

Understanding Elephant Disturbance in Human-Elephant Conflicts in Perak, Malaysia

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Abstract

Human-elephant conflict (HEC) has emerged as a significant challenge in North Peninsular Malaysia, driven by habitat fragmentation, agricultural expansion, and urbanization [1]. This study analyses temporal patterns of HEC from 2015 to 2021 using complaint data categorized into five disturbance types: BK (Berkeliaran), GK (Ganggu Ketenteraman), MK (Mendatangkan Ketakutan), RH (Rosakkan Harta Benda), and RT (Rosakkan Tanaman) [2]. By employing one-way ANOVA, the research investigates whether the mean number of complaints significantly differed across the years [3]. Results indicate no statistically significant differences in complaint frequencies over time, suggesting consistent patterns influenced by persistent conflict drivers rather than random fluctuations [4]. The lack of significant variation suggests that the factors driving HEC, such as habitat loss and human encroachment, have remained constant over the study period, reinforcing the need for long-term mitigation efforts [5]. Key limitations include reliance on historical data, broad categorization of disturbances, and a geographically constrained focus [6]. Recommendations for future research emphasize incorporating real-time data, refining disturbance categories, expanding the study region, and integrating qualitative insights to capture the socio-economic impacts of HEC [7]. This study contributes to the growing body of knowledge on HEC by providing evidence-based insights for policymakers and conservationists [8]. It highlights the need for long-term mitigation strategies, including resource allocation, habitat conservation, and community engagement [9]. The findings underscore the importance of coexistence approaches that balance human welfare with the conservation of endangered Asian elephants, fostering sustainable solutions to address this enduring conflict [10].

1. Introduction

Human-elephant conflict (HEC) has long been a concern in Perak, a state in Malaysia identified as a hotspot for such conflicts due to its extensive forest reserves and expanding agricultural frontiers. Rapid human settlement growth and land-use changes have led to increased encroachment on elephant habitats, exacerbating conflicts.

These conflicts manifest as crop raiding, property damage, and occasional human injuries, often escalating due to habitat fragmentation and human activities [1]. Habitat loss driven by deforestation and agricultural expansion forces elephants to venture closer to human settlements, intensifying conflicts [2]. Perak's ecological significance, coupled with frequent HEC incidents, makes it a critical area for studying and developing mitigation strategies. This issue not only threatens the livelihoods of affected communities but also jeopardizes the survival of the Asian elephant, a species classified as Endangered by the International Union for Conservation of Nature (IUCN) [3].

Elephants, as keystone species, play a critical role in maintaining ecological balance. Their activities contribute to seed dispersal, habitat creation, and biodiversity enhancement [4]. However, the rising frequency and intensity of HEC necessitates a deeper understanding of its drivers and impacts to develop effective and sustainable coexistence strategies [5]. Addressing HEC requires balancing human welfare with conservation priorities, a task made more challenging by limited resources and competing land-use demands [6].

Advancements in data collection methods, such as complaint logging, remote sensing, and statistical analysis, provide opportunities to track and analyse conflict patterns over time [7]. By identifying trends and hotspots of HEC, researchers can inform policymakers and conservationists on resource allocation, intervention design, and mitigation strategies such as improved land-use planning, the implementation of elephant corridors, and community-based conservation programs. These insights can help develop long-term solutions that promote coexistence between humans and elephants while minimizing economic losses and ecological disruptions [8].

This study aims to analyse temporal patterns of HEC complaints, evaluate the effectiveness of existing mitigation strategies, and provide actionable insights to foster coexistence between humans and elephants in Perak [9].

1.1 Objectives

The objectives of this research were:

1. To analyse the movement data of the Asian elephant in North Peninsular Malaysia.
2. To evaluate the seasonal patterns of elephants leaving their dens.

2. Methodology

2.1 Research Area

The study focuses on North Peninsular Malaysia, encompassing regions with significant elephant habitats and frequent HEC reports. Key areas include forest reserves and agricultural zones where human activities overlap with elephant ranges.

2.2 Data Collection

The Department of Wildlife and National Parks (DWNP) provided complaint data from 2015 to 2021. Complaints were categorized into five disturbance types:

- BK (Berkeliaran): Wandering elephants near human settlements.
- GK (Ganggu Ketenteraman): Disturbances to community peace.
- MK (Mendatangkan Ketakutan): Incidents causing fear.
- RH (Rosakkan Harta Benda): Property damage.
- RT (Rosakkan Tanaman): Crop destruction.

Each complaint entry contained details such as the type of disturbance, date, and location. This enabled the identification of temporal and spatial trends in HEC incidents. In addition to DWNP records, interviews with local communities and field officers were conducted to provide qualitative insights into conflict drivers and impacts. These supplemental data sources ensured a comprehensive understanding of the conflict dynamics.

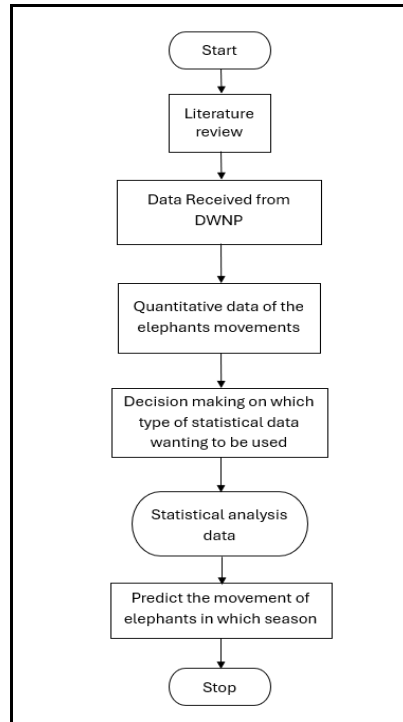


Fig. 1 Flowchart of Research

Fig. 1 shows the flowchart of the research. This procedure shows the obtained raw data from the DWNP by arranging then do statistical analysis data. The investigation of human-elephant conflict (HEC) in North Peninsular Malaysia necessitated the systematic use of data from the Department of Wildlife and National Parks (DWNP), which included data collection, evaluation, and analysis. Collaboration facilitated access to DWNP's vast data on conflicts, elephant migrations, and mitigation techniques. Local community complaints also served as the basis for data collection, providing valuable insights into the frequency and severity of HEC incidents. Once the raw data was collected, it was classified and sorted to ensure dependability and consistency. Statistical analyses, such as trend analysis and correlation studies, reveal patterns and influencing factors.

2.3 Data Cleaning

Data cleaning involved removing duplicates, addressing errors, and stabilizing incomplete entries. This ensured accurate and reliable datasets for analysis.

2.4 Data Analysis

The cleaned data was analysed using Microsoft Excel to compute averages, totals, and trends. One-way ANOVA was employed to determine if complaint frequencies varied significantly across the years. Visualizations, including bar and line graphs, were generated to illustrate temporal trends and disturbance patterns.

3. Results and Discussion

The data includes yearly complaint frequencies classified into five types of disturbances: BK (Berkeliaran), GK (Ganggu Ketenteraman), MK (Mendatangkan Ketakutan), RH (Rosakkan Hartabenda), and RT (Rosakkan Tanaman). Each row represents a specific year, and the columns show the number of complaints for each type. These frequencies indicate how frequently each disturbance occurs annually. The goal of using this data for ANOVA is to see if the average number of complaints varies significantly over the years. The null hypothesis assumes that the average number of complaints remains consistent over time, whereas the alternative hypothesis proposes that at least one year has a significantly different meaning. By analyzing this data using ANOVA, we can determine whether variations in complaint numbers are statistically significant or simply due to random fluctuations. The results can aid in identifying years with unusual patterns, guiding resource allocation and further investigation into the root causes.

Table 1 Count of Complaints based on categories throughout the year 2015 until 2021

Year	Categories				
	BK (Berkeliaran)	GK (Ganggu Ketenteraman)	MK (Mendatangkan Ketakutan)	RH (Rosakkan Hartabenda)	RT (Rosakkan Tanaman)
2015	0	2	15	0	26
2016	2	4	17	1	34
2017	2	0	6	3	40
2018	1	1	6	6	76
2019	1	0	8	11	40
2020	0	1	8	22	85
2021	0	0	14	5	72

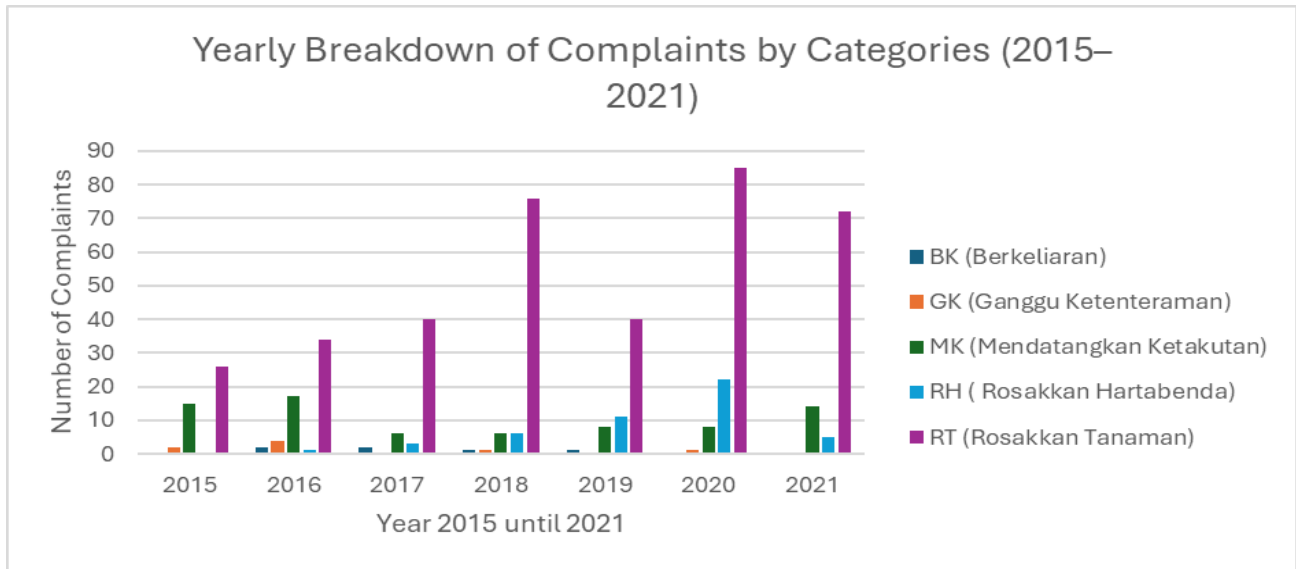


Fig. 2 Yearly Distribution of Complaints Across Different Categories (2015-2021)

The graph represents the distribution of complaints about human-elephant conflicts (HEC) in Perak from 2015 to 2021, categorized into five disturbance types: BK (Berkeliaran), representing elephants wandering near human settlements; GK (Ganggu Ketenteraman), referring to disturbances to community peace; MK (Mendatangkan Ketakutan), indicating incidents causing fear; RH (Rosakkan Harta Benda), covering property damage; and RT (Rosakkan Tanaman), related to crop destruction. The horizontal axis (x-axis) displays the years from 2015 to 2021, while the vertical axis (y-axis) shows the number of complaints for each disturbance type. Each data point corresponds to the total number of complaints recorded for a specific category each year, highlighting temporal patterns and differences in disturbance types. A notable peak in complaints was observed in 2018, particularly for crop destruction (RT) and property damage (RH). While the exact cause is unclear, potential contributing factors include increased human encroachment into elephant habitats, seasonal changes that may have affected food availability in the wild or shifts in elephant movement patterns. Additionally, improved awareness and reporting mechanisms among local communities might have contributed to the rise in recorded complaints during that year. Further research incorporating ecological and socio-economic data is needed to fully understand the reasons behind this spike.

The data used to generate the graph was obtained from the Department of Wildlife and National Parks (DWNP). It included historical records and complaints lodged by local communities regarding HEC. The complaints were systematically categorized into the five disturbance types to allow a focused analysis of specific conflict areas. The raw data was then organized yearly, enabling a systematic comparison of trends over time. Descriptive statistics, such as totals, averages, and variances, were applied to summarize the data and understand the general patterns of complaints. Additionally, inferential statistical methods, including one-way ANOVA, were employed to identify statistically significant differences in complaint frequencies across the years. While habitat loss, agricultural expansion, and urbanization are key drivers of HEC, socio-economic and environmental factors may also play a role in sustaining these conflicts. Crop types cultivated in affected areas, for example, could influence conflict intensity, as elephants are known to be attracted to certain high-nutrient crops such as bananas, oil palm, and sugarcane. Local economic conditions may also contribute, as farmers facing financial constraints may have limited resources for implementing deterrent measures, making their fields more vulnerable to elephant incursions. Additionally, public perception and attitudes toward elephants can shape how communities respond to conflicts, with some perceiving them as a threat while others may

advocate for coexistence strategies. Integrating these socio-economic and environmental considerations into future analyses could provide a more comprehensive understanding of HEC and improve the effectiveness of mitigation efforts.

The analysis revealed consistent patterns in HEC complaints across the years, with no statistically significant differences ($p > 0.05$). This suggests that underlying drivers such as habitat loss, agricultural expansion, and urbanization remain persistent over time. Key findings include:

- **Temporal Trends:** Complaints peaked in 2018, with crop destruction (RT) and property damage (RH) being the most reported disturbances.
- **Geographical Patterns:** Regions near forest reserves reported higher BK (Berkeliaran) and RT (Rosakkan Tanaman) complaints, indicating habitat encroachment as a key factor. Hulu Perak, Kuala Kangsar, and Kinta experienced frequent cases of wandering elephants and crop damage due to their proximity to major forested areas. Hulu Perak recorded the highest complaints, likely due to its extensive forest reserves and agricultural plantations, while Kuala Kangsar and Kinta also faced significant HEC incidents, particularly in farmlands near elephant corridors. A detailed geographical analysis, including conflict mapping, could help refine mitigation strategies and resource allocation.
- **Effectiveness of Mitigation:** Existing strategies, such as electric fencing and translocation, showed limited success, necessitating more holistic approaches.

3.1 Analysis Variance (ANOVA)

The data analysis includes a one-way ANOVA test to determine whether there are significant differences in the dependent variable from 2015 to 2021. The summary table includes descriptive statistics for each year, such as the count, sum, average, and variance, which indicate data variability. The ANOVA table identifies the sources of variation, with "Between Groups" representing differences between annual averages and "Within Groups" accounting for variability within each year. The results show a very small P-value (0.000199), which is less than the standard significance level of 0.05, indicating that there are statistically significant differences in the dependent variable across years. However, the F-value (1) is less than the critical F-value (2.371781), which may affect how the results are interpreted. These findings highlight the dataset's temporal variability, which may be useful for understanding patterns such as trends in human-elephant conflict over time.

Table 2 ANOVA-Single Factor Data Analysis Based on Data Received

Anova: Single
Factor

SUMMARY

<i>Years</i>	<i>Count</i>	<i>Sum</i>	<i>Average</i>	<i>Variance</i>
2015	6	2058	343	671047.2
2016	6	2074	345.6667	669761.9
2017	6	2068	344.6667	671433.5
2018	6	2108	351.3333	667512.7
2019	6	2079	346.5	671554.7
2020	6	2136	356	665551.6
2021	6	2112	352	669284.4

ANOVA

<i>Source of Variation</i>	<i>SS</i>	<i>df</i>	<i>MS</i>	<i>F</i>	<i>P-value</i>	<i>F crit</i>
Between Groups	800.90476	6	133.4841	0.000199	1	2.371781
Within Groups	23430730	35	669449.4			
Total	23431530	41				

The ANOVA analysis of human-elephant conflict (HEC) data in Perak aimed to assess differences in HEC incident frequencies across various categories, such as disturbance types or time periods. A negative result, where the p -value exceeded the significance threshold, indicated that no significant differences were found in HEC frequencies across the groups compared. This suggests that observed variations could be due to random chance rather than meaningful factors. However, this does not rule out real differences, as factors like high variability, insufficient sample size, or limited data precision may have influenced the outcome. Further analysis and data collection are needed to better understand HEC patterns and inform targeted conservation strategies.

3.2 Hypotheses

The one-way ANOVA results show that there is no statistically significant difference in the average number of complaints over two years. The p -value is 1, which is much higher than the significance level of 0.05, indicating that we cannot reject the null hypothesis. The F-statistics (0.00017919) are also much smaller than the critical value of 2.3718, lending credence to the conclusion that variability between groups (years) is negligible when compared to variability within groups (categories). As a result, differences in complaint numbers over time are more likely to be due to random variation than to a significant year-to-year change.

Hypotheses:

In the context of this one-way ANOVA analysis, the hypotheses are:

Null Hypothesis (H_0): The mean number of complaints is the same across all years.

Mathematically: $H_0: \mu_{2015} = \mu_{2016} = \mu_{2017} = \mu_{2018} = \mu_{2019} = \mu_{2020} = \mu_{2021}$

Alternative Hypothesis (H_1): At least one year has a mean number of complaints that is significantly different from the others.

Mathematically: H_1 : At least one μ year differs.

In this analysis, since the p -value is 1 which is greater than 0.05. Therefore, we are fail to reject the null hypothesis, meaning there is no significant difference in the mean complaints across years.

4. Conclusion

This study investigated the patterns of human-elephant conflicts (HEC) in Perak, focusing on yearly complaint frequencies classified by disturbance type. The findings highlight the temporal stability of these complaints from 2015 to 2021, as evidenced by the one-way ANOVA results, which revealed no statistically significant differences in mean complaint frequencies over time. The lack of significant variation suggests that complaint patterns may stem from consistent underlying factors rather than random fluctuations. These findings highlight the importance of long-term strategies to address HEC, emphasizing coexistence between humans and elephants while protecting the latter's endangered population.

However, this study has certain limitations. The analysis relied primarily on complaint data, which may not fully capture the complexity of HEC, as unreported incidents or variations in reporting practices could influence the results. Additionally, the study did not incorporate qualitative insights, such as community perspectives or socio-economic factors, which could provide a deeper understanding of the conflict's drivers. Future research should integrate real-time monitoring, qualitative assessments, and broader geographic coverage to enhance the effectiveness of mitigation strategies.

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Conflict of Interest

Authors declare that there is no conflict of interest regarding the publication of the paper.

Author Contribution

*The authors confirm contribution to the paper as follows: **study conception and design:** Huda Khalidah Khairunizan, Nazirah Mohamad Abdullah, Salman Sabaan; **data collection:** Huda Khalidah Khairunizan; **analysis and interpretation of results:** Huda Khalidah Khairuniza; **draft manuscript preparation:** Huda Khalidah Khairunizan, Nazirah Mohamad Abdullah. All authors reviewed and approved the final manuscript.*

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