	Action value (%)
Just keep quiet because you surrender	53
Report to the authorities	17
Actively carrying out elephant expulsion	30
Amount	100

The Sumber Ringin Village government has implemented human-elephant conflict mitigation efforts, including using elephant-repelling techniques using sounds from gongs and carbide cannons. The village government has also issued warnings to residents affected by elephant disturbances to remain vigilant when operating in their gardens. Furthermore, the effectiveness of the action of driving away elephants by firing carbide cannons was assessed through a public opinion survey by giving a five-point scale value from very ineffective, ineffective, neutral, effective and very effective, the results of which are presented in Figure 2.

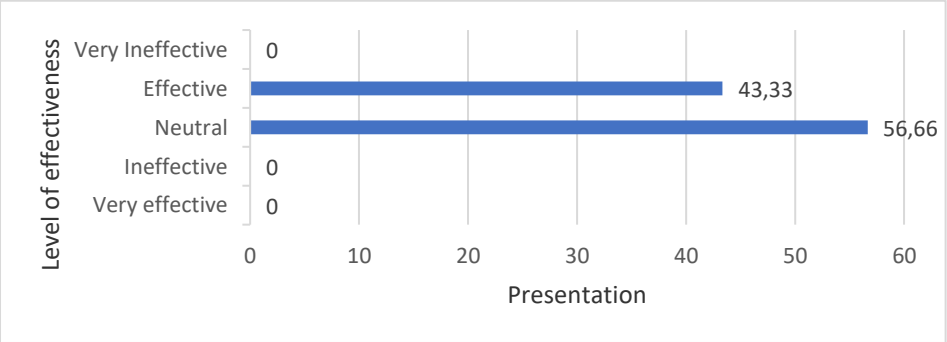

Figure 2. The scale value of the effectiveness of driving away elephants by firing carbide cannons.

4. Discussion

4.1. Decline in the Quality and Quantity of Elephant Habitat

The elephant habitat in the Gunung Raya landscape has experienced a significant decline in both quality and quantity, resulting in reduced carrying capacity to support elephant populations. This decline is mainly caused by the expansion of settlements and plantations, which has led to habitat fragmentation, as also reported by Naha et al. [13]. Natural forest and shrubland cover in the Gunung Raya landscape, which previously functioned as elephant habitat and food sources, has largely been converted into community-managed agricultural land. Approximately 75% of these areas are now used by local communities for cultivation, with coffee representing about 90% of the cultivated commodities, while the remaining areas are planted with bananas and rice or used for buildings and infrastructure.

Similar findings indicate that human-elephant conflict is often triggered by habitat conversion into monoculture plantations, settlements, and infrastructure development, which has resulted in the loss of up to 80–90% of elephant habitats, particularly due to plantation expansion and forestry industry activities [10]. This condition is also driven by population growth, which increases the demand for expanding agricultural land. This is in line with what was expressed by Abdullah [14] that development and land clearing activities cannot be separated from human life, as the world of technology advances and population growth increases rapidly, the need for new land to support human needs, such as food and housing, will become increasingly widespread.

To meet the need for expansion of cultivated land, one of the ways is through the conversion of forest land, as conveyed by Oktavia et al. [15] along with the development of the times and increasing population growth, the conversion of forest land is also increasing, causing fragmentation of animal habitats. The increase in human population directly or indirectly causes human-wildlife conflict in an area [16–19]. Human-elephant conflict has direct impacts on both humans and elephants. Direct impacts for humans include losses caused by crop damage, crop theft, infrastructure and water source damage, livestock disturbance and death, and injuries and deaths [20]. For elephants, these animals can be injured and/or killed by humans [21].

When elephant habitats no longer meet their needs, elephants may leave their natural habitat, disrupting and damaging community plantations. When elephant habitats can no longer adequately meet their needs, elephants may leave their natural habitats and enter community plantation areas, causing disturbances and damage to crops. This condition is caused when elephants try to meet their food needs by eating community plants, especially those the community manages.

The exit of elephants from their natural habitat is also supported by Prasetyo [22] who explains that wild elephants will continue to explore their home range to find food and fulfil their ecological needs. Furthermore, elephants require a large daily food intake. If the food supply in their habitat is insufficient, these wild animals will move in search of food in other areas around their habitat. The average Sumatran elephant weighs 2,378 kg and requires 237.8 kg of food per day [23].

4.2. Elephant Movement and Damaged Objects

According to the land cover map, elephant habitats in the study area consist primarily of scrubland, mixed dryland agriculture, and secondary dryland forest (Figure 2). The dominant land cover type that serves as an elephant crossing is the mixed dryland agriculture type. The mixed dryland agriculture type is land that was originally scrubland, then there was human intervention with heterogeneous planting of cultivated trees, which ultimately associated with cultivated plants and natural plants. This condition characterizes that the forest area has become a community cultivation area, which is actually an elephant crossing that was originally scrubland. The elephant's preference for traversing scrubland is also supported by Rohman et al. [24], which states that elephant roaming in Bukit Barisan Selatan National Park is predominantly in scrubland (41.69%).

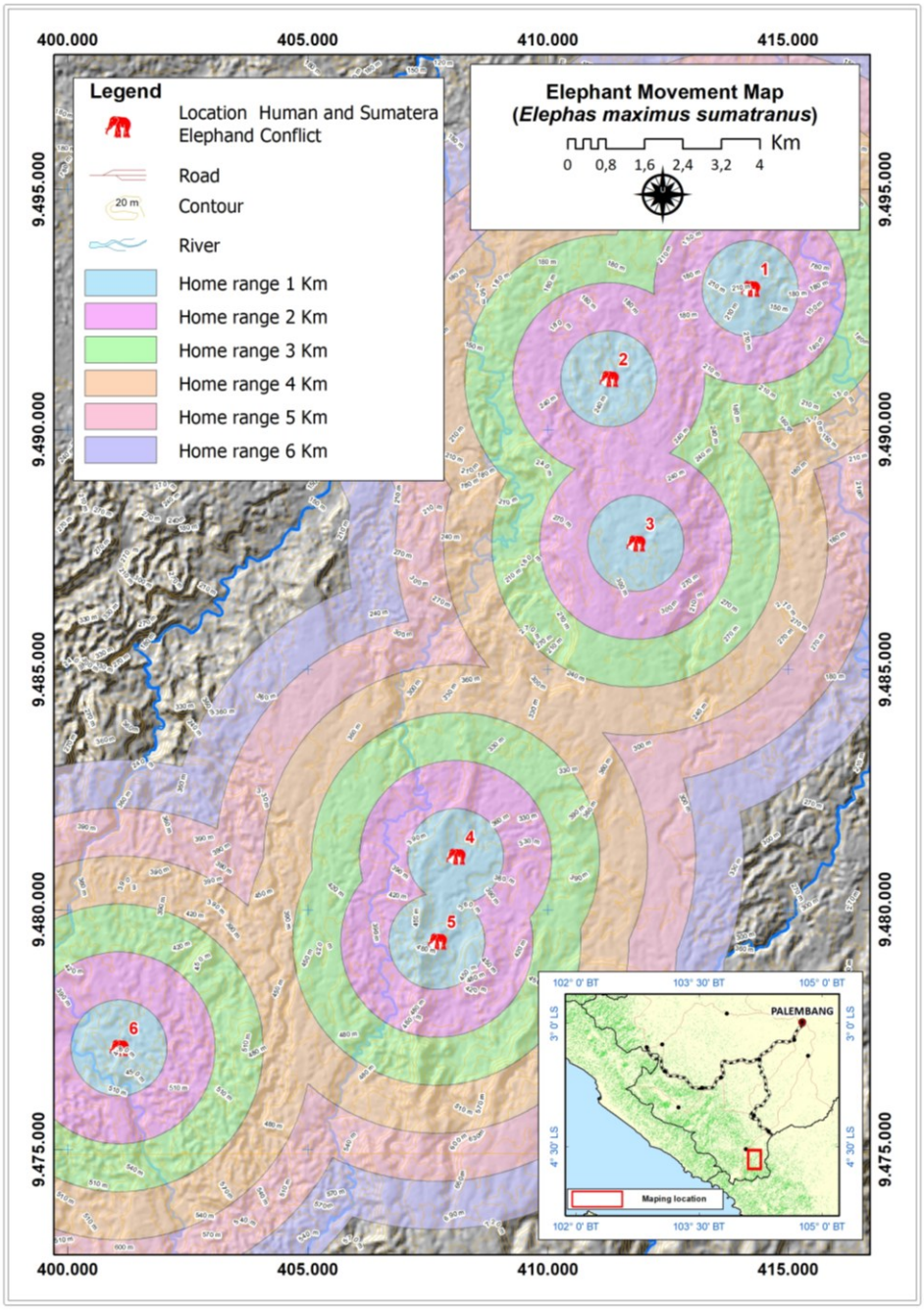

Figure 3. Elephant roaming areas based on elephant movement according to land topography class with roaming areas of 1 km (sea blue), 2 km (purple), 3 km (light green), 4 km (salmon), 5 km (pink) and 6 km (light blue).

According to land contour or topographic class, elephants tend to move on gentle topography at altitudes between 150 and 300 meters above sea level. Only when elephants are in wildlife sanctuaries are altitudes above 300 meters above sea level. The elephant's home range is mapped in roaming areas of 1 km (navy blue), 2 km (purple), 3 km (light green), 4 km (salmon), 5 km (pink) and 6 km (light blue), so that the home range can be mapped as presented in Figure 3. This preference for moving on gentle topography is also supported by the findings of Harahap et al. [25], who reported that human-elephant conflicts occur mostly on gentle slopes (54.17%) and flat areas (31.25%), while steep and moderately steep slopes account for less than 10% of the recorded conflict locations.

This elephant home range is also supported by the opinion Ningrum et al. [9] who stated that the distribution of Sumatran elephant activity tracks is related to land cover type, topographic class, distance from water sources, and distance from settlements. The preference of elephants for forest land cover is also supported by the findings of Harahap et al. [25], which indicate that human-elephant conflicts occur predominantly in forest areas (72.92%), followed by plantations (10.42%) and agricultural land (16.67%).

Based on information from the local community, elephant cross community plantations periodically, generally once a year. Elephant movement routes generally do not move even though conditions have changed, but elephant movements will continue to occur periodically (repeated every certain period), even though they have been cut off by plantation and agricultural land [26]. Furthermore, elephants will travel long distances, even outside their home range, to meet their food, ecological, social, and production needs [27].

This not only causes material damage to plantations within their range but can also lead to human-elephant conflict. The repeated incursion of elephants into agricultural areas disrupts agricultural productivity, resulting in losses for the people of Sumber Ringin Village. When elephant cross community gardens, they damage several objects. Elephants trample crops, damaging them, and when elephants rest (sleep) in agricultural areas, they damage crops. Furthermore, elephants will eat crops planted by farmers to meet their nutritional needs.

Elephants obtain food by knocking down plants and taking young rubber stems [28]. Likewise, Handayani et al. [29] states that banana stems, banana leaves and coconut fronds are the preferred food for elephants. Elephants prefer young leaves or tree shoots because they have high palatability, have high nutritional value and are easily digested compared to bark and roots, thus causing a lot of damage to young rubber stems every time elephants appear [23]. As for coffee plants, they are not eaten but are damaged when elephants pass by. According to Berliani et al. [20] and Pratiwi et al. [30] elephants consume all types of plants in the area, but are very selective in choosing their food.

In addition to destroying crops, elephants also damage agricultural support facilities, namely hut buildings, especially huts located in garden areas that are used by elephants. This incident generally occurs when the hut is abandoned by its owner. According to the community, the purpose of elephants destroying huts is to find salty foods such as salt, rice, and others. This is in accordance with the Resphaty et al. [31], that elephants have salt-lick behaviour, namely the behavior of licking the ground that contains minerals such as Calcium (Ca), Magnesium (Mg), Potassium (K), and other salts. Mineral needs are influenced by several factors, namely reproduction, age, sex, growth rate, and physiological function [32,33]. Elephant behavior like this is supported by the interaction of elephant activities destroying huts. This is shown by the research results that the damaged parts of the cottage building were mostly the kitchen, reaching 42% compared to the stairs and roof, each with 29% damage.

4.3. Public Perception of Elephants

The frequent entry of elephants into agricultural or plantation areas, causing damage to cultivated crops, has led to people having a negative perception of elephants. According to Rianti et al. [34], human attitudes are the result of all kinds of experiences and human interactions with the environment which are manifested in the form of knowledge, attitudes and actions which are included in the perception section. The negative perception

developed because the entire Sumber Ringin Village community had experienced elephant disturbances in their farmland. Meanwhile, the majority of the community work as farmers who tend to be very dependent on the land resources around them to meet their living needs [35].

The significant losses suffered by the elephants affected their economy, including crop failures and the destruction of buildings such as huts. The frequent incursions of elephants into agricultural or plantation areas, causing damage to cultivated crops, have led to a negative perception of elephants in the community. According to Pratiwi [36], communities that frequently experience conflict with wildlife hold negative views of these animals.

Table 2 shows that the community strongly dislikes elephants in their agricultural land. This is demonstrated by statements stating that they want their agricultural land clear of elephants (85%), and that all family members do not want elephants in the village (89%). This attitude is driven by the destruction of much agricultural land and crop failures resulting in losses, which leads the community to believe that elephants should not be around their area. Consequently, the community believes that the presence of elephants provides no benefit.

The community also considers elephants to be dangerous animals because in addition to causing damage to agricultural land, elephants can also cause casualties, due to their large bodies. This is shown by the value of community statements stating that elephants are dangerous and detrimental animals reaching 89%. Therefore, the community wants the government to immediately move/relocate elephants to another location. Community anxiety regarding the presence of elephants also occurs in Tongra Village residents who stated that the presence of wild animals in the forest near the community's plantations is disturbing because these animals often enter and damage crops, reducing agricultural yields and killing some of their livestock [26].

On the other hand, 83% of the public strongly agrees that the Sumatran elephant (*E. maximus sumatranus*) is a protected species due to its dwindling population and the need to save it. Furthermore, from a conservation perspective, the Sumatran elephant (*E. maximus sumatranus*) is an endemic Indonesian species that must be saved. This public perception is relevant to the public's stance that elephants are not being killed, even if they are disruptive and detrimental to the community. This condition is in line with the Utami et al. [37] stated that the community does not hunt elephants because they understand that elephants need to be protected. This indicates a positive public perception of elephants, as evidenced by continued concern for their survival.

The positive perception of the community regarding the existence of elephants indicates that the community in Sumber Ringin Village still has good concern and awareness for Sumatran Elephant conservation. The implementation of this attitude, the community expects the government to save elephants by immediately moving or relocating elephants to other locations with suitable habitats and sufficient food sources or to places where other elephants already live naturally, such as the Way Kambas National Park in Lampung Province or the Padang Sugihan Wildlife Sanctuary in OKI Regency. Regarding community attitudes toward culture and spiritual values, the community strongly disagreed with the perception that elephants are sacred animals to be respected, with a value of 36%. This attitude is supported by Islamic ways of thinking and morals, which are part of the value system that exists in the culture of Muslim communities.

4.4. Community Interaction and Action Towards Elephant

The results of the study, as shown in Table 3, show that 53.33% of the community stated that they remained silent out of resignation. According to the community, elephant conflicts have become commonplace, so they tend to accept them and resort only to minimal eviction measures to prevent further damage to their land. The attitude of the community who are not actively taking action is in line with the research results of Pratiwi et al. [30] which states that the community is confused, on the one hand the community is very disadvantaged economically because groups of elephants damage their crops, but on the other hand the community must comply with the regulations that the state protects

Sumatran elephants. Supported by the consequences of these regulations, the community will be punished if they are proven to have attempted to kill an elephant [38].

A small proportion of the community (16.66%) responded by reporting the incident to the authorities, namely the Village Head and the Natural Resources Conservation Agency (*Balai Konservasi Sumber Daya Alam*/BKSDA). Meanwhile, 30% of the community actively attempted to drive elephants away by firing carbide cannons in groups using their own funds. This response reflects the community's tendency to protect and defend their agricultural land from wild animal disturbances, including elephants. Meanwhile, 30% of the community actively attempted to drive elephants away by firing carbide cannons in groups using their own funds. This response reflects the community's tendency to protect and defend their agricultural land from wild animal disturbances, including elephants, Nuryasin et al. [21] that the community will protect and defend their agricultural land from attacks by wild animals, including elephants.

The interaction that occurs between people and elephants is an interaction that is not mutually beneficial, which is amensalism interaction, namely a relationship between two types of organisms where one inhibits or harms the other [37]. Amensalism occurs when elephants enter and damage and eat agricultural products and also destroy people's huts, so that people become disturbed and uneasy about their presence.

The forest manager of the forest area where the elephants are located is the Gunung Raya Conservation Forest Management Unit (*Kesatuan Pengelolaan Hutan Konservasi*/KPHK). Efforts that the manager has made include (1) Providing assistance with materials and tools for elephant expulsion in the form of carbide cannons and supporting equipment equipped with instructions for use; (2) Socialization of conflict management, fostering an attitude of tolerance and perception, and suggesting choosing types of cultivated plants that elephants do not like; (3) Collaboration with NGOs and private companies in terms of installing GPS Collars on elephants and planting demonstration plots of cultivated plants with types that elephants do not like, such as chilies and lemons; (4) Carrying out elephant herding using tame elephants to expel wild elephants that come close to agricultural areas and community settlements.

Eviction or short-distance drives only provide temporary relief, as elephants tend to return to raiding crops or move on to the next settlement. Another possible approach is for managers to collaborate with the private sector on mitigation measures, such as planting forage crops along their roaming routes [38]. The public considered the use of carbide cannons to be normal (56.66%), and effective (43.33%). However, currently, there is a phenomenon that elephants are no longer afraid of sounds because they have become accustomed to them [39]. Therefore, stronger multi-stakeholder collaboration among forest managers, local governments, NGOs, and local communities is needed to improve the effectiveness of mitigation efforts and reduce human–elephant conflict.

5. Conclusions

Negative interactions between humans and Sumatran elephants in the Gunung Raya Landscape are mainly caused by habitat fragmentation. As a result, elephants often enter community areas and damage plantations as well as supporting facilities. Community assessment of elephant arrivals to plantations: 83.33% arrive annually, and 16.67% every 6 months. The damaged objects are 42.5 ha, or 71% of agricultural land, and 29% of plantation support facilities. Of the 6 community perception indicators, 5 show negative perceptions, with an average of 66.2%. Community attitudes towards elephant disturbances are 53.33% silent and resigned, 30% actively carry out expulsion and 16.66% report to government officials. Actions taken by the village government are to expel them using sounds and appeals to the community to be alert for safety. Actions taken by forest managers include providing assistance with materials and tools for elephant expulsion, socialization of conflict management, collaboration with parties in control and herding elephants.

Author Contributions

LY, **YH**: Conceptualization, Writing - Review & Editing; **H**, **HNS**, **SP, ADK**, **AE**: Methodology, Collecting data, Software, and Investigation; **JH:** Review & Editing.

Conflicts of Interest

There are no conflicts to declare.

Generative AI Writing Statement

The authors confirm that no generative AI or AI-assisted tools were used in the writing or preparation of this manuscript.

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