

# Spatial distribution and visitor satisfaction in a low-visitation protected area in northern Borneo, Malaysia

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## Abstract

Protected areas with low visitation require a clear understanding of spatial use patterns and visitor experiences to guide management. This study examines the spatial distribution of visitors, the influence of travel distance, and visitor satisfaction in the Taliwas River Conservation Area (TRCA), Sabah, Malaysia. Historical visitor records (2011–2017) were analyzed by district of origin to assess spatial trends and distance–decay effects using simple linear regression. A structured online questionnaire (n=30) was used to evaluate visitor experiences and satisfaction. Most visitors originated from nearby districts, particularly Lahad Datu (44.8%), and travel distance showed a strong inverse relationship with visitation ( $R^2=0.6752$ ). Respondents highlighted natural features, occasional wildlife encounters, and service quality as key positive aspects, though concerns regarding facility cleanliness were noted. The study is limited by its small survey sample, reliance on self-reported experiences, and non-overlapping time periods of the datasets. Findings indicate that spatial proximity strongly shapes visitation, while organized group trips can offset distance constraints. These insights support targeted improvements in facilities, services, and outreach to enhance recreational use in low-visitation protected forests.

**Keywords:** Forest recreation, spatial tourism, protected area management

## 1 Introduction

Protected areas receive about 8 billion visits annually worldwide and provide important recreational and wellbeing benefits alongside biodiversity conservation (Balmford et al., 2015; Zhang et al., 2025). Visitation patterns are influenced by site attractiveness, accessibility, and individual motivations, with natural features—such as rivers, waterfalls, and scenic landscapes—often acting as key attractions (Dann, 1977; Deng et al., 2002; Gu et al., 2022). Travel distance also shapes use through distance–decay effects, where nearby sites are visited more frequently due to lower travel costs and effort (Rodrigue, 2017; Giles-Corti et al., 2005). Assessing visitor satisfaction further helps identify how well a site meets expectations and offers insights for improving low-visitation protected forests (Geng et al., 2021).

In Sabah, a Malaysian state in northern Borneo, nearly 1.9 million hectares, or 26% of the land area, are designated as protected areas. While efforts have been made to enhance accessibility and infrastructure, visitation remains highly uneven across sites. This study focuses on the Taliwas River Conservation Area (TRCA), a Class I Protection Forest Reserve that remains ecologically significant but persistently low in visitation. Accordingly, this study aims to: (i) analyse the spatial distribution of visitors to TRCA, (ii) quantify the effect of travel distance on visitation frequency, and (iii) assess visitor experiences and satisfaction to inform the management of low-visitation protected forests. These findings contribute to improving recreational planning and enhancing engagement in protected natural forest settings.

## 2 Materials & Methods

### 2.1 Study area

The study was conducted at the Taliwas River Conservation Area (TRCA), located approximately 36 km from Lahad Datu and 45 km east of the Danum Valley Conservation Area in Sabah, Malaysian Borneo. TRCA covers 9,546 hectares and features a mix of ultramafic and lowland rainforest ecosystems. It was formerly known as Taliwas Camp under the Sabah Forestry Department. Since 1992, TRCA has been managed by the Sabah Foundation. In 2012, it was officially gazetted as a Class I Protection Forest Reserve, emphasizing its role in ecosystem conservation.

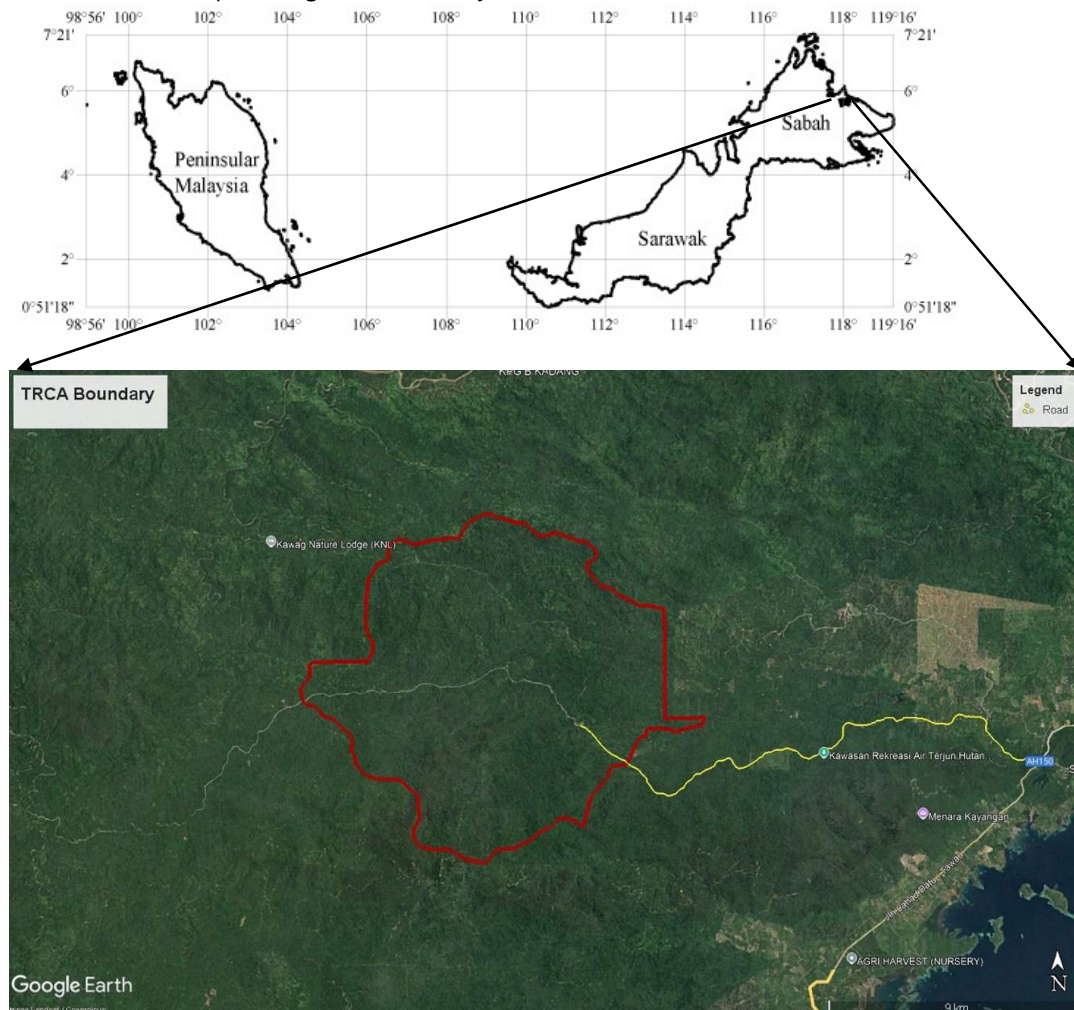


Figure 1: Location of study area

### 2.2 Methods

An on-site inventory of attractions, facilities, and activities in TRCA was conducted in June 2022. Historical visitation data were obtained from the visitor registration book, with records available from 2011 to 2017. These entries were grouped by visitor name and district of origin and were used exclusively to examine spatial visitation patterns. A digitized district map of Sabah was developed in ArcMap 10.8.2, with visitor counts entered as attributes to visualize the spatial distribution.

To assess visitor satisfaction, we focused on visits made in the recent five years (2017–2022). Because TRCA receives very few daily visitors, an on-site survey was not feasible. Instead, past visitors were identified through social media platforms where they had publicly shared photos or information about their trips. While this approach may exclude visitors who do not share their experiences online, it provided a practical means of locating individuals who had demonstrably visited the site. Given TRCA's low annual visitation, the resulting sample was considered reasonably representative of recent active visitors. Notably, the two datasets served distinct analytical purposes and were not directly compared.

#### Travel Distance Estimation

Average travel distance for each district was calculated using Google Maps. For consistency, we used the road distance from each town within the districts to TRCA as a single representative origin point. Distances were calculated as one-way travel and recorded in kilometres. This approach provides a standardized proxy for accessibility across districts. The relationship between visitation frequency and travel distance was examined using regression analysis performed in

Microsoft Excel. Travel distance was treated as the independent variable and number of visitors as the dependent variable. A power-law regression (log–log form) was fitted using Excel’s built-in trendline function, which generated the model equation and coefficient of determination ( $R^2$ ). The analysis was limited to districts from which visitors originated.

**Visitors Satisfaction Survey**

(i) Questionnaire Design and Validation

The questionnaire had two sections. Section A gathered basic demographic and trip information such as age, gender, district of origin, year of visit, transport used, travel companions, and purpose of visit. Section B assessed visitor experience and satisfaction, covering attractions and activities experienced, facilities and services, revisit and recommendation intentions. Most questions used a 5-point Likert scale (from “very dissatisfied” to “very satisfied”), and a few open-ended items asking visitors to share what they found memorable, what disappointed them, and suggestions for improvement. The questionnaire was reviewed by the research team for clarity but was not adapted from a validated instrument nor pre-tested, consistent with the exploratory nature of the survey. All responses were analyzed in SPSS using descriptive statistics to summarise visitor satisfaction patterns.

(ii) Distribution of the Questionnaire Survey

A structured online questionnaire was distributed to visitors who had visited TRCA within the previous five years (2017–2022). Visitors were identified through Instagram, WhatsApp, and Telegram based on publicly shared visit photos and group networks. A total of **42 visitors** were identified, and **30 respondents** completed the survey (71.4% response rate). The questionnaire assessed visitor characteristics, experiences, and satisfaction with site conditions and services. Although the sample size is small, the number of respondents exceeds the average annual visitation (~30 visitors), providing a reasonable representation of recent users. Responses were summarized descriptively in Excel. Participation was voluntary and anonymous. An overall satisfaction index was calculated using the mean Likert score to provide a clearer comparison across attributes.

### 3 Results

#### 3.1 Spatial Distribution and Influence of Distance on Number of Visitors

Figure 2 shows the spatial distribution of visitors to the Taliwas River Conservation Area (TRCA) from 2011 to 2017. Visits from the districts of Kota Kinabalu, Keningau, and Nabawan have likely been enhanced by the completion of a 145 km road upgrade from gravel to paved surface, finalized in 2011 under the 10th Malaysia Plan (Daily Express, 2015).

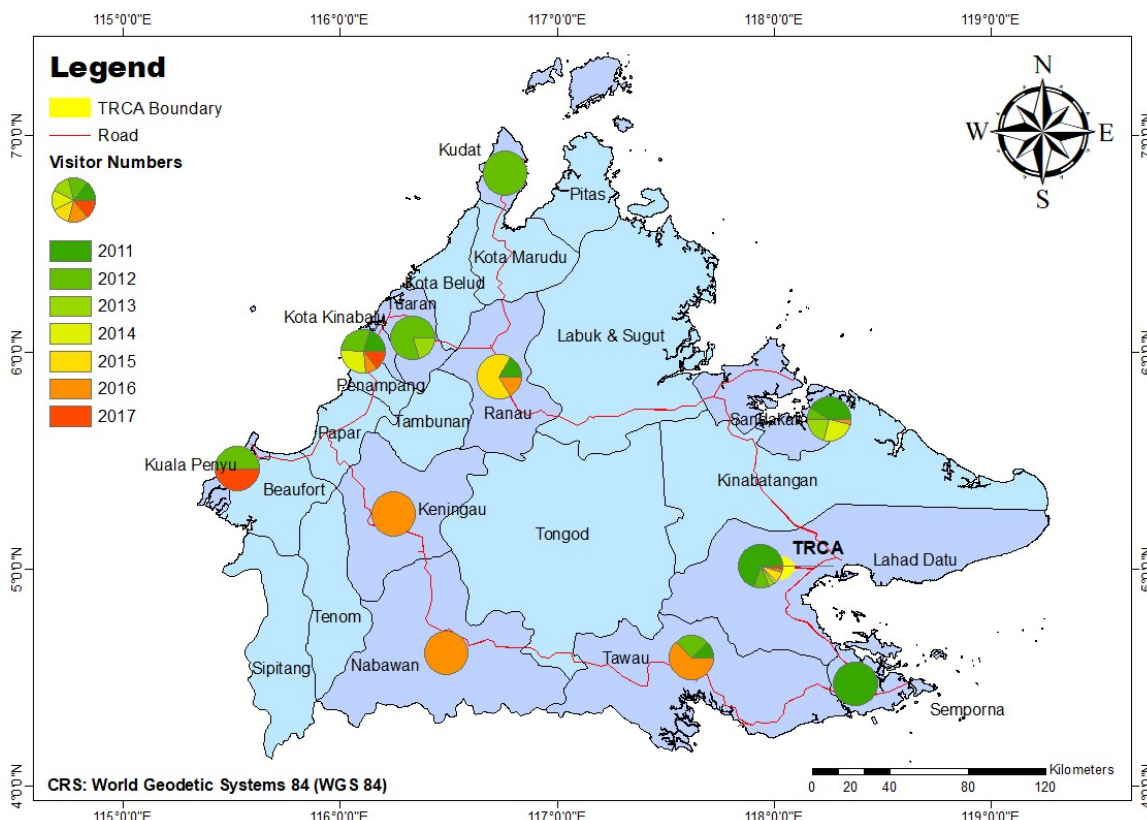


Figure 2: Spatial distribution of TRCA visitors in Sabah by districts (2011-2017)

Table 1 shows that TRCA is a low-traffic recreation area. From 2011 to 2017, TRCA received only 201 visitors, averaging 28.71 visitors annually. Lahad Datu contributed the largest share of total visitors (n = 90; 44.78%), with a notable peak of 63 individuals recorded in 2011. Sandakan and Kota Kinabalu contributed 24 and 55 visitors, respectively. Other districts included Tawau (n = 8), Tuaran (n = 5), Ranau (n = 6), Kuala Penyu (n = 2), Semporna (n = 8), Nabawan (n = 1), and Keningau (n = 1). Across all districts with recorded visitors, the mean travel distance to TRCA was **approximately 200 km** (range: 36.2–556.4 km). This reflects a distance-decay pattern, indicating that most visitors originate from nearby districts.

Table 1: Travel distance and number of visitors by district (2011-2017).

Districts	Distance (km)	Number of Visitors	%
Lahad Datu	36.2	90	44.78
Semporna	139.2	8	3.98
Tawau	154.0	8	3.98
Sandakan	200.6	24	11.94
Ranau	322.3	6	2.98
Tuaran	402.9	5	2.49
Kota Kinabalu	427.8	55	27.36
Nabawan/Pensiangan	430.8	1	0.50
Keningau	433.4	1	0.50
Kudat	474.0	1	0.50
Kuala Penyu	531.2	2	0.99
<b>Total</b>		<b>201</b>	<b>100</b>

Figure 3 shows a clear distance-decay effect, where the number of visitors decreases as travel distance increases. A power-law regression model was fitted to the data from 11 districts, resulting in the equation:  $y = 12,657x^{-1.395}$  and an  $R^2$  value of 0.6752, indicating a moderately strong negative relationship between distance and the number of visitors. Kota Kinabalu, located approximately 428 km from TRCA, stands out as an exceptional case, with a high number of visitors despite the long distance.

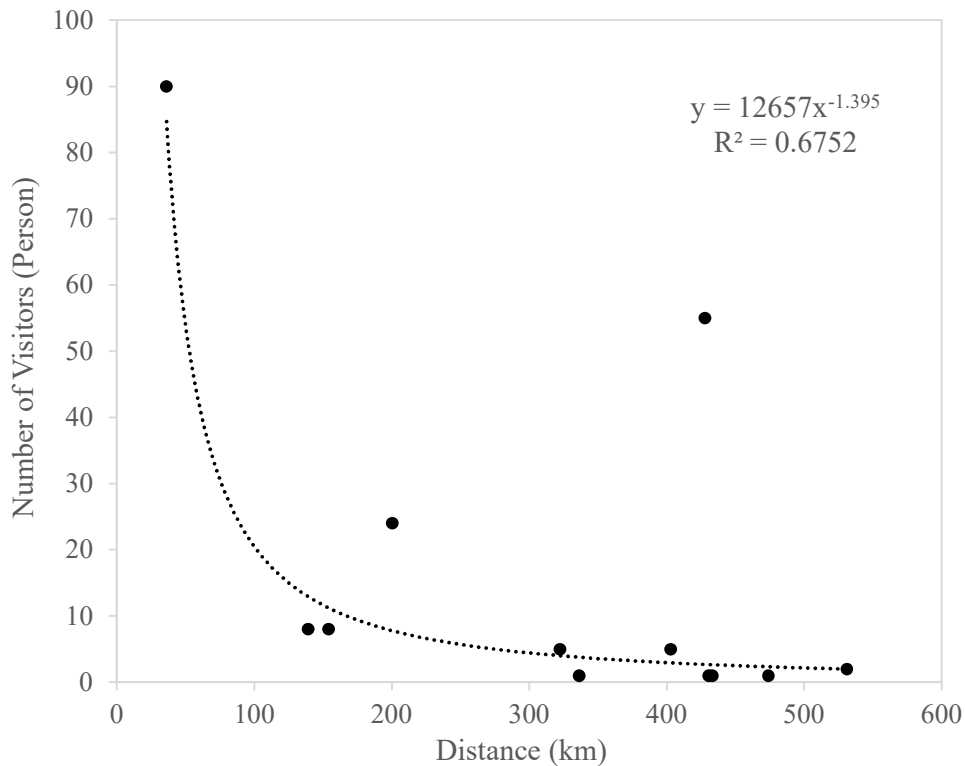


Figure 3: The relationship between travel distance and number of visitors of TRCA.

**Visitor Experiences and Satisfaction**

Visitor experiences and satisfaction were assessed based on the responses of thirty visitors. Female respondents made up the majority (76.7%), and the predominant age group was 18–25 (60.0%), followed by 26–35 (33.3%). Most respondents

were from Kota Kinabalu (70.0%), followed by Lahad Datu (16.7%), and Semporna and Tawau (6.7% each). Modes of transport used included private cars (53.3%), buses or vans (36.7%), and car rentals (10.0%).

Activities included visits to Pandan Lake, waterfalls, nature trails, bird watching, wildlife observation, hiking, camping, and cycling (Table 2). Waterfalls were the most popular attraction (25.2%), followed by hiking (19.4%), trail exploration (17.5%), and Pandan Lake (14.6%). Regarding service quality (Table 3), 93.33% of respondents were satisfied or very satisfied with the staff services. Some respondents noted inconsistent toilet maintenance. In terms of intentions to revisit, 73.3% rated their likelihood of returning a 5 (the highest rating), 16.7% rated it a 4, and no respondents gave the lowest rating. Most respondents expressed willingness to recommend TRCA. The satisfaction index for attractions and activities ranged from 3.90 to 4.68, while it was lower for services and facilities, with a satisfaction index ranging from 3.77 to 4.50.

Table 2: Visitor satisfaction on attractions and activities.

Attractions/Activities	Very Dissatisfied (%)	Dissatisfied (%)	Neutral (%)	Satisfied (%)	Very Satisfied (%)	Satisfaction Index
Waterfall	3.45	0	0	20.69	75.86	4.66
Pandan Lake	0	0	0	31.82	68.18	4.68
Trail	4.17	0	4.17	25.00	66.67	4.48
Hiking	4.35	0	0	30.43	65.22	4.57
Picnic	0	7.69	0	30.77	61.54	4.46
Wildlife Sighting	8.33	0	16.67	33.33	41.67	3.93
Bicycle Activity	10.00	0	0	50.00	40.00	3.90
Bird Watching	0	0	9.09	54.55	36.36	4.18

Table 3: Visitor satisfaction on services and facilities.

Services/Facilities	Very Dissatisfied (%)	Dissatisfied (%)	Neutral (%)	Satisfied (%)	Very Satisfied (%)	Satisfaction Index
Staff Service	0	3.33	3.33	33.33	60.00	4.50
Trail Condition	0	6.67	10.00	33.33	50.00	4.27
Dormitory/Camp	0	0	20.00	43.33	36.67	4.17
Ground Condition						
Toilet and Bathroom Cleanliness	3.33	13.33	13.33	43.33	26.67	3.77

## 4 Discussion

The spatial pattern of visitation to TRCA reflects well-established principles of spatial behavior in nature-based tourism. The concentration of visitors from nearby districts, particularly Lahad Datu, demonstrates how travel cost, time, and accessibility shape recreational choices—an effect widely documented in distance-decay literature (Xue & Zhang, 2020). Rather than merely reflecting geographic proximity, this pattern suggests that TRCA currently functions as a local or intra-regional attraction, drawing primarily residents who face lower logistical and financial barriers. Improvements in road connectivity may have further enhanced this localized demand.

The notable exception of Kota Kinabalu indicates that distance alone does not fully explain visitation behavior. Its higher-than-expected visitor volume suggests the influence of socioeconomic and institutional factors, such as organized group trips by universities, government agencies, and private companies based in the capital. This aligns with findings that institutional networks and higher-income urban populations often maintain strong participation in outdoor recreation despite greater travel distances (Padilla et al., 2025; Zhang et al., 2025). Therefore, TRCA’s visitor profile is shaped by both geographic proximity and institutional affiliations, implying opportunities for targeted promotion among organizational groups beyond its immediate region.

Visitor satisfaction at TRCA also reflects broader theories of nature-based experience. As suggested by Arabatzis & Grigoroudis (2010), satisfaction arises from sensory stimulation and emotional engagement with natural settings. At TRCA, the presence of waterfalls, lakes, and hiking opportunities consistently resulted in high levels of visitor satisfaction, suggesting that these core natural features effectively meet visitor expectations. Wildlife sightings—particularly elephants—contributed to memorable experiences, even though such encounters are infrequent. The role of wildlife unpredictability in shaping satisfaction mirrors findings in other protected areas (Ballantyne et al., 2011), emphasizing that even rare encounters can enhance perceived value of the experience.

Service and facility conditions, particularly sanitation and staff support, emerged as influential components of visitor experience. Cleanliness and basic infrastructure are repeatedly highlighted in tourism literature as determinants of comfort and willingness to revisit (Frinaldi, 2021; Yao, 2020). The inconsistency in toilet and campsite maintenance suggests a gap between visitor expectations and operational performance. Addressing these weaknesses could strengthen TRCA's overall appeal, especially for long-distance visitors who tend to have higher expectations for facilities.

This study has several limitations that should be acknowledged. First, the spatial analysis relied on the available entries from visitor books, which may not capture all visitors. However, these records constitute the only systematic source of spatial information for TRCA and are therefore appropriate for understanding general visitation patterns. Second, the visitor survey involved a modest sample size ( $n = 30$ ). Although this represents a substantial proportion of TRCA's small annual visitor base, some percentage values correspond to only a few individuals (e.g.,  $10\% \approx 3$  respondents). These findings should therefore be interpreted as exploratory rather than definitive.

Clear management implications arise from the findings. Improving priority facilities—particularly sanitation, trail maintenance, and accommodation areas—could enhance visitor satisfaction and revisit intentions. Given the strong distance-decay pattern, nearby districts such as Lahad Datu remain the most promising target market. However, Kota Kinabalu also represents a viable segment due to organized group visits from institutions. To address persistently low visitation, TRCA could strengthen outreach through targeted promotional efforts, partnerships with schools and universities, and digital marketing strategies that highlight unique attractions such as the waterfall, lake, and nature-based activities.

## 5 Conclusion

This study examined visitor patterns and satisfaction at TRCA, focusing on spatial distribution and factors influencing visitor experiences. The findings indicate that most visitors come from nearby districts, highlighting that distance significantly limits visitation. By focusing on a low-visitation protection forest, this study provides useful insights that differ from findings in more popular parks in Malaysia. For effective management, priority should include basic facilities, improve toilet cleanliness, and strengthening staff services. Additionally, targeted promotions aimed at nearby districts within a 200 km radius, along with structured packages for schools, universities, and organizations, could help increase visitation in long run. Future studies should also explore socio-economic factors such as income, awareness, and marketing reach to gain a deeper understanding of the elements that shape visitation patterns.

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### Conflict of interest

The authors declare no conflict of interest.

### Authors' contribution

**NAAD:** Conceptualization, Data curation, Formal analysis, Investigation, Methodology, Validation, Visualization, Writing – original draft. **MHP:** Conceptualization, Funding acquisition, Methodology, Project administration, Resources, Software, Supervision, Writing – review & editing. **WVCW:** Data curation, Resources, Software, Writing – review & editing. **HT:** Data curation, Investigation, Resources, Writing – review & editing.

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