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The Role of Local Communities in Managing Human-Elephant Conflict in Sumatra: Challenges and Opportunities for Conservation

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Abstract: Human-elephant conflict (HEC) involving the Sumatran elephant (*Elephas maximus sumatranus*) remains a significant threat to biodiversity and the livelihoods of rural communities in Aceh Province, Indonesia. This study aims to explore the role of local communities in managing HEC by assessing their level of participation and identifying related challenges and opportunities for conservation. A descriptive quantitative method was applied using a Likert-scale questionnaire distributed to 100 respondents across five villages in Glumpang Tiga and Sakti subdistricts, Pidie Regency. The study assessed three variables: willingness, ability, and opportunity to participate. The results show that overall community participation was in the high category, with a total score of 2.948. Key challenges included limited knowledge, inadequate institutional support, and economic constraints. Meanwhile, the study identified several opportunities such as strong community commitment to conservation, the existence of local customary institutions, and increasing awareness of the importance of elephant protection. These findings highlight that although barriers persist, there is strong potential for enhancing local participation through targeted, community-based strategies. Strengthening collaboration between communities, government, and conservation actors is essential to support sustainable human-elephant coexistence in Sumatra.

Keywords: Conservation strategy; Human-elephant conflict; Sumatran elephant

Introduction

Human–wildlife conflict has become an increasingly frequent and critical ecological and social issue in tropical regions, particularly in biodiversity-rich countries like Indonesia (Basak et al., 2023). One of the most pressing examples is the conflict between humans and the Sumatran elephant (*Elephas maximus sumatranus*), a subspecies of the Asian elephant currently classified as Critically Endangered by the International Union for Conservation of Nature (Makmur et al., 2024). This conflict typically arises when elephants lose access to their natural habitat due to land conversion for agriculture, infrastructure development, or settlement expansion, forcing them to enter human-dominated areas in search of food and space (Shaffer et al., 2019; Kamdar et al., 2022).

In Aceh Province, northern Sumatra, human–elephant conflict (HEC) has become a persistent and escalating issue. Between 2019 and 2023, the Aceh Natural Resources Conservation Agency (BKSDA) recorded 583 incidents involving wild elephants and rural communities (Fonna et al., 2024). Pidie Regency is one of the most affected regions, with annual cases of crop destruction, property loss, and heightened social tension. Concurrently, the elephant population in Aceh has drastically declined from approximately 800 individuals in 2003 to only 539 in 2020 (Qomariah et al., 2019), signaling a serious threat to the species' survival.

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The impacts of these conflicts are far-reaching, disrupting the livelihoods of local farmers, undermining food security, and fueling resistance to conservation efforts. In some instances, retaliatory actions against elephants have further intensified the ecological crisis. Many rural communities are left to navigate these challenges with minimal institutional support, making sustainable human–elephant coexistence increasingly difficult to achieve (Pereira, 2024).

Various mitigation strategies have been employed, including electric fencing, elephant patrol teams, and early warning systems. However, the effectiveness of such initiatives often diminishes without meaningful and continuous participation from the local communities most directly affected by the conflict. Community participation should be understood not merely as passive attendance in conservation activities, but as an inclusive process that involves willingness, ability, and opportunity to contribute actively to conflict resolution and conservation planning (Pretty, 2018; Gunaryadi & Hedges, 2017).

Importantly, communities living near elephant habitats are not merely victims; they are essential stakeholders with deep traditional knowledge, direct experience, and strong intrinsic motivation to protect their environment. When empowered, these communities can serve as proactive agents of change. Previous studies have shown that community-based approaches can reduce conflict intensity, foster conservation awareness, and promote locally adapted solutions (Maqueda et al., 2022; Matsuura, 2024; Hagen, 2024).

Despite promising opportunities such as social cohesion, local leadership, and strong cultural values, many community-based initiatives remain underutilized due to challenges including limited technical capacity, lack of institutional support, and economic constraints (Butler et al., 2021; Silva et al., 2024; Moraes et al., 2023). Yet, little research has been conducted to systematically assess how local communities participate in HEC mitigation, particularly by evaluating their willingness, ability, and opportunity to engage (Ms et al., 2017).

This study aims to fill this gap by assessing the level of community participation in human-elephant conflict mitigation in Pidie Regency, Aceh Province. It also seeks to identify the key challenges and opportunities that influence such participation. The novelty of this research lies in its focus on mapping participatory variables in real community settings, which has received limited scholarly attention in the context of HEC in Sumatra. The findings are expected to inform the development of inclusive, community-based conservation strategies that are contextually grounded and policy-relevant.

Method

This study applied a descriptive quantitative research method aimed at assessing the role of local communities in managing human-elephant conflict (HEC) in Pidie Regency, Aceh Province, Indonesia. The research was conducted from January to March 2025 in five selected villages with a history of HEC: Lhok Panah, Riweuek, and Barieh (Sakti Subdistrict), and Amud Mesjid and Kumbang Keupula (Glumpang Tiga Subdistrict). These locations were chosen purposively based on conflict intensity reports from the Aceh Natural Resources Conservation Agency (BKSDA) and coordination with Fauna & Flora International (FFI).

Primary data were collected through a structured questionnaire containing 30 Likert-scale items assessing three core variables: willingness, capacity, and opportunity. Each item used a 5-point scale (1 = never to 5 = always). The instrument was based on Keith Davis's participation theory and supported by the Motivation–Opportunity–Ability (MOA) framework, which is commonly applied in community and environmental behavior studies (Agusti & Wibawani, 2023; Hung et al., 2011; Rasoolimanesh et al., 2017; Wang et al., 2020; Maqueda et al., 2022).

This study involved 100 purposively selected respondents from a population of 41,967, using the Slovin formula with a 10% margin of error, a method commonly applied in community-based environmental research (Abdullah & Japisa, 2023). To gain comprehensive insights, participants included both individuals who had experienced human–elephant conflict (HEC) and those who had not (Mekonen, 2020). Instrument validity was assessed using Pearson Product-Moment correlation (Pertiwi et al., 2021), while reliability was measured using Cronbach's Alpha, with $\alpha > 0.60$ considered acceptable for exploratory research (Johnson et al., 2023). Data analysis employed descriptive statistics, including frequency distributions and mean scores, which are standard techniques in social and conservation studies (Smith & Lee, 2022). Community participation scores were interpreted based on the following classification.

Table 1. Research respondents

Participation Category	Mean Score Range
Low	1.00–2.33
Medium	2.34–3.66
High	3.67–5.00

Result and Discussion

This study aims to assess the role of local communities in managing human-elephant conflict (HEC) in Pidie Regency, Aceh Province, Indonesia. The

respondents consisted of 100 individuals from five conflict-prone villages: Lhok Panah, Riweuk, Barieh, Kumbang Keupula, and Amud Mesjid.

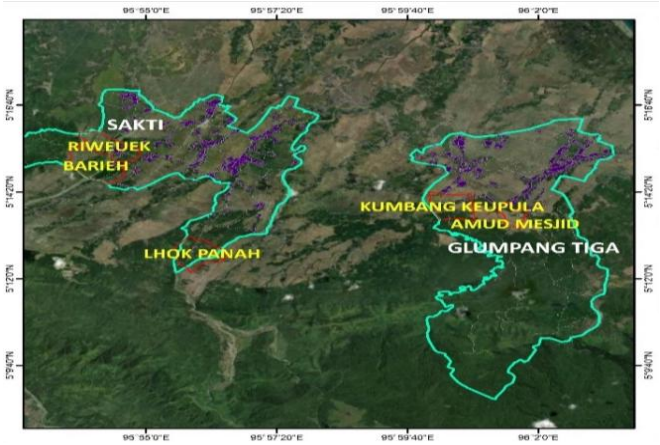

Figure 1. Map of the study area

Instrument validity was tested using the Pearson Product-Moment correlation, and all 30 Likert-scale items were declared valid ($r > 0.1638$). Reliability testing showed Cronbach's Alpha values exceeding 0.60 for each variable: willingness (0.8433), capacity (0.8917), and opportunity (0.9347), indicating good internal consistency. Community participation was assessed using three variables: willingness, capacity, and opportunity. Each was scored on a 5-point Likert scale and categorized into low (1.00–2.33), medium (2.34–3.66), and high (3.67–5.00). The overall analysis produced a comprehensive view of community involvement in HEC mitigation.

The average score for willingness was 3.67, indicating a high level of motivation among respondents. Table 2 details the distribution of responses. Respondents frequently selected often and always highlighting their strong motivation to engage in HEC mitigation. This high willingness is likely shaped by several interconnected factors. First, direct or familial experiences with elephant incursions, such as crop destruction, property damage, or threats to safety, foster a sense of urgency and responsibility among villagers. Second, deeply rooted cultural values in Acehnese society, particularly the spirit of cooperation, encourage collective problem-solving and strengthen the community's resolve to defend their territory. Third, the economic reliance on subsistence farming heightens the desire to protect agricultural livelihoods, especially in areas where elephants frequently encroach. These findings align with studies by Koirala et al. (2022), who emphasize that the frequency of wildlife encounters directly influences public willingness to participate in mitigation.

Several communities have also formed informal patrols and nighttime watch shifts to protect their fields, showing a proactive and necessity-driven stance. Willingness in this context is not merely ethical, but survival-oriented. According to Davis' participation theory (Agusti & Wibawani, 2023), participation increases when stakes are high and benefits are directly felt, conditions that clearly apply in Pidie.

Table 2. Community willingness in HEC mitigation

Item	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)	Total (%)	Mean Score
1	14	23	26	15	22	100	2.92
2	27	48	21	4	0	100	3.98
3	28	40	22	5	5	100	3.81
4	0	20	20	20	40	100	2.20
5	17	55	16	10	2	100	3.75
6	26	56	9	9	0	100	3.99
7	80	20	0	0	0	100	4.80
8	22	62	11	5	0	100	4.01
9	40	20	20	15	5	100	3.75
10	20	40	20	10	10	100	3.50
Average	27	38	17	9	8	100	3.67

The capacity score was slightly higher at 3.72, also categorized as high. Table 3 provides a breakdown of responses. The data demonstrate that community members not only express interest but also possess the relevant knowledge and skills needed to engage in HEC mitigation. Examples of this capacity include the use of traditional elephant deterrents such as bamboo cannons, chili smoke, torch lights, and drum beating. Many villages have also developed informal communication networks, such as using WhatsApp groups or mosque loudspeakers to share real-time information about elephant sightings. The communities have access to and maintain buffer zones planted with crops that elephants tend to avoid, such as chili or citronella, and some have participated in training sessions conducted by NGOs like Fauna & Flora International (FFI) or BKSDA Aceh. These abilities are often passed down through generations, forming a body of localized ecological

knowledge. This aligns with the findings of Chang'a et al. (2016), who demonstrated the effectiveness of chili-based deterrents in human–elephant conflict mitigation (Davies et al., 2020), who emphasized that community-based mitigation efforts are most effective when built upon experiential, place-based knowledge systems.

Table 3. Community capacity in HEC mitigation

Item	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)	Total (%)	Mean Score
1	25	40	20	10	5	100	3.70
2	35	25	30	5	5	100	3.80
3	30	27	28	10	5	100	3.67
4	36	30	20	14	0	100	3.88
5	0	35	24	21	20	100	2.74
6	30	35	15	10	10	100	3.65
7	40	26	16	10	8	100	3.80
8	40	32	10	10	8	100	3.86
9	47	36	17	0	0	100	4.30
10	30	40	15	10	5	100	3.80
Average	31	33	19	10	7	100	3.72

While willingness and capacity were high, opportunity received a mean score of 3.63, placing it in the moderate category (Table 4). Despite strong motivation and skills, community members face significant structural barriers—such as limited inclusion in mitigation programs, exclusion from decision-making processes, and scheduling conflicts due to agricultural duties—that hinder meaningful participation. Mitigation activities are often conducted during peak farming hours, making attendance difficult without sacrificing daily income. Invitations to participate are also frequently extended only to village elites, limiting broader community engagement. These conditions are consistent with research showing that miscommunication and elite capture reduce inclusive participation in conservation programs (Jones et al., 2017; Berkes, 2017; Fischer et al., 2019; Castillo et al., 2021). Furthermore, institutional support plays a critical role in turning motivation into actual engagement, especially when local involvement is not embedded in formal planning structures (Fernandez-Gimenez et al., 2021; Nkhata & Breen, 2018). To improve inclusivity and effectiveness, mitigation programs should adopt adaptive approaches—such as holding activities outside farming hours—and be integrated into community development tools like the RKP-G and APBG.

Table 4. Community opportunity in HEC mitigation

Item	Always (%)	Often (%)	Sometimes (%)	Rarely (%)	Never (%)	Total (%)	Mean Score
1	25	40	20	10	5	100	3.70
2	35	25	30	5	5	100	3.80
3	30	27	28	10	5	100	3.67
4	36	30	20	14	0	100	3.88
5	0	35	24	21	20	100	2.74
6	30	35	15	10	10	100	3.65
7	40	26	16	10	8	100	3.80
8	40	32	10	10	8	100	3.86
9	47	36	17	0	0	100	4.30
10	30	40	15	10	5	100	3.80
Average	31	33	19	10	7	100	3.72

The integrated participation score was calculated by averaging the three variable scores, resulting in an overall mean of 3.67. Table 5 summarizes these results. This composite score confirms that, overall, community participation in HEC mitigation is high. However, the slight lag in opportunity suggests the need for more inclusive and flexible engagement strategies. Practical recommendations include increasing MPKG activities, supporting local patrol initiatives, and ensuring the community has consistent access to information and funding.

Table 5. Overall community participation in HEC mitigation

Variable	Mean Score	Category
Willingness	3.67	High
Capacity	3.72	High
Opportunity	3.63	Medium
Average	3.67	High

These findings support the Motivation–Opportunity–Ability (MOA) framework (Sheil et al., 2022), which posits that effective engagement arises when individuals are motivated, capable, and have enabling environments. The case of Pidie demonstrates that when two of the three factors are strong, community participation is still promising, but full potential is only realized when all elements are aligned.

The findings of this study highlight that willingness to participate in Human-Elephant Conflict (HEC) mitigation among local communities in Pidie is relatively high, with a mean score of 3.67. This elevated level of willingness is not coincidental but reflects a combination of socio-cultural, experiential, and economic motivations. Respondents reported direct or familial experience with elephant-related incidents, including crop destruction, property damage, and personal safety threats. These encounters often result in psychological distress, which over time cultivates a proactive attitude among villagers to prevent future conflicts. Communities who directly experience environmental challenges tend to show higher urgency in participation compared to those who only observe them indirectly (Rinaldi & Fauziah, 2022).

Cultural values embedded in Acehnese society—such as gotong royong (mutual cooperation), peumulia jamee (honoring guests), and rasa malu (collective pride and accountability) strongly motivate community members to engage in efforts that benefit not only themselves but also the wider village. These values shape voluntary actions such as community night patrols, early warning systems using mosque loudspeakers, and traditional deterrents like bamboo cannons or chili smoke. These behavioral expressions of cultural identity demonstrate that conservation efforts are more effective when aligned with local values (Santoso & Hidayat, 2021). Furthermore, because most residents depend economically on farming cocoa, rice, or areca palm, the urgency to protect farmland from elephant incursions becomes an economic necessity. For many, damage from wildlife threatens their only source of income. Similar patterns of economic vulnerability as a driver of community involvement in conservation were also reported in dryland farming communities (Firdaus & Aminah, 2025).

On the other hand, the capacity score was slightly higher (mean = 3.72), which indicates that many villagers are not only willing but also possess practical skills and local knowledge essential for successful mitigation. For example, intergenerational knowledge transfer is commonly observed in these villages, where elder community members teach younger generations how to interpret elephant footprints, recognize vocalizations, and understand migratory behavior. The preservation and utilization of such Local Ecological Knowledge (LEK) has been shown to be crucial in developing community-based conservation strategies that are both culturally relevant and ecologically effective (Albar et al., 2025).

Several communities have initiated informal systems such as WhatsApp-based early-warning groups, patrol teams, and handmade deterrent devices (e.g., burning dried citronella). These are clear examples of functional capacity built from necessity and lived experience. Community-led innovations like these illustrate how localized problem-solving approaches can effectively reduce wildlife conflict. The role of local knowledge and traditional guarding practices has also been shown to support wildlife conservation in other Indonesian contexts (Sahusilawane & Latupapua, 2023).

Conclusion

This study concludes that local communities in Pidie Regency demonstrate a high level of participation in managing human-elephant conflict (HEC), with a composite mean score of 3.67. Among the three variables assessed, capacity scored the highest (3.72), followed by willingness (3.67), and opportunity (3.63). These results suggest that while communities are motivated and knowledgeable, their participation is still hindered by limited institutional support and access to formal decision-making processes. High willingness is driven by direct conflict experiences, cultural values such as mutual cooperation, and the need to protect agricultural livelihoods. These motivations are reflected in community-led efforts like informal patrols and the use of traditional deterrents. Communities also show strong capacity through locally adapted strategies and ecological knowledge passed down across generations. However, the moderate score in opportunity indicates that many communities face structural challenges in fully participating, particularly due to time constraints and lack of inclusion in official conservation planning. Therefore, future policies should promote inclusive and context-sensitive engagement, empowering local communities as central actors in sustainable HEC mitigation strategies in Sumatra.

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