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Cover: Golden-headed Lion Tamarin *Leontopithecus chrysomelas*. Watercolor and acrylics by P. Kritika.

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ARTICLE

People's perceptions on the impacts of select linear infrastructure projects on avifauna in Chhattisgarh, India

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Abstract: India's rapid economic growth has led to widespread expansion of linear infrastructure (LI) such as roads, railways, and power lines, often with significant ecological impacts on wildlife, including avifauna. Understanding public perceptions of these impacts is crucial for participatory conservation and sustainable infrastructure planning. This study assessed people's perceptions of avifaunal impacts from four major LI projects in Chhattisgarh: Ranchi–Dharamjaigarh (765 kV), Korba–Jabalpur (765 kV), and Champa–Kurukshetra (800 kV) transmission lines, as well as the East Rail Corridor. Structured interviews were conducted with 868 rural residents using close-ended questions. Responses were analysed using binary scoring, chi-square tests, and multinomial logistic regression. Overall, 56.6% perceived negative impacts on avifauna, with 51.7% reporting declines in common bird species. While 58.5% of respondents observed no change in migratory birds, 41.5% reported a decline; 43.5% noted electrocution and collision risks. Perceptions varied significantly with respondents' age, education, tribal status, occupation, and proximity to LI. Older, less-educated, and non-tribal individuals expressed more negative views, and those living closer to LI exhibited heightened concern. Despite these, neutral views were prevalent, reflecting a lack of definitive environmental awareness or LI's impact on avifauna. These findings underscore the need for integrating biodiversity safeguards into infrastructure planning and enhancing public awareness through targeted environmental education.

Keywords: Biodiversity impacts, bird responses, community perceptions, conservation planning, electrocution and collision risks, environmental awareness, rural residents, socio-demographic factors.

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INTRODUCTION

Tropical forests are among the most biodiverse and ecologically significant ecosystems, yet they are increasingly threatened by land-use change and fragmentation. One major driver of this fragmentation is the expansion of linear infrastructure (LI), which traverses landscapes in elongated forms, often bisecting habitats. This includes roads, railways, transmission lines, pipelines, and canals (Geist & Lambin 2002; Geneletti 2004; Laurance et al. 2014; Nayak et al. 2020). While LI play a vital role in economic development and connectivity (van der Grift et al. 2015), they also contribute to environmental degradation through habitat loss, increased wildlife mortality, and pollution (Forman & Alexander 1998; De Jonge et al. 2022; Ashwin et al. 2023). Avifauna are particularly vulnerable to LI through electrocution, collisions, and displacement (Bevanger 1998; Loss et al. 2014; van der Grift et al. 2015; Manigandan et al. 2022). While several studies have linked LIs to declines in biodiversity, including bird populations, some studies have also indicated that certain bird species may exploit LI corridors for foraging or perching (van der Grift et al. 2015) and nesting (Byju et al. 2023), highlighting the complexity of ecological responses to the LIs.

People's perceptions of such impacts are critical in shaping conservation and development strategies. Perceived risks and benefits are influenced by individual opinions, environmental knowledge, and sociodemographic factors such as age, education, and occupation (Kaczensky et al. 2004; Viklund 2004; Manigandan et al. 2024). People's perceptions, defined as how individuals interpret and evaluate environmental issues, can provide insights into local ecological knowledge and guide effective conservation interventions (Berkes et al. 2000; Huntington 2011; Bennett 2016) and identify knowledge gaps, plan awareness programs, and guide participatory approaches to conservation (Caily-Arnulphi et al. 2017; Champness et al. 2023).

Despite the recognized importance of perception studies in conservation, the views of local communities regarding LI impacts, especially on avifauna, remain underexplored in India. Particularly in Chhattisgarh, driven by the energy and mining sectors, little is known about how local communities perceive LI impacts on birds (Gajera et al. 2013). Projects such as thermal power plants, transmission lines, and railway corridors are transforming landscapes, raising concerns about ecological consequences and social acceptance. Such rapid development and intrusion of several LI can have potential impacts on both people and the environment. Understanding LI's impacts on people and the surrounding environment is crucial for scientifically managing these impacts. There are very few systematic studies on birds in this region, and research on avifaunal responses to infrastructure expansion in Chhattisgarh is especially limited. This study, therefore, represents one of the first structured attempts to document community perceptions of bird impacts associated with major LI corridors in the state. Avifauna are particularly relevant in this context because birds are highly sensitive to habitat alteration, fragmentation, and electrocution or collision risks, making them strong ecological indicators of infrastructure impacts. Several stretches of the studied LI corridors pass through forest patches, agricultural landscapes, and open woodlands, where canopy removal, vegetation clearing, and disturbance have been reported. The heightened public awareness will lead to more effective conversation efforts geared towards lessening adverse consequences for both sides. Knowing more about people's views of the influence of LI could lead to better landscape and regional design and management. However, public perception alone cannot guide conservation or infrastructure planning and must be complemented with ecological assessments to ensure scientifically sound decisions.

Study area

Four selected linear infrastructures in the state of Chhattisgarh, India, were surveyed for the cause: the Ranchi–Dharamjaigarh Transmission Line (765 kV S/C Power Grid Transmission Line), Champa–Kurukshetra (800 kV S/C Power Grid Transmission Line), Korba–Jabalpur (765 kV S/C Power Grid Transmission Line), and the East Rail corridor (Figure 1). These linear

Image 1. Study area showing the Champa–Kurukshetra 800 kV single-circuit (S/C) power grid transmission line.

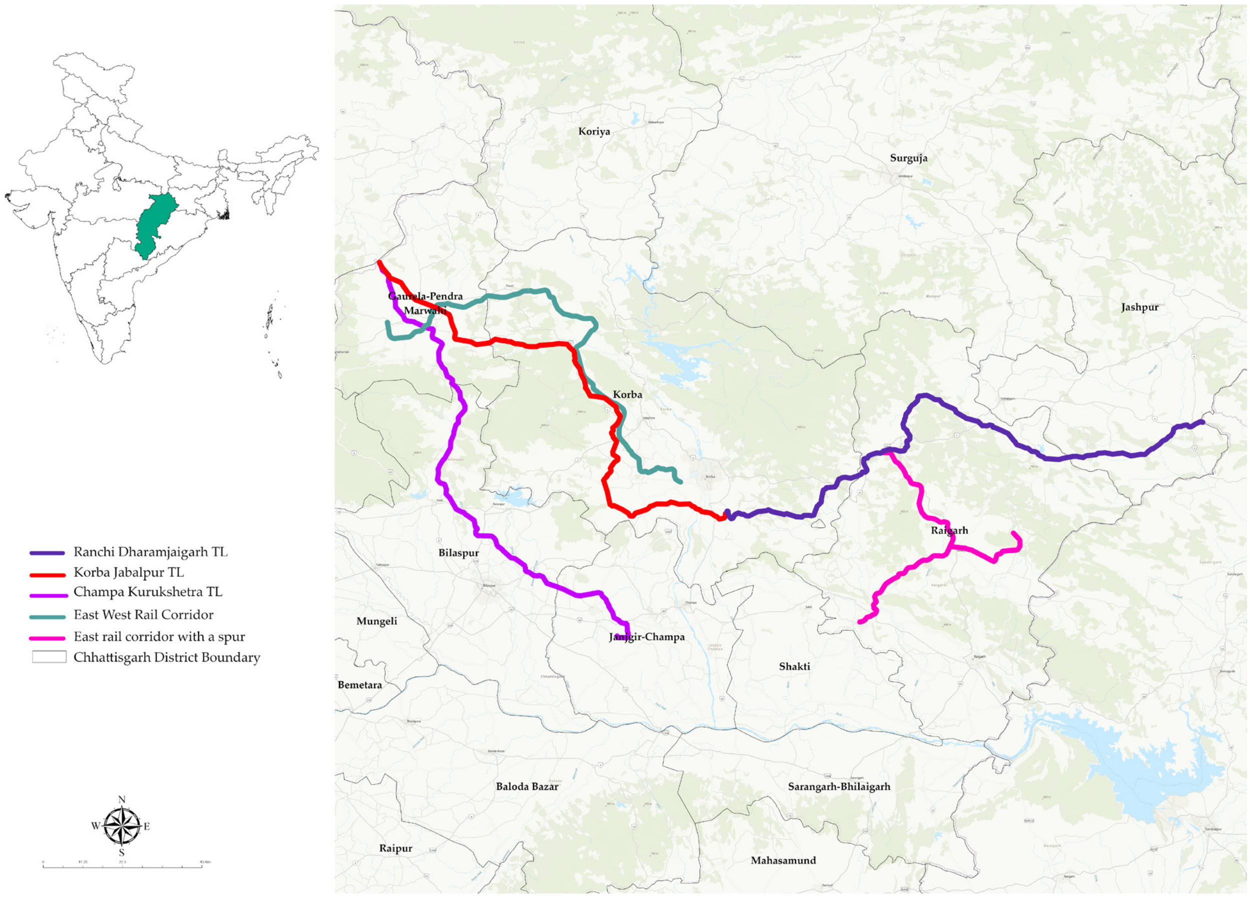

Figure 1. Study area map.

infrastructures intersect six districts in Chhattisgarh, namely Korba, Bilaspur, Gaurela-Pendra-Marwahi, Raigarh, Jangir-Champa, and Jashpur, with an approximate length of 711 km in total.

Chhattisgarh state covers 1,35,191 km^2, accounting for 4.1% of the country's total area. The LI routes cut across predominantly tropical dry deciduous forests, characterised by Sal *Shorea robusta* and associated mixed deciduous species, classified as northern tropical dry mixed deciduous forests (5B/C2; Champion & Seth 1968) (Forest Survey 2021). Chhattisgarh is home to a varied population with diverse ethnic, social, and religious backgrounds. It has the highest tribal population among all Indian states; one-third of the people in the state are officially categorized as scheduled castes or scheduled tribes (Dixit et al. 2023). Chhattisgarh has a total population of 2,55,45,198 people, with 12,832,895 males and 12,712,303 females. The literacy rate in Chhattisgarh is 70.28%. Male literacy rates are 80.27%, while female literacy rates are 60.24% (Census 2011). Rural areas are home to 76.76% of the total population, and most of them are farmers who primarily depend on paddy cultivation.

Methods

A structured, close-ended questionnaire was designed to assess public perceptions of linear infrastructure (LI) impacts on avifauna, based on established guidelines, and expert review. The finalized survey comprised ten simple questions administered through face-to-face interviews, following Patton's (2002). Interviews, lasting 5–10 minutes, were conducted with 868 willing participants between October 2021 and July 2023 across 166 villages near selected LI routes in Korba, Bilaspur, Gaurela-Pendra-Marwahi, Raigarh, Janjgir-Champa, and Jashpur. Villages were selected based on proximity to LI to ensure locally grounded responses. Participants included a diverse group: farmers, students, government employees, housewives, business owners, and daily wage workers. Prior to interviews, participants were briefed on the study's objectives and verbal consent was obtained.

The questionnaire had two sections: (1) socio-demographic data (gender, age, education, occupation, tribal affiliation, proximity to LI, and duration of residence) (Naha et al. 2014; Chin et al. 2019) and (2) perception of LI impacts on avifauna. In this study, the term 'perception' refers specifically to respondents' views on the impact of LI on avifauna, including perceived effects on bird mortality, behaviour, and habitat. While the questionnaire was developed in English and Hindi, most interviews were conducted in local dialects with field support. Close-ended formats were preferred for efficiency and analytical clarity.

To help participants accurately identify bird species, a photo-elicitation approach was used during interviews. Photographs of commonly occurring birds from the region were shown to respondents. In addition, the Merlin Bird ID application (Cornell Lab of Ornithology) was used to display high-resolution images and, when required, to play bird calls to aid recall and confirmation. Responses were categorized as positive, neutral, or negative based on participants' observations and opinions. Perception was quantified using a binary scoring system: "Yes" = 1 and "No" = 0, resulting in a cumulative score from 0–10 (Darawsheh 2020; Ruan et al. 2022). Scores were categorized into three groups for multinomial logistic regression: negative (0–3), neutral (4–6), and positive (7–10). Data categorization followed standard practices, and all the ethical guidelines were strictly adhered to throughout the study (Gubbi 2006).

Data analysis

Analysis of qualitative data was done through content analysis (coding) or thematic analysis by categorizing themes according to the way they relate to research objectives and building relationships and implications as provided by Patton (2002). After data collection in the field, the data were organised, coded, classified, and tabulated using Microsoft Excel and descriptive statistics. In SPSS 23.0, data were cross-tabulated, and a chi-square test (notation: x2 df) was applied to all combinations of independent and dependent variables. To determine the factors that could predict the perceptions of people, a multinomial logistic regression model was fitted to the responses and was used to predict the probabilities of the different possible outcomes (Umaña-Hermosilla et al. 2020). Multinomial logistic regression utilizes maximum likelihood estimation to assess the likelihood of belonging to a specific category, allowing us to characterize the probability of a respondent's decision for a particular multinomial discrete choice, conditional on the values of the explanatory variables (Clark 2009; Umaña-Hermosilla et al. 2020). We use the multinominal function from the net package to estimate a multinomial logistic regression model in R.

Table 1. Respondent demographics.

Demographic variables (M ± SD)	Categories	Frequency (Percentage) n = 868
Age (1.13 ± 0.86)	15–30 years	244 (28.1)
	31–45 years	295 (34)
	46–70 years	299 (34.4)
	> 71	30 (3.5)
Gender (0.22 ± 0.42)	Male	674 (77.6)
	Female	194 (22.4)
Tribe/non-tribe (0.52 ± 0.50)	Tribe	418 (48.2)
	Non-tribe	450 (51.8)
Education level (1.56 ± 0.78)	Uneducated	35 (4)
	Primary	434 (50)
	High school	281 (32.4)
	Graduate and above	118 (13.6)
Occupation (3.35 ± 1.58)	Business	16 (1.8)
	Farmer	436 (50.2)
	Government staff	34 (3.9)
	Homemaker	100 (11.5)
	Labour	174 (20)
	Students	108 (12.4)
Proximity to the LI (0.44 ± 0.52)	0–300 m	502 (57.8)
	>300–600 m	354 (40.8)
	>600–900 m	12 (1.4)
Years of residency (0.66 ± 0.58)	0–30 years	343 (39.5)
	>30–60 years	476 (54.8)
	>60–90 years	49 (5.6)

Respondent demographics

Most of the respondents (34.4%) were in the age group of 46–70, followed by 31–45 years (34%), 15–30 years (28.1%), and more than 70 years old (3.5%). Occupation-wise, 50% were farmers. Respondents were predominantly male (77.6%) since most of the female participants were reluctant to respond. In terms of tribal affiliation, 51.8% were non-tribal and 48.2% tribal. Education levels varied: 50% had primary education, 32.4% high school, 13.6% graduate or above, and 4% were uneducated. Regarding proximity to LI, 57.8% lived or owned land within 0–300 m, and 40.8% within 301–600 m. A majority (54.8%) had resided in the area for 31–60 years (Table 1).

RESULTS

Participant's response – summary

The study assessed public perceptions of LI impacts on avifauna. Overall, 56.6% of respondents perceived LI as having a negative effect on local bird populations, while 43.4% did not. A decline in common bird species post-installation was noted by 51.7%, whereas 48.3% reported no such change. Regarding migratory birds, 41.5% observed a decline, while 58.5% did not. Concerns about bird electrocution or collision were raised by 43.5% of respondents. Only 23.3% reported birds avoiding LI structures during flight, and 34.2% noted an increase in human–bird negative interactions after installation; 65.8% did not. A vast majority (91.6%) did not observe invasive plant proliferation post-installation. While 80.8% did not believe LI had positive effects on birds, 19.2% perceived some benefits. Increased sightings of birds of prey were reported by 10.7%, and 30.8% observed birds using LI pylons for perching, nesting, roosting, or foraging (Table 2).

People perception

People's perception on the impact of LI on avifauna

Chi-square tests revealed significant associations between perception of LI impacts on avifauna and multiple socio-demographic variables (Table 3). Age was significantly associated with perception ($p < 0.001$), with younger respondents (15–45 years) tending to be more neutral, while older groups (46+ years) expressed a mix of views. Education level also influenced perceptions ($p < 0.001$); uneducated individuals more frequently expressed negative views, whereas those with formal education showed more neutral or varied responses. Tribal affiliation was strongly associated with perception ($p < 0.001$), with tribal respondents mostly neutral and non-tribal respondents more evenly distributed across categories. Occupation significantly affected perception ($p < 0.001$), with labourers showing a slightly more positive outlook. Proximity to LI was also significant ($p = 0.040$), with those living nearer expressing greater concern, though neutral views still dominated. Gender ($p = 0.188$) and years of residency ($p = 0.084$) were not significantly associated with perception.

Table 2. Participant's response summary.

	Variables	Yes	No
	People's perception on the impact of LI on avifauna		
1	There is a negative impact of LI on the local Avifauna	491 (56.6%)	377 (43.4%)
2	Absence of regular/common bird species after the LI installation	449 (51.7%)	419 (48.3%)
3	Reduction in migratory birds after the LI installation?	360 (41.5%)	508 (58.5%)
4	LI is imposing significant threats to birds by Electrocution/Collision	378 (43.5%)	490 (56.5%)
5	Birds avoid LI during their flight	202 (23.3%)	666 (76.7%)
6	Human-wildlife conflict (birds) increased after the installation	297 (34.2%)	571 (65.8%)
7	Invasive plant species proliferation increased after the installation of LI	73 (8.4%)	795 (91.6%)
8	LI can positively affect the birds	167 (19.2%)	701 (80.8%)
9	Increased number of birds of prey after the installations	93 (10.7%)	775 (89.3%)
10	Birds utilising the LI pylon for perch, nest, roost, & foraging	267 (30.8%)	601 (69.2%)

Factors determining the people's perception of LI. Multinomial logistic regression results for people's perception on the impact of LI on avifauna (Reference category: Neutral)

Multinomial logistic regression analysis (Table 4) revealed several significant predictors of perception. Individuals aged 30–45 had slightly lower odds of negative perception compared to neutral ($\beta = -0.636$, $p < 0.1$). Males were not significantly associated with negative perception responses but showed a significant negative association with positive responses ($\beta = -0.544$, $p < 0.1$), indicating that males were less likely to report positive perceptions. Non-tribal respondents had significantly higher odds of both negative ($\beta = 1.212$, $p < 0.01$) and positive ($\beta = 0.858$, $p < 0.01$) perceptions, suggesting that non-tribal individuals were more likely to express stronger opinions in either direction. High school-educated individuals had slightly lower odds of negative perception ($\beta = -0.799$, $p < 0.1$), while graduates and above had significantly lower odds ($\beta = -1.163$, $p < 0.01$). Labourers had increased odds of negative perception ($\beta = 1.551$, $p < 0.01$) and suggesting that labourers were more likely to express negative views. Proximity to LI was a strong predictor; individuals living closer to the LI (0–900 m) were significantly more likely to express negative views, with extremely high coefficients ($\beta = 11.515$, $p < 0.01$). Residency of 31–60 years showed slightly lower odds of negative perception ($\beta = -0.493$), while those residing for 61–90 years had significantly higher odds of positive perception ($\beta = -1.377$, $p < 0.05$), suggesting that very long-term residents were less likely to express positive views.

Table 3. Peoples' perception on the impact of LI on avifauna.

People's perception on the impact of LI on avifauna		Negative (n)	Neutral (n)	Positive (n)	
Age	15–30 years	75 (30.7%)	95 (38.9%)	74 (30.3%)	χ^2 = 25.569, df = 6, p = 0.000
	31–45 years	57 (19.3%)	142 (48.1%)	96 (32.5%)	
	46–70 years	75 (25.1%)	102 (34.1%)	122 (40.8%)	
	> 71	11 (36.7%)	15 (50.0%)	4 (13.3%)	
Gender	Male	58 (29.9%)	77 (39.7%)	59 (30.4%)	χ^2 = 3.345, df = 2, p = 0.188
	Female	160 (23.7%)	277 (41.1%)	237 (35.2%)	
Tribe/non-tribe	Tribe	69 (16.5%)	224 (53.6%)	125 (29.9%)	χ^2 = 60.369, df = 2, p = 0.000
	Non-tribe	149 (33.1%)	130 (28.9%)	171 (38.0%)	
Education level	Uneducated	17 (48.6%)	10 (28.6%)	8 (22.9%)	χ^2 = 25.696, df = 6, p = 0.000
	Primary	102 (23.5%)	168 (38.7%)	164 (37.8%)	
	High school	57 (20.3%)	133 (47.3%)	91 (32.4%)	
	Graduate and above	42 (35.6%)	43 (36.4%)	33 (28.0%)	
Occupation	Business	2 (12.5%)	8 (50.0%)	6 (37.5%)	χ^2 = 38.216, df = 10, p = 0.000
	Farmer	86 (19.7%)	183 (42.0%)	167 (38.3%)	
	Government staff	11 (32.4%)	12 (35.3%)	11 (32.4%)	
	Homemaker	31 (31.0%)	46 (46.0%)	23 (23.0%)	
	Labour	57 (32.8%)	49 (28.2%)	68 (39.1%)	
	Students	31 (28.7%)	56 (51.9%)	21 (19.4%)	
Proximity to the LI	0–300 m	95 (21.4%)	184 (41.5%)	164 (37.0%)	χ^2 = 10.038, df = 4, p = 0.040
	301–600 m	122 (29.5%)	164 (39.7%)	127 (30.8%)	
	601–900 m	1 (8.3%)	6 (50.0%)	5 (41.7%)	
Years of living in the locality	0–30	65 (19.0%)	53 (15.5%)	225 (65.6%)	χ^2 = 8.228, df = 4, p = 0.084
	31–60	102 (21.4%)	57 (12.0%)	317 (66.6%)	
	61–90	13 (26.5%)	1 (2%)	35 (71.4%)	

Table 4. Multinomial logistic regression results for people's perception on the impact of LI on avifauna.

Dependent variable	Negative (Odds Ratio)	Positive (Odds Ratio)
Age (31–45)	-0.636* (-0.334)	-0.495 (-0.304)
Gender (Male)	-0.4 (-0.306)	-0.544* (-0.288)
Non-tribe	1.212*** (-0.198)	0.858*** (-0.176)
Education (High school)	-0.799* (-0.446)	0.334 (-0.51)
Education (Graduate and above)	-1.163** (-0.47)	0.03 (-0.524)
Occupation (labour)	1.551* (-0.834)	0.725 (-0.591)
Proximity to the LI (0–300 m)	11.306*** (-0.385)	-0.359 (-1.317)
Proximity to the LI (301–600 m)	11.515*** (-0.384)	-0.599 (-1.319)
Proximity to the LI (601–900 m)	10.296*** (-0.882)	-0.493 (-1.454)
Years of living in the locality (31–60)	-0.493* (-0.267)	-0.295 (-0.235)
Years of living in the locality (61–90)	0.452 (-0.51)	-1.377** (-0.6)
Constant	-12.041*** (-0.794)	0.195 (-1.557)

AIC (Akaike information criterion) value—1,786.93 | *—p < 0.1 | **—p < 0.05 | ***—p < 0.01.

DISCUSSION

This study reveals the multifaceted impacts of LI on avifauna, with respondents expressing mixed but predominantly neutral to negative perceptions. Key concerns include bird mortality from collisions and electrocutions, consistent with earlier studies (Bevanger 1998; Raman 2011; Loss et al. 2014; Serratosa et al. 2024). Environmentally conscious respondents emphasize the need for ecological integration in infrastructure planning (Kaltenborn & Bjerke 2002). Socio-demographic factors significantly influence perceptions. Younger individuals tend to be neutral, likely due to limited experience (Milfont et al. 2010), while tribal affiliation correlates with more neutral or positive views, reflecting cultural influences (Shelley et al. 2011; Bain 2017). Higher education corresponds to fewer negative perceptions, highlighting education's role in environmental awareness (Harris et al. 2016). Proximity to LI and occupation also affect attitudes, with those living closer and in labour-intensive jobs showing more negativity (Batel et al. 2015).

Multinomial logistic regression confirms that proximity to the LI had a very strong and significant association with negative responses across all distance categories. This indicates that individuals residing closer to the LI were substantially more likely to report negative responses, likely reflecting direct exposure to environmental, social, or economic externalities, and this supports the prior findings of spatial proximity to infrastructure often intensifying perceptions of risk (Dear 1992; Devine-Wright & Batel 2013). Non-tribal respondents showed higher odds of both negative and positive responses, suggesting greater polarization and engagement within this group. This contrasts with tribal populations, who may be structurally marginalized or less empowered to express dissent—a pattern noted in participatory governance literature (Cornwall 2008). Lower education increases the odds of negative perceptions, whereas both high school and graduate-level education significantly reduce the likelihood of negative responses. This finding may reflect greater resilience, access to information, or broader worldview among more educated individuals, allowing them to contextualize or mitigate concerns (Dietz et al. 2007). Similarly, long-term residents showed more positive views, indicating perceptual shifts linked to socioeconomic change (Manfredo et al. 2009; George et al. 2016). Local ecological knowledge accrued through experience remains vital for conservation (Ruan et al. 2022). Integrating avian conservation into LI planning supports critical ecosystem services like pollination, seed dispersal, pest control, enhancing biodiversity, ecosystem resilience, and community well-being.

CONCLUSION

This study reveals varied community perceptions on the impacts of LI on birds. Many of the respondents recognized negative effects like electrocution and collisions, but neutral views were common, indicating gaps in awareness and the influence of multiple socio-demographic factors. Perceptions varied by age, education, culture, occupation, and proximity to LI. Younger and tribal individuals tend to be more neutral in their perception of impacts, while uneducated and non-tribal respondents are likely to perceive more negative impacts. Those living closer to LI show greater concern about the impacts, whereas long-term residents are relatively less concerned, possibly suggesting shifting attitudes over time, and acclimatization.

These perception patterns do not necessarily reflect the full ecological impacts, as several bird groups—particularly raptors, hornbills, storks, and owls—are known from existing literature to be highly vulnerable to electrocution and collision. Strengthening environmental awareness among local communities, especially in areas undergoing rapid infrastructure expansion, will help bridge these gaps. The prevalence of neutral views points to a need for improved environmental education and awareness. Measures such as insulating power lines, installing bird diverters, and maintaining habitat buffers can substantially reduce risks. Incorporating bird conservation concerns into infrastructure development and involving local communities are essential to harmonize development with biodiversity conservation and overall ecosystem health.

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