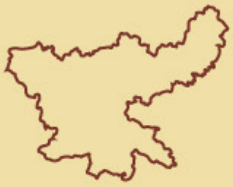
JHARKHAND



भारतीय वन्यजीव संस्थान
Wildlife Institute of India

ELEPHANT - HUMAN CONFLICT IN THE STATE OF JHARKHAND, INDIA (2000-2023)

TRENDS, CHALLENGES & INSIGHTS

March 2025

TR No./2025/05.

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Kashish Sherdia

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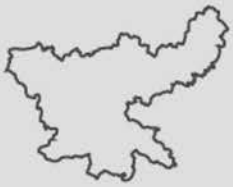

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Acknowledgements

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ADVISORS

Sh. Virendra R. Tiwari *IFS*
Director, WII

Dr. G. S. Bharadwaj *IFS*
ADG, (PT & E), MoEF&CC

PROJECT LEAD

Shri Ramesh K. Pandey *IFS*
IG, (PT & E), MoEFCC

PROJECT INVESTIGATORS

Dr. Bilal Habib
Scientist F & NO Tiger Cell

Dr. Anukul Nath
Scientist C & ANO Elephant Cell

Dr. Parag Nigam
Scientist G & NO Elephant Cell

Dr. Dheeraj Mittal *IFS*
AIGF, (PT & E), MoEF&CC

Dr. Aju Mathew George
Scientist C (PT & E), MoEF&CC

RESEARCHERS

Athira N G
Project associate-I

Kalpana Roy
Project associate-I

Ananya Dutta
Project associate-I

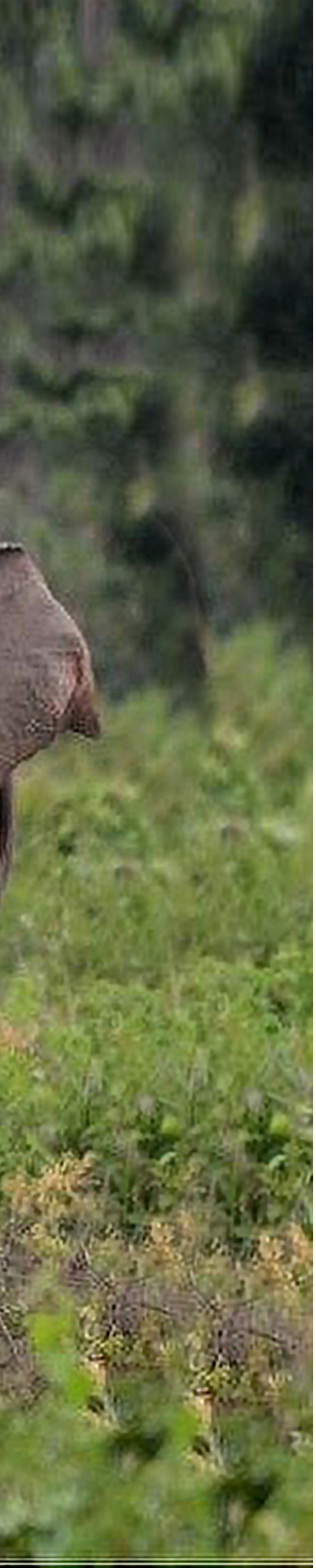


Table Of CONTENTS

EXECUTIVE SUMMARY

Human-elephant conflict (HEC) in Jharkhand has emerged as a critical conservation and socio-economic challenge, resulting in mortality of both humans and elephants. This report presents analysis of HEC from 2000 to 2023, covering data collected from 22 Forest Divisions. The study examines trends in land use and forest fragmentation, highlighting a 14.97% conversion in forest cover and increased habitat fragmentation as key drivers of conflict. Over the past 23 years, 225 elephant deaths (152 anthropogenic and 73 natural deaths) and 1,340 human fatalities have been recorded, with electrocution and train collisions identified as major causes. Conflict hotspots are concentrated in Ranchi, East Singhbhum, and Saraikela, where human expansion into traditional elephant corridors has intensified interactions. The findings highlights the urgent need for mitigation strategies, including habitat restoration, infrastructural modifications, and community-based conflict management to ensure coexistence between humans and elephants in the region.

Data Collection

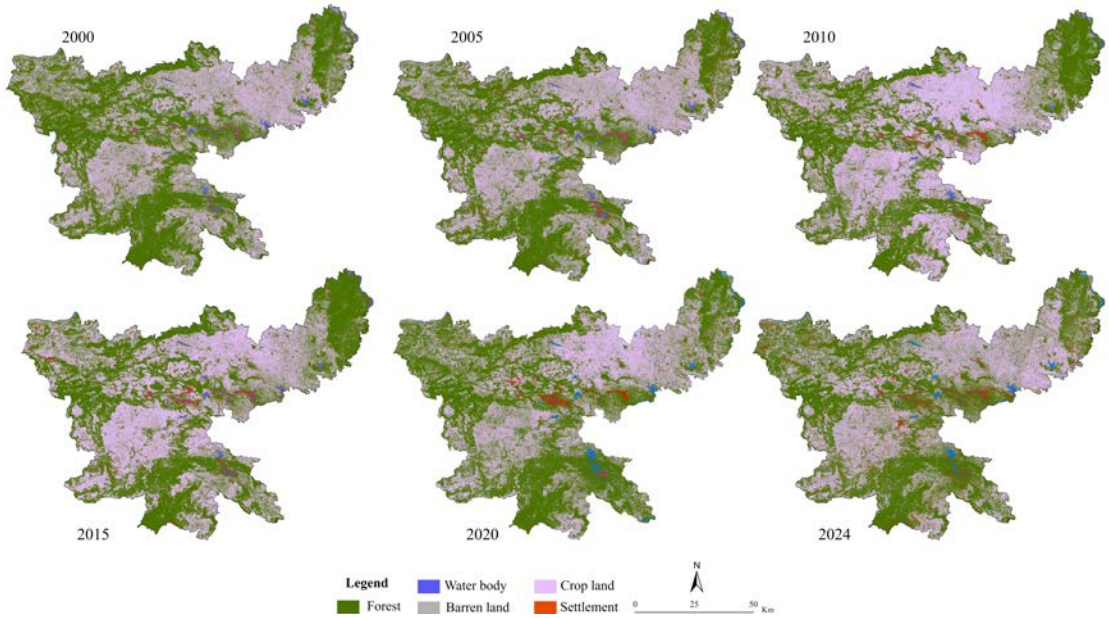
Data collected from **22 FOREST DIVISIONS**

(2000-2023)

- Data segregation: Human Deaths/Injuries and Elephant Mortality
- Temporal trends : Year wise and Seasonal trends of HEC incidents
- Spatial trends : Mapping HEC Hotspot, LULC changes, drivers of conflict

LULC (2000-2024) **225** Elephant Mortality **1740** HEC incident

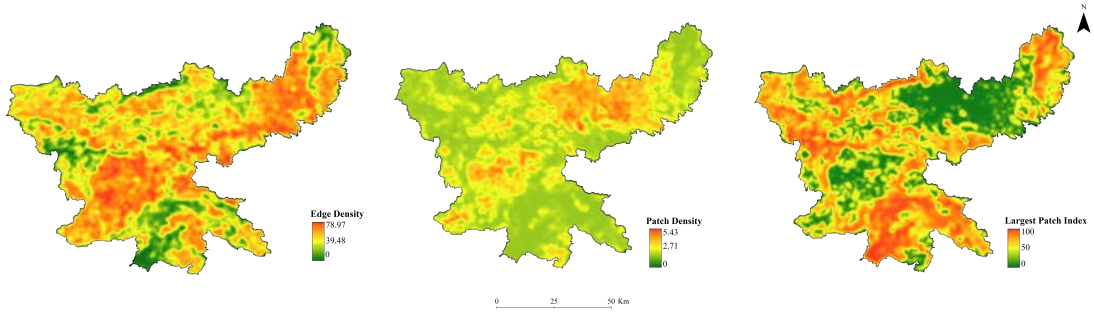
14.97% Change in forest cover



Selected Landscape Matrices (Forest Cover)

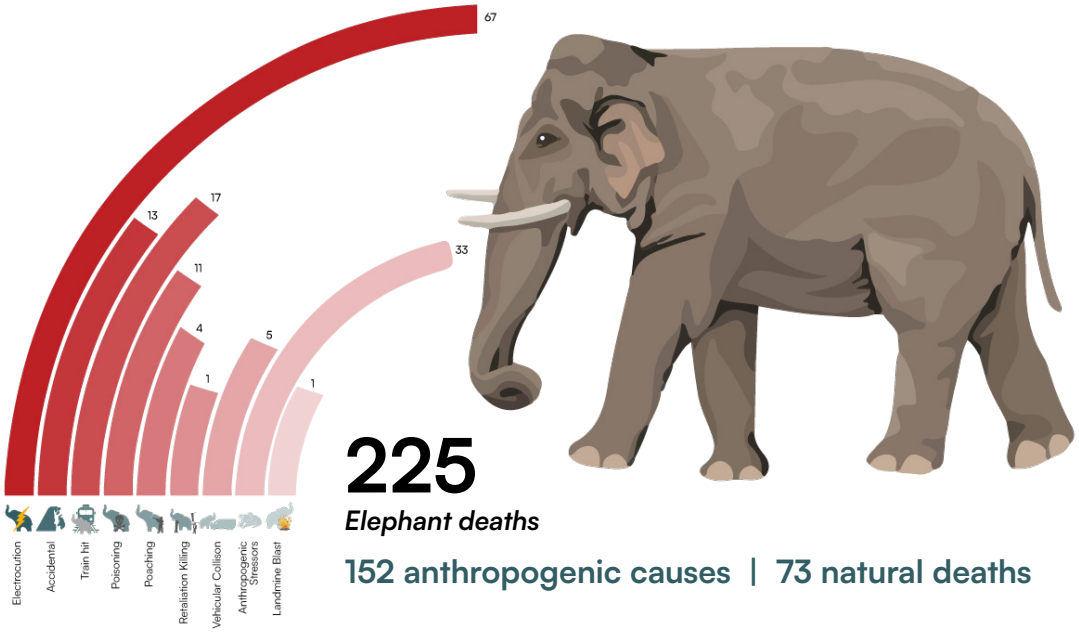
Edge Density
Largest Patch Index
Patch Density

Large forest patches remain intact the southeastern region, while central and southwestern areas exhibit high edge density and fragmentation, due to human activities such as agriculture, settlements, and infrastructure development.



Elephant Mortality

During the 23 years span, a total of 225 cases of elephant mortality were reported (Anthropogenic :152 ; Natural :73).



Electrocution emerged as the leading cause of human-induced mortality (67 deaths). The districts reported the highest number of elephant fatalities include Ranchi, East Singhbum, Saraikela.

Age Class Demography

The monsoon season recorded the highest number of fatalities. As forest degradation continues, elephants are increasingly forced into human settlements, where they are more vulnerable to electrocution, train collisions, and other infrastructure-related hazards (trenches, drains, water canals *etc.*).

39 Adult males

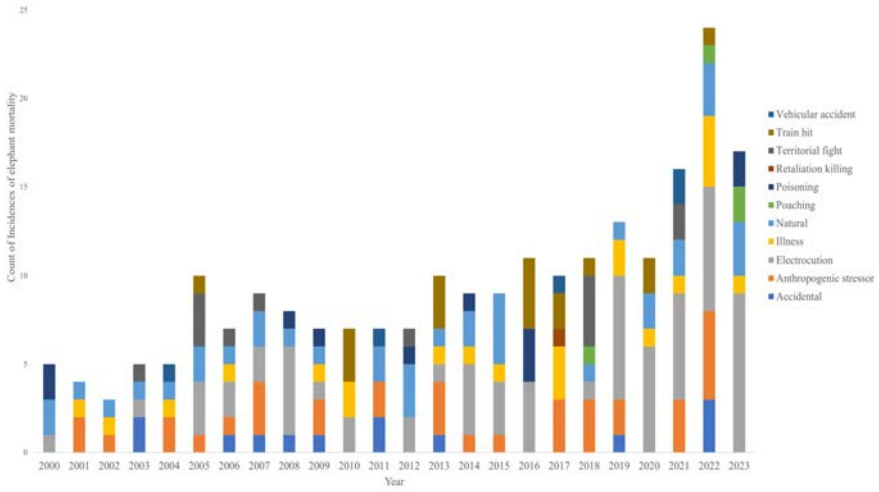
220 Sub adult males

35 Adult females

15 Sub-adult females

19 Calf

22 Yearlings



Elephant mortality characterized by proximity to agricultural fields, human settlements, and fragmented forest patches, have reported multiple elephant mortalities due to electrocution, train accidents, poisoning and poaching over the years. The expansion of railway tracks and poorly maintained power lines in these regions has contributed significantly to elephant deaths, highlighting the urgent need for infrastructural modifications and safety measures.

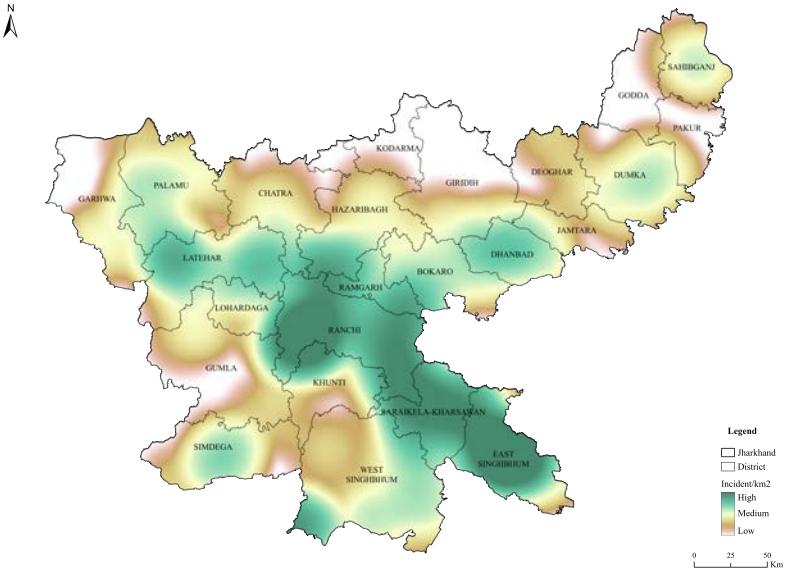
Spatial Distribution of Elephant Mortality

East Singhbum ***(18)***

Saraikela ***(18)***

Latehar ***(14)***

Dhanbad ***(10)***



1740 *Incidents*

Human Mortality

Between 2000 and 2023, 1,340 people lost their lives, and 400 were injured in encounters with elephants in Jharkhand.

1340 Human Deaths | 400 Human Injuries

Spatial Distribution of Human Casualties

(including fatalities & injuries)

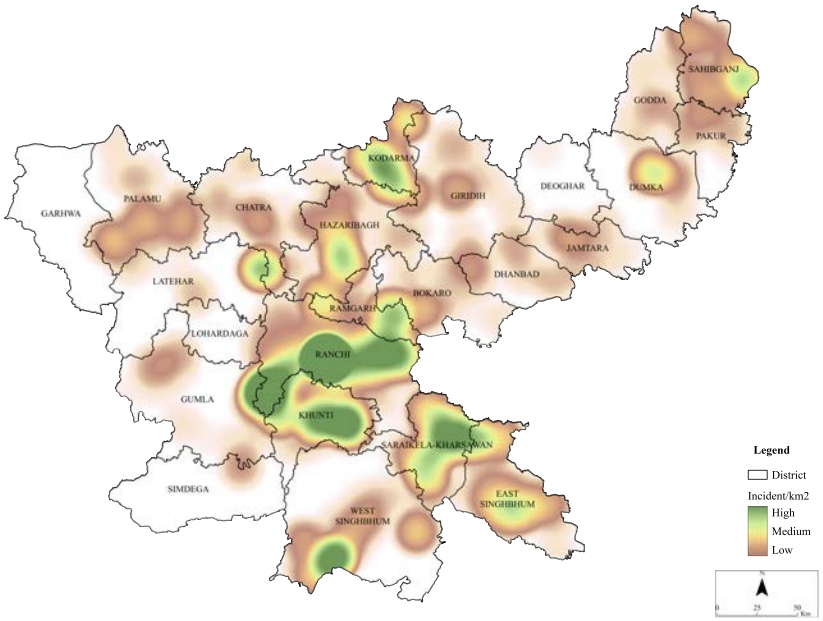
The spatial distribution shows a clear association between regions with dense human population, higher agricultural activities, and conflict hotspots are confined to Ranchi, Khunti, and East Singhbhum, divisions as major hotspots of conflict related causalities and human-elephant conflict was most severe in areas where human settlements and agricultural activities overlap with elephant habitats.

Ranchi *(585)*

Khunti *(147)*

East Singhbum *(76)*

Hazaribagh *(74)*

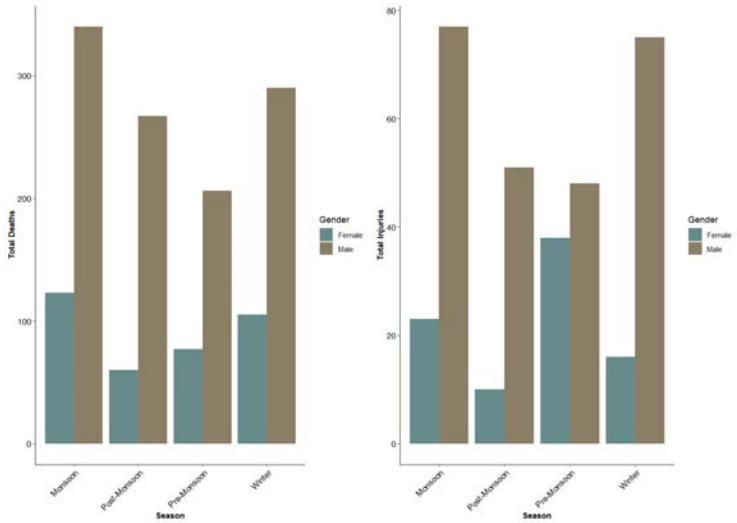


Seasonal variation in gender distribution of human casualties caused by HEC

Seasonal patterns emerge as a significant driver of conflict, with the monsoon season witnessing heightened incidents of human fatalities and injuries. During this period, increased agricultural activities coincide with the seasonal movements of elephants.

Conflict incidents peaked during the monsoon

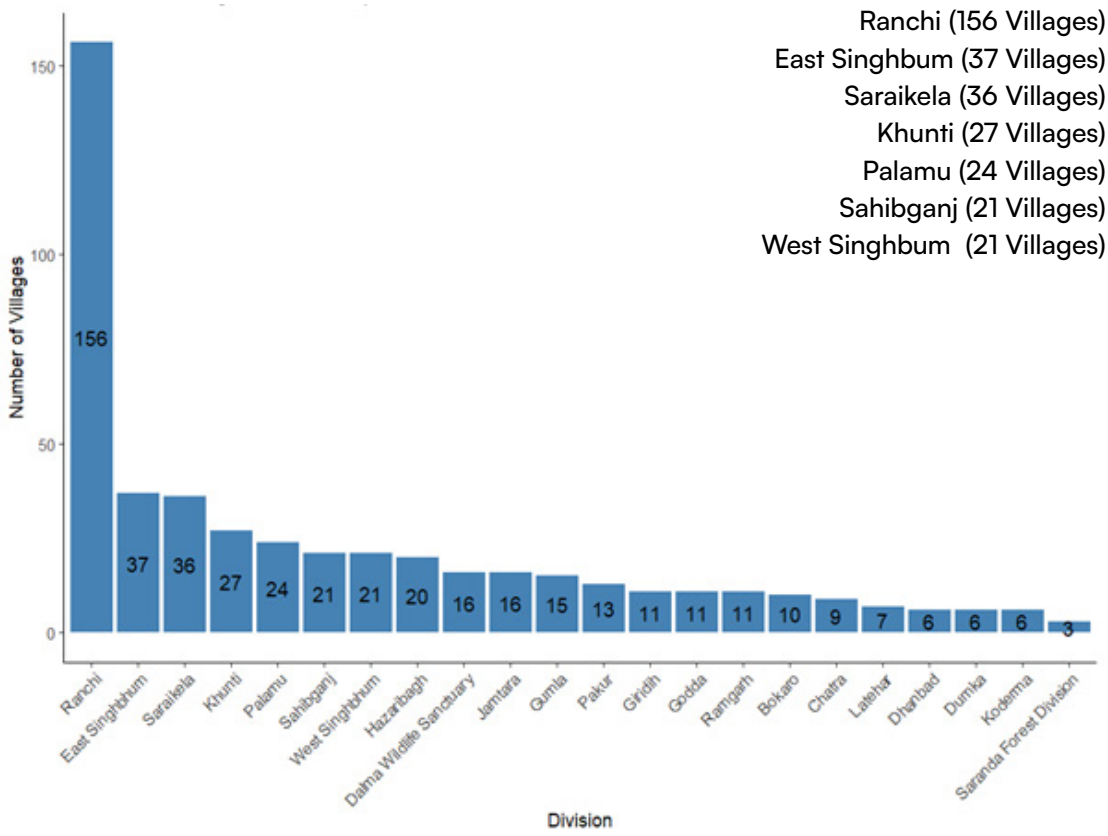
Male victims were significantly more prevalent across all seasons



Villages affected by HEC, categorized by divisions

480 villages experienced conflicts over the years.

Ranchi (156 Villages)
East Singhbum (37 Villages)
Saraikela (36 Villages)
Khunti (27 Villages)
Palamu (24 Villages)
Sahibganj (21 Villages)
West Singhbum (21 Villages)



Categorization of incident villages

ELEPHANT MORTALITY

HIGH > 5	1 VILLAGES
MEDIUM: 3-5	6 VILLAGES
LOW: 1-2	115 VILLAGES

HUMAN MORTALITY

HIGH > 20	14 VILLAGES
MEDIUM: 11-20	19 VILLAGES
LOW: 1-10	447 VILLAGES

A total of 122 villages were identified in the state where elephant mortality has occurred over 23 years with highest death in Tirilposi (7 deaths), Ghatshila CT (5 deaths), Panjri Khurd, Harhanji, Asan Bani, Ghutbahar (3 deaths). High incident villages are characterized by higher built-up areas and forest cover but lower crop percentage and road density. This suggests that elephants are present more where forested areas and human infrastructure intersects, that increases the likelihood of the conflict.

Villages with high cases include Ranchi (218 incidents), Titahia (30 incidents), Gajgaon (28 incidents), Bramhajamalpur (28 incidents), Bhuchungdih (27 incidents), Sarbaha & Koinara (26 incidents), Khokhro (25 incidents). These villages are characterised by dense forest cover, higher percent of crop cover, and high road density and built-up area. These findings underscore the multifaceted nature of HEC, where both ecological features and human activities contribute to the intensity of conflict.

Jharkhand's human-elephant conflict necessitates a comprehensive mitigation strategy addressing various risk factors. Electrocution incidents can be minimized through community awareness programs, promotion of elephant-safe low-voltage electric fencing, and regular inspection of electrical infrastructure to prevent illegal high-voltage setups. Collaboration between forest and electricity departments can ensure safer power distribution systems. To combat poisoning cases, fair and transparent compensation mechanisms for crop damage must be implemented, alongside the formation of community-led squads to deter elephants using non-lethal measures such as chili-based barriers. Train collisions can be reduced by implementing AI-based early warning systems, trackside vegetation management, constructing overpasses and underpasses at key elephant crossings, enforcing speed regulations, and enhancing coordination between railway and forest departments for real-time response. Vehicular accidents require strict speed reduction policies in elephant corridors, the installation of wildlife crossings such as underpasses and overpasses, and proper signage to alert drivers. Habitat degradation and anthropogenic stressors necessitate large-scale habitat restoration efforts, enforcing mining regulations, and fostering community engagement in conservation activities through sustainable land-use training programs. To curb poaching, strengthening on-ground patrols, deploying rapid response teams, engaging communities in monitoring efforts, and utilizing surveillance technologies like drones and camera traps will enhance protection. Effective human-elephant conflict management also involves physical barriers such as solar-powered and non-lethal electric fencing, trip-wire alarms, motion sensors, and light-based deterrents to warn communities of elephant presence. Strengthening village-level early warning systems using mobile apps and radio networks, forming Rapid Response Teams (RRTs), and conducting human-elephant coexistence training will help communities respond safely. Crop protection strategies such as cultivating elephant-resistant crops, promoting alternative livelihoods like honey production and eco-tourism, and using bio-fences with thorny plants can deter elephant incursions. Streamlining compensation schemes and introducing community-based insurance models will offer financial relief and stability to affected households. Long-term solutions must focus on securing and restoring elephant corridors, reforesting degraded habitats with native vegetation, and integrating strategic land-use planning that aligns conservation goals with community welfare. By implementing these holistic measures, Jharkhand can work towards fostering a sustainable and balanced landscape where human and elephant populations coexist with minimal conflict.

CHAPTER 1:
Elephant Mortality in the State of Jharkhand (2000-2023)

1.1. Introduction

A critical conservation issue that has broad ramifications for both the preservation of wildlife and human livelihoods is the growing human-elephant conflict (HEC) in India. Asian elephants have historically wandered freely between habitats in India's vast and interconnected forested landscapes (Sukumar, 2003). These landscapes have been severely disrupted, nevertheless, by post-colonial land-use changes, infrastructural development, and agricultural intensification. Elephant habitats have shrunk to smaller, isolated areas that are frequently surrounded by human settlements as a result of human populations increasing in tandem with agricultural (Choudhury, 1999). Elephant's access to natural resources has been restricted by their confinement, which has forced them to seek food and water in human-dominated regions, increasing the likelihood of human elephant interaction and conflict (Leimgruber *et al.*, 2003). In today's scenario, expanding agriculture and infrastructure and their prolonged impacts have fragmented and degraded elephant habitats due to which HEC is more pervasive than ever (Madhusudan *et al.*, 2015). Elephants, being generalist herbivores, often find high-quality forage in agricultural areas, leading to frequent crop-raid incidents, which create significant economic losses for local communities.

In Central Indian landscape, especially Chota Nagpur Plateau, where forested areas are patchy and interspersed with rural settlements, elephants frequently traverse cultivated lands, resulting in increased conflict with residents (Mandal and Das Chatterjee, 2023). This pattern of conflict has contributed to retaliatory killings of elephants and has made HEC one of the primary causes of non-natural elephant mortality in India (Gubbi *et al.*, 2014). Human and elephant deaths, property damage, and psychological stress for nearby populations are all consequences of HEC that go beyond financial losses (Shaffer *et al.*, 2019a). For instance, from 2010 to 2020, India reported thousands of human deaths attributed to elephant encounters, with states like Jharkhand recording some of the highest incidences(Guru and Das, 2021a). In the State of Jharkhand, till 2014, the length of National Highways was 2,402 km. In 2018, the length of National Highways reached 7,791 km (NHAI report). The total area under irrigation canals amounts to 560.54 hectares roughly (Water Resource Department of Jharkhand). According to the FSI, 1999 elephant habitat in Jharkhand consisted of an area of approximately 6000 sq km, with a range of 600-700 elephants (The population census done before Jharkhand in 2000 separated from Bihar, also holds the elephant population of Bihar) but in the latest MoEF&CC study in 2017 it showed an estimated area of approximately 3800 sq km with 678 elephants left (Sukumar, 2006; Menon *et al.*, 2017). It also shows limitations of space for an increased population. Every year, long-distance elephant jaunts from the Jharkhand's Singhbhum and Dhalbhum forests to adjacent states of Chhattisgarh, West Bengal and Odisha are observed (Palei *et al.*, 2016) . Therefore, it can be said that Jharkhand has an ecologically rich elephant habitat and serves as a link between the elephant population of these three states for dispersion and movement. This region has undergone rigorous changes due to building highways, railways, canals leading to mining, changing agriculture (Latif & Palita, 2023). Due to such anthropogenic stressors elephants have started advancing into areas of Hazaribagh, Ranchi, Ramgarh, Bokaro, Dhanbad (Menon *et al.*, 2017). The stay spans of migrating elephants from Dalma Wildlife Sanctuary, Jharkhand to Panchet Forest Division, West Bengal increased with successive years (Chatterjee and Chatterjee, 2014; Chatterjee and Mandal, 2019). The limited scattered ecosystems, with interspersed agriculture land use in and around, affect the range expansion of elephants during the monsoon season, and have become a cause of concern for human-elephant conflicts (Khanna *et al.*, 2001; Shaffer *et al.*, 2019b). The dynamic and evolving nature of HEC necessitates understanding not only current patterns but also historical trends to inform effective conflict mitigation strategies. A fundamental knowledge of the patterns and influences that have molded modern HEC can be gained from historical data. Researchers can find spatial and temporal patterns using longitudinal data on land-use changes, conflict events, and elephant and human death. This information can be crucial for comprehending how conflict hotspots develop over time (Leimgruber *et al.*, 2003). Furthermore, understanding historical patterns allows for assessing the long-term effectiveness of mitigation strategies, revealing whether certain interventions have reduced or inadvertently intensified conflict(Fernando *et al.*, 2008). In the present study, we pose the following research questions specific to the scenario of elephant mortality in Jharkhand:

(i) How have the causes of elephant mortality and their spatial distribution across Jharkhand shifted over the past two decades (2000—2023)?

(ii) Is there a significant association between the age and demographic characteristics of deceased elephants and specific causes of mortality, with a focus on anthropogenic stressors?

(iii) How have changes in land use and land cover (LULC) during this period potentially influenced these mortality patterns?

We hypothesize that changes in LULC including modifications to natural vegetation, landscape fragmentation, intensification of agriculture, and urbanization are major predictors of human-elephant conflict (HEC) in Jharkhand (Lambin *et al.*, 2001). We also anticipate that proximity to protected areas (Sukumar, 1989; Ramesh Kumar, 1994) and the rapid expansion of linear infrastructures (*e.g.*, roads and railways) contribute to an increased frequency of conflict incidents (Sukumar, 2003; Johnsingh *et al.*, 2010; Ramesh *et al.*, 2012a; Sukumar and Pani, 2016). Other factors potentially degrading elephant habitats include intensive cattle grazing at forest edges and limited distance from water sources. The results of this study aim to provide a comprehensive framework for mitigating HEC in Jharkhand, reducing both elephant and human casualties. By informing policy and guiding land-use planning, this research offers strategic solutions to support the long-term conservation of elephants within Jharkhand's increasingly fragmented landscape.

1.2. Study Area

Jharkhand encompasses 79,716 sq.km, which is abundant in natural resources and has heavily forested areas that have become important Asian elephant habitats. This area's varied terrain, which includes valleys, hills, and plateaus, creates a stunning environment that strikes a balance between areas used for agriculture and mining and forest areas. Approximately 29% of Jharkhand's land area is covered by woods. Tropical moist deciduous forests, tropical dry deciduous forests, and various tracts of sal woods (*Shorea robusta*) make up the majority of these habitats.

The state experiences a subtropical climate with a monsoon period from June to September. The average annual precipitation is approximately 1,398 mm, predominantly received during the monsoon season, while the temperature ranges from 5°C in winter to 45°C in summer long term (Kumar et. al. 2013). The state's population, as per the 2011 Census, is around 32.96 million, with a sex ratio of 947 females per 1,000 males (CENSUS OF INDIA 2011). The literacy rate is 67.63%, with significant rural-urban disparities. Educational attainment among tribal communities remains a key area of concern due to systemic challenges (Kumar, 2008). Jharkhand has a substantial tribal population, constituting about 26.21% of its total population. These communities often rely on subsistence agriculture and forest resources, with a significant proportion holding marginal or small landholdings. Socio-economic studies revealed that annual incomes for many tribal households are below ₹30,000, and unemployment rates remain high in these communities (Islam *et al.*, 2014). Furthermore, the state has seen varying impacts of socio-economic development, influenced by factors such as education, health infrastructure, and access to resources (Prakash, 1998).

Important elephant habitats in the state are Saranda Forest, Palamu Tiger Reserve, and Dalma Wildlife Sanctuary. Besides being a habitat for local elephants, these areas also act as corridors for migration of elephants from one state to the neighbouring states like West Bengal, Odisha, and Chhattisgarh (Sukumar, 2006). There is a seasonal migration of elephants at pre-monsoon and post-monsoon times in search of water and food by elephants (Anoop *et al.*, 2023a). These migrations often bring them in contact with human settlements and increase their human-elephant conflict (Choudhury, 2004a). The presence of bamboo grass and fruiting trees during these seasons in the forests of Jharkhand draws the elephants to those areas, but habitat fragmentation increases the chances of conflict with the local communities (Sukumar, 2006)

Industrialization in the form of mining and infrastructure development has considerably altered the routes of the elephants over the last few decades. Jharkhand is the biggest coal and iron ore-producing state in the country, with numerous mines located either inside or in proximity to the large elephant habitats (Saini *et al.*, 2016). This has caused the fragmentation and degradation of forests, pushing the elephants out of their natural habitats into human-dominated landscapes such as farmlands and villages. Expansion and development of road networks, railroads, and other infrastructure have already limited elephant movement and heightened human-elephant conflicts over land (Talukdar *et al.*, 2024c). For the communities living in and around such forests, who mainly depend on resource usability in these forests for their survival, encounters with elephants are likely to pose significant threats to their safety and security (Barua *et al.*, 2013).

1.3. Methods

1.3.1. Data Analysis

We compiled a database documenting 225 elephant mortality cases over a 23-year period. Each mortality case was categorized based on:

(1) cause of death,
(2) time of incident (year, month, and season: monsoon, post-monsoon, summer, and winter),
(3) division-wise distribution, and
(4) age and demographic details of the deceased elephant.

The causes of death were further classified (Table 1.1), with accidental deaths encompassing incidents caused by natural calamities such as drowning, lightning strikes, and falls from hills. Age groups were categorized as calves (0—1 year), juveniles/ yearlings (1—5 years), sub-adult males and females (6—15 years), and adult males and females (16+ years) following Arivazhagan & Sukumar (2008). Logistic regression models were applied to assess the probability of different causes of death (*e.g.*, poaching, electrocution, and human-elephant conflict) in relation to age groups and regions. This analysis aimed to determine which age groups were most vulnerable to specific threats.

Table 1.1: Causes of elephant deaths and their categorization

Causes of Elephant deaths	Indirect/ Direct sources	Categories
Still birth, old age, heart attacks, Malnourishment, heat stroke, dehydration	Natural	Natural
drowning, lightning strikes, fall from hills	Natural calamities, accidents	Accidental
Poisoning, pesticide poisoning	Retaliation killing, HEC	Poisoning
Poaching	HEC	Poaching
Illness	Genetic disorders, spreading of diseases	Illness
Territorial fights	Natural behavior, Interspecies conflict, decrease in territorial space	Territorial fights
Stuck in drains, falling into canals, wells and trenches	Anthropogenic climate change, stress due to human infrastructures	Anthropogenic stressors

1.3.2. Land Use and Land Cover Change & Influencing Factors of Elephant Mortality

The data was analysed in five-year intervals (2000—2005, 2005—2010, 2010—2015, 2015—2020, and 2020—2023) using Landsat 5 TM and Landsat 8 OLI satellite imagery (2000—2024) at a 30 m spatial resolution. Jharkhand falls under UTM Zone 46. The classification process utilized six spectral bands (blue, green, red, NIR, and two SWIR), while the QA band was applied for cloud and shadow masking. A total of 1,250 random points were collected for training and validation of the Random Forest (RF) classifier, with 70% used for training and 30% for validation in each iteration. Accuracy assessment was conducted to evaluate classification performance. Image processing and classification were performed using Google Earth Engine (GEE), while ArcGIS Pro was used for sub-setting, fragmentation analysis, distance measurements, and map preparation. The Landsat dataset was classified using a supervised pixel-based RF algorithm from the "smileRandomForest" library in GEE, mapping five land-use/land-cover (LULC) categories:

(1) forest,
(2) water,
(3) barren land,
(4) agriculture and
(5) settlement.

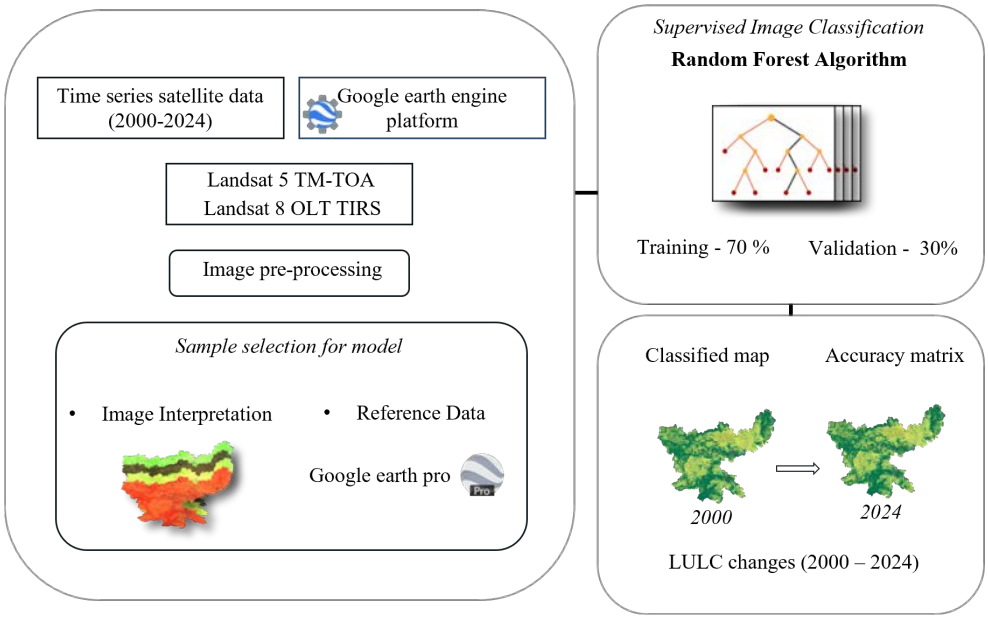


Figure.1.1: Land Use Land Cover Analysis Flowchart

To assess forest fragmentation, Patch Density (PD), Edge Density (ED), and Largest Patch Index (LPI) were extracted from the LULC maps using FRAGSTATS v.4.2. The spatial distribution of elephant mortality was analyzed through kernel density estimation in ArcGIS to identify mortality hotspots across divisions and villages. To determine the impact of ecological and anthropogenic factors on elephant mortality, Generalized Linear Models (GLMs) with a binomial distribution were applied in R (version 4.3.1). Mortality incidents (excluding natural deaths) were coded as 1, while pseudoabsence locations (coded as 0) were generated using a two-step approach: random point selection and spatially representative non-mortality zone selection.

The GLM analysis included 12 explanatory variables: distances to forests, croplands, built-up areas, roads, railways, mines, water bodies, protected areas, and elephant reserves, along with edge density, patch density, and the largest patch index derived from FRAGSTATS. Hypotheses supporting each variable were formulated (Table 1.2). Model performance was evaluated using Akaike Information Criterion (AIC), with models having $\Delta AIC \leq 2$ considered well-supported (Burnham and Anderson, 2002). The "MuMIn" package in R was used for model ranking. The global model, which included all predictor variables, encountered convergence issues. As a result, the model estimates were unreliable. This second model successfully converged, providing stable parameter estimates. Model selection criteria, including AIC and likelihood ratio tests, indicated that the refined model performed comparably to the global model while avoiding convergence issues. Thus, the second model was considered more appropriate for interpretation and further analysis.

Table 1.2: A priori hypotheses for all environmental variables corelating elephant deaths

Feature	Variable	Description and Source	A-priori hypothesis
Landcover	Distance from Built-up (db)	Classified landcover types, such as built-up areas, cropland, forests, and waterbodies, were used to calculate distances between conflict points and each landcover type using the Near Table tool in ArcPro 3.0.0.	Higher elephant mortality near settlements due to increased human-elephant interactions.
	Distance from Cropland (dc)		Proximity to cropland increases mortality risk due to electrocution and retaliation.
	Distance from Forest (df)		Mortality risk decreases with distance from forests, which provide essential resources.
	Distance from Waterbodies (dw)		Proximity to waterbodies lowers mortality risk by reducing movement into human areas.
	Edge density (ed)	Edge density represents the total length of transitions between different landcover types per unit area. The distance from edge density is calculated by measuring how close conflict points are to areas with high edge density using GIS spatial analysis tools.	Higher edge density increases mortality risk due to habitat fragmentation and human interaction.
	Largest Patch Index (lpi)	The Largest Patch Index measures the size of the largest continuous habitat patch within a landscape. Distance to the Largest Patch Index is calculated by determining the distance between conflict points and the largest habitat patches through GIS spatial analysis.	Elephants near large habitat patches have lower mortality risk due to resource availability.
	Patch Density (pd)	The Patch Density quantifies the number and distribution of habitat patches within a landscape. Distance from the Patch Index is calculated by assessing how close conflict points are to areas with high patch density using GIS tools.	Higher patch density increases fragmentation and human-elephant conflicts.
	Distance from Mining Areas (dmn)	Distance from mines and quarries digitized using Google Earth Pro and Near Table tool (ArcPro 3.0.0)	Mortality risk increases near mining areas due to habitat destruction and increased human presence.
Anthropogenic	Distance from Railways (drail)	Railway network shapefiles were sourced from OpenStreetMap.org, with distances calculated using the Near Table tool in ArcPro 3.0.0.	Close proximity increases mortality risk from train collisions and habitat fragmentation.
	Distance from Road (dr)	Road network shapefiles were sourced from OpenStreetMap.org, with distances calculated using the Near Table tool in ArcPro 3.0.0.	Higher mortality risk due to vehicle collisions and habitat disturbance.
	Distance from Protected Areas (dpa)	Distance between elephants and protected area boundaries was calculated using shapefiles from the Elephant Cell at the Wildlife Institute of India (WII), processed in ArcPro 3.0.0.	Lower mortality risk near protected areas due to reduced human pressure.
	Distance from Elephant Reserve (der)	Distances were measured between elephant reserves and conflict points to evaluate the role of these areas in mortality risk.	Lower mortality risk near reserves due to sufficient resources.

1.3.3. Village Categorization for Elephant Mortality

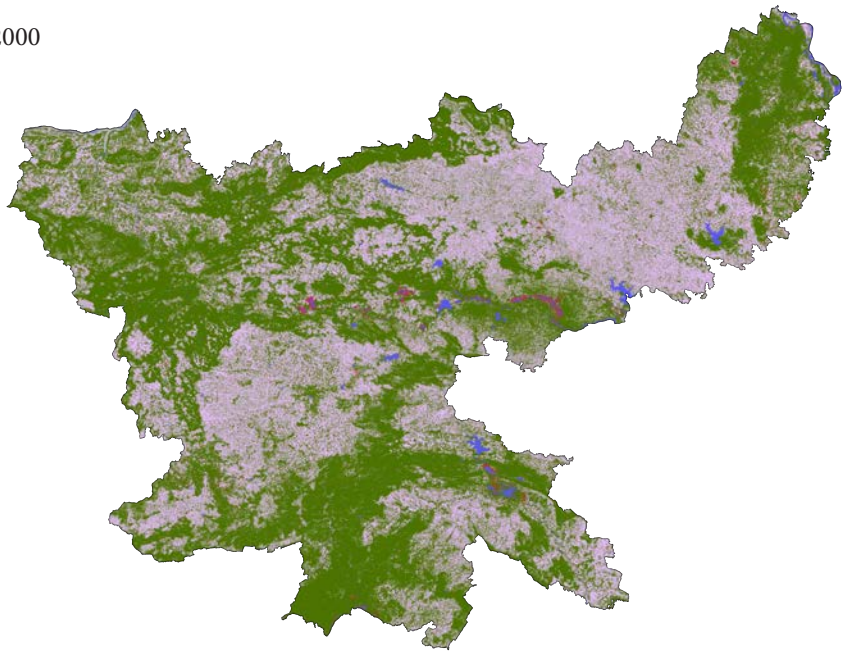
To examine the spatial distribution of elephant mortality in Chhattisgarh, villages were categorized into three risk levels: low (0—2 deaths), medium (2—5 deaths), and high (more than 5 deaths). This classification helps in identifying key environmental factors influencing elephant mortality, including forest cover percentage, crop cover percentage, mine density, water density, built-up density, road density, and railway density. Understanding these spatial patterns enables targeted conservation and mitigation strategies, particularly in high-risk areas, focusing on habitat restoration, human-elephant conflict management, and infrastructure planning to reduce mortality incidents. The village boundaries were obtained from the ArcGIS Online, shapefile : Indian Administrative Layer 2024.

1.4. Results

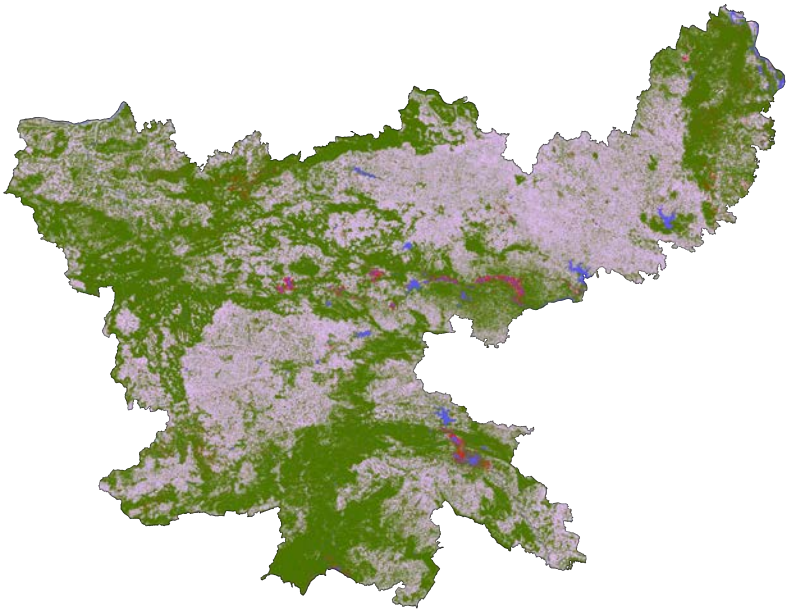
1.4.1. Temporal Trends and Land Use Land Change Patterns in Elephant Mortality

The land cover change analysis from 2000 to 2024 showed notable changes in forest cover, water bodies, barren land, cropland, and built-up areas. Forest cover showed a decreasing trend, decreasing from 48,440 km² in 2000 to 41,194 sq.km in 2024. Cropland expanded significantly, peaking at 41,628 km² in 2015 (+23.36%) before falling to 29,239 km² in 2024 (-1.76%). Built-up areas demonstrated continuous expansion, increasing from 2000 to 2024, with the highest surge observed between 2020 and 2024 (+93.34%). Additionally, transition matrix highlighted the conversion of forest cover primarily to cropland (33.2%), built-up areas (1.17%), and barren land (1.3%), while cropland has been onverted to built-up areas (7%) and other land categories (Fig. 1.2 a-f).

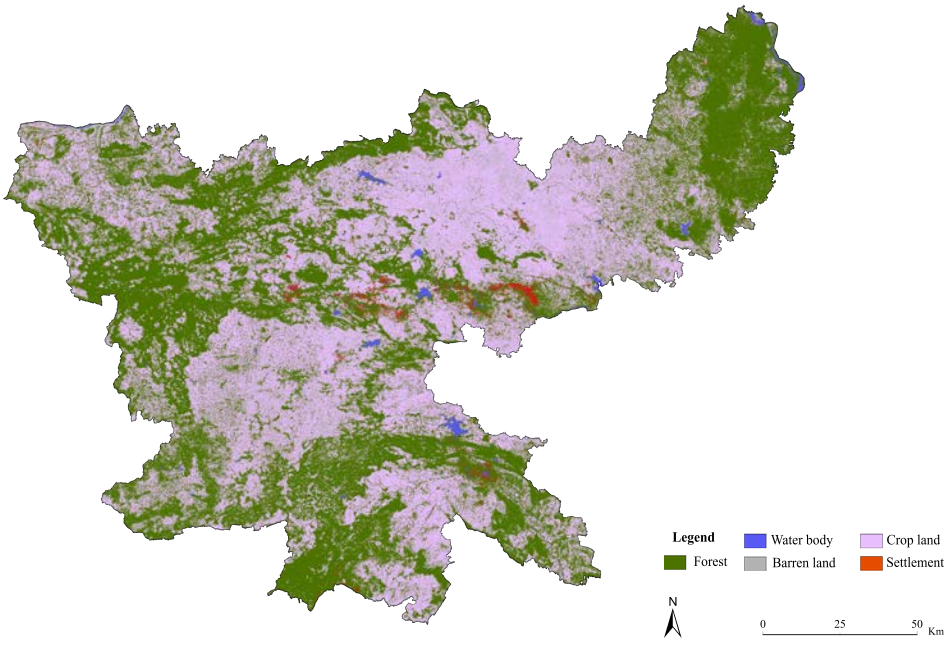
a) Year 2000



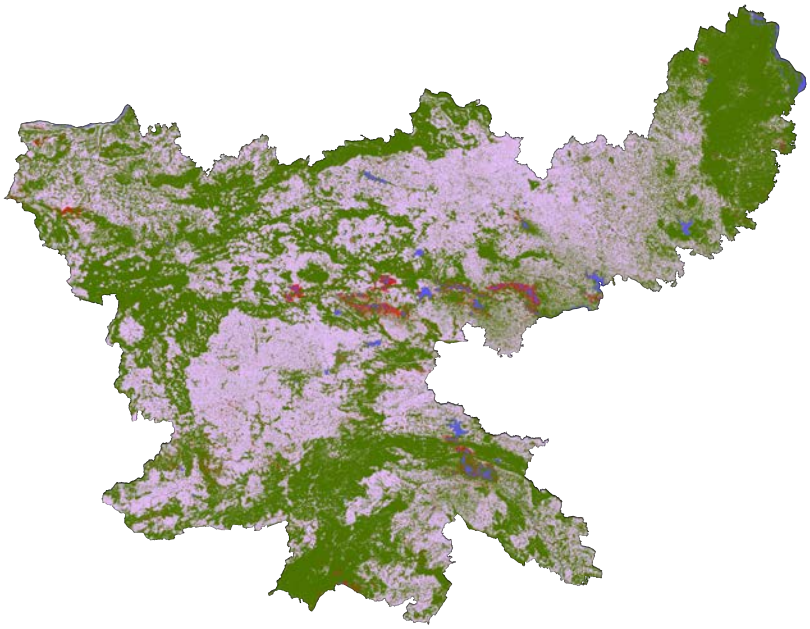
b) Year 2005



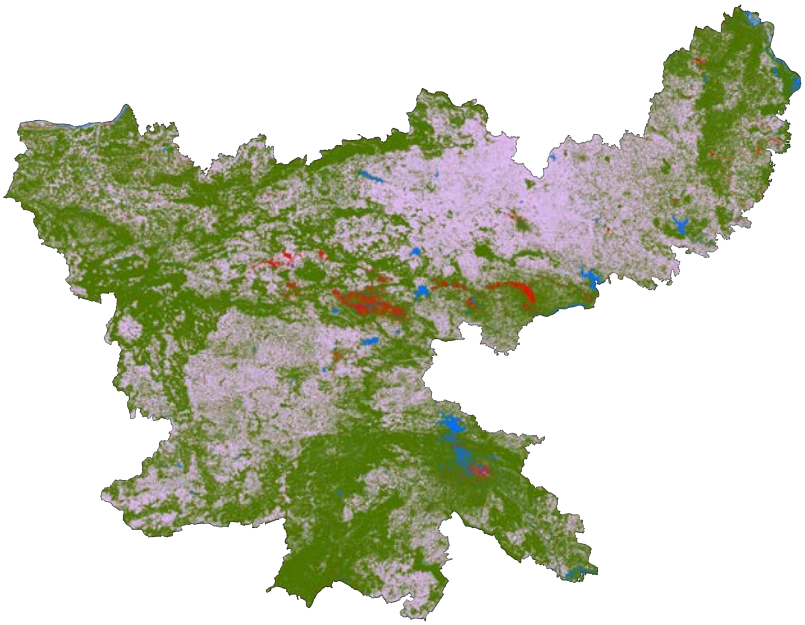
c) Year 2010



d) Year 2015



e) Year 2020



f) Year 2024

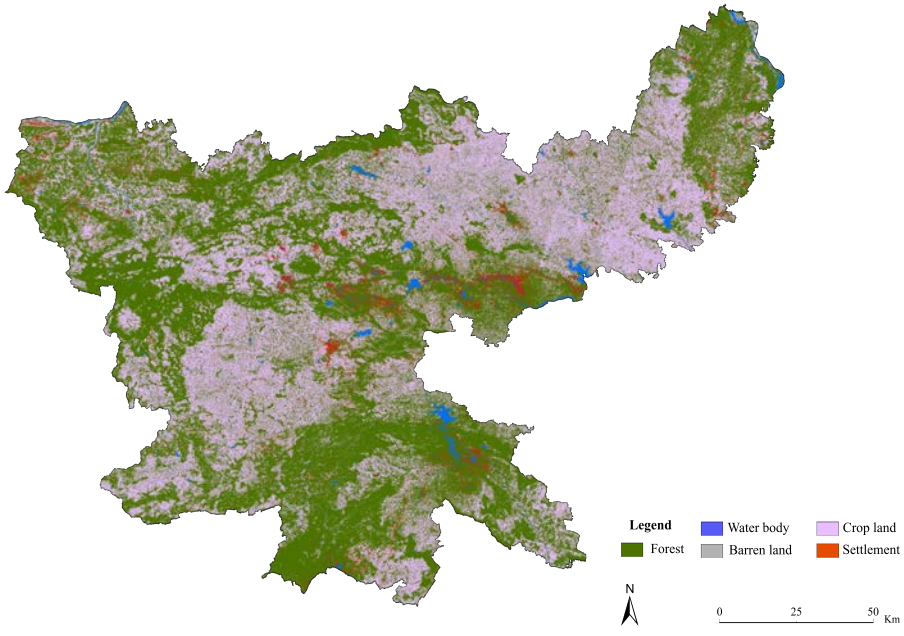


Figure 1.2: Land Use Land Cover (LULC) of Jharkhand from year 2000-2024 (a-f respectively).

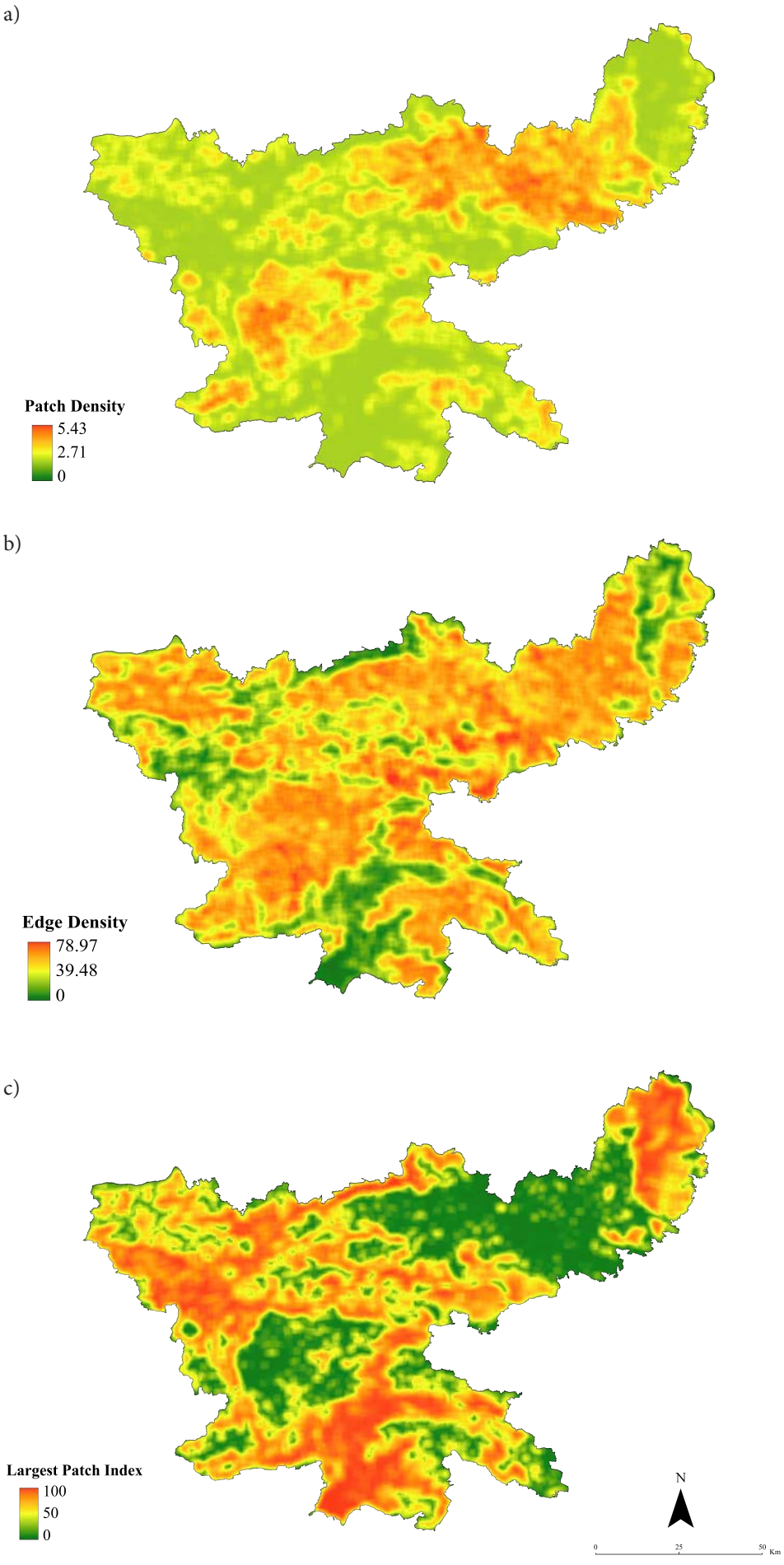


Figure.1.3 (a-c): Spatial Distribution of Patch Density, Edge Density, and Largest Patch Index in Jharkhand respectively.

1.4.2. Temporal trends and spatial distribution of elephant mortality

During the 23 years span, a total of 225 cases of elephant mortality were reported. Among them 60 cases were from natural deaths, Territorial fight : 13 and Anthropogenic cases 152 (including Accidental deaths: 13 ; Anthropogenic stressor : 33 ; Electrocution: 67 ; Landmine blast: 1 ; Poaching: 4 ; Poisoning: 11 ; Retaliation killing: 1 ; Train hit: 17 ; Vehicular Accident: 5).The highest number of deaths were reported in the year 2022 (Fig.1.4). Electrocution emerged as the main cause of elephant mortality (χ^2=2.1316, df = 1, p-value = 0.1443). Distribution of age group due to anthropogenic causes differed significantly (χ^2 = 19.158, df = 5, p-value = 0.0017), with adult male (39) having the highest number of mortalities, followed by adult female (35), sub adult male (22), yearling (21), sub adult female (15) and calf (19) Monsoon (56 deaths) accounts for the most elephants' deaths (χ^2 = 44.382, df = 4, p-value = 5.345e-09), followed by post-monsoon (43), winter (33) and pre-monsoon (20) (Fig. 1.5). Ranchi division (30 deaths) had the highest number of deaths with electrocution (16 deaths) and train hit (3 deaths), then East Singhbum (18 deaths) with electrocution (18 deaths) then Saraikela division (14 deaths) with electrocution (11 deaths) (Fig. 1.6).

This pattern was also observed in our kernel density-output, highlighting these areas as the hotspots for elephant deaths in the state (Fig.1.7).

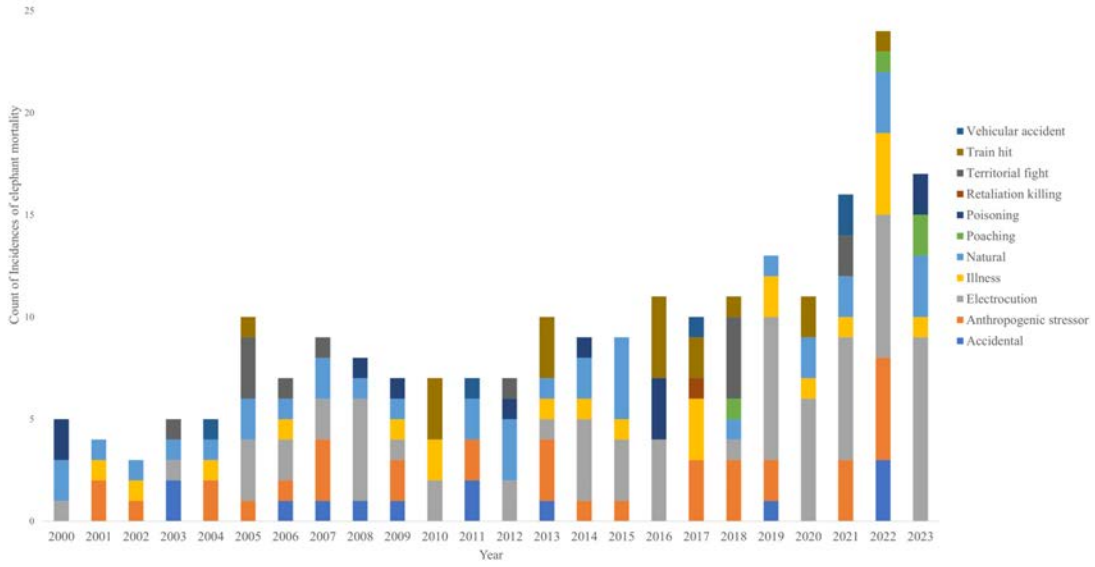


Figure 1.4. Temporal trends of elephant mortality in Jharkhand from 2000 to 2023

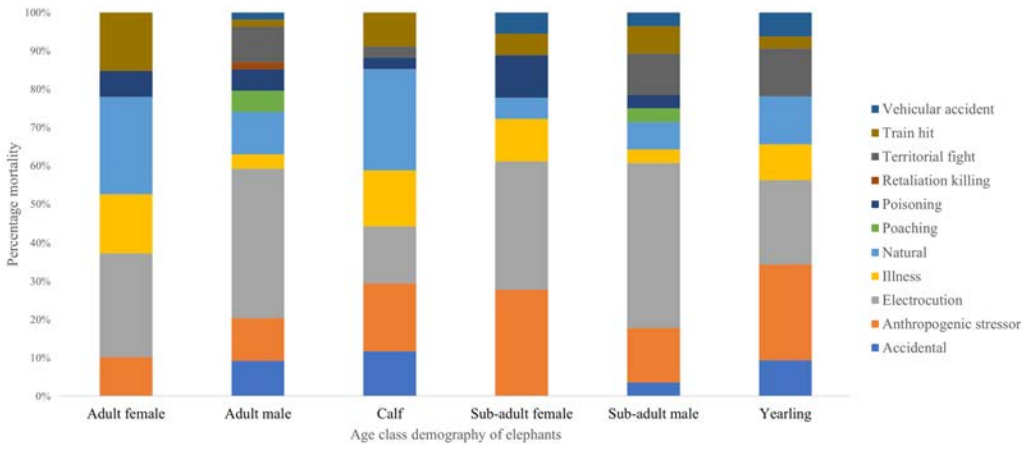


Figure 1.5. Causes of Elephant mortality in relation to age class demography

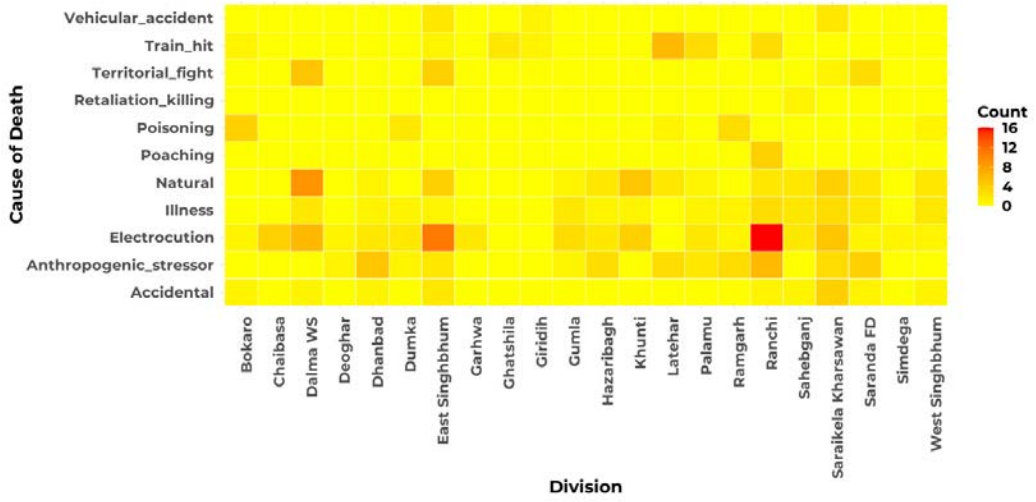


Figure 1.6: Heatmap showing distribution pattern of Elephant mortality in different divisions of Jharkhand

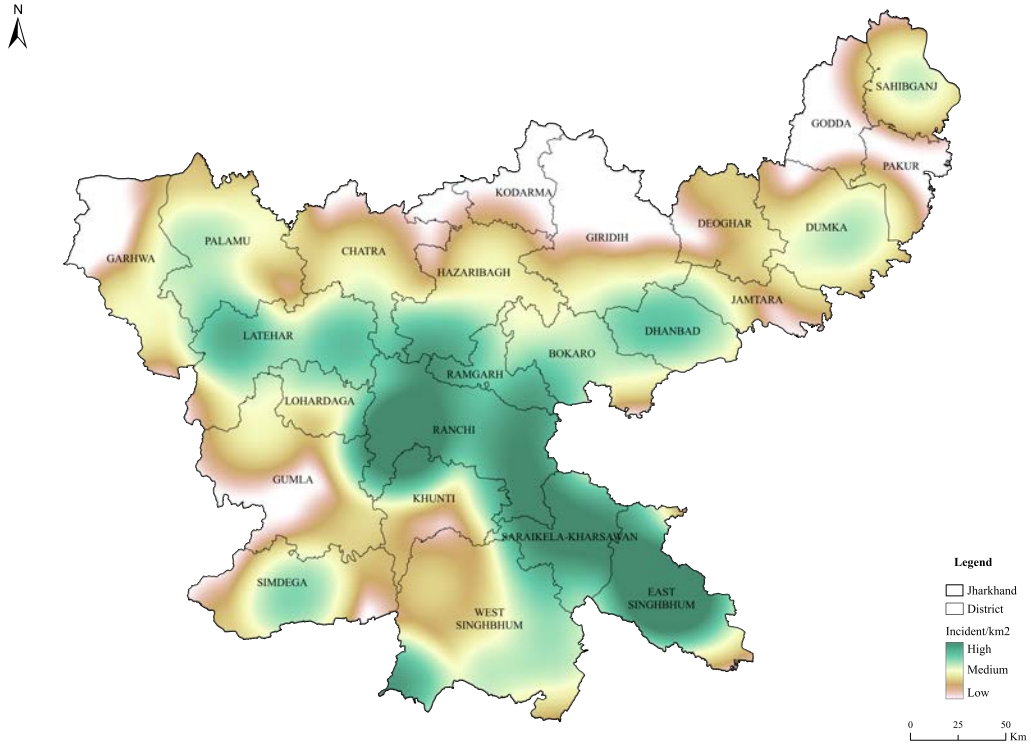


Figure 1.7: Kernel density map of Jharkhand highlighting high, medium and low mortality zones for elephant mortality

1.4.3. Natural Deaths of Elephants

During the 23-year span, a total of 225 cases of elephant mortality were reported in Jharkhand. Among them, 73 cases were attributed to natural causes. Age-wise distribution revealed that adult females (23) had the highest mortality, followed by calves (15), adult males (14), yearlings (11), sub-adult males (6), and sub-adult females (3). Natural deaths, which accounted for 60 cases, were primarily observed in adult females (23) and calves (14), followed by adult males (9), yearlings (7), sub-adult males (3), and sub-adult females (3). Territorial fights contributed to 13 deaths, predominantly affecting adult males (5) and yearlings (4), with sub-adult males (3) and calves (1) also impacted.

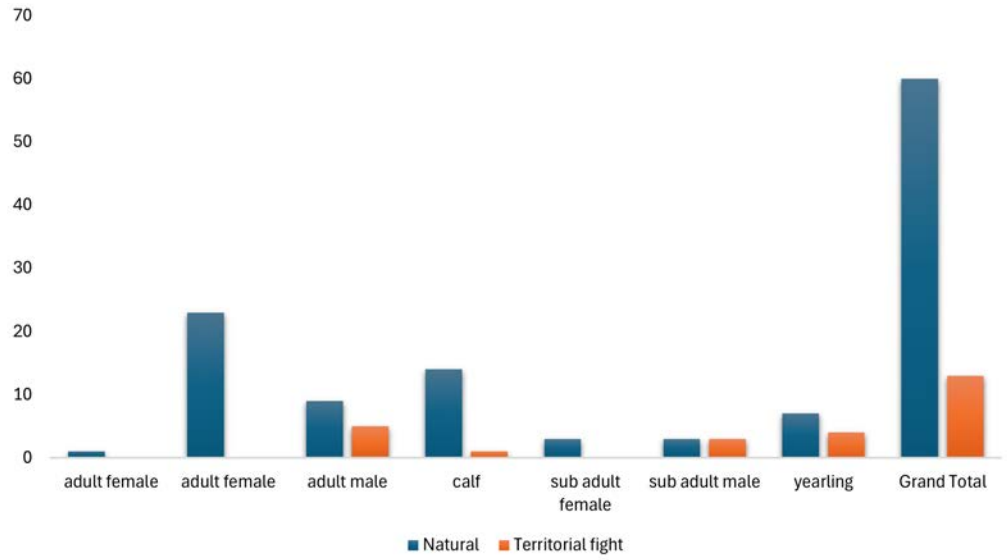


Figure.1.8. Natural reasons elephant deaths distribution in Jharkhand from 2000-2023

1.4.4. Factors influencing elephant mortality and village characteristics

A total of 122 villages were identified in the state where elephant mortality has occurred over 23 years (Appendix 1). Out of 6 environmental variables that were taken to see the characteristics of the villages where the deaths have been happening showed a variance in results. High incident villages have higher built-up areas (Kruskal- Wallis: χ^2 = 2.31, p = 0.509; Fig 1.9a). High incident villages have high forest cover (χ^2 = 4.92, p = 0.17; Fig.1.9b). High incident villages have very low crop percentage on comparison of medium and low incident villages (χ^2 = 4.88, p = 0.18 Fig. 1.9c). High incident villages have lower water density on comparison with medium and low incident villages (χ^2 = 0.82, p = 0.84; Fig. 1.9d). High incident villages have lower road density, (χ^2 = 9.47, p = 0.023; Fig.1.9e). Post hoc Dunn's test showed significant difference between incident and low incident villages (p=0.01). No significant difference came for forest cover, water density, built-up area and crop cover. Environmental variables showed significant influences on elephant mortality. Conflict incidences were higher closer to water bodies (β = -1.332, p < 0.05), railway (β = -0.636, p < 0.05). Areas with higher edge density also showed increased risk (β = 0.819 p < 0.05), The analysis revealed lesser conflict probability near mines (β = 3.202, p < 0.05). However, conflict incidence increases with increase in distance from built-up (β = 2.867, p < 0.05) and elephant reserve (β = 0.530, p < 0.05) and crop land (β = 0.329, p = 0.33) (Fig. 1.10; Table 1.3 & 1.4).

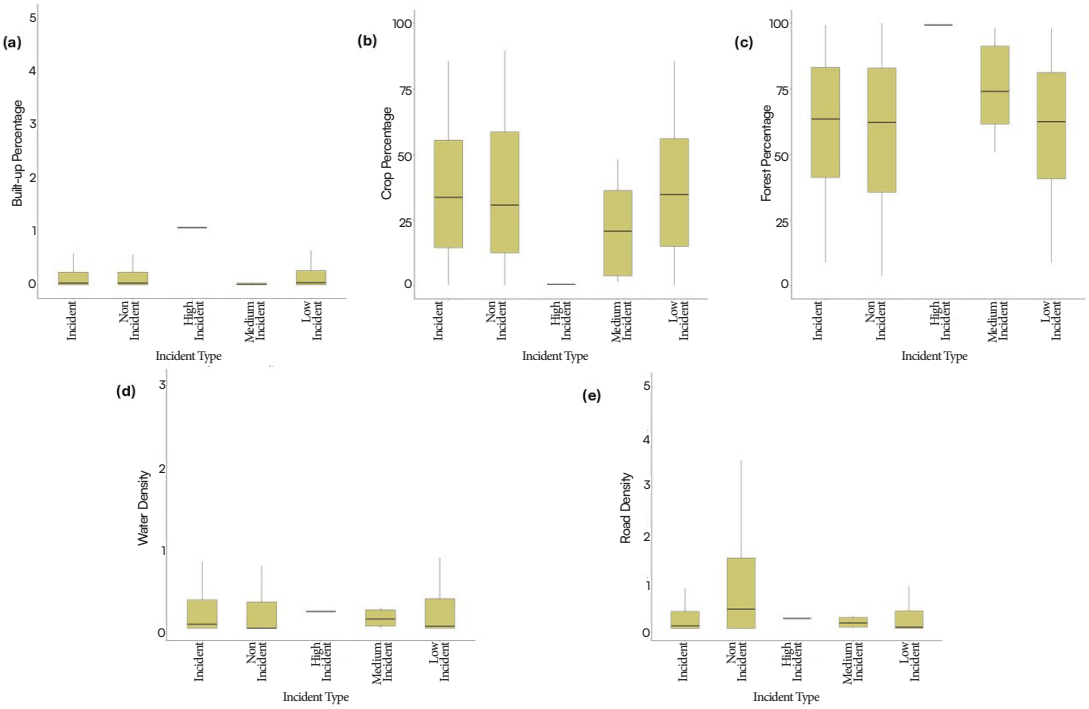


Figure 1.9: Built-up percentage, crop percentage, forest cover percentage, water density, road density and mined percentage in non- incident, low incident, medium incident and high incident villages in Jharkhand (incident — elephant mortality)

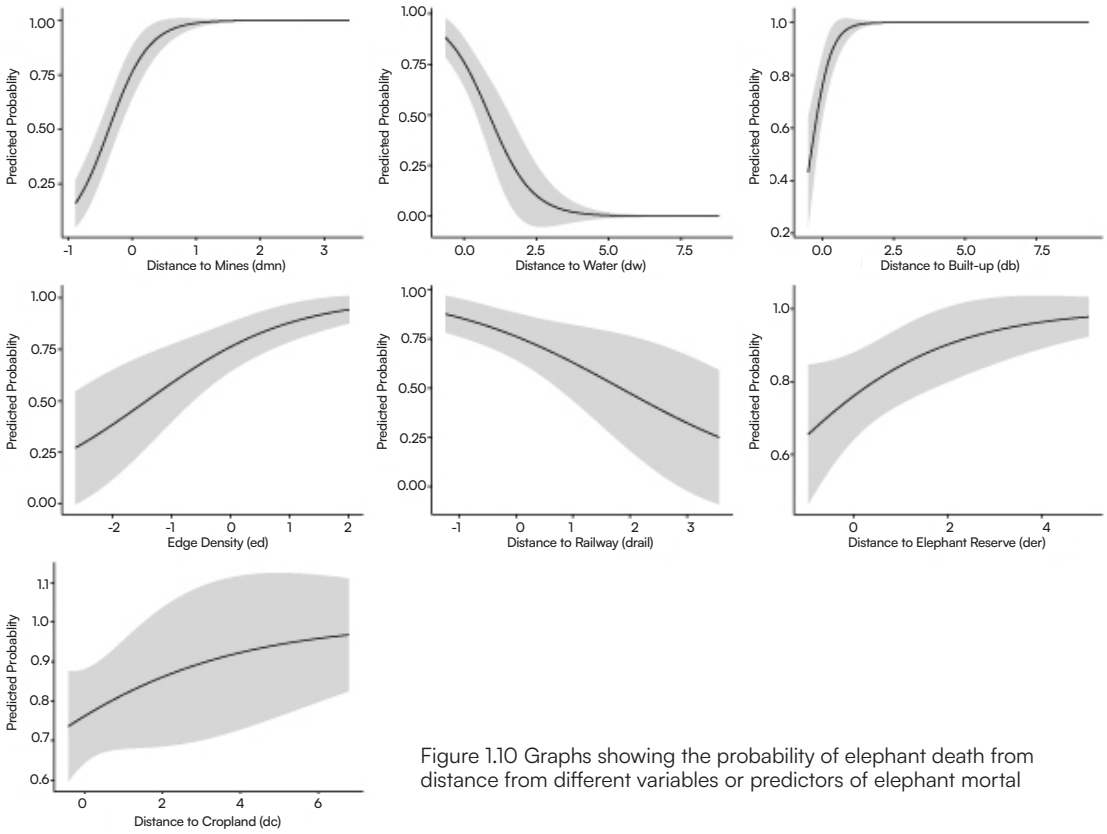


Figure 1.10 Graphs showing the probability of elephant death from distance from different variables or predictors of elephant mortal

Table 1.3: Summary statistics loglikelihood (LogL), degrees of freedom (df), Akaike Information Criteria (AICc), relative support for hypothesis (Δ AICc), Akaike weights (Wi) of candidate regression model explaining elephant mortality in Jharkhand.

Model Description	*LogL*	*df*	*AICc*	*ΔAICc*	*Wi*
dw + dr + df + dc + db + der + dpa + dmn + pd + ed + drail	-47.111	12	119.291	0	1
dmn + der + dc + db + ed + dw + drail	-79.357	8	175.201	55.910	0.00
dpa + db + ed + der + dc	-89.309	6	190.900	71.609	0.00
dmn + db + dc + ed	-92.878	5	195.957	76.666	0.00
dmn + der + dr	-100.026	4	208.185	88.893	0.00
dr + dmn + df + drail	-99.144	5	208.489	89.197	0.00
dw + df + dr + dmn + pd	-104.906	6	222.094	102.803	0.00
dmn	-114.253	2	232.546	113.255	0.00
dmn + pd	-114.171	3	234.422	115.131	0.00
dw + dr + df + dpa + pd + drail	-128.287	7	270.952	151.661	0.00
dw + pd + der + dpa + drail	-135.358	6	282.998	163.707	0.00
df + db	-141.399	3	288.879	169.587	0.00
db	-144.432	2	292.903	173.612	0.00
db + dc + pd	-142.480	4	293.093	173.801	0.00
dpa	-149.952	2	303.943	184.652	0.00
null	-211.408	1	424.830	305.538	0.00

Table 1.4: Summary statistics of the best fit model

Predictor	*Beta Coefficient (β)*	*Z value*	*P value*	*Significance*
(Intercept)	1.16306	3.48	0.0005	***
Distance to Mines (dmn)	3.202	5.43	0.0000	***
Distance to Elephant Reserves (der)	0.530	2.05	0.0396	*
Distance to Croplands (dc)	0.329	0.96	0.3344	
Distance to built-up (db)	2.859	3.68	0.0002	***
Edge Density (ed)	0.819	3.25	0.0012	**
Distance to Waterbodies (dw)	-1.332	-3.69	0.0002	***
DIstance to Railway (drail)	-0.635	-2.65	0.0078	**

**Indicate the significance of result*

1.5. Discussion

From 2000 to 2024, forest cover exhibited a continuous decline, while cropland initially expanded before reducing in later years. Built-up areas showed significant growth, with the most rapid expansion occurring in recent years. The transition analysis indicated that forest cover was primarily converted into cropland, built-up areas, and barren land, while cropland also transitioned into built-up areas and other land categories. The findings align with broader patterns of land transformation driven by urbanization, agricultural expansion, and resource extraction in Jharkhand (Sharma *et al.*, 2021). The spatial and temporal trends of elephant mortality in Jharkhand over a 23-year period gives insights into the different interactions between environmental and anthropogenic variables and land use/land cover characteristics. The east-central region, including Jharkhand, faces major challenges in identifying and managing elephant corridors due to rapid expansion of elephant distribution and fluid home ranges (Pandey *et al.*, 2024b). Our study reflects electrocution as the leading cause elephant mortality, accounting for most of the deaths particularly in Ranchi and East Sighbum which are also the hotspots for the elephant mortality in the state. This finding encompasses several studies that have identified electrocution as a major threat to elephant population in human dominated landscape (Goswami *et al.*, 2015a; Menon *et al.*, 2017). Highest elephant mortality in the monsoon season highlights elephants' seasonal vulnerability due to increased human activities (Fernando *et al.*, 2005a; Baskaran *et al.*, 2013). This is likely driven by increased agricultural activity and elephant movement in the season (Fernando *et al.*, 2005a). Adult males and females exhibited highest mortality rates, consistent with findings suggesting adult elephants venture in human- dominated areas in search of resources increasing their exposure to anthropogenic threats (Desai and Baskaran, 1996; Sukumar, 2003). The dominance of anthropogenic causes, mainly electrocution emerges as the primary reason for the deaths of elephants. A similar trend observed in north Bengal where adult males face higher mortality because they are more prone to entering human-dominated areas for resource (Mitra, 2017). The concentration of elephant mortality in regions like Ranchi and East Singhbum, that are characterized by fragmented landscapes and high human activity, aligns with the study showing a strong link between mortality, habitat fragmentation, and proximity to human settlements (Fernando *et al.*, 2008; Vasudev *et al.*, 2020).

The environmental variables characteristics provide a critical role of LULC in shaping pattern of elephant mortality. High incident villages are characterized by higher built-up areas and forest cover but lower crop percentage and road density. This suggests that elephants are present more where forested areas and human infrastructure intersects, that increases the likelihood of the conflict. This is consistent with the studies that have linked elephant mortality to encroachment of human's settlements into elephant corridors and habitat fragmentation (Goswami *et al.*, 2015b; Leimgruber *et al.*, 2003). Singhbhum Elephant Reserve (ER) in Jharkhand has the highest number of identified elephant corridors (n=14) among all reserves in India. However, only 38% of the reserve is forested, while the remaining area is under human use, leading to significant human-elephant conflict (Pandey *et al.*, 2024a). Fragmented habitats force elephants to move through human dominated landscapes, exposing them to risks such as electrocution, vehicle collision and retaliatory killing (Leimgruber *et al.*, 2003; Sitati *et al.*, 2003a)

The lower crop cover in high-incident villages aligns with the idea that elephants in these areas are often moving through transitional zones between forests and human settlements, where agricultural activity is less dense but human infrastructure (such as power lines and roads) is more prevalent. This pattern has been observed in other studies in Sri Lanka, where elephants moving through fragmented landscapes faced higher mortality risks due to encounters with human infrastructure. Similarly, the lower water density in high-incident villages may reflect the scarcity of natural water sources, forcing elephants to travel greater distances and increasing their exposure to anthropogenic threats (Fernando *et al.*, 2005a).

The lower road density in high-incident villages suggests that even limited infrastructure can have a disproportionate impact on elephant mortality. This finding is consistent with studies where even low-density road networks in fragmented landscapes can significantly increase elephant mortality due to vehicle collisions and other human-related threats (Goswami *et al.*, 2015b; Lakshminarayanan *et al.*, 2016). The negative relationship between elephant mortality and distance to elephant reserves is particularly significant. This finding suggests that elephants are more vulnerable in areas farther from protected zones, likely due to increased exposure to anthropogenic threats such as poaching, electrocution, and vehicle collisions. This aligns with studies from Africa and Asia, which have shown that elephants outside protected areas face higher mortality risks due to human activities (Fernando *et al.*, 2005a; Blake *et al.*, 2008). Proximity to water and railways showed a negative association with HEC, suggesting that areas near water sources, railways, and fragmented habitats are more prone to conflict. These findings are consistent with previous studies highlighting the role of water bodies in attracting elephants and altering their movement patterns (Dodd *et al.*, 2024; Wilson *et al.*, 2016; Shaffer *et al.*, 2019b). In Jharkhand, elephants are not confined to elephant reserves (ERs), leading to frequent conflicts even in areas far from ERs. On the other hand, conflict tends to increase with distance from built-up areas, croplands, and mines, likely because most conflicts are concentrated along corridors and their surrounding landscapes, where elephant movement overlaps significantly with human activities. Additionally, landscape fragmentation metrics, such as edge density, were significant, with higher fragmentation associated with increased conflict. This finding aligns with studies which reported higher mortality in fragmented habitats due to increased human-elephant conflict (Fernando *et al.*, 2008).

1.6. Conclusion

Over the past 23 years, elephants in Jharkhand have faced growing threats from human-elephant conflict, habitat loss, and electrocution, with adult males and the monsoon season being particularly vulnerable. Areas like Ranchi, East Singhbum, and Saraikela have seen high mortality rates, underscoring the need for urgent conservation action. Jharkhand's unique position as a transitional zone for elephant populations moving between Odisha and neighboring states adds another layer of complexity to the issue. To address these challenges, several practical measures can be implemented. Restoring and protecting critical elephant corridors is essential to ensure safe passage for elephants migrating between states. Simple yet effective steps like insulating power lines, building wildlife-friendly infrastructure, and creating underpasses or overpasses along railways and highways can significantly reduce accidents and deaths. Engaging local communities through early warning systems, compensation programs, and awareness campaigns can help build trust and reduce conflicts, especially in villages where human-elephant interactions are frequent. Technology can also play a key role—tools like AI-based monitoring, drones, and GPS-enabled collars can track elephant movements in real time, providing early alerts to communities and forest officials. Strengthening policies, improving land-use planning, and fostering collaboration between states are equally important to ensure a coordinated approach to conservation. By combining these efforts, Jharkhand can not only reduce elephant mortality and human-elephant conflict but also secure its role as a vital habitat for elephants moving across state borders, ensuring a safer future for both elephants and people.

CHAPTER 2:
Human Fatalities in the State of Jharkhand (2000-2023)

2.1. Introduction

Human-Elephant Conflict (HEC) has become one of the most significant issues in Asia, primarily in India, Sri Lanka, and Nepal, where expanding human populations and infrastructure developments have invaded natural habitats (Shaffer *et al.*, 2019c). HEC refers to the negative interactions between humans and elephants, typically resulting in damage to crops, property, and infrastructure, as well as injuries and fatalities for both humans and elephants (Sukumar, 2006). In South Asia, the distribution of HEC is influenced by the large elephant populations and increased human encroachment into forested regions (Choudhury, 2004; Fernando *et al.*, 2005b). This overlap has resulted in a significant rise in conflicts in areas where elephants traditionally venture. For example, in Sri Lanka, HEC is most prevalent in the dry zones, where elephants' home ranges overlap with intensive paddy cultivation (Fernando *et al.*, 2005b). Similarly, in Nepal, elephants raid crops near buffer zones of national parks, leading to rising death tolls and monetary losses (Pant *et al.*, 2016).

India, which holds around 60% of the global Asian elephant population (Baskaran *et al.*, 2011). HEC has become a critical conservation and social issue. States such as Assam, Odisha, Karnataka, and Jharkhand experience high rates of conflict due to habitat fragmentation and expansion of human settlement (Chartier *et al.*, 2011). In Jharkhand, HEC has sharply increased in the past two decades due to deforestation, mining, industrialization, and rapid urbanization (Dash *et al.*, 2024). Once a densely forested region, Jharkhand served as a natural habitat and migratory corridor for elephants between the forests of West Bengal, Odisha, and Chhattisgarh (Kanga *et al.*, 2017). However, extensive coal mining operations, particularly in districts such as Dhanbad, Hazaribagh, and West Singhbhum, have led to significant habitat fragmentation (Pande *et al.*, 2014). The degradation of important elephant corridors, such as the Saranda Forest, which connects Jharkhand to Odisha, has further disrupted elephant migration routes (Rangarajan, 2019). As elephants are pushed into human settlements, incidents of crop-raiding, property destruction, and human fatalities have surged, creating a significant burden for local communities that rely on agriculture and forest resources for their livelihoods (Dash *et al.*, 2024).

The extensive deforestation and fragmentation of natural habitats in Jharkhand, driven by mining activities, have forced elephants into closer proximity to human settlements. Between 2001 and 2020, the state lost nearly 8,000 hectares of forest cover, with districts such as West Singhbhum and Giridih experiencing the highest levels of deforestation (Global Forest Watch, 2020). As a result, traditional migratory routes for elephants, which once connected the forests of the Chotanagpur plateau to neighbouring regions, have been disrupted. The reduction in forest cover has also led to the degradation of key elephant corridors, such as those linking Jharkhand with Odisha's Simlipal National Park (Debata *et al.*, 2013). This has not only increased the frequency of HEC incidents but also threatens the long-term survival of elephants by limiting their access to critical habitats and reducing genetic diversity within populations (Baskaran, 1993).

Communities living in and around these forested areas are particularly vulnerable to the impacts of HEC. Many of these communities, especially indigenous tribes, rely on forest resources for food, fuel, and medicine (Rao *et al.*, 2007). The loss of crops and property due to elephant raids has severe economic consequences for these households, many of which have limited alternative sources of income (Weinmann, 2018). Despite government efforts to provide compensation for losses incurred through HEC, many community members report that these payments are insufficient and delayed (Guru and Das, 2021b). As a result, frustration and resentment toward elephants have grown, complicating efforts to promote human-wildlife coexistence. Mining and industrial development in Jharkhand have not only fragmented elephant habitats but have also increased human presence in these areas, further escalating the likelihood of conflict (Madineni *et al.*, 2015; Sonter *et al.*, 2018). Mines attract large numbers of workers, and the resulting influx of people has led to the expansion of settlements and agricultural fields into elephant habitats. These areas often become hotspots for HEC as elephants, in search of food and water, raid crops and home (Saini, 2018). The disruption of elephant corridors, such as the Saranda Forest corridor, exacerbates these conflicts by limiting the elephants' ability to move between forested areas (Menon *et al.*, 2017). The degradation of elephant habitats in Jharkhand has far-reaching consequences for both ele-

phants and humans. Elephants that are unable to access traditional migratory routes are forced into fragmented habitats, increasing the likelihood of inbreeding and reducing genetic diversity within populations (Nad *et al.*, 2022). This, in turn, can negatively impact the health and survival of elephant populations in the long term (Baskaran *et al.*, 2013). For local communities, the economic and social impacts of HEC are severe. Crop losses, property damage, and human fatalities have become common occurrences, particularly in districts such as West Singhbhum, Giridih, and Hazaribagh (Dash *et al.*, 2024). Human injuries or deaths caused by elephants are rare but often result from accidental encounters, such as crossing paths near water bodies, being too close to distressed or aggressive elephants, or during conflicts over crop protection (Lingaraju and Venkataramana, 2014a). These incidents, though infrequent compared to other causes of mortality like malaria or road accidents, generate fear in rural communities and hinder conservation efforts (Lingaraju and Venkataramana, 2014b). Factors contributing to such conflicts include blocked traditional routes, harassment, and settlements encroaching on elephant habitats. Studies from India and Sri Lanka document human fatalities, highlighting the need for further research into human-elephant conflict. However, studies on the factors governing the human fatalities due to HEC are limited. Therefore, in the present study, we investigate the spatial, temporal, and demographic patterns of human mortality caused by HEC in Jharkhand, identify the influencing factors, and prioritize villages for targeted mitigation measures.

2.2. Methodology

2.2.1. Collection of HEC occurrences

Data on Human-Elephant Conflict (HEC) occurrences were gathered from 22 Divisional Forest Offices in Jharkhand, covering the period from 2000 to 2023. The available information from the department included the name of the division, village, the date of the incidents, human fatalities and injuries (including gender), and compensation. Additional qualitative surveys were conducted in high-conflict villages to verify incidents and gather contextual insights, and forest divisions assisted in the verification process.

2.2.2. Land use land cover, spatial pattern of HEC and forest fragmentation

The dataset on HEC comprised 1,740 cases of human deaths and injuries caused by wild elephants over a span of 23 years. We divided the data into 5-year interval grouped as 2000-2005, 2006-2010, 2011-2015, 2016-2020, 2021-2023. Land Use Land Cover (LULC) map of Jharkhand state was created using Landsat 5 TM and Landsat 8 OLI imagery for the respective years. Data were categorised by death and injury, gender, year, season, division. To understand the spatial distribution of conflict, we mapped the conflict hotspot using kernel density estimator, using ArcGIS with an output cell size of 200 meters to account for geolocation accuracy. In addition, landscape fragmentation was analysed using FRAGSTATS (v4.2) to calculate key landscape metrics. The input data, derived from LULC maps, were reclassified into forest and non-forest classes using the ArcGIS Spatial Analyst tool. To avoid redundancy and enhance interpretability, metrics that only effectively capture important landscape features were selected. Class-level metrics for forest cover, such as Patch Density (PD), Edge Density (ED), and Largest Patch Index (LPI), were calculated. A 7 km moving window analysis, based on the average movement of elephants (Hassan *et al.*, 2023), was used to generate a continuous surface, ensuring ecologically relevant outcomes. To analyse the factors influencing HEC events, spatial data were utilized for variables including distances to forests, croplands, built-up areas, roads, waterways, protected areas, elephant reserves, and mines. Using the "Generate Near Table" tool in GIS, the shortest distances between conflict points and these features were calculated. These distance values along with above mentioned fragmentation metrices were subsequently employed as predictor variables and human fatalities and injuries as response variable. We used candidate regression model using Generalized Linear Models (GLMs) along with the "MuMIn" package in R for model selection. The models were built based on a-priori hypotheses, ensuring the inclusion of variables with theoretical relevance to HEC (Table 2.1). Prior to model building all the variables were z-transformed and check for multicollinearity. Models were ranked using the Akaike Information Criterion (AIC). Cross-validation techniques evaluated model robustness, and the optimal model was selected by averaging candidate models with $\Delta AIC \leq 2$. Each HEC event involving human fatalities was coded as 1, while pseudo-points (areas without conflict) were randomly assigned a value of 0. These pseudo-points were generated for conflict zones within the study area using ArcGIS Pro, ensuring spatial relevance to the conflict data. Specifically, the pseudo-points were created at least 1 km away from the actual conflict points to maintain an appropriate spatial separation while retaining contextual relevance.

Table 2.1: A priori hypotheses for all environmental variables corelating human deaths and injuries by elephants

Feature	Variable	Description and Source	
Landcover	Distance from Built-up (db)	Distance from built-up areas, Cropland, Forest, Mines and Waterbodies using Near Table tool (ArcPro 3.0.0).	Proximity to built-up areas increases HEC due to habitat loss and higher human activity.
	Distance from Cropland (dc)		Proximity to croplands increases HEC due to crop-raiding by elephants.
	Distance from Forest (df)		Proximity to forests increases HEC as fragmented forests bring elephants closer to human settlements.
	Distance from Waterbodies (dw)		Proximity to waterbodies increases HEC as elephants seek water, especially in dry seasons.
	Distance from Mines and Quarries (dmn)		Proximity to mines increases HEC due to habitat fragmentation and human disturbances.
Anthropogenic	Distance from Road (dr)	Distance from roads using OpenStreetMap.org data and Near Table tool (ArcPro 3.0.0).	Proximity to roads increases HEC due to habitat fragmentation and human-elephant interactions.
	Distance from Protected Areas (dpa)	Distance from protected areas using shapefiles provided by the Elephant Cell, WII, and Near Table tool (ArcPro 3.0.0).	Proximity to protected areas increases HEC due to elephants venturing out for resources.
	Distance from Elephant Reserves (der)	Distance from elephant reserves using Near Table tool (ArcPro 3.0.0).	Proximity to reserves increases HEC as elephants move between reserves and human settlements.
Landscape Metrics	Edge Density (ed)	Edge density (ED) calculated using FRAGSTATS 4.2	Higher edge density increases HEC due to greater human-elephant interfaces.
	Patch Density (pd)	Patch density (PD) calculated using FRAGSTATS 4.2.	Higher patch density increases HEC due to habitat fragmentation and disrupted elephant movement patterns.

2.2.3. Village level analysis for highlighting prioritization villages for mitigation

To assess the intensity of HEC, we analysed the frequency of conflict incidents reported across all villages within the forest divisions. Based on the occurrence rates, villages were categorized into three levels of conflict intensity: high (> 20 conflict incidents), medium (11-20), and low (1-10). Percentage of each environmental variables water, built-up, road density, forest, crop, mines percentage were calculated for each village. We performed nonparametric Kruskal Wallis test to test whether these environmental variables are varying significantly across incidents groups (incident, non-incident, high incident, medium incident, low incident). The village boundaries were obtained from the ArcGIS Online, shapefile : Indian Administrative Layer 2024.

2.3. Results

2.3.1. Temporal and Seasonal pattern

Between 2000 and 2023, Jharkhand recorded 1,740 incidents, resulting in 1,340 human fatalities and 400 injuries. Fatalities peaked in 2014, while injuries showed an upward trend from 2011(Fig. 2.1). Ranchi was the most affected division (391 deaths, 194 injuries), followed by Khunti (131 deaths, 16 injuries), East Singhbhum (68 deaths, 8 injuries), Hazaribagh (58 deaths, 16 injuries) and Palamu (48 deaths, 8 injuries) (Fig. 2.2). Kernel density estimator using spatial location also revealed conflict hotspots in Ranchi, Khunti, and East Singhbhum, with expanding conflict areas including protected regions like Hazaribagh, Palamu, and Dalma Wildlife Sanctuary (Fig. 2.3). The fatality and injury reported significantly higher in males compared to females (χ^2 = 886.53, df = 1, p <0.0001; Fig. 2.4). However, there was no significant association between gender and seasons (χ^2 = 2.99, df = 3; p = 0.39).

At present 480 villages of Jharkhand were affected by HEC (Appendix 2). Ranchi recorded the maximum number of affected villages (156) followed by East Singhbhum (37) and Saraikela (36) (Fig. 2.5). Other divisions including Khunti, Palamu, Sahibganj, West Singhbhum, Hazaribagh, and Dalma Wildlife Sanctuary also reported frequent incidents. Other Forest Divisions like Gumla, Pakur, and Giridih, experienced comparatively fewer incidents.

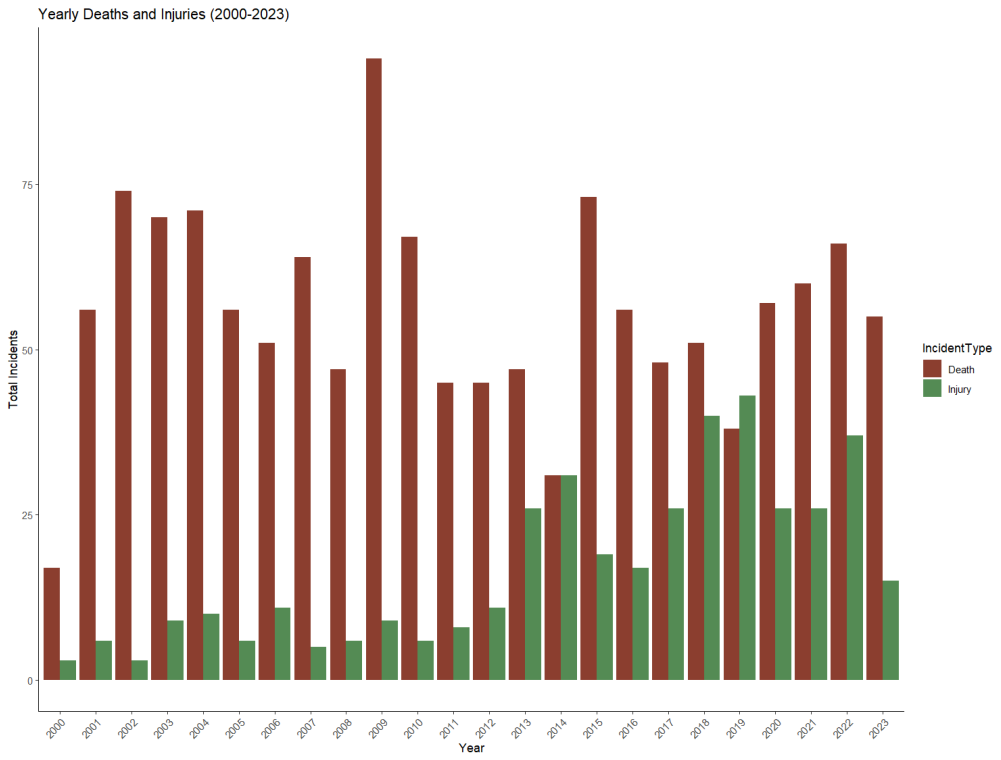


Figure 2.1: Trends in human deaths/injuries due to human elephant conflict over 23 years (2000-2023)

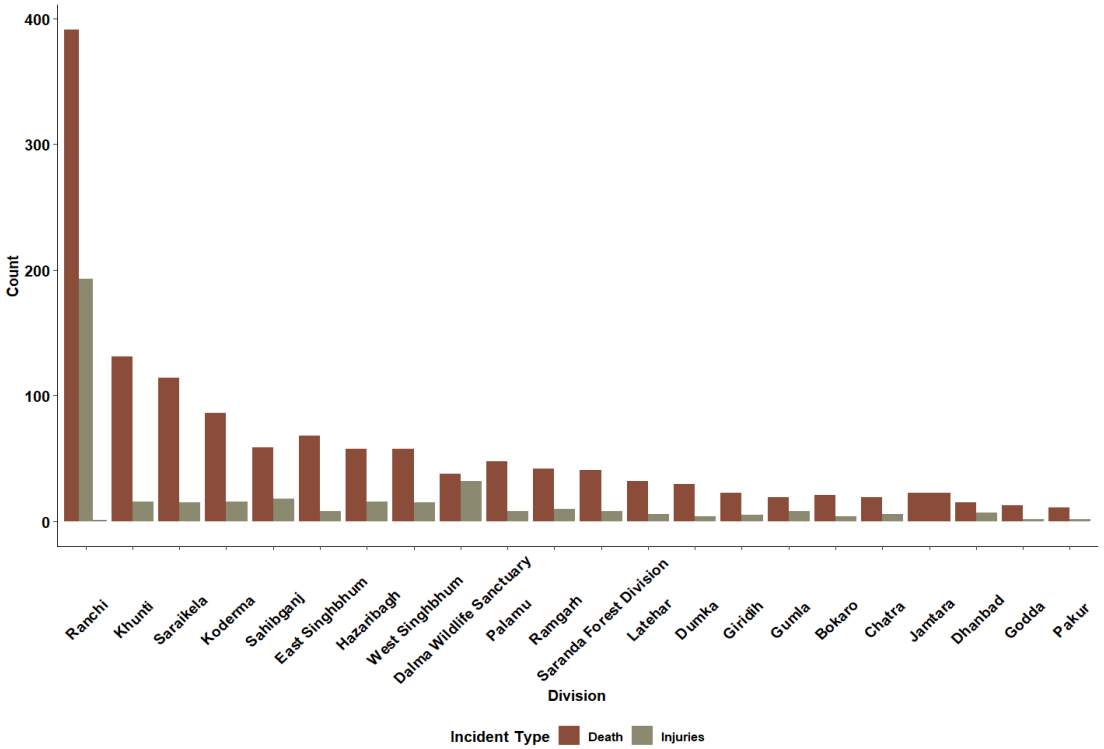


Figure 2.2: Division-wise distribution of human-elephant incidents in Jharkhand from 2000-2023

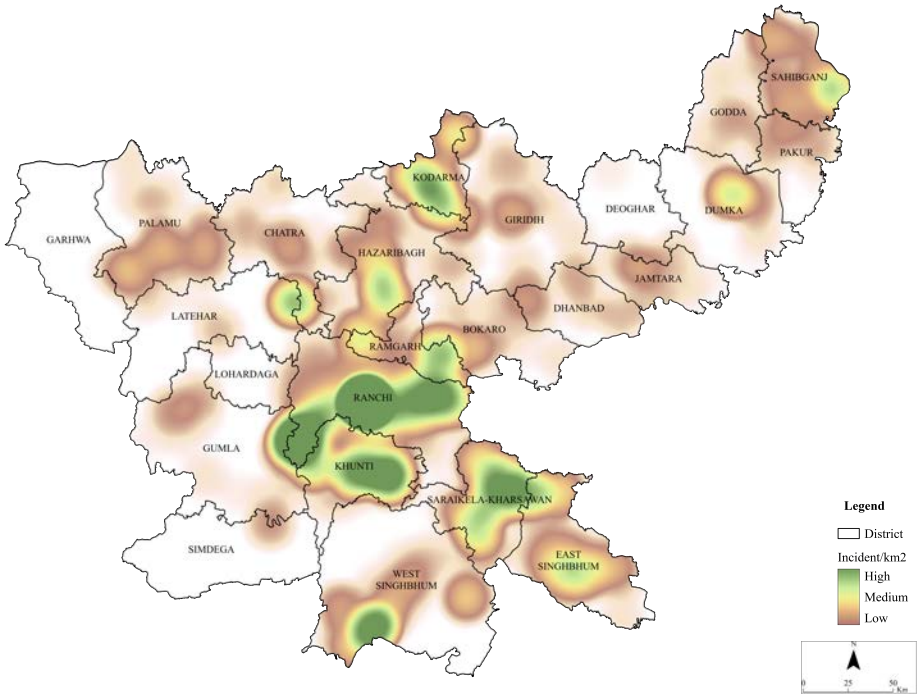


Figure 2.3. Conflict hotspot (human fatalities and injuries) from 2000-2023 in Jharkhand.

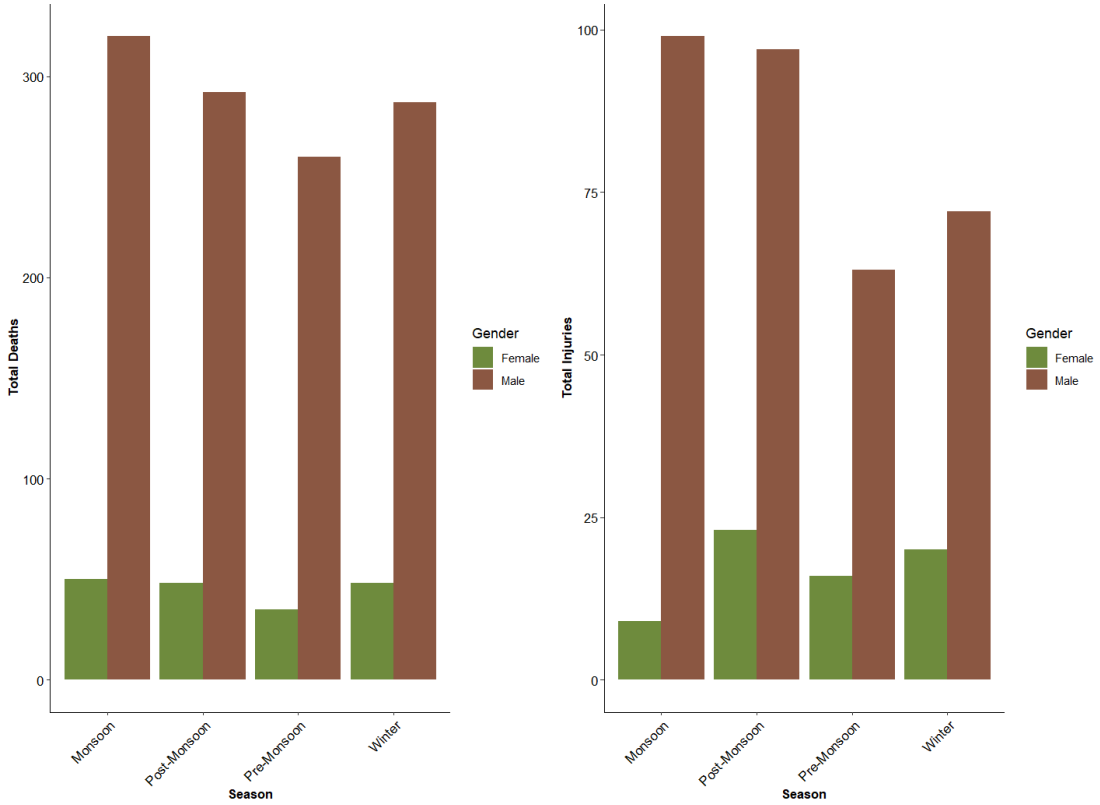


Figure 2.4: Seasonal variation in human fatalities/injuries (male & female) in the state of Jharkhand during 2000-2023

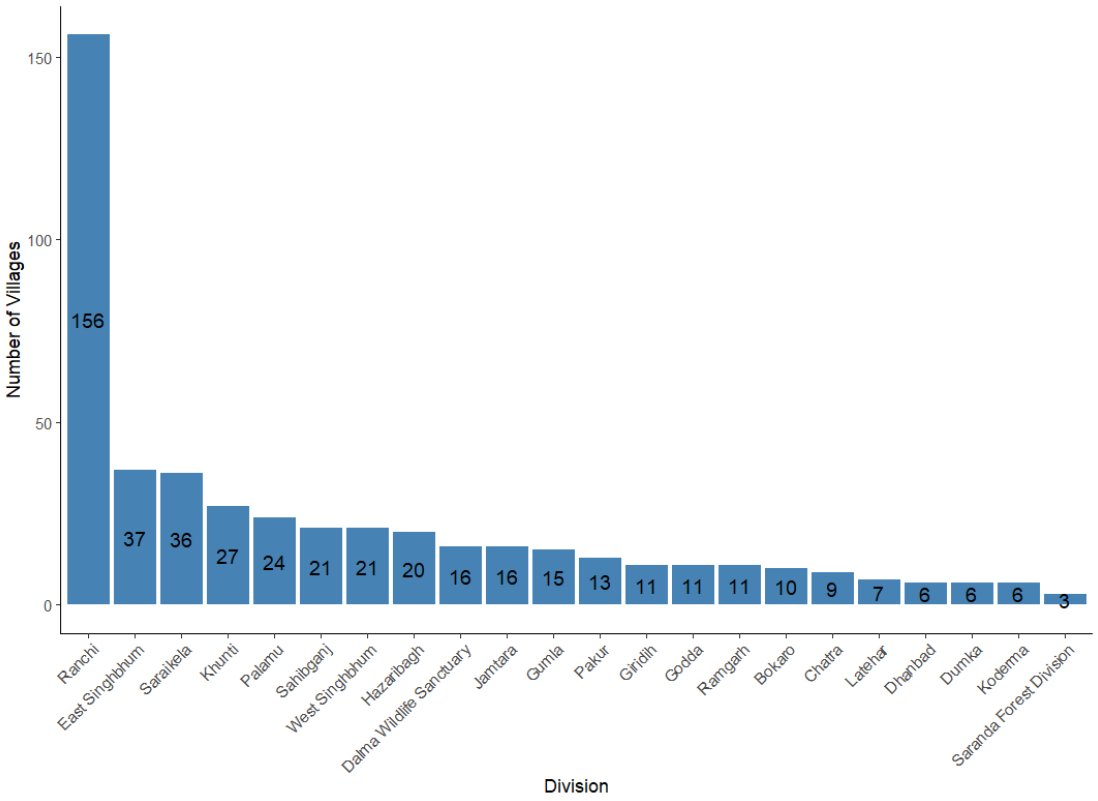


Figure 2.5: Number of villages affected by human elephant conflict per division in Jharkhand (2000-2023)

2.3.2. Ecological and Anthropogenic Drivers of HEC

We found that proximity to both natural features (forests, water bodies, and elephant reserves) and human-modified landscapes (roads, crop fields, and built-up areas) were critical factors influencing human fatalities and injuries (Fig. 2.6 & Table 2.2, 2.3). As expected, conflict incidences were higher closer to water bodies (β = -0.007978, $p < 0.001$), roads (β = -0.906427, $p < 0.001$), and elephant reserves (β = -0.878, $p < 0.001$), highlighting the spatial overlap of human and elephant activity in these areas. Areas closer to forests also showed increased risk (β = -0.003, $p < 0.001$), emphasizing the importance of forest edges as conflict zones. The analysis revealed higher conflict probability near mines (β = -0.101, $p < 0.001$). However, conflict incidence decreased with increase in distance from built-up (β = 0.143, $p < 0.001$) and protected areas (β = 0.011, $p < 0.001$). Landscape configuration also influenced conflict patterns, with higher fragmented forest patch density (β = 0.220, $p < 0.001$) associated with increased conflict risk.

Table 2.2: Summary statistics loglikelihood (LogL), degrees of freedom (df), Akaike Information Criteria (AICc), relative support for hypothesis (Δ AICc), Akaike weights (Wi) of candidate regression model explaining HEC in Jharkhand.

Model Description	*LogL*	*df*	*AICc*	*ΔAICc*	*Wi*
dw + dr + df + der + dmn + dpa + pd + dc + db	-1925.23	10	3870.52	0	0.51
dw + dr + df + der + dmn + dpa + pd + db	-1926.29	9	3870.629	0.109	0.49
dr + df + der + dmn + dpa + pd + db	-1943.48	8	3902.992	32.472	0.00
dw + dr + df + der + dpa + pd + db	-1945.61	8	3907.259	36.739	0.00
dw + dr + df + der + dmn + pd + db	-1952.93	8	3921.909	51.389	0.00
dr + df + dmn + db	-2071.05	5	4152.118	281.598	0.00
dw + dpa + pd + db	-2151.75	5	4313.521	443.001	0.00
der + db	-2183.69	3	4373.378	502.858	0.00
dr + df + der + dmn + dpa + pd	-2190.17	7	4394.366	523.846	0.00
dr + df + der + dmn + dpa	-2203.85	6	4419.717	549.197	0.00

dw + dr + df + dpa + pd	-2266.12	6	4544.254	673.733	0.00
dr + dpa + dc	-2276.13	4	4560.272	689.752	0.00
dw + der + dmn + pd	-2277.51	5	4565.034	694.513	0.00
dr + dpa	-2289.96	3	4585.918	715.398	0.00
dw + dr + pd	-2295	4	4598.014	727.494	0.00
dw + df + der	-2324.18	4	4656.379	785.859	0.00
Intercept only	-2412.15	1	4826.306	955.785	0.00

Table 2.3: Summary statistics of model (dw + dr + df + der + dmn + dpa + pd + db + dc)

Predictor Variable	Beta Coefficient (β)	Std. Error	z value	P value	Significance
(Intercept)	0.043	0.040	1.071	0.28	
Distance to Waterbodies (dw)	-0.250	0.042	-5.835	0.001	***
Distance to Roads (dr)	-0.708	0.054	-12.992	0.001	***
Distance to Forests (df)	-0.152	0.042	-3.558	0.001	***
Distance to Elephant Reserves (der)	-0.466	0.041	-11.343	0.001	***
Distance to Mines & Quarries (dmn)	-0.244	0.040	-6.014	0.001	***
Distance to Protected Areas (dpa)	0.298	0.040	7.346	0.001	***
Patch Density (pd)	0.285	0.043	6.58	0.001	***
Distance to Croplands (dc)	0.072	0.05	1.446	0.15	
Distance to Built-up (db)	1.138	0.063	17.879	0.001	***

**Indicate the significance of result*

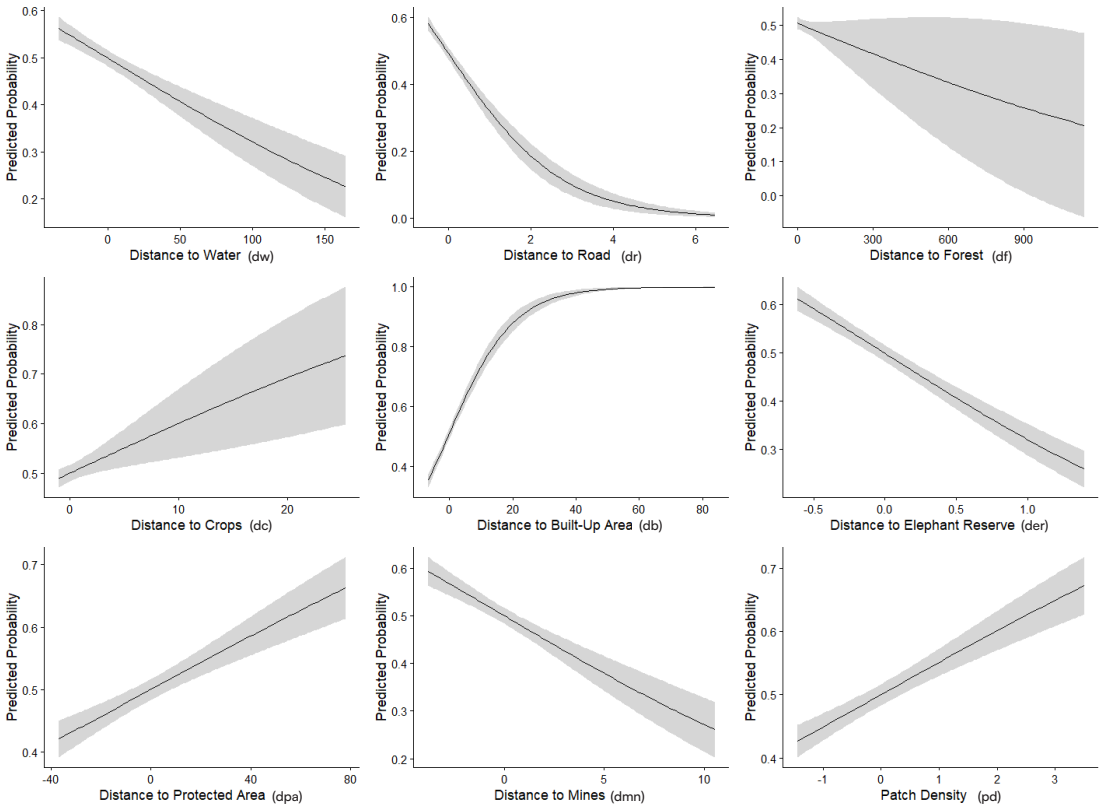


Figure 2.6. Response of predictor variables for determining the probability of HEC (human fatalities and injuries) in Jharkhand

2.3.3. HEC-Village level

A detailed analysis of ecological and anthropogenic variables at the village level reveals important patterns across different conflict intensity categories. Non-incident villages exhibit the highest median forest cover, while high-conflict villages have relatively higher forest cover compared to other conflict categories (Kruskal Wallis: χ^2 = 30.93, df = 4, p <0.0001; Fig. 2.7a). Post hoc-Dunn test showed differences between incident and low-incident villages (p adj.=0.0001). High-conflict villages show the highest cropland percentages, whereas medium-and low-conflict villages display broader variability in cropland cover (χ^2 = 11.40, df = 4, p = 0.022; Fig. 2.7b). Road density is highest in high-conflict villages, correlating with increased conflict intensity (χ^2 = 86.44, df = 4, p < 0.0001; Fig. 2.7c). High-conflict villages have the lowest water density, while medium-conflict villages show variability, and low-conflict villages demonstrate relatively stable water availability (χ^2 = 0.344, df = 4, p = 0.98: Fig. 2.7d). Built-up percentage is highest in high-conflict villages and decreases with conflict intensity, with non-incident villages having the lowest levels (χ^2 = 2.303, df = 4, p = 0.68; Fig. 2.7e). Mining percentages are lowest in high-conflict villages, whereas medium-conflict villages report the highest mining activity (χ^2 = 13.24, df = 2, p = 0.0013; Figure 2.7f).

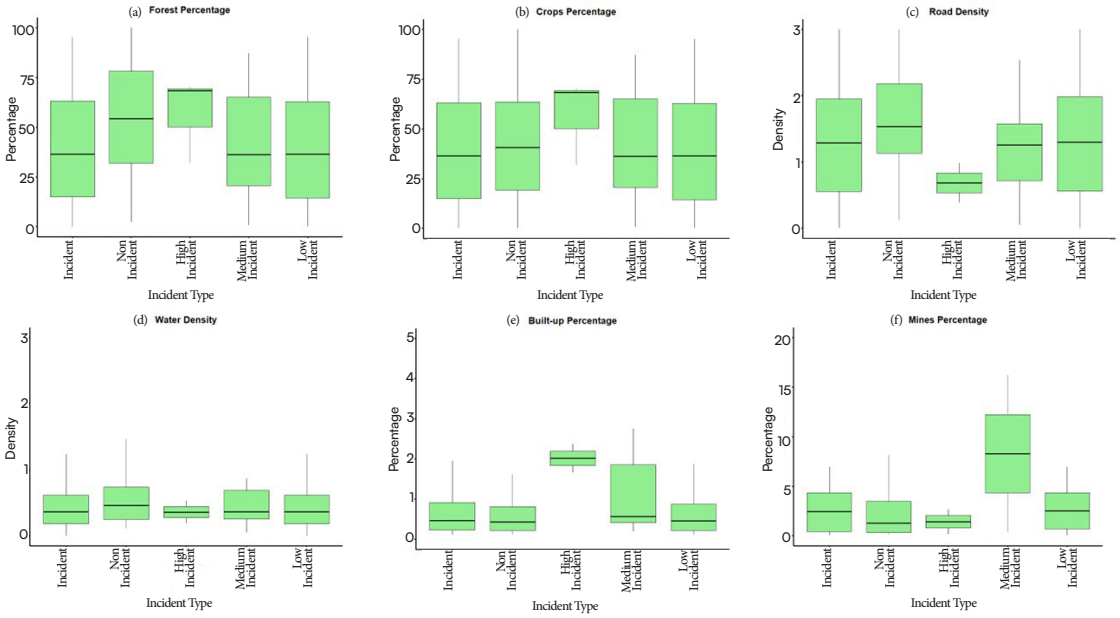


Figure (2.7a-2.7f). Comparison of Land Use and Density Variables Across Incident and Non-Incident Sites in Relation to Human-Elephant Conflict

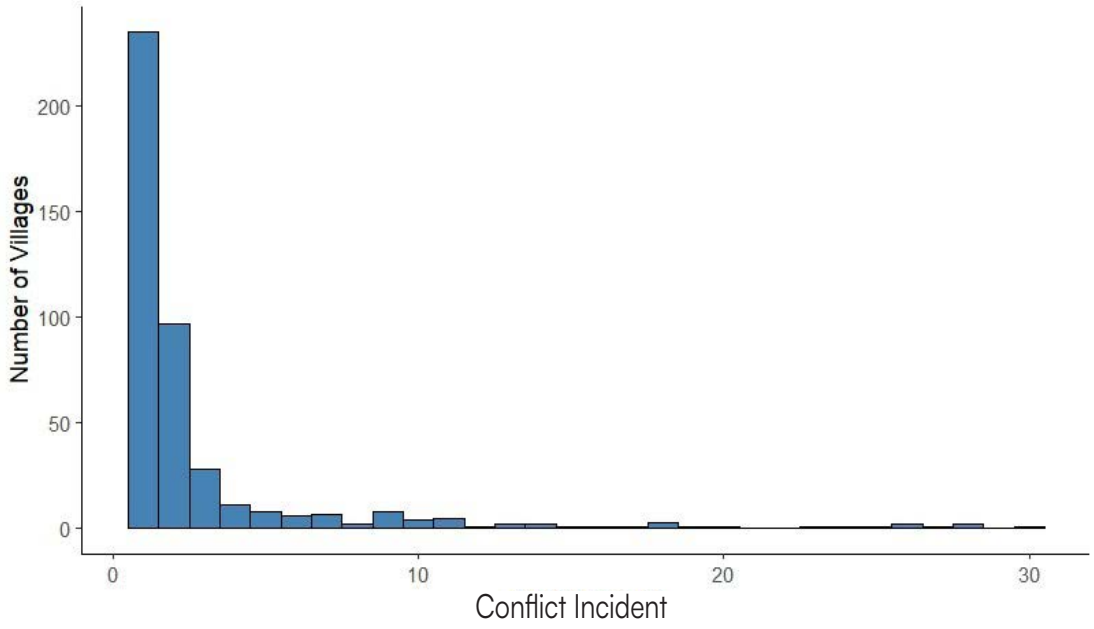


Figure.2.8. Distribution of Human-Elephant Conflict Incidents Across Villages in Jharkhand

2.4. Discussion

Human-elephant conflict in Jharkhand has evolved from a sporadic issue to a more pervasive concern, mirroring global trends where human activities, particularly agricultural expansion and habitat fragmentation—are increasingly intersecting with elephant habitats, thereby escalating the frequency and intensity of conflicts (Sukumar, 2006; Hazarika *et al.*, 2008). The spatial distribution showed a clear association between regions with dense human population, higher agricultural activities, and conflict hotspots are confined to Ranchi, Khunti, and East Singhbhum. This is consistent with the findings of (Khan *et al.*, 2014), which reported similar trends highlighting Ranchi and Khunti divisions as major hotspots of conflict related causalities and human-elephant conflict was most severe in areas where human settlements and agricultural activities overlap with elephant habitats. The Dalma Wildlife Sanctuary and its surrounding areas, despite being a protected area, report a significant number of fatalities (Johnsingh and Williams, 1999), emphasized the challenges posed by such overlaps, which escalate the frequency of human-elephant conflicts. Our spatial analysis highlights significant human encroachment in areas like Ranchi and Khunti, disrupting traditional elephant corridors and escalating HEC (Baskaran *et al.*, 2013). These trends reflect broader patterns of HEC that have been documented in South Asia, particularly in regions where habitat fragmentation, agricultural expansion, and human settlement overlap with elephant habitats (Fernando *et al.*, 2008.; Baskaran *et al.*, 2013; Pant *et al.*, 2016). Similar trends have been reported in Assam, Odisha, and Sri Lanka, where human-elephant conflict is exacerbated by encroachment into elephant corridors and protected areas (Fernando *et al.*, 2005b; Chartier *et al.*, 2011b; Guru and Das, 2021a). The east-central region, including Jharkhand, has seen major dispersal of elephants from their former ranges (Pandey *et al.*, 2024). In our study, we found that elephant movement in the fragmented landscapes leads to increase encounter with humans, contributing to higher levels of HEC. This aligns with findings on habitat encroachment and conflict escalation, particularly in Singhbum, which has the highest number of identified elephant corridors. Only 38% of area is forested, the rest is under human use, intensifying conflict (Pandey *et al.*, 2024a). Despite conservation policies, elephant movement remains disrupted due to road and railway infrastructure. Approximately 1340 km of railway networks goes through elephant habitats, leading to alter in their movement patterns and increasing HEC particularly in regions like Assam, Odisha and Jharkhand (Pandey *et al.*, 2024a). This is reflected in our findings where high road density correlated with increased human fatalities, as disrupted corridors force elephants into closer contact with human settlements, intensifying conflicts.

The monsoon season in Jharkhand is a period having heightened HEC, which could be associated with the comparatively dense forests and reduced visibility during this time, making it more difficult for humans to spot elephants and leading to more frequent encounters. These factors contribute to the higher incidence of human-elephant interactions during this period These findings align with global studies that emphasize how ecological conditions during the monsoon season, such as reduced visibility and landscape disruptions, can drive increased conflict (Karanth *et al.*, 2013; Shaffer *et al.*, 2019c). Furthermore, our village level analysis of HEC across Jharkhand highlights the complex interactions between ecological and anthropogenic factors. Villages without conflict tend to have higher forest cover, supporting the idea that intact, undisturbed forests act as natural buffers, reducing human-elephant interactions. However, villages with higher forest cover also exhibit high conflict levels, suggesting that abundant forests may attract elephants seeking food and shelter (Sukumar, 2003). The presence of agricultural land, particularly in high-conflict villages, aligns with findings on crop-raiding behaviour, confirming that agricultural activities attract elephants into human-dominated landscape (Montgomery *et al.*, 2021). Road density also plays a significant role; high-conflict villages show a strong positive correlation with road density, which fragments elephant habitats and disrupts traditional corridors, increasing the frequency of encounters (Sitati *et al.*, 2003b; Chaiyarat *et al.*, 2022). Water availability also influences conflict, with high-conflict villages showing lower water availability, supports previous studies that water scarcity can drive elephants into human settlements (Naha *et al.*, 2020; Gunawansa *et al.*, 2023). In addition, percent built-up areas, which are more prevalent in high-conflict villages, further exacerbate the potential for conflict (Scrizzi *et al.*, 2017; Fernando *et al.*, 2023). These findings underscore the multifaceted nature of HEC, where both ecological features and human activities contribute to the intensity of conflict.

Furthermore, our findings on the factors influencing human fatalities and injuries were largely consistent with the trends observed in village-level analysis. Proximity to water, roads, and forests all had negative associations with conflict, indicating that areas closer to water sources, roads, and fragmented habitats are more prone to HEC. These findings align with existing literature that highlights the role of water bodies in attracting elephants and roads in disrupting their movement (Dodd *et al.*, 2024; Wilson *et al.*, 2016;

Shaffer *et al.*, 2019b). In Jharkhand, elephants are not restricted to protected areas (PAs), resulting in a high incidence of conflicts even in regions far from PAs. However, as Elephant Reserves extend beyond PA boundaries, conflict incidence tends to decrease with increasing distance from these reserves. Conversely, conflict increases with distance from PAs, likely because most conflicts are concentrated along corridors and their surrounding areas, where elephant movement and human activities overlap significantly. Landscape fragmentation metrics, such as patch density and edge density, were also significant, with higher fragmentation linked to increased conflict (Gubbi, 2012; Karanth *et al.*, 2012).

Overall, our results reinforce the need for spatially informed conflict mitigation strategies. Interventions should prioritize areas near water bodies, forest edges, roads, and mines to minimize conflict risk. Enhancing landscape connectivity, especially in fragmented forest patches, is crucial for ensuring safe passage for elephants while reducing human-wildlife interactions. Additionally, regulating land-use changes in conflict-prone zones and incorporating local communities in management efforts will be vital for long-term coexistence.

2.5. Conclusion

Human-elephant conflict (HEC) in Jharkhand has escalated from a localized issue to a widespread concern, driven by the overlapping pressures of habitat fragmentation, agricultural expansion, and human encroachment into elephant habitats. Our findings demonstrate that proximity to natural and anthropogenic features significantly influences conflict patterns, with hotspots concentrated in regions like Ranchi, Khunti, and East Singhbhum. Our analysis also underscores the necessity for proactive mitigation measures, encompassing ecological and socio-economic factors. By giving priority to the villages Ranchi (218), Chatkuri Reserve Forest (54), Titahia (30), Gajgaon & Bramhajamalpur (28), Bhuchungdih (27), Sarbaha &Koinara (26) that are highly affected by HEC, targeted interventions can be undertaken with the goal of reducing the extent of conflict. Seasonal factors, particularly during the monsoon, exacerbate conflicts due to reduced visibility and increased landscape disturbances. While intact forests can act as natural buffers, they may also attract elephants, highlighting the complex and multifaceted nature of HEC. Factors such as road density, water availability, and fragmented landscapes further intensify these interactions. Overall, the spatial and ecological factors identified in this study align with broader trends observed across South Asia, emphasizing the need for comprehensive, region-specific conflict mitigation strategies. Addressing these challenges is critical for promoting coexistence between humans and elephants while safeguarding biodiversity and human livelihoods.

To mitigate human-elephant conflict (HEC) in Jharkhand, a multi-faceted approach is essential, beginning with enhancing landscape connectivity and habitat restoration. Efforts should focus on improving the connectivity of forest patches and elephant corridors to facilitate safe movement for elephants and reduce their intrusion into human-dominated areas. Land-use changes near critical habitats, including water bodies, forest edges, and movement corridors, must be strictly regulated. Prioritization of high-conflict areas such as Ranchi, Khunti, and East Singhbhum, where interventions like early warning systems, physical barriers (*e.g.*, trenches or fences), and seasonal strategies during the monsoon to improve visibility and monitor elephant movements are crucial. Community-based approaches are equally important, involving the training and active participation of local communities in monitoring elephant movements, conflict mitigation, and resource management. Promoting alternative livelihoods and implementing compensation schemes will help reduce the economic burden on affected communities.

In addition, infrastructure and land-use planning should aim to minimize road construction in critical elephant habitats, with mitigation measures such as wildlife corridors, underpasses, or overpasses where construction is unavoidable. Additionally, developing water resources in conflict-prone areas can help reduce competition between humans and elephants. Strengthening policies to prevent habitat encroachment, illegal mining, and agricultural expansion around protected areas and Elephant Reserves is vital. Collaborative governance, involving forest departments, local governments, and NGOs, is necessary to create integrated and adaptive conflict management frameworks. Furthermore, expanding research on seasonal and long-term trends in HEC will enhance our understanding of conflict drivers and allow for the development of adaptive management strategies. Utilizing spatial data and predictive models to identify emerging conflict zones will enable pre-emptive interventions, contributing to long-term coexistence between humans and elephants in the region.

CHAPTER 3:
Suggested Measures to minimize Human-Elephant Conflict in the State of Jharkhand

Human-elephant conflict (HEC) in Jharkhand has become a significant conservation and socio-economic challenge, leading to losses in both human and elephant populations. Between 2000 and 2023, a total of 1,340 human fatalities and 400 injuries were recorded due to human elephant interaction, while 225 elephants lost their lives, including 152 deaths caused by anthropogenic causes such as electrocution, train collisions, poaching, and poisoning. These incidents are concentrated in conflict hotspots such as Ranchi, East Singhbhum, and Saraikela, where habitat fragmentation, rapid land-use changes, and increasing human settlements have intensified interactions between humans and elephants. Out of 122 villages where elephant mortality happend, 94.26% (115 villages) experienced low conflict, while a small percentage fell into the medium (4.92%) and high (0.82%) conflict categories. The analysis also reveals a strong relation between human activities and conflict levels. Elephant mortality has been recorded across all 122 villages, highlighting the widespread impact of human-elephant conflict. This suggests that while severe conflict is rare, medium and high-conflict villages, along with those experiencing elephant mortality, require urgent mitigation measures. Similarly, among the 527 villages affected by human deaths due to HEC, 92.61% experienced low mortality, 4.17% had medium mortality, and 2.28% had high mortality, making them conflict hotspots. Given these distinct causes and consequences of human and elephant fatalities, separate mitigation strategies will be recommended to effectively address each challenge.

3.1. Recommendation for Elephant Deaths in Jharkhand

Elephant mortality in Jharkhand is driven by multiple factors, with electrocution emerging as the most significant cause, reported in villages like Tirilposi R.F (7 deaths), Ghatshila CT (5), Harhanji (3), Asan Bani (1), Tokisud (2), Arahanga (2), Harhi (1), Gurgain (1), Hulsi (1), and Jidu (2). Train collisions also pose a major threat, causing fatalities in Latehar Forest (3), Panjri Khurd (3), and Sitadih (2). Vehicular accidents contributed to deaths in Ghutbahar (3), while poisoning was recorded in Gurgain (1). Anthropogenic stressors led to deaths in Tundi Pahar (2) and Bagra (1), while accidental causes were responsible for fatalities in Tundi Pahar (2) and Alaudia CT (2). Additionally, poaching was reported in Tirilposi R.F (1) & Harhi (1). These incidents are spread across various divisions, including Saranda Forest, East Singhbhum, Latehar, Palamu, Ranchi, Saraikela Kharsawan, Ramgarh, Dhanbad, Dalma Wildlife Sanctuary, and Bokaro.

3.1.1 Electrocution

Electrocution was the leading cause of elephant deaths in Jharkhand, with the highest numbers recorded in Tirilposi R.F (7), Ghatshila CT (5), Harhanji (3), Asan Bani (1), Tokisud (2), Arahanga (2), Harhi (1), Gurgain (1), Hulsi (1), and Jidu (2). Key measures for prevention:

Community Awareness & Safe Electricity Practices: Many electrocution incidents result from illegal direct connections from power distribution lines to electric fences used by farmers for crop protection. Conducting awareness programs and workshops will educate local communities on the dangers of unsafe electrical setups and the importance of using authorized methods.

Regular Inspection and Maintenance of Electrical Infrastructure: Many electrocution cases are linked to unsafe local electrical setups rather than main power grids. Regular inspections and maintenance of transformers, poles, and fencing connections can help identify and eliminate hazards. No electric fence should be directly connected to power lines, as this practice creates lethal hazards for both wildlife and humans. Authorities should enforce strict monitoring and penalties against illegal fencing practices. Safer alternatives, such as solar-powered or battery-operated fencing, should be promoted to mitigate human-elephant conflicts. Moreover, Jharkhand Forest Department may work closely with local electricity distribution agencies to implement safety measures and ensure compliance with regulations. Encouraging community involvement in monitoring and reporting hazardous setups can help prevent future incidents.

3.1.2. Poisoning

Poisoning-related elephant deaths were recorded in Gurgain (1). This often occurs due to retaliatory killings following crop raids. Key measures that can be adopted are as follows:

Compensation Mechanisms: Transparent and efficient compensation schemes for crop damage encourage farmers to report incidents rather than resorting to poisoning. Fair and rapid

compensation builds trust between communities and wildlife authorities.

Community-Based Conflict Mitigation:
Establishing trained community-led squads to safely deter elephants from agricultural fields can be effective. Using non-lethal electric fences and natural deterrents, such as chili-based barriers, can reduce elephant raids.

3.1.3. Train Collisions
Train collisions resulted in elephant deaths in Latehar Forest (3), Panjri Khurd (3), and Sitadih (2). Key measures that can adopted;

Early Warning Systems: Implementing AI-based sensors, seismic detectors, and Distributed Acoustic Sensing (DAS) along railway tracks can help detect elephant movement in real time. Integrating these with Intrusion Detection Systems (IDS) can provide timely alerts to train operators, enabling speed reduction or stoppage to prevent collisions.

Vegetation Management & Track Visibility: Clearing vegetation up to 30 meters on both sides of railway tracks enhances visibility and reduces accidental encounters.

Infrastructure Modifications:
Constructing underpasses and overpasses at known elephant crossing points ensures safe passage across railway lines. These structures should be strategically placed based on elephant movement patterns.

Enhanced Coordination Between Railway and Forest Departments: Establishing a robust communication framework between railway authorities and wildlife conservation agencies is crucial. insatlling elephant trackers near tracks and sensitizing train crews on emergency response protocols can prevent accidents.

3.1.4. Vehicular Accidents
Vehicular accidents led to elephant fatalities in Ghutbahar (3). Key Measures for Prevention:

Speed Reduction in Elephant Corridors:
Implementing speed restrictions in high-risk areas, particularly near forest patches, can help reduce collisions.

Wildlife Crossings and Signage: Constructing dedicated wildlife underpasses and overpasses at known crossing points can provide safe passage for elephants. Proper signage should be installed to alert drivers about elephant-prone zones.

3.1.5. Anthropogenic Stressors & Accidental Deaths
Human-induced stressors and accidental deaths were recorded in Tundi Pahar (2), Bagra (1), and Alaudia CT (2). Key Measures for Prevention:

Habitat Restoration: Restoration of degraded habitats and establishing buffer zones provide elephants with safe foraging areas, reducing their movement into human settlements. Engaging local communities in reforestation efforts fosters long-term sustainability.

Mining Regulations: Strict environmental guidelines must be enforced for mining operations near elephant habitats. These should include noise reduction measures, controlled blasting activities, and ensuring mining infrastructure does not obstruct elephant corridors. Regular environmental impact assessments are necessary.

Community Engagement: Workshops and training programs on sustainable land-use practices can equip communities with tools for coexistence. Establishing community-based wildlife monitoring groups empowers residents to take an active role in conservation.

3.1.6. Poaching
Poaching incidents were reported in Tirilposi R.F (1) and Harhi (1). Key Measures for Prevention:

Strengthening Patrols: Increasing well-trained rangers with proper resources can enhance on-ground patrolling and deter poachers. Collaboration between government bodies, NGOs, and local communities is crucial.

Community-Based Monitoring: Engaging local communities in wildlife protection fosters responsibility and enables early reporting of poaching activities.

Rapid Response Teams:
Specialized, well-equipped units should be deployed to handle poaching incidents swiftly, increasing the likelihood of apprehending offenders.

Surveillance Technology: Utilizing drones, camera traps, and GPS tracking strengthens monitoring and enables proactive anti-poaching measures.

3.2. Recommendation for Human Deaths in Jharkhand

Human-elephant conflict remains a serious concern in Jharkhand, with Ranchi, West Singhbhum, Koderma, Khunti, Sahibganj, Ramgarh, Hazaribagh, and other districts witnessing high numbers of fatalities. Villages that are either located near elephant corridors or experience frequent elephant movement due to habitat fragmentation have been particularly affected. Over the past 23 years, out of 480

villages, 12 villages fall into high-conflict areas, 22 villages are classified as medium-conflict areas, and 488 villages are categorized as low-conflict areas based on the number of human deaths.

Among the high-conflict villages, Chatkuri Reserve Forest recorded the highest number of human deaths at 48, followed by Titahia (30) and Gajgaon (28). Other villages with severe human-elephant conflict include Bramhajamalpur (28), Bhuchungdih (27), Sarbaha and Koinara (26 each), Khokhro (25), Urikel (24), Barinijkel and Kodarma (23 each), and Seraikella and Chandil CT (22 each). These villages have experienced the most significant impact of human-elephant conflict, requiring urgent attention for mitigation measures.

3.2.1. Physical Barriers & Early Warning Systems

Trip-Wire Alarms, Motion Sensors, and Distributed Acoustic Sensing (DAS): Advanced warning systems such as infrared motion sensors, trip-wire alarms, and DAS technology can detect elephant presence and alert communities in real time. DAS uses fiber optic cables to detect seismic vibrations caused by elephant movements, providing early warnings and reducing human-elephant encounters. Integration of AI-based predictive models and GPS collar tracking of elephant herds can further enhance these early-warning networks, improving response times and minimizing conflict risks.

Use of Light-Based Deterrents: Research indicates that LED flashing lights and high-intensity torches can deter elephants at night, thereby reducing nocturnal crop raids.

3.2.2. Human Safety, Awareness, and Conflict Management

Village-Level Early Warning Systems: Establishing community-based elephant alert networks using mobile apps (*e.g.*, Gaj Yatra) and radio messaging systems can help disseminate real-time warnings, reducing the risk of direct encounters.

Formation of Rapid Response Teams (RRTs): Trained local youth and forest department personnel should be equipped with non-lethal deterrents such as firecrackers, chili smoke bombs, and acoustic devices to guide elephants away safely.

Human-Elephant Coexistence Training: Awareness campaigns should focus on safe behavior around elephants, avoiding conflict-prone areas at night, and non-provocative responses to elephant presence, ensuring better risk management.

3.2.3. Agricultural Strategies and Crop Protection

Cultivation of Elephant-Resistant Crops: Studies suggest that crops like chili (*Capsicum* spp.), ginger (*Zingiber officinale*), garlic (*Allium sativum*), and citrus fruits are unpalatable to elephants and can serve as buffer crops around high-risk farmlands.

Livelihood Diversification Programs: Encouraging alternative livelihoods such as honey production, mushroom farming, and eco-tourism-based employment can reduce dependency on traditional agriculture, mitigating economic losses from elephant raids.

Use of Bio-Fences and Natural Deterrents: Thorny plant species like Agave (*Agave americana*) and Cactus (*Opuntia* spp.) can be planted along village borders to serve as a natural deterrent against elephant intrusions.

3.2.4. Compensation Mechanisms and Policy Implementation

Streamlining Compensation for Crop Loss and Human Casualties: Governments should implement fast-track compensation schemes with minimal bureaucratic delays, ensuring timely financial relief for affected communities.

Community-Based Insurance Models: Establishing village-led insurance schemes in collaboration with wildlife conservation organizations can provide long-term financial resilience against conflict-related losses.

3.2.5. Habitat Restoration and Landscape-Level Conservation

Protection of Elephant Corridors: Securing recognized elephant corridors ensures uninterrupted movement and minimizes human-elephant encounters. Restoring corridors with native vegetation and strategic land-use planning can facilitate safe passage.

Habitat Restoration: Restoring degraded corridors by planting native vegetation enhances habitat connectivity and biodiversity. Large-scale afforestation efforts improve habitat functionality, while agroforestry models that combine tree plantations with non-palatable crops create buffer zones, reducing elephant intrusion into farmlands.

Strategic Land-Use Planning: Collaborative land-use planning with local communities ensures alignment with conservation goals, reducing human-elephant conflicts. This includes zoning

regulations and community engagement initiatives to promote coexistence.

3.3. Elephant Corridors Near High-Conflict Villages

The following key elephant corridors, as identified in the "Right of Passage" report, are critical for mitigating human-elephant conflict:

1. Dalma-Asanbani Corridor — A major movement route connecting elephant habitats with human settlements.

2. Dalma-Chandil Corridor — Essential for seasonal migration, requiring restoration efforts to reduce fragmentation.

3. West Singhbhum Corridor — High-conflict area due to encroachment and habitat loss, necessitating stringent conservation measures.

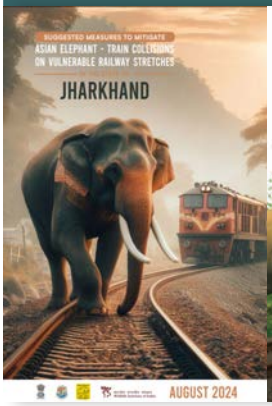
4. Chatkuri-Latehar Corridor — A critical passage where habitat restoration and early warning systems should be prioritized.

5. Ichagarh Corridor — Vulnerable due to mining activities, requiring stronger legal protection and mitigation structures.

Suggested Mitigation Measures to minimize Asian elephant-train collisions on vulnerable railway stretches in the State of Jharkhand

Wildlife Institute of India and Project Elephant Division has surveyed 17 railway stretches totalling 983.1 km for suggesting mitigation measures to ease the movement of elephants across the landscape. Based on joint survey by WII, PE, MoEFCC, Jharkhand Forest Department and Ministry of Railways, 10 level crossings with ramps, 5 bridge modifications. 29 underpass, 5 overpasses and fencing at 20 sites along with landscaping, light and sound barriers have been recommended. The details of these measures has been published in a report (PE-MoEFCC-WII (2024). Suggested Measures to Mitigate Asian Elephant- Train Collisions on Vulnerable Railway Stretches in the state of Jharkhand. Project Elephant Division, Ministry of Environment, Forest and Climate Change, Government of India and Wildlife Institute of India. Pp. 40)

The details are also available on the portal (Elephant Railway Portal) developed for the purpose of monitoring the implementation of mitigation measures.



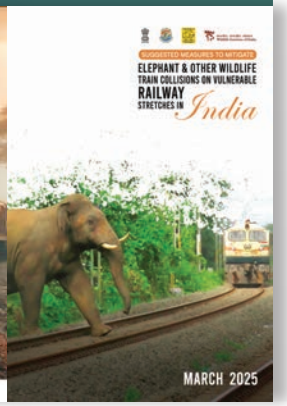


Table 3.1. Conflict villages and nearest corridors

Village	Corridor Name
Khokhro	Dalma-Asanbani
Khokhro	Dalma-Chandil
Tokisud	Dalma-Asanbani
Tokisud	Dalma-Chandil
Ghatshila	Dalma-Asanbani
Musabani	Dalma-Asanbani
Forest Bloc	Dalma-Asanbani
Khelarisai	Dalma-Asanbani
Khelarisai	West Singhbhum
Adityapur	Dalma-Asanbani
Adityapur	West Singhbhum

Table 3.2 Human-elephant conflict hotspots: Villages where both elephant mortality and human casualties occurred with count

Elephant mortality count	Human casualty count	Village	Division
5	5	Ghatshila CT	East Singhbhum
2	16	Tokisud	Dalma wildlife sanctuary
2	1	Gurgain	Bokaro
2	3	Sitadih	Ranchi
1	1	Uda	Bokaro
1	14	Meramhonar	Chaibasa
1	25	Khokhro	Dalma wildlife sanctuary
1	1	Musabani CT	East Singhbhum
1	3	Forest Block	East Singhbhum
1	1	Ghaghra	Ramgarh
1	7	Itkithakurgoan	Ranchi
1	218	Ranchi	Ranchi
1	9	Hajam	Ranchi
1	10	Lali	Ranchi
1	1	Churi CT	Ranchi
1	2	Kuli	Ranchi
1	1	Khelarisai	Saraikela Kharsawan
1	1	Adityapur	Saraikela Kharsawan

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Appendix 1: Villages in Jharkhand with recorded Elephant Mortality (2000-2023)

S.No.	Elephant Mortality Count	Village Name	Division	Administrative level	Rural / Urban	Household	Population	Male%	Female%	Area (Ha)
1	5	Ghatshila CT	East Singhbhum	Town	Urban	8893	40624	51.47696	48.52304	1359.188
2	3	Panjri Khurd	Palamu	Village	Rural	123	660	51.81818	48.18182	229.6307
3	3	Harhanji	Ranchi	Village	Rural	117	736	50.95109	49.04891	349.6144
4	3	Asan Bani	Saraikela Kharsawan	Village	Rural	842	3876	50.5676	49.4324	1690.353
5	3	Ghutbahar	Ramgarh	Village	Rural	896	4427	49.74023	50.25977	2802.621
6	2	Tundi Pahar	Dhanbad	Village	Rural	56	270	47.77778	52.22222	3345.845
7	2	Bagra	Dhanbad	Village	Rural	282	1409	49.68062	50.31938	235.0721
8	2	Alaudia CT	Latehar	Town	Urban	958	4943	52.53894	47.46106	839.3133
9	2	Tokisud	Dalma wildlife sanctuary	Village	Rural	183	997	50.45135	49.54865	1237.741
10	2	Arahanga	Dhanbad	Village	Rural	252	1411	50.31892	49.68108	1128.841
11	2	Harhi	Ranchi	Village	Rural	208	1099	51.50136	48.49864	233.8115
12	2	Gurgain	Bokaro	Village	Rural	558	3008	50.26596	49.73404	625.7144
13	2	Hulsi	Ranchi	Village	Rural	85	425	50.11765	49.88235	654.0186
14	2	Jidu	Bokaro	Village	Rural	185	852	50.23474	49.76526	303.185
15	2	Sitadih	Ranchi	Village	Rural	185	850	49.41176	50.58824	551.3599
16	1	Uda	Bokaro	Village	Rural	70	352	50.85227	49.14773	568.2545
17	1	Tironala	Bokaro	Village	Rural	150	733	51.02319	48.97681	449.156
18	1	Manjura	Ranchi	Village	Rural	1099	5503	50.89951	49.10049	815.4812
19	1	Etke	Bokaro	Village	Rural	174	792	51.38889	48.61111	614.5994
20	1	Pabo	Dalma wildlife sanctuary	Village	Rural	120	626	51.4377	48.5623	284.9327
21	1	Dasiyodih	Deoghar	Village	Rural	42	288	51.73611	48.26389	56.73317
22	1	Bisuwani	Deoghar	Village	Rural	137	768	50.13021	49.86979	145.1972
23	1	Jiramuri	Saraikela Kharsawan	Village	Rural	130	784	51.27551	48.72449	128.1009
24	1	Benagoria	Dhanbad	Village	Rural	384	2369	51.03419	48.96581	242.9366
25	1	Sadariadih	Bokaro	Village	Rural	256	1393	51.83058	48.16942	146.2499
26	1	Harinsinha	Dumka	Village	Rural	119	534	50.93633	49.06367	266.0625

27	1	Dukhiadih	Dumka	Village	Rural	19	73	49.31507	50.68493	251.3742
28	1	Asanbani	Dumka	Village	Rural	47	212	52.83019	47.16981	162.3157
29	1	Jili	Dumka	Village	Rural	65	281	52.31317	47.68683	100.4826
30	1	Hematpur	Dumka	Village	Rural	145	716	48.18436	51.81564	248.9566
31	1	Bhaunri	Gumla	Village	Rural	440	2278	52.01932	47.98068	2174.576
32	1	Bishram-pur	Garhwa	Village	Rural	701	3493	51.70341	48.29659	2570.87
33	1	Thak-urchak	Giridih	Village	Rural	607	3452	51.33256	48.66744	76.9046
34	1	Ghujadih	Giridih	Village	Rural	91	490	54.4898	45.5102	117.6012
35	1	Bantoli	Ranchi	Village	Rural	244	1510	50.33113	49.66887	464.938
36	1	Dalmadih	Gumla	Village	Rural	243	1372	48.68805	51.31195	822.9854
37	1	Jalim	Gumla	Village	Rural	133	880	48.97727	51.02273	770.025
38	1	Chirodih	Gumla	Village	Rural	320	1862	47.95918	52.04082	2122.032
39	1	Lurunga	Ranchi	Village	Rural	249	1194	53.09883	46.90117	985.1632
40	1	Chano	Hazaribagh	Village	Rural	228	1286	49.92224	50.07776	1005.922
41	1	Potanga	Hazaribagh	Village	Rural	546	2808	50.81909	49.18091	1512.416
42	1	Meramga-rah	Ranchi	Village	Rural	231	1497	49.6994	50.3006	378.7534
43	1	Harli	Hazaribagh	Village	Rural	639	3710	51.75202	48.24798	470.1371
44	1	Pagar	East Singh-bhum	Village	Rural	564	2756	50.58055	49.41945	956.8855
45	1	Parbatpur	Dhanbad	Village	Rural	74	386	47.40933	52.59067	121.0625
46	1	Masko	Khunti	Village	Rural	132	707	49.64639	50.35361	478.7891
47	1	Makund-pur	Palamu	Village	Rural	72	449	52.11581	47.88419	993.9812
48	1	Chetar	Latehar	Village	Rural	382	1996	50.2004	49.7996	1504.78
49	1	Ete	Latehar	Village	Rural	171	849	48.76325	51.23675	485.0221
50	1	Forest	Hazaribagh	Reserve Forest	Rural	0	0	0	0	4380.058
51	1	Barwadih CT	Latehar	Town	Urban	1623	7888	52.73834	47.26166	485.7304
52	1	Harauho-pa	Latehar	Village	Rural	210	1251	52.19824	47.80176	1048.637
53	1	Phulbasia Alias Ama-rwadih	Dalma wildlife sanctuary	Village	Rural	301	1828	49.17943	50.82057	953.5608
54	1	Keri	Latehar	Village	Rural	380	2199	50.84129	49.15871	1221.364
55	1	Barwa-dih Alias Koshiara	Sahebganj	Village	Rural	34	179	51.39665	48.60335	476.7828
56	1	Matnag	Palamu	Village	Rural	2	16	43.75	56.25	334.7175
57	1	Sarea	Palamu	Village	Rural	606	3763	52.11268	47.88732	137.5975
58	1	Galubasa	West Sing-hbhum	Village	Rural	163	897	48.71795	51.28205	334.3104
59	1	Guntia	Chaibasa	Village	Rural	147	691	43.99421	56.00579	135.3192
60	1	Daubera	Bokaro	Village	Rural	88	413	49.87893	50.12107	291.6176
61	1	Gulikera	West Sing-hbhum	Village	Rural	277	1341	50.85757	49.14243	6227.852
62	1	Ratnasai	Saraikela Kharsawan	Village	Rural	57	291	48.45361	51.54639	1657.721
63	1	Meram-honar	Chaibasa	Village	Rural	503	2639	49.07162	50.92838	1063.11
64	1	Jomkojuri	West Sing-hbhum	Village	Rural	186	940	48.19149	51.80851	220.8897
65	1	Dudhbila	Ranchi	Village	Rural	322	1673	47.93784	52.06216	946.8862
66	1	Noamundi CT	Ranchi	Town	Urban	3792	17954	49.521	50.479	2992.343
67	1	Daudunga	Chaibasa	Village	Rural	180	907	51.70893	48.29107	400.5963

68	1	Bhalki	East Singh-bhum	Village	Rural	387	1803	49.58403	50.41597	1189.864
69	1	Khokhro	Dalma wildlife sanctuary	Village	Rural	111	470	49.57447	50.42553	965.5186
70	1	Chimti	Dalma wildlife sanctuary	Village	Rural	134	573	52.1815	47.8185	333.9945
71	1	Bankati	Ghatshila	Village	Rural	27	95	48.42105	51.57895	84.39509
72	1	Malkham	East Singh-bhum	Village	Rural	101	436	52.06422	47.93578	172.5761
73	1	Punda	East Singh-bhum	Village	Rural	41	163	50.92025	49.07975	159.0039
74	1	Phulpal	Ghatshila	Village	Rural	326	1684	50.35629	49.64371	249.5116
75	1	Baki	East Singh-bhum	Village	Rural	265	1253	50.51875	49.48125	307.1897
76	1	Phuljhor	East Singh-bhum	Village	Rural	111	545	51.55963	48.44037	457.7274
77	1	Pathar-ghara	East Singh-bhum	Village	Rural	428	1983	50.73122	49.26878	404.9978
78	1	Forest Block	East Singh-bhum	Village	Rural	511	2665	48.93058	51.06942	4796.667
79	1	Bhatin	Chaibasa	Village	Rural	365	2000	50.85	49.15	1096.381
80	1	Bara-ghutusigra	East Singh-bhum	Village	Rural	24	118	44.91525	55.08475	104.257
81	1	Dokarsai	East Singh-bhum	Village	Rural	169	812	51.10837	48.89163	314.9897
82	1	Kharband	East Singh-bhum	Village	Rural	130	598	47.49164	52.50836	267.4905
83	1	Raorao	Ramgarh	Village	Rural	299	1629	49.96931	50.03069	1305.043
84	1	Badgon	Ramgarh	Village	Rural	40	224	50.44643	49.55357	379.0309
85	1	Ghaghra	Ramgarh	Village	Rural	111	629	49.92051	50.07949	446.2594
86	1	Itkithakur-goan	Ranchi	Village	Rural	2285	12174	50.44357	49.55643	571.9267
87	1	Jegodakai	Ramgarh	Village	Rural	150	677	51.40325	48.59675	337.1643
88	1	Chogadih	Palamu	Village	Rural	70	291	49.48454	50.51546	186.4805
89	1	Murpa	Dalma wildlife sanctuary	Village	Rural	224	1086	54.69613	45.30387	442.6625
90	1	Sosodih	Simdega	Village	Rural	123	448	49.55357	50.44643	130.9982
91	1	Londra	Khunti	Village	Rural	166	712	49.7191	50.2809	348.1039
92	1	Japno	Ranchi	Village	Rural	205	923	50.16251	49.83749	875.3918
93	1	Mankidih	Ranchi	Village	Rural	361	1760	50.96591	49.03409	945.293
94	1	Biseriya	Ranchi	Village	Rural	370	1823	49.91772	50.08228	489.7485
95	1	Hehal	Ranchi	Village	Rural	347	1845	48.56369	51.43631	388.9155
96	1	Ranchi	Ranchi	Town	Urban	207636	1073427	52.06428	47.93572	15874.72
97	1	Hajam	Ranchi	Village	Rural	127	672	50.59524	49.40476	333.8552
98	1	Lali	Ranchi	Village	Rural	663	3316	49.24608	50.75392	2440.937
99	1	Murma	Ranchi	Village	Rural	462	2670	51.08614	48.91386	234.4875
100	1	Churi CT	Ranchi	Town	Urban	4972	24876	52.23911	47.76089	1670.16
101	1	Kuli	Ranchi	Village	Rural	571	3208	49.15835	50.84165	1033.237
102	1	Ghaghra	Ranchi	Village	Rural	628	3464	52.02079	47.97921	1044.722
103	1	Id	Ranchi	Village	Rural	169	896	52.67857	47.32143	343.1663
104	1	Mutugoda	Saraikela Kharsawan	Village	Rural	299	1305	50.72797	49.27203	958.8037
105	1	Gajudih	Saraikela Kharsawan	Village	Rural	162	741	50.20243	49.79757	131.52
106	1	Asura	Saraikela Kharsawan	Village	Rural	135	699	49.21316	50.78684	103.6441
107	1	Tikar	Saraikela Kharsawan	Village	Rural	1057	4470	51.05145	48.94855	628.1337

108	1	Tentidih	Saraikela Kharsawan	Village	Rural	152	817	49.5716	50.4284	141.5333
109	1	Rawtara	Saraikela Kharsawan	Village	Rural	304	1348	51.55786	48.44214	152.8281
110	1	Dhunab-uru	Saraikela Kharsawan	Village	Rural	395	1843	51.81769	48.18231	818.1545
111	1	Adityapur	Saraikela Kharsawan	Town	Urban	37206	174355	52.5732	47.4268	4877.479
112	1	Bara Barpani	Hazaribagh	Village	Rural	306	1532	51.10966	48.89034	723.7932
113	1	Kundur-munda	Garhwa	Village	Rural	498	2431	48.33402	51.66598	3166.961
114	1	Brindaban	Sahebganj	Village	Rural	388	1772	50.6772	49.3228	302.0044
115	1	Patra CT	Sahebganj	Town	Urban	1630	9536	50.80747	49.19253	533.8583
116	1	Binderi Bender Kola	Sahebganj	Village	Rural	75	342	51.75439	48.24561	1260.942

Appendix 2: Villages in Jharkhand with recorded Human Mortality (2000-2023)

S.No.	Human Casualties Count	Village Name	Division	Administrative level	Rural / Urban	Household	Population	Male%	Female%	Area (Ha)
1	218	Ranchi	Ranchi	Town	Urban	207636	1073427	52.06428	47.93572	15874.72
2	30	Titahia	Koderma	Village	Rural	79	498	50.80321	49.19679	80.41429
3	28	Gajgaon	Khunti	Village	Rural	199	1194	50.75377	49.24623	567.6787
4	28	Bramhajamalpur	Sahibganj	Village	Rural	264	1378	51.88679	48.11321	601.6666
5	27	Bhuchungdih	Ramgarh	Village	Rural	417	2309	50.49805	49.50195	605.9647
6	26	Sarbaha	Hazaribagh	Village	Rural	479	2423	51.71275	48.28725	996.5635
7	26	Koinara	Ranchi	Village	Rural	254	1301	46.50269	53.49731	818.8382
8	25	Khokhro	Dalma Wildlife Sanctuary	Village	Rural	111	470	49.57447	50.42553	965.5186
9	24	Urikel	Khunti	Village	Rural	127	560	52.14286	47.85714	316.7189
10	23	Barinijkel	Khunti	Village	Rural	321	1670	50.71856	49.28144	1097.634
11	23	Kodarma	Koderma	Town	Urban	4337	24633	52.53522	47.46478	1505.811
12	22	Seraikella	Saraikela	Town	Urban	2975	14252	52.27337	47.72663	572.8355
13	22	Chandil CT	Saraikela	Town	Urban	1025	4839	51.66357	48.33643	110.9582
14	20	Dum	Dumka	Village	Rural	51	248	49.19355	50.80645	55.26032
15	19	Bisrampur	Saraikela	Village	Rural	91	488	49.18033	50.81967	309.0024
16	18	Khatanga	Khunti	Village	Rural	74	455	49.67033	50.32967	300.1453
17	18	Nagri	Koderma	Village	Rural	50	286	55.94406	44.05594	99.73123
18	18	Chamatu	Latehar	Village	Rural	340	1606	51.1208	48.8792	1254.863
19	17	Mahthadih	Koderma	Village	Rural	726	4084	51.42018	48.57982	127.3131
20	16	Tokisud	Dalma Wildlife Sanctuary	Village	Rural	183	997	50.45135	49.54865	1237.741
21	15	Chetar	Latehar	Village	Rural	143	810	50	50	474.1201
22	14	Meramhonar	West Singhbhum	Village	Rural	503	2639	49.07162	50.92838	1063.11
23	14	Ichagarh	Saraikela	Village	Rural	358	1546	48.83571	51.16429	340.9982
24	13	Dimba	Ranchi	Village	Rural	276	1381	46.48805	53.51195	784.7551
25	12	Nagwan	Hazaribagh	Village	Rural	626	3565	51.2763	48.7237	478.19
26	11	Meral	Khunti	Village	Rural	86	390	53.07692	46.92308	195.0083

27	11	Utrung	Khunti	Village	Rural	24	116	48.27586	51.72414	54.33768
28	11	Meghahatu-buru Forest Village	Saranda Forest Division	Town	Urban	1291	5992	52.62016	47.37984	228.8553
29	11	Gohla	East Sing-hbhum	Village	Rural	545	2545	50.13752	49.86248	658.4247
30	11	Lawa	Dalma Wildlife Sanctuary	Village	Rural	529	2487	49.33655	50.66345	378.6063
31	11	Pabira	Ranchi	Village	Rural	190	890	48.31461	51.68539	617.4809
32	10	Lota	Ranchi	Village	Rural	998	4760	50.77731	49.22269	443.7506
33	10	Lali	Ranchi	Village	Rural	663	3316	49.24608	50.75392	2440.937
34	10	Beti Benti	Ranchi	Village	Rural	265	1409	50.53229	49.46771	712.5114
35	10	Jarga	Ranchi	Village	Rural	344	1716	51.1655	48.8345	775.1774
36	9	Chargo	Giridih	Village	Rural	152	1017	49.36087	50.63913	315.8159
37	9	Dhangain	Palamu	Village	Rural	115	690	49.42029	50.57971	100.1152
38	9	Kolbonga	West Singh-bhum	Village	Rural	92	421	49.16865	50.83135	199.175
39	9	Hajam	Ranchi	Village	Rural	127	672	50.59524	49.40476	333.8552
40	9	Pandu	Ranchi	Village	Rural	131	705	47.94326	52.05674	457.0338
41	9	Danekera	Ranchi	Village	Rural	366	1764	48.12925	51.87075	1363.727
42	9	Nehalu-kapariya	Ranchi	Village	Rural	541	3344	50.77751	49.22249	1593.819
43	9	Gaubathan	Sahibganj	Village	Rural	0	0	0	0	65.83493
44	8	Gagi	Bokaro	Village	Rural	465	2667	51.93101	48.06899	89.28833
45	8	Kujukalan	Ramgarh	Village	Rural	73	463	51.83585	48.16415	284.5351
46	7	Gulhutu	Chatra	Village	Rural	28	139	48.20144	51.79856	153.4397
47	7	Katkamsanr	Hazarib-agh	Village	Rural	880	5132	50.83788	49.16212	1297.798
48	7	Marangburu	Khunti	Village	Rural	151	736	50.54348	49.45652	766.798
49	7	Itkithakur-goan	Ranchi	Village	Rural	2285	12174	50.44357	49.55643	571.9267
50	7	Kasari	Sahibganj	Village	Rural	36	155	55.48387	44.51613	115.6155
51	7	Panchkatiya	Sahibganj	Village	Rural	333	1563	51.82342	48.17658	271.0143
52	6	Topchanchi	Dhanbad	Town	Urban	1149	6082	51.11805	48.88195	345.1919
53	6	Telia Chak	Dumka	Village	Rural	113	561	52.94118	47.05882	26.91485
54	6	Turbunga	Gumla	Village	Rural	266	1346	49.10847	50.89153	731.2976
55	6	Hazaribag	Ranchi	Town	Urban	25794	142489	52.02647	47.97353	1596.269
56	6	Lipunga	West Singh-bhum	Village	Rural	138	749	48.33111	51.66889	1420.279
57	6	Lodhma	Ranchi	Village	Rural	224	1130	50.70796	49.29204	228.61
58	6	Katingkela	Ranchi	Village	Rural	193	1055	49.19431	50.80569	445.9878
59	6	Nimdih	Saraikela	Village	Rural	286	1349	52.48332	47.51668	102.2054
60	5	Simaria Khurd	Chatra	Village	Rural	190	1055	47.96209	52.03791	69.31765
61	5	Tundi	Dhanbad	Village	Rural	763	4221	48.96944	51.03056	199.0889
62	5	Gurdari	Gumla	Village	Rural	559	3432	54.31235	45.68765	2714.31
63	5	Ghatshila CT	East Sing-hbhum	Town	Urban	8893	40624	51.47696	48.52304	1359.188
64	5	Kontatola	Ranchi	Village	Rural	263	1213	51.4427	48.5573	596.4647
65	5	Ulatu	Ranchi	Village	Rural	1488	7812	50.47363	49.52637	4568.838
66	5	Latratu	Ranchi	Village	Rural	221	1175	50.7234	49.2766	938.4328
67	5	Bisa	Ranchi	Village	Rural	556	2976	50.70565	49.29435	1132.914
68	5	Bitaburu	Saraikela	Village	Rural	280	1338	51.34529	48.65471	416.7418
69	4	Kasmar	Bokaro	Village	Rural	587	2867	51.30799	48.69201	247.644
70	4	Pithakiyari	Dhanbad	Village	Rural	698	3506	52.53851	47.46149	37.12292

71	4	Tisri	Giridih	Village	Rural	680	3786	53.51294	46.48706	418.7352
72	4	Chappatoli	Gumla	Village	Rural	156	814	52.7027	47.2973	364.8031
73	4	Kunrwa	Hazaribagh	Village	Rural	205	1208	49.83444	50.16556	544.7264
74	4	Khunti	Khunti	Town	Urban	7245	36390	51.01951	48.98049	2334.013
75	4	Chakulia	East Singhbhum	Town	Urban	3606	16306	51.22041	48.77959	1702.298
76	4	Kundaloka	East Singhbhum	Village	Rural	250	1265	49.72332	50.27668	736.1162
77	4	Paruliya	East Singhbhum	Village	Rural	1132	5286	49.65948	50.34052	1946.384
78	4	Duru	Ranchi	Village	Rural	119	606	51.9802	48.0198	347.8555
79	4	Kharsawan	Saraikela	Village	Rural	1192	5793	52.82237	47.17763	559.1485
80	4	Kandra	Saraikela	Town	Urban	1712	8157	51.96764	48.03236	279.3584
81	4	Parerkola	Sahibganj	Village	Rural	46	208	53.84615	46.15385	141.2531
82	3	Nawadih	Bokaro	Village	Rural	790	4362	50.82531	49.17469	209.8178
83	3	Tandwa	Chatra	Village	Rural	1126	6475	53.09653	46.90347	505.4252
84	3	Bakspura	Dhanbad	Village	Rural	425	2274	54.04573	45.95427	75.32242
85	3	Nipaniya	Godda	Village	Rural	586	2703	53.16315	46.83685	769.273
86	3	Cherra CT	Hazaribagh	Town	Urban	953	5279	52.64255	47.35745	214.1345
87	3	Saraia	Hazaribagh	Village	Rural	820	4855	50.7518	49.2482	1011.157
88	3	Sekhpura	Jamtara	Village	Rural	39	316	54.74684	45.25316	73.71273
89	3	Mihijam	Jamtara	Town	Urban	8139	40463	52.89029	47.10971	1055.077
90	3	Fatehpur	Jamtara	Village	Rural	841	4107	51.40005	48.59995	462.7602
91	3	Rengrahatu	West Singhbhum	Village	Rural	345	1892	51.63848	48.36152	1444.487
92	3	Forest Block	East Singhbhum	Village	Rural	511	2665	48.93058	51.06942	4796.667
93	3	Mohanadi	East Singhbhum	Village	Rural	76	379	49.60422	50.39578	280.8072
94	3	Hehal	Ramgarh	Village	Rural	631	3808	51.65441	48.34559	479.9293
95	3	Patratu	Ramgarh	Town	Urban	6356	32899	52.60038	47.39962	2153.78
96	3	Bantara	Ramgarh	Village	Rural	300	1579	52.1216	47.8784	61.50309
97	3	Itihasa	Ranchi	Village	Rural	113	569	51.6696	48.3304	466.505
98	3	Lalganj	Ranchi	Village	Rural	382	1931	49.71517	50.28483	345.7354
99	3	Tati CT	Ranchi	Town	Urban	2544	12878	53.37009	46.62991	358.1733
100	3	Tumbaguttu	Ranchi	Village	Rural	562	3014	50.56403	49.43597	563.6805
101	3	Palandu	Ranchi	Village	Rural	211	1033	47.62827	52.37173	210.5759
102	3	Malti	Ranchi	Village	Rural	136	684	46.49123	53.50877	215.4549
103	3	Sakarpur	Ranchi	Village	Rural	181	1076	48.42007	51.57993	519.4541
104	3	Tilai	Ranchi	Village	Rural	72	408	48.52941	51.47059	288.6918
105	3	Biramkel	Ranchi	Village	Rural	116	663	49.4721	50.5279	364.2244
106	3	Dola	Ranchi	Village	Rural	76	426	51.40845	48.59155	428.0012
107	3	Sarugori	Ranchi	Village	Rural	202	880	51.59091	48.40909	463.7663
108	3	Sirka	Ranchi	Village	Rural	529	2550	51.05882	48.94118	554.4774
109	3	Barwadag	Ranchi	Village	Rural	250	1129	48.00709	51.99291	833.0239
110	3	Sitadih	Ranchi	Village	Rural	185	850	49.41176	50.58824	551.3599
111	3	Manipur	Saraikela	Village	Rural	66	300	52	48	200.307
112	3	Chati Gobindpur	Dhanbad	Village	Rural	224	1355	49.7417	50.2583	25.68687
113	2	Chandankiari	Bokaro	Village	Rural	1831	9836	52.12485	47.87515	752.4467
114	2	Gumia CT	Bokaro	Town	Urban	9001	48141	52.17798	47.82202	3021.923
115	2	Bandh Dih CT	Bokaro	Town	Urban	2531	13192	53.03972	46.96028	1531.635

116	2	Partappur	Chatra	Village	Rural	717	3530	52.35127	47.64873	148.1146
117	2	Lawalong	Chatra	Village	Rural	67	347	53.60231	46.39769	387.1249
118	2	Majhipara	Chatra	Village	Rural	174	753	51.39442	48.60558	617.0536
119	2	Bariarchak	Chatra	Village	Rural	105	609	51.88834	48.11166	74.77489
120	2	Sikaripara	Dumka	Village	Rural	577	2646	50.90703	49.09297	182.0106
121	2	Ramgarh	Dumka	Village	Rural	191	961	49.21956	50.78044	104.9656
122	2	Jama	Dumka	Village	Rural	68	316	47.1519	52.8481	144.0977
123	2	Gopikandar	Dumka	Village	Rural	283	1293	50.58005	49.41995	146.9422
124	2	Jarmune	Giridih	Village	Rural	2616	15269	51.06425	48.93575	1143.615
125	2	Mohandih	Giridih	Village	Rural	296	1757	53.38645	46.61355	203.1836
126	2	Dhanwar Dakshin	Giridih	Town	Urban	1526	8777	51.62356	48.37644	201.9791
127	2	Harla	Giridih	Village	Rural	381	2332	51.84391	48.15609	164.1466
128	2	Chirki	Giridih	Village	Rural	425	2608	46.43405	53.56595	389.8284
129	2	Bara Boarijor	Godda	Village	Rural	452	2423	49.31903	50.68097	214.3052
130	2	Pareya Hat	Godda	Village	Rural	1294	6319	52.16015	47.83985	482.9034
131	2	Tajpur	Hazaribagh	Village	Rural	782	4214	51.61367	48.38633	768.8329
132	2	Gopalpur	Jamtara	Village	Rural	357	1725	52.57971	47.42029	132.6035
133	2	Lappa	Ranchi	Village	Rural	277	1377	50.90777	49.09223	594.4689
134	2	Lumluma	Khunti	Village	Rural	87	452	50	50	195.6145
135	2	Barudih	Dalma Wildlife Sanctuary	Village	Rural	28	120	49.16667	50.83333	70.18098
136	2	Sisi	Latehar	Village	Rural	250	1345	48.77323	51.22677	486.4756
137	2	Babhandih	Palamu	Village	Rural	338	1755	52.53561	47.46439	466.9219
138	2	Nawa	Palamu	Village	Rural	248	1150	49.47826	50.52174	950.4031
139	2	Ladi	Palamu	Village	Rural	223	1232	53.8961	46.1039	136.1073
140	2	Sagalim	Palamu	Village	Rural	698	3577	49.98602	50.01398	471.1804
141	2	Kudaga Kalan	Palamu	Village	Rural	294	1434	52.51046	47.48954	217.1776
142	2	Baida	Palamu	Village	Rural	86	461	49.89154	50.10846	231.3245
143	2	Kamat Tola	Palamu	Village	Rural	42	204	46.56863	53.43137	15.85237
144	2	Chandarpur	Palamu	Village	Rural	130	827	51.39057	48.60943	143.402
145	2	Manatu	Palamu	Village	Rural	148	970	58.96907	41.03093	277.4978
146	2	Dumri	Palamu	Village	Rural	217	1271	53.81589	46.18411	968.1038
147	2	Rajhara	Palamu	Village	Rural	788	3958	50.90955	49.09045	1030.242
148	2	Teugri	Palamu	Village	Rural	70	332	53.31325	46.68675	60.18505
149	2	Hussainabad	Palamu	Town	Urban	4821	29241	52.24172	47.75828	1294.041
150	2	Baralota CT	Palamu	Town	Urban	2756	14880	53.40054	46.59946	704.9491
151	2	Bara	Palamu	Village	Rural	537	3342	51.94494	48.05506	213.2284
152	2	Adar	Palamu	Village	Rural	63	347	53.89049	46.10951	1079.641
153	2	Hisra	Palamu	Village	Rural	227	1044	48.27586	51.72414	899.9316
154	2	Haminpur	Palamu	Village	Rural	12	88	53.40909	46.59091	204.7385
155	2	Berma	Palamu	Village	Rural	444	2269	49.05245	50.94755	1298.37
156	2	Salatua	Palamu	Village	Rural	721	3583	50.96288	49.03712	1950.589
157	2	Belhara	Palamu	Village	Rural	217	1407	51.59915	48.40085	208.908
158	2	Bargua	West Singhbhum	Village	Rural	23	99	44.44444	55.55556	9951.298
159	2	Kechabaipi	West Singhbhum	Village	Rural	45	222	50.9009	49.0991	512.6183
160	2	Mohanpur	East Singhbhum	Village	Rural	428	1694	50.64935	49.35065	38.97547
161	2	Kantabani	East Singhbhum	Village	Rural	110	538	48.32714	51.67286	391.2531

162	2	Manikabera	East Singhbhum	Village	Rural	92	409	50.36675	49.63325	131.5326
163	2	Choira	East Singhbhum	Village	Rural	198	896	50.11161	49.88839	343.1496
164	2	Jambani	East Singhbhum	Village	Rural	111	496	55.04032	44.95968	70.61619
165	2	Dublabera	East Singhbhum	Village	Rural	128	654	49.38838	50.61162	560.1984
166	2	Galudi	East Singhbhum	Village	Rural	69	311	52.41158	47.58842	111.6411
167	2	Gobarghusi	Dalma Wildlife Sanctuary	Village	Rural	321	1482	50.53981	49.46019	1083.167
168	2	Dhusra	Dalma Wildlife Sanctuary	Village	Rural	213	993	50.25176	49.74824	432.8864
169	2	Khariyasai	East Singhbhum	Village	Rural	244	1146	48.51658	51.48342	273.9519
170	2	Gola	Ramgarh	Village	Rural	1527	8076	52.45171	47.54829	243.8634
171	2	Mandu CT	Ramgarh	Town	Urban	1926	10223	53.31116	46.68884	1742.537
172	2	Burhakhap	Ramgarh	Village	Rural	78	430	49.76744	50.23256	310.2396
173	2	Hariharpur	Ranchi	Village	Rural	238	1236	51.13269	48.86731	508.7891
174	2	Tunku	Ranchi	Village	Rural	262	1137	49.69217	50.30783	408.7146
175	2	Bantahajam	Ranchi	Village	Rural	1866	8677	50.66267	49.33733	2307.483
176	2	Chachgura	Ranchi	Village	Rural	259	1359	52.02355	47.97645	313.0669
177	2	Dharampur	Ranchi	Village	Rural	59	264	56.06061	43.93939	445.9045
178	2	Goradih	Ranchi	Village	Rural	574	2754	50.83515	49.16485	823.3277
179	2	Baridih	Ranchi	Village	Rural	230	1304	49.76994	50.23006	251.9975
180	2	Basantpur	Ranchi	Village	Rural	361	1716	48.71795	51.28205	237.8993
181	2	Purnadih	Ranchi	Village	Rural	89	464	52.37069	47.62931	376.4056
182	2	Kuchu	Ranchi	Village	Rural	459	2371	51.83467	48.16533	474.8332
183	2	Bhusur	Ranchi	Village	Rural	148	745	50.4698	49.5302	316.7909
184	2	Damari	Ranchi	Village	Rural	324	1436	52.08914	47.91086	91.96449
185	2	Jaratoli	Ranchi	Village	Rural	47	250	52.8	47.2	180.9261
186	2	Kota	Ranchi	Village	Rural	207	1244	50.5627	49.4373	203.1911
187	2	Piska	Ranchi	Village	Rural	188	954	48.11321	51.88679	305.008
188	2	Karum	Ranchi	Village	Rural	113	584	51.5411	48.4589	144.758
189	2	Malgo	Ranchi	Village	Rural	433	2248	49.33274	50.66726	874.8487
190	2	Jataloya	Ranchi	Village	Rural	184	958	48.32985	51.67015	350.419
191	2	Sarangloya	Ranchi	Village	Rural	123	651	48.69432	51.30568	385.4161
192	2	Pithauriya	Ranchi	Village	Rural	1243	6550	52.10687	47.89313	451.0853
193	2	Kuli	Ranchi	Village	Rural	571	3208	49.15835	50.84165	1033.237
194	2	Bhandra	Ranchi	Village	Rural	232	1519	51.4154	48.5846	343.4898
195	2	Chatwal	Ranchi	Village	Rural	399	2447	50.91949	49.08051	214.1696
196	2	Sero	Ranchi	Village	Rural	422	2278	50.26339	49.73661	760.5367
197	2	Tuko	Ranchi	Village	Rural	372	2270	51.4978	48.5022	395.592
198	2	Mahru	Ranchi	Village	Rural	117	687	51.96507	48.03493	253.1499
199	2	Jahanabaj	Ranchi	Village	Rural	269	1346	50.14859	49.85141	491.9362
200	2	Koynardih	Ranchi	Village	Rural	183	826	48.30508	51.69492	793.5235
201	2	Badri	Ranchi	Village	Rural	288	1438	51.32128	48.67872	897.3612
202	2	Palna	Saraikela	Village	Rural	171	843	49.58482	50.41518	397.6321
203	2	Chowka	Saraikela	Village	Rural	366	1492	52.27882	47.72118	132.4728
204	2	Raghunathpur	Saraikela	Village	Rural	759	3351	50.88033	49.11967	381.3297
205	2	Sirkadih	Saraikela	Village	Rural	182	802	49.62594	50.37406	101.349
206	2	Rajnagar	Saraikela	Village	Rural	390	1806	49.83389	50.16611	207.4843
207	2	Raipur	Saraikela	Village	Rural	131	668	50.8982	49.1018	146.618

208	2	Komdih	West Singh-bhum	Village	Rural	89	660	45.60606	54.39394	141.3098
209	2	Kandarbera	Saraikela	Village	Rural	266	1159	50.38827	49.61173	665.6411
210	2	Rudih	Saraikela	Village	Rural	466	1957	51.25192	48.74808	687.1544
211	2	Nawapara	Sahibganj	Village	Rural	167	833	49.45978	50.54022	309.1973
212	1	Chandrapu-ra CT	Bokaro	Town	Urban	5520	27425	52.60893	47.39107	710.0745
213	1	Chas	Bokaro	Town	Urban	25540	141640	52.7584	47.2416	1890.515
214	1	Uda	Bokaro	Village	Rural	70	352	50.85227	49.14773	568.2545
215	1	Kalyanpur	Bokaro	Village	Rural	456	2105	50.30879	49.69121	682.7964
216	1	Jhirki	Ranchi	Village	Rural	171	821	52.00974	47.99026	128.4209
217	1	Khutikewal Khurd	Chatra	Village	Rural	452	2372	50.92749	49.07251	94.66339
218	1	Gidhaur	Chatra	Village	Rural	1021	5520	51.86594	48.13406	1451.751
219	1	Sagdaha	Ranchi	Village	Rural	181	1026	53.9961	46.0039	157.859
220	1	Dhanbad	Dhanbad	Town	Urban	220783	1162472	52.88059	47.11941	21639.64
221	1	Sihulibana	Dalma Wildlife Sanctuary	Village	Rural	114	535	53.08411	46.91589	250.2328
222	1	Dongo	Giridih	Village	Rural	43	392	49.4898	50.5102	196.4215
223	1	Asgando	Giridih	Village	Rural	0	0	0	0	215.1235
224	1	Karodih	Giridih	Village	Rural	220	1632	51.59314	48.40686	511.8262
225	1	Sundar Pahari	Godda	Village	Rural	196	888	41.21622	58.78378	436.4776
226	1	Dumberi Kajri	Godda	Village	Rural	12	39	58.97436	41.02564	60.6862
227	1	Basantpur	Godda	Village	Rural	129	676	49.55621	50.44379	16.44154
228	1	Chamru Kaprigangti	Godda	Village	Rural	64	400	52.25	47.75	52.77691
229	1	Duarichak	Godda	Village	Rural	238	1150	54.08696	45.91304	36.25238
230	1	Banka Ghat	Godda	Village	Rural	631	3092	51.94049	48.05951	555.8086
231	1	Godda	Godda	Town	Urban	8969	48480	53.02599	46.97401	793.1708
232	1	Lunga	Gumla	Village	Rural	89	401	46.63342	53.36658	316.6319
233	1	Nawagarh	Gumla	Village	Rural	1231	6529	48.30755	51.69245	2968.596
234	1	Tigawal	Gumla	Village	Rural	207	1209	49.54508	50.45492	887.9088
235	1	Korekera	Gumla	Village	Rural	186	863	46.34994	53.65006	488.5699
236	1	Bhagidera	Ranchi	Village	Rural	342	1644	50.36496	49.63504	121.1934
237	1	Basiya	Gumla	Village	Rural	821	3985	49.66123	50.33877	983.1025
238	1	Palkot	Gumla	Village	Rural	1753	8945	49.33482	50.66518	2728.008
239	1	Beyar	Gumla	Village	Rural	112	662	50	50	634.9645
240	1	Ruki	Gumla	Village	Rural	233	1268	50.07886	49.92114	767.0739
241	1	Besna	Gumla	Village	Rural	80	504	53.37302	46.62698	572.4143
242	1	Rajadera	Gumla	Village	Rural	52	344	48.83721	51.16279	785.3384
243	1	Harsari	Gumla	Village	Rural	176	901	50.83241	49.16759	476.6018
244	1	Barhi CT	Hazarib-agh	Town	Urban	2011	11867	51.46204	48.53796	379.9937
245	1	Barkagaon	Hazarib-agh	Village	Rural	2063	11689	51.52708	48.47292	341.4436
246	1	Barahkatha	Hazarib-agh	Village	Rural	1445	8364	52.05643	47.94357	370.5233
247	1	Masipirhi	Hazarib-agh	Village	Rural	281	1799	51.13952	48.86048	358.1209
248	1	Churchu	Hazarib-agh	Village	Rural	246	1279	52.77561	47.22439	335.8683
249	1	Dari CT	Hazarib-agh	Town	Urban	1219	6405	51.25683	48.74317	1098.509
250	1	Parasi	Hazarib-agh	Village	Rural	591	3211	52.94301	47.05699	317.2811

251	1	Keredari	Hazaribagh	Village	Rural	716	3693	51.77363	48.22637	907.6293
252	1	Padma	Hazaribagh	Village	Rural	1407	7896	54.78723	45.21277	898.3637
253	1	Aintha	Hazaribagh	Village	Rural	42	260	54.61538	45.38462	100.3765
254	1	Daldala	Jamtara	Village	Rural	101	494	51.21457	48.78543	103.0872
255	1	Muraam	Jamtara	Village	Rural	117	689	54.86212	45.13788	253.8185
256	1	Mahulbana	Jamtara	Village	Rural	306	1464	51.02459	48.97541	381.6658
257	1	Teliadi	Jamtara	Village	Rural	164	765	51.24183	48.75817	84.35936
258	1	Karma Tanr CT	Jamtara	Town	Urban	1082	5868	51.36333	48.63667	294.6071
259	1	Rampur Bhitra	Jamtara	Village	Rural	78	488	51.02459	48.97541	179.2819
260	1	Raghunathpur	Jamtara	Village	Rural	5	32	50	50	20.85273
261	1	Jorbhitha	Jamtara	Village	Rural	109	529	47.82609	52.17391	271.5377
262	1	Kushmapahari	Jamtara	Village	Rural	92	488	51.63934	48.36066	156.9332
263	1	Posai	Jamtara	Village	Rural	209	1060	52.92453	47.07547	153.8287
264	1	Jamtara	Jamtara	Town	Urban	5743	29415	52.25905	47.74095	1377.067
265	1	Kumhardih	Khunti	Village	Rural	78	569	51.84534	48.15466	437.6519
266	1	Jilingkel	Khunti	Village	Rural	210	1128	50.26596	49.73404	776.9331
267	1	Kudapurti	Khunti	Village	Rural	391	2027	50.66601	49.33399	1804.92
268	1	Hunth	Khunti	Village	Rural	225	1242	49.75845	50.24155	557.1155
269	1	Chuklu	Khunti	Village	Rural	267	1392	50.71839	49.28161	1322.863
270	1	Raytorang	Khunti	Village	Rural	77	391	47.82609	52.17391	411.2485
271	1	Ronhi	Ranchi	Village	Rural	117	584	48.9726	51.0274	231.37
272	1	Galiondar	Khunti	Village	Rural	59	350	49.71429	50.28571	287.1411
273	1	Dumargari	Ranchi	Village	Rural	261	1235	48.34008	51.65992	950.2836
274	1	Kadal	Gumla	Village	Rural	78	455	47.47253	52.52747	501.8252
275	1	Taski	Ranchi	Village	Rural	125	683	50.51245	49.48755	210.8015
276	1	Timra	Ranchi	Village	Rural	114	741	47.36842	52.63158	190.1979
277	1	Jojodag	Ranchi	Village	Rural	149	622	49.03537	50.96463	202.2641
278	1	Suti	Ranchi	Village	Rural	66	323	48.60681	51.39319	117.1047
279	1	Korakel	Khunti	Village	Rural	519	2489	49.57814	50.42186	423.2207
280	1	Hethgowa	Khunti	Village	Rural	292	1565	50.35144	49.64856	645.7577
281	1	Sirka	Khunti	Village	Rural	183	913	50.60241	49.39759	842.4586
282	1	Selda	Khunti	Village	Rural	90	509	51.8664	48.1336	251.7669
283	1	Bundu Mamail	Khunti	Village	Rural	97	572	53.14685	46.85315	717.7468
284	1	Guruburu	Khunti	Village	Rural	46	218	51.37615	48.62385	101.9987
285	1	Dembukel	Khunti	Village	Rural	101	520	48.84615	51.15385	453.5486
286	1	Kelo	Khunti	Village	Rural	89	416	47.83654	52.16346	207.2752
287	1	Okra	Ranchi	Village	Rural	412	2184	49.03846	50.96154	1030.026
288	1	Dumangdiri	Khunti	Village	Rural	66	398	49.49749	50.50251	191.8394
289	1	Anigara	Khunti	Village	Rural	394	2071	49.44471	50.55529	763.0735
290	1	Sandasom	Khunti	Village	Rural	160	791	52.33881	47.66119	426.2283
291	1	Khirikala	Koderma	Village	Rural	23	108	58.33333	41.66667	154.9877
292	1	Mail	Latehar	Village	Rural	487	2885	51.43847	48.56153	1085.08
293	1	Hundru	Latehar	Village	Rural	213	1149	50.82681	49.17319	332.3284
294	1	Baritu Jagir	Latehar	Village	Rural	257	1261	49.64314	50.35686	308.9705
295	1	Betla	Palamu	Village	Rural	432	2193	52.30278	47.69722	618.2215
296	1	Kharta	Ranchi	Village	Rural	284	1578	49.42966	50.57034	614.8854
297	1	Sitagarh	Pakur	Village	Rural	82	430	49.30233	50.69767	126.6353
298	1	Kasila	Pakur	Village	Rural	383	1919	48.82751	51.17249	302.6543

299	1	Anupdanga	Pakur	Village	Rural	147	766	50.78329	49.21671	279.6251
300	1	Jirli	Pakur	Village	Rural	229	1057	48.06055	51.93945	257.8852
301	1	Dasgora	Pakur	Village	Rural	95	397	42.06549	57.93451	349.4873
302	1	Champa	Pakur	Village	Rural	24	102	50.98039	49.01961	129.0564
303	1	Karmatanr	Pakur	Village	Rural	157	716	51.11732	48.88268	315.2824
304	1	Nerpahari	Pakur	Village	Rural	2	12	50	50	23.93392
305	1	Telopara	Pakur	Village	Rural	102	494	50.80972	49.19028	173.3952
306	1	Kidirpur	Pakur	Village	Rural	187	875	51.65714	48.34286	91.55354
307	1	Talpahari	Pakur	Village	Rural	173	784	50.12755	49.87245	252.6651
308	1	Gorpara	Pakur	Village	Rural	115	559	50.9839	49.0161	421.6843
309	1	Kundamatia	Pakur	Village	Rural	95	413	52.7845	47.2155	282.2377
310	1	Ghaghri	West Singh-bhum	Village	Rural	251	1263	47.26841	52.73159	477.5853
311	1	Kebedkara	West Singh-bhum	Village	Rural	193	983	52.18718	47.81282	270.9827
312	1	Sangajata	West Singh-bhum	Village	Rural	82	410	50	50	486.8949
313	1	Jojohatu	West Singh-bhum	Village	Rural	94	437	51.25858	48.74142	259.264
314	1	Thaikobad	West Singh-bhum	Village	Rural	76	320	55.625	44.375	221.5167
315	1	Kudripa	West Singh-bhum	Village	Rural	47	266	47.36842	52.63158	5106.536
316	1	Thakura	West Singh-bhum	Village	Rural	140	694	49.71182	50.28818	1242.543
317	1	Patamda	East Singhbhum	Village	Rural	511	2558	52.15012	47.84988	385.1854
318	1	Boram	East Singhbhum	Village	Rural	664	3314	53.10803	46.89197	425.2204
319	1	Laylam	Dalma Wildlife Sanctuary	Village	Rural	330	1673	51.46444	48.53556	1086.947
320	1	Muturkham	East Singhbhum	Village	Rural	142	650	49.23077	50.76923	352.0246
321	1	Swargachhinra	East Singhbhum	Village	Rural	89	389	50.64267	49.35733	144.3419
322	1	Mahisadhara	East Singhbhum	Village	Rural	110	524	50.38168	49.61832	438.5321
323	1	Behra	East Singhbhum	Village	Rural	178	768	49.47917	50.52083	212.8206
324	1	Katashol	East Singhbhum	Village	Rural	164	865	54.21965	45.78035	456.8466
325	1	Bankishol	East Singhbhum	Village	Rural	428	2001	49.42529	50.57471	621.388
326	1	Jangle Block	East Singhbhum	Village	Rural	109	622	51.76849	48.23151	1851.488
327	1	Kalimati	East Singhbhum	Village	Rural	82	434	47.92627	52.07373	342.0428
328	1	Manpita	Dalma Wildlife Sanctuary	Village	Rural	434	2207	50.11328	49.88672	325.175
329	1	Jadugora CT	East Singhbhum	Town	Urban	3755	18563	51.34407	48.65593	409.7298
330	1	Sohada	East Singhbhum	Village	Rural	585	2754	51.08932	48.91068	368.9916
331	1	Musabani CT	East Singhbhum	Town	Urban	6650	31035	51.75769	48.24231	1344.325

332	1	Bikrampur Alias Mainjhariya	East Singhbhum	Village	Rural	282	1381	48.51557	51.48443	764.7763
333	1	Kakdaha	East Singhbhum	Village	Rural	254	1233	50.36496	49.63504	1029.891
334	1	Sindurgauri	East Singhbhum	Village	Rural	41	190	50	50	105.796
335	1	Tilaitanr	East Singhbhum	Village	Rural	248	1203	48.5453	51.4547	68.62268
336	1	Dabanki	East Singhbhum	Village	Rural	219	1071	51.07376	48.92624	228.6495
337	1	Saharjuri	East Singhbhum	Village	Rural	65	321	48.59813	51.40187	556.1022
338	1	Harina	East Singhbhum	Village	Rural	294	1359	51.21413	48.78587	419.1471
339	1	Telaidi	East Singhbhum	Village	Rural	52	236	47.88136	52.11864	188.2694
340	1	Roteda	East Singhbhum	Village	Rural	38	169	44.97041	55.02959	62.54537
341	1	Ghaghra	Ramgarh	Village	Rural	111	629	49.92051	50.07949	446.2594
342	1	Ramgarh Nagar Parishad	Ramgarh	Town	Urban	16592	88781	54.18952	45.81048	2952.905
343	1	Gorha	Ranchi	Village	Rural	139	623	53.29053	46.70947	472.0553
344	1	Dowaru	Ranchi	Village	Rural	684	2989	50.68585	49.31415	1984.939
345	1	Lawadag	Ranchi	Village	Rural	207	966	51.34576	48.65424	148.0887
346	1	Chatambari	Ranchi	Village	Rural	154	706	50	50	493.3335
347	1	Patratu	Ranchi	Village	Rural	124	678	47.34513	52.65487	188.8936
348	1	Birgaon	Ranchi	Village	Rural	863	3565	50.57504	49.42496	1166.985
349	1	Jaluhutang	Ranchi	Village	Rural	155	706	48.86686	51.13314	498.5604
350	1	Jumla	Ranchi	Village	Rural	109	546	49.6337	50.3663	427.7834
351	1	Bhuli	Ranchi	Village	Rural	73	367	49.04632	50.95368	99.51224
352	1	Lagam	Ranchi	Village	Rural	356	1837	50.2994	49.7006	157.3246
353	1	Silli	Ranchi	Village	Rural	1072	5222	51.39793	48.60207	236.8513
354	1	Tutki	Ranchi	Village	Rural	434	2048	50.24414	49.75586	364.0558
355	1	Madni	Ranchi	Village	Rural	154	742	49.0566	50.9434	385.7595
356	1	Ratu CT	Ranchi	Town	Urban	4434	22379	51.4813	48.5187	929.7835
357	1	Tilta	Ranchi	Village	Rural	350	1839	50.08157	49.91843	260.0563
358	1	Nauasoso	Ranchi	Village	Rural	215	1116	50.98566	49.01434	155.2945
359	1	Bansiya	Ranchi	Village	Rural	395	1817	50.96313	49.03687	736.0887
360	1	Ladhup	Ranchi	Village	Rural	339	1445	50.38062	49.61938	643.6979
361	1	Guchidih	Ranchi	Village	Rural	189	782	50	50	179.8443
362	1	Dunde	Ranchi	Village	Rural	71	375	52.53333	47.46667	98.3014
363	1	Mahilong	Ranchi	Village	Rural	917	4371	50.90368	49.09632	846.5363
364	1	Arma	Ranchi	Village	Rural	0	0	0	0	38.74858
365	1	Tetri	Ranchi	Village	Rural	299	1473	51.79905	48.20095	467.2017
366	1	Baredih	Ranchi	Village	Rural	271	1262	52.6149	47.3851	282.2074
367	1	Sukurhuttu	Ranchi	Village	Rural	206	1112	48.56115	51.43885	143.6137
368	1	Jaipur	Ranchi	Village	Rural	177	1008	50	50	149.3348
369	1	Saher	Ranchi	Village	Rural	587	3084	51.32944	48.67056	559.9153
370	1	Sugda	Ranchi	Village	Rural	123	714	50.28011	49.71989	134.0589
371	1	Rege	Ranchi	Village	Rural	115	624	50.48077	49.51923	108.764
372	1	Nagra	Ranchi	Village	Rural	943	5929	49.67111	50.32889	1068.706
373	1	Kanijari	Ranchi	Village	Rural	184	1089	47.56657	52.43343	310.7493
374	1	Taberkalan	Ranchi	Village	Rural	54	303	50.16502	49.83498	238.6713
375	1	Balandu	Ranchi	Village	Rural	189	1008	49.60317	50.39683	190.8343
376	1	Sarsa	Ranchi	Village	Rural	205	1163	49.26913	50.73087	641.7799

377	1	Pola	Ranchi	Village	Rural	126	736	48.77717	51.22283	482.5043
378	1	Tetra	Ranchi	Village	Rural	113	618	51.77994	48.22006	166.1588
379	1	Koisara	Ranchi	Village	Rural	193	831	48.25511	51.74489	353.3712
380	1	Fatehpur	Ranchi	Village	Rural	210	1126	49.02309	50.97691	300.3878
381	1	Lapung	Ranchi	Village	Rural	192	903	50.94131	49.05869	258.5996
382	1	Chalha	Ranchi	Village	Rural	42	230	50.86957	49.13043	107.1567
383	1	Churi CT	Ranchi	Town	Urban	4972	24876	52.23911	47.76089	1670.16
384	1	Khelari CT	Ranchi	Town	Urban	3800	20010	51.72914	48.27086	1744.283
385	1	Pusu	Ranchi	Village	Rural	172	888	49.66216	50.33784	791.9364
386	1	Jidu	Ranchi	Village	Rural	92	508	39.96063	60.03937	187.7839
387	1	Marwa	Ranchi	Village	Rural	268	1274	49.68603	50.31397	777.9051
388	1	Jaipur	Ranchi	Village	Rural	471	2560	51.28906	48.71094	160.6899
389	1	Sukurhuttu	Ranchi	Village	Rural	2118	11862	52.91688	47.08312	1148.601
390	1	Soso	Ranchi	Village	Rural	200	1035	52.07729	47.92271	230.026
391	1	Chinaro	Ranchi	Village	Rural	84	523	48.94837	51.05163	194.6014
392	1	Puriya	Ranchi	Village	Rural	116	733	51.29604	48.70396	643.1801
393	1	Ara	Ranchi	Village	Rural	114	510	52.15686	47.84314	480.8171
394	1	Kamta	Ranchi	Village	Rural	483	2401	49.77093	50.22907	460.1318
395	1	Harra	Ranchi	Village	Rural	172	899	50.16685	49.83315	277.5945
396	1	Madai	Ranchi	Village	Rural	114	731	50.75239	49.24761	134.7577
397	1	Umedanda	Ranchi	Village	Rural	675	3644	51.75631	48.24369	1242.659
398	1	Gurgain	Ranchi	Village	Rural	558	3008	50.26596	49.73404	625.7144
399	1	Kotari	Ranchi	Village	Rural	165	843	51.24555	48.75445	470.8374
400	1	Nawadih	Ranchi	Village	Rural	49	225	52.44444	47.55556	77.86024
401	1	Murto	Ranchi	Village	Rural	349	2063	51.04217	48.95783	462.4116
402	1	Karanji	Ranchi	Village	Rural	538	3119	51.07406	48.92594	413.6117
403	1	Bero	Ranchi	Village	Rural	1557	7193	48.89476	51.10524	671.2505
404	1	Singari	Ranchi	Village	Rural	386	2025	49.58025	50.41975	633.3831
405	1	Sursu	Ranchi	Village	Rural	414	2026	43.97828	56.02172	1400.86
406	1	Malghong-hsa	Ranchi	Village	Rural	369	1814	50.60639	49.39361	946.4913
407	1	Hesatu	Ranchi	Village	Rural	620	3161	52.76811	47.23189	569.5298
408	1	Soso	Ranchi	Village	Rural	210	1124	50.97865	49.02135	333.32
409	1	Jaradih	Ranchi	Village	Rural	186	955	51.72775	48.27225	361.0819
410	1	Dahua	Ranchi	Village	Rural	112	556	50.89928	49.10072	141.1334
411	1	Kashidih	Ranchi	Village	Rural	181	822	51.94647	48.05353	566.9034
412	1	Mungadih	Ranchi	Village	Rural	63	327	49.84709	50.15291	185.8356
413	1	Jonha	Ranchi	Village	Rural	414	1982	47.32593	52.67407	335.2686
414	1	Heslabera	Ranchi	Village	Rural	264	1430	50.27972	49.72028	652.3927
415	1	Kachojara	Ranchi	Village	Rural	18	86	58.13953	41.86047	211.3182
416	1	Sindri	Saraikela	Village	Rural	170	769	55.6567	44.3433	176.2343
417	1	Jhimiri	Dalma Wildlife Sanctuary	Village	Rural	731	3381	52.26264	47.73736	532.2888
418	1	Bandhdih	Dalma Wildlife Sanctuary	Village	Rural	186	851	50.88132	49.11868	946.2175
419	1	Edaldih	Saraikela	Village	Rural	92	341	48.97361	51.02639	100.0266
420	1	Kuchai	Saraikela	Village	Rural	247	1315	56.12167	43.87833	379.3515
421	1	Raijama	Saraikela	Village	Rural	161	752	51.59574	48.40426	1058.782
422	1	Kashidih	Saraikela	Village	Rural	53	284	56.69014	43.30986	295.6404
423	1	Raidih	Saraikela	Village	Rural	133	593	52.27656	47.72344	279.3857
424	1	Sauntari	Saraikela	Village	Rural	158	777	51.09395	48.90605	165.6433
425	1	Khelarisai	Saraikela	Village	Rural	136	665	52.18045	47.81955	184.9167
426	1	Bandu	Saraikela	Village	Rural	390	1773	51.77665	48.22335	374.8331

427	1	Jamdih	Saraikela	Village	Rural	134	824	47.93689	52.06311	304.2961
428	1	Mahuldiha	Saraikela	Village	Rural	49	230	47.3913	52.6087	85.68882
429	1	Ramgarh	Saraikela	Village	Rural	153	752	52.26064	47.73936	690.4422
430	1	Kopali CT	Saraikela	Town	Urban	7633	43256	51.63908	48.36092	645.1824
431	1	Dobo	Saraikela	Village	Rural	466	2235	49.61969	50.38031	566.6225
432	1	Pusisili	Saraikela	Village	Rural	278	1262	50.31696	49.68304	478.7727
433	1	Saharbera	Saraikela	Village	Rural	304	1492	52.27882	47.72118	531.385
434	1	Balrampur	Saraikela	Village	Rural	826	3893	53.0953	46.9047	176.6148
435	1	Adityapur	Saraikela	Town	Urban	37206	174355	52.5732	47.4268	4877.479
436	1	Sakarpada	Ranchi	Village	Rural	249	1381	50.76032	49.23968	185.8047
437	1	Hurhuru	Hazarib-agh	Village	Rural	357	1929	49.45568	50.54432	355.5526
438	1	Sirsi No I	Hazarib-agh	Village	Rural	291	1621	50.64775	49.35225	92.32478
439	1	Buti	Ranchi	Village	Rural	33	150	51.33333	48.66667	140.4353
440	1	Harwadih	Ranchi	Village	Rural	195	836	49.16268	50.83732	233.3049
441	1	Masna Miapur	Sahibganj	Village	Rural	0	0	0	0	212.9064
442	1	Komodari	Sahibganj	Village	Rural	40	191	51.3089	48.6911	198.7904
443	1	Bistupur	Sahibganj	Village	Rural	189	1006	49.50298	50.49702	325.728
444	1	Banjhikend	Sahibganj	Village	Rural	116	487	47.22793	52.77207	77.34815
445	1	Jetkekumar-jori	Sahibganj	Village	Rural	195	914	50.76586	49.23414	285.2409
446	1	Sitalpur	Sahibganj	Village	Rural	70	332	51.50602	48.49398	213.4793
447	1	Pokria	Sahibganj	Village	Rural	22	96	55.20833	44.79167	150.1582
448	1	Tilaki	Sahibganj	Village	Rural	123	624	53.20513	46.79487	206.2552
449	1	Sabda Chhota Gargram	Sahibganj	Village	Rural	197	826	53.1477	46.8523	129.0961
450	1	Satrampur	Sahibganj	Village	Rural	0	0	0	0	99.67424
451	1	Risor	Sahibganj	Village	Rural	800	4007	50.08735	49.91265	519.9643
452	1	Mirjapur Khurd	Sahibganj	Village	Rural	0	0	0	0	55.45004
453	1	Maheshghati	Sahibganj	Village	Rural	477	2219	50.15773	49.84227	192.6313

Project Elephant Division
Ministry of Environment, Forest &
Climate Change
6th Floor, Jal Block,
Indira Paryavaran Bhawan,
Jor Bagh Road,
New Delhi 110003
E-mail: projectelephant.moef@gmail.com

Dr. Bilal Habib
Scientist F / Project Investigator
Wildlife Institute of India
Chandrabani, Dehradun,
Uttarakhand 248001
E-mail: bh@wii.gov.in