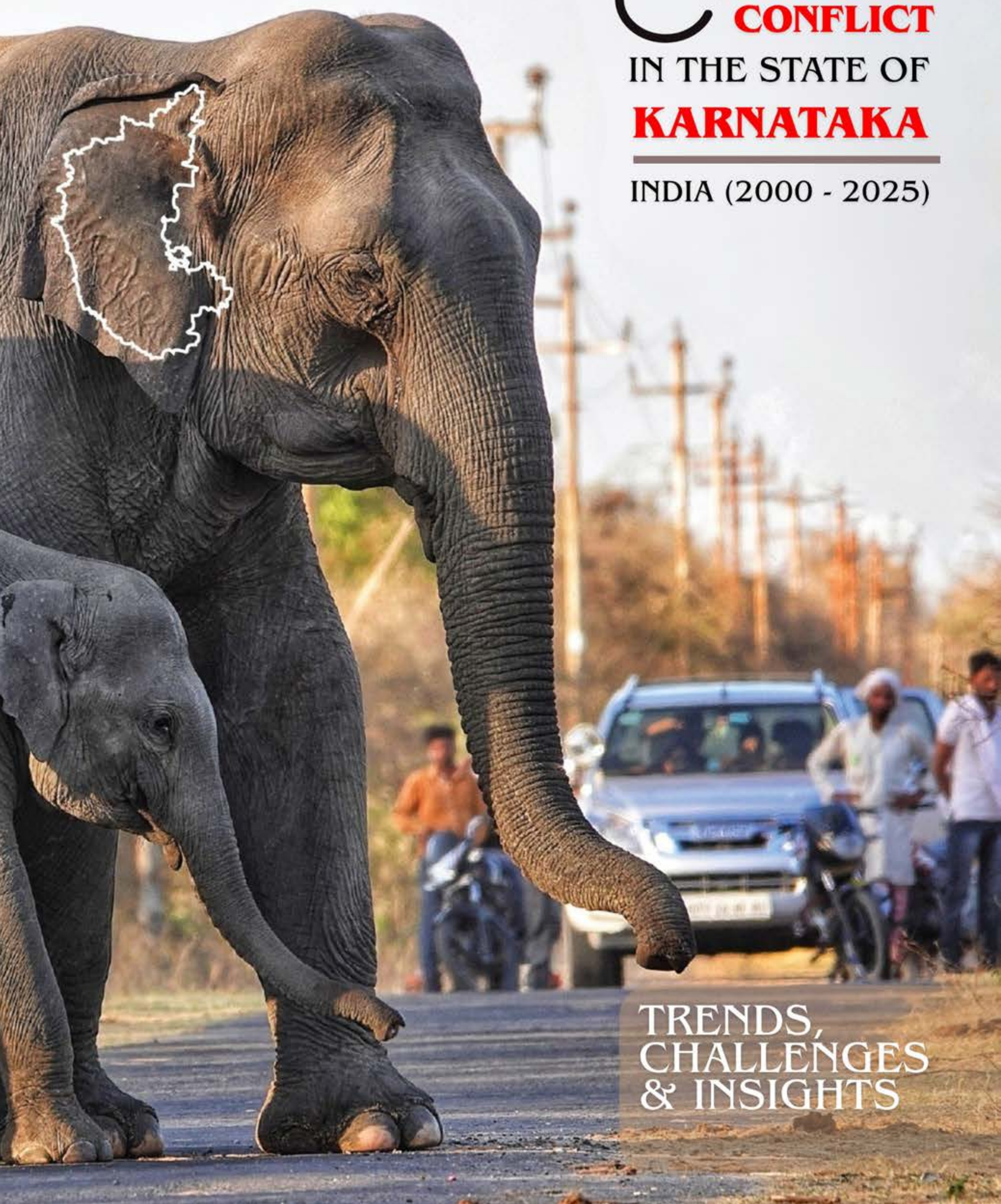
भारतीय वन्यजीव संस्थान
Wildlife Institute of India

HUMAN ELEPHANT CONFLICT IN THE STATE OF KARNATAKA

INDIA (2000 - 2025)



TRENDS, CHALLENGES & INSIGHTS

Final Project Report
TR-TR-0040-2026

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Citation: Bilal Habib, Anukul Nath, Mukesh Chand, Anshuman Gogoi, Athira N. G., Kalpana Roy, Aju Mathew George, Vaibhav C. Mathur, Parag Nigam, Gobind Sagar Bhardwaj, Ramesh Kumar Pandey (2026): Human-elephant conflict in the State of Karnataka, India (2000 - 2025): Trends, Challenges and Insights. Wildlife Institute of India & Project Elephant Division, Ministry of Environment, Forest and Climate Change, Government of India. Pp. 92. TR-0040-2026.

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Acknowledgements

We express our sincere gratitude to the Project Elephant Division of the Ministry of Environment, Forest and Climate Change (MoEFCC) for their financial assistance and necessary approvals for this study. Our heartfelt thanks go to the Principal Chief Conservator of Forests (PCCF) and Chief Wildlife Warden, Government of Karnataka, for granting the permits essential to our work. We are also indebted to the staff of the Karnataka Forest Department for providing access to their official records, which were invaluable to our research.

Additionally, we appreciate the support from the staff of the Project Elephant Division at MoEFCC and the Elephant Cell at the Wildlife Institute of India. Lastly, we extend our thanks to the Director, Dean, and Registrar of the Wildlife Institute of India for their unwavering support throughout this research endeavour.

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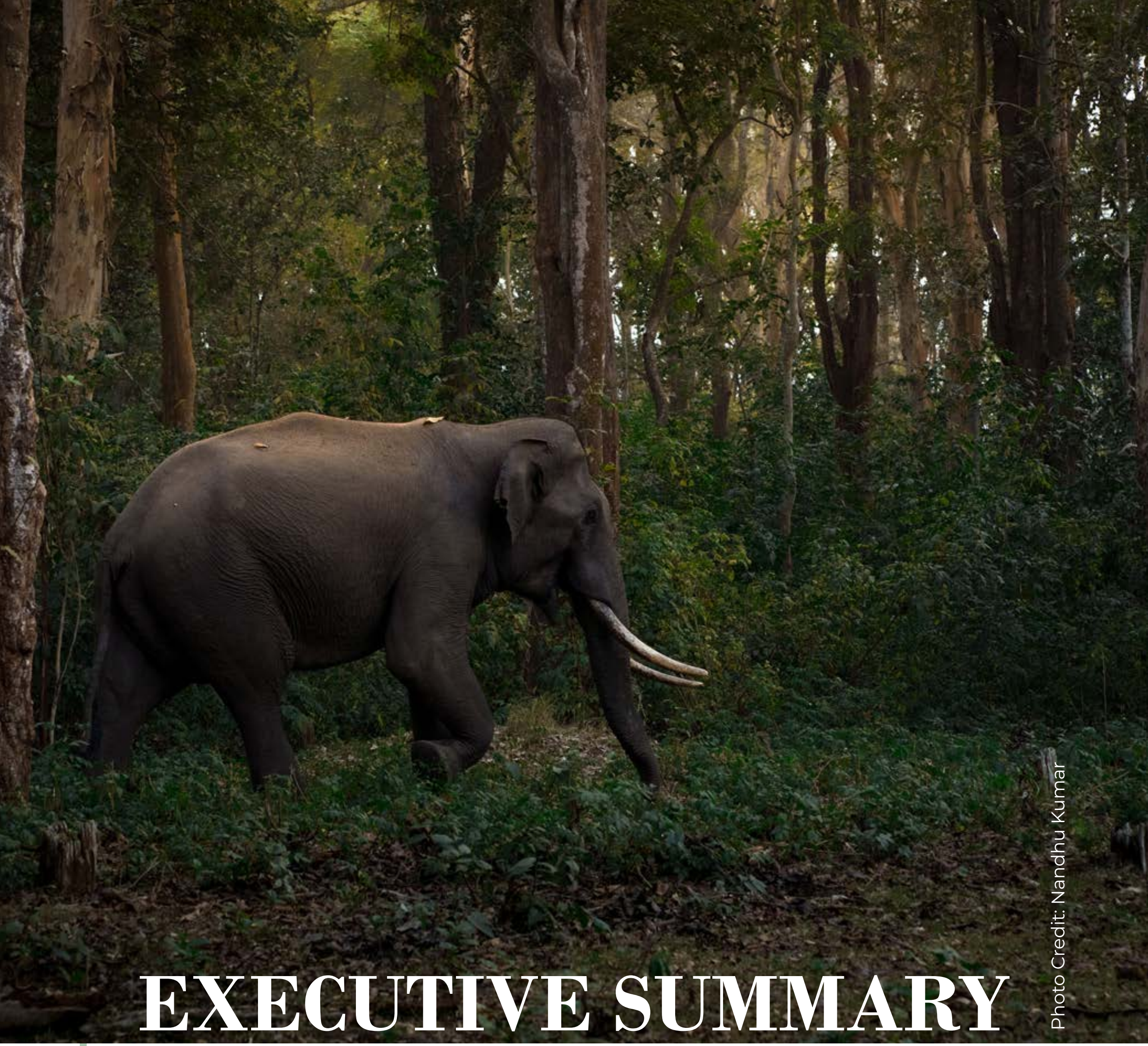

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EXECUTIVE SUMMARY

Karnataka supports one of the largest Asian elephant populations in India across the forests, plantations and agricultural landscapes of the southern Western Ghats. However, increasing overlap among elephant habitats, coffee estates, croplands, settlements, roads, railways and electrical infrastructure has intensified human–elephant conflict. This study examined elephant mortality and human casualties recorded across the major elephant-bearing forest divisions of Karnataka between 2000 and 2025 to identify temporal patterns, spatial hotspots, demographic trends and major causes of elephant and human losses.

The Landscape in Numbers

6013
Wild Elephants (SAIEE-2025)

25 YEARS
Study Duration (2000–2025)

MAJOR ELEPHANT-BEARING
Forest Divisions Covered

Priority Areas and Management Implications

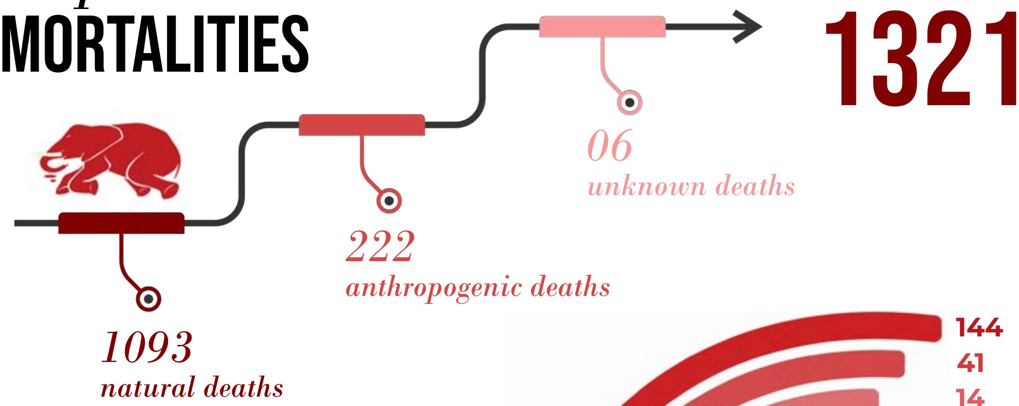
Elephant mortality and human casualties were concentrated within a limited number of landscapes. Nagarahole Wildlife, Virajpet and Madikeri recorded substantial losses of both elephants and people. Male Mahadeshwara Hills Wildlife and BRT Tiger Reserve were important elephant mortality hotspots, while Hassan and Ramanagara recorded high numbers of human casualties.

The principals recommended actions are:

1. Remove electrocution hazards: Eliminate illegal live-wire fencing, unsafe connections and low-hanging powerlines through joint inspections.
2. Strengthen early warning: Link local watchers, plantation workers and villagers with trained rapid-response teams and clear alert procedures.
3. Restore invasive habitats: Remove Lantana and Senna gradually and restore native forage in corridors and elephant refuge areas.
4. Secure vulnerable railway stretches: Improve safe crossings and test DAS-based elephant detection only along verified high-risk sections.
5. Improve barrier performance: Repair damaged barriers and place them around settlements without blocking elephant corridors or exit routes.
6. Monitor recurrent conflict elephants: Radio-collar repeatedly involved solitary males and avoid shifting them between forest divisions.
7. Improve interdepartmental coordination: Forest, Railways, Electricity, Police and local authorities should jointly review hotspots and mitigation performance.

Reducing human–elephant conflict in Karnataka requires targeted action in hotspot landscapes. Coordinated efforts among forest divisions, infrastructure agencies, district administrations and local communities can reduce preventable elephant deaths, improve human safety and support coexistence.

Elephant MORTALITIES

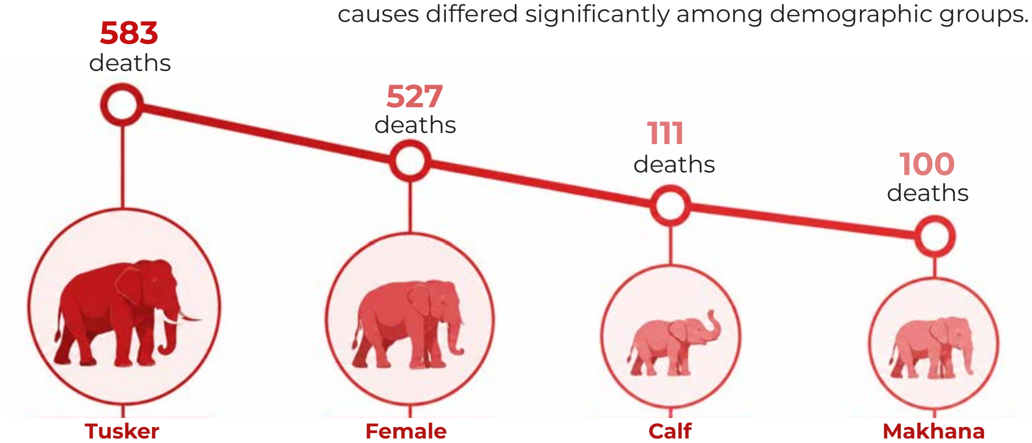


Overall DEATHS

Anthropogenic mortality categories differed significantly, and electrocution was significantly higher than all other anthropogenic causes combined. Electrocution therefore represented the most important preventable elephant mortality threat identified in Karnataka.

Age-Class DEMOGRAPHY

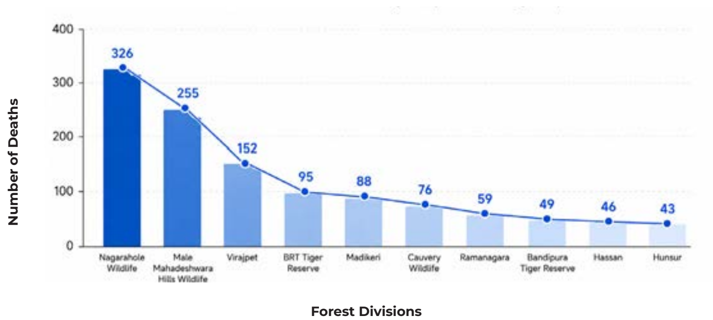
Tuskers recorded the highest overall mortality and were particularly affected by electrocution and poaching. However, the association between the major anthropogenic mortality categories and elephant age/ sex class was not statistically significant. The distribution of electrocution compared with all other anthropogenic causes differed significantly among demographic groups.



Spatial Distribution of

OVERALL ELEPHANT MORTALITY

These divisions were also identified as major elephant-mortality hotspots.



These divisions formed the major elephant mortality hotspots in Karnataka. Natural deaths were the predominant category in most high-mortality divisions.

Elephant mortality peaked in 2021 (125 deaths), followed by 2024 (123), 2017 (122), 2023 (121) and 2013 (96). Mortality was highest during the monsoon (451 deaths), followed by summer (358), post-monsoon (350) and winter (162). Anthropogenic elephant mortality also peaked during the monsoon.

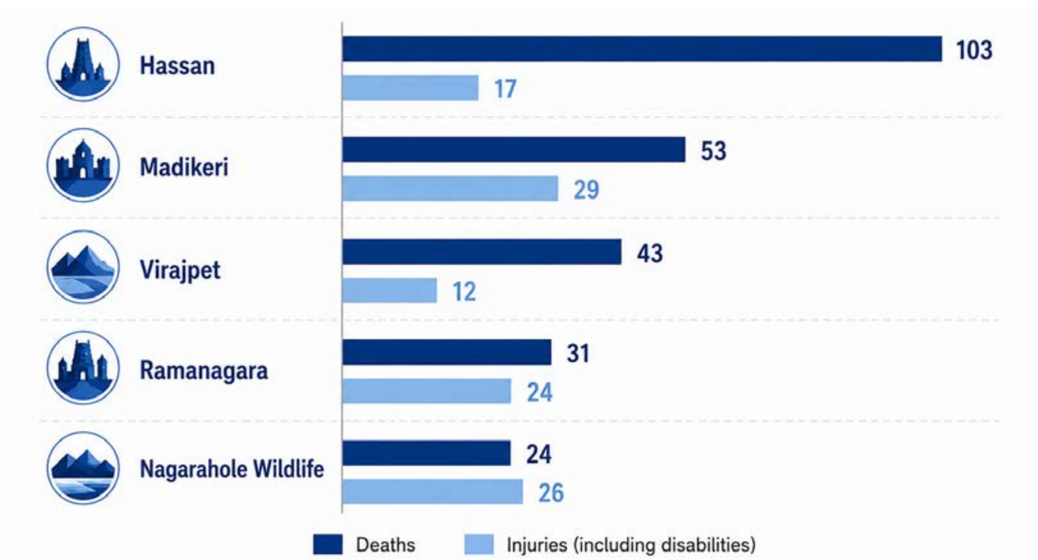
Human Fatalities

AND INJURIES

522
Human fatalities

233
Human injuries

Incident type differed significantly among seasons. However, casualties occurred throughout the year, showing that conflict management and early-warning systems should remain operational across all seasons.

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INTRODUCTION

Human-elephant conflict (HEC) has emerged as a major conservation and socio-ecological challenge across elephant-range countries, with serious consequences for both human communities and elephant populations. It includes direct and indirect encounters between people and elephants, often resulting in crop destruction, property damage, human injuries, human fatalities and elephant deaths (Das *et al.,* 2025; Sukumar, 2003). Agricultural expansion, infrastructure development, deforestation and increasing human pressure continue to alter natural landscapes, compelling elephants to move closer to human settlements in search of food, water and safe movement pathways (Das *et al.,* 2025; Prasad *et al.,* 2025). Forest fragmentation and changes in resource availability also alter elephant movement strategies, increasingly bringing them into contact with agricultural fields, transport networks and expanding rural populations (De Silva *et al.,* 2023; Roy *et al.,* 2025; Pandey *et al.,* 2024b; Lingaraju *et al.,* 2024; Thekaekara *et al.,* 2021). Similar patterns have been observed in East African and Southeast Asian landscapes, where long-term ecological changes and human land-use pressures have intensified interactions between elephants and people (Juma *et al.,* 2025; Deng *et al.,* 2025).

Within this broader global context, HEC in India has become a complex conservation and governance concern involving ecological, economic and social dimensions. India supports the largest remaining population of Asian elephants, comprising approximately 60% of the extant global wild population, yet it records some of the highest conflict-related incidents globally (Anoop *et al.,* 2025; Das *et al.,* 2025; Pandey *et al.,* 2024a). In rural landscapes, where livelihoods are closely linked to agriculture and forest resources, HEC places substantial economic, emotional and social burdens on communities while also threatening the long-term survival of elephant populations. Each year, hundreds of people and elephants are killed due to negative interactions, while crop loss, property damage and the psychological burden of guarding fields at night further affect rural communities (MoEF&CC, 2010; Prasad *et al.,* 2025; Sengupta *et al.,* 2020). Repeated encounters can also alter daily movement, livelihood decisions and community tolerance towards elephants (Pandey *et al.,* 2022; Pandey *et al.,* 2026).

These impacts are closely linked to landscape changes across India. Continuous deforestation, monoculture expansion, road development and the conversion of forest land into settlements or plantations have reduced elephant-accessible habitats and restricted connectivity across their traditional ranges (Anoop *et al.,* 2025; Gubbi *et al.,* 2014). The expansion of agriculture along forest fringes and the loss of migratory routes have increasingly forced elephants into human-dominated areas, increasing the frequency and unpredictability of encounters (Anoop *et al.,* 2023; Pavithra *et al.,* 2025 ; Roy *et al.,* 2025). These interactions result not only in human injuries and fatalities but also expose elephants to retaliatory harm, electrocution, poisoning and other non-natural causes of mortality (Roy *et al.,* 2025; Pandey *et al.,* 2025). National guidance on HEC management has therefore emphasised landscape-level planning, early warning systems, coordinated responses and safe mitigation practices (MoEF&CC, 2022).

Despite these challenges, elephants continue to hold deep cultural, religious and symbolic significance across India. Communities commonly associate them with wisdom, strength and prosperity through cultural traditions, folklore and religious beliefs that span centuries (Thekaekara *et al.,* 2021). Historically, large and contiguous forests allowed elephants to meet their ecological requirements without depending heavily on human-dominated landscapes, thereby supporting coexistence. However, this relationship has become increasingly complex as agricultural fields, settlements and transport infrastructure have expanded across historical elephant movement routes.

This changing relationship is especially important in southern India, where Karnataka, Tamil Nadu and Kerala support the highest densities of elephants and remain central to the long-term survival of the species. Among these states, Karnataka is estimated to harbour approximately 6,013 elephants (Qureshi *et al.,* 2025), making it one of the most important elephant strongholds in India. Situated within the southern Western Ghats, Karnataka supports one of the largest elephant populations in Asia. Elephants move across a diverse landscape of protected forests, coffee estates, paddy fields, other agricultural areas, river valleys, plantation belts and peri-urban zones (Gubbi *et al.,* 2014; Senthilkumar *et al.,* 2019). This ecological and cultural diversity has historically shaped human-elephant interactions and continues to influence present-day conflict patterns.

Karnataka's elephant-bearing landscapes include evergreen, semi-evergreen, moist deciduous and dry deciduous forests across key districts such as Kodagu, Chikkamagaluru, Hassan, Mysuru, Chamarajanagar and Ramanagara (Anoop *et al.,* 2023; Pavithra *et al.,* 2025). These landscapes provide important habitats and movement corridors connecting Karnataka with neighbouring states. However, their close interface with plantations, croplands and settlements requires elephants to regularly move through human-use areas, particularly when natural resources within forests become scarce (Anoop *et al.,* 2023).

Geospatial analyses indicate that elephants account for more than 90% of recorded human-wildlife conflict incidents in Karnataka. Conflict hotspots are concentrated in districts where forest cover has declined, roads intersect elephant movement paths and settlements occur near forest edges (Pavithra *et al.,* 2025). These areas represent the landscapes where elephant ecological requirements and human activities overlap most strongly.

Within these shared landscapes, the relationship between people and elephants is marked by coexistence, reverence and fear. Elephants remain spiritually significant animals associated with local traditions, festivals and belief systems. However, increasing population density, agricultural expansion and dependence on land have intensified competition for space. As agricultural fields extend towards forest boundaries and settlements expand across historical elephant routes, the likelihood of direct encounters increases markedly (Prasad *et al.,* 2025; Gubbi *et al.,* 2014). Elephants may consequently enter villages, farms and peri-urban areas in search of food and water, particularly during the dry season. These encounters can result in human injuries and fatalities, with long-term consequences for household stability and community wellbeing (Lingaraju & Venkataramana, 2014).

The history of land-use change provides important context for understanding these conflict patterns. Over recent decades, the Western Ghats region has experienced substantial forest loss driven by agricultural expansion, commercial plantations and infrastructure development. Tree-cover reductions exceeding 5,700 hectares in certain regions have altered habitat connectivity and reshaped elephant ranging behaviour (Anoop *et al.,* 2025). In Kodagu, Chikkamagaluru, Hassan and parts of Mysuru, coffee plantations, teak stands and mixed agroforestry systems increasingly occupy the spaces between forest fragments. Although these modified landscapes may sometimes function as movement routes, they also increase contact between elephants and people (Anoop *et al.,* 2023). The expansion of monoculture plantations, particularly coffee and tea, has further fragmented elephant habitats, modified natural movement paths and replaced biodiverse forests (Anoop *et al.,* 2025; Pavithra *et al.,* 2025). Similar patterns have been reported from Bhutan and Sri Lanka, where habitat fragmentation and corridor bottlenecks have been identified as major drivers of human-elephant interactions (Yun *et al.,* 2025).

Infrastructure development has further intensified this conflict interface. Roads, railways, powerlines and settlements restrict elephant movement and increase the likelihood of encounters in densely populated and agricultural areas (Banerjee *et al.,* 2025). Linear infrastructure is particularly concerning because it can fragment habitats, disrupt movement routes and increase mortality risks where road and railway networks intersect elephant-use areas (PE-MoEFCC-WII, 2025). Conflict patterns are also influenced by rainfall, water availability and crop cycles, with interactions often peaking when agricultural fields provide easily accessible, high-energy forage (Anoop *et al.,* 2023). During the dry season, reduced availability of natural fodder and water within forests may require elephants to travel greater distances and enter farms. Similar seasonal peaks have been documented in other conflict-prone landscapes of southern India, showing how ecological rhythms influence the timing and distribution of conflict incidents (Routray *et al.,* 2025).

These landscape, infrastructure and seasonal pressures affect both human communities and elephant survival. Although the human impacts of HEC are well documented, elephant mortality has emerged as an equally important conservation concern. Across India, elephants die because of electrocution, train and vehicle collisions, poisoning, entrapment in infrastructure and retaliatory killings, reflecting a combination of ecological pressures and human behavioural responses (Roy *et al.,* 2025; Pandey *et al.,* 2025). In Karnataka, historical accounts and case studies from regions such as Bandipur highlight the severity of these encounters, with human deaths, crop loss and injuries to elephants occurring regularly along forest fringes (Lingaraju & Venkataramana, 2014). Analyses from neighbouring states similarly indicate that elephant mortality reflects weakened habitat connectivity, expanding settlements near forest boundaries and the limited effectiveness of certain mitigation structures (Banerjee *et al.,* 2025; Ekuban, 2025). In situations of acute conflict, interventions such as capture, restraint and translocation require clear operating procedures and post-release monitoring to ensure that they remain safe, targeted and scientifically justified (PE-MoEFCC-WII, 2024). Despite the increasing importance of elephant deaths in shaping conflict dynamics, comprehensive evaluations of mortality drivers specific to Karnataka remain limited.

Existing studies have documented the distribution and consequences of human–elephant conflict in Karnataka, but a long-term, state-wide comparison of human fatalities and elephant mortality remains limited (Gubbi *et al.,* 2014). Such a comparison is important because human fatalities and elephant deaths may occur within the same conflict-prone landscapes but can arise through different processes. Human fatalities result mainly from direct encounters, whereas elephant deaths may also be associated with electrocution, transport infrastructure, poisoning, retaliation and other anthropogenic causes. Examining both outcomes over the same period therefore allows this report to assess whether their spatial and temporal patterns overlap and to distinguish shared landscape associations from those specific to either human casualties or elephant mortality. This information can help prioritise monitoring and mitigation in recurrent high-risk locations and is consistent with national guidance promoting landscape-level assessment, early-warning systems and coordinated conflict responses (Gubbi *et al.,* 2014; MoEF&CC, 2022).

In this context, the present report examines long-term patterns of human-elephant conflict in Karnataka by analysing elephant mortality and human casualties across the state. It aims to identify the spatial and temporal patterns of human mortality associated with HEC, examine the causes and spatial distribution of elephant mortality, assess associations between elephant demographic characteristics and mortality patterns, and understand the ecological, landscape and anthropogenic factors influencing conflict risk. Specifically, the report seeks to address:

1. How the causes and spatial distribution of elephant mortality have changed across Karnataka between 2000 and 2025;

2. Whether demographic characteristics of deceased elephants are associated with specific causes of mortality;

3. How human fatalities and injuries vary spatially and temporally across Karnataka; and

4. Which landscape and human-induced features influence the risk of elephant deaths and human casualties across key conflict-prone regions.

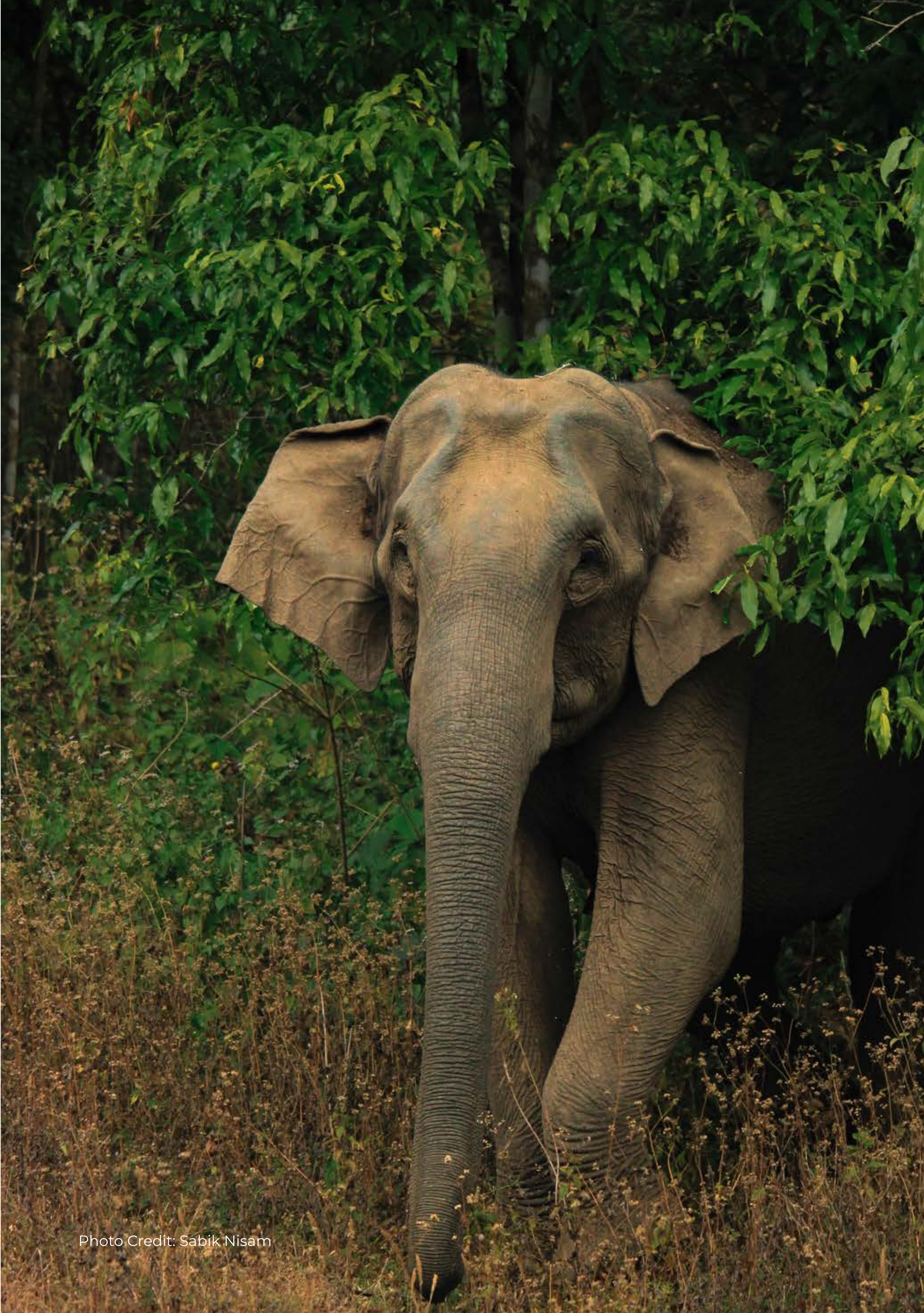
Photo Credit: Sabik Nisam

STUDY AREA

Karnataka is located in southern India, between approximately 11.5° and 18.5° N and 74° and 78.5° E. It is bordered by Maharashtra to the north, Goa to the northwest, Kerala to the southwest, Tamil Nadu to the southeast, and Andhra Pradesh and Telangana to the east. The state covers an area of 191,791 km^2 and supports a human population exceeding 61 million across its coastal, hilly and inland districts. Elevation ranges from low-lying coastal plains to the high hills of the Western Ghats, with several areas in Chikkamagaluru and Kodagu exceeding 1,800 m (Anoop *et al.,* 2025). This varied physiography contributes to Karnataka's ecological richness and supports extensive wildlife habitats.

Karnataka forms an important part of the southern Western Ghats and the adjoining Deccan Plateau. The state contains tropical evergreen, semi-evergreen, moist deciduous and dry deciduous forests, as well as grasslands, riverine habitats and plantation landscapes dominated by coffee, tea and mixed agroforestry systems (Anoop *et al.,* 2023; Pavithra *et al.,* 2025). Evergreen and semi-evergreen forests are mainly distributed across the high-rainfall regions of Kodagu, Chikkamagaluru and Uttara Kannada. Moist deciduous and dry deciduous forests are more widespread across Mysuru, Chamarajanagar and Hassan, where they form important linkages between protected areas and surrounding land-use types (Gubbi *et al.,* 2014). These habitats support Asian elephants, tigers, leopards, gaur, sloth bears and numerous endemic species of birds, amphibians and plants.

The state experiences a tropical monsoonal climate, with most rainfall occurring between June and September. Districts along the Western Ghats receive high annual rainfall, whereas inland areas generally experience moderate to low precipitation. These climatic differences influence vegetation productivity, surface-water availability and the seasonal distribution of wildlife (Anoop *et al.,* 2023). Perennial rivers, streams and waterholes distributed across protected and non-protected areas provide important water resources for elephants (Prasad *et al.,* 2025). Seasonal variation in these resources influences elephant ranging patterns across the state.

Karnataka contains several major protected areas that support large elephant populations. These include Bandipur National Park, Nagarahole National Park, Biligiri Rangaswamy Temple Tiger Reserve, Cauvery Wildlife Sanctuary and Bannerghatta National Park. These protected areas, along with adjoining reserve forests, river valleys and plantation belts, form part of one of the largest connected elephant landscapes in Asia (Gubbi *et al.,* 2014; Lingaraju & Venkataramana, 2014). They also provide cross-border connectivity with elephant habitats in Tamil Nadu and Kerala. Maintaining these landscape connections is important because elephants regularly move across administrative boundaries and between protected and non-protected habitats.

Human-modified landscapes also form an important component of Karnataka's elephant range. Kodagu, for example, contains extensive coffee plantations interspersed with forest fragments and supports high elephant densities, as demonstrated by landscape-scale abundance assessments (Kolipakam *et al.,* 2025). Coffee plantations, teak stands and mixed agroforestry areas may provide movement routes and feeding areas within the broader landscape (Anoop *et al.,* 2023). However, their location between forest blocks, agricultural areas and settlements creates close spatial overlap between elephant habitats and human land use.

Karnataka's varied topography, climatic conditions, vegetation types and protected-area network therefore create a complex elephant landscape. The movement of elephants between protected forests, reserve forests, plantations and agricultural areas places many elephant-use locations close to human settlements. This spatial overlap is particularly important for understanding the distribution of human casualties and elephant mortality across the state (Prasad *et al.,* 2025; Pavithra *et al.,* 2025).

Photo Credit: Anshuamn Gogoi

METHODS

Collection of HEC Occurrence Records

Records of human-elephant conflict incidents were compiled from the major elephant-bearing forest divisions of Karnataka for the period 2000–2025. The elephant mortality dataset included deaths attributed to both natural and anthropogenic causes. The human HEC dataset included fatalities, injuries, partial disabilities and permanent disabilities resulting from encounters with wild elephants.

Information associated with each incident included the forest division, village or place of occurrence, date of incident, sex of the deceased person or elephant, and contextual remarks recorded by field staff. Additional information, including elephant age and cause of mortality, was included where available.

All records were obtained directly from the Karnataka Forest Department. The entries were reviewed and cross-verified by the respective divisional authorities to improve their completeness and accuracy. Only officially documented and field-confirmed incidents were retained in the final dataset for temporal, spatial, demographic and landscape-level analyses.

Categorization of Datasets

Following verification, the elephant mortality and human HEC records were organised and standardised for analysis. The final database contained 1,321 elephant mortality records and 755 HEC incidents involving human fatalities, injuries, partial disabilities and permanent disabilities across the major elephant-bearing forest divisions of Karnataka.

Elephant mortality records were categorised into natural and human-induced causes following the classification system used by the Karnataka Forest Department. The detailed categorisation of elephant mortality causes is presented in Table 2.1. For each elephant mortality incident, information was compiled on: (1) cause of death, (2) year of occurrence, (3) season of occurrence, (4) forest division, (5) place of occurrence, and (6) age, sex and other available demographic characteristics of the deceased elephant.

Natural deaths included mortality attributed to old age, disease, heart failure, malnourishment, neonatal mortality and intra-specific fighting. Accidental deaths included incidents associated with natural calamities or environmental conditions, such as drowning in rivers, lightning strikes, falls from cliffs or steep terrain, and entrapment in natural obstacles. Human-induced mortality included deaths associated with poisoning, poaching, electrocution, human-made infrastructure and other anthropogenic stressors, as classified in the departmental records.

Human-related records were categorised separately into human fatalities, human injuries, partial disabilities and permanent disabilities. For each incident, information was compiled on the year and season of occurrence, place of occurrence, forest division, incident type, and the age and sex of the affected person. The timing of each incident was classified by year and season. Seasonal categories included summer from March to May, monsoon from June to September, post-monsoon from October to December, and winter from January to February. The same month-based classification was applied consistently across all study years.

Pearson's chi-square tests were performed using R version 4.3.1 to examine associations between elephant mortality causes and demographic groups. For human HEC incidents, separate chi-square tests were performed to examine associations between sex and incident type, sex and season, incident type and season, and age group and incident type.

The demographic characteristics of deceased elephants were examined in relation to the recorded causes of mortality. Based on the categories available in the Karnataka Forest Department records, elephants were grouped as adult females, adult tuskers, makhnas, calves, and individuals of unknown demographic status. Makhnas represented adult males without visible tusks and were treated separately from adult tuskers (Arivazhagan and Sukumar, 2008).

Table 1.1. *Flowchart illustrating the categorisation of elephant mortality factors in Karnataka.*

Categories	Sub-categories	Examples
Natural	Natural causes	Stillbirth, old age, disease, heart failure, malnourishment, heat stroke, dehydration
Accidental	Natural calamities	Drowning, lightning strikes, falling from hills or slopes
Poisoning	Retaliatory killings/HEC	Poisoning, direct attacks, chase-related injuries
Poaching	Poaching	Ivory removal, snares, traps
Electrocution	Electrocution	Illegal lines, low-hanging wires, fence lines
Human-made infrastructure stress	Linear infrastructure	Train hits, vehicular collisions
Anthropogenic stressors	Entrapment in drains or canals	Wells, open tanks, trenches, drains
Natural	Illness	Anthrax, acute fascioliasis, endoparasitism

Land Use and Land Cover change and factors influencing Human Mortality

Land use and land cover analysis was conducted across Karnataka for the period 2000–2025 to examine landscape transformations associated with the spatial and temporal patterns of elephant mortality and human HEC incidents. Satellite-based LULC maps were generated at five-year intervals for 2000, 2005, 2010, 2015, 2020 and 2025.

Google Earth Engine was used for image preprocessing, classification and multi-temporal comparison. ArcGIS Pro was used to subset the spatial datasets to the Karnataka study boundary, compile the raster datasets, assess landscape fragmentation, calculate distances to settlements, plantations, water bodies and roads, and prepare the final maps.

Landsat imagery was classified using a Random Forest classifier from the "smileRandomForest" library (Bhungeni *et al.,* 2024). Six spectral bands were used: blue, green, red, near-infrared and two shortwave infrared bands. The spatial resolution was maintained at 30 m, and all data were projected to UTM Zone 43N for Karnataka. Ten major LULC classes were mapped: forest, water bodies, barren land, cropland, settlements, scrubland, grassland, mangroves, plantations, and non-forest tree cover.

The classified maps for 2000, 2005, 2010, 2015, 2020 and 2025 were compared to quantify changes in habitat extent, landscape fragmentation and the expansion of human-modified land uses. Particular attention was given to changes in agriculture, settlements and plantations because these land-cover types were relevant to conflict-prone areas and elephant movement pathways in Karnataka. The multi-temporal comparison presented in Figure 1.1 was used to examine the spatial correspondence between LULC transitions and recorded patterns of elephant mortality and human HEC incidents.

LULC layers for Karnataka for 2000 and 2025 were used to calculate the fragmentation metrics Largest Patch Index (LPI) and Edge Density (ED). A 7 km × 7 km fishnet grid was overlaid on the fragmentation layers, and LPI and ED values were reclassified into five classes: Very Low, Low, Medium, High, and Very High. For LPI, higher classes indicate larger and more continuous forest patches, whereas lower classes indicate greater fragmentation. Conversely, higher ED classes represent greater forest fragmentation due to increased edge density, while lower classes indicate more compact and less fragmented forest landscapes. The proportion of each fragmentation class within every 7 km × 7 km grid was calculated and summarized as percentages to compare changes in forest fragmentation between 2000 and 2025 and to assess changes in forest landscape dynamics across Karnataka.

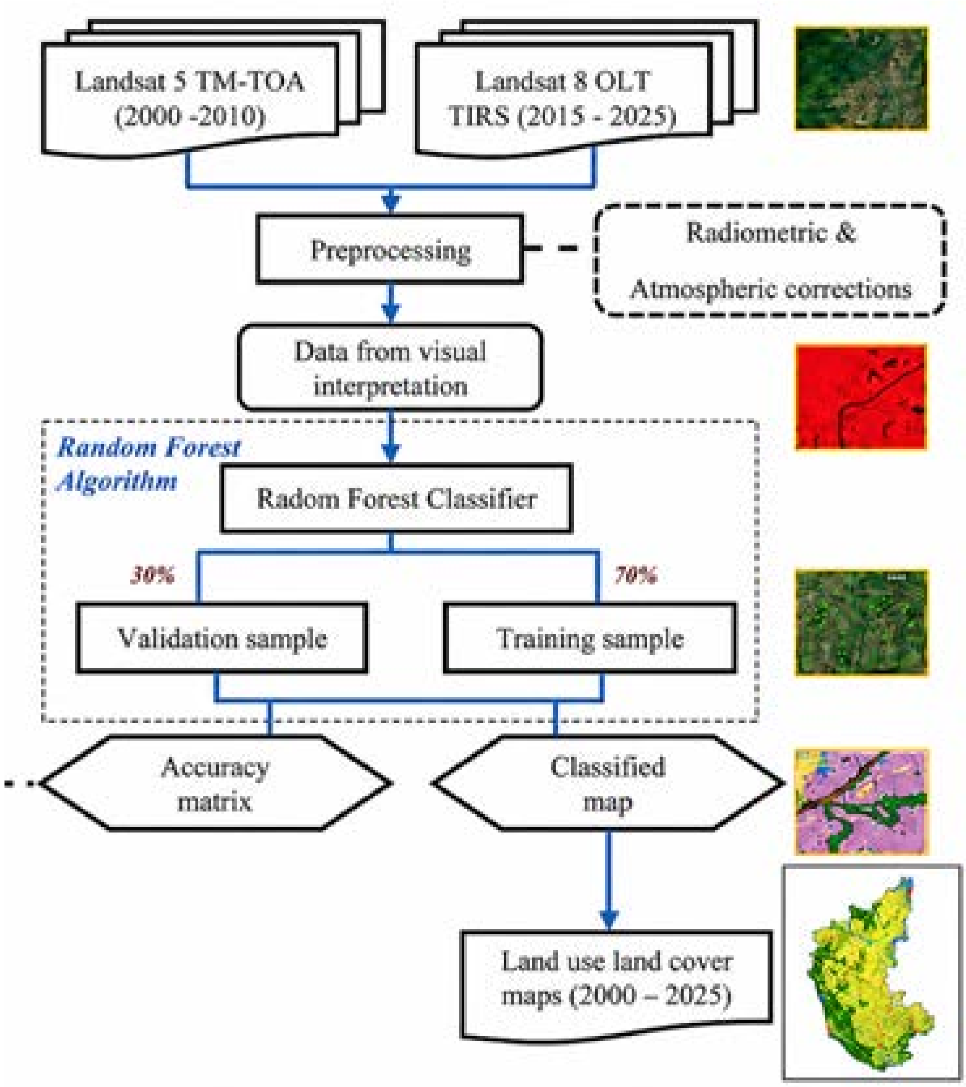

Figure 1.1: *Land use and land change pattern methodology flowchart for the state Karnataka.*

Spatial Distribution of Elephant Mortality and Human Mortalities and Injuries

Elephant mortality and human HEC incidents in Karnataka were georeferenced using GPS coordinates and systematically mapped to examine their spatial distribution across the state. Heat maps were generated using R version 4.3.1 to visualise spatial variation in the intensity of elephant mortality and human fatalities and injuries. Kernel Density Estimation was applied to identify zones where elephant deaths and human fatalities and injuries were disproportionately concentrated. Administrative boundaries, including forest ranges, forest divisions and village limits, were overlaid to contextualise the identified concentrations across the major elephant-bearing landscapes of Karnataka.

Landscape Fragmentation Analysis

Landscape fragmentation in Karnataka was assessed using FRAGSTATS version 4.2. The LULC datasets were reclassified into two primary categories: forest and non-forest. Key landscape metrics, including Patch Density, Edge Density and Largest Patch Index, were calculated for the six mapped years: 2000, 2005, 2010, 2015, 2020 and 2025.

These metrics were used to quantify the degree of habitat fragmentation, changes in forest-patch configuration and implications for habitat connectivity across Karnataka's elephant ranges. A moving window with a radius of 7 km was applied to calculate localised fragmentation metrics around each forest pixel (Hassan *et al.,* 2023; Pandey *et al.,* 2025). The moving-window distance was selected because it corresponds to the approximate daily movement distance of elephants of around 7 km.

Fragmentation metrics were examined in relation to elephant mortality and human HEC patterns across forest divisions. Spatially explicit maps of Patch Density, Edge Density and Largest Patch Index were generated to visualise fragmentation gradients and identify areas where reduced habitat connectivity may contribute to elephant movement into human-dominated landscapes.

Table 1.2: *Landscape metrics, definitions and computational formulas.*

Landscape Metric	Description	Formula
Patch Density (PD)	Number of patches per unit area	$PD = (N / A) \times 10{,}000 \times 100$
Edge Density (ED)	Total edge length per unit area	$ED = (\Sigma e_{ik} / A) \times 1000$
Largest Patch Index (LPI)	Percentage of total landscape area comprised by the largest patch	$LPI = (\max(a_{ij}) / A) \times 100$

Where: N = number of patches, A = total landscape area (m^2), Σe_{ik} = sum of all edge lengths, $\max(a_{ij})$ = area of the largest patch, and i, j and k = patch or edge identifiers. Units: PD = patches/100 ha, ED = m/ha and LPI = %.

Predictors of Elephant Mortality and Human Mortalities and Injuries

Binomial Generalized Linear Models were implemented using R version 4.3.1 to identify environmental and anthropogenic factors associated with elephant mortality and human HEC incidents in Karnataka. Spatial attributes of the recorded incidents were integrated with GIS-based environmental layers representing major landscape variables across the state. For the elephant mortality model, mortality locations were coded as 1, whereas randomly generated pseudo-absence points were coded as 0. The pseudo-absence points were generated across non-mortality landscape units to allow comparison between mortality locations and available background landscape conditions.

The explanatory variables included distance to forests, croplands, built-up areas, major and minor roads, water sources, railways, protected areas, elephant reserves, and plantation areas such as tea and coffee estates. Patch Density, Edge Density and Largest Patch Index were calculated from a reclassified binary forest–non-forest layer, in which forest pixels were coded as 1 and all other land-cover classes were coded as 2. The metrics were calculated for the forest class to represent forest fragmentation and patch configuration. These variables were selected because of their documented influence on elephant movement, habitat selection and conflict occurrence in the Western and Eastern Ghats landscapes.

For the human HEC model, recorded locations of human mortalities and injuries were coded as 1, whereas randomly generated background or pseudo-absence points were coded as 0. Predictor variables included distance to built-up areas, croplands, forests, water bodies, tea gardens, roads, protected areas and elephant reserves. The a priori hypotheses for elephant mortality and human HEC incidents are presented in Tables 2.3 and 2.4. Variance Inflation Factors were calculated to assess multicollinearity among the predictor variables. Highly correlated variables with VIF values greater than 3 were removed to improve model stability.

A set of competing models was generated and ranked using the Akaike Information Criterion. Model selection followed the information-theoretic approach of Burnham and Anderson (2002), with models within $\Delta AIC \leq 2$ of the highest-ranked models considered equally plausible. Where more than one model received substantial support, model averaging was performed across the top-ranked models.

Cross-validation techniques were used to evaluate predictive accuracy and reduce overfitting. Spatial predictions from the supported models were used to map high-risk areas and identify landscape characteristics associated with elephant mortality and human casualties.

Categorization of Villages Based on the Intensity of Elephant Mortality and Human HEC Incidents

Villages in Karnataka were categorised into four incident-intensity classes: high-incident villages with more than 20 incidents, medium-incident villages with 11–20 incidents, low-incident villages with 1–10 incidents, and no-incident villages with no recorded incidents. This classification was applied separately to elephant mortality and human HEC records based on the total number of incidents recorded within or near each village's administrative boundary. The village classifications were used to investigate potential relationships between incident intensity and key landscape variables, including forest cover, crop cover, built-up areas, plantations and mining areas. A Kruskal–Wallis ranksum test was used to determine whether statistically significant differences occurred in the median values of landscape variables among the four village categories. This non-parametric method provided a robust comparison across multiple independent groups when the assumptions of normality were not satisfied.

A Dunn test was subsequently conducted as a post-hoc analysis to identify specific pairs of village categories that differed significantly in their landscape characteristics, including high-incident versus low-incident villages and medium-incident versus no-incident villages. Appropriate corrections for multiple comparisons were applied. Village boundary data were obtained from ArcGIS Online using the Indian Administrative Layer shapefile. These boundaries were used to assign incidents to villages, extract landscape variables and link the resulting landscape information with the elephant mortality and human HEC intensity categories for statistical analysis.

Table 1.3: *A priori hypotheses on environmental and anthropogenic factors influencing elephant mortalities and human mortalities in Karnataka*

Feature	Variable	Description and source	A priori hypotheses for elephant mortality	A priori hypotheses for Human casulities
Land cover	Distance from built-up areas (db)	Classified land-cover types, such as built-up areas, cropland, forests, waterbodies, and plantation were used to calculate distances between conflict points and each landcover type using the "Near Table" tool in Arc-Pro 3.0.0	Higher elephant mortality near settlements due to increased human-elephant interactions.	Higher proximity near settlement may reduce HEC due to increased human activity and habitat loss.
	Distance from crop-land (dc)		Proximity to cropland increases mortality risk due to electrocution and retaliation.	Closer proximity near cropland increases HEC due to crop damage.
	Distance from forest (df)		Mortality risk decreases with distance from forests, which provide essential resources.	Closer proximity near forest increases HEC as elephants move into human settlements.
	Distance from water-bodies (dw)		Proximity to waterbodies lowers mortality risk by reducing movement into human areas.	Closer proximity to water bodies increases HEC, especially in dry seasons.
	Distance from planta-tion (dpla)		Mortality risk increases near plantations due to disrupted corridors and human encounters.	Closer proximity to plantation may increase HEC due to habitat loss, pesticides and human activity.

Anthropogenic	Distance from mines and quarries (dmn)	Mines and quarries were identified using Indian Geomorphology layerand further digitised using Google Earth Pro. Distance from each observation location was calculated using the "Near Table" tool in ArcGIS Pro 3.0.0.	Elephant mortality risk increases near the mining area due to habitat destruction.	Mines and quarries were not included in HEC analysis.
	Distance from roads (dr)	Road-network and Railway network shapefiles were sourced from OpenStreetMap. Distance from each observation location was calculated using the "Near Table" tool in ArcGIS Pro 3.0.0.	Higher mortality risk due to vehicle collisions and habitat disturbance.	Closer proximity to road increases HEC due to habitat fragmentation and human activity.
	Distance from railways (drail)		Close proximity increases mortality risk from train collisions and habitat fragmentation.	Railway network is not included in the HEC analysis.
Protected areas	Distance from protected areas (dpa)	Distance from each observation location to the nearest protected-area boundary and elephant reserve boundary (Elephant Cell, Wildlife Institute of India) was calculated using the "Near Table" tool in ArcGIS Pro 3.0.0.	Lower mortality risk near protected areas due to reduced human pressure.	Lower mortality risk near protected areas due to reduced human pressure.
	Distance from elephant reserves (der)		Lower mortality risk near elephant eserves due to sufficient resources.	Lower mortality risk near elephant reserves due to resource availability.
Landscape metrics	Patch Density (pd)	Patch density, Edge density and largest patch index were calculated using the Fragstat and the value is extracted using “Extract Multi Values to Points” tool in ArcGIS Pro 3.0.0.	Higher patch density increases fragmentation and human-elephant conflicts.	Landscape metrics were not included in HEC analysis.
	Edge Density (ed)		Higher edge density increases mortality risk due to habitat fragmentation and human interaction.	
	Largest Patch Index (lpi)		Elephants near large habitat patches have lower mortality risk due to resource availability.	

RESULTS

Forest Fragmentation Pattern

Landscape fragmentation metrics showed noticeable temporal changes between 2000 and 2025. The largest patch index exhibited a decline in the proportion of grid cells belonging to the very high class, accompanied by increases in the very low, low, and medium classes. This pattern indicates a reduction in the dominance of large, contiguous forest patches and a corresponding increase in smaller and less continuous patches. Similarly, the edge density distribution shifted from the very low class towards the low, medium, High, and very high classes, reflecting an increase in forest edge complexity over time. Collectively, these changes suggest that Karnataka's Forest landscape experienced progressive fragmentation between 2000 and 2025, characterized by reduced patch continuity and enhanced edge formation, which may have implications for habitat connectivity and wildlife movement.

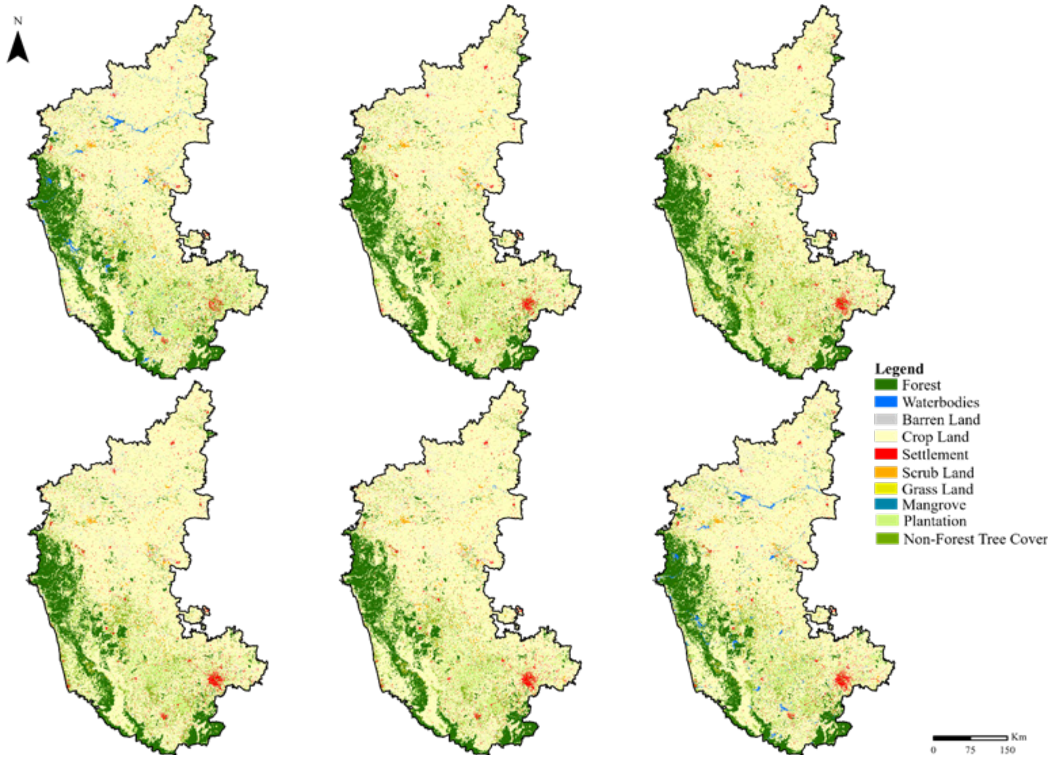

Figure 1.2(a): *Land Use Land Cover (LULC) of Karnataka from year 2010-2025.*

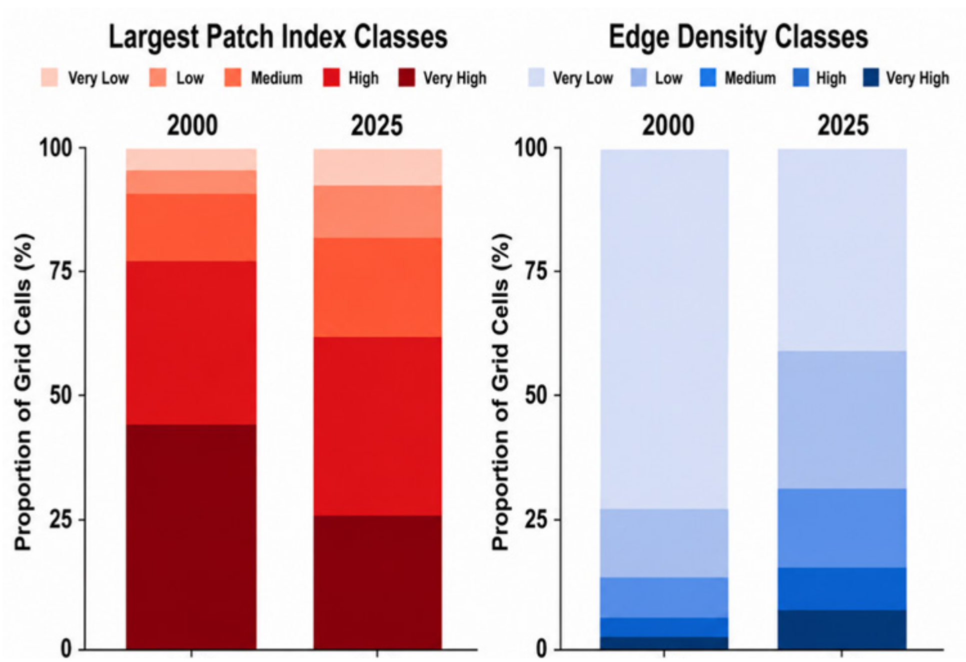

Figure 1.2(b): *Temporal changes in Largest Patch Index (LPI) and Edge Density (ED) classes in Karnataka between 2000 and 2025*

The forest landscape still retains a large, relatively intact central core, whereas fragmentation is concentrated mainly along its boundaries. High patch density and edge density in peripheral areas, together with a lower largest patch index, indicate that forest disturbance and subdivision are occurring primarily at the forest margins. This spatial pattern is consistent with landscapes affected by agricultural expansion, settlement growth, and road development, where increasing edge creation gradually fragments formerly continuous forest and places greater pressure on the remaining core habitat (Fig. 1.3).

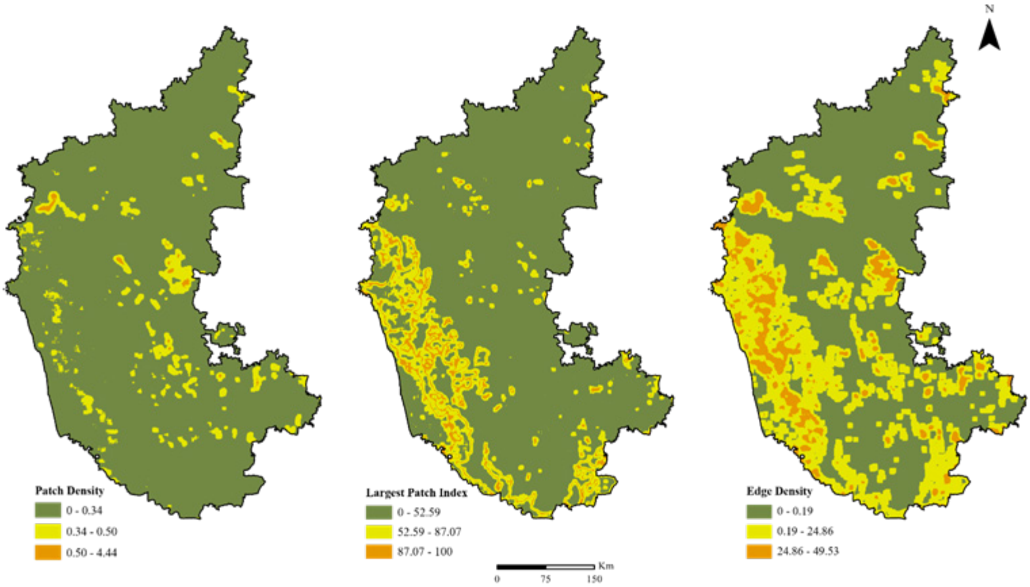

Figure 1.3: *Spatial Distribution of Forest Patch Density, Largest Edge Density, and Patch Index in Karnataka respectively.*

Temporal trends and spatial distribution of elephant mortality

During the study period (2000–2025), 1,321 elephant deaths were recorded in Karnataka. Natural causes, including illness, accounted for 1,093 deaths (82.7%), anthropogenic causes accounted for 216 deaths (16.4%), and accidental natural calamities or unknown causes accounted for the remaining 12 deaths (0.9%). Of all recorded deaths, 1,085 were classified as natural deaths, followed by electrocution (144), poaching (41), anthropogenic stressors (14), illness (8), gunshot (7), accidental natural calamities (6), unknown causes (6), road accidents (4), train hits (4), poisoning (1), and (1) snaring (Fig. 1.4).

Among the major anthropogenic causes, electrocution accounted for the highest number of elephant deaths and was significantly higher than all other anthropogenic causes combined ($\chi^2 = 27.25$, df = 1, $p < 0.0001$). The distribution of deaths across anthropogenic mortality categories also differed significantly after excluding rare categories with very low sample sizes ($\chi^2 = 323.33$, df = 4, $p < 0.0001$).

The age/sex-wise distribution of elephant mortality showed the highest number of deaths among tuskers (583), followed by females (527), calves (111) and makhnas (100). Among anthropogenic deaths, tuskers were most affected by electrocution (72) and poaching (29), followed by females affected by electrocution (46) and poaching (6). The distribution of major anthropogenic mortality categories across age/sex classes did not differ significantly ($\chi^2 = 14.05$, $p = 0.2874$). However, when electrocution was compared with all other anthropogenic causes combined, its distribution across age/sex classes differed significantly ($\chi^2 = 7.84$, $p = 0.0461$) (Fig. 1.5).

Division-wise distribution showed that Nagarahole Wildlife division (326 deaths) recorded the highest number of elephant mortalities, followed by Male Mahadeshwara Hills Wildlife (255 deaths), Virajpet (152 deaths), BRT Tiger Reserve (95 deaths), Madikeri (88 deaths), Cauvery Wildlife (76 deaths), Ramanagara (59 deaths), Bandipura Tiger Reserve (49 deaths), Hassan (46 deaths) and Hunsur (43 deaths). These divisions formed the major elephant mortality hotspots in Karnataka, with natural deaths being the predominant category in most high-mortality divisions (Fig. 1.6; 6a).

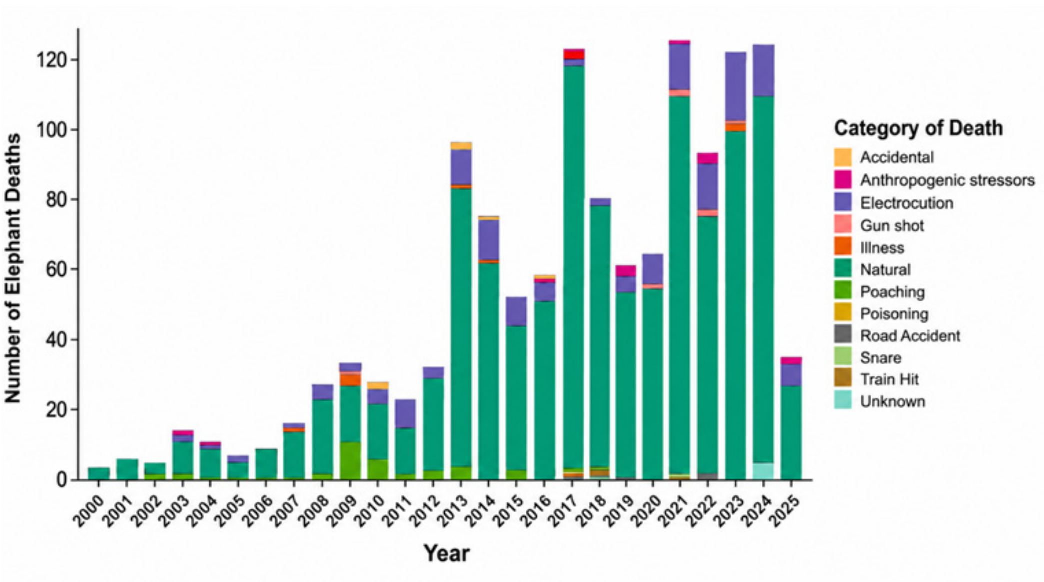

Figure 1.4: *Temporal trends of elephant mortality in Karnataka (2000- 2025).*

Season-wise distribution revealed that the highest number of elephant deaths occurred during the monsoon season (451 deaths), followed by summer (358 deaths), post-monsoon (350 deaths) and winter (162 deaths). For non-natural mortality, the seasonal distribution also differed significantly ($\chi^2 = 28.80$, df = 3, $p < 0.0001$), with the highest number recorded during monsoon (86 deaths), followed by post-monsoon (60 deaths), summer (50 deaths) and winter (30 deaths). Similarly, anthropogenic mortality showed a significant seasonal pattern ($\chi^2 = 27.43$, df = 3, $p < 0.0001$), with the highest number of anthropogenic deaths recorded during monsoon (80 deaths), followed by post-monsoon (59 deaths), summer (45 deaths) and winter (28 deaths) (Fig. 1.7).

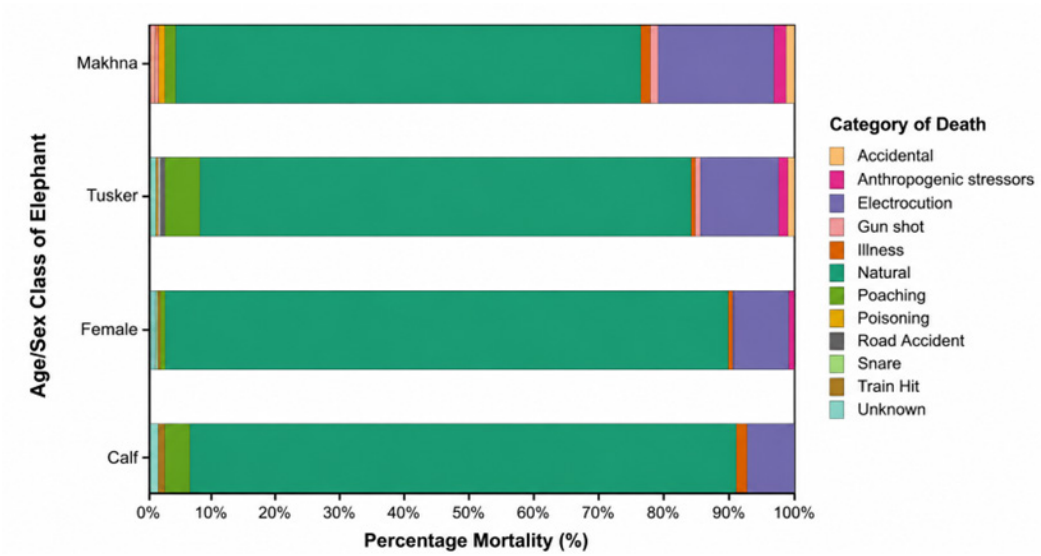

Figure 1.5: *Causes of elephant mortality in relation to age class demography in the state of Karnataka during 2000-25 .*

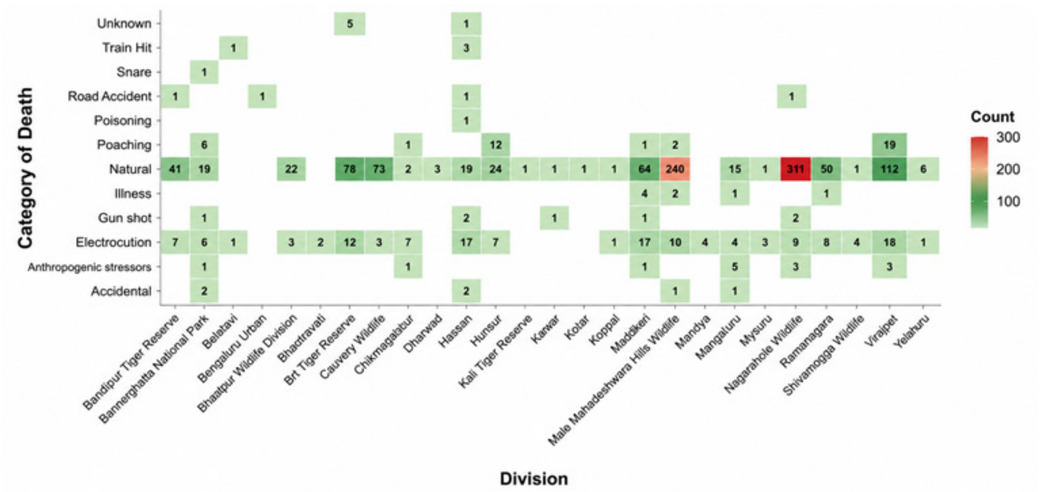

Figure 1.6: *Heatmap showing distribution pattern of Elephant mortality in the different forest divisions of Karnataka.*

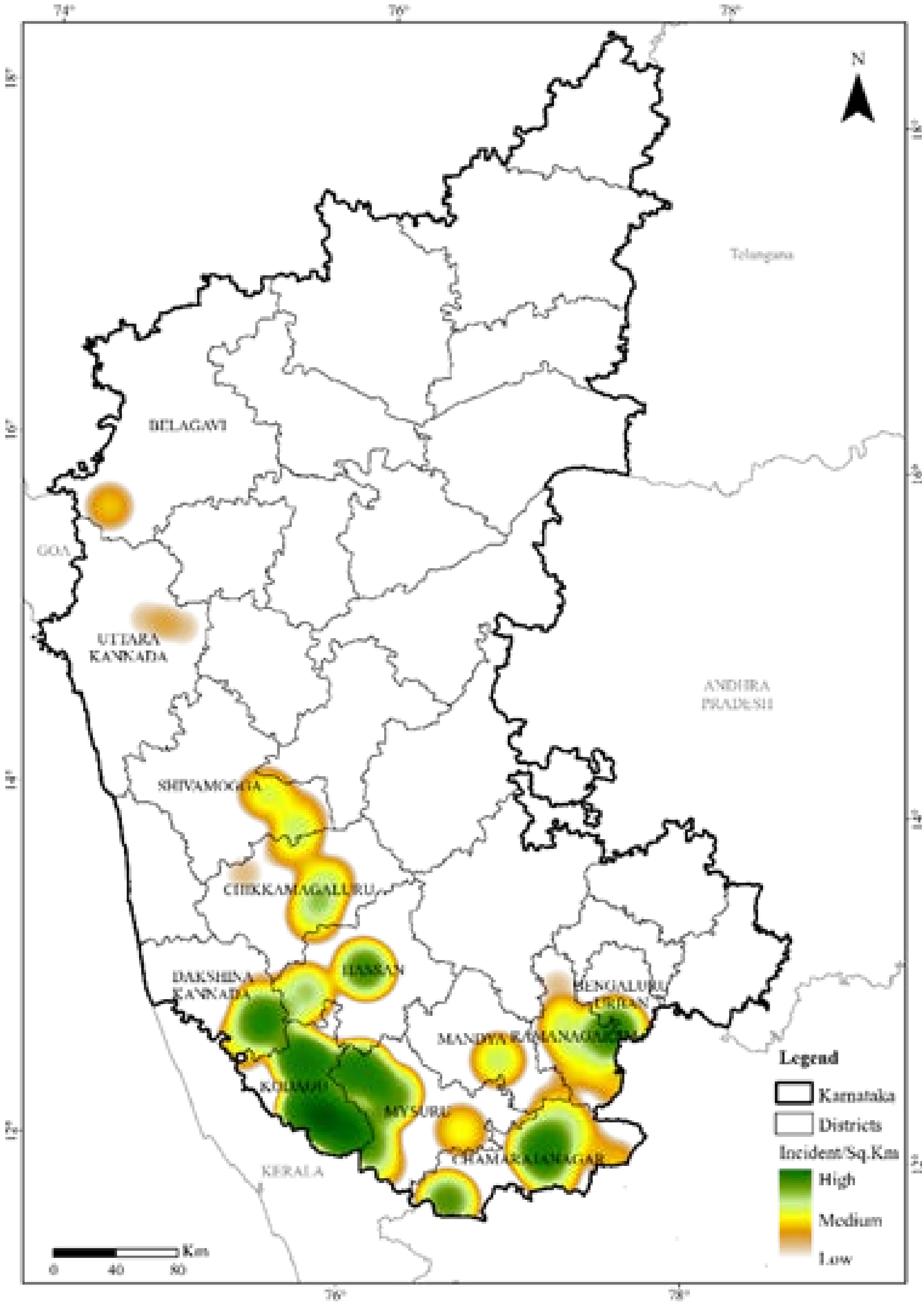

__Figure 1.6(a):__ Asian Elephant mortality due to anthropogenic factors hotspot in Karnataka (2000–2025).

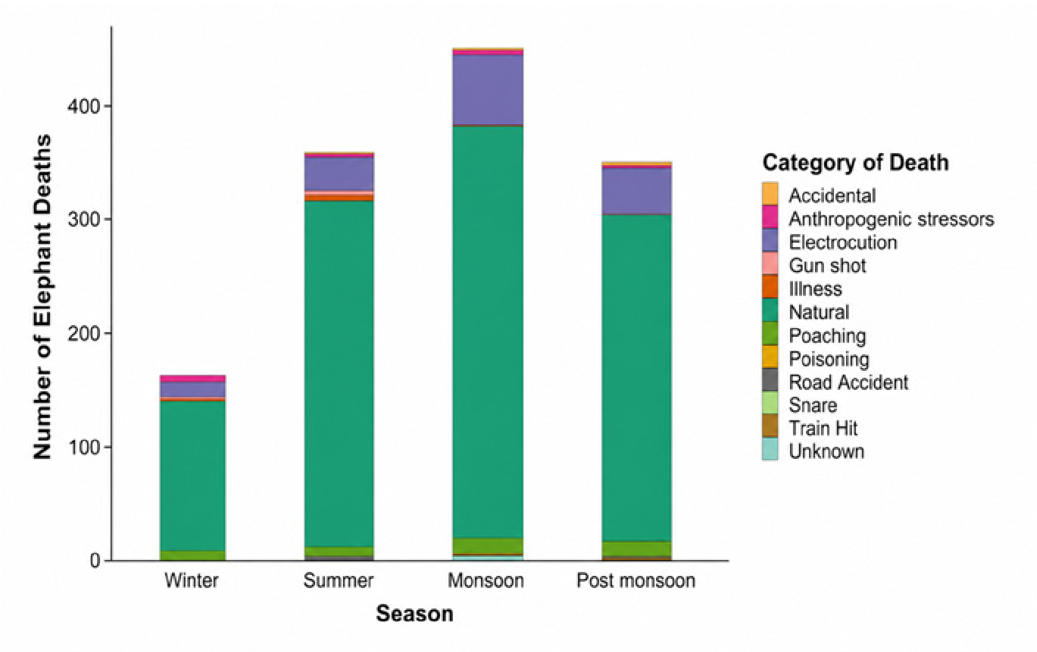

Figure 1.7: *Seasonal pattern of elephant death distribution in Karnataka.*

Natural Deaths of Elephants

During the study period (2000–2025), a total of 1,321 elephant mortality cases were recorded in Karnataka. Among them, 1,093 cases were attributed to natural-type causes, including natural deaths (1,085 cases) and illness (8 cases). Natural-type mortality formed the largest proportion of elephant deaths in the state (Fig. 1.8).

Age/sex-wise distribution of natural-type mortality showed that females had the highest number of deaths (467 deaths), followed by tuskers (455 deaths), calves (97 deaths) and makhnas (74 deaths). Natural deaths alone accounted for 1,085 cases, with females recording the highest mortality (465 deaths), followed by tuskers (453 deaths), calves (95 deaths) and makhnas (72 deaths). Illness contributed to 8 deaths, distributed equally across tuskers (2 deaths), makhnas (2 deaths), females (2 deaths) and calves (2 deaths). These results indicate that natural mortality was the dominant cause of elephant deaths in Karnataka during the study period, while electrocution and poaching were the major anthropogenic causes requiring focused mitigation attention.

Factor influencing elephant mortality and village characteristics

A comprehensive examination of ecological and anthropogenic variables at the village level highlights distinct patterns across elephant-mortality intensity categories. High-mortality villages exhibit the highest median forest cover,

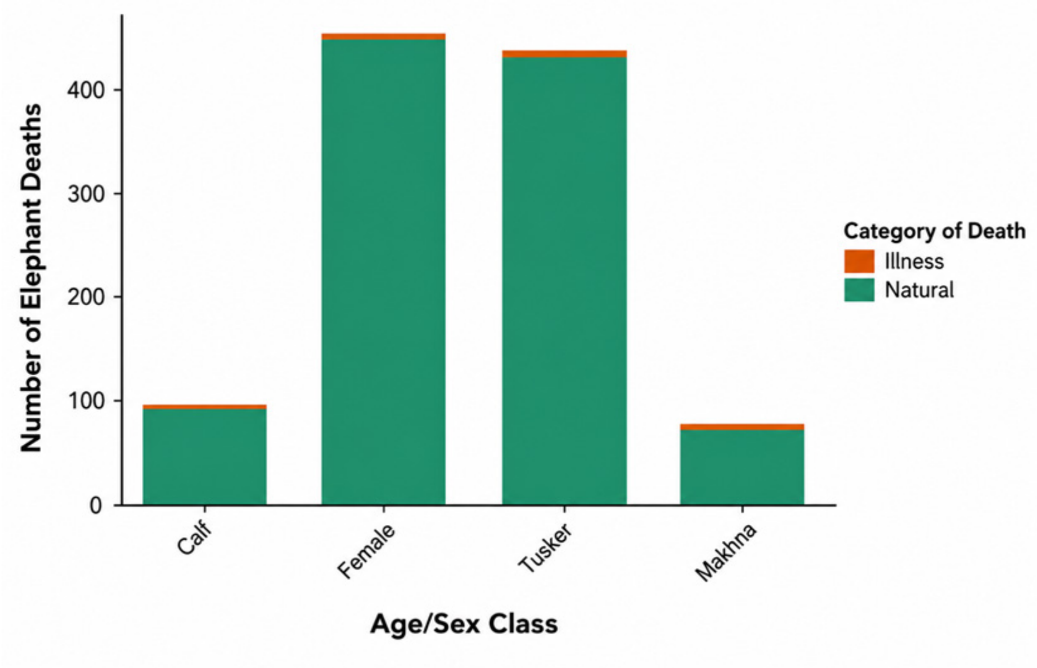

Figure 1.8: *Natural reasons elephant death distribution in Karnataka.*

while low-mortality villages have the lowest median forest cover (Fig. 1.9a, Kruskal–Wallis: χ^2 = 2.25, df = 2, p = 0.325). High-mortality villages show lower crop cover percentages than low- and medium-mortality villages, while low-mortality villages have the highest median crop cover (Fig. 1.9b, χ^2 = 2.41, df = 2, p = 0.299). Water sources are highest in medium-mortality villages, while high-mortality villages show the lowest median water availability (Fig. 1.9c, χ^2 = 0.67, df = 2, p = 0.715). Built-up cover is lowest in high-mortality villages, whereas medium-mortality villages show the highest median built-up cover (Fig. 1.9d, χ^2 = 0.25, df = 2, p = 0.884). Tea-estate cover is lowest in medium-mortality villages and highest in low-mortality villages (Fig. 1.9e, χ^2 = 0.93, df = 2, p = 0.627). Railway density is higher in medium-mortality villages than in low-mortality villages; however, no observations were available for high-mortality villages, preventing a three-category comparison (Fig. 1.9f). Road density is highest in low-mortality villages, while medium-mortality villages show the lowest median road density (Fig. 1.9g, χ^2 = 0.61, df = 2, p = 0.736).

Ecological and Anthropogenic Drivers of Elephant Mortality

The probability of elephant mortality was significantly influenced by ecological and anthropogenic landscape factors. Elephant deaths were more likely to occur closer to Protected Areas (p = 0.002). The best-supported model also included distance from built-up areas, roads, tea plantations, and cropland; however, these variables were not significantly associated with elephant mortality occurrence (built-up areas: p = 0.077; roads: p = 0.290; tea plantations: p = 0.095; cropland: p = 0.426) (Tables 1.4 and 1.5; Fig. 1.10).

Table 1.4: *Summary of log-likelihood (LogL), number of estimated parameters [df (K)], small-sample corrected Akaike Information Criterion (AICc), relative model support (ΔAICc), and Akaike weights (Wi) for candidate regression models explaining Asian elephant mortality occurrence in Karnataka .*

Predictor combination	LogL	df	AICc	Δ AICc	Wi	Wi
dr_z + der_z + dtea_z + lpi_z + ed_z + db_z	-291.768	6	595.734	0	0.3378	0.9800
dr_z + der_z + dtea_z + lpi_z	-293.879	4	595.852	0.118	0.3185	0.0171
dc_z + dr_z + der_z + dtea_z	-294.823	4	597.74	2.006	0.1239	0.0020
df_z + dw_z + der_z	-296.572	3	599.2	3.466	0.0597	0.0009
der_z	-297.961	2	599.951	4.216	0.041	0.0000
dc_z + dr_z + dtea_z	-296.396	4	600.886	5.152	0.0257	0.0000
df_z + dc_z + dtea_z	-299.44	1	600.888	5.154	0.0257	0.0000
dr_z	-298.883	2	601.794	6.06	0.0163	0.0000
dw_z + db_z	-297.911	3	601.878	6.143	0.0157	0.0000
db_z + dc_z	-298.006	3	602.068	6.334	0.0142	0.0000
df_z + dw_z	-299.431	2	602.891	7.157	0.0094	0.0000
df_z	-296.823	5	603.788	8.054	0.006	0.0000
dpa_z	-296.823	5	603.788	8.054	0.006	0.0000

Table 1.5: *Parameter estimates (β), standard errors, z-values, p-values, and significance of ecological and anthropogenic landscape variables associated with Asian elephant mortality occurrence in Karnataka.*

Predictor	Effect (β)	Z-value	Probability (p-value)	Significance
Intercept	-0.004	-0.043	0.9656	
Distance from built-up area	-0.264	-1.767	0.0773	.
Distance from road	-0.107	-1.059	0.2895	
Distance from tea plantation	-0.183	-1.67	0.095	.
Distance from Protected Area	-0.339	-3.073	0.0021	**
Distance from cropland	0.118	0.796	0.4258	

** Significance level*

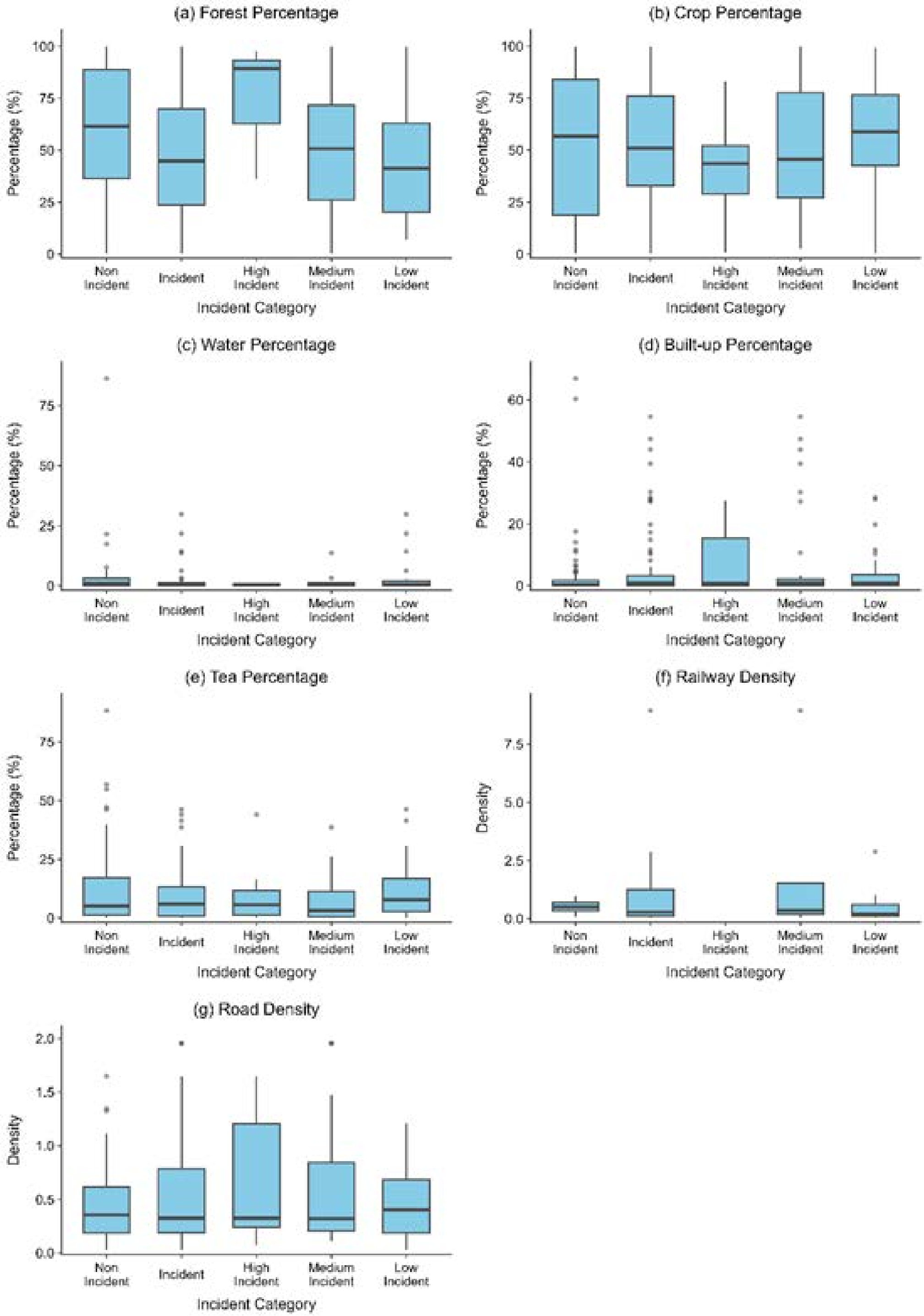

Figure 1.9: *Box plot showing the built-up density, road density, railway density, crop percentage, forest percentage and mining percentage in non-incident, low-incident, medium-incident and high-incident villages in Karnataka.*

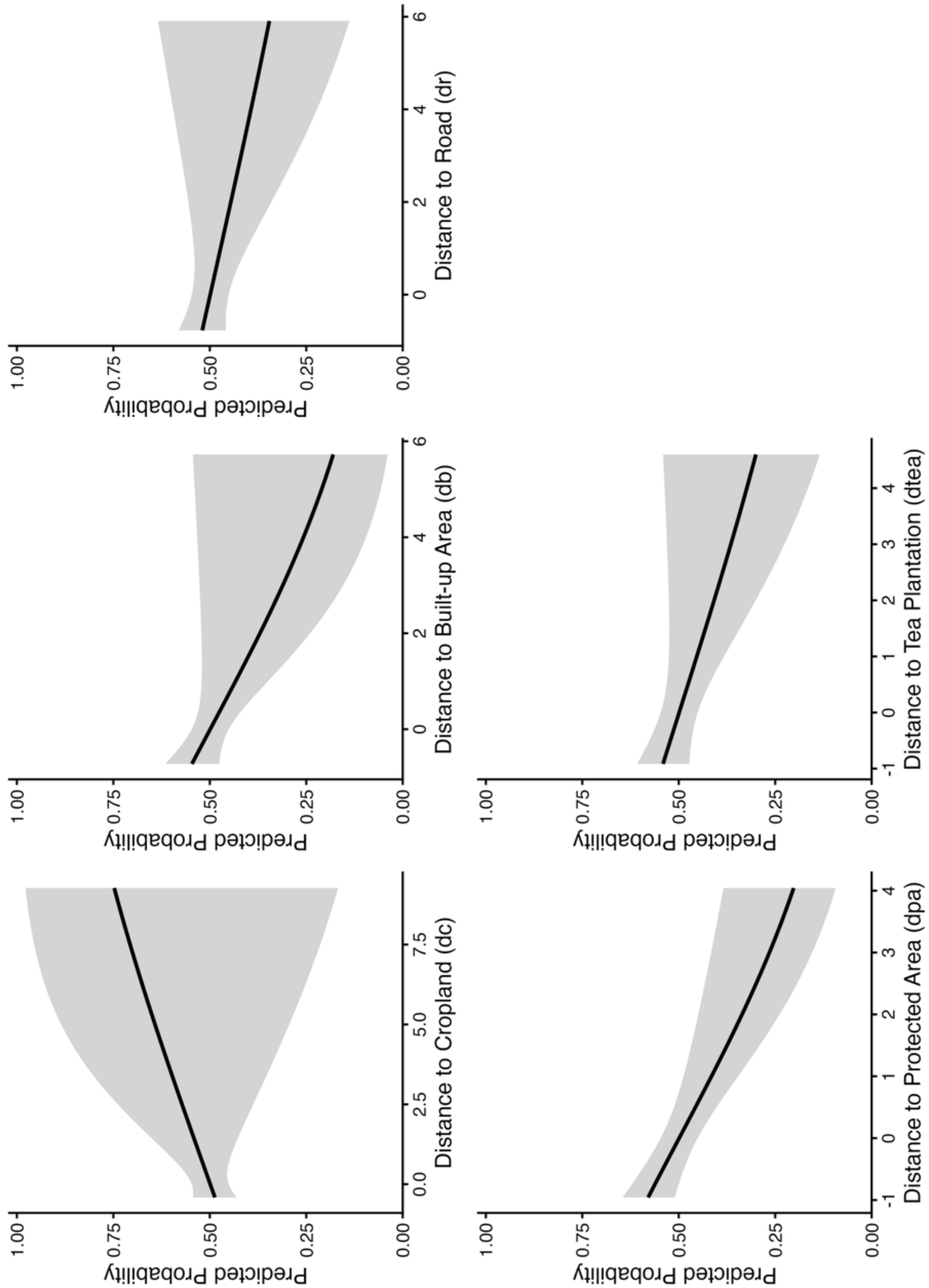

Figure 1.10: *Graphs showing the probability of elephant mortality in relation to the different ecological and anthropogenic variables in Karnataka.*

Temporal and Seasonal Pattern of Human Mortality and Injuries

Between 2000 and 2025, Karnataka recorded 755 human–elephant conflict incidents, resulting in 522 human fatalities, 205 injuries, 19 cases of partial disability and 9 cases of permanent disability. Human fatalities were recorded throughout the study period, with marked variation across years (Fig. 1.11). Among the recorded incidents, deaths formed the highest proportion of cases, followed by injuries, while partial and permanent disability cases were comparatively lower.

Division-wise distribution showed that Hassan was the most affected division, with 103 deaths, 16 injuries and 1 partial disability case, followed by Madikeri with 53 deaths, 26 injuries, 2 partial disability cases and 1 permanent disability case. Other highly affected divisions included Ramanagara with 31 deaths, 21 injuries, 1 partial disability case and 2 permanent disability cases, Virajpet with 43 deaths, 8 injuries, 3 partial disability cases and 1 permanent disability case, and Nagarahole Wildlife with 24 deaths, 25 injuries and 1 partial disability case (Fig. 1.12). Chikkamagaluru, Bannerghatta National Park, Bandipura Tiger Reserve, BRT Tiger Reserve and Male Mahadeshwara Hills Wildlife also reported considerable numbers of incidents (Fig. 1.13; 1.13a).

Male victims accounted for the highest number of both fatalities and injuries compared to females. A total of 290 male fatalities and 165 male injuries were recorded, compared to 232 female fatalities and 40 female injuries. A significant association was observed between gender and incident type ($\chi^2 = 44.09$, $p = 0.0001$, Fig. 2.3). However, no significant association was observed between gender and seasons ($\chi^2 = 0.04$, df = 3, $p = 0.9981$).

Season-wise distribution showed that the highest number of incidents occurred during the monsoon season (247 incidents), followed by summer (208 incidents), post-monsoon (168 incidents) and winter (132 incidents). Fatalities were also highest during the monsoon season (165 deaths), followed by summer (155 deaths), post-monsoon (107 deaths) and winter (95 deaths). Incident type differed significantly across seasons ($\chi^2 = 20.22$, $p = 0.0161$), indicating seasonal variation in the pattern of human casualties. Overall, human–elephant conflict incidents were recorded across all seasons, showing that conflict remained persistent throughout the year in Karnataka (Fig. 1.14; 1.15).

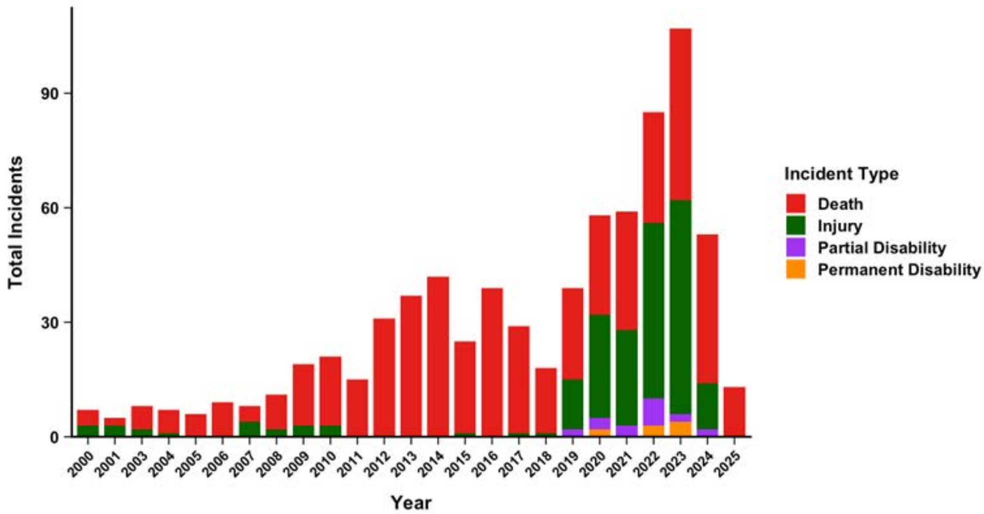

Figure 1.11: *Trends in human deaths/Injuries due to human elephant conflict in Karnataka (2000-2025).*

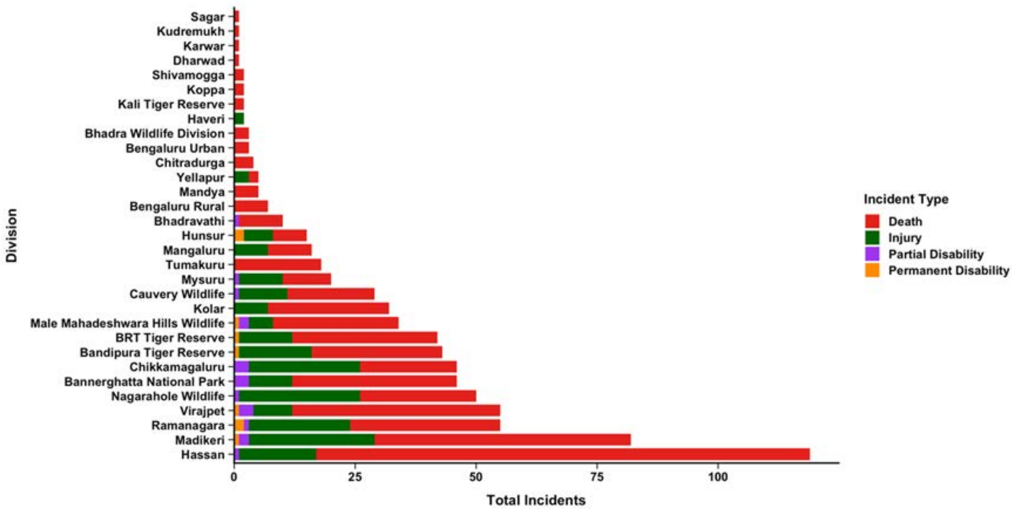

Figure 1.12: *Division Vise distribution of human elephant incidents in Karnataka (2000-2025).*

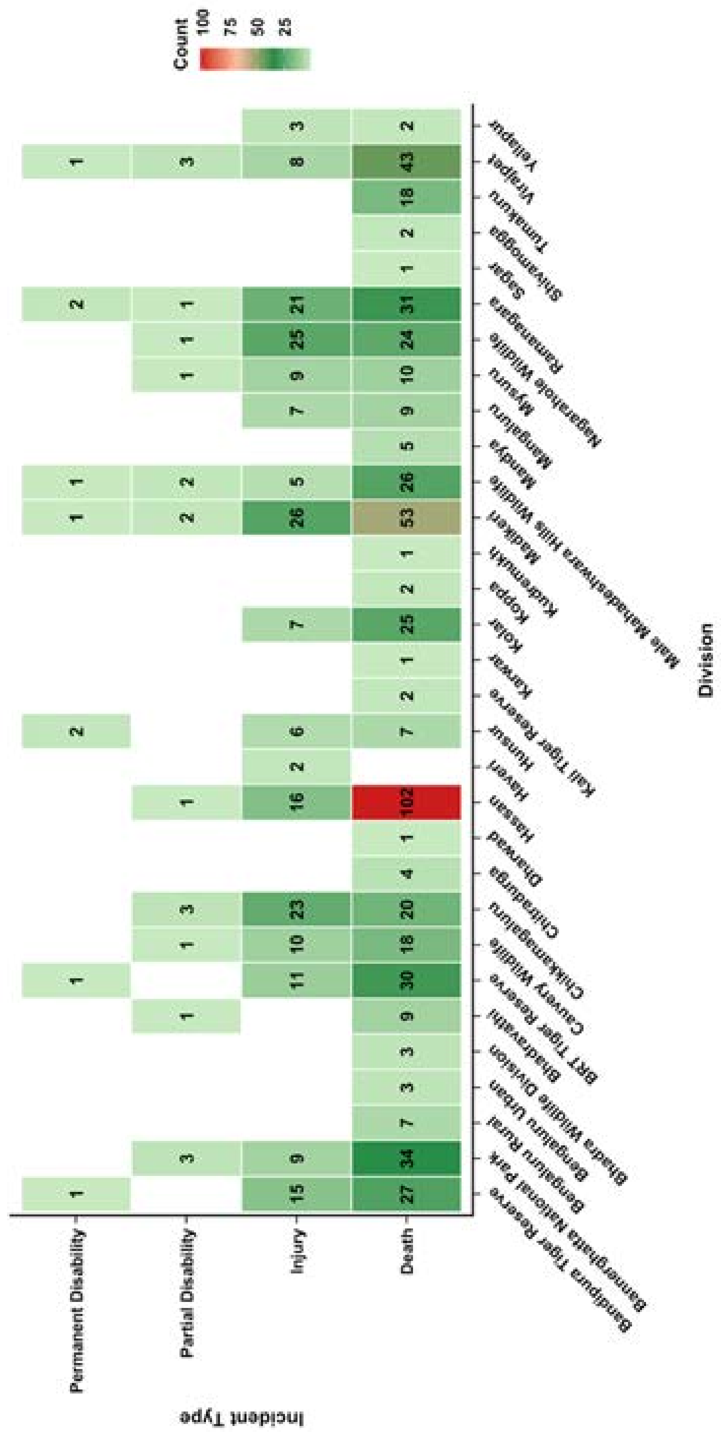

Figure 1.13: *Division Vise distribution heat map of human elephant incidents in Karnataka.*

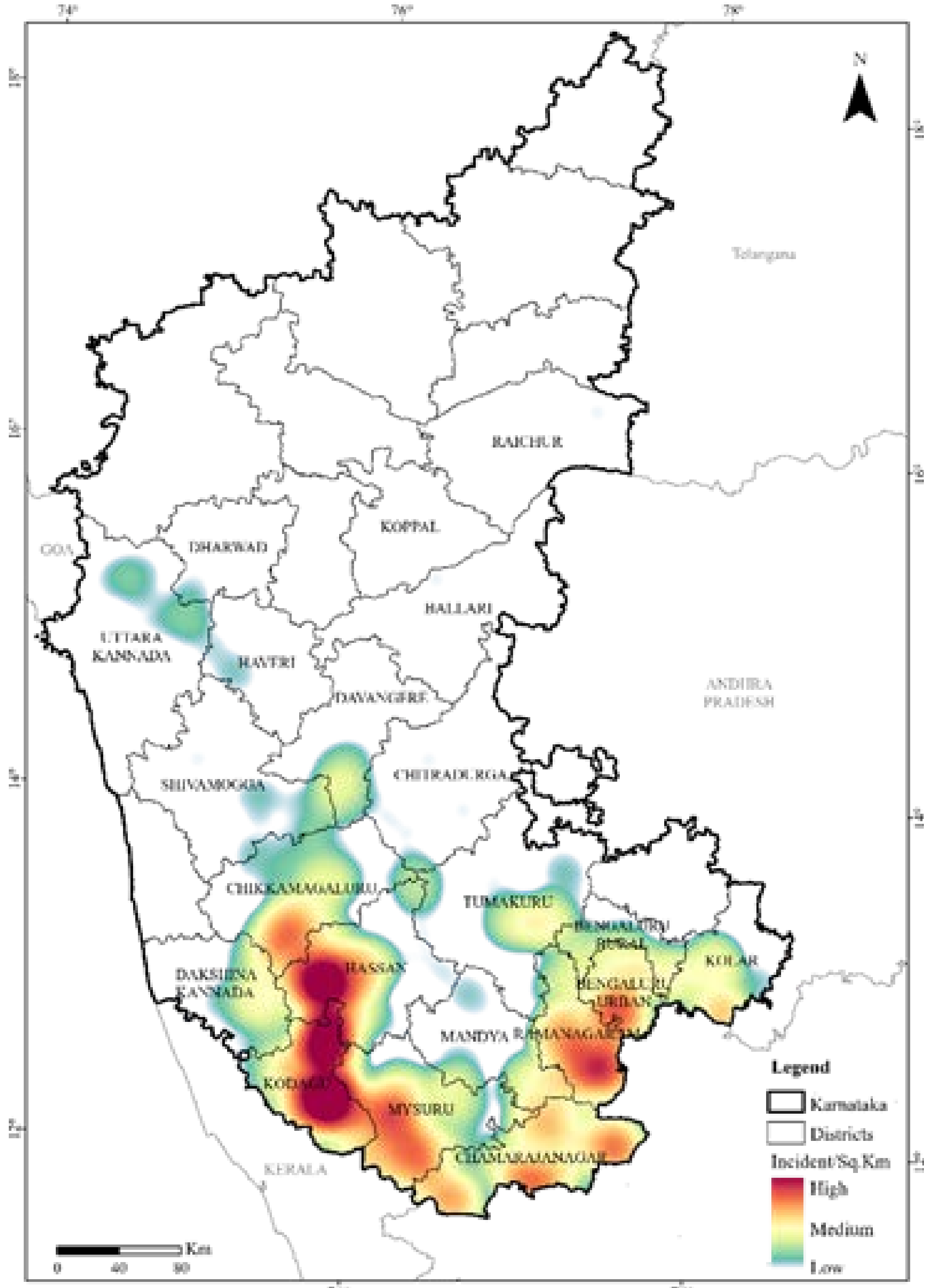

Figure 1.13(a): *Kernel Density map visualizing the intensity and distribution, highlighting areas with higher HEC occurrences in Karnataka (2000-2025).*

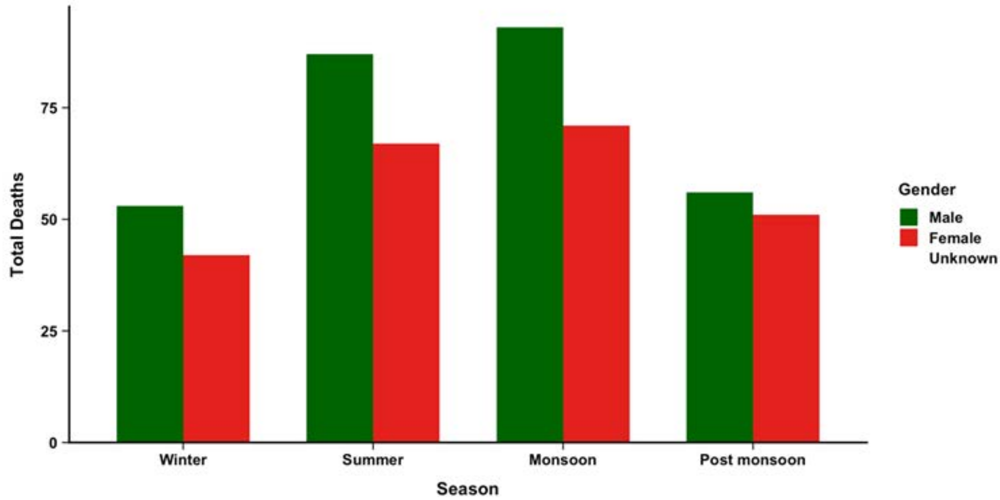

Figure 1.14. *Seasonal variation in human deaths (male & female).*

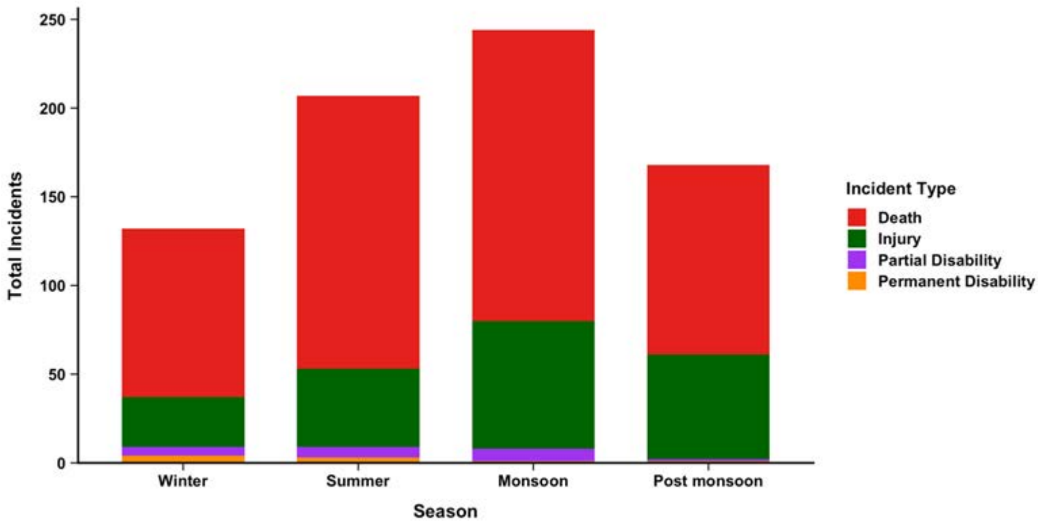

Figure 1.15: *Seasonal variation in human fatalities/injuries (male & female).*

Village-Level Analysis of Ecological and Anthropogenic Variables of Human mortality and Injuries

A comprehensive examination of ecological and anthropogenic variables at the village level highlights distinct patterns across HEC-intensity categories. High-HEC villages exhibit the highest median forest cover, while low-HEC villages have the lowest median forest cover (Fig. 1.16a, Kruskal–Wallis: χ^2 = 8.76, df = 2, p = 0.013). High-HEC villages show substantially lower crop cover percentages than low- and medium-HEC villages (Fig. 1.16b, $\chi^2 = 13.40$, df = 2, $p = 0.001$). Water cover is highest in high-HEC villages, while medium-HEC villages show the lowest median water availability (Fig. 1.16c, $\chi^2 = 4.04$, df = 2, $p = 0.133$). Built-up cover is highest in high-HEC villages, whereas medium-HEC villages show the lowest median built-up cover (Fig. 1.16d, $\chi^2 = 10.00$, df = 2, $p = 0.007$). Tea-estate cover is lowest in high-HEC villages and highest in medium-HEC villages (Fig. 1.16e, $\chi^2 = 1.45$, df = 2, $p = 0.483$). Railway density is highest in high-HEC villages and lowest in medium-HEC villages (Fig. 1.16f, $\chi^2 = 0.75$, df = 2, $p = 0.686$). Road density is highest in high-HEC villages, while medium-HEC villages show the lowest median road density (Fig. 1.16g, $\chi^2 = 4.58$, df = 2, $p = 0.101$).

Key Predictors of HEC

Human mortality occurrence was significantly influenced by ecological and anthropogenic landscape factors. Human-death records were more likely to occur closer to Elephant Reserves ($p < 0.001$) and roads ($p < 0.001$). The best-supported model also included patch density and distance from tea plantations; however, patch density was not significantly associated with human mortality occurrence ($p = 0.422$), while distance from tea plantations showed a marginal association ($p = 0.050$) (Tables 1.4 and 1.5).

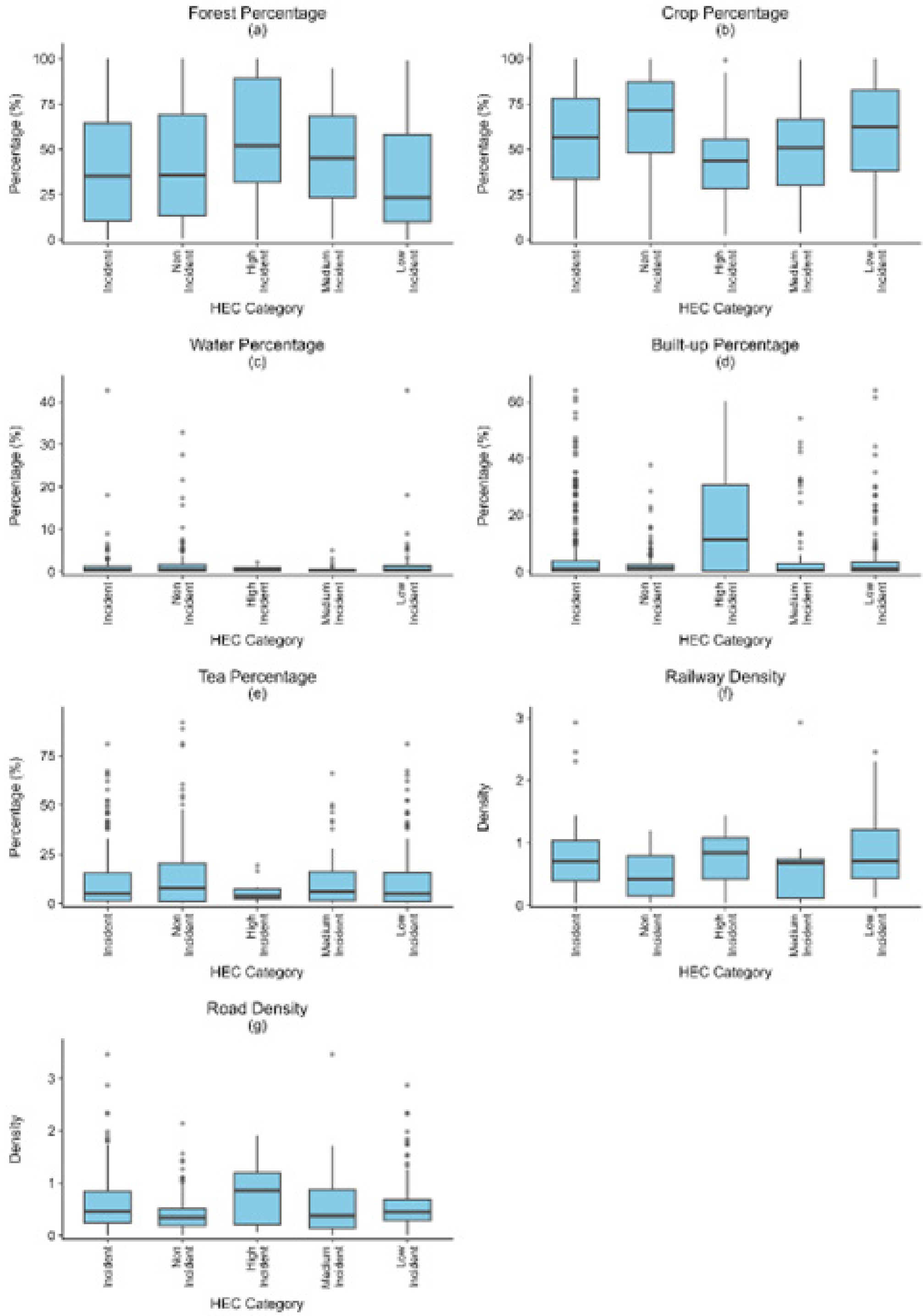

Figure 1.16: *Comparison of ecological and anthropogenic variables across different incident types and non-incidence villages of Karnataka.*

Table 1.6: *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 Karnataka.*

Variables	LogL	df (K)	AICc	Delta AICc	Wi
der_z + pd_z + dtea_z + dr_z	-972.95	5	1955.95	0	0.999
dw_z + dpa_z + der_z + dtea_z	-980.81	5	1971.65	15.71	<0.001
der_z + dtea_z	-984.15	3	1974.32	18.38	<0.001
der_z + lpi_z + dw_z + df_z + dtea_z	-983.88	6	1979.82	23.87	<0.001
dw_z + der_z	-988.22	3	1982.45	26.51	<0.001
der_z + pd_z + df_z	-987.29	4	1982.61	26.67	<0.001
dc_z + dr_z + dtea_z + db_z	-999.69	5	2009.43	53.48	<0.001
db_z + dr_z	-1024.75	3	2055.51	99.57	<0.001
df_z + dw_z	-1037.63	3	2081.28	125.33	<0.001
df_z + dtea_z	-1038.13	3	2082.27	126.32	<0.001
dw_z	-1040.12	2	2084.25	128.3	<0.001
dr_z	-1040.14	2	2084.29	128.34	<0.001
df_z + dc_z	-1040.57	3	2087.16	131.21	<0.001
pd_z	-1045.02	2	2094.06	138.11	<0.001

Table 1.7: *Parameter estimates effect (β), standard errors (S.E), and probabilities of ecological and anthropogenic variables in determining the human elephant conflict in Karnataka.*

Variable	Effect (β)	z value	p-value	Significance
Distance from Elephant Reserve	-0.755	-10.084	<0.001	***
Patch density	-0.047	-0.803	0.4221	
Distance from tea plantation	-0.13	-1.959	0.0501	.
Distance from road	-0.254	-4.444	<0.001	***

**Significance level*

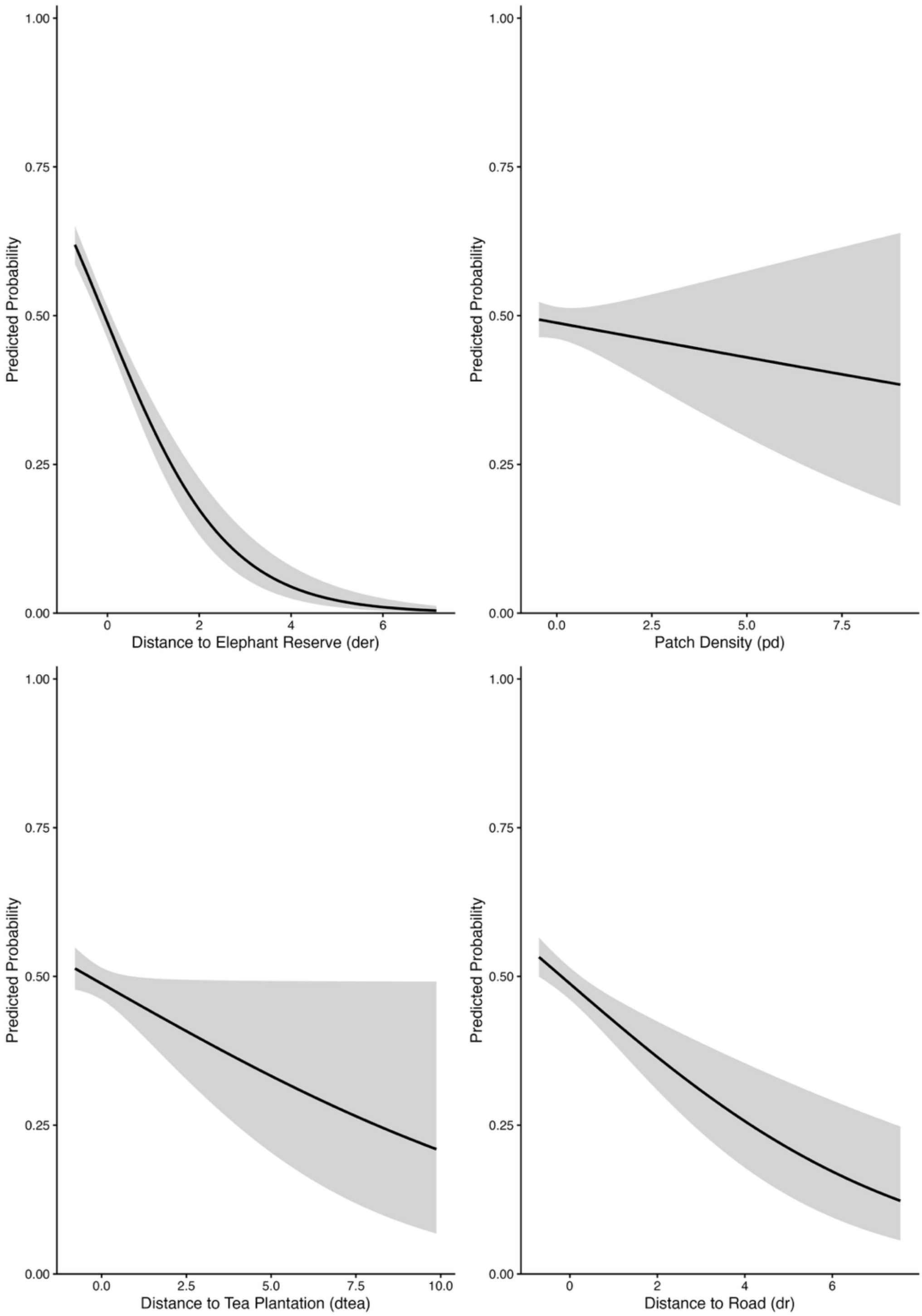

Figure 1.17: *Evaluation of Key Factors Affecting Human-Elephant Conflict (Human Fatalities and Injuries) in Karnataka.*

Photo Credit: Tamblu

DISCUSSION

SPATIAL AND TEMPORAL PATTERNS OF ELEPHANT MORTALITY AND HUMAN CASUALTIES

Karnataka experienced persistent human-elephant conflict during 2000-2025, with consequences for both elephant conservation and human safety. Our study recorded 1,321 elephant deaths, of which 1,093 (82.7%) were attributed to natural causes, including illness, and 216 (16.4%) were linked to anthropogenic causes. The remaining 12 deaths (0.9%) were classified as accidental deaths caused by natural calamities or unknown causes. and 755 human casualty incidents, including 522 fatalities, 205 injuries, 19 cases of partial disability and nine cases of permanent disability. Elephant mortality was highest in Nagarahole Wildlife, Male Mahadeshwara Hills Wildlife, Virajpet, BRT Tiger Reserve and Madikeri, while human casualties were concentrated in Hassan, Madikeri, Ramanagara, Virajpet and Nagarahole Wildlife. The overlap in Madikeri, Virajpet and Nagarahole indicates that both human and elephant losses were concentrated within major elephant landscapes where protected forests, plantations, agricultural areas and settlements occur in close proximity. Karnataka supports one of the largest elephant populations in India, with animals moving across protected and human-modified landscapes within the southern Western Ghats (Qureshi *et al.,* 2025; Gubbi *et al.,* 2014; Senthilkumar *et al.,* 2019). Our findings show that elephant deaths and human casualties were concentrated in many of the same landscapes, but the divisions with the highest elephant mortality were not always those with the highest human casualties.

Annual elephant mortality varied considerably during 2000–2025, with the highest number of deaths recorded in 2021, followed by 2024, 2017, 2023 and 2013. Because high-mortality years occurred at different points during the study period, the results do not indicate a consistent increase in elephant deaths over time. However, the occurrence of several high-mortality years after 2017 shows that substantial elephant losses continued during the later part of the study period.

Elephant mortality and human casualties both showed significant seasonal variation. Elephant deaths were highest during the monsoon, and the same season recorded the greatest number of anthropogenic deaths. Human conflict incidents and fatalities were also highest during the monsoon, followed by summer, post-monsoon and winter. Evidence from Assam indicates that monsoon conditions can intensify casualty risk, particularly where fragmented forests, agricultural fields and disrupted elephant corridors occur together (Habib *et al.,* 2025a). Seasonal changes in rainfall, water availability, crop cycles and vegetation productivity influence elephant movement and the use of agricultural and plantation landscapes (Anoop *et al.,* 2023; Routray *et al.,* 2025). However, incidents were recorded in every season, indicating that conflict in Karnataka is not restricted to a short period of resource scarcity. Elephants regularly move between forests, plantations and agricultural areas, while people continue crop guarding, plantation work and daily movement near elephant habitats throughout the year (Prasad *et al.,* 2025; Lingaraju & Venkataramana, 2014). Mitigation must therefore remain continuous, with additional preparedness during the monsoon and other periods of increased elephant activity in human-use areas.

ANTHROPOGENIC ELEPHANT MORTALITY AND DEMOGRAPHIC VULNERABILITY

Natural-type causes accounted for the largest share of elephant mortality in Karnataka, with 1,093 deaths attributed to natural causes and illness. Females recorded the highest natural-type mortality, closely followed by tuskers. Although these records describe the dominant mortality pattern, they cannot alone indicate population status without corresponding information on abundance, age structure and recruitment.

Anthropogenic mortality formed a smaller but largely preventable component of elephant deaths. Electrocution was the dominant anthropogenic cause and occurred significantly more often than the other major causes, followed by poaching, anthropogenic stressors, gunshot, accidental deaths, road accidents, train hits, poisoning and snaring. Similar threats have been reported where illegal electric fences, unsafe powerlines and transport infrastructure overlap with elephant-use areas (Roy *et al.,* 2025; Habib *et al.,* 2025b; Pandey *et al.,* 2025; Banerjee *et al.,* 2025; PE-MoEFCC-WII, 2025). Regular inspection of powerlines and fences, removal of illegal electrical connections and modification of exposed or low-hanging wires are therefore essential, particularly near forests, plantations and croplands (Gubbi *et al.,* 2014; Anoop *et al.,* 2023; Prasad *et al.,* 2025).

Tuskers recorded the highest overall mortality and were most affected by electrocution and poaching. However, anthropogenic mortality categories were not significantly associated with age/sex class. The higher mortality of tuskers should therefore be interpreted as a recorded demographic pattern rather than evidence that all anthropogenic threats affect males more strongly. Their greater exposure may reflect wider movement through agricultural fields, coffee estates and settlement edges, where contact with people and infrastructure is more likely (Gubbi *et al.,* 2014; Anoop *et al.,* 2023).

Male victims also accounted for more human fatalities and injuries than females, and gender was significantly associated with incident type but not with season. This pattern may reflect greater involvement of men in crop guarding, plantation work, forest-resource collection and movement through elephant-use areas (Lingaraju & Venkataramana, 2014; Prasad *et al.,* 2025). The observed male predominance therefore indicates greater recorded exposure rather than showing that gender alone determines casualty risk.

SHARED LANDSCAPE CONTEXT AND MANAGEMENT PRIORITIES

The partly overlapping hotspots show that elephant mortality and human casualties occur within the same broader elephant landscapes, although their local drivers differ. Nagarahole, Virajpet and Madikeri recorded substantial losses of both elephants and people, while Male Mahadeshwara Hills Wildlife had high elephant mortality and Hassan recorded the highest human casualties. These patterns reflect the close interface of forests, plantations, croplands, roads and settlements across Karnataka. Evidence from Jharkhand further shows that elephant deaths can become concentrated near agricultural fields, settlements and fragmented forests where unsafe electrical and transport infrastructure creates additional mortality risks (Habib *et al.,* 2025c). Forest loss, plantation expansion and infrastructure development have further increased overlap between elephant movement and human activity (Anoop *et al.,* 2025; Pavithra *et al.,* 2025).

Management should therefore focus on local incident patterns rather than applying uniform measures across the state. Elephant mortality hotspots require inspection of powerlines and electric fences, removal of illegal electrical connections, securing of open wells and drains, and monitoring of roads and railway lines crossing elephant-use areas (Banerjee *et al.,* 2025; PE-MoEFCC-WII, 2025). Capture, restraint and translocation should follow clear operating procedures and post-release monitoring where such interventions are necessary (PE-MoEFCC-WII, 2024).

Human casualty hotspots require year-round early-warning systems, rapid communication with forest staff and safer crop-guarding practices. Landscape-level planning and community-based responses are important because local residents often provide the earliest information on elephant movement near farms and settlements (MoEF&CC, 2022; Prasad *et al.,* 2025; Pandey *et al.,* 2026). Maintaining connectivity between protected forests, reserve forests and plantation landscapes is equally necessary, as coffee estates and agroforestry areas may support elephant movement while also increasing contact with people and infrastructure (Anoop *et al.,* 2023; Gubbi c 2014; Pavithra *et al.,* 2025). A two-decade spatial analysis from Assam located conflict hotspots near fragmented forests, agricultural edges and elephant reserves, with greater conflict intensity in villages characterised by reduced forest connectivity and expanding built-up areas (G *et al.,* 2026).

Our study identifies where elephant and human losses were concentrated, but the observed patterns do not prove that any single landscape feature directly caused an incident. Some records also contained limited contextual information, and several mortality categories had small sample sizes. The LULC, village-level and predictive analyses are therefore important for examining these landscape relationships more directly.

CONCLUSION

Our study shows that elephant mortality and human casualties remained persistent across Karnataka between 2000 and 2025. Natural-type causes accounted for most elephant deaths, while electrocution was the leading anthropogenic cause and the most important preventable mortality threat identified. Tuskers recorded the highest overall and anthropogenic mortality, while human fatalities and injuries were more frequently recorded among men. Both elephant mortality and human casualty incidents were highest during the monsoon but occurred throughout the year.

The concentration of elephant and human losses within a limited number of forest divisions indicates that management should prioritise identified hotspots rather than applying uniform interventions across the state. Preventing electrocution through the removal of illegal electrical connections and regular inspection of powerlines and electric fences should receive immediate attention. Other measures should include strengthening protection against poaching, securing hazardous wells and drainage structures, and monitoring roads and railway lines that intersect elephant-use areas. Human safety measures should include year-round early-warning systems, safer crop-guarding practices and rapid communication with forest staff.

Long-term reduction of human–elephant conflict will also require the protection of habitat connectivity and safe elephant movement pathways across forests, plantations and agricultural landscapes. Coordinated action among forest divisions, infrastructure agencies and local communities will be necessary to reduce avoidable elephant deaths and human casualties and support safer coexistence in Karnataka.

Photo Credit: Anshuman Gogoi

Suggested Measures to Minimize Human-Elephant Conflict in the State of Karnataka

Human–elephant conflict (HEC) in Karnataka remains a persistent conservation and socio-economic challenge because the state supports large elephant populations across connected forest and human-modified landscapes. These include the Bandipur–Nagarahole–BRT–Male Mahadeshwara Hills complex, the Cauvery landscape, and the plantation–forest mosaics of Kodagu, Hassan and Chikkamagaluru. Elephants regularly move between protected forests, reserve forests, coffee plantations, agricultural fields and settlements. Conflict is not uniformly distributed across Karnataka. It is shaped by: (i) regular and seasonal elephant movement through recognised corridors; (ii) forest fragmentation, corridor bottlenecks and land-use change around plantations, farms, mines and settlements; (iii) reduced forage availability in areas affected by invasive plants; and (iv) roads, railways and powerlines that intersect elephant movement routes. Mitigation must therefore follow a site-specific and risk-based approach. This should combine barriers, guarding, early-warning systems, rapid response and compensation with corridor protection, habitat restoration and safe-passage measures at important movement bottlenecks (Bal *et al.,* 2011; Gubbi, 2012; Gubbi *et al.,* 2014; Karnataka Evaluation Authority, 2022).

Karnataka has already adopted a broad conflict-management framework. Existing measures include rail-track barricades, solar-powered fences, elephant-proof trenches, stone walls and other barriers along vulnerable forest boundaries. The Forest Department also uses rapid-response teams, field patrols, local watchers, trained captive elephants and elephant-driving operations when wild elephants enter farms, coffee estates or settlements. Monitoring has been strengthened through radio-collaring, camera traps, drones, mobile communication networks and geo-referenced conflict records. The e-Parihara system supports incident reporting and compensation for human casualties, crop damage, livestock loss and property damage. Research partnerships and landscape-level monitoring are also being used to improve elephant tracking, corridor assessment and early-warning systems. However, the effectiveness of these measures depends on correct placement, regular maintenance, timely communication, adequate funding and coordination among the Forest Department, local communities and other responsible agencies (Mantelingachar & Venkatareddy, 2025; Prasad *et al.,* 2024).

Building on these ongoing actions, the measures suggested below focus on preventing avoidable elephant deaths, reducing human fatalities and injuries, and addressing risks associated with corridor bottlenecks, habitat degradation, plantations and linear infrastructure. Particular attention is given to electrocution, road and railway collisions, retaliatory killing, poorly maintained and placed barriers, delayed compensation and repeated conflict in agricultural and plantation landscapes. The aim is to strengthen existing interventions, address weaknesses in their design and maintenance, improve coordination among responsible agencies and prioritise action in forest divisions and villages identified as having the highest risk (Karnataka Evaluation Authority, 2022; Krishnan *et al.,* 2017; Prasad *et al.,* 2025).

RECOMMENDATIONS FOR MANAGING ELEPHANT MORTALITY IN KARNATAKA

Elephant mortality risk in Karnataka is closely linked to electrocution, poaching, unsafe barriers, road and railway interfaces, and conflict-related retaliation. Although the causes differ among landscapes, the prevention strategy should follow a clear principle: remove preventable hazards, maintain safe elephant movement routes and strengthen field-level monitoring in high-risk areas (MoEF&CC, 2010; MoEF&CC, 2022; Panda *et al.,* 2020; Pandey *et al.,* 2024b; Pandey *et al.,* 2026).

Railway Collisions: Site-Specific Prevention along Vulnerable Stretches in Karnataka

Railway-related elephant mortality in Karnataka is concentrated along specific stretches where railway lines intersect established elephant movement routes. Railway-risk mitigation should therefore be restricted to verified vulnerable sections rather than applied uniformly across the railway network.

Joint assessments by the Wildlife Institute of India, Karnataka Forest Department and Indian Railways identified vulnerable (Ambewadi – Alnavar, Londa – Khanapura -Desur, Casterock – Tinaighat – Londa – Nagargali, Shimoga – Kumsi – Anandapura – Talaguppa, Balupete – Sakleshpura – Subrahmanya Road) stretches and recommended location-specific interventions, including level crossings, underpasses, overpasses, reinforced cement concrete box structures and Distributed Acoustic Sensing-based early-warning systems. Such assessment is necessary to ensure that mitigation measures are applied only where elephant movement and collision risk have been confirmed (PE-MoEFCC-WII, 2024; PE-MoEFCC-WII, 2025).

Based on these assessments, the following measures are recommended for reducing elephant–train collisions along vulnerable railway stretches in Karnataka:

a. **Improvement and maintenance of safe crossing structures:** Underpasses, overpasses, rubberised level crossings with ramps and suitable reinforced cement concrete box structures should be constructed, maintained or improved at confirmed elephant crossing locations.

b. **Implementation of DAS early-warning and detection systems:** On railway sections frequently crossed by elephants, DAS-based intrusion detection could use existing optical-fiber infrastructure to provide continuous monitoring without relying solely on visual detection. AI-enabled cameras remain useful for visual confirmation but require regular maintenance and can be affected by vegetation, weather, restricted fields of view and false or missed detections. Where suitable optical fiber is available, DAS could complement camera-based monitoring and reduce the number of trackside installations required. Its operational performance, maintenance needs and comparative cost-effectiveness should be assessed through site-specific trials before wider deployment.

c. **Vegetation and visibility management along tracks:** Vegetation should be regularly managed along high-risk railway sections to improve visibility for train operators without unnecessarily degrading adjoining elephant habitat.
d. **Evidence-based speed regulation:** Speed restrictions should be applied along verified risk stretches and during periods of increased elephant movement, based on field evidence and joint assessment.
e. **Institutional coordination and operational protocols:** Regular coordination between the Forest Department and railway authorities should be established for inspection, monitoring, maintenance, communication and rapid response.

These measures, when applied selectively to verified elephant movement zones and supported by regular interdepartmental coordination, can reduce elephant mortality from railway collisions without creating new barriers to elephant movement (PE-MoEFCC-WII, 2024; PE-MoEFCC-WII, 2025).

Electrocution Risk: Enforcement of Safe Practices and Removal of Unsafe Electrical Installations

Electrocution is one of the major causes of elephant mortality in Karnataka, particularly in agricultural areas, plantations and forest-edge landscapes where elephants regularly encounter unsafe electrical infrastructure. The main risks include illegal live-wire fencing, direct tapping of electricity distribution lines, and low-hanging or damaged powerlines. Although solar-powered and low-voltage fencing can support crop protection, these systems must be correctly installed and regularly maintained to avoid creating additional risks to elephants and people (MoEF&CC, 2010; MoEF&CC, 2022). The high anthropogenic mortality among males is particularly concerning, especially where mature bulls are affected. Older bulls can influence collective movement and social regulation, and reduced presence of older males has been associated with increased aggression in African elephant populations; its relevance to Asian elephants should therefore be interpreted cautiously (Kopf *et al.*, 2025).

The following measures are recommended to reduce electrocution-related elephant mortality in Karnataka:

a. **Joint inspection and monitoring in high-risk areas:** The Forest Department, electricity distribution agencies and local administration should conduct joint inspections in high-risk divisions, particularly before and during periods of increased elephant movement.
b. **Removal of illegal electrical installations:** Illegal live-wire fences, direct connections to distribution lines, and low-hanging or sagging powerlines should be identified and removed or repaired immediately.
c. **Strategic Installation of Electric Fencing:** Before installing electric fencing, the Forest Department should assess the proposed location to ensure that the barrier does not obstruct established elephant movement routes.
d. **Local reporting and rapid response:** Villages should have a simple system for reporting unsafe electric fences and damaged powerlines. Clear responsibilities and response timelines should be established for Forest Department staff and electricity agencies.

Implementing these measures consistently in high-risk landscapes will reduce preventable elephant deaths while ensuring that crop-protection systems remain safe, lawful and properly maintained.

Improving the Effectiveness of Physical Barriers

Karnataka uses elephant-proof trenches, solar fencing, rail barricades, rubble walls and other barriers to reduce elephant entry into farms and settlements. However, their effectiveness depends on suitable placement, appropriate design and regular maintenance. Evaluations in Karnataka identified unsuitable locations, gaps, discontinuous sections and poor maintenance as important limitations. Repeated barrier damage and breaches have also been recorded in many divisions. (MoEF&CC, 2010; Karnataka Evaluation Authority, 2022; Saklani *et al.,* 2018).

The following measures are recommended:

a. **Placement around vulnerable human-use areas:** Barriers should be placed around villages, agricultural fields and other areas with a high likelihood of elephant entry. They should not block corridors or movement routes connecting forested areas.
b. **Selection of suitable barrier types:** Elephant-proof trenches should be avoided in steep, erosion-prone and high-rainfall areas where they cannot be maintained effectively.

These measures can improve barrier performance while avoiding obstruction of natural elephant movement.

Protection and Restoration of Elephant Movement Routes

Elephants in Karnataka move across protected areas, reserve forests, plantations and agricultural mosaics. Maintaining connections among these habitats is therefore essential. The Elephant Corridors of India report identifies corridor protection and restoration as important for elephant conservation and recognises Karnataka-linked corridors such as Kaniyanpura–Moyar and Edayarahalli–Doddasampige (Project Elephant, 2023). Subsequent assessment has emphasised field verification, periodic monitoring and the incorporation of active elephant corridors into conservation and management planning (Pandey *et al.,* 2024c).

The following measures are recommended:

a. **Verification of active movement routes:** Elephant corridors and regularly used movement paths should be confirmed through field surveys and included in working plans, management plans and Elephant Conservation Plans.
b. **Regular monitoring of corridor use:** Corridor use should be assessed using patrolling records, camera traps, local information and spatial records of elephant movement and conflict.
c. **Coordination across connected divisions:** Forest divisions within connected landscapes, including Bandipur–Nagarahole–BRT–MM Hills, Cauvery Wildlife, Bannerghatta and Hassan–Madikeri–Virajpet, should coordinate management and monitoring.

These actions can maintain safe movement between forested areas and reduce pressure at narrow conflict-prone locations.

Management of Food, Water and Refuge Areas

Habitat management should reduce factors that repeatedly draw elephants towards farms and settlements while protecting natural refuge and movement areas. In the Hassan–Alur–Sakleshpur landscape, elephant movement is influenced by forest fragments, coffee plantations, paddy fields, water sources and refuge habitats. Habitat interventions should therefore be based on field evidence and local conditions (MoEF&CC, 2010; Krishnan *et al.,* 2017).

The following measures are recommended:

a. **Protection of refuge areas:** Forest remnants, wooded patches and other places used by elephants for resting and movement within plantation landscapes should be identified and protected.
b. **Careful improvement of water and forage:** Water or forage improvement

should be undertaken only where seasonal shortages have been confirmed through field surveys and elephant-movement records. Such resources should not be created near farms or settlements.

This approach can reduce repeated elephant visits to human-use areas without interfering with natural movement.

Management of Recurrent Conflict Elephants

Capture, restraint and translocation should not be used as routine responses to human–elephant conflict. These interventions should be considered only in exceptional cases where other measures have failed or where an identified elephant poses a repeated and serious risk to human life. All operations should follow the Recommended Operating Procedure and Field Manual guidance (MoEF&CC, 2022; PE-MoEFCC-WII, 2024).

The following measures are recommended:

a. **Monitoring after release:** Captured or translocated elephants should, where practicable, be radio-collared and monitored through telemetry and field observations.
b. **Pre and Post Monitoring of solitary male elephants:** Solitary males repeatedly involved in conflict should, where feasible, be radio-collared and monitored before and after intervention to assess movement, habitat use, behaviour and conflict recurrence.
c. **Avoid shifting conflict between divisions:** Repeatedly driving elephants from one range or division into another should be avoided unless corridor bottlenecks, habitat constraints and local food attractants are also addressed. Otherwise, the conflict may simply move to another area.

These interventions should remain limited, carefully monitored and linked with long-term measures such as corridor protection, barrier maintenance, early warning and removal of attractants.

Prevention of Poaching and Retaliatory Poisoning

Poaching and poisoning represent preventable causes of elephant mortality in Karnataka. Poaching is mainly associated with the illegal killing of elephants for ivory, while poisoning may occur as retaliation following repeated crop damage, property loss or human casualties. These threats require both stronger enforcement and timely support for conflict-affected communities.

The following measures are recommended:

a. **Strengthen surveillance and intelligence:** Patrolling, camera-based monitoring and confidential information networks should be strengthened in poaching-prone areas to identify illegal hunters, ivory traders and transport routes.
b. **Improve compensation and community reporting:** Fair and timely compensation should be provided for crop damage, property loss, injuries and human deaths. Communities should also have safe and confidential systems for reporting suspected poaching, ivory trade and poisoning incidents.
c. **Community awareness and enforcement:** Such incidents must also be treated as social issues and awareness programmes should conducted to explain the ecological and legal consequences of killing elephants, trading ivory and using poison against wildlife, while enforcement agencies should act promptly against confirmed offences.

Reducing Elephant Mortality on High-Risk Roads

Vehicular collisions may occur where roads pass through forests, corridor bottlenecks and regularly used elephant-crossing locations. Risk is generally greater at night, during poor visibility and where vehicles travel at high speed. Road mitigation should therefore be applied to verified crossing sections rather than uniformly across all roads.

The following measures are recommended:

a. **Identification of vulnerable road sections:** Elephant-crossing locations should be identified using collision records, field surveys, camera traps and elephant-movement information.
b. **Speed control at crossing zones:** Reduced speed limits should be enforced on high-risk sections, particularly at night and during periods of increased elephant movement.
c. **Installation of warning and detection systems:** Reflective signs, flashing warning lights and camera- or sensor-based systems should be used to alert motorists when elephants are approaching or crossing roads.

Applying these measures at confirmed crossing locations can reduce collision risk without restricting elephant movement between forested areas.

Management of Invasive Plants and Restoration of Native Forage

Invasive plants such as Lantana camara and Senna spectabilis can reduce the availability of native grasses and forage plants, restrict animal movement and alter habitat conditions within elephant-use areas. Their dense growth may encourage elephants to move farther in search of food and may increase their use of plantations, farms and settlements. Invasive-species removal should

therefore be linked with habitat restoration and long-term monitoring rather than treated as a one-time clearance activity.
The following measures are recommended:

a. **Identification of heavily invaded elephant habitats:** Forest patches, corridors and refuge areas affected by dense invasive vegetation should be mapped and prioritised according to elephant use and habitat condition.
b. **Phased removal of invasive plants:** Removal should be undertaken gradually using scientifically suitable methods to avoid extensive soil disturbance, sudden loss of cover or rapid reinvasion.
c. **Restoration with native vegetation:** Cleared areas should be restored with native grasses, shrubs and forage species suitable for the local habitat.
d. **Community participation in restoration:** Local and indigenous communities should be involved where appropriate in removal, restoration and long-term maintenance activities.
e. **Monitoring of ecological outcomes:** Vegetation recovery, elephant use and conflict patterns should be monitored to determine whether restoration improves forage availability and reduces movement into human-use areas.

Invasive-species management will be effective only when removal is followed by native habitat recovery and regular prevention of reinvasion.

Reducing Elephant Mortality on High-Risk Roads

Vehicular collisions may occur where roads pass through forests, corridor bottlenecks and regularly used elephant-crossing locations. Risk is generally greater at night, during poor visibility and where vehicles travel at high speed. Road mitigation should therefore be applied only to verified high-risk sections.

The following measures are recommended:

a. **Identification of vulnerable road sections:** Elephant-crossing locations should be identified using collision records, field surveys, camera traps and elephant-movement information.
b. **Speed control and warning systems:** Reduced speed limits, reflective signs, flashing lights and camera- or sensor-based alerts should be used at confirmed crossing locations, particularly at night and during periods of increased elephant movement.

Applying these measures at verified crossing zones can reduce collision risk without restricting elephant movement.

Management of Invasive Plants and Restoration of Native Forage

Invasive plants such as *Lantana camara* and *Senna spectabilis* can reduce native forage, restrict elephant movement and alter habitat conditions. Their dense growth may encourage elephants to move farther in search of food and enter plantations, farms and settlements. Removal should therefore be followed by habitat restoration and monitoring.

The following measures are recommended:

a. **Identification and phased removal:** Heavily invaded forest patches, corridors and refuge areas should be identified and cleared gradually using scientifically suitable methods that minimise soil disturbance and reinvasion.

b. **Restoration and monitoring:** Cleared areas should be restored with suitable native grasses, shrubs and forage species. Vegetation recovery, elephant use and conflict patterns should then be monitored to assess the effectiveness of restoration.

RECOMMENDATIONS FOR MANAGING HUMAN FATALITIES AND INJURIES IN KARNATAKA

Reducing human deaths and injuries caused by human–elephant conflict in Karnataka requires a combination of prevention, early warning, rapid response, safe behaviour and timely compensation. Human casualties may occur during sudden encounters, night-time movement, crop guarding, crowding around elephants and repeated elephant entry into high-risk villages. Mitigation should therefore reduce unexpected encounters and strengthen local preparedness throughout the year (MoEF&CC, 2022; Pandey *et al.,* 2022; Prasad *et al.,* 2025).

Karnataka has already developed several conflict-response measures, including Rapid Response Teams, local information networks, mobile alerts, camera traps, drones and GPS-based monitoring. The following recommendations aim to strengthen these existing systems by improving coordination, community participation and their use in repeatedly affected locations (PE-WII-MoEF&CC, 2024).

Strengthening Early Warning and Rapid Response

Early warning and rapid response should form the main strategy in high-conflict forest ranges. Their effectiveness depends on accurate information, timely communication and the ability of field teams to respond safely when elephants approach settlements or agricultural areas (PE-WII-MoEF&CC, 2024).

The following measures are recommended to strengthen early warning and rapid response in Karnataka:

a. **Clear alert-to-action procedures:** Each high-conflict range should have a defined system explaining how alerts are received, verified and communicated, and which staff are responsible for responding.
b. **Local information and warning networks:** Forest watchers, villagers, plantation workers and crop-guarding groups should be included in local information networks. SMS alerts, WhatsApp groups, sirens, trip alarms, camera traps, drones and GPS-based monitoring may be used where they are supported by a reliable response system.
c. **Training and preparedness of response teams:** Rapid Response Teams should receive regular training in elephant behaviour, safe deterrence, crowd control, first aid and public communication. Timely night-movement warnings should also be issued in villages experiencing repeated elephant presence.

Community Safety and Crowd Management

Human casualties may increase when people approach elephants, participate in driving operations, gather in large crowds or move alone at night. Community safety should therefore be treated as an important conflict-management measure rather than only as a general awareness activity (MoEF&CC, 2022; PE-MoEFCC-WII, 2024).

The following measures are recommended to reduce risky encounters in Karnataka:

a. **Targeted safety awareness:** Awareness programmes should focus on hotspot villages, schools, colleges, estate workers and farmers living near elephant movement routes. Guidance should cover night travel, crop guarding, group movement, safer routes and the need to avoid approaching elephants.
b. **Crowd-control procedures:** Response teams should establish clearly marked restricted areas during elephant presence. Police personnel, local leaders and village-level committees should assist Forest Department staff in keeping people away from active conflict locations.
c. **Village-level participation:** Local committees may support alert sharing, reporting, crowd management and communication with responsible authorities during periods of repeated elephant movement.

Protection of Settlements and Agricultural Fields

Physical barriers should be used to protect settlements and crop fields at selected locations rather than as continuous landscape-wide structures. Their effectiveness depends on appropriate placement, regular maintenance and community participation. Barriers that block elephant movement or cannot be maintained may shift conflict towards neighbouring areas (MoEF&CC, 2010;

Karnataka Evaluation Authority, 2022; Panda *et al.,* 2020).

The following measures are recommended:

a. **Strategic placement around high-risk areas:** Barriers should be installed around compact settlements, crop clusters and other locations with repeated elephant entry. They should not be placed across elephant corridors or movement routes connecting forested areas.
b. **Community maintenance and rapid repair:** Collective fencing systems may be promoted where farmers and village committees can share responsibility for inspection and maintenance. Construction plans should include assigned responsibilities, transparent maintenance funding and procedures for rapid repair.
c. **Safe exit routes and performance assessment:** Barriers should allow elephants to leave farms or settlements without becoming trapped. Their effectiveness should be assessed using breach records, repair records, incident frequency and community feedback.

Timely Compensation and Grievance Redressal

Timely and transparent compensation is important for maintaining public trust and reducing retaliatory attitudes. Compensation for human death, injury, crop damage and property loss is most effective when claims are assessed consistently, payments are made without unnecessary delay and affected households can track their applications (Karnataka Evaluation Authority, 2022; Panda *et al.,* 2020; MoEF&CC, 2022).

The following measures are recommended to improve compensation in Karnataka:

a. **Fixed timelines and transparent claim tracking:** Claims should be verified and processed within clearly defined timelines. Their status should be communicated to affected individuals and families through a transparent tracking system.
b. **Support for affected households:** Families affected by human death or permanent disability should receive assistance with documentation, compensation procedures and access to relevant welfare schemes.
c. **Linking compensation with prevention:** Villages submitting repeated claims should be prioritised for early-warning systems, barrier improvement and other preventive measures. Compensation records should also be reviewed annually to identify recurring conflict locations.

Reducing Risk around Crop Fields and Settlements

Crop damage can lead to repeated encounters, human injuries, retaliatory

actions and elephant mortality. In Hassan and adjoining coffee–paddy landscapes, elephants regularly move through forest fragments, plantations and agricultural areas, creating repeated risk for farmers and local residents (Krishnan *et al.,* 2017; Prasad *et al.,* 2025).
The following measures are recommended:

a. **Mapping seasonal crop risk:** Paddy, banana, sugarcane and other attractive crops should be mapped in villages with repeated elephant presence. Patrolling and warning coverage should be increased during crop maturation and harvesting periods.
b. **Management of attractants:** Stored grain, crop residues, fruit waste and other edible materials near houses and settlements should be securely stored or removed.
c. **Local conflict calendars and alternative practices:** Hotspot villages should prepare seasonal calendars showing periods of elephant movement, crop vulnerability and increased encounter risk. Less palatable buffer crops and alternative agricultural practices may be tested in selected locations and evaluated before wider use.

Institutional Coordination and Long-Term Monitoring

Human–elephant conflict management in Karnataka requires coordination among the Forest, Revenue, Police, Electricity, Railways, Agriculture and Health departments, local bodies and affected communities. Landscape-level planning, early warning, rapid response, corridor protection and regular evaluation are necessary because no single department can address all causes of conflict independently (PE-WII-MoEF&CC, 2024; Karnataka Evaluation Authority, 2022).

The following measures are recommended:

a. **District-level coordination and annual review:** HEC coordination committees should remain active in high-conflict districts and regularly review elephant mortality, human casualties, crop damage, electrocution incidents, railway risks and barrier breaches.
b. **Training and equipment for frontline teams:** Frontline staff and Rapid Response Teams should receive regular training and be provided with vehicles, searchlights, public-address systems, first-aid kits, protective equipment and approved non-lethal deterrence tools.
c. **Long-term scientific monitoring:** Research institutions may support monitoring of elephant movement, corridor use, barrier performance and mortality risk. The findings should be used to modify interventions that are ineffective or create unintended conflict elsewhere.

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APPENDIX I

Details of Villages which witnessed Elephant Mortality in the state of Karnataka from (2000-2025)

S.No.	Elephant Mortality Count	Village Name	Sub-district	District
1	1	Bhoothanahalli	Anekal	Bengaluru Urban
2	1	Bannerughatta	Anekal	Bengaluru Urban
3	1	Ragihalli	Anekal	Bengaluru Urban
4	1	Muthagatti	Anekal	Bengaluru Urban
5	1	Yellapur	Yellapur	Uttara Kannada
6	1	Mainalli	Mundgod	Uttara Kannada
7	1	Singanamane	Bhadravati	Shivamogga
8	2	Malligenahalli	Bhadravati	Shivamogga
9	1	Yalavalli	Shivamogga	Shivamogga
10	1	Shivamogga	Shivamogga	Shivamogga
11	2	Veeragarana Bhairana Koppa	Shivamogga	Shivamogga
12	2	Bhadravati	Bhadravati	Shivamogga
13	1	Yemmedoddi	Kadur	Chikkamagaluru
14	1	Hogrehalli	Kadur	Chikkamagaluru
15	1	Koppa Rural	Koppa	Chikkamagaluru
16	1	Kamenahallikaval	Chikkamagaluru	Chikkamagaluru
17	2	Gonakal	Chikkamagaluru	Chikkamagaluru
18	3	Chikkamagaluru	Chikkamagaluru	Chikkamagaluru
19	1	Hiremagalur	Chikkamagaluru	Chikkamagaluru
20	2	Manturga	Khanapur	Belagavi
21	2	Sathegala	Kollegal	Chamarajanagara
22	2	D M Samudra	Hanur	Chamarajanagara
23	2	Jakkalli	Kollegal	Chamarajanagara
24	2	Maddur	Yelandur	Chamarajanagara
25	1	Belathur	Hanur	Chamarajanagara
26	6	Biligiriranganabetta	Yelandur	Chamarajanagara
27	2	Budabalu Beat	Hanur	Chamarajanagara
28	7	Hanur R F	Hanur	Chamarajanagara

29	2	Mavathur ΓÇÿBΓÇÖ Beat	Hanur	Chamarajanagara
30	1	Hangaladahosahalli	Gundlupet	Chamarajanagara
31	1	Maguvinahally	Gundlupet	Chamarajanagara
32	2	Hundipura	Gundlupet	Chamarajanagara
33	4	Maguvinahallimel Kamanahalli	Gundlupet	Chamarajanagara
34	4	Mandya	Mandya	Mandya
35	1	Rajegowdanahundi	Heggadadevankote	Mysuru
36	2	Kailasapura	Piriyapatna	Mysuru
37	1	Seeguru	Piriyapatna	Mysuru
38	1	Veeredevanapura	Nanjangud	Mysuru
39	2	Nanjangud	Nanjangud	Mysuru
40	10	Barse	Piriyapatna	Mysuru
41	2	Doddahonnur	Piriyapatna	Mysuru
42	3	Kakanakote	Heggadadevankote	Mysuru
43	8	Hunsur	Hunsur	Mysuru
44	1	Thuppadakola	Hunsur	Mysuru
45	3	Subramanya	Kadaba	Dakshina Kannada
46	1	One Hundred Two Nekkilady	Kadaba	Dakshina Kannada
47	1	Shirady	Kadaba	Dakshina Kannada
48	1	Aithoor	Kadaba	Dakshina Kannada
49	1	Konaje	Kadaba	Dakshina Kannada
50	1	Yedamangala	Kadaba	Dakshina Kannada
51	3	Sulya	Sulya	Dakshina Kannada
52	1	Balagodu	Sulya	Dakshina Kannada
53	4	Kenya	Kadaba	Dakshina Kannada
54	2	Balpa	Kadaba	Dakshina Kannada
55	4	Mukkodlu	Madikeri	Kodagu
56	1	Herur	Kushalanagar	Kodagu
57	1	Nakur Sirangala	Kushalanagar	Kodagu
58	1	Ulugulli	Kushalanagar	Kodagu
59	1	Makkandur	Madikeri	Kodagu
60	2	Kedakal Negadal	Kushalanagar	Kodagu
61	2	Horur	Kushalanagar	Kodagu
62	1	Karadigodu	Virajpet	Kodagu
63	11	Virajpet	Virajpet	Kodagu
64	3	Arji	Virajpet	Kodagu

65	6	Gonikoppal CT	Ponnampet	Kodagu
66	3	Balugodu	Virajpet	Kodagu
67	15	Balyamandur	Ponnampet	Kodagu
68	2	Nalkeri Forest	Ponnampet	Kodagu
69	5	Kalooru	Madikeri	Kodagu
70	1	Kallahalli	Kanakapura	Ramanagara
71	3	Goduru	Harohalli	Ramanagara
72	1	Madhapura Doddi	Harohalli	Ramanagara
73	1	Gadaranahalli	Harohalli	Ramanagara
74	2	Hosadurga	Kanakapura	Ramanagara
75	1	Billiganakuppe	Harohalli	Ramanagara
76	1	Thattekere	Harohalli	Ramanagara
77	2	Gullahatti Kaval	Harohalli	Ramanagara
78	4	Ramanagara	Ramanagara	Ramanagara
79	1	Magadi	Magadi	Ramanagara
80	1	Honnahalli	Kanakapura	Ramanagara
81	1	Virupasandra	Kanakapura	Ramanagara
82	1	Janivara	Hassan	Hassan
83	3	Uddur	Hassan	Hassan
84	2	Hassan	Hassan	Hassan
85	1	Chikka Honnenahalli OG	Hassan	Hassan
86	2	Hassan	Hassan	Hassan
87	1	Kenchatavalli	Hassan	Hassan
88	3	Kyanahalli	Sakleshpur	Hassan
89	2	Hadlahalli	Sakleshpur	Hassan
90	1	Karadigala	Sakleshpur	Hassan

APPENDIX II

Details of Villages which witnessed Human Mortality by Elephants in the state of Karnataka from (2000-2025)

S.No.	Human Casualties Count	Village Name	Sub-district	District
1	1	Madhugiri	Madhugiri	Tumakuru
2	1	Hosahalli	Koratagere	Tumakuru
3	1	Urdigere	Tumakuru	Tumakuru
4	5	Tumakuru	Tumakuru	Tumakuru
5	1	Kothihalli Kaval	Tumakuru	Tumakuru
6	1	Galigenahalli	Tumakuru	Tumakuru
7	1	Guleharavi	Tumakuru	Tumakuru
8	1	Pura	Gubbi	Tumakuru
9	4	Gubbi	Gubbi	Tumakuru
10	1	Manchaladore	Gubbi	Tumakuru
11	1	Honnavalli	Tiptur	Tumakuru
12	1	Chitradurga	Chitradurga	Chitradurga
13	1	Talikatti	Holalkere	Chitradurga
14	1	Hosdurga	Hosdurga	Chitradurga
15	1	Hiriyur	Hiriyur	Chitradurga
16	1	Tanigere	Channagiri	Davangere
17	3	Rudrapura	Channagiri	Davangere
18	1	Channeshapura	Channagiri	Davangere
19	1	Yarehalli	Channagiri	Davangere
20	2	Channagiri	Channagiri	Davangere
21	1	Hosapete	Hosapete	Vijayanagar
22	1	Basavanahalli	Nelamangala	Bengaluru Rural
23	1	Nelamangala	Nelamangala	Bengaluru Rural
24	1	Nijagal	Nelamangala	Bengaluru Rural
25	1	Sompura	Nelamangala	Bengaluru Rural
26	2	Byrasettihalli	Nelamangala	Bengaluru Rural
27	1	Pandithapura	Devanahalli	Bengaluru Rural
28	1	Bettenahalli	Devanahalli	Bengaluru Rural
29	1	Anugondahalli	Hosakote	Bengaluru Rural
30	4	Hosakote	Hosakote	Bengaluru Rural
31	1	Jadigenahalli	Hosakote	Bengaluru Rural

32	1	Sathnur	Yelahanka	Bengaluru Urban
33	1	Gantiganahalli	Yelahanka	Bengaluru Urban
34	1	Bilmaranahalli	Yelahanka	Bengaluru Urban
35	1	Vaddarapalya	Bengaluru South	Bengaluru Urban
36	1	Tharalu	Bengaluru South	Bengaluru Urban
37	3	Kommaghatta	Bengaluru South	Bengaluru Urban
38	10	Bannerughatta Shan-karikavalu	Anekal	Bengaluru Urban
39	1	Jigani CT	Anekal	Bengaluru Urban
40	12	BBMP	Yelahanka	Bengaluru Urban
41	3	Anekal	Anekal	Bengaluru Urban
42	2	Phansoli	Supa	Uttara Kannada
43	1	Chapoli Kalsai	Supa	Uttara Kannada
44	1	Yellapur	Yellapur	Uttara Kannada
45	1	Gunjavati	Mundgod	Uttara Kannada
46	1	Mainalli	Mundgod	Uttara Kannada
47	1	Nagnoor	Mundgod	Uttara Kannada
48	1	Aladevara Hosuru	Shivamogga	Shivamogga
49	1	Basavapura	Hosanagara	Shivamogga
50	1	Hosuru	Bhadravati	Shivamogga
51	1	Nagathibelagalu	Bhadravati	Shivamogga
52	1	Sagar	Sagar	Shivamogga
53	1	Hadikere	Tarikere	Chikkamagaluru
54	1	Lakkavalli	Tarikere	Chikkamagaluru
55	1	Kanive	Narasimharajapura	Chikkamagaluru
56	1	Bargenahalli	Tarikere	Chikkamagaluru
57	1	Lingadahalli	Tarikere	Chikkamagaluru
58	5	Yemmedoddi	Kadur	Chikkamagaluru
59	1	Seethur	Narasimharajapura	Chikkamagaluru
60	1	Kadur	Kadur	Chikkamagaluru
61	2	Thimlapura	Kadur	Chikkamagaluru
62	2	Kesave	Chikkamagaluru	Chikkamagaluru
63	1	Bindiga	Chikkamagaluru	Chikkamagaluru
64	1	Byaravalli	Chikkamagaluru	Chikkamagaluru
65	1	Chikkamagaluru	Chikkamagaluru	Chikkamagaluru
66	4	Hedadalu	Chikkamagaluru	Chikkamagaluru
67	1	Devarahalli	Chikkamagaluru	Chikkamagaluru

68	1	Doddamagaravalli	Chikkamagaluru	Chikkamagaluru
69	1	Biggadevanahalli	Chikkamagaluru	Chikkamagaluru
70	1	Kesavinamane	Chikkamagaluru	Chikkamagaluru
71	5	Kundur	Mudigere	Chikkamagaluru
72	1	Chikkamagaravalli	Chikkamagaluru	Chikkamagaluru
73	2	Kelagoor	Chikkamagaluru	Chikkamagaluru
74	2	Machagondanahalli	Chikkamagaluru	Chikkamagaluru
75	1	Heggodlu	Mudigere	Chikkamagaluru
76	3	B Hosahalli	Mudigere	Chikkamagaluru
77	1	Guddada Estate	Mudigere	Chikkamagaluru
78	2	Karadagodu	Mudigere	Chikkamagaluru
79	1	G Agrahara	Mudigere	Chikkamagaluru
80	2	Kogile	Mudigere	Chikkamagaluru
81	1	Gutti	Mudigere	Chikkamagaluru
82	1	Urubage	Mudigere	Chikkamagaluru
83	3	Hemmadi	Mudigere	Chikkamagaluru
84	1	Kalghatgi	Kalghatgi	Dharwad
85	1	Merched	Raichur	Raichur
86	1	Tellanur	Kollegal	Chamarajanagara
87	1	Chikkilur	Kollegal	Chamarajanagara
88	1	Bandalli	Hanur	Chamarajanagara
89	10	Kollegal	Kollegal	Chamarajanagara
90	1	Alagumole	Hanur	Chamarajanagara
91	3	Lakshmipura	Kollegal	Chamarajanagara
92	1	Thimmarajipura	Kollegal	Chamarajanagara
93	2	Hanur	Hanur	Chamarajanagara
94	1	Siragodu	Hanur	Chamarajanagara
95	11	Mahadeshwarabetta	Hanur	Chamarajanagara
96	1	Martalli	Hanur	Chamarajanagara
97	2	Suleri Palya	Hanur	Chamarajanagara
98	1	Kudalur	Chamarajanagar	Chamarajanagara
99	6	Chamarajanagar	Chamarajanagar	Chamarajanagara
100	16	Punajur	Chamarajanagar	Chamarajanagara
101	1	P G Palya	Hanur	Chamarajanagara
102	1	Arabigere 85	Hanur	Chamarajanagara
103	2	Manchahalli	Gundlupet	Chamarajanagara
104	1	Ayyanapura	Chamarajanagar	Chamarajanagara
105	2	Huthur	Hanur	Chamarajanagara

106	1	Haradanahalli	Chamarajanagar	Chamarajanagara
107	16	Hanur	Hanur	Chamarajanagara
108	1	Bedaguli	Chamarajanagar	Chamarajanagara
109	1	Gundlupet	Gundlupet	Chamarajanagara
110	4	Punajanur	Chamarajanagar	Chamarajanagara
111	1	Yanagumba	Chamarajanagar	Chamarajanagara
112	1	Kunagahalli	Gundlupet	Chamarajanagara
113	2	Maguvinahally	Gundlupet	Chamarajanagara
114	1	Hundipura	Gundlupet	Chamarajanagara
115	1	Maguvinahallimel Kamanahalli	Gundlupet	Chamarajanagara
116	1	Kebbepura	Gundlupet	Chamarajanagara
117	6	Bandipura	Gundlupet	Chamarajanagara
118	1	Yalapatti	Gundlupet	Chamarajanagara
119	2	Kaniyanapura	Gundlupet	Chamarajanagara
120	1	Lalankere	Nagamangala	Mandya
121	1	Nagamangala	Nagamangala	Mandya
122	1	Siddapura	Gundlupet	Chamarajanagara
123	1	K Bellur	Maddur	Mandya
124	2	Manchanahalli	Pandavapura	Mandya
125	1	Kandegala	Malavalli	Mandya
126	1	Bydarahalli	Malavalli	Mandya
127	1	Basavanabetta	Malavalli	Mandya
128	4	Malavalli	Malavalli	Mandya
129	1	Solaba	Malavalli	Mandya
130	1	Marehalli	Malavalli	Mandya
131	1	Dabbahalli	Malavalli	Mandya
132	1	Netkal	Malavalli	Mandya
133	1	Huskur	Saraguru	Mysuru
134	1	Beguru	Saraguru	Mysuru
135	1	Agasanahundi	Heggadadevan-kote	Mysuru
136	1	Hosahalli	Heggadadevan-kote	Mysuru
137	2	Rajegowdanahundi	Heggadadevan-kote	Mysuru
138	3	Metikuppe	Heggadadevan-kote	Mysuru
139	1	Chikkabeechanahalli	Hunsur	Mysuru

140	1	Doddabeechanahalli	Hunsur	Mysuru
141	5	Mysuru	Mysuru	Mysuru
142	2	Doddahejjur	Hunsur	Mysuru
143	2	Nanjangud	Nanjangud	Mysuru
144	1	Hommaragahalli	Heggadadevan-kote	Mysuru
145	1	Gowdimachanayaka-na Halli	Heggadadevan-kote	Mysuru
146	1	Bharathavadi	Hunsur	Mysuru
147	1	Kuttavadi	Hunsur	Mysuru
148	2	Yarahalli	Heggadadevan-kote	Mysuru
149	2	Bheemanahalli	Heggadadevan-kote	Mysuru
150	2	Kolavige	Hunsur	Mysuru
151	1	Kurubarahosahalli	Hunsur	Mysuru
152	3	Varanchi Or Gurupura	Hunsur	Mysuru
153	1	Naragyathanahalli	Tirumakudal Narsipur	Mysuru
154	1	Heggadadevankote Rural	Heggadadevan-kote	Mysuru
155	1	Dallalu	Hunsur	Mysuru
156	1	Hediyala	Nanjangud	Mysuru
157	1	Kellupura	Nanjangud	Mysuru
158	1	Kugalur	Nanjangud	Mysuru
159	1	Kadajetti	Nanjangud	Mysuru
160	3	Mullur	Saraguru	Mysuru
161	3	Halasur	Saraguru	Mysuru
162	1	Saragur	Saraguru	Mysuru
163	1	Kenchanahalli	Heggadadevan-kote	Mysuru
164	1	Anemala	Heggadadevan-kote	Mysuru
165	1	Antharasanthe	Heggadadevan-kote	Mysuru
166	1	Badaga	Saraguru	Mysuru
167	3	Seegevadi	Saraguru	Mysuru
168	1	Hegganur	Saraguru	Mysuru
169	9	Kakanakote	Heggadadevan-kote	Mysuru
170	1	Moleyurukaval	Saraguru	Mysuru
171	1	Kurnagala	Saraguru	Mysuru

172	7	Hunsur	Hunsur	Mysuru
173	1	Kuppekolagatta	Hunsur	Mysuru
174	5	Heggadadevankote	Heggadadevan-kote	Mysuru
175	1	Anechowkur	Piriyapatna	Mysuru
176	3	Bidagalu	Heggadadevan-kote	Mysuru
177	1	Akki Alur	Hangal	Haveri
178	1	Ghalapuji	Byadgi	Haveri
179	3	Neriya	Beltangadi	Dakshina Kannada
180	1	Malavanthige	Beltangadi	Dakshina Kannada
181	1	Puttur	Puttur	Dakshina Kannada
182	1	Kodimbala	Kadaba	Dakshina Kannada
183	2	Shirady	Kadaba	Dakshina Kannada
184	1	Ichlampady	Kadaba	Dakshina Kannada
185	2	Alanthaya	Kadaba	Dakshina Kannada
186	2	Aithoor	Kadaba	Dakshina Kannada
187	1	Noojibalthila	Kadaba	Dakshina Kannada
188	1	Renjilady	Kadaba	Dakshina Kannada
189	1	Sulya	Sulya	Dakshina Kannada
190	1	Kollamogru	Sulya	Dakshina Kannada
191	3	Mudravalli	Somvarpet	Kodagu
192	28	Choudlu	Somvarpet	Kodagu
193	1	Nerugalale	Somvarpet	Kodagu
194	2	Negalale Karkalli	Somvarpet	Kodagu
195	1	Garagandur	Somvarpet	Kodagu
196	1	Anekad	Kushalanagar	Kodagu
197	2	Bhagamandala	Madikeri	Kodagu
198	5	Kushalnagar	Kushalanagar	Kodagu
199	1	Basavana Halli	Kushalanagar	Kodagu

200	1	Made	Madikeri	Kodagu
201	1	Horur	Kushalanagar	Kodagu
202	9	Madikeri	Madikeri	Kodagu
203	1	Cherala Srimangala	Kushalanagar	Kodagu
204	1	Nanjarayapatna	Kushalanagar	Kodagu
205	10	Karadigodu	Virajpet	Kodagu
206	1	Hoskeri	Madikeri	Kodagu
207	3	Maldare	Virajpet	Kodagu
208	1	Nelliyahadikeri	Kushalanagar	Kodagu
209	1	Channayan Kote	Virajpet	Kodagu
210	1	Bethu	Madikeri	Kodagu
211	1	Guhya	Virajpet	Kodagu
212	6	Badagabanangala	Virajpet	Kodagu
213	2	Kunjila	Madikeri	Kodagu
214	3	Devamachi	Ponnampet	Kodagu
215	1	Blockcut From Jain-kalbetta	Somvarpet	Kodagu
216	1	Puliyeri	Virajpet	Kodagu
217	1	Kannangala	Virajpet	Kodagu
218	3	Mekur Hosakeri	Virajpet	Kodagu
219	1	Nariyandada	Madikeri	Kodagu
220	1	Ammathi	Virajpet	Kodagu
221	1	Yevakapadi	Madikeri	Kodagu
222	1	Arameri	Virajpet	Kodagu
223	2	Arekeri	Ponnampet	Kodagu
224	3	Hebbale	Ponnampet	Kodagu
225	1	Bettakeri	Virajpet	Kodagu
226	8	Nokya	Ponnampet	Kodagu
227	2	Kaikeri	Ponnampet	Kodagu
228	1	Hosoor	Virajpet	Kodagu
229	20	Virajpet	Virajpet	Kodagu
230	1	Kalathmadu	Virajpet	Kodagu
231	1	Mayamudi	Ponnampet	Kodagu
232	1	Kolatodu Bygodu	Ponnampet	Kodagu
233	1	Balele	Ponnampet	Kodagu
234	2	Hathugattu	Ponnampet	Kodagu
235	1	Begur	Ponnampet	Kodagu
236	4	Nalkeri	Ponnampet	Kodagu

237	1	T Shettigeri	Ponnampet	Kodagu
238	1	Nemmale East And West	Ponnampet	Kodagu
239	1	Kurchi	Ponnampet	Kodagu
240	1	Kutta	Ponnampet	Kodagu
241	1	Monnangeri	Madikeri	Kodagu
242	2	Galibeedu	Madikeri	Kodagu
243	1	Doddabandara	Somvarpet	Kodagu
244	1	Kundalli	Somvarpet	Kodagu
245	1	Gonimarur	Somvarpet	Kodagu
246	1	Thippur	Kanakapura	Ramanagara
247	2	Sathanur	Kanakapura	Ramanagara
248	1	Sasalapura	Kanakapura	Ramanagara
249	2	Achalu	Kanakapura	Ramanagara
250	1	Herandyappanahalli	Kanakapura	Ramanagara
251	1	Tigalarahosahalli	Kanakapura	Ramanagara
252	10	Kanakapura	Kanakapura	Ramanagara
253	1	Nayakanahalli	Kanakapura	Ramanagara
254	2	Cheelandavadi	Kanakapura	Ramanagara
255	1	Alahalli	Kanakapura	Ramanagara
256	1	Kolliganahalli	Harohalli	Ramanagara
257	1	Kerelallusandra	Kanakapura	Ramanagara
258	1	Virupakshipura	Channapatna	Ramanagara
259	1	Bannimukkodlu	Kanakapura	Ramanagara
260	1	Gattigunda	Kanakapura	Ramanagara
261	1	Narayanapura	Harohalli	Ramanagara
262	3	Sundagatta	Harohalli	Ramanagara
263	1	Honniganahalli	Kanakapura	Ramanagara
264	1	Mavathoor	Harohalli	Ramanagara
265	1	Kodipura	Channapatna	Ramanagara
266	1	Bijjahalli	Kanakapura	Ramanagara
267	1	Arakere	Kanakapura	Ramanagara
268	2	Baradanahalli	Kanakapura	Ramanagara
269	1	Gullahatti Kaval	Harohalli	Ramanagara
270	1	Bidadi CT	Ramanagara	Ramanagara
271	1	Kabbal	Kanakapura	Ramanagara
272	1	Archikarahalli	Ramanagara	Ramanagara
273	11	Chikkamannugudde	Channapatna	Ramanagara

274	1	Honniganahalli	Channapatna	Ramanagara
275	1	Donakuppe	Magadi	Ramanagara
276	1	Mallamgere	Channapatna	Ramanagara
277	2	Ramanagara	Ramanagara	Ramanagara
278	1	Kempanahalli	Ramanagara	Ramanagara
279	1	Thagachaguppe	Magadi	Ramanagara
280	2	Magadi	Magadi	Ramanagara
281	1	Gudemaranahalli	Magadi	Ramanagara
282	1	Bhantrakuppe	Magadi	Ramanagara
283	1	Aralagadakallu	Kanakapura	Ramanagara
284	1	Chamundipura	Kanakapura	Ramanagara
285	1	Hoolya	Kanakapura	Ramanagara
286	1	Hakkipikki	Ramanagara	Ramanagara
287	1	Kempegowdana Doddi	Kanakapura	Ramanagara
288	1	Anedoddi	Harohalli	Ramanagara
289	3	Kadushivanahalli	Harohalli	Ramanagara
290	1	Medanahalli	Kanakapura	Ramanagara
291	1	Mugguru	Kanakapura	Ramanagara
292	1	Mallapura	Kanakapura	Ramanagara
293	4	Bilikal	Harohalli	Ramanagara
294	1	Ramasandra	Kolar	Kolar
295	2	Balamande	Bangarapet	Kolar
296	1	Yelesandra	Bangarapet	Kolar
297	1	Kooteri	Kolar	Kolar
298	1	N G Hulkur	Kolar Gold Field	Kolar
299	5	Malur	Malur	Kolar
300	6	Kolar	Kolar	Kolar
301	3	Thamatamakanahalli	Bangarapet	Kolar
302	2	Bangarapet Tmc	Bangarapet	Kolar
303	1	Kodagurki	Bangarapet	Kolar
304	3	Bathlahalli	Bangarapet	Kolar
305	1	Sakarasanhalli	Bangarapet	Kolar
306	1	Kundarasanahalli	Bangarapet	Kolar
307	2	Doddapannandahalli	Bangarapet	Kolar
308	1	Polenahalli	Bangarapet	Kolar
309	1	Kammasandra	Kolar Gold Field	Kolar
310	1	Bennigundihalli	Arsikere	Hassan

311	1	Chikkabyadigere	Belur	Hassan
312	3	Belur	Belur	Hassan
313	1	Seegegudda Kaval	Hassan	Hassan
314	1	Madihalli	Belur	Hassan
315	1	Kogodu	Belur	Hassan
316	1	H Mylahalli	Hassan	Hassan
317	1	Kanaguppe	Belur	Hassan
318	1	Appenahalli	Channarayapatna	Hassan
319	1	Huskur	Belur	Hassan
320	1	Arehalli	Belur	Hassan
321	7	Hassan	Hassan	Hassan
322	1	Hanbal	Sakleshpur	Hassan
323	1	Heggadde	Belur	Hassan
324	1	Hebbanahalli	Sakleshpur	Hassan
325	1	Kelagalale	Sakleshpur	Hassan
326	11	Kasaba Alur	Alur	Hassan
327	2	Golagonde	Sakleshpur	Hassan
328	1	Kakanamane	Sakleshpur	Hassan
329	1	Matasagara	Sakleshpur	Hassan
330	1	Bage	Sakleshpur	Hassan
331	17	Sakleshpur	Sakleshpur	Hassan
332	1	Chikkanayakanahalli	Sakleshpur	Hassan
333	2	Kadumane Estate	Sakleshpur	Hassan
334	1	Rajendrapura	Sakleshpur	Hassan
335	1	Kiruhunse	Sakleshpur	Hassan
336	2	Sullakki	Sakleshpur	Hassan
337	2	Madagodu	Alur	Hassan
338	1	Honkaravalli	Alur	Hassan
339	2	Malagalale	Alur	Hassan
340	1	Hydur	Alur	Hassan
341	2	Byakaravalli	Sakleshpur	Hassan
342	3	Kadlur	Alur	Hassan
343	2	Aluvalli	Sakleshpur	Hassan
344	1	Sulagodu	Alur	Hassan
345	1	Adibylu	Alur	Hassan
346	1	Garighatta	Alur	Hassan
347	1	Kyathanahalli	Alur	Hassan

348	1	Garighatta	Arkalgud	Hassan
349	4	Arkalgud	Arkalgud	Hassan
350	1	Doddahalli	Hole Narsipur	Hassan
351	2	Sulagodu Somavara	Arkalgud	Hassan
352	4	Kerodi	Sakleshpur	Hassan
353	4	Yeslur	Sakleshpur	Hassan
354	2	Bagadalu	Arkalgud	Hassan
355	1	Banagere	Sakleshpur	Hassan
356	2	Tarigalale	Arkalgud	Hassan
357	1	Bettagalale	Arkalgud	Hassan
358	2	Kadanoor	Arkalgud	Hassan
359	1	Ranganathapura	Arsikere	Hassan


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