



# A Spatial and Socio-Ecological Analysis of Human–Panther Conflicts and Premature Mortality of Panthers in Rajsamand District of Rajasthan

Dr. Devendra Singh Chauhan<sup>1</sup>, Krishna Kanwar<sup>2</sup>

Assistant Professor, Department of Geography, MLS University, Udaipur (Rajasthan) India<sup>1</sup>

Masters' Student, Department of Geography, MLS University, Udaipur (Rajasthan) India<sup>2</sup>

**Abstract:** Human–wildlife conflict has emerged as a critical conservation challenge in human-dominated landscapes of India, particularly affecting large carnivores such as the Indian leopard (*Panthera pardus*). This study examines the patterns, causes, and spatial distribution of premature panther deaths and human–panther conflict in Rajsamand district, Rajasthan. Using a mixed-methods approach, the research integrates geospatial analysis, field surveys, and community-based interviews to identify conflict hotspots and underlying socio-ecological drivers. Secondary data on mortality incidents were analyzed alongside primary data collected from affected villages to assess the role of habitat fragmentation, prey depletion, and anthropogenic pressures.

The findings reveal that a significant proportion of panther deaths are linked to human activities, including retaliatory killings, road accidents, and accidental falls into open wells. Spatial analysis highlights clustering of conflict incidents near forest–agriculture interfaces and rapidly urbanizing zones. Community perceptions indicate a complex relationship characterized by fear, economic loss, and limited awareness of conservation measures.

The study underscores the need for integrated management strategies, including habitat restoration, securing open wells, strengthening compensation mechanisms, and enhancing community participation in conservation programs. By linking ecological patterns with human dimensions, the research contributes to a more nuanced understanding of coexistence challenges and offers practical recommendations for mitigating conflict and reducing premature mortality of panthers in Aravali landscape.

**Keywords:** Premature Mortality, Human–wildlife conflict, Socio-ecological drivers, Anthropogenic pressures.

## I. INTRODUCTION

Indian leopard (*Panthera pardus fusca*) is a top most predator in the semi-arid environment of Rajasthan, especially in rugged landscape of the Aravalli Range. The leopard as a versatile carnivore contributes a core role in controlling ecological balance through regulation of the population of ungulates and smaller mesopredators (Qureshi et al., 2024). In the Rajsamand district, which encompasses vital wildlife corridors like the Kumbhalgarh Wildlife Sanctuary and Todgrah Raoli Wildlife Sancturay. Panthers are solitary and territorial animals. Each adult usually lives alone and marks its territory using scent marks, scratches on trees, and urine to warn other leopards to stay away. They are mostly nocturnal, meaning they hunt and move mainly during the night to avoid human disturbance and extreme daytime heat. They are carnivorous, and are opportunistic hunters. They prey on animals such as Chital, Nilgai, Wild Boar, Indian Hare, and sometimes livestock when wild prey is scarce. In terms of reproduction, female leopards usually give birth to 2–3 cubs after a gestation period of about 90–105 days. The cubs stay with the mother for about 1.5 to 2 years, during which she teaches them hunting and survival skills.

All in all, lifestyle of panthers is marked by lone behaviour, nocturnal feeding habits, strong territorial instincts, and high adaptability to new habitats hence their survival in such areas as the Aravalli landscape. Nevertheless, this ecological balance is now under the risk as there is a frightening increase in the premature mortality of leopards. Premature mortality in these big cats is increasingly driven by anthropogenic pressures. While leopards are legally protected under Schedule I of the Wildlife (Protection) Act, 1972, they face persistent threats from illegal poaching for body parts, habitat fragmentation, and retaliatory killings resulting from human-wildlife conflict (WWF-India, 2011; Qureshi et al., 2024).

In regions like Rajsamand, where human settlements and livestock grazing areas closely overlap with leopard habitats, the frequency of "accidental" deaths—such as road kills on expanding highway networks and drownings in open agricultural wells—has surged (Chauhan et al., 2025). These deaths are "premature" as they occur well before the animal's natural lifespan, often removing reproductive adults and disrupting the social structure of local populations. The loss of these apex predators poses a significant risk to the ecology of Rajsamand. The removal of a top predator can trigger a "trophic cascade," leading to the overpopulation of herbivores which, in turn, causes overgrazing and the degradation of native flora (Borrego et al., 2018). Furthermore, the Aravalli hills in Rajsamand act as a crucial barrier against the eastward expansion of the Thar Desert; the degradation of this forest ecosystem, exacerbated by the loss of its primary guardian, the panther, could accelerate land degradation and threaten local water security (Foundation for Ecological Security, 2010). This paper examines the specific drivers of premature panther mortality in Rajsamand and evaluates the resulting ecological imbalances that threaten the region's environmental future.

## II. STUDY AREA

Rajsamand district is situated in the southern part of Rajasthan, spanning an area of 4,629.3 sq. km. Geographically, it is located between 24° 46' and 26° 01' North latitudes and 73° 28' and 74° 18' East longitudes. The district is characterized by a stark topographical divide: the western part is dominated by the rugged, ancient Aravalli Range, while the eastern section transitions into fertile plains (Kumari & Singh, 2024).

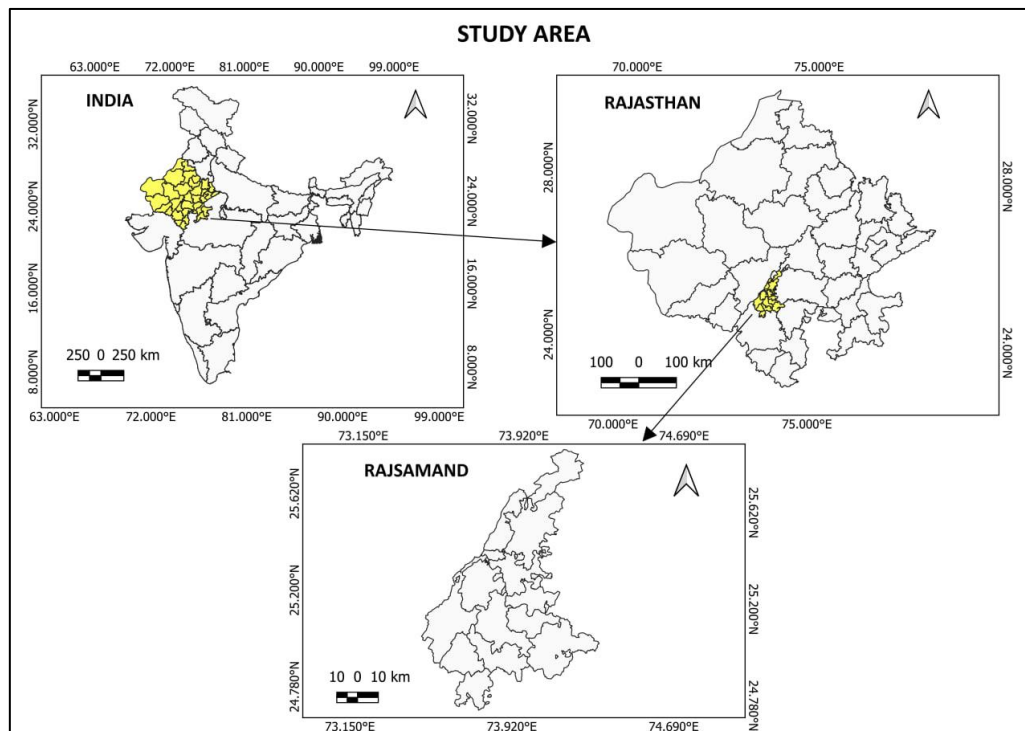


Figure 1

The general topographic elevation in the district is between 500 to 625 m above mean sea level. The Rajsamand District has a predominantly rural demographic structure with total population of 1,156,597, comprising 581,339 males and 575,258 females. The population density of the district is 302 persons per square kilometre, and the decadal population growth rate is 17.35 percent. About 84.1 percent of the population lives in rural areas, while 15.9 percent resides in urban areas, indicating that the district's economy and lifestyle are largely rural in character. The district was formed on 10 April 1991 by the Government of Rajasthan. Before its formation, the areas that now constitute Rajsamand district were parts of Udaipur District, Pali District, and Bhilwara District. Due to the Aravalli Range, the district of Rajsamand District has semi-arid environment and a hilly topography, which hosts various plants and animals that are characteristic of dry deciduous forests and thorn forests. The original flora is primarily dry deciduous trees, thorny bushes and seasonal grasses. Some tree species found are Dhonk (*Anogeissus pendula*) that is dominant in the Aravalli hills, Khejri (*Prosopis cineraria*), Babool (*Acacia nilotica*), Neem (*Azadirachta indica*) and Ber (*Ziziphus mauritiana*). In dry and rocky environments, different shrubs are also grown, like Capparis decreua (Ker) and Calotropis procera (Aak). The nearby forest areas that impact on wildlife of the district include Kumbhalgarh Wildlife Sanctuary and Todgarh Raoli Wildlife



Sanctuary. The popular mammals in the area include the Indian Leopard, Striped Hyena, Indian Wolf, Golden Jackal, Nilgai and Wild Boar. Smaller fauna like the Indian Hare and Indian Fox is also present. Rajsamand District has a semi-arid and subtropical climate with the influence of the Aravalli Range. The summers are extremely hot (March- June) and usually the temperatures reach more than 40°C. Southwest monsoon carries rainfall between June and September and the district has a rainfall of approximately 500-600 mm per year. Winters (November -February) are cool and favourable and occasionally reach about 8-10° C. The district is a key ecological belt in Western India. The Kumbhalgarh Wildlife Sanctuary (610.53 sq. km.) and the Todgarh-Raoli Wildlife Sanctuary (495.27 sq. km.) cover a large part of Rajsamand. The Zoological Survey of India states that 22 villages are located within the Kumbhalgarh Wildlife Sanctuary (Bohra, 2013). In addition, as a 2026 notification by the Ministry of Environment, Forest and Climate Change (MoEFCC) established 94 villages in the districts of Rajsamand, Pali and Udaipur, which are under the Eco Sensitive Zone (ESZ) of the sanctuary.

### III. METHODOLOGY

The study focuses on the secondary data which is mainly newspaper articles of Times of India, Dainik Bhaskar, NDTV Rajasthan, ETV Rajasthan etc. reports of Forest Department from a time period Spanning between 2021 to 2025 as shown in Figure 2. Detailed analysis has been done of all the incidents which affect panther and humans respectively with the help of mapping and visualization using QGIS.

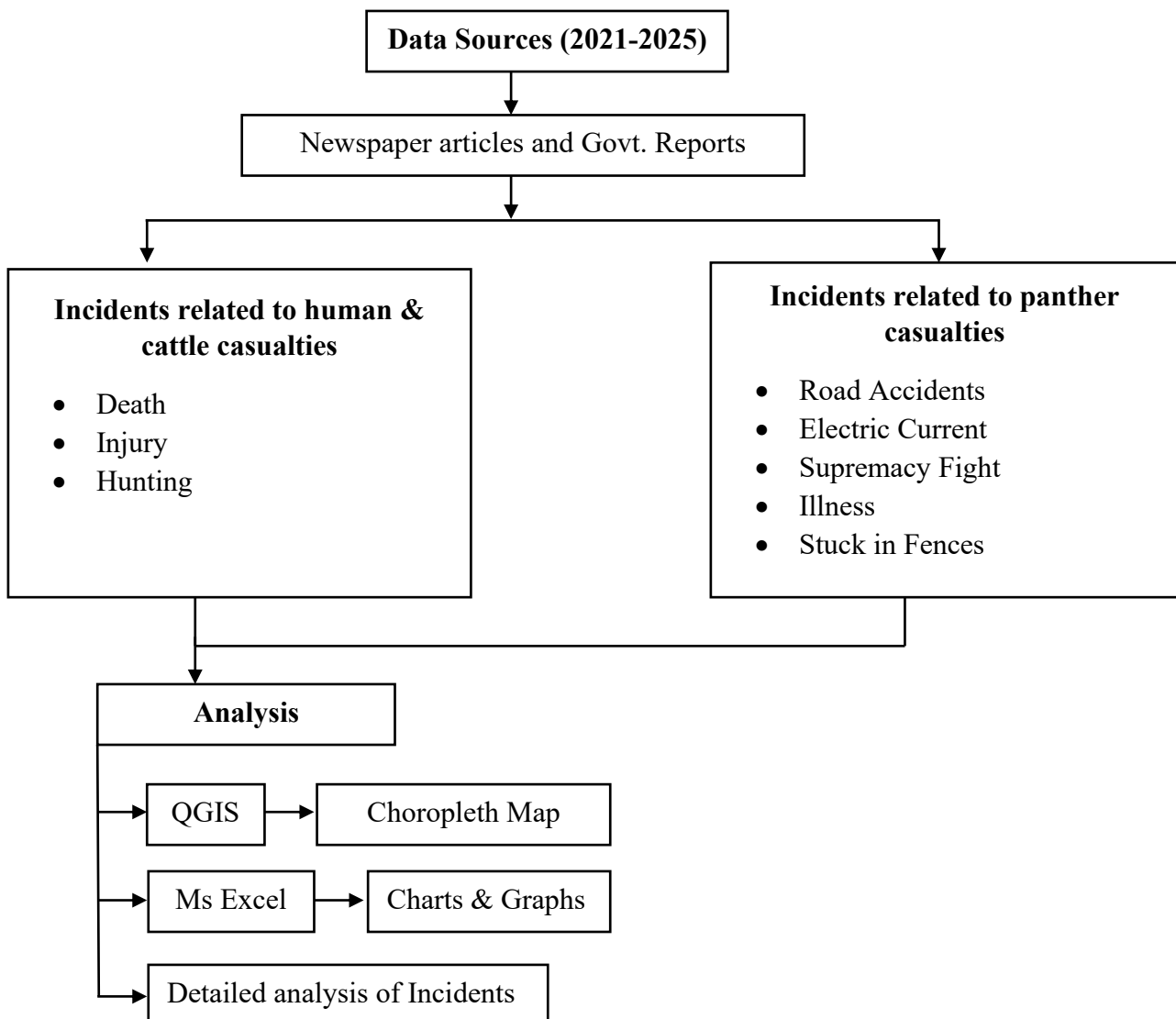


Figure 2. Methodology Chart



IV. RESULTS AND DISCUSSION

According to the findings of this study it can be noted that the Rajsamand district is in high intensity zone of human-panther conflict as shown in Figure3. Some tehsils such as Amet, Deograh, Kumbhalgarh and Nathdwara, belongs to the category of moderate intensity. These two categories have a high rate of contact primarily due to the fact that people and panthers are now living closer together than they were previously. Under third category of incidents intensity falls remaining tehsils like Bhim, Delwara, Garbhor, Khamnor, Kuwariya, Railmagra and Sardargarh. As a result of shrinkage of forests and increase in human activities, panthers have often been forced to migrate to villages and agricultural fields to seek food.

One of the most noticeable results is the high number of livestock losses, which directly affects the livelihood of rural families who are depend on cattle rearing. With this, there are human injuries and at times deaths, which instill fear and tension among the locals. Simultaneously, the fact that the number of panthers caught or spotted is very high indicates that these animals are repeatedly entering the human territory not by choice but as a result of the varying conditions in the environment.

The paper also indicates that certain threats such as electric wires, fencing and roads are accidentally damaging panthers, complicating the situation. On the whole, the conflict is a manifestation of a scenario in which people and wildlife are both trying to adapt. This is why it is important to find the solutions that will save the livelihoods of people and also enable the panthers to live peacefully in their natural habitat.

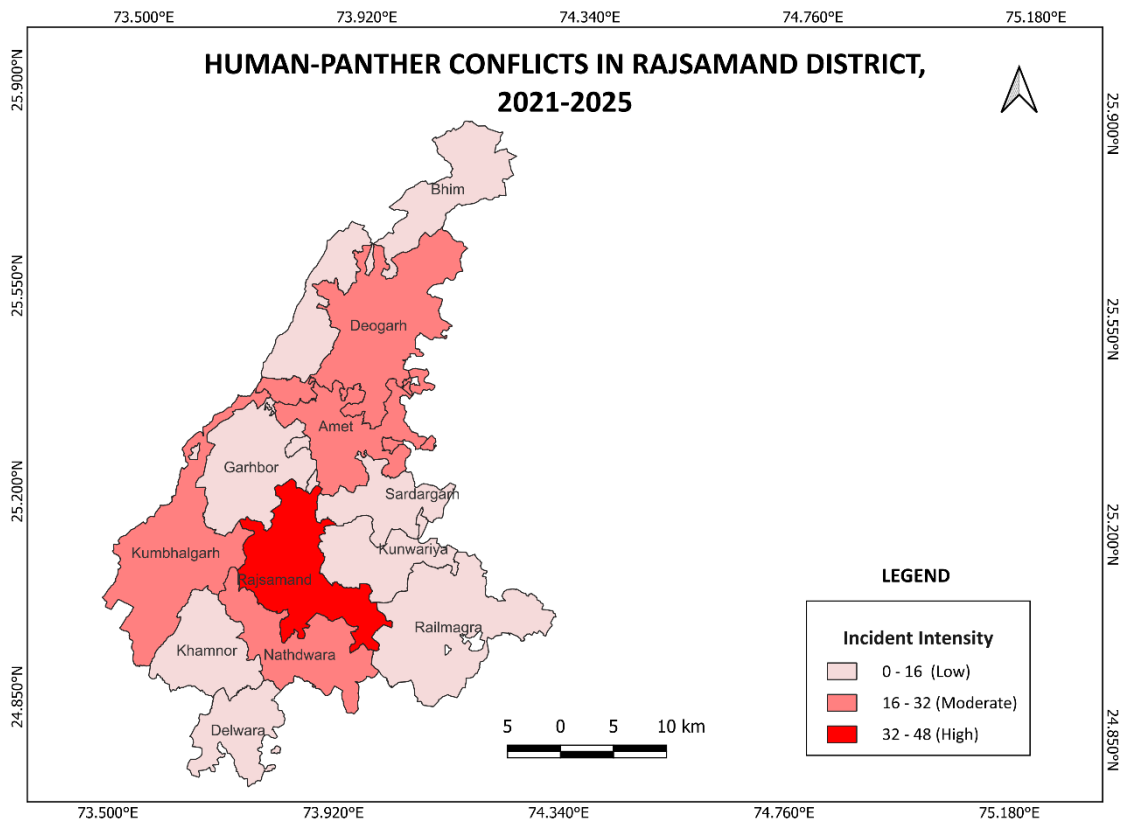


Figure 3.

**A. PANTHER RELATED INCIDENTS**

This section includes detailed analysis of all the incidents affecting Panther and its frequency tehsil wise. Various indicators have been used as follows:

- Death in Road Accident
- Death due to Electric Current
- Injured by Other Animals

- Death in Supremacy (Territorial) Fight
- Captured in Cage
- Rescued
- Death and injured due to Fencing
- Death due to Illness
- Panther Sighted

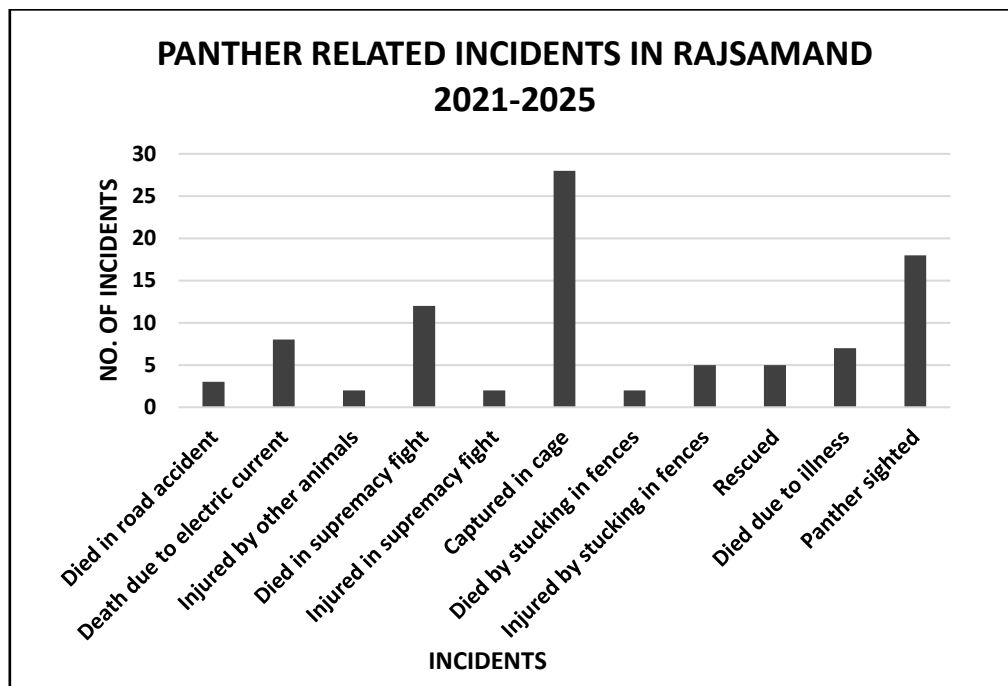


Figure 4.

**1. Death in Road Accident:**

The distribution of deaths that occurred due to road accidents shows a very low but spatially specific occurrence as in Figure 4, limited to Nathdwara (2 cases) and Rajsamand (1 case). The density in Nathdwara and Rajsamand implies that these tehsils have higher road-habitat intersection since transport routes are likely to intersect the movement paths of wildlife. The presence of Rajsamand also suggests that the infrastructure-related risks also influence even high-conflict areas. These are important events though limited in number because they point to the discontinuities of movement corridors and increasing effects of linear infrastructure on wildlife.

**2. Death due to Electric Current:**

This category as shown in Figure 4 is a uniform distribution across several tehsils-Rajsamand, Railmangra, Deogarh and Kuwariya (2 cases each) meaning that electrocution is not localized but a pervasive anthropogenic threat. They received electric shocks on their way to hunting prey on electric transformers. The smooth distribution indicates that use of electric fencing or exposed wiring is a widespread agricultural practice within the district. It is one of the most avoidable yet common causes of mortality due to its pattern of being systemic, reflecting lack of regulation, awareness and safe infrastructure.

**3. Injured by Other Animals:**

Injuries by other animals are limited as shown in Figure 4. to Amet and Kuwariya with 1 case each indicating very low level of natural interspecific conflict. This implies that ecological processes like predator competition or defense encounters is not a prevailing factor in determining panther vulnerability in the district. Rather, it strengthens the notion that the anthropogenic factors are more decisive in the conflict dynamics as compared to the natural causes.

**4. Death in Supremacy (Territorial) Fight:**

Deaths due to Supremacy fight reveals a clear spatial concentration with 5 cases in Khamnor coming out as the main hot spot followed by Kumbhalgarh with 2 cases and scattered cases in other tehsils. The fact that Khamnor is dominant shows that there is a strong intraspecific competition, probably because of a compressed habitat or a high population density. In

these cases panthers often found dead in fields. The presence of cases in multiple tehsils suggests that territorial conflict is a district-wide ecological phenomenon, but with localized intensity in certain areas.

#### ***5. Injured in Supremacy Fight:***

The injuries that occur due to the conflicts over the territory further highlight the extent of occurrence of intraspecific competition. Such injuries do not necessarily cause death but they can render individuals weak and more susceptible to illness, starvation or human conflict. This shows that there has been a constant form of ecological stress in the panther population, in which there is a high level of competition, which is intense and constant. Total 2 cases were noted in Rajsamand and Delwara tehsil.

#### ***6. Captured in Cage:***

The large number of panthers found in cages is the most dominant type and a good indicator of high human-panther interactions. These traps are also usually made when panthers move into human communities or when they are perceived to be a threat to humans and animals. This is an indication of habitat encroachment, inaccessibility of prey, and reliance on human-dominated landscapes. Although it also implies proactive intervention of forest authorities, at the same time, it means that conflicts are common and recurrent and not isolated. Figure4 (shown above) shows that 28 cases were distributed across virtually all tehsils including Rajsamand with 6 cases, Nathdwara, Amet, Deogarh, Kumbhalgarh and Delwara with 3 cases each.

#### ***7. Death due to Fencing:***

The number of deaths due to agricultural fencing is an example of the unforeseen consequences of unsafe agricultural practices. Electrified fencing and barbed wire are also hazardous to wildlife, particularly in the regions in the agricultural lands where panthers roam in search of their prey. Even though the number of cases is relatively low i.e. 2 only in Railmagra and Rajsamand, these incidences are significant because they constitute preventable causes of death, which are the results of human activities.

#### ***8. Injury due to Fencing:***

Fencing-related injuries are more common than fencing causes death, which means that such fences are an ongoing threat to panthers. By making movement and hunting more difficult, such injuries indirectly add to the reliance on livestock and increase conflict. This shows the importance of the adoption of wildlife friendly methods of fencing in order to minimize adverse interactions. These cases were recorded in Rajsamand, Devgarh and Kumbhalgarh.

#### ***9. Rescued:***

Rescue operations reflect the active role of forest management authorities in responding to conflict situations. Panthers are normally rescued when injured, trapped or when they are discovered in human-controlled zones. Although this is an indicator of effective intervention mechanisms, it also implies that distress situations are relatively frequent and therefore requires constant monitoring and prompt response systems. These kinds of cases recorded in Tehsil are Amet (2 cases) leading, Rajsamand, Kuwariya, and Sardargarh (1 each).

#### ***10. Death due to Illness:***

Deaths because of illness suggest underlying health problems in the panther population, which may be linked to environmental stress, malnutrition, or disease. These are instances of secondary influence of habitat degradation and ecological imbalance, whereby the dynamic environmental changes have a negative effect on the welfare and survival of wildlife. Deogarh (3 cases) and Rajsamand (2 cases), with minor cases in Kumbhalgarh and Nathdwara.

#### ***11. Panther Sighted:***

The frequent observation of panthers in and around human settlements denotes the augmented spatial interaction between human beings and wildlife. These sightings can be used in most cases as an early warning sign of possible conflict, and that panthers are either expanding their territory or are being forced into human-invasive regions by loss of habitat and scarcity of prey. This is an indication of a change in behavioral pattern and an increase in adaptability to the presence of human beings. Total 18 cases were reported in Rajsamand, Amet, Nathdwara, Bhim, Devgarh, Kumbhalgarh, Railmagra, Delwara, Kuwariya and Sardargarh.

### ***B. HUMAN-PANTHER INCIDENTS***

Rajsamand district has become a major district in human panther and mainly which affects humans in great extent. Here is the detailed analysis of incidents affected humans.

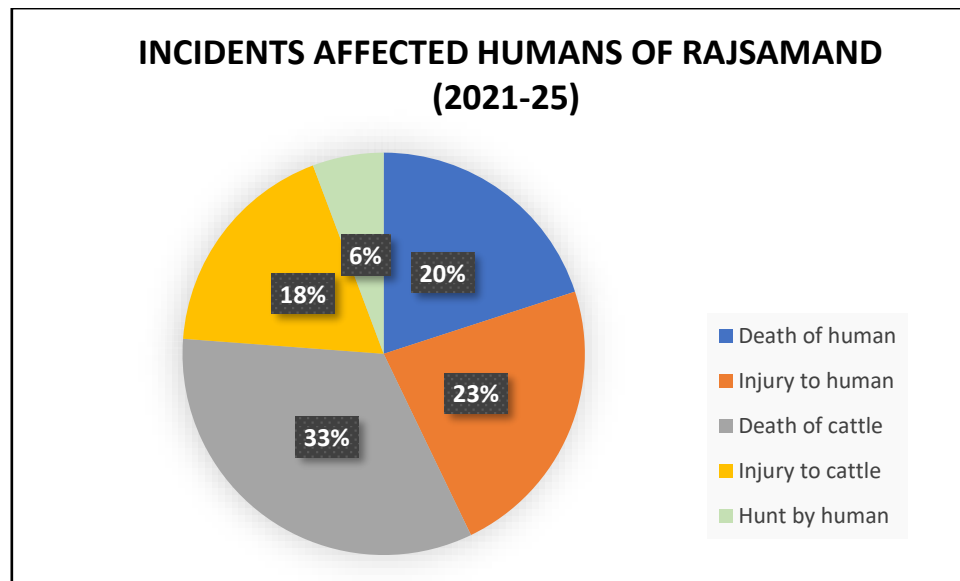


Figure. 5

### 1. Death of Human:

Cases of human death as shown in Figure 5 are the worst consequence of human-panther conflict. These incidences increase fear and negative perception by the local communities and this may culminate into demands that the animal should be removed or eliminated. These events indicate direct and threatening interactions, which point to the necessity of preventive and mitigation measures. Human fatalities are highest in Kumbhalgarh (7 cases) and Nathdwara (6 cases) then followed by Delwara and Rajsamand.

### 2. Injury to Human:

The number of human injuries is a little higher than that of fatalities, which means that they have to face them more frequently, but these encounters do not always lead to death. This implies more and more contact between the people and the panthers, usually as a result of the common use of space between agricultural fields and forest fringes when grazing cattles. These incidents highlight the recurring nature of conflict and the need for awareness and safety measures. Total 24 cases were registered with highest in Rajamand (9) followed by Devgarh(4), Nathdwara(3), Kumbhalgarh (2), Amet (2), Delwara(2), Bhim (1), Sardargarh(1) and Railmagra(1). In such instances humans suffered serious injuries on their head, hands and legs.

### 3. Death of Cattle:

The most frequent incidents are registered in the category of cattle deaths, which makes livestock depredation the main cause of the conflict. This shows that panthers are becoming increasingly dependent on domestic animals as a food source, probably because of a decreasing availability of natural prey and because livestock is readily available. This is not only leading to economic losses but also creating retaliatory behavior among the local communities. In this category total 35 incidents recorded with Amet (10) takes the first position followed by Rajsamand (10), Kumbhalgarh (5), Kuwariya and Devgarh (4), Bhim and Delwara (2), Railmagra, Devgrah and Garbhor (1).

### 4. Injury to Cattle:

Cattle injuries also solidify the trend of frequent livestock attacks. Such occurrences can be due to failed hunting missions or predator-disruption. Even though they are not as devastating as fatalities, they cause a considerable amount of economic damages and heighten tension between humans and wildlife. There were a total of 19 cases whereby Amet (5) was ranked first followed by Rajsamand and Deogarh (4), Kumbhalgrah, Bhim and Kuwariya (2) and Nathdwara, Delwara and Sardargarh (1) respectively.

### 5. Hunt by Human:

Cases of panthers being hunted by humans can be thought of as acts of retaliation or defense against conflict. These incidents, although less numerous, point to dissatisfaction of the community and low tolerance rates. This shows that compensation schemes, awareness programs and conflict mitigation strategies should be implemented to avoid escalation. Total 6 incident took place in Bhim (2), each in Delwara, Nathdwara, Railmagra, Rajsamand and Sardargarh.

V. DETAILED ANALYSIS OF TEHSIL-WISE DISTRIBUTION

The tehsil-wise distribution of the total incidents in Rajsamand district as shown in Figure6 gives a clear picture of the spatial intensity and concentration of human panther conflict and it can be seen that such human panther conflicts are highly localized and not evenly distributed across the district.

At the top, the tehsil of Rajsamand (46 incidents) still reigns supreme as the major conflict hot spot and this indicates that there is a high and sustained level of human/panther interaction. The fact that the incidents are concentrated in this tehsil indicates that there is a high level of spatial overlap which may be dictated by the high density of settlements, agricultural influence and patchy forest areas.

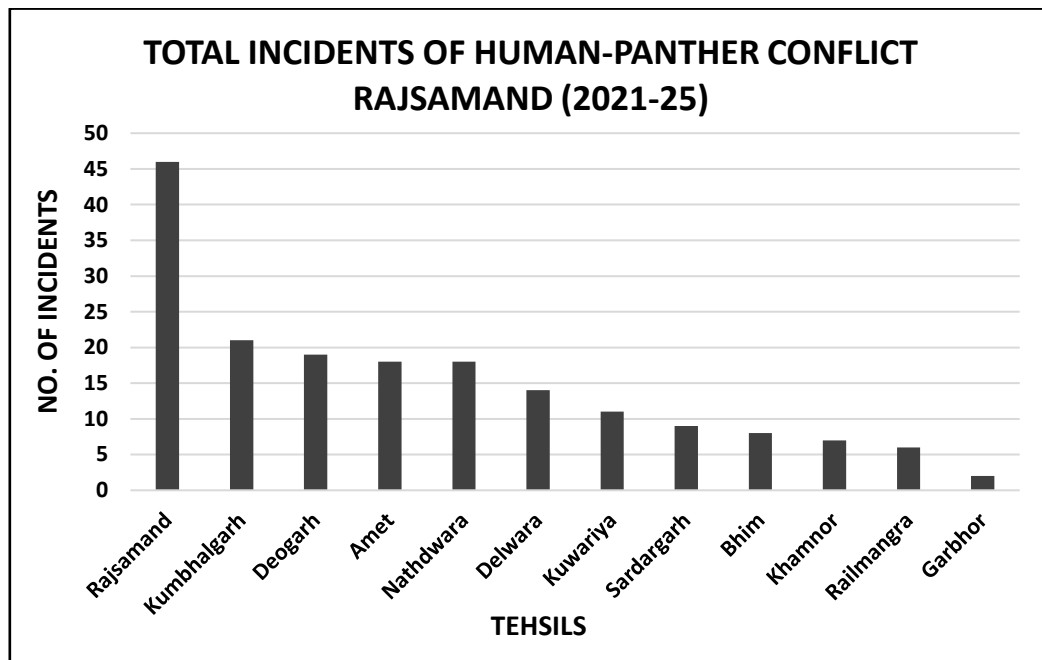


Figure 6.

At the second level we can see Kumbhalgarh (21 incidents) and Deogarh (19 incidents) that are large but relatively less intensive areas of conflict. The site of Kumbhalgarh is especially critical, since it is linked to forested and conserved landscapes, implying that being closer to core wildlife habitats is likely to increase the risk of conflict spill over into other human-populated regions. On the same note, Deogarh is a transitional environment, in which human land use overlaps the natural habitats, leading to moderate yet consistent incidences of conflict.

A third group comprises of Amet (18 incidences) and Nathdwara (18 incidences) which represent the same level of conflict. These tehsils seem to serve the purpose of buffer zones, in which movement of panthers within patches of their habitat as well as across into the areas where human habitation occurs is very common. The similarity in ranking implies that the socio-ecological conditions are similar, i.e., dependency on livestock and agricultural practices, as well as moderate proximity to forests, all of which lead to the recurring patterns of interactions.

Interestingly, the intensity of the conflicts in Delwara (14 incidents) show a noticeable increase in the intensity of conflicts compared with the previous observations, which implies that the previously low-conflict areas may emerge as new zones of interaction. This may be explained by the changing land-use trends, settlement growth or wildlife displacement, leading to a dynamic and evolving conflict landscape.

The intermediate to low conflict intensity areas represented by the mid-to-lower tier tehsils-Kuwariya (11), Sardargarh (9), and Bhim (8 incidents)-are quite representative of the regions with moderate and low conflict intensity. The interactions between these regions are probably sporadic, possibly because of reduced overlap of habitat, or reduced presence of wildlife. The fact that they are included in the dataset, though, indicates that conflict is not isolated in a handful of hotspots but is slowly spreading throughout the district.



More down the hierarchy, Khamnor (7 incidents) and Railmangra (6 incidents) have relatively low levels of conflict, suggesting that there is either better spatial dispersion between humans and wildlife or that there are fewer opportunities to interact. These regions might actually be relatively stable areas but might be vulnerable in the event of ecological or land-use alterations. Lastly, Garbhor (2 incidents) has the least number of cases, which means there is a lack of interaction. This could be indicative of a low panther density, the existence of effective natural barriers, or a low rate of reporting. One thing that comes out of this increased data is the development of a gradient pattern of conflict intensity, with high on one end (Rajsamand) and very low on the other (Garbhor) on the ends. This gradient is a combination of ecological factors (availability of habitats, prey base), and human factors (settlement density, agricultural activities, infrastructure). Further, the fact that other tehsils, like Delwara, Kuwariya, Sardargarh and Khamnor are also included in the tehsils list, shows that the human-panther conflict is not fixed but is spatially dynamic, with new areas gradually becoming part of the conflict landscape.

Conclusively, the tehsil-wise distribution shows that human-panther conflict in the Rajsamand district is multi-scalar in nature, evolving, and expanding geographically, which needs a tiered and spatially adaptive approach to management. Where core hotspots are critical and intense in nature, emerging and low-intensity areas demand preventive planning and monitoring to prevent future escalation.

## VI. CONCLUSION

The study clearly shows that human-panther conflict in Rajsamand district is not just about wildlife incidents, but about a shared struggle between people and nature. With the spread of human settlements and the decrease in natural habitats, panthers are moving into villages and farmland, which results in frequent encounters. To the local communities, it can mean loss of livestock, loss of lives, or being captured, to the panthers, it results in injuries, deaths, or capture. This scenario is indicative of an increasing imbalance wherein both parties are seeking to co-exist within the same arena. The results indicate that the issue cannot be resolved by addressing only one aspect of the problem. Instead, there is a need for practical and balanced solutions. Losses can be minimized by farmers through improved livestock protection strategies, including secure enclosures. Unnecessary harm to animals can be avoided by the use of safe and wildlife-friendly fencing and proper control of electric lines. Raising awareness amongst local people of the manner in which they should react in the event of an incident can also help in preventing panic and taking of risks. Meanwhile, conservation and rehabilitation of natural habitats can aid in retaining panthers in the forest.

## REFERENCES

- [1]. Borrego, A. Ozgul, & F. Courchamp, "Trophic cascades and ecosystem functioning: Impacts of apex predator loss", *Ecological Indicators*, vol. 93, pp. 116–123, 2018.
- [2]. N. Chauhan, R. Sharma, & P. Singh, "Anthropogenic causes of leopard mortality in Rajasthan: A regional assessment", *Journal of Wildlife Studies*, vol. 14(2), pp. 45–58, 2025.
- [3]. Foundation for Ecological Security, "Ecological restoration and desertification control in the Aravalli region", Anand, India: FES, 2010.
- [4]. S. Kumari, & R. Singh, "Topographical and environmental characteristics of Rajsamand district, Rajasthan", *Journal of Geographical Studies*, vol. 12(2), pp. 45–58, 2024.
- [5]. Q. Qureshi, P. Nigam, P. Basu, & Y. V. Jhala, "Status of leopards and human-leopard conflict in India", *Wildlife Institute of India Report*. Dehradun, India, 2024.
- [6]. World Wide Fund for Nature-India (WWF-India) "Status and conservation of leopards in India" New Delhi: WWF-India, 2011.
- [7]. Dainik Bhaskar, Various additions, (2021-2025).
- [8]. ETV Rajasthan, Various bulletins, (2021-2025).
- [9]. The Times of India, Various additions, (2021-2025).