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Tharandt, Germany

**Governing Tiger-Human Conflicts: Institutional Effectiveness and Actor
Adaptations in Wayanad, Kerala.**

Thesis submitted to the Institute of International Forestry and Forest Products
In partial fulfilment of the requirements for the award of Master of Science (MSc.)

Global Forestry

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Acknowledgements

I would like to express my sincere gratitude to my supervisor, Dr. Jude Ndzifon Kimengsi, for his guidance, constructive feedback, and continuous support throughout this research. Also, my second Supervisor Dr. Adarsh CK, for helping me with all the field-related information, ideas and suggestions. Their insights greatly strengthened the clarity, structure, and academic rigour of this thesis.

I am thankful to Technische Universität Dresden and the Institute of Tropical Forestry and Forest Products for providing the academic environment and resources needed to carry out this study. I am also entitled to extend my sincere gratitude to Erasmus Mundus Secretariat and the European Union for the opportunity of the Scholarship program, which made me complete my master's without any difficulties. I also extend my appreciation to my friends and peers for their valuable suggestions and encouragement.

This research would not have been possible without the support of the communities in Wayanad, especially the residents of Chekady and Channothukolly, who generously shared their time and experiences. I am deeply grateful to all respondents who participated in the household surveys, focus group discussions, and interviews. I also thank the officials of the Kerala Forest Department, representatives from local Panchayats, and members of NGOs and civil society organisations who contributed important perspectives and facilitated access during the fieldwork.

I would also like to acknowledge my field assistants and local facilitators for their help with teamwork, coordination, and data collection, and for making the fieldwork process smoother and more reliable.

Finally, I am deeply grateful to my family and friends for their patience, encouragement, and emotional support throughout this journey. Their faith in me helped me stay motivated and complete this work.

Dedication

I dedicate this thesis to my parents, Mr and Mrs Soly, whose unwavering support and commitment to my education have shaped my journey. Their belief in the value of learning and their constant encouragement have been my greatest motivation. Their sacrifices, patience, and guidance have given me the strength to persevere through every challenge so far. I am deeply grateful for the love and stability they have always provided, and for standing by me at every step of this educational process.

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Abstract

Human-wildlife conflict is a growing challenge for conservation and rural livelihoods, especially in biodiverse landscapes where settlements overlap with wildlife habitats. In India, Tiger-human conflict has intensified in forest-fringe regions such as Wayanad, Kerala, raising concerns about both ecological drivers and the effectiveness of local governance and adaptation. This study examines the governance of human-tiger conflict in Wayanad District, Kerala, focusing on institutional effectiveness and actor-level adaptations by the Forest Department, NGOs, political bodies, local and tribal communities, in line with three objectives: (SO1) conflict evolution, nature, severity, and drivers; (SO2) awareness and perceived effectiveness of formal and informal rules; and (SO3) actor adaptation strategies and how they shape coexistence perceptions. Drawing on the Institutional Analysis and Development (IAD) framework and a Socio-ecological Co-evolution perspective, the research explores how ecological pressures, institutional arrangements, and everyday responses interact over time. A mixed-method approach was employed in two conflict-prone wards, combining semi-structured household interviews ($n = 274$) with key informant interviews, focus group discussions, and field observations. Quantitative data were analysed using descriptive statistics and non-parametric tests, while qualitative insights were used to contextualise and interpret survey patterns. For SO1, findings indicate that conflict is perceived as increasingly severe, shaped by frequent tiger incursions, livestock depredation, and disrupted daily routines. Participants attributed conflict escalation to interacting ecological and land-use pressures (habitat degradation, invasive species, abandoned farmland, and edge permeability) alongside political-institutional constraints such as delayed compensation, limited preventive planning, and low transparency in decision-making. For SO2, the study shows a gap between rule awareness and rule usability; while formal measures are recognised, they are widely viewed as reactive and insufficient, and communities rely more on practical, informal “rules-in-use” for everyday safety. For SO3, the findings show that informal adaptation strategies (collective vigilance, avoidance of high-risk times and spaces, group travel, and neighbourhood alert systems) are the most trusted day-to-day responses, while formal responses (monitoring, capture/relocation, and compensation) remain central but are seen mainly as crisis management. Perceptions of coexistence were overwhelmingly negative, reflecting cumulative fear, livelihood vulnerability, psychological stress, and limited institutional trust. Overall, the study highlights the need to bridge institutional and community-led responses through proactive, participatory, and locally grounded coexistence strategies supported by transparent governance, timely compensation, and early-warning systems with equal importance in habitat restoration.

Keywords: Human-Wildlife Conflict (HWC), Tiger-human conflict, Institutional effectiveness, Formal and Informal Institutions, Actor adaptation strategies, Adaptive co-management, Coexistence

Chapter One: Introduction

1.1 Introduction to the chapter

This chapter presents a comprehensive background of the study on “Governing Tiger-Human Conflicts: Institutional Effectiveness and Actor Adaptations in Wayanad, Kerala.” It emphasises the growing significance of human-wildlife conflicts as a global conservation and livelihood concern, with a particular focus on tiger-human interactions in the Wayanad district, Kerala, India. Furthermore, the chapter provides a detailed statement of the research problem, underscoring the need to understand how institutions and different actors respond and adapt to recurring tiger-human conflicts in Wayanad. It also justifies the importance of this study by outlining the unique ecological and socio-economic context of the study region and the existing gaps in current research on institutional and actor-based approaches to conflict management. Finally, the chapter concludes by outlining the objectives of the study and the corresponding research questions that guide the investigation. Together, these components provide the conceptual and contextual foundation upon which the subsequent chapters are developed.

1.2 Background of the study

Human-wildlife conflict (HWC) has emerged as a critical conservation challenge, threatening biodiversity and human livelihoods globally. It is generally described as a tension that occurs between people and wildlife in situations where (1) human or animal actions can harm the other, (2) wildlife threatens human life, economic security, or recreation, and (3) people perceive wildlife as a danger to their safety, health, food, or property (Nyhus, 2016). These conflicts have been a persistent challenge since prehistoric times, evolving from early predation on humans to modern-day conflicts involving crop and livestock depredation, property damage, and human casualties (Anand & Radhakrishna, 2017). Alongside its long history, the increasing severity and complex nature of such conflicts have made them a central issue in wildlife management today.

HWC has worsened due to several factors, such as human population growth, urbanisation, industrialisation, land-use transformation, habitat loss, degradation and fragmentation, increasing livestock populations, expansion of ecotourism, and climate-related pressures (Distefano, 2005; Manfredo, 2009; Reshamwala et al., 2018; Acharya et al., 2016). Once seen as a rural issue affecting forest communities (Messmer, 2000), conflicts are now increasingly reported in peri-urban and urban areas as well, involving species that adapt well to human-dominated environments (Soulsbury & White, 2015).

Human-wildlife conflicts manifest in diverse forms across different regions of the world. From the African savannahs to Asian rainforests, clashes over resources have intensified. Predators like lions, tigers, and leopards cause livestock and human losses, mongooses and jackals prey on poultry, while elephants, primates, and other herbivores are known for crop raiding (Distefano, 2005; Seoraj-Pillai & Pillay, 2016; Barnes, 1996; Holmern & Røskoft, 2014; Carter et al., 2014). In South America, big cats such as jaguars are involved in livestock predation, while in North America, wolves and urban deer populations have created similar challenges (Ng et al., 2008; Sharma et al., 2021). In Asia, particularly in India, conflicts with large mammals like elephants, leopards, and tigers are most common. These conflicts disproportionately affect developing nations in the tropics, where 75% of global incidents occur, often impacting subsistence farming communities (Treves et al., 2003; Seoraj-Pillai & Pillay, 2016).

Asia experiences an intensified rate of HWC due to habitat disturbance, rapid urbanisation, and population growth. In Nepal's Chitwan National Park, for example, wildlife crop raiding caused damages exceeding \$0.8 million between 2012 and 2021, affecting nearly 38% of farmers (Sharma et al., 2021). Similarly, in Bhutan, 68% of households experience crop losses primarily due to elephants and wild boars (Yeshey et al., 2024), while in China, over 449 documented conflict cases involving Asiatic black bears and wild boars near protected areas have led to significant economic losses (Wu et al., 2024).

In India, the problem is particularly acute due to the country's dense human population and large numbers of tigers and elephants. Historically, India has coexisted with wildlife, but increasing deforestation and development have pushed many species closer to human settlements. In West Bengal, for example, 62 elephant deaths were recorded alone between 2004 and 2015 due to train collisions along forest corridors (Roy & Sukumar, 2017). In Himachal Pradesh, rapid infrastructure development has increased encounters with leopards and black bears (Bharti et al., 2025). Crop

raiding by elephants and livestock predation by tigers are widespread in the buffer zones of protected areas. Although compensation schemes exist, delays in processing and disbursing claims -only 44% resolved promptly, often heighten local resentment toward wildlife authorities (Roy & Sukumar, 2017).

Kerala, in southern India, is no exception. Almost all forest divisions in the state report cases of HWC, with particularly high incidence in its northern regions. The number of recorded human casualties and injuries increased from 796 in 2019-20 to 2,416 in 2020-21. Between 2021 and 2024, reported HWC cases rose from 7,966 to 8,873, including over 100 human deaths. The Kerala Forest Department spent Rs. 17.2 crore on human-animal conflict management during this period, including Rs. 10.49 crore as compensation for deaths, injuries, and damages to crops and livestock (State Planning Board, 2024). The Kerala government declared human-wildlife conflict a state-specific disaster to expedite aid and relief, including ex gratia payments to victims or their next of kin in case of fatalities (Balan, 2025), very recently. However, the escalating trend of conflicts reflects deeper governance and institutional challenges, highlighting the need for adaptive frameworks that integrate local participation, timely compensation, and transparent management systems.

Wayanad, a biodiversity hotspot within the Nilgiri Biosphere Reserve, exemplifies this complex interaction between conservation and development. The district supports a significant tiger population and functions as an important corridor linking the Nagarhole, Bandipur, and Mudumalai tiger habitats. However, factors such as habitat loss, depletion of prey, and cross-border animal movements have intensified tiger-human conflicts (Easa & Sankar, 2001). Despite its ecological importance, Wayanad receives limited funding for tiger conservation as it is not yet designated a tiger reserve, making mitigation and management more challenging. The rising frequency of tiger-human conflicts in Wayanad underscores the urgent need for effective governance mechanisms and adaptive management strategies. Strengthening institutional effectiveness, improving compensation systems, and enhancing community engagement are essential steps towards fostering coexistence between humans and tigers in this critical landscape.

1.3 Problem Statement and Justification of the Study

Wayanad district, situated within the Nilgiri Biosphere Reserve, has become the epicentre of human-wildlife conflict in Kerala (Sumitha & Shaharban, 2022). The district's strategic location as a vital corridor for tiger movement between adjacent protected areas makes it a key site for understanding the dynamics of tiger-human interactions. However, the persistence and intensification of these conflicts reveal that current management mechanisms have not been fully effective.

Although several initiatives have been implemented to address human-wildlife conflict in India, including compensation schemes and conservation programmes, the issue persists in Wayanad due to complex ecological, institutional, and social factors. Previous research has largely focused on ecological and economic dimensions, leaving a gap in understanding the institutional effectiveness and adaptive responses of different actors involved in conflict management. In particular, there is limited exploration of how formal and informal governance systems-laws, policies, norms, and local practices-interact to shape outcomes on the ground (Madhusudan & Mishra, 2003).

Furthermore, while tiger conservation initiatives have successfully increased tiger populations, the limited integration of community concerns and livelihoods into these efforts has exacerbated conflicts at the forest margins. Crop losses, livestock depredation, and human casualties have become recurring challenges, resulting in financial strain and psychological distress for residents (Barua et al., 2013). The absence of efficient, transparent, and responsive institutional mechanisms has contributed to growing mistrust between communities and the Forest Department (Haris, 2024). This mistrust between communities and the Forest Department blurs the line between people's fear of animals and their suspicion of the government. Thus, the core problem lies in the lack of a comprehensive understanding of how governance frameworks and actor-specific adaptations influence tiger-human conflict management in Wayanad. Without insights into these socio-institutional dynamics, conflict mitigation strategies risk remaining fragmented, reactive, and unsustainable.

Against this background, this study is justified by the urgent need to examine tiger-human conflict through the lens of governance effectiveness and actor adaptations in Wayanad, Kerala. The district's ecological significance and high incidence of conflicts make it an ideal case for

understanding how institutions and stakeholders respond to recurring conservation challenges. Existing research provides valuable ecological insights but often neglects the socio-institutional context that shapes conflict outcomes. There is a critical need for more localised and integrative studies that explore how different actors, such as the Forest Department, community members, NGOs, and policymakers, interact, adapt, and negotiate their roles within evolving conservation frameworks. Understanding these dynamics will help bridge the gap between policy intent and on-ground implementation.

Moreover, Wayanad's ongoing crisis reflects a broader governance dilemma faced globally, where conservation objectives must balance with socioeconomic realities. Investigating the institutional structures and actor behaviours that drive or mitigate conflict can provide lessons for other conflict-prone landscapes in India and beyond. By analysing the effectiveness of both formal and informal institutions, and how local actors adapt to policy and ecological pressures, this study aims to contribute to a more adaptive, participatory, and equitable governance framework for tiger conservation. The findings are expected to inform policymakers and conservation practitioners, improve institutional trust and transparency, and promote coexistence strategies that respect both human livelihoods and ecological integrity. In essence, this research is both timely and necessary—it seeks to fill a critical knowledge gap in understanding how institutional governance and actor-level adaptations can collectively foster sustainable coexistence between humans and tigers in Wayanad, Kerala.

1.4 Objectives and Research Questions

1.4.1 General Objective

To contribute to theoretical perspectives on the governance of human-wildlife conflicts through an actor-cum-institutional analysis of tiger-human conflicts in Wayanad, Kerala.

1.4.2 Specific Objectives and Research Questions

SO1. To examine the evolution, nature, and severity of tiger-human conflicts in Wayanad, focusing on the socio-cultural, economic, ecological, and political factors influencing them.

RQ1: How has the severity of tiger-human conflicts evolved over the past decade in Wayanad?

RQ2: What socio-cultural, economic, ecological, and political factors are perceived to contribute to tiger-human conflicts?

SO2. To assess the awareness and perceived effectiveness of formal and informal rules governing tiger-human conflict management.

RQ3: How aware are local communities of the formal and informal rules related to tiger-human conflict management?

RQ4: How effective are these formal and informal rules perceived to be, and how has their effectiveness changed over time?

SO3. To evaluate the adaptation strategies of different actors involved in tiger-human conflict management and their influence on community perceptions of coexistence.

RQ5: How do different actors (formal and informal) adapt to tiger-human conflicts, and how effective are these adaptation strategies?

RQ6: How do these actor adaptations influence community perceptions of coexistence with tigers?

1.4.3 Hypotheses

H₁: The perceived severity of tiger-human conflicts has significantly increased over the past decade.

H₂: Awareness of formal rules is positively associated with their perceived effectiveness in mitigating tiger-human conflicts.

H₃: Higher adoption of informal adaptation strategies is associated with more positive perceptions of coexistence with tigers.

Chapter 2: Literature Review

This chapter presents an extensive review of the literature on the concepts and theories, and evidence of human-wildlife (Tiger) conflicts. It begins with theoretical and conceptual perspectives on human-wildlife conflict, governance and institutions, actors' roles in conflict management, and the shift from conflict to the idea of coexistence, concluding with the two frameworks guiding this study-the Socio-Ecological Co-evolution and IAD frameworks.

It then examines the empirical evidence: global patterns of human-wildlife conflict, tiger-human conflicts in India, and studies specific to Kerala and Wayanad, followed by institutional responses, actor adaptations and approaches to coexistence. Thus, the review links theory with field evidence and highlights the gaps this research aims to address.

2.1. Theoretical and Conceptual Review

2.1.1 Understanding Human-Wildlife Conflict

Human-wildlife interactions have long been an integral part of human life, bringing both benefits and challenges as humans have been interacting with other species for resources and habitat since the dawn of humanity (Boivin et al., 2016). These interactions occur on every continent, in both developed and developing countries, but the nature of the problem can vary depending on the environment and people's livelihoods. The result of this interaction can vary widely, from positive to negative; its intensity can range from minor to severe, frequency from rare to common, depending on the region of occurrence (Nyhus, 2016). Over time, however, these interactions have also led to serious consequences, including the extinction of many species (Woodroffe et al., 2005; Hilton-Taylor & Brackett, 2000), disruption of ecosystem structure and functioning (Estes et al., 2011; Doherty et al., 2021), and caused a very high toll on human life, crops, livestock, and property damage across the world (Manral et al., 2016; Torres et al., 2018; Woodroffe et al. 2005).

These negative effects, commonly referred to as "Conflicts" or "Human-wildlife conflicts (HWC)," are a common feature of human society and can take place in various forms. Many scholars argue over the idea of "human-wildlife conflict" because it is not self-explanatory and is generally shaped by underlaid conflicts among human beings over conservation and utilisation of natural resources (Woodroffe et al., 2005; Madden, 2004; Peterson et al., 2010; Redpath et al., 2015). Adding to this complexity, human interactions with wildlife are generally described as problematic, the traditional definition often picturing animals as deliberately acting against humans (Peterson et al., 2010), even while they have a great deal

to provide by way of recreation, education, mental well-being, and fundamental ecosystem function (Soulsbury & White, 2015). The conceptualisation of what constitutes HWC has undergone a significant evolution, moving from a simplistic, narrow focus on direct interactions to a complex, multi-dimensional understanding.

The most straightforward and long-standing definition defines HWC as direct interactions between humans and wildlife that result in negative outcomes for one or both parties (Conover, 2001). Often, when we hear the term "human-wildlife conflict," we picture clear scenes of a tiger preying on village cattle, an elephant raiding crops, or a bear breaking into a suburban garbage can or even an angry farmer killing a tiger. As articulated by Woodroffe et al. (2005), HWC occurs when wildlife requirements overlap with those of human populations, creating costs both to residents and wild animals. These costs are often immediate and severe, like crop raiding, livestock depredation, property damage, and human injury or death (Distefano, 2005; Treves & Karanth, 2003). Under this lens, the conflict is a clear, two-sided battle, and in most cases, the animal itself is often perceived as the problem, and the primary and immediate management goals are to mitigate these direct losses. The solutions born from this perspective are usually reactive and direct, which is sometimes required for immediate safety, including lethal control, translocation of the problematic animals, and the installation of physical barriers like fences (Linnell et al., 2012; Treves, 2005). While this definition accurately describes the triggering events of conflict, it is constrained and fails to address the underlying human dimensions of conflict causes that lead to these interactions (Redpath et al., 2015; Marshall et al., 2007; White et al., 2009) often treating symptoms rather than the disease itself (Dickman, 2010; Peterson et al., 2010).

Then there was a more nuanced ecological perspective that defined HWC not as a deliberate antagonism, but as a competition between humans and wildlife for scarce resources. Thus, this definition shifts the focus from the animal as a causative agent to the ecological sphere of scarcity. HWC, in this view, is a struggle for space, food, water, and shelter, which is intensified by human encroachment into wildlife habitats, resulting in habitat loss and fragmentation of ecosystems (Madden, 2004; Nyhus, 2016; Distefano, 2005; Redpath et al., 2015; Woodroffe et al., 2005). This idea explains why there are conflicts, ie, a leopard or tiger kills livestock because of declining natural prey populations; elephants raid crops because their migratory corridors have been blocked by human infrastructures (Barua et al., 2013). This definition facilitates anticipatory, landscape-scale action. Management responses inspired by this view include restoration of habitats, creating alternative water sources external to human settlements, and defence of attractants like grain stores and garbage (King et al., 2017; Pooley et al., 2017). This was a critical step forward, as it redirected the focus from the individual animal to the

common ecosystem and resource base shared by humans and wildlife, which resulted in these negative results.

Later, the Contemporary Socio-Ecological view represented the most modern and holistic understanding of Human-Wildlife Conflict (HWC) as fundamentally a conflict among humans, manifested through disagreements over wildlife. It builds upon the ecological perspective by arguing that while the interaction is between humans and wildlife, the conflict itself is fundamentally among humans over how to manage, value, and live with wildlife. The negative interactions with animals are merely the triggers that expose deeper social conflicts over values, priorities, rights, and risk tolerance (Dickman, 2010; Madden & McQuinn, 2014). This perspective highlights that the real conflict lies between different human stakeholders: local communities who bear the costs of coexistence, government agencies mandated with protection, conservation NGOs with specific agendas, and the broader international community (Peterson et al., 2010). As Madden (2004) argues, these struggles are often "clashes between different human values and needs in relation to wildlife. A farmer demanding the killing of a problematic tiger and an urban activist advocating for its protection are not just in conflict with the tiger; instead, they conflict with each other's worldviews and livelihoods. Conflict is no longer just about material loss; instead, it is shaped by people's perceptions, attitudes, cultural beliefs, and their tolerance for wildlife, which is again influenced by past experiences, social norms, and trust in the responsible authorities. This definition demands a radical shift in management approaches. Solutions are no longer solely technical or ecological but must incorporate principles from social science, including conflict resolution, participatory decision-making, equitable benefit-sharing and the building of social tolerance (Dickman, 2010; Dickman, 2010; Pooley et al., 2017). Here, the ultimate goal shifts from mere mitigation to the promotion of sustainable coexistence, which requires addressing the root causes of social conflict (Frank, 2016).

2.1.2. Governance and Institutions in Conservation

Institutional dynamics are central to understanding the governance of human-wildlife conflict. Institutions are understood as the diverse sets of formal and informal "rules-in-use" that structure social interactions and decision-making around shared resources (Ostrom, 2009). This institutional landscape is multifaceted, encompassing not only structures like Forest Departments, traditional councils or village councils but also the processes like laws, customs, and taboos, with much of the scholarly focus often on the latter (Kimengsi et al., 2022), because these determine how people respond to wildlife and to conservation interventions.

These institutions are typically classified along a spectrum. A primary distinction is drawn between formal and informal institutions. Formal institutions are written laws and state regulations, for example, the Wildlife Protection Act (1972) of India or government-administered compensation schemes for livestock loss. They are valued for providing clarity, uniform standards across jurisdictions and the backing of the state's coercive power (Helmke & Levitsky, 2004). While Informal institutions, by contrast, consist of unwritten customs, social norms, religious beliefs and taboos that derive authority from community values and are enforced through social sanction rather than external legal coercion (Osei-Tutu et al., 2015; Yeboah-Assiamah et al., 2017). The relative efficacy of these two types of institutions has been a long-standing debate in conservation governance (Agrawal, 2001). Proponents of formal rules argue that the strength of formal institutions lies in their potential for standardised, enforceable frameworks over large areas. However, though their design is critical, poorly implemented policies like compensation can create perverse incentives that undermine conservation goals (Bulte & Rondeau, 2005; Yeboah-Assiamah et al., 2017). Advocates of informal rules argue that mechanisms like social taboos, norms, etc, can be more legitimate, cost-effective, and sustainable conservation tools. According to them, the top-down rules frequently fail as they lack local legitimacy or disregard context-specific realities, whereas norms embedded in community life are more sustainable because they align with local values and practices (Colding & Folke, 2001; Osei-Tutu et al., 2015; Berkes, 2007). According to them, the top-down rules would frequently fail as they lack local legitimacy or disregard context-specific realities, whereas norms embedded in community life are more sustainable because they align with local values and practices (Berkes, 2007).

Conversely, in practice, formal and informal institutions rarely operate in isolation. Helmke and Levitsky (2004) describe how they may be **complementary** (for example, when state law recognises traditional hunting taboos), **accommodating** (informal norms filling gaps in formal rules), **competitive** (formal laws undermining local authority) or **substitutive** (informal arrangements replacing weak formal enforcement). Informal rules can also be “corrosive” at times, undermining formal conservation goals, such as when entrenched norms supporting retributive killing of wildlife persist despite legal prohibitions (Treves, 2006). This dynamic interplay underscores that the governance of human-wildlife conflict cannot be understood through a simple binary of formal versus informal systems.

This interplay is further complicated by the presence of quasi-formal institutions; institutions that operate under legal rules but were developed by the community itself to help manage forest resources in their area (Akamani et al., 2015; Lund and Saito-Jensen, 2013; Senganimalunje et al., 2016; Kimengsi et al., 2022). Further categorisation is based on the origin: a) Endogenous institutions, which develop naturally

within a society, such as traditional customs and informal rules, while Exogenous institutions are introduced from outside, like government-imposed regulations (Fleetwood, 2008a, 2008b). Institutions may also be categorised based on their durability as: 1) ephemeral-meaning they are short-term agreements made to help manage forest resources and reduce conflicts; 2) partially enduring, where these agreements last for some time but fade away when new people take charge (Kimengsi & Balgah, 2021) and 3) Enduring institutions which are either officially written into laws or deeply rooted in customs and traditions that continue for generations (Ostrom, 1990).

In the management of the human-wildlife conflicts, these institutional arrangements set the rules for land and resource usage (Kimengsi et al., 2022). However, their effectiveness depends not simply on their existence but on the quality of enforcement and governance - the interaction of structures, processes and traditions that determine how authority and power are exercised (Lockwood, 2010). Weak enforcement or poorly designed rules can allow minor tensions to escalate into open disputes (Yusran et al., 2017; Sahide et al., 2021). As Redpath et al. (2013) emphasise, most human-wildlife conflicts are ultimately conservation conflicts, manifesting as clashes between stakeholders with competing interests. Within this arena, powerful actors leverage coercion, incentives, and information to influence policy, often leading to conflicts over land use near protected areas (Krott et al., 2014; Kimengsi et al., 2023).

Achieving good governance in this context requires more than simply having rules in place. There should be governance structures that uphold the principles of legitimacy, transparency, and inclusivity, which are necessary to build trust and achieve fair outcomes (Lockwood, 2010). Moreover, resolving multi-scale conflicts would frequently require a polycentric or multi-level governance approach that devolves decision-making to the lowest appropriate level while maintaining vertical linkages to regional and national authorities (Berkes, 2007; Borrini et al., 2013). This often necessitates the need for adaptive governance approaches that encourage social learning and allow institutions to evolve based on emerging ecological and social feedback (Folke et al., 2005). Consequently, communities often respond to these dynamics by adjusting their livelihoods, changing their farming or livestock protection practices, underlining the need for flexible, multi-level institutional arrangements that can support long-term coexistence (Kimengsi et al., 2023). Effective conflict management must therefore go beyond a simple preservation-use dichotomy (Treves & Karanth, 2003). It must engage with the complex interplay of institutional diversity, power relations and adaptations, and the crafting of context-specific solutions that are attentive both to ecological imperatives and to the intricate social fabric of conflict.

2.1.3 Actors and Adaptations in Conflict Management

An actor-centred approach is also essential for understanding the complex governance of human-wildlife conflict, as it shifts the focus beyond institutions to the roles, interests, power, and agency of the stakeholders involved. An actor can be defined as any entity that has a distinct interest and the possibility of influencing a policy (Schusser et al., 2016). Within the human-wildlife conflict scenario, the actors involved may vary according to the context in which people and wildlife interact; actors operate at multiple scales-global, national, regional and local and can be distinguished between formal actors, i.e., government departments and statutory agencies, and informal actors, e.g., local leaders, customary institutions and community groups (Krott et al., 2014; Schusser et al., 2016). Conflict management, therefore, emerges not necessarily as a passive outcome of institutional structures and processes, but is actively shaped by the interactions of multiple actors, including state agencies, local communities, Non-Governmental Organisations (NGOs), and politicians (Krott et al., 2014).

2.1.3.1 Top-down and community-based solutions

One of the largest conceptual debates surrounding conservation governance is the tension between top-down, state-initiated intervention and community-led approaches. State leadership advocates think that states must be the primary leaders in conflict management, as they hold the legitimate authority, financial resources, and technical capacity to implement large-scale policies, enforce laws, and administer compensation schemes (Treves & Bruskotter, 2014). Some of the studies have addressed the expert authority" or "top-down" approach as typically commended for their ability to yield rapid, concerted responses to crises, e.g., selective culling of conflict wildlife, imposing conservation legislation or providing immediate compensation for livestock loss (Schell et al., 2021; McCulloch-Jones et al., 2021). Evidence from Europe and North America shows that large carnivore population recovery has largely been facilitated by effective legal provisions and their enforcement at the state level, rather than local community initiatives alone (Chapron et al., 2014). In most Asian contexts, well-managed government compensation schemes have reduced retaliatory killings by paying immediate economic losses (Treves et al., 2009). However, in most cases, this top-down success is measured almost exclusively in ecological terms, i.e., population growth and geographic range expansion, rather than its social sustainability, which is more contentious. Comprehensive reviews caution that this success is often achieved at a cost, as such centralised programs are frequently plagued by challenges like financial unsustainability, moral hazard, and a failure to address underlying conflict drivers. Bulte and Rondeau (2005) noted that poorly designed compensation schemes can create dependency, delays, and resentment, while Nyhus et al. (2003) argue

they may even worsen conflicts by encouraging risky behaviour. Similarly, a study by Mishra et al. (2003) also showed that top-down economic incentive programs are fragile and unlikely to succeed on their own. While they can be a useful tool to demonstrate goodwill and share costs, they are still plagued by practical problems. Scholars from a political ecology perspective caution that state-conservation can serve to consolidate government authority over land and resources and push aside local livelihoods and knowledge, generating new socio-political tensions while resolving some of the ecological problems (Goldman, 2003). Thus, while top-down approaches can be powerfully effective for achieving immediate conservation targets and crisis management, their long-term sustainability and social legitimacy are often contested.

State-conservation failures gave rise to Community-based conservation (CBC), which seeks to advance devolved power, grassroots participation and integrating conservation with rural development. However, it is very rare to find studies that argue for a purely community-led approach with no role for external support. While CBC emerged as a response to the failures of top-down conservation, it has encountered severe limitations: insufficient devolution of power, weak local institutions, lack of financial sustainability, and conflicts between local livelihood needs and conservation goals (Berkes, 2004, 2007; Agrawal and Ribot, 1999; Songorwa, 1999), for example, illustrated how in the majority of Tanzania, community-based wildlife management did not translate into meaningful participation or equitable compensation of the local communities. There are also instances where these programmes often fail to achieve their goals when responsibility is decentralised but power and resources remain centralised, leading to poor outcomes for both people and wildlife (Nelson and Agrawal, 2008). Such experiences indicate that Community-based conservation is not a failure, but it needs to be rethought as a more dynamic, adaptive, and multi-level governance system fostering partnerships, knowledge exchange, and resilience, rather than a one-size-fits-all model focused only on the local level (Berkes, 2007)

2.1.3.2 NGOs, political actors and power relations

Beyond the state-community dichotomy, NGOs take on crucial roles as mediators, facilitators and agenda-setters. They seek to bridge the space between local people and government institutions through the provision of technical expertise, research, mobilisation of funding, and debate forums (Lewis, 2004; Treves et al., 2006). As an external actor, or often called a third party, an NGO can play a valuable role in situations where there is existing mistrust between local communities and wildlife managers. Meanwhile, they must take care not to appear biased toward government authorities instead of supporting the local communities (Treves et al., 2006). Sub-Saharan African studies, however, warn that international donors and NGOs sometimes overburden the conservation agenda, prioritising

international objectives at the expense of local needs and even creating dependency or exclusion on occasion (Brockington & Scholfield, 2010). It is also argued by scholars such as Büscher (2010) and Holmes (2011) that the majority of international conservation activities are shaped by a few NGO leaders, government and donors whose ability to guide policies may not always be sensitive to the priorities at local levels.

To date, the majority of research and advocacy addressing HWC has largely neglected attention to the political-economic forces behind it (Büscher & Fletcher, 2020). Yet, a closer look at these dynamics reveals that the role of political actors is also ambiguous. Political institutions may mobilise resources and legitimacy for conservation but also impose their interventions on the basis of short-term electoral imperatives, leading to the politicisation of conflict-management decisions. Political agendas determine which areas are highlighted to be conserved, how resources are allocated and whose interests are perpetuated, sometimes at the cost of relocating populations or heightening conflict over land use (Jepson & Whittaker, 2002; Rangarajan & Shahabuddin, 2006). As Büscher (2010) points out in the context of trans-frontier conservation in southern Africa, such programs can be presented as collaborative but actually consolidate governments' and donors' power at the cost of local people.

2.1.3.3 Concepts of actor adaptation

Actors involved in human-wildlife conflict rarely remain static; they adapt their approach in reaction to changing ecological pressures, institutional arrangements and social relationships. This adaptive capacity is highlighted in the adaptive governance literature, which stresses the need for institutions and stakeholders to adjust rules and practices in response to feedback and uncertainty (Folke et al., 2005; Olsson et al., 2004). Within the socio-ecological systems theory, such adaptations are seen as part of a co-evolutionary process where human activities and ecological changes influence each other over time (Berkes & Folke, 1998; Pretzsch et al., 2014). At the household scale, the livelihood-adaptation framework describes how rural communities respond to wildlife damage by altering their cropping choices, livestock management or diversifying incomes to reduce risk (Scoones, 1998; Ellis, 2000). These perspectives underline that adaptation is shaped both by local agency and by the institutional settings that enable or constrain innovation - an insight central to analysing the evolving responses of state agencies, communities and NGOs to tiger-human conflict in Wayanad.

2.1.4 From Conflict to Coexistence

The paradigm for managing human-wildlife interactions is undergoing a profound shift, moving away from a reactive focus on conflict mitigation and towards a proactive goal of fostering sustainable coexistence through co-adaptation. This conceptual transition reframes the issue from a binary struggle between humans and wildlife to a complex socio-ecological challenge of sharing landscapes (Carter & Linnell, 2016). Recent scholarship emphasises that coexistence is best understood as a continuum of outcomes rather than the simple absence of conflict; Carter & Linnell (2023) identify outcomes ranging from eradication to mutual co-benefit that help map where a landscape sits along the conflict-coexistence spectrum. Similarly, Ferraz et al. (2025) propose classifying human-wildlife interactions by their type and effect as positive, neutral, or negative to enable more precise interventions.

Coexistence is not the mere absence of conflict but is more accurately defined as a dynamic but sustainable state wherein humans and wildlife co-adapt to living in shared ecosystems, and where unacceptably damaging interactions, tensions and trade-offs are managed so that they remain the exception rather than the rule (Pooley et al., 2021). Coexistence depends on reciprocal adaptations rather than simply separating people and carnivores through protected areas. For example, carnivores may adapt their movement or hunting patterns in human-dominated landscapes, while people can modify their behaviour, institutions and tolerance levels to support a functional coexistence (Carter & Linnell, 2016). As Green et al. (2024) argue, durable coexistence depends as much on relational connections and trust among communities, managers and researchers as on technical measures such as fences or compensation. Similarly, Gross et al. (2021) describe coexistence as a dynamic state in which the interests and needs of both humans and wildlife are generally met.

In conservation debates, two contrasting views dominate discussions of human-wildlife interactions. One sees conflict as inevitable, especially for wide-ranging and dangerous species like tigers; a certain degree of conflict is an inevitable and persistent outcome of shared space and finite resources (Dickman, 2010; Madhusudan & Mishra, 2003; Redpath et al., 2013). Proponents of this view argue that management must therefore focus on continuous containment by minimising the frequency and severity of conflicts through compensation, deterrents, and, when necessary, fencing, relocation, or other control measures (Dickman, 2010; Redpath et al., 2013), rather than on eradicating conflict.

By contrast, a growing body of scholarship challenges this deterministic view, conceptualising coexistence as both possible and necessary if the right social, economic and institutional conditions are

in place (Carter & Linnell, 2016; Pooley et al., 2021; Frank, 2016; Bhatia et al., 2020). Conservation efforts must also increase tolerance by addressing perceptions, values, and social norms (Treves & Bruskotter, 2014), not just reducing damages. Instead of viewing conflict as inevitable, they stress the importance of understanding the social and psychological drivers of tolerance, such as trust in institutions, fairness, and perceived risks and benefits. These scholars point out that with the correct social, economic, and institutional conditions, including equitable benefit-sharing and the cultivation of tolerance towards wildlife, coexistence is a viable, though challenging, objective (Frank, 2016; Bhatia et al., 2020). This debate is highly relevant to the context of tiger-human conflict in Kerala, where high human density, fragmented habitats and thriving tiger populations make encounters likely. The key question is whether such encounters are treated as an unavoidable hazard or addressed as opportunities to build tolerance and adapt together.

Effective strategies, therefore, need to be multifaceted - combining ecological interventions, economic tools, and social processes that build trust, integrate local knowledge and empower communities (Dickman, 2010; Mishra et al., 2003). Ultimately, the pathway from conflict to coexistence is negotiated through context-specific, adaptive approaches that recognise the agency of all stakeholders in shaping a shared vision for landscapes where both humans and tigers can thrive (König et al., 2020; Peterson et al., 2010).

2.1.5 Theoretical Frameworks Adopted for the Study

This study integrates two complementary theoretical frameworks-the **Socio-Ecological Co-evolution Framework** and the **Institutional Analysis and Development (IAD) Framework**-to investigate the governance of tiger-human conflicts in Wayanad, Kerala. This integrated approach offers a multidimensional and interdisciplinary lens for understanding the complexity of human-wildlife conflict, examining how ecological transformations, institutional effectiveness, and actor adaptations interact over time.

The conceptual model is designed around the study's three core objectives:

1. Understanding the ecology (refers to the complex interplay of ecological, socio-cultural, economic, and political factors that shape the patterns, severity, and evolution of tiger-human interactions in Wayanad) of conflicts.
2. Assessing institutional effectiveness, and

3. Analysing actor adaptations to examine how ecological changes, institutional arrangements, and actor-level strategies collectively shape the dynamics of tiger-human conflict and shape co-existence attitudes. In this study, institutions are viewed as both structures (organisations, groups, or systems that manage forests, such as the State Forest Department, local bodies, and NGOs) and processes (rules, norms, traditions, and laws that guide forest management) (Fleetwood, 2008a, 2008b).

2.1.5.1 Socio-Ecological Co-evolution Framework

The Socio-Ecological Co-evolution Framework emphasises that institutional changes can trigger the co-evolution of both ecological and social systems (Pretzsch et al., 2014; Kimengsi et al., 2022; Kimengsi et al., 2023). In simpler terms, the framework illustrates how people's needs and decisions are influenced by institutions, and how, in turn, these behaviours influence ecological outcomes, particularly in socio-ecological interfaces like forests. In the context of tiger-human conflicts, the framework allows for an analysis of how institutions, both formal (laws and policies) and informal (beliefs, customs, and taboos), function and affect the intensity and nature of interactions between humans and wildlife and how these, in turn, shape actor-specific adaptations. By assessing the effectiveness of these institutions in mitigating conflicts or making them latent (hidden) (Yusran et al, 2017), the study can explore whether sustainable adaptation strategies exist (or not) and how these governance mechanisms contribute to coexistence. The framework's co-evolutionary perspective aligns with the study's objective (SO1), understanding the evolution, nature, and severity of conflicts, and with hypotheses H₁ and H₂, which examine conflict trends and causal factors. It also supports SO3 by framing actor responses as adaptive elements within the broader socio-ecological change. This approach thus offers a holistic foundation for analysing the dynamic feedback loops between ecological change, human behaviour, and institutional adaptation. It could be used to check whether institutional rigidity or inefficacy leads to latent conflicts or ineffective adaptation strategies.

2.1.5.2 Institutional Analysis and Development (IAD) Framework

The Institutional Analysis and Development (IAD) Framework, which was originally developed by Elinor Ostrom and her collaborators, provides a robust structure to analyse how institutions operate across different levels of governance and how these influence decision-making, conflict management, and adaptation strategies (Ostrom, 2009; Cole et al., 2019; Madhusudan & Mishra, 2003). The framework breaks down institutions into three levels: operational rules (day-to-day practices), collective-choice rules (decisions about how rules are made), and constitutional rules (higher-level legal

or constitutional structures). In the Wayanad context, this framework is instrumental in deconstructing the governance landscape of tiger-human conflict by identifying the roles and effectiveness of various actors such as the State Forest Department, local communities, NGOs, and political actors within these institutional layers.

The IAD framework supports Specific Objective 2 (SO2) and hypotheses H₂ and H₃ by guiding the assessment of rule awareness, compliance, perceived effectiveness, and change in effectiveness over time. It helps examine how formal and informal institutional arrangements interact, where governance gaps exist, and how institutional design shapes both conflict outcomes and perceptions of effectiveness. In complementing the Socio-Ecological Co-evolution Framework, the IAD approach adds a governance-centred lens clarifying how decision-making processes, actor roles, and institutional interplay shape adaptation and coexistence outcomes.

Together, the Socio-Ecological Co-evolution and IAD frameworks converge at the intersection of ecological change, institutional effectiveness, and actor agency. These elements are viewed as interdependent, interacting through continuous feedback loops. For example, ecological degradation may drive institutional reform, which then influences actor strategies; conversely, weak governance may heighten conflict severity, prompting communities to devise informal coping mechanisms. This integrated framework supports the study's overarching aim of contributing to theoretical perspectives on the governance of human-wildlife conflict by linking ecological processes with institutional and behavioural responses.

2.2 Empirical Review

2.2.1 Global and Regional Patterns and Drivers of Human-Wildlife Conflicts

Human-wildlife conflict (HWC) is a widespread and escalating challenge that threatens both biodiversity and human well-being worldwide. It is not merely a biological problem, but a complex socio-ecological issue that arises where the human needs for land, water, and security overlap with the ecological requirements of wildlife (Nyhus, 2016). Conservation gains have, paradoxically, intensified such conflicts in many places as recovering wildlife populations increasingly compete with expanding human populations and their activities around forests (Woodroffe et al., 2005; Gross et al., 2021).

Across regions, the underlying drivers for HWC are similar: rapid human population growth and settlement expansion, agricultural encroachment, habitat loss, degradation and fragmentation, linear infrastructure, resource extraction, and in some cases, rising wildlife numbers (Distefano, 2005; Soulsbury & White, 2015; Roy & Sukumar, 2017; Ripple et al., 2014). Among these, habitat loss and fragmentation remain the most significant drivers, pushing people and wildlife into closer contact and increasing competition over space, crops, and livestock. The consequences include crop damage, livestock depredation, property loss, and injuries or fatalities in extreme cases. The resulting fear, economic loss, and perceived unfairness can erode tolerance and trigger retaliation against wildlife (Woodroffe et al., 2005; Dickman, 2010). Climate change further escalates these pressures by altering rainfall, vegetation, and migration patterns, forcing wildlife into agricultural and settlement areas (World Wildlife Fund, 2021).

HWC occurs on all continents and across diverse ecosystems, though its expression varies with ecology and livelihoods (Treves et al., 2006; Woodroffe et al., 2005). In North America and Europe, strict legal protection has enabled the recovery of large carnivores such as wolves, bears, and cougars, but has also revived tensions with livestock farmers and rural communities (Chapron et al., 2014). Conflicts typically involve livestock predation and debates over prevention measures or fairness in compensation (Treves et al., 2003). In contrast, conflicts in the Global South, where subsistence farming and pastoralism are widespread, are more frequent and varied, with crop raiding, livestock predation, and property damage common when wildlife moves beyond protected area boundaries (Seoraj-Pillai & Pillay, 2016; Das, 2014). Agricultural expansion and grazing reduce wild prey bases, increasing livestock vulnerability (Mishra et al., 2003), while urbanisation and tourism can extend HWC into peri-urban and urban areas (Soulsbury & White, 2015). In Asia, where high human densities coincide with biodiversity hotspots, conflicts are particularly intense. Studies have documented livestock predation and human attacks by large carnivores (including tigers and leopards) in India and the Himalayan regions (Athreya et al., 2013; Jackson et al., 2010), alongside significant human-elephant conflict with heavy crop loss and human casualties across South and Southeast Asia (Xu et al., 2024). Land-cover change and agricultural transitions intensify conflict, especially near protected-area fringes, where encounters are most frequent (Nyhus & Tilson, 2004; Vijayan & Pati, 2002). Similar trends are reported in Nepal, Bhutan, and China, where crop damage and economic losses are highest near protected-area edges (Lamichhane et al., 2017; Sharma et al., 2021; Yeshey et al., 2024; Wu et al., 2024).

Although species and circumstances differ regionally, several common patterns emerge. First, HWCs frequently occur at the interface of protected areas and agricultural lands, where wildlife seek food or

water (Athreya et al., 2013). Second, the burden of conflict disproportionately affects small-scale farmers and herders with limited coping resources. Third, climate variability amplifies pressures by altering wildlife movement and resource availability (World Wildlife Fund, 2021). Lessons from large-carnivore conservation show that mitigation must be context-specific, combining physical deterrents (e.g., predator-proof corrals, electric fencing) with fair and timely compensation or insurance to offset losses (Treves et al., 2009). However, technical solutions alone are insufficient; long-term success depends on social acceptance, trust, and participation (Dickman, 2010). Landscape-level planning that maintains habitat quality and ecological corridors can reduce encounters by separating human and wildlife activity in space and time (Roy & Sukumar, 2017; Pooley et al., 2021).

In summary, HWC is rarely a random event but reflects systemic interactions among ecological change, land use, climate pressures, and governance, underscoring the need for adaptive strategies that integrate ecological management, equitable risk-sharing, and inclusive governance (Pooley et al., 2021).

2.2.2 Tiger-Human Conflicts in India

Tigers are the keystone and flagship species in Asia, whose survival ensures the health of ecosystems, protects biodiversity, secures vital resources like water, and supports both wildlife and human well-being (Kerala Forests and Wildlife Department, 2023). Yet, the species has suffered a dramatic decline, losing over 90% of its historical range and being reduced to a few thousand individuals by the mid-20th century, primarily because of hunting, prey depletion, and habitat destruction (Dinerstein et al., 2007; Wikramanayake et al., 2010).

India's modern conservation journey began with the Wildlife (Protection) Act of 1972, which laid the legislative foundation for species protection (Jhala et al., 2021). The launch of Project Tiger in 1973 marked a turning point, initially establishing nine tiger reserves and later expanding to 53 reserves covering over 75,000 km² of forest. This early phase stabilised tiger populations within protected areas but was challenged in the 1990s and early 2000s by a severe poaching crisis that caused local extinctions, such as in Sariska, exposing institutional weaknesses (Karanth et al., 2003). The crisis led to the creation of the Tiger Task Force (2005), which recommended a shift from a fortress-style approach to a landscape model that integrated core habitats with buffer zones and corridors, offered incentives for voluntary relocation, and promoted benefit-sharing through tourism. These reforms led to amendments to the Wildlife (Protection) Act in 2006, the establishment of the National Tiger Conservation Authority (NTCA) and the Wildlife Crime Control Bureau (WCCB), and the adoption of science-based monitoring

through the All-India Tiger Estimation (Project Tiger, Tiger Task Force, 2005; Gopal et al., 2007; Jhala et al., 2021).

Around 2010, leaders from tiger-range countries launched the Global Tiger Recovery Program, aiming to double tiger numbers by 2022 (Joshi et al., 2016; Jhala et al., 2021). India has been at the forefront of this effort. The latest All-India Tiger Estimation (2022) reported 3,167 tigers, a 30% increase since 2010, occupying about 138,200 km² of habitat (Qureshi et al., 2023a, 2023b; Jhala et al., 2025). India now harbours approximately 75% of the global wild tiger population, with nearly 35% of these animals living outside designated reserves (Jhala et al., 2021; Dertien et al., 2023). This conservation success has, however, created what scholars call a “success paradox”: as tiger numbers rise and individuals disperse from protected areas, they increasingly enter agricultural mosaics, farmlands, and villages at reserve edges, escalating human-tiger encounters (Chatterjee et al., 2022; Malviya et al., 2022).

2.2.2.1 Ecological Drivers, Spatial Patterns, and Governance Gaps

Tigers are large, territorial carnivores that require extensive home ranges—about 20 breeding females (roughly 75–100 individuals) for a viable population (Gittleman & Harvey, 1982; Chapron et al., 2008; Bisht et al., 2019). In densely populated India, this spatial requirement brings tigers into close contact with people (Karanth & Gopal, 2005), especially around reserves (Harihar et al., 2009). Many core areas are too small—42% cannot sustain viable populations, making corridor connectivity essential (Hanski et al., 1996; Gopal et al., 2007). Fragmentation from roads, railways, and other infrastructure has disrupted these corridors (Saxena & Habib, 2022). Corridor mapping identifies “pinch points” where infrastructure and settlements constrain movement, forcing dispersal into farmlands and villages (Dutta et al., 2016). Because of high densities inside reserves, dispersing tigers frequently cross croplands and human settlements in search of territory or prey (Smith, 1993; Karanth & Gopal, 2005; Lamichhane et al., 2017; Jhala et al., 2018). Edge landscapes—transition zones between forests and farms, thus emerge as conflict hotspots (Nyhus & Tilson, 2004; Warrier et al., 2020).

Conflict risks intensify when wild prey is scarce or replaced by livestock (Treves & Karanth, 2003; Goodrich, 2010). Studies from Central and Western India document frequent livestock depredation and occasional human attacks, especially among forest-dependent communities collecting fodder or fuelwood (Karanth et al., 2018; Dhanwatey et al., 2013). Broad landscape studies confirm that prey abundance, connectivity, and human disturbance determine tiger occupancy, with corridors and edges functioning simultaneously as key habitats and high-risk zones (Harihar et al., 2012). Reintroductions,

such as in Panna, raised livestock depredation at forest-village interfaces (Malviya & Krishnamurthy, 2022). In Tadoba-Andhari, most victims of tiger attacks were forest-edge users engaged in fuelwood collection (Dhanwatey et al., 2013). In the Northeast, recovery in Manas National Park has led to increased dispersal and intensified edge conflicts, with corridors under stress (Lahkar et al., 2024). Beyond fragmentation, invasive plants such as *Lantana camara* and *Prosopis juliflora* have degraded grasslands in many regions, reducing forage for wild ungulates and indirectly increasing livestock predation (Prasad, 2007; Babu et al., 2009; Mungi et al., 2020; Malviya & Krishnamurthy, 2022). Dense thickets restrict visibility, movement, and access to the forest for both wildlife and people, thereby complicating predator-prey dynamics and encounter risk (Dasgupta, 2023; Mungi et al., 2020). Forest fires, whether climate-induced or anthropogenic, also displace prey and predators into villages (Tigers4Ever, 2021; Kandel et al., 2025).

Although ecological recovery has driven India's tiger resurgence, governance gaps remain a parallel source of conflict. Persistent challenges include delayed or inadequate compensation, weak enforcement outside reserves, and shortages of trained frontline staff (Milda et al., 2020; MoEFCC, 2022; Wildlife Trust of India, 2018). These patterns underscore the shared vulnerability of both people and tigers in edge habitats.

2.2.3 Tiger-Human Conflicts in Kerala and Wayanad

Kerala, located within the Western Ghats, a global biodiversity hotspot, supports a significant population of large carnivores, including tigers. According to the most recent national assessment, the Western Ghats region recorded 824 individual tigers in 2022, distributed mainly across the Wayanad, Periyar, and Parambikulam landscapes (Qureshi et al., 2023). Among these, Wayanad has emerged as a hotspot for tiger-human conflicts because of its unique geographical and ecological characteristics and high human population densities near forest edges (Clement & Srinivasa, 2019; Easa & Sankar, 2001).

The Wayanad landscape, part of the Nilgiri-Wayanad-Mysore Interstate Tiger Landscape, forms a critical link in the Western Ghats' tiger metapopulation network, one of India's largest contiguous tiger populations (Kerala Forests and Wildlife Department, 2023; Jhala et al., 2018). This landscape includes territorial forest divisions (Wayanad North, Wayanad South, and part of Kannur) and protected areas such as Aralam, Kottiyur, and Wayanad Wildlife Sanctuary (WLS). It connects to Brahmagiri WLS, Nagerhole and Bandipur Tiger Reserves in Karnataka, and Mudumalai Tiger Reserve in Tamil Nadu. Wayanad WLS functions as a vital corridor linking these habitats, maintaining genetic diversity and

facilitating tiger dispersal. However, the sanctuary is fragmented, with over 11,000 people living inside 55 forest enclosures and about 6,000 in 44 fringe settlements (Kerala Forests and Wildlife Department 2022). Its perennial streams provide refuge during summer when drought in neighbouring reserves pushes herbivores and carnivores into Wayanad, intensifying human–wildlife interactions. Dense settlements, fragmented forests, and seasonal animal movement further contribute to conflict (Clement & Srinivasa, 2019; Easa & Sankar, 2001).

Recent camera-trap studies indicate a decline in Wayanad’s tiger population from 120 individuals in 2018 to 84 in 2023, with only 30-40 resident tigers and the rest identified as floaters moving between neighbouring reserves with more favourable conditions due to fewer fire events and early rains (Qureshi et al., 2023; Kerala Forests and Wildlife Department, 2023). This dispersal heightens the risk of conflict in edge habitats. The population is also female-biased ($\approx 1:1.62$), which may further influence dispersal and conflict patterns (Kerala Forests and Wildlife Department, 2023).

Habitat degradation compounds these challenges. The invasive *Senna spectabilis* expanded from 47.6 km² in 2013-14 to 123.86 km² in 2023, while other weeds such as *Lantana*, *Eupatorium*, *Mikania*, and *Rhynchospora corymbosa* have reduced the productivity of marshy meadows (vayals, 1,477 ha), crucial grazing grounds for wild herbivores (Vinayan, 2020). Declining wild prey availability forces tigers to rely on livestock grazing near forest fringes, fuelling cattle depredation and conflict (Kerala Forests and Wildlife Department, 2023). Despite a strong prey base of chital, sambar, and wild pig within core areas, the surrounding mosaic of coffee, banana, and rubber plantations provides additional breeding grounds and shelter for wild herbivores. The proximity of livestock and settlements along the fringes further increases the likelihood of tiger-human encounters (Sumitha & Shaharban, 2022).

Kerala has witnessed a sharp rise in human-wildlife conflicts in the past decade. Compensation claims for human deaths and injuries increased from 796 in 2019-20 to 2,416 in 2020-21, with payouts of ₹437.52 lakh and ₹366.00 lakh, respectively (Kerala State Planning Board, 2022). The state recorded 7,966 incidents in 2021-22, rising to 8,873 in 2022-23, with 98 human deaths, and further to 105 deaths in 2023-24 (Kerala State Planning Board, 2024). Wayanad alone accounted for about 4,000 compensation claims in 2021 (Sumitha & Shaharban, 2022).

Despite spending ₹17.2 crore in 2023 on conflict management, including ₹2.4 crore under Project Elephant and ₹10.2 crore for wildlife protection outside protected areas, the Kerala Forest Department continues to face major challenges. Of this, ₹10.49 crore was paid as compensation for deaths, injuries,

livestock loss, and crop damage, yet the process remains delayed and inadequate, with over 8,200 claims pending in 2023, including 2,000 from Wayanad (Kannan, 2023; Kerala State Planning Board, 2024).

These bureaucratic delays, combined with forest fragmentation, seasonal prey scarcity, and corridor degradation, exacerbate local resentment and sometimes provoke retaliation against wildlife (Karanth et al., 2018; Reddy, 2023). The Kerala State Human Rights Commission (2023) reported increasing fear among residents, particularly dairy farmers, who have sold cattle or abandoned grazing lands due to recurring tiger attacks. The Commission stressed the need to balance tiger conservation with human safety and livelihoods. Addressing conflict, therefore, requires strengthening habitat and prey conditions, improving response and compensation delivery, and building meaningful community participation to support coexistence and long-term conservation.

2.3 Institutional Responses

The governance of tiger-human conflicts in India is shaped by both formal and informal institutions. The Wildlife (Protection) Act, 1972, and NTCA Standard Operating Procedures (SOPs) guide responses to tigers outside core habitats, outlining stepwise protocols for verification, rapid response, crowd control, capture or immobilisation, and, when necessary, elimination. Compensation mechanisms provide monetary relief to conflict victims. Alongside these state-led mechanisms, informal rules rooted in religion, ritual practices, and local beliefs have historically guided community behaviour, often fostering restraint and coexistence with tigers. Together, these formal and informal systems influence how conflicts are perceived, managed, and resolved, underscoring the importance of integrating cultural knowledge with state-driven conservation strategies to achieve sustainable coexistence.

2.3.1 Formal Rules

There is no specific law in India that addresses human-wildlife conflicts exclusively; however, a comprehensive wildlife protection act, the Wildlife (Protection) Act, 1972, was passed by Parliament on 9 September 1972 (Pati, 2023; Choudhary, 2024; Pascal et al., 2025). The Act remains India's most significant legal instrument for wildlife conservation. It introduced schedules that classify species by their conservation status, with Schedule I - including the tiger - providing the highest level of protection. Section 9 prohibits hunting, while Sections 11 and 12 allow exceptions only for animals posing a serious threat to human life or property, or for research and scientific purposes, with prior written approval from the Chief Wildlife Warden (Pati, 2023). In tiger-human conflict situations, the WPA, together with NTCA SOPs, provides the legal framework for interventions, ensuring that lethal action is used strictly

as a last resort after capture or relocation efforts have failed. Despite these achievements, the WPA faces limitations in addressing modern conflict scenarios. The Act does not define “human-wildlife conflict,” creating interpretive and enforcement challenges (Pascal et al., 2025). It also struggles to balance conservation goals with livelihood concerns, and scholars argue that it must evolve beyond strict protection to incorporate community participation, indigenous knowledge, and equitable mitigation measures addressing both ecological conservation and human well-being (Choudhary, 2024; Pascal et al., 2025). On the ground, conflict management primarily rests with state governments, and the 2021-2026 National Human-Wildlife Conflict Mitigation Strategy provides advisory guidance but lacks legal enforceability (MoEFCC, 2021).

Within this framework, the National Tiger Conservation Authority (NTCA), functioning under the Ministry of Environment, Forest and Climate Change, issues Standard Operating Procedures (SOPs) for tiger-related incidents. Issued under Section 38(O) of the Wildlife (Protection) Act, the SOPs apply nationwide and are implemented by the State Chief Wildlife Warden through Wildlife Wardens or Divisional Forest Officers (NTCA, 2019). The 2019 compendium details protocols for situations such as tiger straying, livestock depredation, tiger mortality, orphaned cubs, and old or injured tigers, strengthening documentation, procedural clarity, and accountability (NTCA, 2019). The earlier 2013 SOP on straying tigers provided an emergency plan emphasising monitoring, identification, crowd control, and capture through chemical immobilisation, with lethal control permitted only as a last resort and only after a written declaration by the Chief Wildlife Warden (NTCA, 2013). While SOPs strengthen procedural clarity, scholars highlight persistent challenges in implementation due to uneven capacity, enforcement, and socio-political pressures (Bhalla, 2021; Margulies, 2019).

Compensation - often described as “payments to encourage coexistence” - is among the most widely used post-conflict mitigation strategies worldwide, reimbursing individuals for wildlife-related losses through monetary payments or non-monetary aid (Dickman et al., 2011; Nyhus et al., 2005; Ravenelle & Nyhus, 2017). In India, compensation frameworks date back to Project Tiger (1973), and national advisories recommend ₹10 lakh for human deaths and ₹2 lakh for grievous injuries, with state-specific rates for other losses (MoEF, 2008; Rangarajan, 2006; Mishra et al., 2003; MoEFCC/PIB, 2024). Kerala’s system, rooted in the Kerala Rules for Payment of Compensation to Victims of Attack by Wild Animals, 1980, has evolved into an online claim process via the Akshaya web portal, offering payouts for deaths, injuries, livestock, crops, and property damage, and in 2025 the state raised death compensation to ₹10 lakh and introduced direct benefit transfers (Times of India, 2025; Onmanorama, 2025). Despite their importance, compensation schemes face persistent challenges that are largely procedural rather than

conceptual, including delays, paperwork burdens, and inconsistent valuation, which can reduce reporting, weaken trust, and limit the intended role of compensation in supporting tolerance (Agarwala et al., 2010; Barua et al., 2013; Ogra & Badola, 2008; Johnson et al., 2018; Karanth et al., 2012; Rohini et al., 2016).

2.3.2 Informal Rules: Norms, Beliefs and Community Practices

Informal rules, including taboos, customs, social norms, religious beliefs, and cultural traditions, play a vital role in shaping how communities across the world interact with wildlife and respond to wildlife-related conflicts. These systems are diverse, context-specific, and deeply embedded in local cultures, often reducing hostility even toward large carnivores (McKay et al., 2018). However, local attitudes and behaviour towards wildlife, especially large carnivores, can vary across different contexts. In South Africa, for instance, the Shangaan farming culture displayed greater tolerance toward predators despite livestock losses, unlike the more hostile Zulu pastoralists (Lagendijk & Gusset, 2008).

Across tiger-range countries, informal rules like taboos, customs, religious beliefs, and local norms consistently mediate how people use forests, interpret tiger attacks, and decide whether to retaliate. In Sumatra (Indonesia), Islamic ethics and ancestral tiger lore encouraged villagers to respect tigers as part of their natural and spiritual world, reducing retaliation despite suffering losses. Communities distinguish between “zoological tigers” and “spirit tigers,” the latter viewed as moral enforcers or guardians of the forest (McKay et al., 2018). Among the Kerinci, tiger attacks are believed to occur when individuals break moral or social rules, for example, committing adultery or unfairly dividing inheritance, while the Minangkabau people believe that the soul of a sinner can enter a tiger to protect family and friends. Such cultural beliefs make tigers seem less frightening and more understandable, reducing hostility (Bakels, 2000). Historical accounts from Java and the Malay world describe rituals and beliefs that discouraged hunting and promoted coexistence, while Buddhist reverence in Bhutan has similarly fostered tolerance for carnivores. Nevertheless, studies emphasise that tangible incentives like timely compensation remain necessary to maintain this tolerance (Boomgaard, 2008; Sangay & Vernes, 2008).

2.3.2.1 Informal Traditions in India

In India, informal rules are deeply rooted in cultural landscapes and often complement formal conservation systems. In the Sundarbans, the Bonbibid-Dakhin Rai tradition frames the forest as a shared

space, promoting respect for tigers as spiritual protectors who punish greed or arrogance (Jalais, 2014; Chowdhury et al., 2016). Rituals such as Bonbibi prayers and taboos on behaviour in the forest act as unwritten safety codes. Among the Warli in Maharashtra, worship of Waghoba through 150 shrines and annual Waghbaras rituals fosters a “we protect you/you protect us” ethic with tigers and leopards (Nair et al., 2021; Athreya et al., 2018). In central India, Baiga and Gond kinship stories regard tigers as ancestors, discouraging hunting and promoting avoidance (Prasad, 2008), while in the Western Ghats, sacred-grove taboos and the bhūta/daiva Pilichamundi cult establish informal restraint in tiger habitats (Chandran & Hughes, 2000; Times of India, 2017). The Mishmi people in Arunachal Pradesh consider tigers as kin-“our brothers”-and observe strict taboos against killing them, resisting conservation measures that disregard these beliefs (Aiyadurai, 2016). These cultural traditions encode practical strategies for coexistence, shaping beliefs about tiger attacks while encouraging cautious behaviour and restraint in dangerous areas. However, these same belief systems can sometimes reinforce social stigma: when a tiger kills someone, the death may be interpreted as divine punishment, and widows of victims are sometimes blamed or ostracised (Chowdhury et al., 2016; Jalais, 2005). Ethnographic studies further show that cultural systems fostering restraint can shift toward protest or covert retaliation when formal responses such as compensation or capture are delayed or perceived as unfair (Karanth et al., 2018; Johnson et al., 2018).

2.3.2.2 Cultural Norms and Informal Rules in Kerala

Kerala, despite being part of a major tiger landscape, has fewer published studies on tiger-specific taboos or rituals compared to regions such as the Sundarbans or Warli areas. In Wayanad, where tiger conflict is high, community cooperation often depends more on immediate and transparent state responses, such as rapid verification and timely relief, than on cultural norms (Sengupta et al., 2020). Most cultural research in Kerala has focused on elephants, leaving a gap in understanding tiger-related informal practices.

Evidence collectively shows that informal rules-ritual codes, sacred geographies, and taboos-can reduce risky behaviour, legitimise restraint, and foster coexistence. However, they cannot substitute for fair and efficient formal governance. These traditions work best when aligned with transparent verification, rapid compensation, and effective conflict responses. Where institutions fail, or losses are chronic, cultural reverence alone rarely prevents escalation (Bhatia et al., 2020; Jalais, 2005; Sangay & Vernes, 2008). Moreover, modernisation and policy change can erode these traditions, weakening their influence. For Kerala, understanding existing informal rules, integrating cultural knowledge into formal conflict

management strategies, and investing in research on tiger-specific cultural practices could significantly enhance long-term coexistence between humans and tigers.

2.4 Actor-Specific Adaptations

Wildlife conflicts are intricate systems involving multiple actors at every stage. This study focuses on the key actors-namely, the Forest Department, local communities, NGOs, and political actors engaged in the governance and management of tiger-human conflicts. Adaptation strategies generally fall into two categories: preventive and mitigative. The most common approach is prevention (Treves & Karanth, 2003). These can be lethal measures, such as limited or seasonal hunting to control problem animals (Conover, 2001; Gittleman, 2001; Woodroffe et al., 2005), or non-lethal measures, such as fencing and other barriers to keep animals away from human spaces (Reidinger & Miller, 2013). A growing approach is mitigation, which offsets people's losses through compensation or insurance payments after damage has occurred (Ravenelle & Nyhus, 2017; Schwerdtner & Gruber, 2007; Woodroffe et al., 2005).

2.4.1 Forest Department Strategies

Globally, forest and wildlife departments have moved from protected-area-centric conservation to integrated, landscape-level mitigation, recognising that tigers often range beyond reserve boundaries and that ecological and social interventions must complement one another (Chapron et al., 2014). Empirical studies show that tiger-range countries generally employ a three-part approach combining prevention, crisis response, and post-conflict relief (IUCN-SSC 2023). Prevention includes fencing, habitat buffers, predator-proof livestock pens, and early-warning systems; crisis response involves Rapid Response Teams, tranquilisation units, carcass-disposal protocols, and crowd control; and post-conflict relief consists of verified compensation or insurance. Examples include Russia's telemetry-guided Tiger Response Teams, which immobilise and relocate conflict animals while providing emergency livestock compensation (Goodrich, 2010; Goodrich et al., 2015), Bangladesh's Village Tiger Response Teams that manage crowds and disseminate early-warning messages in the Sundarbans (Khan, 2013), and the integrated systems of Nepal and Bhutan that combine SMS alerts, solar-powered predator-proof fencing, community relief funds, and corridor restoration (Thapa & Kelly, 2017). In Sumatra, Tiger Protection and Conservation Units use conflict-hotspot mapping and household attitude surveys, preventing up to half of potential livestock attacks (Linkie et al., 2007; Goodrich et al., 2015). Forest agencies worldwide increasingly rely on real-time technologies such as drones, camera traps, GPS collars, and AI-enabled systems like TrailGuard AI to improve detection and response times (Chapron et al., 2014).

In India, forest departments function under the National Tiger Conservation Authority (NTCA) and the Ministry of Environment, Forest and Climate Change (MoEFCC), which together provide a strong national framework through strategies, action plans, and Standard Operating Procedures (Rajesh et al., 20007; NTCA, 2013, 2019). The country now has over fifty-four tiger reserves managed under core–buffer zoning, with management practices focusing on prey-based augmentation to retain tigers within protected areas. Technological tools such as the Monitoring System for Tigers -Intensive Protection and Ecological Status (M-STrIPES) app, drones, GPS patrolling, and AI-based camera traps allow real-time monitoring and rapid response (Jhala et al., 2015; Dertien et al., 2023; Karanth & Chellam, 2009). Departments deploy Rapid Response Teams, twenty-four-hour helplines, tranquilisation squads, carcass-handling protocols, and verification systems for livestock depredation (Athreya et al., 2013). They also conduct awareness programmes, install electric fencing, and promote alternative livelihoods for forest-dependent people (Alam & Nayak, 2024). In the Indian Sundarbans, nylon fences have been erected along forest edges to prevent tiger crossings, and forty per cent of tourism revenue is shared with residents to build public support for conservation (WWF-India, 2021). Compensation schemes for human deaths, injuries, livestock loss, and crop damage remain central, although delays and inadequate payouts have reduced their effectiveness, as seen in Kanha, Maharashtra, and Rajasthan (Karanth et al., 2012; Agarwala et al., 2010; Johnson et al., 2018). Community engagement through buffer-zone committees, awareness campaigns, and participatory forest management has become a defining feature of departmental efforts, though bureaucracy and underfunding continue to constrain their success (NTCA, 2024; Dertien et al., 2023).

Kerala's Forest and Wildlife Department represents one of India's most adaptive and technology-driven models. Compensation claims are now digitised through the Akshaya portal with direct-benefit transfers, while death compensation has been raised to ₹ 10 lakh, and payouts for livestock loss and disability have been standardised (Onmanorama, 2025; Times of India, 2025). The state launched a three-phase conflict-mitigation campaign covering 273 local self-governments and thirty high-risk hotspots, managing nearly 18,000 complaints in its first year (Times of India, 2025). Field strategies include AI-based camera alerts, drones, thermal-sensor fencing, solar-powered deterrents, Rapid Response Teams with tranquiliser units, night-patrolling squads, and the Wildwatch app for real-time alerts (KFD, 2025). Awareness campaigns in fringe villages train residents in safety protocols and timely reporting. Kerala's Gothrabheri initiative integrates indigenous ecological knowledge from thirty-seven tribal communities to enhance early-warning systems (KFD,2025). Recent academic analyses show a shift from a purely compensatory model toward a data-driven prevention-plus-relief approach, although staff shortages and verification

delays have left more than 8,200 claims pending as of 2023 (Sengupta et al., 2020; Issac & Prasad, 2022).

2.4.2 Community Coping Mechanisms

Local communities in tiger habitats worldwide rely on behavioural, spatial, and material adaptations shaped by ecology, culture, and livelihoods. Research documents the widespread use of low-cost methods such as electric or mesh-wire fencing, predator-proof corrals, stall-feeding of livestock, night-watching, group herding, clearing undergrowth near houses, and avoiding forests at dawn or dusk (Lamichhane et al., 2018; Nyhus, 2016). In Nepal's Khata corridor, villagers have shifted grazing times, organised patrols, and diversified their livelihoods to reduce vulnerability to conflict (Sharma et al., 2024). In Sumatra, people combine livestock enclosures with ritual offerings and protective ceremonies, reflecting a blend of practical and cultural adaptations rooted in reverence for tigers, reflecting both ecological adaptation and spiritual coexistence (Jalais, 2014; Struebig et al., 2018).

In India's Sundarbans, honey collectors pray to the forest deity Bonbibi, travel in groups, and historically used tiger-face masks or human-shaped dummies to deter attacks. Recent research shows that torchlights and night-lights are more effective deterrents than shouting or noise (Jalais, 2005; Datta et al., 2024). In central India, studies confirm that strong physical livestock enclosures correlate most strongly with reduced losses, while scare devices or guard animals alone have proven less reliable (Karanth et al., 2012; 2013). However, high-cost preventive measures, such as solar-powered electric fencing, remain limited due to financial barriers and a lack of external support (Akhila et al., 2025).

In Kerala, farmers commonly adopt stall-feeding, improved lighting, vegetation clearing near homesteads, bio-fencing, and group farming to reduce the risk of wildlife incursions (Mahanti & Kumar, 2018; Rohini et al., 2016). Studies highlight that active guarding methods, such as the use of watchtowers, trained dogs, or close supervision of livestock, offer better protection but demand considerable labour and investment (Killion et al., 2021). These findings consistently demonstrate that communities prioritise low-cost, traditional strategies over expensive technologies. The adoption of modern deterrent methods remains constrained by poverty, weak institutional support, and uneven access to funding and technical.

2.4.3 NGOs and Political Actors

Non-governmental organisations (NGOs) play a pivotal role in tiger conflict management worldwide, acting as mediators, capacity builders, advocates, and rapid responders. They facilitate dialogue between communities and authorities, provide training on conflict mitigation, advocate for policy changes, and deliver humanitarian aid following conflict incidents. NGOs also conduct research, promote coexistence through education and awareness campaigns, and foster international collaboration to share best practices. Political actors, on the other hand, are responsible for policy formulation, resource allocation, multilevel governance, stakeholder engagement, and crisis management. The synergy between NGOs and political actors is essential for sustainable, community-based conflict management, with NGOs providing technical expertise and grassroots connections, while political actors offer legitimacy, policy support, and financial resources. Conservation organisations such as Panthera and the Wildlife Conservation Society promote coexistence through predator-proof livestock enclosures, community guardianship, and education initiatives. These measures have significantly reduced livestock losses and retaliatory killings of large carnivores, strengthening local tolerance towards them. (Lichtenfeld et al., 2015; Wakoli et al., 2023).

In India, NGOs have pioneered several adaptation strategies for wildlife conflict mitigation, many of which have later been adopted or scaled by government agencies. The Wildlife Trust of India (WTI), the World Wide Fund for Nature–India (WWF-India), and the Nature Conservation Foundation (NCF) have implemented Rapid Response Teams, mobile conflict units, participatory monitoring, early-warning systems, and community-based insurance schemes across multiple states, with empirical evidence showing reduced conflict incidents and improved community tolerance (Athreya et al., 2015). WWF-India's honey-collection zoning in the Sundarbans reduced tiger-related deaths among honey collectors (WWF-India, 2021), while solar-powered Parabraksh lights have been effective in deterring wildlife from farms (Basu, 2024). These NGOs also collect and analyse conflict data to inform regional and national policies and advocate for improved governance and compensation systems.

Political actors, particularly the Ministry of Environment, Forest and Climate Change (MoEFCC) and state government, have institutionalised many NGO-led innovations. For example, ex gratia compensation for livestock and human casualties, now a national policy, originated from NGO advocacy and pilot projects (Athreya et al., 2015). The MoEFCC and state governments have also funded Eco-Development Committees (EDCs) that link conservation with rural livelihoods, while crafting state-specific Human-Wildlife Conflict Action Plans based on empirical data (MoEFCC, 2021). Political

actors also play an important role in crisis mediation, managing public protests and conflict flashpoints by promising support, ensuring transparency, and maintaining social stability (Qureshi, 2023).

In Kerala's Wayanad landscape, NGOs and political actors have together developed one of India's most participatory conflict-mitigation models. The Wildlife Trust of India (WTI), through its Wayanad Conflict Mitigation Project, collaborates with the Kerala Forest Department, local panchayats, and community members to reduce risks and manage conflict situations. Their team conducts anti-snare walks to remove traps, sets up and manages camera traps to monitor tiger movements, and shares data daily with forest officials to identify problem animals. They assist in determining cage-trap locations and support night patrolling in high-risk areas, integrating science-based monitoring with community participation to improve safety (WTI, n.d.). The state government has complemented these efforts by institutionalising Rapid Response Teams, prioritising compensation for crop and livestock losses, and supporting alternative livelihoods such as eco-tourism and spice cultivation (MoEFCC, 2021).

Empirical evidence from across the globe, India, and Kerala highlights that NGOs and political actors are central to developing, implementing, and scaling effective adaptation strategies for human-wildlife conflict. Their collaboration combining local innovation, policy reform, and participatory governance, has demonstrably reduced conflict incidents, enhanced community resilience, and fostered coexistence with tigers and other wildlife.

2.5 Insights on Coexistence

Across the globe, coexistence between humans and wildlife is increasingly recognised as both a conservation necessity and a social reality. Empirical research emphasises that coexistence is shaped not only by ecological factors but also by social acceptance, tolerance, and institutional arrangements. For instance, community conservancies in Namibia have significantly reduced retaliatory killings of lions while increasing local benefits from wildlife tourism, demonstrating that economic incentives and inclusive governance can foster peaceful human-wildlife relationships (Naidoo et al., 2016). A global meta-analysis further reveals that both people and wildlife adapt their behaviour through spatial (habitat partitioning) and temporal (activity pattern) strategies to avoid conflict. Examples include jaguars in Brazil and wolves in Europe shifting to nocturnal activity in response to daytime human presence, while herders alter grazing schedules accordingly (Carter & Linnell, 2023).

Adaptive behaviour is closely linked to risk perception, cultural values, and past experiences, also. Studies from South and Southeast Asia show that rural communities often adapt to carnivore presence

through improved livestock protection, night-time vigilance, and selective tolerance rather than eradication (Oommen, 2021; Carter & Linnell, 2016). Across tiger-range countries, coexistence emerges where communities maintain agency and adopt locally grounded coping strategies supported by responsive governance (Oommen, 2021; Inskip & Zimmermann, 2009). In central and eastern India, communities living near the reserves in Madhya Pradesh, Chhattisgarh, and West Bengal continue to share space with tigers and leopards despite the periodic livestock predations. Studies show that large carnivores persist in human-dominated landscapes through a combination of local adaptation, such as controlled herding, being vigilant, clearing dense undergrowth near settlements to improve visibility, etc., along with cultural tolerance, and community resilience (Naha et al., 2020; Naha et al., 2021; Dhee et al., 2019). Broader research indicates that effective compensation schemes and trust in local institutions further strengthen coexistence outcomes (Oommen, 2021; MoEFCC, 2022).

In the Western Ghats, participatory governance mechanisms such as Eco-Development Committees (EDCs) foster co-management and community benefit sharing (e.g., income from eco-tourism, regulated resource use, etc.), in improving trust and conflict outcomes (Parr, 2015; Bhardwaj et al., 2023; MoEFCC, 2022). Studies from Periyar and Nagarhole Tiger Reserves show that conflict mitigation is most effective when residents are directly involved in decision-making and receive tangible conservation benefits (Parr, 2015; Karanth & Nepal, 2012). Kerala's tiger landscapes, particularly Wayanad and Periyar, illustrate the value of integrating community participation with science-based monitoring. The Wildlife Trust of India's Conflict Mitigation Programme collaborates with forest officials and local panchayats on anti-snare patrols, rapid-response teams, and conflict data sharing (Wildlife Trust of India, 2024). The state government's institutionalised compensation and livelihood-diversification schemes have further reduced wildlife-related tensions (MoEFCC, 2021; Kerala Forest Department, 2024). Together, these experiences demonstrate that coexistence is strengthened by empowered communities, adaptive management, and resilient social–ecological systems (Oommen, 2021; Carter & Linnell, 2016).

In conclusion, coexistence between humans and wildlife is possible and often resilient when communities are empowered, adaptive strategies are supported, and cultural values are respected. The most successful coexistence outcomes arise from participatory governance, livelihood diversification, risk mitigation, and strong social norms favouring tolerance.

2.6 Conceptual framework

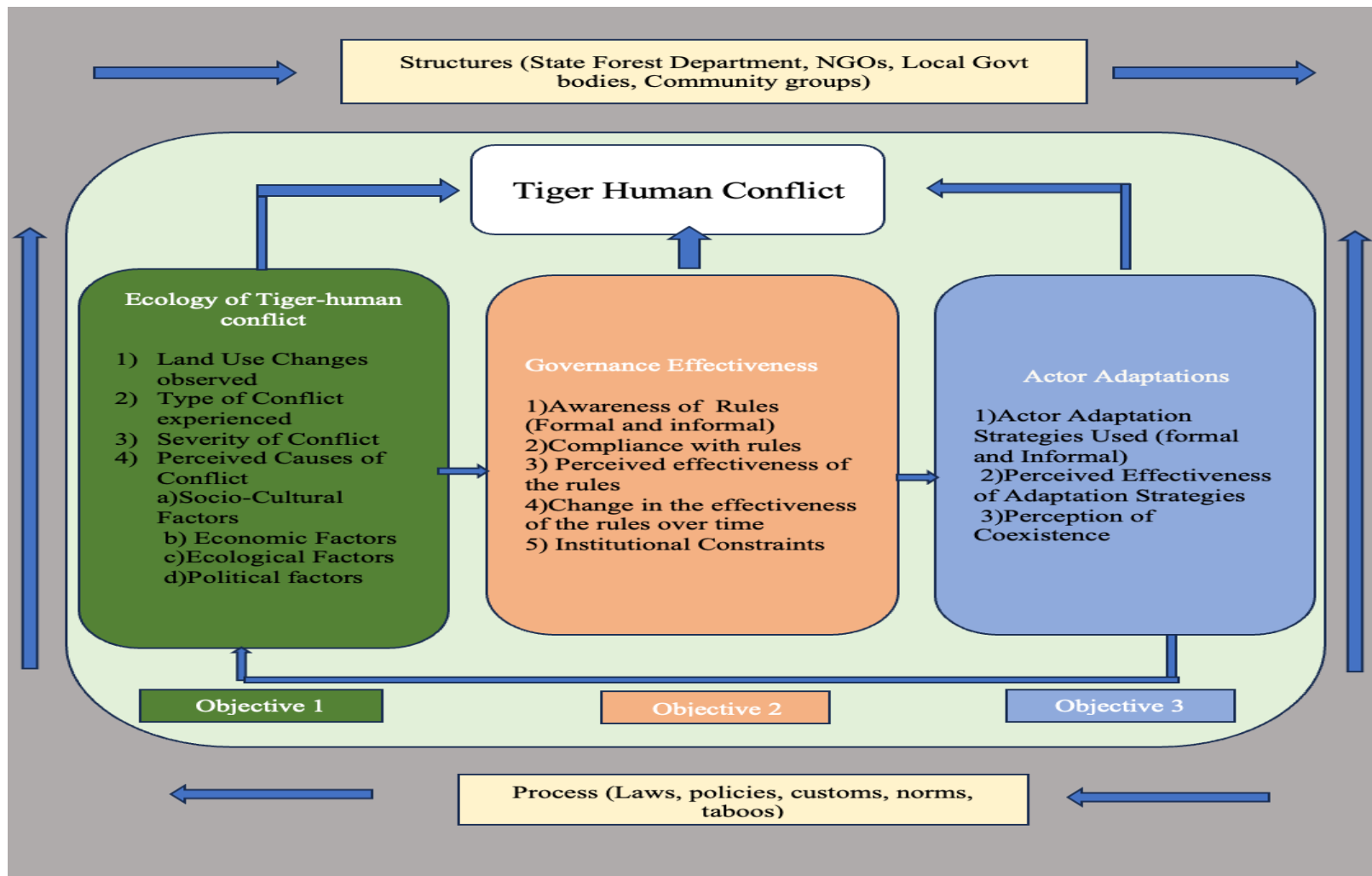


Figure 2.1: Source: Author (based on Pretzsch et al., 2014; Kimengsi et al., 2022; Kimengsi et al., 2023, Ostrom, 2009; Cole et al., 2019).

As illustrated in Figure 2.1, this study's conceptual framework integrates the Socio-Ecological Co-evolution Framework and the Institutional Analysis and Development (IAD) Framework to explain the interrelationships among ecological changes, institutional dynamics, and actor adaptations in tiger-human conflicts in Wayanad, Kerala. The framework links three analytical dimensions: 1) ecology of conflict, 2) governance effectiveness, and 3) actor adaptations and coexistence, corresponding directly to the study's objectives, research questions, and hypotheses.

The first dimension, the ecology of tiger-human conflict, examines the evolution, nature, and drivers of conflict over time. It captures variables such as land use change, conflict severity, and perceived causal factors, categorised as socio-cultural, economic, ecological, and political. This dimension addresses whether conflict severity has increased and which factors most influence its occurrence.

The second dimension, governance effectiveness, evaluates the awareness, compliance, and perceived effectiveness of formal and informal institutional rules governing tiger-human conflict management. Grounded in the IAD framework (Ostrom, 2009), it focuses on how rules-in-use, enforcement mechanisms, and institutional constraints shape the governance outcomes.

The third dimension, actor adaptations and coexistence, explores the strategies adopted by different actors, formal (e.g., forest department, Local government and NGOs) and informal (e.g., local and tribal communities)-and how these affect the perceptions of coexistence among the community. Drawing from the Socio-Ecological Co-evolution perspective, it considers how adaptive strategies, such as fencing, patrolling, traditional deterrents, or rituals, emerge in response to the ecological pressures and institutional support. This dimension also tests relationships between strategy effectiveness and coexistence attitudes.

Together, these dimensions form an integrative model that captures feedback loops between ecological change, institutional performance, and human adaptation. Ecological pressures influence governance responses, which in turn shape local adaptations and perceptions of coexistence. Conversely, local strategies and perceptions inform institutional reform and policy effectiveness. This cyclical interaction embodies the co-evolutionary nature of human-wildlife conflict, providing a coherent pathway from theoretical perspectives on governance to evidence-based analysis of actor-institution dynamics in tiger-human conflicts in Wayanad.

Chapter 3: Methodology

3.1 Introduction

This section of the study gives details on how the study was conducted. It outlines the study area, research design, sampling strategy, data collection tools, and analytical procedures used to investigate the governance of human-tiger conflict in Wayanad. The present study was carried out during March, April and May of 2025 in the district of Wayanad, Kerala. The household surveys were conducted in the villages of Chekady and Channothukolly, respectively, in the local households and tribal settlements. Additionally, the section explains the data collection methods, study population, how the sample size was determined, and the method used to select the sample. The chapter ends by describing how both the qualitative and quantitative data were analysed.

3.2 Study Area

India is a megadiverse country in South Asia, covering approximately 3.288 million km² (Manral et al., 2016). It is characterised by 10 distinct biogeographic zones and 4 of the world's 34 global biodiversity hotspots - namely, the Himalaya, Indo-Burma, Western Ghats–Sri Lanka, and Sundaland (Venkataraman et al., 2018). This ecological diversity supports a wide range of flora and fauna, with India hosting about 45,000 plant species and 86,874 animal species (Shaharban & P, 2024).

India's landscapes range from the Himalayan mountains to coastal plains and plateaus, and its climate is largely shaped by monsoon-driven seasonal variation (Tripathi et al., 2019; Sankar et al., 2016). The country has an estimated population of 1.45 billion. Approximately 24.4% of India's land area is under forest cover (World Bank, 2022), and the country maintains an extensive protected area network comprising over 100 national parks and 500 wildlife sanctuaries. However, rapid development, deforestation, habitat fragmentation, and agricultural expansion have contributed to widespread human-wildlife conflicts across many regions (Manral et al., 2016).

3.2.2 Kerala

Kerala is a coastal state located in the southwestern part of India, lying between latitudes 8°15'N and 12°50'N and longitudes 74°50'E and 77°30'E. It is bordered by the Arabian Sea on the west, Tamil Nadu on the east, and Karnataka on the north. Covering an area of about 38,863 km², Kerala represents 1.18% of India's total land area. Kerala has a varied landscape. It rises gradually from the lowlands along the western coast to the midlands and then to the highlands of the Western Ghats in the east (Simon &

Mohankumar, 2004). Kerala has a tropical monsoon climate with heavy rainfall during the southwest monsoon (June–September) and the northeast monsoon (October–December). The average annual rainfall ranges between 2,000 mm and 5,000 mm, depending on altitude and location (IMD, 2022). The Western Ghats, which run along the eastern border of the state, are among the most biodiverse regions in the world and are designated as a UNESCO World Heritage Site.

3.2.3 Wayanad

Wayanad District is situated in the northeastern part of Kerala, on the southern tip of the Deccan Plateau (11°26'54" to 11°58'52" N and 75°46'11" to 76°25'8" E) (Achu et al., 2021). Covering an area of approximately 2,132 km², the district accounts for about 5.5% of Kerala's total land area. Roughly 40% of Wayanad is covered by forest, falling under the three forest divisions - North Wayanad, South Wayanad, and Wayanad Wildlife Sanctuary (Census of India, 2011). The district is part of the Nilgiri Biosphere Reserve and forms a contiguous habitat with Brahmagiri Wildlife Sanctuary in Kerala, and the Nagerhole, Bandipur, and Mudumalai Tiger Reserves in Karnataka and Tamil Nadu, making it an ecologically sensitive and biologically rich landscape (Menon & Warriar, 2024). Wayanad's rich biodiversity includes large mammals such as tigers, elephants, leopards, and Asiatic wild dogs, as well as diverse herbivore species like gaur, sambar, chital, etc.

3.2.3.1 Topography and Climate

Topographically, the district rests on a slightly east-sloping plateau with a general elevation of 800–900 m above sea level, drained primarily by the Kabini River, a tributary of the Cauvery (Anoop et al, 2025). The terrain is marked by undulating hills interspersed with low-lying swamps. The major forest types of the forest include tropical moist deciduous forests, southern dry mixed deciduous forests, tropical semi-evergreen and evergreen forests, shola-grassland mosaics, and bamboo forests (Kurup, 2011). The region has a humid tropical climate influenced by the monsoon, which gradually becomes slightly drier toward the eastern side. On average, the area receives about 3,000 mm of rainfall each year, and the annual mean temperature is around 30°C (Achu et al., 2021). Higher elevations experience colder winters between November and December (Nair et al., 1978). The district has lost 62% of its forest cover over 68 years due to monoculture expansion, forest fires, and human-driven deforestation (Menon & Warriar, 2025). These land-use changes, along with agricultural expansion and settlement near forests, have increased the frequency of human-wildlife conflicts in Wayanad (Clement & Srinivasa, 2019). These

characteristics make Wayanad a critical landscape for studying how conflict is shaped by ecological change, forest-edge livelihoods, and governance responses.

3.2.3.2 Demography and Livelihoods in Wayanad

According to the 2011 Census, Wayanad had a total population of 817,420, with males and females comprising 49.1% and 50.9% of the population, respectively, and a population density of 384 persons per km² (Census of India, 2011). Agriculture forms the backbone of local livelihoods, with perennial plantations, spice cultivation, and agroforestry systems dominating the land use. Key crops include paddy, pepper, coffee, coconut, tea, cardamom, and plantains. However, agricultural livelihoods are increasingly vulnerable to climate variability, crop disease, and wildlife depredation, making human - wildlife conflict a significant socio-ecological concern in the region (Sumitha & Shaharban, 2022).

Wayanad has a significant Adivasi (tribal) population, constituting 18.5% of the district population and 36% of Kerala's tribal population. Prominent tribes include the Paniyas, Kurumas, Adiyars, Kurichyas, Ooralis, Kadars, and Kattunaikkans (Menon & Warriar, 2024). Historically, these communities have coexisted sustainably with wildlife, developing traditional knowledge and practices for managing forest resources. However, post-independence conservation policies, such as the Wildlife Protection Act of 1972, led to the relocation of many tribal communities. The Forest Rights Act of 2006 attempted to restore land access, but many groups, including the Kattunayakans, were unable to claim rights due to a lack of formal documentation (Agrawal & Redford, 2009; Jolly et al., 2022). The district also hosts a diverse settler population, including Hindus, Christians, Muslims, and a small Jain community (Jolly et al., 2024). Many residents, both tribal and non-tribal, depend on forests for fuelwood, fodder, grazing, wild tubers, and medicinal plants (Anoop & Ganesh, 2020). This dependence, combined with forest proximity, contributes to frequent human-wildlife conflicts across Wayanad.

3.2.3.3 Selected Wards: Chekady and Channothukolly

The study focused on two wards from the South Wayanad Division: Chekady (Pulpally Panchayath) and Channothukolly (Mullankolly Panchayath). These wards were purposively selected based on past severity and frequency of tiger-human conflicts, with Chekady representing a higher-conflict area and Channothukolly a comparatively lower-conflict area. The selection of contrasting wards enabled comparison between a higher-conflict and a lower-conflict setting while maintaining similar forest-range governance conditions. Both wards fall under the Chethalath Forest Range. The 1–5 km criterion was

used as a practical proxy for exposure to forest-edge interactions, consistent with human-wildlife conflict research that links proximity to protected/forest edges with encounter risk.

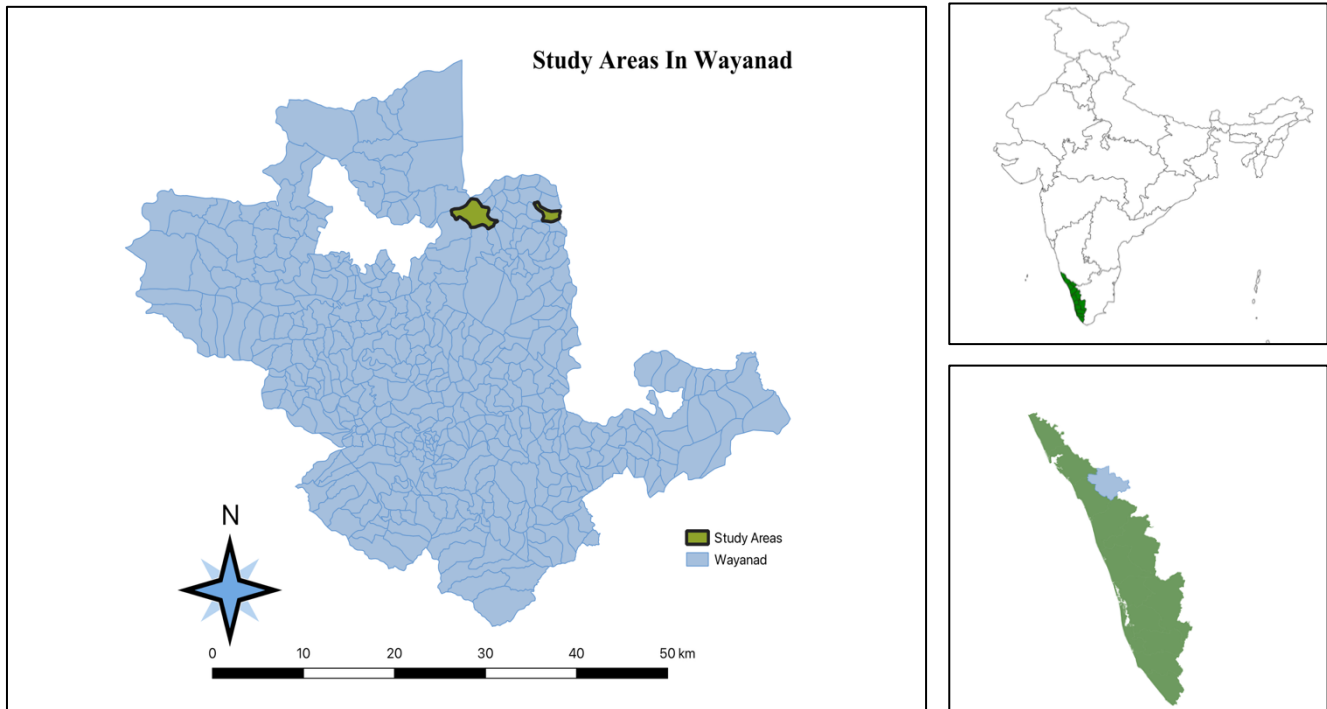


Figure 3.1: Location Map of the Study area, Wayanad; Source: (designed with the QGIS Software by the Author)

3.3.1 Research Design

This study adopted an exploratory sequential mixed-methods design, where an initial qualitative phase informed the development of the household instrument, followed by a quantitative phase to examine patterns and test relationships, with integration at the interpretation stage (Creswell & Plano Clark, 2017; Creswell & Creswell, 2018). This design was suitable because tiger-human conflict governance involves both measurable perception patterns (e.g., severity, awareness, perceived effectiveness) and contextual processes that require explanation (e.g., how rules operate in practice and how actors adapt).

The qualitative component (Key Informant Interviews and Focus Group Discussions, supported by field observations) explored: (i) perceived change in conflict over time, (ii) how formal and informal rules are understood and applied, and (iii) actor responses and adaptations across the Forest Department, households, NGOs, and local bodies. Insights from this phase guided the development the semi-structured household questionnaire, ensuring local relevance and alignment with the study objectives.

The quantitative component (semi-structured household interviews) generated standardised household-level data to describe ward-level patterns and test associations relevant to the hypotheses: perceived changes in conflict severity (H1), relationships between awareness of formal rules and perceived effectiveness (H2), and associations between adoption of informal strategies and coexistence perceptions (H3). Non-parametric tests appropriate for ordinal measures were used where required. Integration was achieved through triangulation at the interpretation stage, using qualitative evidence to explain statistical patterns and quantitative findings to assess the prevalence and consistency of themes across the sample. This strengthened validity by linking lived experience to measurable trends and reducing reliance on a single data source.

3.3.2 Research Instruments

The research instruments were developed between January and March 2025. The main tools employed were: 1) Key Informant Interviews (KII), 2) Focus Group Discussions (FGD) and 3) Semi-structured Household Interviews. Together, these instruments captured both qualitative depth and quantitative breadth, essential for addressing the study's objectives and hypotheses.

3.3.3 Key informant interviews (KII)

This involves interviewing a select group of individuals who are likely to provide the needed information, ideas, and insights on a particular topic. A small number of informants are preselected for interviews because they possess information or ideas that could be solicited by the investigator (Akhter, 2022; Taylor & Blake, 2015). The interviews are usually conducted on a one-to-one basis and require a large amount of the investigator's time during the interviews and for transcribing and coding the data collected (Adams & Cox, 2008). KII with the relevant people are expected to help in cross-checking the information and improve the accuracy of the research by comparing different perspectives on the conflict scenario. KII and FGD are successful tools in understanding "why" and "how" things happen in a short time for studies involving complex institutional dynamics (Marshall, 1996; Gill et al., 2008).

For the study, a list of the possible key informants was preselected, and a set of questions was developed for the purpose of gaining insights on the evolution, conflict severity over the years, the institutional effectiveness and adaptation strategies existing in the community. The questions from the questionnaire were asked to each of the informants, and then followed by other follow-up questions based on the responses and information provided by them. A total of 13 KIIs were conducted. This includes 3 State

Forest Department officials, including one Ranger, one Beat Forest Officer and a guard, 4 Civil society representatives, 4 village elders representing the local people, and 2 NGO representatives.

The data obtained through the KIIs provided a comprehensive understanding of various aspects of tiger-human conflicts, including their evolution, ecological and social dimensions, institutional arrangements, and community-level adaptation strategies. They also served as a basis for cross-checking and validating information derived from other sources.

3.3.4 Focus Group Discussions (FGD)

Focus Group Discussions were organised to gather community-level perspectives and experiences related to tiger-human conflicts. Participants representing different socio-economic and gender groups were invited to discuss their attitudes toward tiger conservation, adaptation strategies, and the perceived effectiveness of the existing rule systems. FGDs are a widely used qualitative tool for exploring collective views, drawing on participants' shared experiences and interactions to deepen understanding of social dynamics (Kitzinger, 1995; Krueger & Casey, 2015). Two FGDs were conducted - one in each selected ward - following transect walks that helped identify key conflict areas and build rapport with residents. Although participation was uneven across wards, the discussions were treated as contextual qualitative evidence rather than representative estimates.

3.3.5 Semi-structured interviews

The third phase of the study consisted of Semi-structured household interviews in the two selected wards. This approach balanced standardisation with flexibility to capture local perspectives on human–tiger conflict (Bryman, 2016) and is commonly used in human–wildlife conflict research to examine attitudes, risk perceptions, and livelihood impacts (e.g., Torkar et al., 2011; Poudel et al., 2022).

The interview guide covered three sections: (a) household profiling (age, gender, education, occupation), (b) institutional framework (awareness and perceived effectiveness of formal and informal rules), and (c) actor adaptations and responses (experiences and strategies used to manage conflict). Although the format was semi-structured, most questions were closed-ended (multiple choice and Likert-type scales) to ensure comparability and support statistical analysis. A smaller number of open-ended questions allowed contextual explanations; however, most responses were brief, resulting in limited narrative

detail. To reduce interviewer bias and improve consistency, field assistants followed a standard script and used neutral probing techniques.

Households within a 1-5 km radius of forest patches were eligible for inclusion. Tribal and non-tribal households were proportionally represented, including Kattunaikans and some Paniyas in forest-fringe settlements. The household head was the primary respondent (or another adult if unavailable). Interviews were conducted in Malayalam using a neutral, non-judgmental approach to minimise response bias. Field observations and notes were recorded to document adaptation strategies and support interpretation. Informed consent was obtained, participation was voluntary, and respondents could withdraw at any time.

Given the structured nature of responses, findings are presented primarily using descriptive and inferential statistics (frequencies, percentages, mean scores, and non-parametric tests), with brief qualitative insights used to contextualise quantitative patterns.

3.3.6 Pre-testing of the semi-structured household interviews

Before the main survey, the questionnaire was pre-tested with five households in the Chekady ward to assess clarity, flow, and comprehension. Feedback from respondents and supervisors was used to refine the wording of questions and eliminate ambiguities.

Following the pre-test, minor revisions were made, and the finalised questionnaire was approved. The final sample included 274 households, selected primarily within a 5 km radius of the forest, as these households are more likely to be exposed to tiger-human interactions. All interviews and discussions were recorded with prior consent. Field notes were maintained to capture contextual details and observations. Participants were informed of the research objectives and their right to withdraw at any stage. Since humanwildlife conflict is dynamic and cyclical (Harris et al., 2023), the questionnaire incorporated questions addressing past, present, and anticipated future experiences to account for temporal variability in conflict patterns.

3.3.7 Scale and Measurement

To ensure consistency and analytical rigour, all the major variables in the household survey were measured using a combination of nominal, ordinal, and Likert-type scales. Nominal scales were used to capture categorical information such as gender, occupation, conflict experience, awareness of specific rules, and the types of adaptation strategies employed. Ordinal scales were applied to variables that

required ordered responses, including conflict severity over time, perceived land-use change, and overall perceptions of coexistence, etc. Several key variables, such as awareness of rules, compliance, and the perceived effectiveness of formal and informal institutions and adaptation strategies, were measured using 4-point and 5-point Likert scales, which helped minimise central tendency bias and enabled more precise analysis of attitudes and perceptions. Some questions allowed people to choose more than one answer, especially when listing causes of conflict or adaptation strategies. These questions were analysed by counting how often each option was selected. Open-ended questions from the KIIs and FGDs were analysed using manual thematic coding to capture deeper insights and community perspectives. These qualitative findings formed the core of the analysis, while the semi-structured survey items provided supportive descriptive patterns. Together, these measurement approaches ensured that the key variables were clearly defined and that the qualitative insights were strengthened by basic descriptive and inferential statistics wherever appropriate.

3.3.8 Population, Sample, and Sampling Procedure Used in the Study

The basic unit of analysis in this study is the household. Semi-structured interviews were conducted with households in the selected wards. A multistage sampling technique was employed to select the study sample, combining both probability and non-probability approaches (Etikan & Bala, 2017; Sedgwick, 2015).

The selection process began with identifying forest divisions, followed by the selection of ranges, panchayaths, and finally wards with relatively high incidences of tiger encounters. Specifically, the sampling sequence proceeded through the South Wayanad Division, Chethalath Range, and the Pulpally and Mullankolly panchayaths, culminating in the selection of the Chekady and Channothukolly wards. These wards were purposively chosen based on guidance from forest department officials and local leaders - one representing an area with higher conflict intensity and the other with relatively lower risks. To determine the representative sample size, the Yamane (1967) formula for finite populations $n = N/(1 + N(e)^2)$, with a 5% precision level, was applied (Muyembe Asenahabi & Ikoha, 2023; Louangrath, 2017). With a total of 437 households in Chekady and 430 in Channothukolly (867 in total), the calculated representative sample size was 274 households.

The population of each stratum (ward) was divided by the total population and multiplied by the total sample size to determine proportional representation. Consequently, 138 households were selected from Chekady and 136 from Channothukolly. Within each ward, random sampling was used to select individual households, ensuring fair representation of both tribal and non-tribal communities.

Table 3.1: Determining the sample size as well as the sample from each stratum

Determining sample size using Yamane's formula	Sample size from Chekady	Sample size from Channothukolly
$= \frac{867}{1 + 867 (0.05)^2} = 274$	$= \frac{437}{867} \times 274 = 138$	$= \frac{430}{867} \times 274 = 136$

3.3.9 Review of Research Instruments

The semi-structured questionnaire and KII guide were reviewed by academic peers and supervisors to ensure alignment with research objectives. Ambiguous or redundant questions were revised or removed based on feedback. The final instruments were approved for data collection.

3.4 Data Collection

3.4.1 Secondary Data Collection

Secondary data were collected at the beginning of the study to contextualise the research and examine the evolution of tiger-human conflicts in Wayanad since 2015. These included academic literature, media reports, government, policy and law documents, and conservation policy frameworks (Yusran et al., 2017). The review provided insights into the ecological and institutional dimensions of the conflict and informed the selection of key actors for the qualitative phase.

3.4.2 Field Data Collection

Primary data collection was conducted between March and May 2025. Necessary permissions were obtained from the District Forest Department and District Tribal Development Office.

Data collection followed this sequence:

1. Key Informant Interviews to obtain expert perspectives. (Details in Appendix 7.6)
2. Focus Group Discussions for community-level dialogue.(Details in Appendix 7.6)
3. Transect walks along forest fringes to observe adaptation strategies and identify conflict hotspots, and understand the local situation.

4. Semi-structured household interviews to collect standardised data across 274 respondents.

Each household interview lasted approximately 30-40 minutes, and an average of six interviews were completed daily. Two field assistants supported the process of data collection. All data were entered and cleaned in Excel, and then analysed using RStudio (version 2025.05.1+513), for further analysis.

In Chekady, 14 participants (11 females and 3 males) participated in the FGD, while in Channothukolly, 6 male participants took part. All discussions and Key informant interviews were audio-recorded with prior consent.

3.5 Data Analysis

3.5.1 Qualitative Data Analysis

The Qualitative data collected from the Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) were then transcribed verbatim, translated into English, and analysed using Braun and Clarke's (2006) six-phase thematic analysis framework. This involved data familiarisation, generation of initial codes, identification and review of themes, definition, and final reporting (Braun & Clarke, 2019). Thematic analysis alone was chosen for its flexibility and suitability in identifying patterns and meanings within participants' responses related to the evolution of tiger-human conflicts, institutional effectiveness, and actor adaptation strategies. The process allowed the researcher to move from descriptive observations to interpretive understanding, highlighting both shared and divergent experiences among the actors.

Manual coding allowed direct engagement with the data, capturing both shared and divergent experiences. Initial in-vivo and descriptive codes were highlighted in the transcripts and compiled into a preliminary list. Related codes were clustered into sub-themes by examining patterns, similarities, and differences across interviews, which were iteratively refined through constant comparison with the transcripts. Broader themes were then constructed by grouping sub-themes into conceptual patterns aligned with the study objectives, including the evolution of conflict, governance effectiveness, adaptation strategies, institutional trust, and coexistence perceptions. The final codebook comprises three hierarchical levels- codes, sub-themes, and overarching themes- grounded in verbatim data and reflecting socio-ecological and institutional dimensions of tiger-human conflict in Wayanad.

Reliability and trustworthiness were enhanced through several strategies: peer debriefing, iterative self-checking of codes, iterative review of transcripts, triangulation with quantitative household survey data, and maintaining a detailed audit trail of analytic decisions (O'Connor & Joffe, 2020).

3.5.2 Quantitative Data Analysis

Quantitative data from the semi-structured household interviews were analysed in RStudio using descriptive and non-parametric inferential statistics.

Descriptive statistics (frequencies, percentages, means, and cross-tabulations) summarised socio-demographic characteristics, conflict experiences, rule awareness/adherence, perceived effectiveness, adaptation strategies, and coexistence perceptions.

Inferential statistics were used to test hypotheses and examine group differences and associations, including Chi-square tests for associations between categorical variables, Spearman's rank correlations for relationships between ordinal variables, Mann-Whitney U tests for two-group comparisons, Wilcoxon signed-rank tests for paired comparisons (e.g., "before vs today"), Kruskal-Wallis tests for comparisons across multiple groups, and Friedman tests with post-hoc Wilcoxon comparisons for repeated-measures ranking questions. Non-parametric tests were used because most key variables were ordinal (Likert-type scales) and/or did not meet normality assumptions. Where multiple pairwise comparisons were conducted, p-values were adjusted (e.g., Holm correction; Dunn post-hoc following Kruskal-Wallis). All tests were conducted at a 5% significance level ($\alpha = 0.05$).

3.6 Integration of Qualitative and Quantitative Findings

Integration of qualitative and quantitative findings was conducted during the interpretation stage to ensure a comprehensive understanding of tiger-human conflict governance. Thematic patterns identified through KIIs and FGDs were cross-validated with quantitative results from the semi-structured household survey. This allowed qualitative insights to explain the underlying reasons behind statistical relationships, while quantitative data provided measurable evidence supporting or contrasting qualitative themes. The integrated interpretation thus enhanced the validity and depth of the overall findings, aligning with the mixed-methods design of the study (Creswell & Plano Clark, 2018; Fetters et al., 2013).

3.7 Triangulation

Methodological triangulation was used to strengthen credibility by comparing evidence across multiple sources (KIIs, FGDs, household interviews, field observations, and secondary documents). Data from these sources were systematically compared to identify convergences and divergences in ideas and themes. Triangulation enhances research validity by integrating different perspectives, reducing bias, and improving the credibility of interpretations (Denzin, 1978; Patton, 1999; Flick, 2004). This approach provided a more comprehensive and balanced understanding of the institutional, ecological, and social dimensions of tiger-human conflict governance in Wayanad.

3.8 Ethical Considerations

Ethical considerations were central to all research stages. I was committed to ensuring that no physical or psychological harm was inflicted on any individuals involved in the research, whether human or animal, while remaining mindful of the power dynamics within villages and social groups. Informed consent was obtained from all participants after explaining the study's aims, methods, and potential risks. Participation was voluntary, and respondents were free to withdraw at any time. Personal identifiers were anonymised, and confidentiality was maintained.

Secondary data were appropriately cited following academic standards. Community engagement was emphasised by sharing findings with local stakeholders to ensure transparency and practical relevance. The research adhered to the ethical guidelines outlined by Staksrud et al. (2022).

Chapter 4: Results

4.1 Introduction

This chapter presents a comprehensive analysis of both quantitative and qualitative data collected to examine the governance of tiger-human conflicts in Wayanad, Kerala. The chapter starts by presenting the socio-demographic data collected during the household surveys. Then, in the rest of the Chapter, the results are organised around the three key objectives of the study: (1) the evolution, nature, and severity of tiger-human conflict; (2) the awareness and effectiveness of formal and informal institutional rules governing conflict management; and (3) the adaptation strategies adopted by various actors and their influence on perceptions of coexistence.

The quantitative component provides insights from household surveys on perceptions of conflict severity, the prevalence of different conflict drivers, rule adherence, institutional effectiveness, adaptation practices and co-existence attitudes. These findings are complemented by qualitative insights drawn from Key Informant Interviews (KIIs) and Focus Group Discussions (FGDs) with different stakeholders. Together, the results aim to triangulate statistical trends with lived experiences, offering a nuanced understanding of the socio-ecological dynamics of tiger-human conflict and the governance systems in place to manage it.

4.2 Socio-demographic characteristics of households

The socio-demographic characteristics of the surveyed households provide critical context for understanding their interactions with tiger-human conflict in Wayanad (Figure 4.1). A total of 274 households were analysed from the two wards of Wayanad - Chekady (n = 138; 50.4%) and Channothukkolly (n = 136; 49.6%). The sample was slightly male-skewed (Male: 150, 54.7%; Female: 124, 45.3%), with nearly equal male representation across both wards ($\approx$ approximately 75 each) and comparable female counts (63 in Chekady and 61 in Channothukkolly). The mean age of respondents was 50.1 years (SD = 10.2), with a median of 52 years (IQR = 43-57; range = 25 - 4). Household size averaged 4.0 members (SD = 1.08), with a median of 4 (IQR = 3-5; range = 2-7).

In terms of education, most respondents had no formal schooling (43.8%) or only primary education (44.9%); secondary education accounted for 8.8%, while just 2.2% held a degree and 0.4% a postgraduate qualification. With respect to occupation, the majority were engaged in daily-wage labour (52.2%) or agriculture (43.1%), with smaller proportions in business (4.0%) and government employment (0.7%). By social category, General households comprised 69.0% of the sample, while Tribal households accounted for 31.0%. Land ownership was reported by 68.6% of respondents, whereas 31.4% were

landless. Regarding proximity to forests, 77.7% of households were located within 1 km of the forest edge, while the remaining 22.3% were situated within a 1-5 km range. With income, nearly 95% of the households reported less than Rs. 50,000 as their annual household income, reflecting the seasonal and fluctuating nature of incomes in an agriculture-based economy.

When the data are disaggregated by the social category (Figure 4.2), both General and Tribal groups display similar overall patterns, though some differences emerged. Tribal respondents are more concentrated among those with no formal education, in daily wage occupations, and in settlements located closest to forests, suggesting their greater economic vulnerability and reliance on natural resources. General respondents, on the other hand, have slightly higher representation among landowners and those with primary or secondary education levels. Together, these patterns indicate a socioeconomically constrained population, with distinct yet overlapping livelihood and educational characteristics.

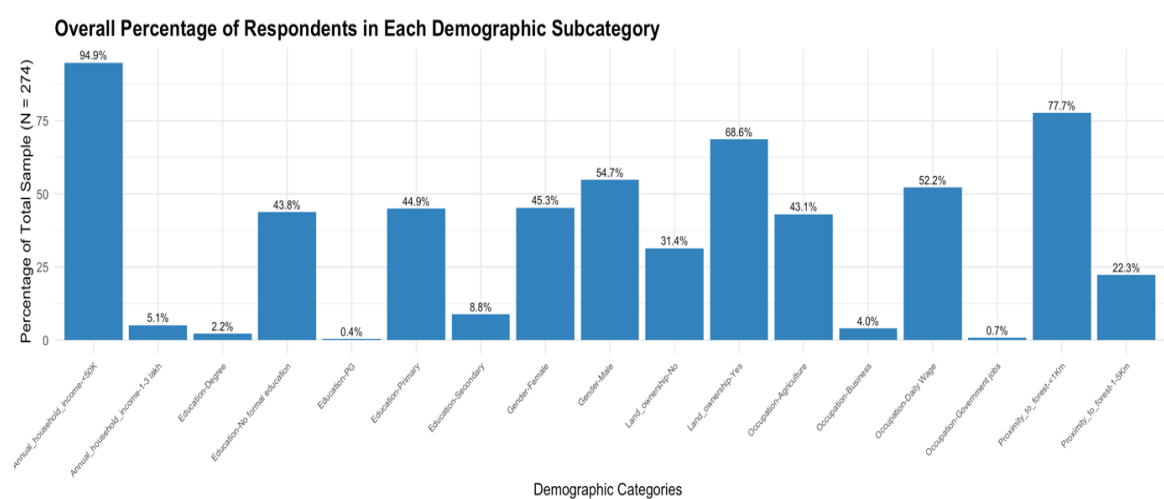


Figure 4.1: Overall Distribution of Respondents Across Demographic Categories

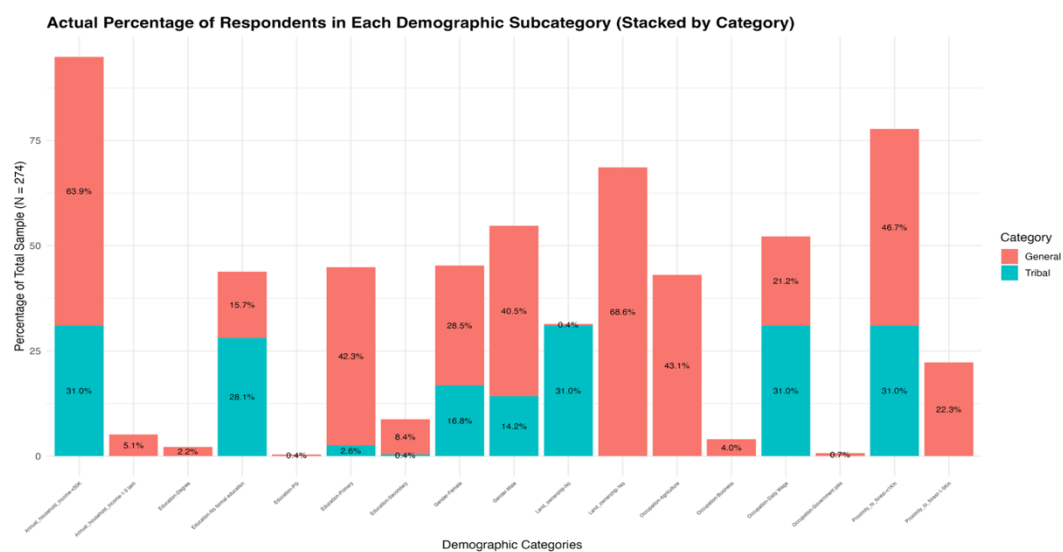


Figure 4.2: Demographic Distribution by Social Group (General vs. Tribal)

4.3. Evolution, Nature, and Severity of Conflict

This section presents findings related to the first objective of the study: to examine the evolution, nature, and severity of tiger-human conflicts in Wayanad, focusing on the socio-cultural, economic, ecological, and political factors that influence them.

4.3.1 Nature and Perceived Severity of Tiger-Human Conflict

To assess how the perceptions of tiger–human conflict severity have evolved in Wayanad over the past decade, respondents were asked to rate conflict severity “before” and “today” on a five-point scale (Very low = 1, low = 2, Moderate =3, High =4, Very high =5). As illustrated in Figure 4.3, there is a dramatic shift in perceived severity: while 59.8% of households rated past severity as “very low” and 40.2% as “low,” present-day ratings are concentrated at the high end of the spectrum, with 71.2% identifying conflict as “high” and 28.8% as “very high.” The mean severity rating increased from 1.40 (± 0.65) previously to 4.29 (± 0.79) currently, indicating a widespread belief that conflict intensity has escalated significantly.

Spatial differences are also evident across the two study sites. Figure 4.4 shows that in Channothukkolly, all respondents rated current conflict severity as level 4 (“high”), whereas in Chekady, responses were split between level 4 (42.8%) and level 5 (“very high”) (57.3%). This suggests that while both wards perceive increasing conflict, residents in Chekady experience more acute impacts.

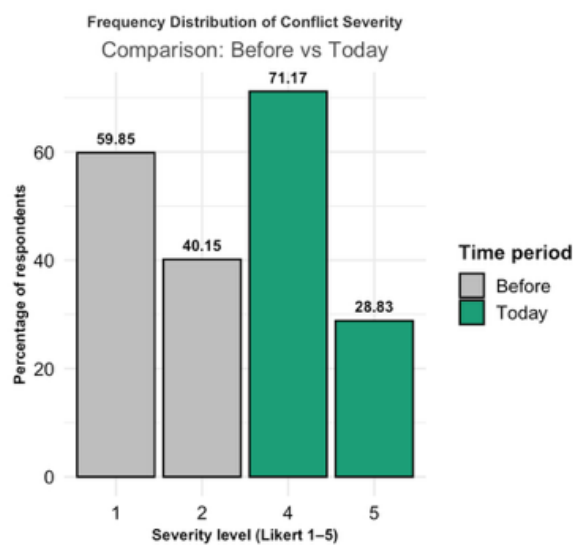


Figure 4.3 Comparison of Conflict Severity Levels Before and Today"

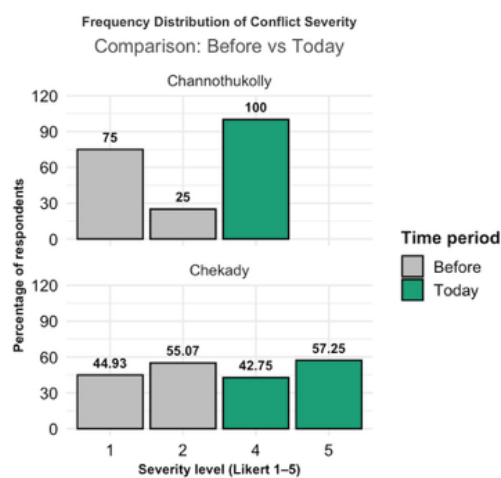


Figure 4.4 Comparison of Conflict Severity Levels Before and Today in both the study wards

Figure 4.5 further supports this trend, showing a significant increase in mean severity scores across the study area.

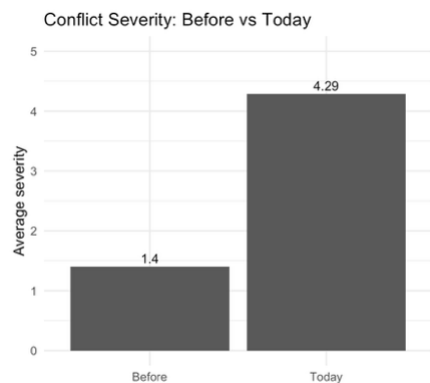


Figure 4.5. Comparison of Mean Conflict Severity Scores Before and Today Across the Study Area

Further analysis explored the different types of direct experiences or the nature of conflict that shaped these perceptions of increased severity (Figure 4.6). None of the surveyed households reported human injuries or fatalities; however, 100% of households expressed fear of living due to tiger presence, 15% reported livestock depredation, and 29.9% felt pressure to relocate (see Table 4.1 in the Appendix for the frequency of conflict experiences).

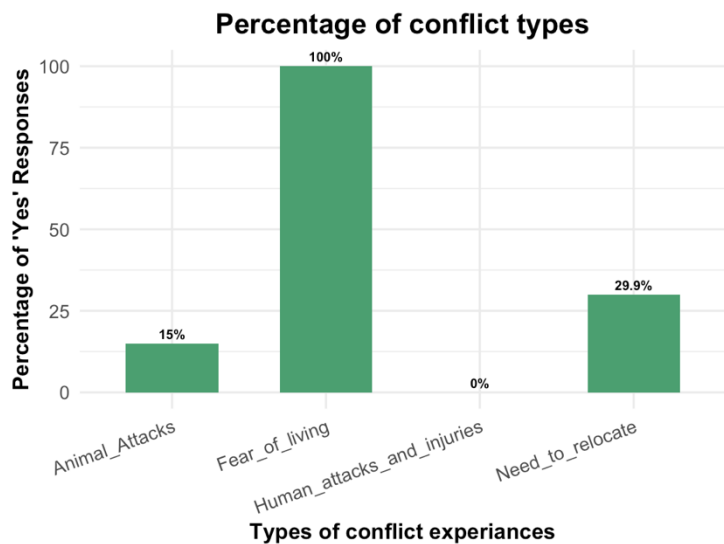


Figure 4.6. Percentage Distribution of Different Types of Conflict Experiences Reported by Households

Further, Mann-Whitney U tests revealed that households experiencing livestock attacks or relocation pressure perceived significantly higher conflict severity ($p < .001$), with moderate effect sizes ($r = 0.39$

and $r = 0.45$, respectively). Chi-square tests supported this, showing significant associations between severity and both livestock loss ($\chi^2 = 38.89, p < .001$) and relocation pressure ($\chi^2 = 52.41, p < .001$) (see Tables 4.2 and 4.3 in the Appendix).

The qualitative data from the KIIs and FGDs strongly supported the quantitative findings, affirming a widely perceived increase in the severity of tiger-human conflict over the past decade. Participants across different actor categories commonly described the situation as more tense and unpredictable, particularly within the last five to seven years. Many key informants and residents agree that encounters are more frequent and widespread now than a decade ago, indicating a genuine intensification on the ground. A Chekady citizen emphasised,

“It wasn’t like this before. Only in the last few years have we seen tigers near the forest boundaries.”

Furthermore, one of the participants observed that *“Even when we go to our fields in daylight, we are always in fear of encountering some wild animals, which was not the case earlier”*. In FGD discussions, residents described having to be home before dark and avoid forest routes, reflecting how heightened conflict risk has altered livelihoods and routines.

One of the KII also noted that, *“earlier, the tribals showed less concern, but now they are concerned about this due to relocation to fringe areas; they are also adapting to the general life”*.

A contrasting yet important viewpoint was provided by the Range Forest Officer, who noted that Tiger-human conflict has not drastically increased - It existed earlier as well. He suggested that much of the current perception of rising conflict is driven by improved technologies like mobile phones, CCTV cameras, and the amplification effect on social media. He explained,

“In the past, if livestock disappeared, people assumed it was taken by a fox or a stray dog. Today, surveillance footage often reveals that it was actually a tiger.”

These qualitative accounts collectively reinforce the quantitative evidence of an escalating human-tiger conflict and its growing impact on daily life and well-being.

Hypothesis test (H₁). A Wilcoxon signed-rank test compared perceived conflict severity “before” and “today” for the same respondents ($n = 274$). Perceived severity was significantly higher today ($Mdn = 4.00$, High) than before ($Mdn = 1.00$, Very low), $W = 0, p < .001, r = 0.90$, 95% CI [0.90, 0.91]. Therefore, H_1 is supported. (see Table 4.4 and Table 4.5 in the Appendix).

4.3.2 Perceived Drivers of Tiger-Human Conflict

This section outlines the key, connected drivers of tiger–human conflict in Wayanad. Using both quantitative and qualitative evidence, it begins by examining the land-use change as the structural backdrop. It then summarises the ecological, socio-cultural, economic, and political factors that together explain the rising tensions. Taken as a whole, these dimensions offer a concise, holistic perspective on why conflict intensity is perceived to be increasing.

4.3.2.1 Observed Land Use Changes in the area

Across the study area, nearly two-thirds of households (64.2%) reported observing one or more forms of land-use change in recent years, while 35.8% indicated that no significant change had occurred (Figure 4.7). This indicates that land-use transformations continue to be a noticeable and ongoing process for most respondents within the region. Among the specific types of changes observed, abandonment of agricultural land was the most frequently cited (45.6%), followed by urbanisation (39.8%) and deforestation (30.7%) (Figure 4.8). Other forms of change, such as farmland expansion, plantation expansion, or forest encroachment, were not reported by any respondents, suggesting that these processes are either not prominent or not easily perceived by local communities.

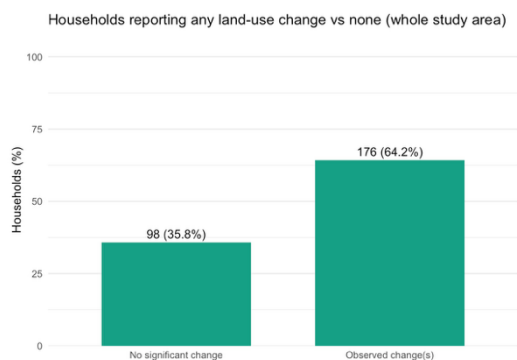


Figure 4.7 Households Reporting Any Land-Use Change vs. None (Entire Study Area)

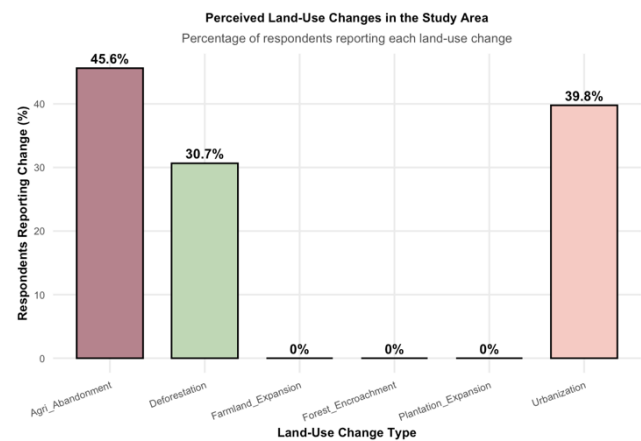


Figure 4.8 Perceived Land-Use Changes by Type (Entire Study Area)

Ward-wise differences were also pronounced. In Channothukolly, almost all households (97.8%) reported observing land-use changes, with high reporting of agricultural land abandonment (91.9%), urbanisation (65.4%), and deforestation (38.2%). In Chekady, only 31.2% of respondents reported noticing such changes, while 68.8% indicated no significant change. Within Chekady, deforestation (23.2%) and

urbanisation (14.5%) were the main changes reported, whereas agricultural abandonment was not observed (Figures 4.9 and 4.10).

This stark contrast suggests that land-use change is far more visible and widespread in Channothukolly than in Chekady, possibly due to differences in population pressure, agricultural dependency, or local development dynamics.

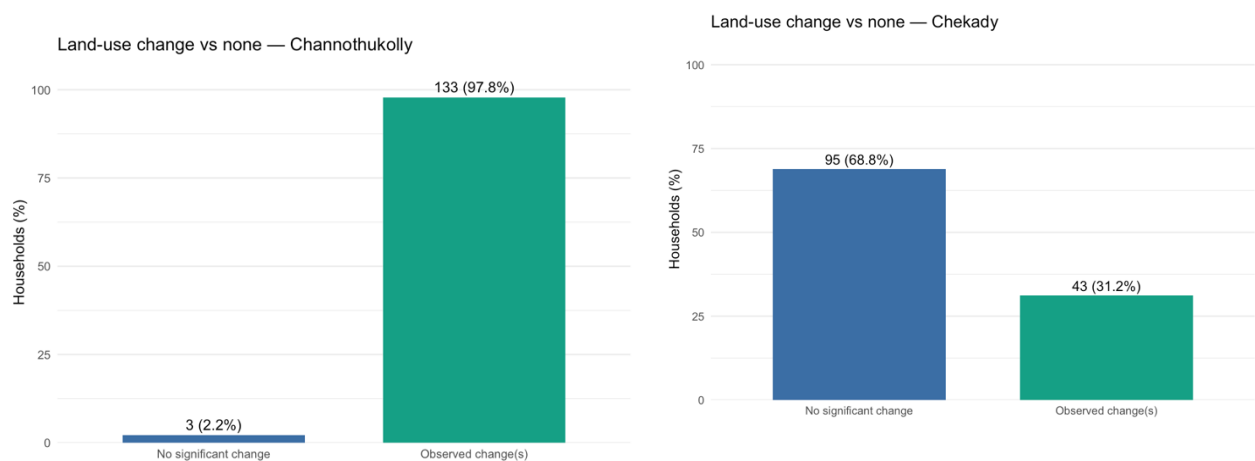


Figure 4.9 Households Reporting Any Land-Use Change vs. None (Ward-wise comparison)

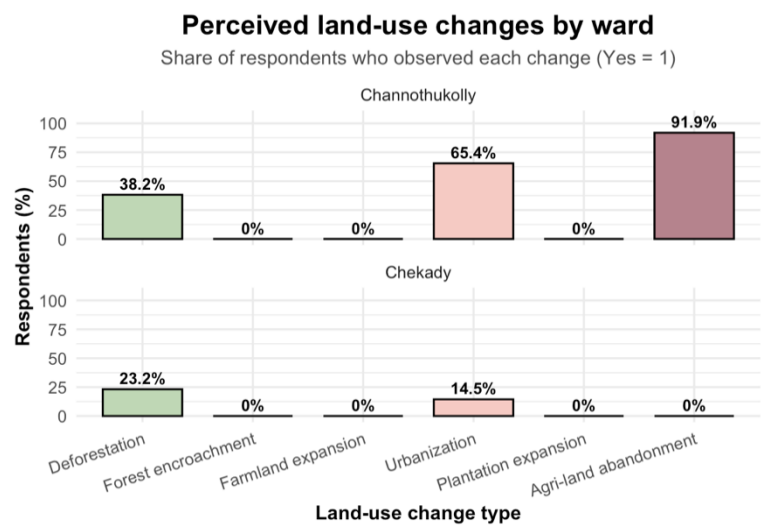


Figure 4.10 Perceived Land-Use Changes by Type (Ward-wise comparison)

Regarding the pace of change, most respondents rated the ongoing transformations, particularly deforestation, urbanisation, and agricultural abandonment, as either low or moderate in intensity (Figure 4.11). This reflects a steady transformation in the landscape rather than abrupt disruption, although the impacts may still be deeply felt over time.

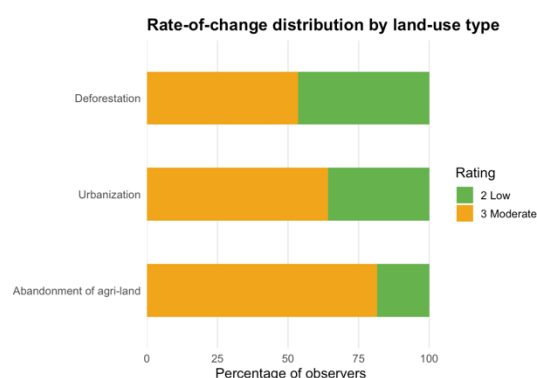


Figure 4.11. Rate-of-change distribution by land-use type (Whole study area)

The qualitative data also echoed these patterns. Institutional actors frequently mentioned deforestation, infrastructural expansion, and tourism-related development as ongoing features of the landscape, whereas some community members described these changes as less obvious day-to-day. People may not recognise changes when they happen slowly, especially if it's legal or spread out over time.

In Channothukkolly, participants linked farmland abandonment to repeated crop losses, labour shortages, and perceived wildlife risk, reporting that cultivation has become increasingly unsafe and unviable. Key informants further associated land abandonment with declining productivity in degraded fields and increased wildlife disturbances, which can encourage smallholders to sell land and facilitate tourism and real-estate-related land conversion. In contrast, participants in Chekady described farmland abandonment as uncommon, emphasising continued reliance on farming as a primary livelihood.

Informants also referred to a decline in buffer species (e.g., bamboo) and an increase in quarrying permits over the last 5-6 years, with perceived impacts on local environments and groundwater. Participants described a gradual replacement of continuous forest cover with plantations (coffee, rubber) over the last decades and scattered infrastructure (roads, homestays), creating fragmented zones between settlements and wildlife habitat: “One forest beat officer summed it up:

“Even tigers cannot tell where the forest ends and the village begins - our village has started to look like a mini forest”.

As one NGO member noted that When farms are abandoned, they turn into bushy wastelands that mimic a forest. Tigers can easily breed and move through these areas without needing to go back to the forests and reach settlements unnoticed. Several respondents highlighted tourism growth and resort development as additional drivers of land transformation and ecological disturbance.

Overall, Triangulation of quantitative and qualitative data revealed strong agreement across sources. Themes from interviews and FGDs, particularly agricultural land abandonment, urbanisation, and deforestation, aligned closely with the most frequently reported changes in the household survey. Both datasets reflected greater change in Channothukkolly and limited change in Chekady, with the pace generally described as gradual or moderate. Qualitative insights further highlighted aspects not captured in the survey, such as quarrying, loss of buffer vegetation, and tourism-related development.

Although land-use change forms an important structural backdrop to the conflict, respondents attributed emerging tensions to a wider combination of ecological, political, economic, and socio-cultural influences, elaborated in the subsequent sections.

4.3.2.2 Ecological, Economic, Socio-Cultural and Political reasons

The household survey data revealed that respondents overwhelmingly attributed tiger-human conflict to political, ecological, and economic factors. All participants (100%) endorsed at least one cause under these three categories, while only 34.3% acknowledged any socio-cultural causes (Figure 4.12, also see Table 4.6 in the Appendix).

When considering the average rate of endorsement within each category, political drivers stood out most strongly, with 85% of political sub-reasons selected. This was followed by ecological (31.9%) and economic (25%) factors, while socio-cultural causes received the least support (12.3%) (Figure 4.13; also see Table 4.6 in the Appendix).

At the sub-reason level, the most frequently cited causes of tiger-human conflict were directly associated with ecological, economic, and political domains. Every respondent (100%) identified the increased presence of tigers in the forest and financial loss due to conflict as major contributors. Similarly, almost all respondents cited election-related political manipulation (100%), poor or delayed compensation (98.2%), and outdated wildlife laws (98.2%) as key factors. Moderate attention was given to land-use issues such as deforestation (34.3%), abandoned agricultural land (33.9%), and increased human settlements (32.8%). Socio-cultural explanations, including the loss of traditional beliefs and decline of traditional deterrents, received minimal endorsement (Figure 4.14).

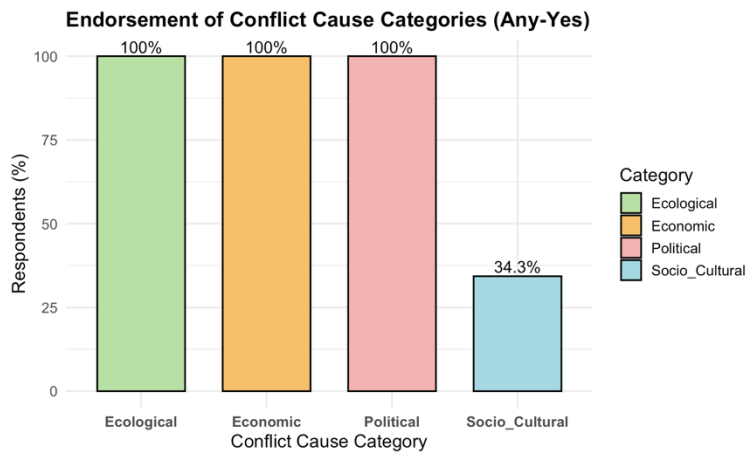


Figure 4.12. Endorsement of conflict cause categories by respondents. Percentage of respondents identifying at least one cause within each main category (ecological, economic, political, socio-cultural).

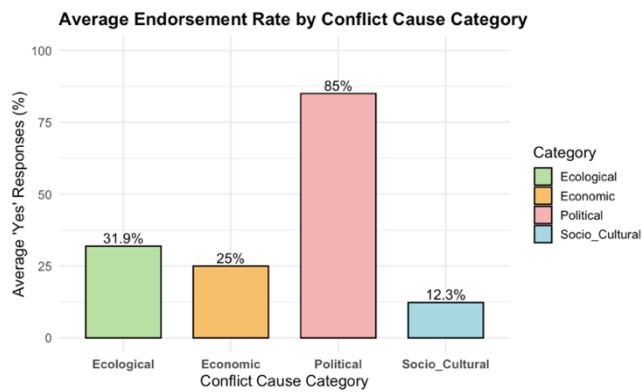


Figure 4.13. Average endorsement rate by conflict cause category.

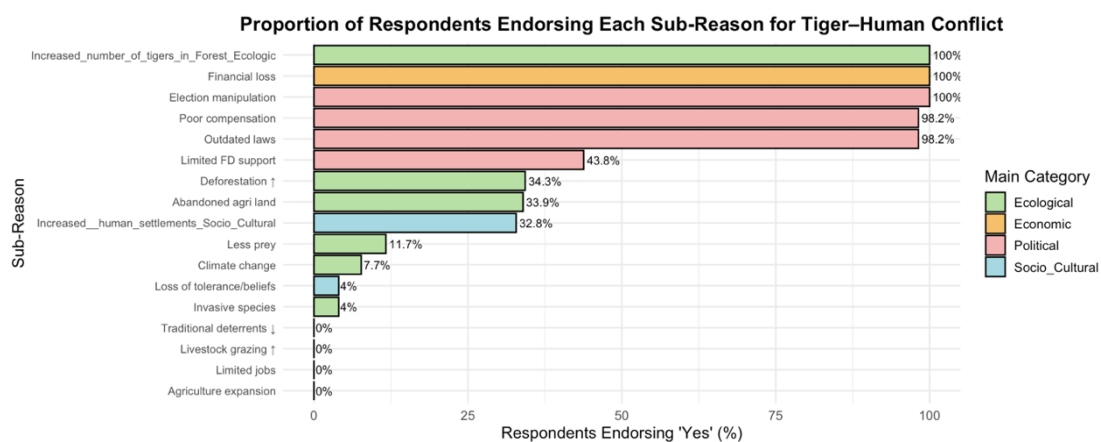


Figure 4.14. Proportion of respondents endorsing specific sub-reasons for tiger-human conflict.

To assess whether certain categories of causes were perceived as more important than others, a Friedman test was conducted. The test indicated a statistically significant difference across the four categories ($\chi^2(3) = 571.0$, $p < .001$), showing that respondents did not view all drivers equally (See Table 4.7 in the Appendix). Pairwise Wilcoxon signed-rank tests (Holm-corrected) revealed that political causes were rated significantly higher than ecological, economic, and socio-cultural ones ($p < .001$ for all). No significant difference was found between ecological and economic causes ($p = .178$), indicating similar perceived weight (See Table 4.8 in the Appendix).

Furthermore, Spearman correlation analyses were used to examine the relationship between endorsement of each conflict cause category and perceived conflict severity. Socio-cultural ($\rho = 0.40$) and ecological ($\rho = 0.36$) causes were moderately positively associated with higher severity ratings, while political concerns were negatively associated ($\rho = -0.55$) (See Table 4.9 in the Appendix).

While survey data highlighted political and ecological factors as dominant drivers of tiger-human conflict, qualitative interviews and focus group discussions provided deeper insights into how these factors are perceived and experienced locally. Perspectives from forest officials, NGO representatives, and residents revealed interconnected ecological, economic, political, and socio-cultural processes underlying the conflict.

Ecological Reasons: Interviewees broadly agreed with the survey's emphasis on ecological drivers. Forest officials and NGO representatives linked conflict escalation to tiger population recovery following the Wildlife Protection Act (1972), which reduced hunting and allowed tiger numbers to rebound. Officials explained that population recovery has intensified territorial competition, occasionally pushing tigers toward village boundaries:

"When there is an increase in tiger population, occasional straying will be common", a forest officer opined.

However, they also noted that the population may stabilise or decline as older tigers reach their natural lifespan. NGO workers highlighted habitat degradation, invasive plant spread (e.g., Lantana, Senna, Eupatorium), and prey depletion within deep forests as the key pressures forcing predators toward settlements.

"The problem is not the increased tiger population, but the degradation of the forest," said one NGO worker. Another official also noted that the genetic composition of the tigers found in the Kerala forest is good for a better survival rate. Abandoned farmlands and plantations were described as "mini forests" that provide cover for tigers. However, this would not be the case everywhere, as in Chekady, where most people still practise agriculture out of necessity, and other reasons played behind the scenes. Seasonal

droughts and water scarcity within forests and ecological stresses within the neighbouring tiger reserves were also facts supported for driving wildlife closer to human spaces.

Political Reasons: Political and institutional challenges also emerged as a dominant theme across interviews. Forest officials acknowledged that although laws like the Wildlife Protection Act(WPA) (1972) safeguard wildlife effectively, they offer limited proactive protection for affected communities. Delayed compensation, staff shortages, and funding constraints were cited as major barriers to rapid response. As one officer stated,

“Even if we act quickly, one death can cause protests and blame on the department.”

One of them also acknowledged the role of Political parties and their influence on the media to fuel anxiety and distress among people regarding wildlife incidents, which could be a hidden political agenda.

Among the community people, A common sentiment was that current wildlife policies prioritise animals over rural communities and described government intervention as largely reactive. As two villagers in Chekady commented, *“the only rule, WPA, it protects animals, not us humans. Conservation is being done for everyone, but we farmers bear the burden.”*

remarked one frustrated resident, highlighting feelings of institutional neglect during the FGD. A focus group in Channothukkolly described government response as largely reactive, suggesting that action typically follows only after an incident occurs. Participants also mentioned circulating rumours about wildlife management, including claims that problematic tigers are being moved into the area or released back into nearby forests after capture. Although these accounts were unverified, they indicate a wider sense of mistrust and uncertainty about official conflict-response decisions.

NGO representatives were more critical, pointing to weak governance, slow compensation, and politically charged responses. Overall, political reasons were seen as structural constraints that exacerbate people’s vulnerability, echoing quantitative findings where political factors were the most frequently endorsed causes of conflict.

Economic Reasons: Economic hardship was identified as both a cause and a consequence of tiger-human conflict. Respondents described how declining agricultural profitability due to rising costs, labour shortages, and low yields has led to farmland abandonment, which indirectly increases wildlife proximity.

At the household level, limited financial capacity prevents the construction of protective fences or enclosures.

“We don’t have private electric fencing-it’s costly,” said one farmer, highlighting the community’s limited ability to safeguard livestock. In focus groups, villagers admitted their cow pens or enclosures are open at the front, so the tiger can easily attack, as they did not construct it to prevent tiger attacks and that they never imagined a tiger would come to their homestead. Participants across both wards also voiced dissatisfaction with compensation mechanisms, which they described as delayed, bureaucratic, and insufficient. These accounts demonstrate how poverty, economic vulnerability, and weak institutional support amplify exposure to conflict while constraining people’s ability to adapt or recover.

Socio-Cultural Reasons: Although socio-cultural factors received the least endorsement in the survey, qualitative evidence revealed important shifts in human behaviour and social attitudes. Residents described a decline in forest dependence, as fear and legal restrictions discourage activities such as firewood collection and grazing. Even tribal families have now reduced their forest dependency, as noted by the residents. Tolerance toward wildlife has also diminished. Several respondents recalled a time when animal attacks were accepted as fate, contrasting it with today’s zero-tolerance attitude. The Range Forest Officer reflected,

“In the past, wild animal attacks were seen as acts of fate, but today they are viewed as a failure of the forest department.” Even one loss becomes a major issue in the current scenario. Social media further fuels anger and mobilises villagers rapidly after any tiger sighting. Traditional reverence for tigers has largely disappeared. None of the participants described tigers as sacred, instead viewing them as threats.

“We don’t treat tigers as gods - they are nightmares to us now,” remarked one villager. While informal safety norms remain, such as travelling in groups or making noise near forests, most respondents rely on practical rather than spiritual practices.

In short, socio-cultural findings point to declining tolerance and the erosion of traditional coexistence norms, which now contribute to heightened perceptions of insecurity and conflict. Overall, both quantitative and qualitative findings converge on ecological and political factors as the primary drivers of tiger-human conflict in Wayanad. Ecological stressors such as increased tiger populations, habitat degradation, and land-use changes directly contribute to rising encounters, while political issues like weak governance, delayed compensation, and poor enforcement heighten community frustration. Economic hardship and limited adaptive capacity further intensify vulnerability. Although socio-cultural factors

were the least endorsed, qualitative evidence reveals that declining tolerance and the erosion of traditional beliefs amplify fear and resentment. Together, these results indicate that ecological pressures and institutional shortcomings jointly shape the escalating conflict dynamics.

4.4. Awareness and Perceived Effectiveness of Formal and Informal Rules

This section presents the results related to institutional aspects of conflict management, focusing on community awareness, adherence, and perceived effectiveness of both formal and informal rules. It further looks into the reasons for the ineffectiveness of the existing rule system. The analysis also examines some spatial and demographic variations and explores the relationships among awareness, adherence, and perceived rule effectiveness.

4.4.1 Awareness of formal and Informal rules

To assess how local communities engage with tiger conflict management, it is essential to understand their awareness of the rules - both formal regulations set by authorities and informal rules developed within the community.

Awareness of formal rules was measured across three domains: the Wildlife Protection Act (WPA) 1972, compensation schemes, and NTCA guidelines. As shown in Figure 4.15, awareness of the WPA was very high, with 98% reporting “well aware.” Compensation schemes were also widely known, with 65% “moderately aware,” 20% “well aware,” and 13% “aware (name only).” In contrast, NTCA guidelines were entirely unfamiliar (100% not aware).

Awareness of informal rules and practices was nearly universal. As shown in Figure 4.16, all respondents (100%) reported awareness of safety rules such as avoiding solo forest entry, moving in groups, using traditional warning signs, and basic faith rituals (e.g., prayer before entry). By contrast, no respondents endorsed awareness of belief-based items, such as viewing them as sacred or believing that killing one brings bad luck.

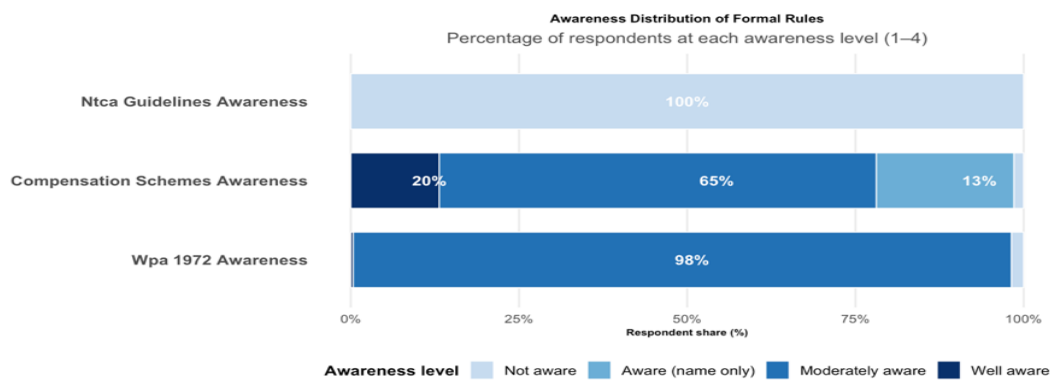


Figure 4.15. Awareness distribution of formal rules by awareness level (1–4).

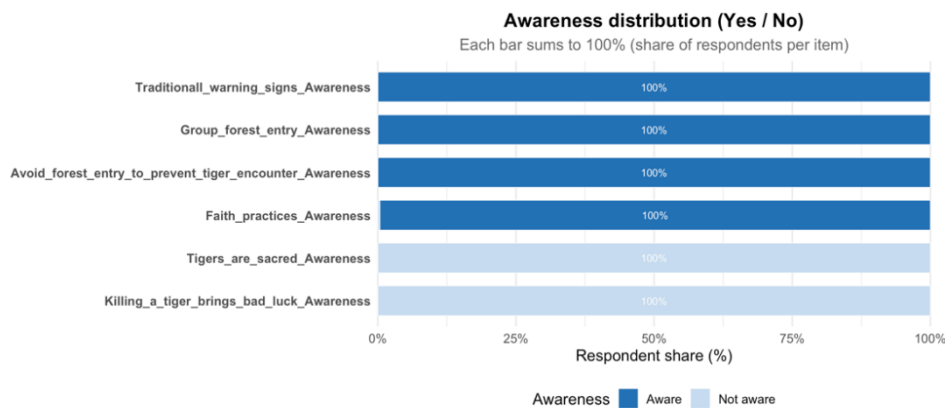


Figure 4.16. Awareness distribution of informal rules and practices

4.4.2 Comparison of Awareness between Formal and Informal Rules

When awareness indices were standardised to a 0 -1 scale (with lower values indicating lower awareness), respondents demonstrated substantially higher familiarity with informal rules than with formal institutional regulations. Formal rule awareness averaged $M = 0.43$ ($SD = 0.09$), whereas informal rule awareness was nearly universal, averaging $M = 0.99$ ($SD = 0.02$) (see Table 4.10 in the Appendix).

A Wilcoxon signed-rank test was conducted to statistically compare awareness levels between the two domains. Results indicated that awareness of formal rules was significantly lower than awareness of informal rules ($V = 0$, $p < .001$, one-sided). The Hodges-Lehmann median paired difference (informal - formal) was 0.56 (95% CI [0.56, 0.56]), confirming that respondents exhibited much greater understanding of informal community practices than of formal policy frameworks (see Table 4.11 in the Appendix).

This quantitative gap in awareness between formal and informal rules was supported by interview and focus group evidence. Participants described commonly practised informal safety measures such as avoiding forest entry alone, travelling in groups, and watching for pugmarks or animal calls for their own safety. These informal rules were seen as essential and widely shared. Participants also noted that traditional or religious beliefs about tigers are no longer widely followed.

In contrast, knowledge of formal regulations such as the Wildlife Protection Act (WPA), NTCA guidelines, and compensation procedures was limited. While many were aware of the WPA as a law protecting wildlife.

“Even wild boar, if we kill it, it opens up jail and punishments,” one participant noted. Few were aware of specific provisions under the Act or NTCA guidelines. Understanding of compensation schemes was similarly general rather than detailed. There is very little awareness among people about how to claim compensation; people often accept whatever is given because they don’t know the exact process.

Some variation existed across locations. Residents of Chekady, where conflict incidents were more frequent, showed relatively greater exposure to forest officials and therefore higher awareness of compensation practices than residents in Channothukkolly. However, informal safety practices were widely shared across both sites.

Forest officials and local representatives confirmed that structured awareness programs had primarily reached only selected Vana Samrakshana Samiti members, with limited outreach to the broader community. Community members expressed that they had not received any classes, training, or formal communication about wildlife laws or compensation policies. Most updates came informally, through word of mouth or social media if at all.

Thus, both quantitative and qualitative findings converge to show that community awareness is rooted in informal, experience-based rules rather than formal institutional rules.

4.4.3 Enforcement Actors of Formal and Informal Rules

The Forest Department emerged as the primary enforcement authority responsible for implementing the Wildlife Protection Act (WPA, 1972) and administering compensation procedures. Key informants reported that the department responds to tiger sightings by monitoring affected areas, setting cages, and conducting tranquilisation operations in accordance with NTCA Standard Operating Procedures (SOPs).

Local Panchayat officials and community volunteers supported coordination and information sharing during such incidents, while community vigilance groups like Jana Jagratha Samithis served as platforms for discussions, disseminating warnings and updates. Non-governmental organisations (NGOs) such as the Wildlife Trust of India (WTI) provided technical support, including camera trapping, animal tracking, and response facilitation during conflict events.

In contrast, informal rules such as travelling in groups or avoiding forest entry during high-risk periods were self-regulated and collectively maintained. These practices were followed voluntarily and reinforced through community norms rather than formal enforcement mechanisms.

4.4.4 Adherence to the Formal and Informal Rules

Figures 4.17 and 4.18 illustrate the extent to which respondents adhere to formal institutional rules and informal community-based practices.

For formal rules, most respondents reported high compliance with the Wildlife Protection Act (WPA, 1972)-74% followed it “most of the time” and 26% “always”. Adherence to compensation scheme procedures was slightly lower and more variable, with 67% following them “most of the time,” 19% “always,” and 12% “rarely”.

Adherence Percentages were calculated only for respondents who reported relevant experience with each rule. For instance, compensation scheme adherence was only answered by those who had relevant experience, and hence percentages are relative to that subgroup.

In contrast, informal rules showed more diverse patterns of adherence. Practical, safety-oriented behaviours had the highest consistency-90% “always” entered forests in groups, while 47% “always” avoided forest entry during high-risk times. Adherence to symbolic or belief-based norms was comparatively lower: only 45% “always” followed faith-based practices like prayers, and 40% “always” observed traditional warning signs.

Overall, these patterns indicate that communities display stronger and more consistent adherence to pragmatic, safety-related informal practices than to symbolic or procedural aspects of either formal or informal rules.

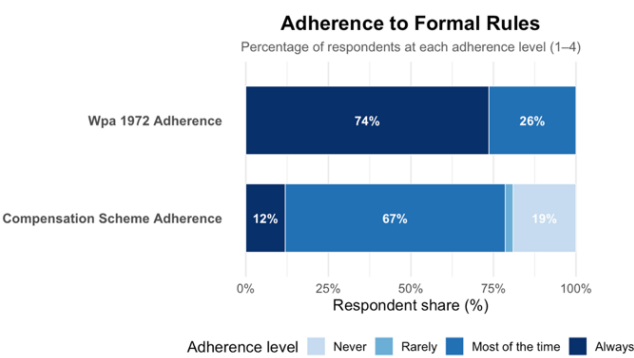


Figure 4.17. Adherence to formal institutional rules

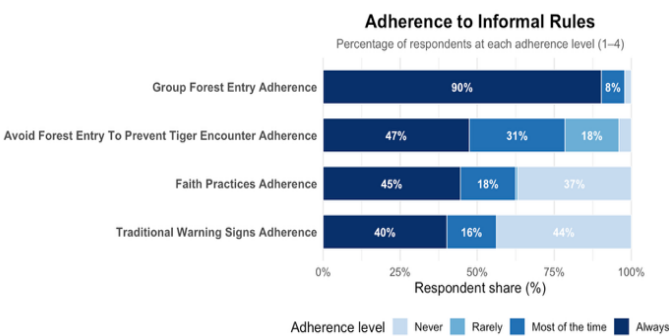


Figure 4.18. Adherence to informal rules

Interview and focus group data indicated that adherence to formal rules was generally maintained, particularly regarding hunting restrictions and animal protection. Several informants noted that hunting had declined due to awareness of legal penalties. As one Panchayat representative explained, “*Earlier, people used to hunt animals, but now they are scared of legal proceedings.*”

Participants described reporting tiger sightings to the Forest Department and following official instructions during incidents. At the same time, some participants expressed that the Wildlife Protection Act was primarily understood as protecting wildlife, as reflected in the statement, “*WPA is not for conflict management... it is only protecting the animals.*” No participants reported direct retaliatory actions, though discussions occasionally included references to frustration following repeated incidents.

Adherence to informal rules was consistently described across communities. Participants characterised practices such as entering forests in groups, avoiding high-risk times, and watching for warning signs as part of their everyday routine. However, some respondents explained that livelihood activities such as firewood collection or grazing sometimes required entering forest-edge areas despite perceived risk: “*Sometimes we have to go, even if we are afraid-there is no choice*”. Informal practices were widely described as shared knowledge reinforced through collective experience rather than formal instruction. Key informants also observed that tribal households were particularly familiar with these unwritten safety norms due to regular interaction with forested environments.

Thus, the survey findings showing high adherence to formal rules and strong reliance on practical informal safety practices were supported by interview accounts. While formal rules were followed largely due to legal obligation, informal rules were consistently practised as practical measures for everyday safety.

4.4.5 Perceived Effectiveness of Rules and Their Changes Over Time

Perceptions of rule effectiveness in mitigating tiger–human conflict revealed a clear divide between formal and informal systems. Most respondents expressed scepticism toward the capacity of formal mechanisms to reduce conflict. Nearly all (96%) rated the Wildlife Protection Act (1972) as ineffective for conflict mitigation, viewing it primarily as a wildlife-protection tool. Similarly, two-thirds (66%) perceived compensation schemes as ineffective, while only about one-third rated them as moderately or fully effective (Figure 4.19).

By contrast, informal community-based rules were viewed as far more effective. Respondents expressed the strongest confidence in practical safety behaviours, with 90% or more rating group forest entry and

avoiding forest entry to prevent tiger encounters as “effective” or “very effective.” Symbolic or belief-based practices, such as traditional warning signs and faith rituals, were viewed more ambivalently-roughly half of respondents considered them only moderately effective (Figure 4.20).

Also, across the household surveys, all respondents reported that both formal and informal rules were more effective in the past than they are today.

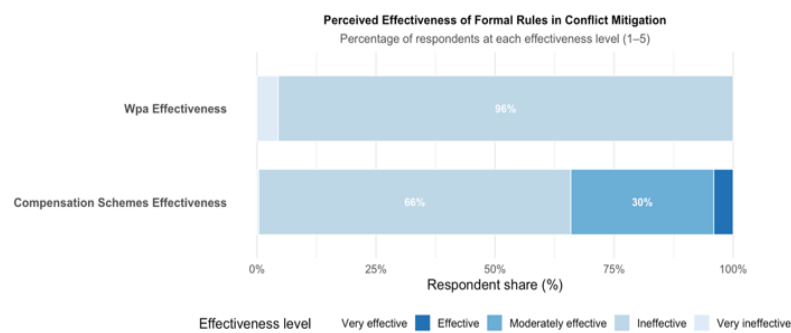


Figure 4.19. Perceived effectiveness of formal rules in mitigating tiger-human conflict

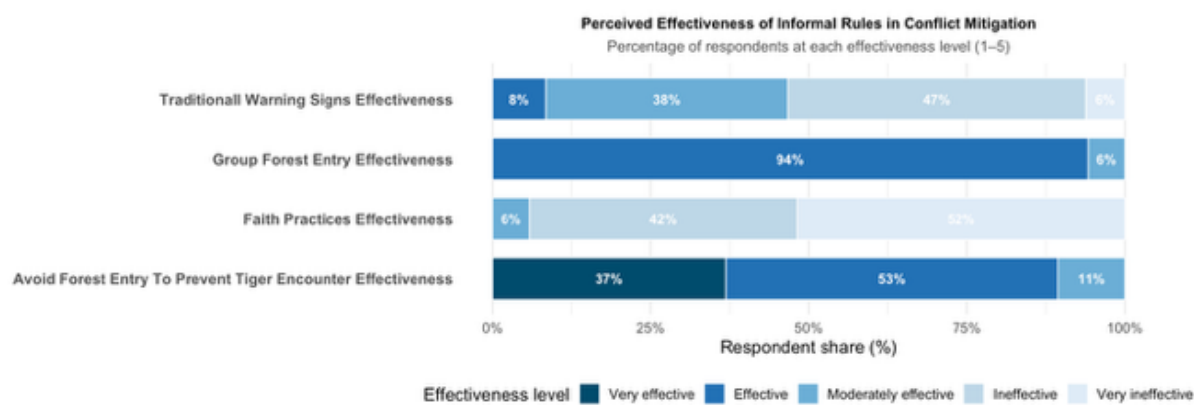


Figure 4.20. Perceived effectiveness of informal rules and practices in mitigating tiger-human conflict.

The qualitative data shed light on similar stories as well. Participants consistently stated that the Wildlife Protection Act (WPA, 1972) is recognised as protecting wildlife, but viewed it as limited in addressing human–tiger conflict situations, particularly when animals move outside protected areas. Forest officials acknowledged that formal actions, such as legal provisions and compensation, primarily take effect after an incident occurs, rather than preventing conflict. They also noted that funding and staff constraints can limit compensation delivery and surveillance capacity. They also stressed the need to make time-bound amendments to the existing rules.

Some officials and NGO representatives suggested that improved management capacity, such as increased funding or structural adjustments, could strengthen response measures.

As one of the officials noted, “*As the Wayand Wildlife Sanctuary become a Tiger Reserve, most of the issues can be solved as more funds could be allotted and they can be better utilised for managing the conflict issues*”. They also highlighted the need for strategies that prevent animal movement into settlements.

Community representatives similarly described formal interventions as reactive, noting that response mechanisms generally follow an incident. While the state’s main formal intervention-compensation is acknowledged as “*better than nothing*”, its limitations are widely resented. Several respondents stated that compensation is often delayed, does not reflect the actual loss, or does not always reach applicants.

Informal rules, such as avoiding forest entry at night, travelling in groups, and observing warning signs, were consistently described as part of daily routines aimed at reducing risk. Participants explained that these practices offer a sense of personal safety, even though they do not stop conflict from occurring. Informal rules were noted to be passed through community experience and local knowledge. However, across the interviews and focus groups, community members expressed that current formal and informal rules function as coping strategies rather than preventive solutions.

Overall, the quantitative and qualitative findings were consistent, indicating that formal rules were widely viewed as limited in preventing conflict, whereas informal safety measures were perceived as more effective than the formal ones in managing everyday risk. These perceptions indicate that while formal rules are acknowledged as important, they are not experienced as practically helpful, leading communities to rely more heavily on informal, experience-based strategies.

Hypothesis test (H₂): Awareness of formal rules is positively associated with their perceived effectiveness.

Spearman’s rank correlations were conducted to examine the association between awareness of formal rules and their perceived effectiveness. For the Wildlife Protection Act (WPA, 1972), there was a significant negative association ($\rho = -0.283$, $p < .001$), indicating that greater awareness was linked to lower perceived effectiveness. For compensation schemes, the association was weak and non-significant ($\rho = -0.106$, $p = .082$). The NTCA guidelines were excluded due to insufficient awareness data (Also see Table 4.12 in the Appendix).

Therefore, H₃ is not supported. Greater awareness did not correspond to higher perceived effectiveness, and in the case of the WPA, awareness was associated with more critical evaluations.

Note. To aid the interpretation, the 5-point effectiveness scale used in data collection (1 = Very effective, 5 = Very ineffective) was reversed before analysis so that higher scores indicate greater effectiveness.

As all respondents were aware of informal rules, no awareness-effectiveness correlation was conducted for them.

4.4.6 Reasons for ineffectiveness of the formal and Informal rules

Respondents highlighted several factors behind the declining effectiveness of both formal and informal rules governing tiger–human conflict management.

For formal rules, most respondents (98.2%) pointed to conflicts between conservation policies and local livelihoods as the main reason for ineffectiveness, followed by impractical or overly strict laws (70.4%), lack of awareness (59.3%), and poor enforcement and corruption (52.9%). About one-third (32.5%) mentioned lack of resources, highlighting gaps in policy implementation and institutional capacity (Figure 4.21).

For informal rules, respondents most frequently cited the impact of conflict on traditional restraint (100%), indicating that recurring losses have eroded tolerance toward tigers. Other prominent reasons included the replacement of customary norms by formal government regulations (92%), declining awareness among younger generations (81.8%), and changing religious and cultural beliefs (75.5%) (Figure 4.22).

Taken together, these findings suggest that the perceived weakening of formal rules stems largely from institutional and policy-level challenges, whereas the decline in informal rules is attributed to cultural transformation, generational change, and increased conflict frequency.

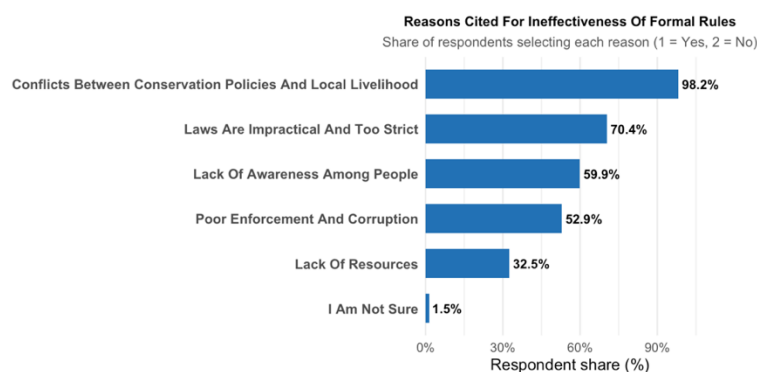


Figure 4.21. Reasons for the ineffectiveness of formal rules in tiger-human conflict management

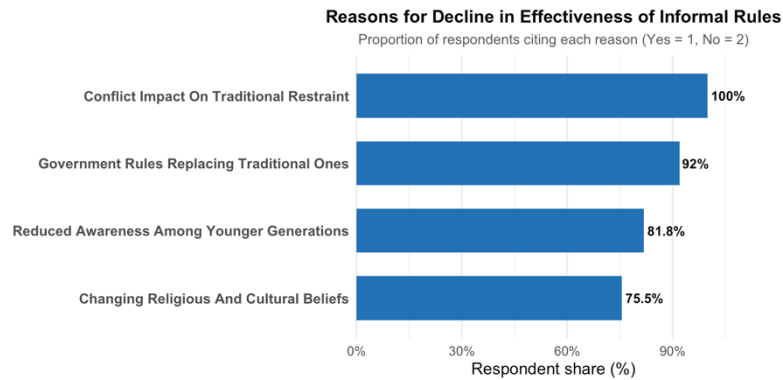


Figure 4.22. Reasons for the ineffectiveness of informal rules in tiger-human conflict management.

Interview and focus group findings closely mirrored the survey results. Participants across age groups described informal rules as more effective in the past, when encounters were less frequent. Several long-term residents recalled that avoiding the forest was once sufficient to prevent incidents, whereas increased tiger movement into settlements has made such practices less reliable.

As one respondent reported, *“We follow the safety rules because they help us every day, but they cannot stop the tiger from coming out of the forest”*. This shift in encounter patterns was consistently associated with a sense that informal practices now offer reduced protection.

On the formal side, respondents acknowledged improvements in departmental responsiveness and compensation schemes, but expressed frustration that these measures still remain reactive, delayed and insufficient given the rising frequency of conflict.

Together, the quantitative results and narrative explanations point to overlapping causes behind the reduced effectiveness of both rule systems: formal mechanisms struggle with enforcement, responsiveness, and alignment with livelihood realities, while informal practices have been undermined by generational change and more frequent tiger presence near settlements.

4.4.7 Statistical Relationships Between Awareness, Adherence, and Perceived Effectiveness

4.4.7.1 Adherence and Perceived Effectiveness

The association between adherence and perceived effectiveness differed between rule types. For formal rules, adherence showed no meaningful association with perceived effectiveness ($p = 0.039$, $p = 0.528$). In contrast, adherence to informal rules demonstrated a moderately strong, positive and significant

association ($p = 0.378$, $p < 0.001$), indicating that those who more consistently followed informal safety practices were more likely to consider them effective. (See table 4.13 in the Appendix)

4.4.7.2 Ward-Level Variation in awareness of formal rules and perceived effectiveness

Mann–Whitney U tests revealed significant ward-level differences for both rule domains. For formal rules, awareness was significantly higher in Chekady ($W = 5419$, $p < .001$), the higher-conflict area, but perceived effectiveness did not differ between wards ($p = .851$). For informal rules, awareness levels were similar across wards ($p = .324$), yet respondents from Chekady rated these practices as significantly more effective ($W = 6769.5$, $p < .001$).

These results suggest that exposure to frequent conflict may enhance both familiarity with formal rules and confidence in informal coping mechanisms (See Table 4.14 in the Appendix.)

4.4.7.3 Additional Tests and Demographic Patterns

Additional non-parametric tests explored relationships between awareness, adherence, and demographic factors. Correlations between awareness and adherence were weak and non-significant for both formal and informal rules, indicating that knowing about a rule did not necessarily translate into compliance. No significant demographic effects were observed, except that respondents from Chekady (the higher-conflict area) reported greater awareness of formal rules and higher perceived effectiveness of informal rules. Full statistical details are provided in Appendix Tables 4.15 and 4.16.

These statistical findings reinforce the qualitative insights that community members place greater trust in informal, experience-based norms than in formal regulatory systems for managing tiger–human conflict. While awareness of both rule types is widespread, it does not necessarily drive adherence or belief in their effectiveness. Adherence to informal rules, however, positively shapes perceived effectiveness, particularly in high-conflict areas. Overall, the results highlight a legitimacy gap in formal conservation governance while underscoring the enduring relevance and resilience of community-based management practices.

This persistent sense of insecurity, despite the existence of multiple formal and informal rules, underscores the need to examine how different actors, from officials to community members, are adapting (or failing to adapt) to ongoing conflict. These adaptive responses, and their perceived effectiveness, shape the evolving prospects for human–tiger coexistence in Wayanad. The following section explores these

adaptation strategies and perceptions, linking them to the broader dynamics of rule awareness, adherence, and effectiveness discussed above.

4.5 Adaptation Strategies and Community Perceptions of Coexistence

This section examines the adoption and perceived effectiveness of both formal and informal adaptation strategies used by households to manage human–tiger conflict. It also explores how these strategies shape local perceptions of coexistence and influence the broader relationship between people and tigers in Wayanad.

4.5.1 Formal Adaptation Strategies and Implementing Actors

Survey results indicated that the Forest Department is perceived as the primary institutional actor responsible for implementing formal adaptation strategies (Figure 4.23). Nearly all respondents attributed key conflict mitigation measures such as patrolling, monitoring and rapid response deployment, caging and relocation of tigers, and administration of compensation schemes to the forest department. In contrast, the roles of local governments and joint initiatives between agencies were reported less frequently, suggesting a centralised implementation structure with limited local collaboration.

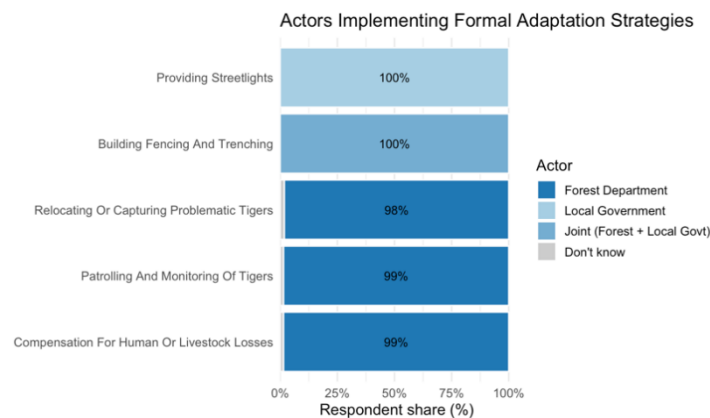


Figure 4.23. Actors responsible for implementing formal adaptation strategies

Interview and focus group findings supported this pattern. Community members consistently identified the Forest Department as the lead authority in responding to tiger sightings. They described a standard response process beginning with local forest guards assessing the situation, followed by the deployment of Rapid Response Teams (RRTs) in high-risk cases. These teams were reported to conduct field inspections, track pugmarks, and install camera traps to identify individual animals. Where continued risk was perceived, cages were set up for capture. In several accounts, the officials acknowledged that cages

were sometimes placed pre-emptively, even before receiving official clearance, in response to heightened community concern.

Participants also described the capture and relocation of tigers that were repeatedly associated with livestock predation or movement near houses. Decisions to capture or relocate were reported to be made through multi-stakeholder committees that included Forest Department officials, veterinarians, and NGO representatives, operating under NTCA Standard Operating Procedures. Lethal control was described as legally permissible only in cases involving human fatalities or risks during the capture events, and respondents emphasised that such cases were rare.

Preventive strategies were also mentioned to have become part of the formal adaptation toolkit. Respondents reported that in coordination with local Panchayats, the Forest Department has undertaken the digging and maintenance of trenches, installation of fencing along forest edges, and selective clearing of vegetation near village boundaries. In high-conflict areas, Panchayat representatives noted the use of MGNREGA funds to clear abandoned agricultural fields adjacent to forests.

Compensation for livestock and crop losses was widely known, and most participants reported having either applied for or witnessed compensation processing. However, respondents commonly reported delays in receiving payments and perceived compensation amounts as not fully covering losses, as mentioned before.

Non-governmental organisations, particularly the Wildlife Trust of India (WTI), were also identified as active contributors. Although the community people were less aware of the organisation, NGO staff reported that they had provided steel-mesh cattle sheds to vulnerable households and supported the formation of Predator Response Teams (PRTs) in several villages and provided awareness and information to the affected families. These PRTs were reported to coordinate through mobile messaging groups to share alerts and assist during conflict incidents. Along with Panchayat representatives, they also reported participating in conflict-related committees alongside Forest Department staff.

While respondents acknowledged increased responsiveness of Rapid Response Teams in recent years, they also noted that structured awareness programmes and preventive community engagement activities remained limited.

These qualitative findings reinforce the survey results, showing that formal adaptation efforts in Wayanad are primarily driven by the Forest Department, with limited roles for Panchayats or NGOs. Both data sources highlight a reactive rather than preventive orientation, with most interventions such as caging, relocation, and compensation occurring after conflict events. Although community respondents acknowledged improved responsiveness, they consistently emphasised delays, limited outreach, and insufficient preventive engagement. Overall, the findings reveal that formal strategies remain institutionally centralised but operationally constrained in addressing the complexities of tiger-human conflict.”

4.5.2 Informal Adaptation Strategies and Implementing Actors

The informal adaptation strategies in this study were undertaken primarily by two groups: the general community and the tribal households residing along the forest fringes. These strategies are developed and practised independently by residents, without direct institutional coordination. For the household survey, a predefined list of commonly observed informal practices was used to assess both their adoption and perceived effectiveness.

Survey data indicate that informal adaptation strategies are widely practised across households (Figure 4.24). The most commonly reported responses included avoiding nighttime outdoor movement (96%), alerting neighbours immediately when a tiger was sighted (87.6%), and keeping guard animals (82.1%). Lighting the surroundings and animal sheds at night (62.8%), reliance on prayer or faith-based practices (63.1%), and observing traditional environmental warning signs (56.2%) were also frequently noted. Avoiding forest entry altogether was reported by 47.4% of respondents, reflecting behavioural adjustments where livelihoods allowed flexibility.

In contrast, more resource-intensive measures such as private electric fencing (1.8%), strengthening or rebuilding livestock enclosures with durable materials (2.6%), and the revival of older traditional strategies (5.8%) were reported at low levels. Respondents attributed this to financial limitations and labour constraints.

Ward-level comparisons revealed similar patterns with minor variations (Figure 4.25). In Chekady, the higher-conflict area, the use of traditional warning signs (79.7%) and faith-based coping practices (89.9%) were more prevalent. In Channothukkolly, a lower-conflict ward, households more often reported avoiding forest areas (78.7%) and maintaining guard animals (84.6%). Private fencing and structural reinforcements were rarely used in either ward. These findings indicate that informal adaptations are

predominantly low-cost, behaviourally driven, and rooted in collective experience rather than material investment.

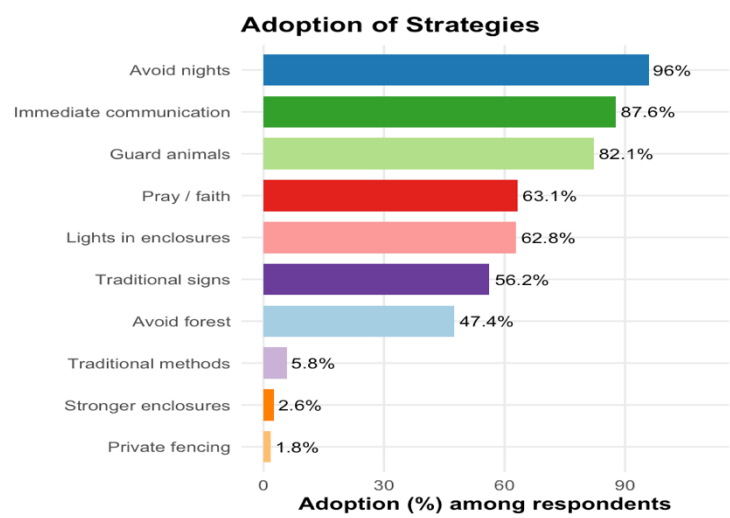


Figure 4.24. Adoption of informal adaptation strategies for mitigating human-tiger conflict.

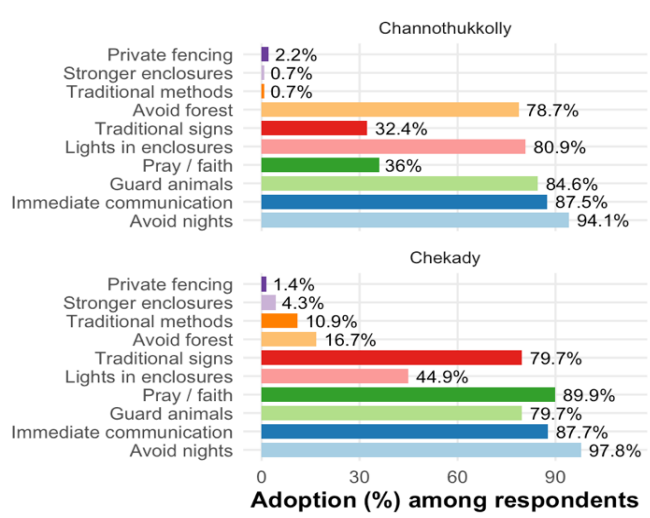


Figure 4.25. Adoption of informal adaptation strategies across study wards.

Qualitative data supported these findings. Across interviews and focus group discussions, residents described a set of everyday precautionary behaviours, such as avoiding solitary travel after dark, reducing or stopping firewood collection from forest edges, moving in groups, and increasing vigilance around livestock housing. Some households reported installing additional lighting in yards and sheds, as one FGD participant said,

“we try to put lights on animal sheds... most sheds have no proper coverings, so a tiger can easily attack from the front”.

Guard dogs were widely regarded as valuable for early warning, though respondents noted variation in their reliability. Many respondents mentioned being constantly alert to noises at night. Livelihood adjustments were also observed. Several respondents and officials noted that agricultural activities have declined in parts of Wayanad, with some farmers reducing cultivation or abandoning fields entirely.

Tribal livestock herders described collective grazing practices in which one or more individuals continuously monitored animals near forest edges. Community-level communication networks, including informal neighbourhood alert groups and, where present, Predator Response Teams, were used to share sightings and coordinate responses.

Participants further indicated that ritual or symbolic practices have largely declined, and that current adaptations are primarily practical and precautionary. Overall, informal adaptation strategies were characterised as low-cost, flexible, and collectively maintained households adjusted daily routines and behaviours in response to perceived risk rather than through major infrastructural or financial investments.

These qualitative insights closely aligned with the survey findings, showing that informal adaptation in Wayanad is rooted in everyday, collective practices rather than formal interventions. The most common strategies - avoiding night travel, maintaining lights in livestock sheds, using guard dogs, and alerting neighbours were repeatedly described as practical and community-driven. Together, the qualitative and quantitative results underscore the central role of local knowledge and mutual support in shaping resilience to tiger-human conflict.

4.5.3 Perceived Effectiveness of Formal and Informal Strategies

Figure 4.26 shows that respondents perceived patrolling and monitoring of tigers (86%) and relocating problematic tigers (73%) as the most effective formal strategies. Compensation for losses received moderate confidence (51%), while infrastructural measures were viewed least favourably: streetlights were rated ineffective by 65%, and fencing or trenching had the lowest confidence, with only 31% rating them as moderately effective.

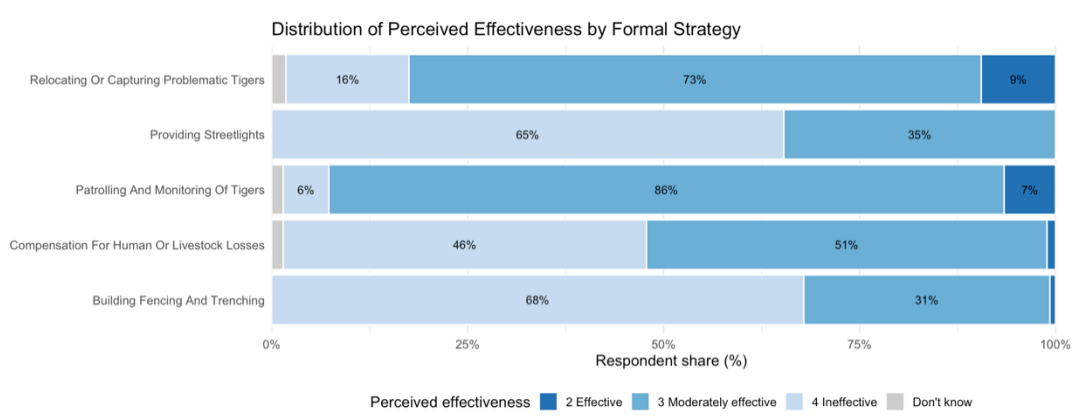


Figure 4.26. Perceived effectiveness of formal adaptation strategies among respondents.

In contrast, communities expressed greater confidence in their own informal practices (Figure 4.27). Avoiding nighttime activities and avoiding forest areas were perceived as the most effective behavioural practices, followed by immediate communication and guard animals. In contrast, symbolic strategies such as prayer and traditional signs were rated much less effective, despite moderate usage rates. A notable portion of respondents did not use strategies requiring material investment (e.g., electric fencing or enclosure upgrades)(see the detailed mean rating tables (Tables 4.17 & 4.18) in the appendix).

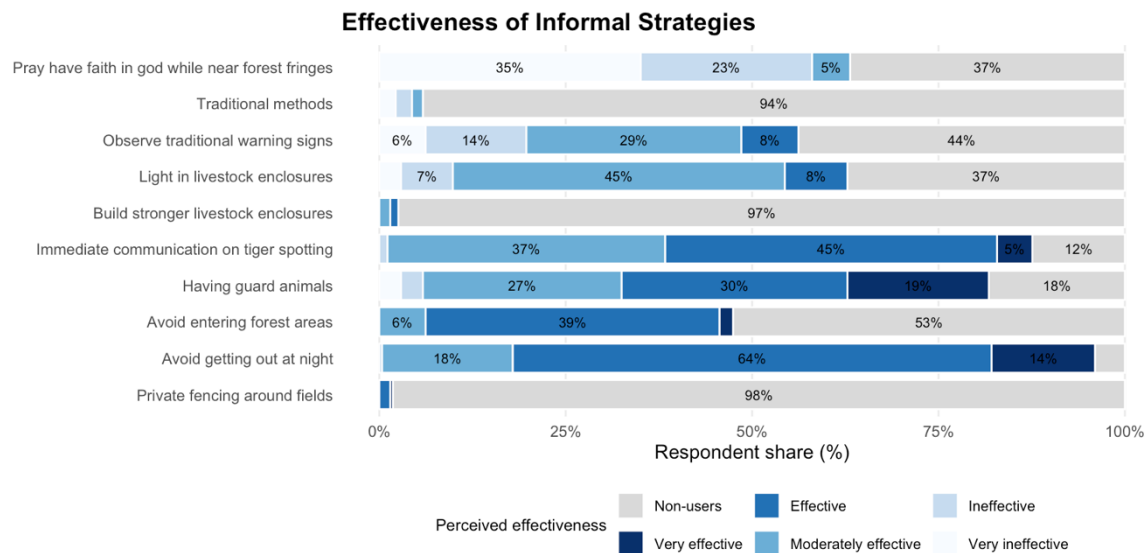


Figure 4.27. Perceived effectiveness of informal adaptation strategies among respondents.

Statistical analyses supported these patterns. A Wilcoxon signed-rank test (see Table 4.19 in the appendix) showed that respondents rated informal strategies as significantly more effective than formal strategies ($p < 0.001$). Kruskal-Wallis tests (see Tables 4.20 & 4.21 in the appendix) further indicated substantial variation within each category: behavioural and preventive informal practices were rated significantly higher than symbolic methods, while active formal interventions such as patrolling and relocation were rated higher than infrastructure-based measures. Post-hoc comparisons (see Tables 4.22 and 4.23 in the appendix) confirmed these differences ($p < 0.001$). Together, these results demonstrate that communities place greater trust in direct, experience-based actions than in passive or centralised interventions.

Qualitative accounts supported these patterns. Participants consistently described informal strategies as necessary for day-to-day safety. Many respondents said that avoiding night-time movement, staying indoors when a tiger was reported, and alerting neighbours helped them “*feel safer*” and “*prevent sudden encounters*”. Several livestock owners noted that guard dogs and group vigilance around sheds provided early warning at night. Although villagers regularly share pugmark sightings and warnings, they admit that they cannot predict when and where the tiger will come. Respondents also emphasised that these practices are “*easy to do every day*” and do not require external support.

In contrast, perceptions of formal strategies were more mixed. Patrolling and Rapid Response Team interventions were generally viewed positively, particularly in cases where tigers were trapped or relocated quickly. At the same time, several community members expressed scepticism about relocations, noting uncertainty about what happens to the tiger after capture; many believed that the animal is simply released back into the forest and may eventually return to settlements. Participants also raised concerns about infrastructure-based measures such as fencing and streetlights, which often fail when not properly maintained, with one respondent noting that “*the fence works only at first, then it stops.*” Compensation was appreciated but frequently described as delayed or insufficient, and some livestock owners reported being unable to claim losses when carcasses had been dragged into the forest.

Several respondents stated that both formal and informal strategies help manage the situation, but do not prevent repeated incursions, noting that “*the tiger still comes; we just try to stay careful*”. Overall, qualitative evidence indicates that community members view informal behavioural adjustments as more consistently useful for everyday safety, while formal responses are recognised as important but limited to specific conflict events. Participants noted that these strategies help them cope with conflict situations but do not fully prevent future tiger visits.

The triangulation of quantitative and qualitative data indicates a consistent pattern in how adaptation strategies are perceived and used. Informal, behaviour-based strategies are considered more reliable for everyday safety because they are directly controlled by households and can be adjusted immediately in response to risk. In contrast, formal strategies are valued but viewed as reactive, since they typically come into play only after a tiger has already entered settlement areas or livestock have been lost. Overall, while formal measures provide support during conflict events, informal strategies are regarded as essential for managing daily risk and maintaining a sense of precaution in forest-fringe life.

4.5.4 Perception on Co-existence

Figure 4.28 shows that coexistence with tigers is perceived overwhelmingly negatively among respondents. A total of 93% of households reported coexistence as “poor”, 6% as “very poor”, and 1% as “neutral”. No respondents reported a positive perception of coexistence.

These patterns were consistent across both study wards (Figure 4.29). In Channothukkolly, 93% rated coexistence as poor or very poor, compared to 92% in Chekady. Neutral responses were minimal, and no respondents in either ward perceived coexistence positively. This high degree of uniformity suggests that negative coexistence perceptions are widespread and not strongly influenced by ward-level differences.

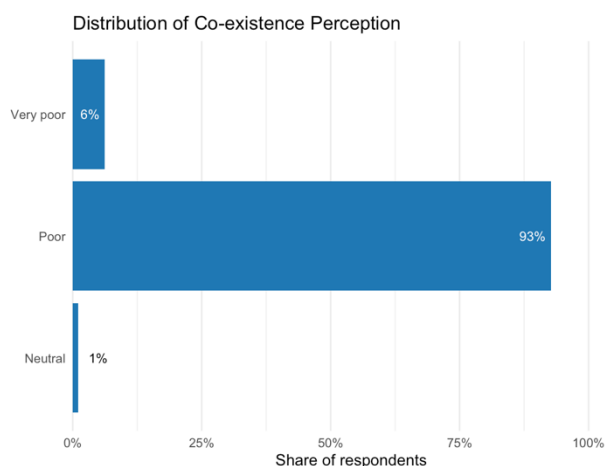


Figure 4.28 Distribution of Perceived Coexistence (Wole study area)

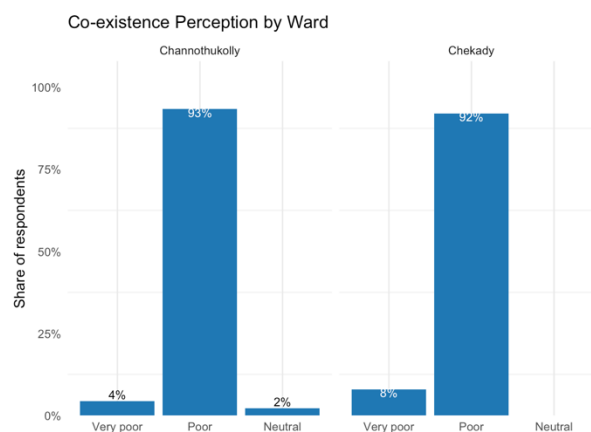


Figure 4.29 Ward-Level Differences in Human-Tiger Coexistence-Perception

Qualitative accounts reinforced the quantitative findings, with participants consistently expressing low tolerance for living alongside tigers under current conditions. Respondents described fear, uncertainty, and disruption to everyday activities as key reasons. Statements emphasised a “threshold of tolerance,” where coexistence was considered acceptable only if encounters were extremely rare. One resident remarked,

“It is bearable if it is a very rare incident, but at the present rate, this seems very unsafe and intolerable.”

Several participants reported changing daily routines, such as avoiding night travel and remaining vigilant when working in fields. Some described a constant psychological burden, noting that everyday life required “constant caution.”

Concerns regarding economic loss, personal safety, and insufficient protection or compensation were frequently raised. Respondents also associated increased conflict frequency with declining tolerance, stating that coexistence is perceived as increasingly difficult. In both wards, some participants mentioned considering relocation, although feasibility constraints such as attachment to land, financial limitations, and lack of buyers made relocation difficult. Across focus groups and key informant interviews, there were also mentions of distrust or dissatisfaction with institutional support, with some respondents feeling that wildlife protection is prioritised over human safety.

Both the quantitative survey data and qualitative accounts show strong convergence: perceptions of coexistence with tigers are widely negative and consistent across study sites. Quantitative results indicate near-unanimous dissatisfaction, and qualitative narratives explain this in terms of fear, livelihood insecurity, routine disruptions, and perceived inadequacy of institutional responses. Together, the findings

indicate that current coexistence is experienced as strained and difficult, with limited variation across demographic groups or locations. This sets the stage for examining what kinds of measures might shift the perceptions toward safety.

Hypothesis Test (H₃): Adoption of Informal Strategies and Coexistence Perceptions

A Spearman's rank-order correlation was conducted to examine whether higher adoption of informal adaptation strategies was associated with more positive coexistence perceptions. Coexistence perceptions were coded so that higher scores indicate more positive perceptions. The analysis showed a very weak and non-significant correlation ($\rho = 0.025$, $p = 0.676$), indicating that households adopting more informal strategies did not report more favourable coexistence attitudes.

To further explore this relationship, households were categorised into low, medium, and high adoption groups based on the number of informal strategies used. A Kruskal–Wallis test found no significant difference in coexistence perceptions across these groups, $\chi^2(2) = 3.61$, $p = 0.164$ (see table 4.24 in the appendix). Median coexistence scores remained consistently low (approximately 2 = “Poor”) across all adoption levels, showing minimal variation between groups.

Taken together, these findings demonstrate that the extent of informal strategy adoption does not meaningfully shape coexistence perceptions. Instead, attitudes toward coexistence are likely influenced by broader structural and experiential factors such as institutional trust, previous conflict events, and livelihood vulnerability rather than by behavioural adjustments alone.

Thus, Hypothesis H₃ is not supported.

Chapter 5: Discussion, Conclusion and Recommendations

5.1 Introduction

This chapter discusses and interprets the key findings of the study in relation to existing research on human–tiger conflict, governance, and adaptation strategies in forest-fringe landscapes. The chapter builds on the empirical and qualitative results presented earlier, covering conflict patterns, rule awareness and adherence, adaptation strategies, and perceptions of coexistence, and situates them within broader theoretical and policy debates. This section focuses on explaining why these patterns emerged, how they connect to wider ecological and institutional dynamics, and what they imply for future management.

The discussion examines how human-tiger conflict in Wayanad has intensified and how this shapes the rule perceptions, adaptation strategies, and coexistence attitudes of people. It interprets findings using the Institutional Analysis and Development (IAD) framework and a Socio-ecological co-evolution perspective, showing that institutional responses have remained largely reactive compared to faster ecological change and community adaptation, which contributes to declining trust and negative coexistence perceptions.

5.2 Evolution, Nature, and Severity of Conflict

This section addresses the SO1 by arguing that conflict intensification in Wayanad is shaped not only by increased tiger presence alone but also by increasing landscape permeability and information amplification, which together raise both exposure and fear among people.

5.2.1 Nature and Perceived Severity

The study reveals a marked escalation in perceived conflict severity, with Chekady showing more “very high” ratings than Channothukkolly. This pattern aligns with research showing that proximity to forests and recent conflict experiences amplify perceived risk and intolerance (Inskip & Zimmermann, 2009; Kansky & Knight, 2014). The significant associations between severity, livestock depredation, and relocation pressure reinforce established relationships between direct losses, fear, and declining tolerance (Dickman et al., 2013). Nevertheless, studies demonstrate that large carnivores can coexist within densely populated agrarian landscapes when social tolerance remains high (Athreya et al., 2013), underscoring that coexistence depends as much on human attitudes as on ecological exposure.

The triangulation of results indicates two complementary pathways driving heightened perceptions of conflict documented in this study. First, material exposure through frequent encounters, livestock depredation, and disrupted daily routines contributes to a genuine increase in perceived danger. Second, informational amplification through mobile phones, CCTV, and social media magnifies both the visibility and emotional salience of such incidents. The Range Forest Officer's remark that conflict "existed earlier" but is now more visible mirrors wider evidence that communication technologies and media framing amplify public awareness of wildlife incidents. The growing circulation of tiger encounter videos on social media similarly escalates fear and collective anxiety, consistent with findings that digital media can dramatise encounters and politicise local tensions (Ballejo et al., 2021; Gao et al., 2023). Comparable dynamics have been observed in India, where online platforms increasingly shape narratives around human–wildlife conflict and influence public tolerance (Ravi Krishnan & Soundra Rajan, 2025).

These findings suggest that intensified perceptions of danger arise not only from actual increases in tiger activity but also from enhanced detection, documentation, and rapid information sharing. In other words, the escalation in perceived severity reflects a combination of real ecological pressures (frequent incursions, livestock losses) and heightened social visibility through digital media and surveillance technologies. This interpretation matters because it shifts the problem definition: conflict governance must manage both ecological risk and uncertainty produced through fast-moving information environments. From a co-evolution perspective, community fear and behavioural change can escalate quickly when encounters become more visible, while institutional communication and prevention often adjust more slowly, widening the mismatch. From a management perspective, these findings show that addressing human-tiger conflict requires attention not only to ecological risk but also to how conflict information circulates and shapes public fear. Ecological interventions and strengthening preventive measures (eg, predator-proof livestock enclosures, improved nighttime safety measures, etc) must be paired with transparent, timely and verified communication to counter misinformation and reduce panic. A more consistent approach, such as verified alerts, clear incident updates, and post-action follow-ups, may help communities distinguish between isolated sightings and repeated high-risk patterns.

5.2.2 Observed Land-Use Changes

Land-use change in Wayanad has been gradual yet ecologically significant, reshaping forest-settlement boundaries even where residents perceive little visible transformation. In Channothukkolly, respondents reported clear signs of deforestation and farmland abandonment, while

in Chekady, smaller but continuous alterations such as infrastructure growth and settlement expansion were less perceptible yet coincided with higher conflict intensity. This asymmetry suggests that slow, dispersed, and often legal transformations, including small-scale clearing, agricultural retreat, and tourism development, may go unnoticed while still increasing human-wildlife interface risk.

Remote-sensing studies support these perceptions. Over the past two decades, Wayanad has witnessed steady declines in forest and agricultural areas, coupled with an expansion of built-up and plantation land, contributing to fragmentation and higher land-surface temperatures (John, 2020). Satellite data show that approximately 200 ha of natural forest were lost in 2024, leaving only about 43 % forest cover (Global Forest Watch, 2025). Studies also reported that Increased human activity and landscape fragmentation in Wayanad are major contributors to ecological stress and wildlife encounters (Thomas et al, 2021). These trends align with and help explain residents' perceptions of increasing conflict.

Three mechanisms appear to connect land-use change to rising conflict. First, boundary blurring occurs when abandoned fields and plantations turn into dense “bushy wastelands,” offering cover for tigers and prey near human settlements. Second, fragmentation and disturbance from roads, resorts, and quarries disrupt habitat continuity and alter prey availability. Third, livelihood withdrawal driven by crop loss, labour shortages, and fear reduces cultivation, enabling vegetation overgrowth and increasing wildlife proximity. Comparable processes have been observed across India, particularly in the Western Ghats and around the Ranthambhore Tiger Reserve, where forest fragmentation and corridor encroachment have facilitated carnivore movement and elevated conflict risk (Athreya et al., 2013; Singh et al., 2025). The frequently cited “mini-forest” metaphor among respondents captures this boundary-softening process. Karanth et al. (2019) likewise note that when farmland abandonment coincides with forest regeneration and weak buffer management, ecological permeability increases, facilitating predator dispersal. Such gradual, dispersed change underscores the need for proactive rather than reactive land-use planning.

Effective preventive management, therefore, requires coordinated, landscape-level interventions that link conservation concerns with land-use and rural development planning, regulating resort and quarry expansion, maintaining wildlife corridors, and promoting managed cultivation or buffer vegetation (e.g., bamboo or mixed hedgerows) to retain open visibility near settlements. Strengthening land-use governance can reduce both ecological permeability and livelihood vulnerability, thereby reinforcing coexistence capacity in Wayanad's interface zones. From an IAD perspective, land-use outcomes at the forest edge are not only ecological; they reflect how rules,

responsibilities, and enforcement are coordinated (or fragmented) across departments and local bodies, shaping the conditions that produce encounters.

5.2.3 Drivers of Tiger-Human Conflict

The persistence and escalation of tiger-human conflict in Wayanad emerge from a convergence of ecological, political-institutional, economic, and socio-cultural dynamics. These dimensions interact to reshape risk perception, exposure, and local tolerance toward wildlife. The central argument from SO1 is that conflict is best understood as an interaction between changing landscapes and changing governance capacity, rather than a single driver such as tiger abundance.

Ecological drivers: Respondents' emphasis on ecological causes, particularly the increase in tiger presence and forest degradation, reflects a broader pattern of "recovery under constraint" observed across India's tiger landscapes. Following the implementation of the Wildlife (Protection) Act, 1972 and Project Tiger, India has witnessed a steady resurgence of tiger populations, including in Kerala's Wayanad landscape (Jhala et al., 2021; NTCA, 2023). The IUCN Red List assessment (Goodrich et al., 2022) similarly recognises India's conservation success, but cautions that continued habitat fragmentation and limited connectivity pose serious challenges to sustaining this recovery. Recent range-wide analyses confirm that tiger conservation landscapes across Asia have shrunk and become more fragmented, expanding edge habitats and increasing the human potential-wildlife interactions (Sanderson et al., 2023). These findings reinforce the local perceptions that Wayanad's forests are recovering in numbers but not in quality or spatial continuity.

The interviews and focus-group discussions from this study vividly captured this ecological tension. Forest officials linked "occasional straying" of tigers to population pressure within confined habitats, while NGO representatives argued that "the problem is not tiger numbers but the degradation of the forest." Both perspectives are consistent with ecological studies from the Western Ghats, which highlight how declining habitat quality, invasive species, and fragmentation degrade interior forests and push carnivores toward human-used edges (Goodrich et al., 2022; Mungi et al., 2021; Sanderson et al., 2023). Invasive plants such as *Lantana camara*, *Senna spectabilis*, and *Chromolaena odorata* are now widespread in Kerala's forests, including Wayanad Wildlife Sanctuary, where *Senna* occupies more than 70 km², reducing understorey diversity and wild grazer forage (Bradley et al., 2019). These ecological changes can lower prey availability inside the forest, encouraging predators to hunt livestock at the periphery.

Seasonal drought and water scarcity raised by local participants further intensify these dynamics. During dry months, wild herbivores and their predators concentrate near remaining water sources, often close to settlements, heightening the likelihood of encounters. Similar seasonal patterns of hydrological stress and increased human-tiger interface have been reported in the Sundarbans region (Chatterjee, 2022; WWF Tigers Alive, 2022). However, research also shows that well-connected and prey-rich habitats can sustain stable tiger ranges even in densely populated regions. Long-term occupancy studies in the Terai-Arc Landscape demonstrate that tigers tend to remain within their traditional territories when forest connectivity and prey abundance are sufficient (Harihar & Pandav, 2012). This suggests that habitat permeability and landscape connectivity, not merely tiger numbers, are decisive factors in shaping conflict risk. These findings closely align with local observations that abandoned farmlands and plantations have turned into “mini-forests”, creating continuous cover that enables wildlife to move freely between protected and settled areas. While such mosaics enhance connectivity for wildlife, they also blur the boundaries between forest and farmland, thereby expanding the interface where conflict can occur (John et al., 2020; Karanth et al., 2019).

In summary, conflict in Wayanad is driven less by the absolute number of tigers and more by the changing structure and permeability of the landscape. Addressing these pressures requires a multi-pronged approach—restoring native vegetation, managing invasive species, maintaining water and prey availability within forest interiors, and carefully managing edge habitats to prevent uncontrolled “mini-forest” formation that intensifies interface contact.

Political and institutional constraints: Political factors emerged as the most strongly endorsed causes in the survey and interviews, echoing national critiques of India’s wildlife governance systems. Interviewees cited delayed or inadequate compensation, opaque bureaucratic processes, and political manipulation of incident issues that have been widely documented elsewhere. These concerns are consistent with evidence from other Indian contexts: compensation programmes can be unevenly administered and slow, limiting their effectiveness and eroding trust (Johnson et al., 2018). A national review likewise documents systemic bottlenecks, delays, limited transparency, and weak oversight in compensation and insurance schemes (Leslie et al., 2019). In Kerala, the government reported over ₹79 crore in compensation payments for human-animal incidents over the past six years; however, local media highlight that many payouts are delayed and amounts deemed insufficient by claimants (Times of India, 2025). As one forest officer noted, “*Even if we act quickly, one death can cause protests and blame on the department,*” capturing how political risk aversion shapes bureaucratic response. Research also shows that news framing influences how the public perceives wildlife events:

media can amplify conflict narratives and sensationalise incidents, which undermines evidence-based management (Bhatia et al., 2013; Hathaway et al., 2017).

Interestingly, the Spearman analysis revealed a negative correlation between perceived political causes and conflict severity ($\rho = -0.55$), implying that respondents who recognised political roots were less likely to rate conflict as “severe.” This may indicate that some respondents attribute conflict to governance weaknesses rather than viewing the animal itself as the main cause. This echoes the findings that transparent and inclusive governance can foster local tolerance for wildlife (Ogra, 2008; IUCN, 2023). Although political and institutional weaknesses remain significant, recent initiatives in Kerala, such as increased budget allocations for conflict mitigation and the declaration of wildlife conflicts as a state-specific disaster (The Indian Express, 2024), indicate a gradual shift toward more predictable, transparent, and participatory governance, rather than purely reactive crisis management. Building trust requires faster, transparent compensation processes and participatory decision-making mechanisms that acknowledge local risk and responsibility. This pattern is consistent with an IAD interpretation in which negative evaluations of outcomes (e.g., safety, fairness, timeliness) weaken perceived legitimacy of formal rules, pushing the households to rely more on locally embedded “rules-in-use” instead.

Economic drivers: Economic vulnerability forms both a root cause and a reinforcing loop within conflict dynamics. In the survey, every respondent cited financial loss and inadequate compensation; interviews added farm abandonment, labour scarcity, and unaffordable prevention and mitigation patterns consistent with Indian studies showing compensation can be slow or uneven and often fails to reduce risk or rebuild trust (Johnson et al., 2018; Karanth et al., 2018). When cultivation becomes unprofitable, fields are left fallow and can overgrow, increasing cover for wild herbivores and predators, an outcome linked to broader rural economic change producing new zones of encounter (Margulies, 2018). Gulati et al. (2021) show that human casualties are the dominant monetised cost of HWC in India, while many indirect losses (crop damage, time, stress) remain under-compensated, echoing villagers’ concerns that delayed payments have limited utility. Evidence from Indian reserves further indicates that limited financial capacity constrains the adoption of protective measures (e.g., reinforced sheds, fencing), creating a cycle of exposure and dependency and shaping attitudes toward wildlife and management (Karanth et al., 2012; Karanth et al., 2019).

The correlation analysis from the study showed that endorsement of ecological and socio-cultural causes was positively associated with conflict severity, but economic causes were not. This nuance suggests that while livelihoods frame people’s vulnerability, institutional and ecological conditions

determine the perceived risk intensity. Still, economic insecurity matters. Global and India-focused analyses show that the burden of carnivore conflict falls disproportionately on economically sensitive areas, meaning coexistence is harder where margins are thin (Brackowski et al., 2023). Several scholars similarly argue that as livelihood security declines and adaptive capacity falls, tolerance for wildlife tends to narrow (Treves & Santiago-Ávila, 2020; IUCN, 2023).

Socio-cultural drivers: Although socio-cultural causes received the lowest quantitative endorsement (34%), qualitative evidence indicates subtle but meaningful shifts in community attitudes. Older residents' recollections of fatalistic acceptance ("acts of fate") contrast sharply with younger generations' expectations of state protection and rapid institutional response. Similar generational transitions have been documented in Uttarakhand and Maharashtra, where rising education, mobility, and digital connectivity have reshaped perceptions of risk and responsibility (Ogra, 2008; Bhatia et al., 2020). In Kerala, where literacy and smartphone penetration are particularly high, social media can rapidly amplify isolated incidents into region-wide controversies, eroding tolerance and pressuring forest authorities toward reactive rather than preventive responses. The findings also indicate a decline in symbolic reverence for tigers. Historically, many Indigenous and agrarian communities in India maintained animistic and kinship-based relationships with large carnivores, which encouraged restraint and forms of everyday coexistence (Aiyadurai, 2016). In contrast, participants in this study frequently referred to tigers as "nightmares," reflecting a shift from relational familiarity to more fear-based and adversarial interpretations of wildlife. In the selected sites in Wayanad, cultural practices that once may have buffered encounters, such as ritual respect or spiritual meaning, appeared largely absent among at least the forest fringe communities. This contrast shows that cultural foundations of coexistence are not uniform or fixed; they are historically grounded and can erode when social, economic, and institutional conditions change.

Taken together, the findings show that tiger-human conflict in Wayanad arises from the interaction of ecological recovery, livelihood stress, institutional limitations, and shifting cultural attitudes rather than tiger abundance alone. As Carter and Linnell (2016) argue, coexistence depends not merely on predator numbers but on how societies manage risk through governance, adaptation, and shared responsibility. Conflict, therefore, cannot be explained by tiger abundance alone; it is shaped by how permeable and contested ecological, institutional, and cultural boundaries have become. In Wayanad, this means that conflict mitigation cannot rely on single measures such as compensation or relocation, but requires integrated interventions. Sustainable coexistence requires restoring ecological buffers, improving livelihood and compensation support, strengthening transparent governance, and fostering

community dialogue to rebuild tolerance. Together, these measures can shift management from short-term crisis responses toward long-term, proactive coexistence. Most of all, coexistence depends on recognising that the people who live closest to wildlife carry the greatest burden and therefore must be central to the solutions. Therefore, from a co-evolution perspective, landscape change and livelihood adjustments are evolving faster than preventive governance, while encounter visibility (through surveillance and social media) can accelerate fear and behavioural change, helping explain why perceived severity rises even when “tiger numbers alone” cannot fully account for people’s experience.

5.3 Awareness and Perceived Effectiveness of Formal and Informal Rules

5.3.1 Awareness of Formal and Informal Rules

This section addresses SO2 by arguing that formal rules are widely recognised in principle but remain weak in day-to-day usability, which shifts reliance toward informal “rules-in-use” that are immediately actionable.

The findings from the study demonstrate a marked contrast between the community’s strong reliance on informal safety practices and its limited engagement with formal institutional rules. Although many respondents were aware that wildlife is legally protected, this knowledge was broad and largely symbolic rather than procedural. As one resident explained,

“Even wild boar, if we kill it, it opens up jail and punishments.”

This indicates that the Wildlife Protection Act is recognised principally as a restrictive and punitive instrument, rather than as a framework that might also provide support or recourse. This pattern reflects national observations that wildlife laws in India are more widely understood as prohibitory rather than participatory (Karanth et al., 2018; Johnson et al., 2018). The complete lack of awareness of NTCA guidelines suggests that top-down regulatory frameworks remain largely disconnected from everyday conflict management at the village level. Most participants recognised the Wildlife Protection Act (WPA) 1972, commonly referred to simply as “the Act”, with a general understanding that it protects wild animals and punishes harm against them.

In contrast, informal rules were deeply embedded in everyday life. Participants described travelling in groups, maintaining vigilance around forest edges, and rapidly sharing information when a tiger was sighted. One respondent noted,

“We try to put lights on animal sheds... we inform each other and the forest department immediately if a tiger is seen.”

Such practices function as collective self-regulation, developed from repeated encounters rather than formal instruction. Similar findings in the Western Ghats and central Indian landscapes show that communities frequently rely on experiential knowledge systems to manage risk, especially when institutional outreach is limited (Ogra, 2008; Athreya et al., 2013; Kshetry et al., 2017).

The study also revealed a shift in socio-cultural orientations toward tigers. Older ritual practices, such as carrying charms or tiger teeth for protection, were recalled as stories but not actively followed. A forest guard mentioned the past practice of using elephant placenta as a protection charm, but community members emphasised that such beliefs are now viewed as old concepts. Today, perceptions are shaped by fear and loss rather than reverence. As one villager stated,

“We don’t treat tigers as gods... tigers are nightmares to us.”

This decline in symbolic value aligns with research suggesting that cultural tolerance erodes when communities experience repeated conflict and feel unsupported by governance structures (Aiyadurai, 2016; Bhatia et al., 2020).

Awareness of formal mechanisms, particularly compensation procedures, was broadly recognised but poorly understood. Many respondents reported not knowing the necessary steps, documentation, or points of contact. “People often accept whatever is given because they don’t know their rights,” one participant observed. Many participants noted that compensation applications and interactions with the Forest Department were “usually attended by the men of the household,” reflecting gendered patterns of public-facing decision-making. This aligns with research from other parts of India showing that while women often bear the daily impacts of wildlife encounters, men typically engage with external institutions and bureaucratic processes (Ogra, 2008; Bhatia et al., 2020; Banerjee & Sharma, 2022). However, this pattern was less pronounced among tribal communities in the study area, where forest use and decision-making practices tend to be more collectively negotiated among both males and females.

Differences between locations further underscore the role of exposure and institutional presence. Residents of Chekady, a high-conflict zone, interacted more often with forest staff and therefore displayed relatively greater familiarity with compensation claims than those in Channothukkolly.

Even so, both groups reported minimal awareness of classes given. As several respondents explained, they have not received any classes or training. Forest officials confirmed that most awareness efforts target only Vana Samrakshana Samiti members, leaving the wider community reliant on informal communication channels such as neighbours, word of mouth, or social media. However, some noted an improvement in general awareness in recent years, indicating that outreach efforts may be slowly bridging the gap. Educating the youth from the conflict-prone area can build empathy and understanding from an early age (Baishya et al., 2025). Integrating knowledge about wildlife, human-animal interactions, and safety practices into school lessons can help build a future generation that is better prepared to live alongside wildlife (Jacobson et al., 2015).

Taken together, these findings indicate that informal knowledge currently forms the primary operational framework through which communities manage tiger encounters, while formal institutions remain present but distant, recognised, yet not fully accessible or practical in everyday situations. Informal norms function as the immediate safety net: they are learned through lived experience, shared rapidly, and enacted collectively. In contrast, formal rule awareness often remains abstract, especially when communities lack guidance on how to navigate legal procedures or obtain entitlements. From an IAD perspective, this gap in procedural knowledge can reduce meaningful participation in the formal action arena and limit access to institutional benefits, reinforcing dependence on local rules-in-use. Therefore, improving “awareness” alone may not be sufficient unless it also improves the practical usability of formal mechanisms, such as with clear steps, contact points, and timelines. Strengthening coexistence in Wayanad requires shifting formal rule awareness from symbolic recognition to practical use. This can be supported through locally accessible training, simplified compensation procedures, and more direct engagement between forest officials and the wider community, not only Vana Samrakshana Samiti members. These efforts should build on, rather than replace, the informal safety practices that already guide daily behaviour. Without such measures, community safety will continue to rely primarily on informal norms, which reduce immediate risk but offer limited long-term security or institutional support. A more integrated approach that values local knowledge while improving access to formal mechanisms is therefore essential for sustainable coexistence. From a co-evolution perspective, the dominance of informal rules indicates rapid behavioural adaptation under repeated exposure, while formal systems lag in usability and prevention, widening the governance–risk mismatch.

5.3.2 Enforcement Actors and Adherence to Rules

The findings indicate that formal enforcement of tiger-related regulations in Wayanad is largely state-led, while everyday risk management is primarily community-driven. The Forest Department's role as the central authority aligns with the broader governance structure of wildlife protection in India, where state agencies are mandated to enforce the Wildlife Protection Act (WPA) and operationalise conflict response protocols. In this study, respondents described the Forest Department's rapid-response actions, such as cage-setting, monitoring, and tranquilisation, indicating an increasingly structured approach to conflict response. These efforts were supported by Panchayat officials, community vigilance groups, and NGOs, creating a multi-actor enforcement system where formal state interventions are complemented by local coordination.

Despite these structures, adherence to formal rules appears to be shaped more by fear of legal punishments than by shared legitimacy. Participants frequently associated the WPA with punishment rather than protection. This indicates compliance grounded in fear of legal consequences, rather than in confidence in institutional support. Similar findings have been documented in other parts of India, where wildlife laws are perceived as prioritising conservation goals over community safety, contributing to a sense of "legal asymmetry" in which wildlife are protected while people feel vulnerable (Dhee et al., 2019; Fanari, 2022; Ogra, 2008; Johnson et al., 2018). Some respondents reported choosing not to apply for compensation due to the lengthy application process, the relatively low compensation amount, and past experiences of not receiving payments despite submitting claims. The reluctance to apply for compensation reflects a broader erosion of confidence in formal conflict-mitigation mechanisms, reinforcing the community's dependence on informal practices over institutional processes. Similar issues have been documented elsewhere in India; for instance, research from Rajasthan shows that compensation schemes are often designed primarily to support the conservation of threatened species, rather than to safeguard local livelihoods (Johnson et al., 2018). In contrast, people strongly follow informal safety practices like going in groups and avoiding dangerous times, based on what they have learned from experience. They are followed because they are perceived as necessary, not required. Similar patterns are seen in other forest-edge communities (Ogra, 2008).

Taken together, the findings suggest that formal rules are acknowledged but not socially embedded, whereas informal rules are socially embedded but not institutionally recognised. This disjuncture has implications for coexistence policy. Formal enforcement systems may be more effective when combined with recognition of community-based knowledge, and when compensation and response

mechanisms are made more accessible, relational, and trust-building rather than solely procedural. From an IAD perspective, this indicates weak legitimacy of formal rules-in-use: institutions are present, but their authority is not translated into everyday support or predictable outcomes.

5.3.3 Perceived Effectiveness of Rules and Changes Over Time

Formal rules are perceived as ineffective mainly because they are experienced as procedurally difficult and reactive, while informal rules are valued because they reduce immediate everyday risk. The respondents' low confidence in formal instruments (WPA/compensation) and higher confidence in pragmatic, informal behaviours mirrors patterns reported across India. In Rajasthan, compensation has been shown to maintain tolerance for wildlife rather than fully offset losses, reflecting a similar gap between livelihood needs and institutional response (Johnson et al., 2018). In Maharashtra, compensation reduced anger and discouraged retaliatory killing, but did not meaningfully restore losses, leading communities to view it as a tolerance-support mechanism rather than a livelihood safeguard (Bayani et al., 2016). Likewise, in parts of the Western Ghats, compensation payments have often been delayed, partial, or inconsistent, reinforcing local scepticism (Karanth et al., 2013). A national review further documents wide variation in eligibility criteria, payout levels, and application procedures, which contributes to uneven experiences across states (Bhatia et al., 2021).

At the same time, communities' reliance on experience-based, informal rules like moving in groups, avoiding high-risk areas is strongly echoed in ethnographic research from forest-edge settlements in Uttarakhand, where such behaviours function as collectively learned, socially reinforced risk-management norms, not government-led directives (Ogra, 2008). Ecological work also shows that large carnivores continue to use human-dominated landscapes, increasing everyday exposure and making behavioural adaptation central to people's sense of safety (Kshetry et al., 2017). However, the participants' view that informal practices feel more useful can be understood in the context, since human injury and livelihood loss are the most serious impacts of conflict in India (Gulati et al., 2021), thereby households prioritise measures that reduce immediate risk. This helps explain why, every day, experience-based rules are seen as more effective than reactive formal measures like compensation.

At the same time, there are cases in India showing that formal mechanisms can be effective when actively supported and simplified. The Wild Seve intervention in Karnataka assisted households with filing and tracking claims and achieved high claim acceptance and faster disbursement, improving trust and satisfaction (Karanth & Vanamamalai, 2020). This contrasts with the respondents'

frustrations from the study site and suggests that the weakness lies in implementation, not the concept of compensation itself.

Furthermore, participants linked the perceived decline in the effectiveness of both formal and informal rules to the increased frequency and spatial spread of tiger encounters in recent years. Earlier, informal practices such as avoiding forests were sufficient when conflicts occurred primarily within forest boundaries. However, with tigers increasingly entering settlements and agricultural areas, these measures are no longer adequate. This shift underscores the need for stronger preventive strategies, rather than relying solely on reactive and mitigative mechanisms such as compensation or post-incident interventions. Finally, several officials in the study argued that better resourcing, preventive planning, and boundary management could improve outcomes. This is consistent with broader national governance recommendations emphasising proactive infrastructure, clearer institutional mandates, and community-inclusive planning (Bhatia et al., 2021). Overall, low confidence in formal mechanisms appears to emerge from three interconnected factors: procedural complexity that makes compensation difficult to access, limited transparency and communication around post-capture decisions, and the predominantly reactive nature of state interventions. The rule effectiveness depends less on the existence of formal policies but more on their accessibility, responsiveness, and alignment with local realities. Thus, awareness of a rule does not guarantee its usability during high-stress incidents shaped by time pressure, documentation burdens, and uncertainty. From an IAD perspective, these barriers reduce practical access to the action arena and weaken perceived legitimacy of formal arrangements, reinforcing reliance on informal rules-in-use.

5.3.4 Perceived Ineffectiveness of Formal and Informal Rules

While the previous section established that informal rules are considered more effective than formal instruments, the present discussion examines why both systems are perceived to be weakening over time. Rather than a simple preference for local practices over state-led measures, the findings suggest that the effectiveness of rule systems is shaped by ecological change, institutional capacity, and cultural and generational transitions.

The perceived ineffectiveness of both formal and informal rules appears to stem from broader socio-ecological changes rather than from any single failure of policy or tradition. Participants consistently linked the decline in effectiveness to the increased frequency and spatial spread of tiger encounters, noting that past coexistence was supported by a degree of spatial separation between forests and settlements. As one respondent explained,

“We lived with animals in the past, but now we have lost the tolerance for that,”

suggesting that informal norms once relied on the relative predictability of where tigers would be. This aligns with ecological research showing that large carnivores increasingly use human-dominated landscapes, eroding earlier patterns of mutual avoidance (Athreya et al., 2016; Kshetry et al., 2017). At the same time, respondents highlighted that state conservation laws have gradually displaced local authority and decision-making, contributing to the weakening of community-based rule systems, a dynamic also observed in other parts of India and globally, where centralised wildlife governance has reduced the legitimacy of local norms (Rangarajan, 2001; Goldman et al., 2010). One NGO representative also referred to an earlier cultural practice known locally as *“Narikuthu”*, in which the tribal community members would collectively kill tigers that were perceived as weak or had strayed into settlements. While this practice functioned historically as a form of community-led risk management, it is no longer socially legitimate and is now illegal under the Wildlife Protection Act (1972). Its disappearance was described as part of a broader shift in authority from local customary regulation to state-controlled conservation governance.

The generational shifts further compound this decline, as younger community members are less engaged in agriculture and forest-based livelihoods and therefore less exposed to the situated knowledge through which informal safety practices were historically learned and transmitted (Berkes, 2012). Meanwhile, although respondents acknowledged improvements in formal responses, such as faster compensation and more active field staff, these measures were still viewed as reactive and insufficient in the face of recurring incidents. As one participant put it, “We follow the safety rules because they help us every day, but they cannot stop the tiger from coming out of the forest,” indicating that both formal and informal approaches are now outpaced by changing conditions on the ground. Evidence from elsewhere in India, such as the Wild Seve programme in Karnataka, demonstrates that formal mechanisms can function effectively when administrative burdens are reduced, and support is provided to households (Karanth & Vanamamalai, 2020), suggesting that the challenge lies less in the principle of compensation than in its implementation and its limited preventive capacity. Taken together, these findings indicate that the declining perceived effectiveness of rules reflects a mismatch between the current scale and frequency of human–tiger interactions and the ability of existing institutional and cultural systems to manage them, pointing to the need for preventive, locally grounded, and co-produced strategies that better align with lived realities and rapidly changing human–wildlife spatial dynamics. From a co-evolution perspective, this “weakening” is best interpreted as a speed mismatch: encounter patterns and everyday adaptation

change faster than institutional design, outreach, and preventive capacity. Also, from an IAD perspective, this translates into declining legitimacy and reduced confidence in outcomes, which further entrenches reliance on informal rules even as they become insufficient.

5.4 Adaptation Strategies and Community Perceptions of Coexistence

5.4.1 Formal Adaptation Strategies in Context

This section addresses SO3 by arguing that formal adaptation strategies are experienced as event-driven and centralised, which provides short-term containment but is not experienced as consistently reducing everyday exposure or uncertainty, thereby shaping coexistence perceptions.

The results from the study indicate that formal conflict mitigation in Wayanad is highly centralised, with the Forest Department perceived as the primary actor responsible for rapid response, monitoring, capture/relocation, and managing compensations. This governance pattern reflects India's broader institutional framework for large carnivore conflict, where the National Tiger Conservation Authority (NTCA) mandates that state Forest Departments lead response actions under Standard Operating Procedures (NTCA, 2013; 2019). The community's description of Rapid Response Teams (RRTs) conducting site visits, setting camera traps, and placing cages during high-tension situations closely aligns with these formal SOP guidelines regarding emergency containment of tigers in human-use landscapes (NTCA, 2013; 2019).

However, while the Forest Department's responsiveness was acknowledged, respondents consistently viewed these strategies as reactive rather than preventive. This echoes findings from other parts of India, where formal interventions primarily manage the aftermath of conflict, rather than reducing the frequency of encounters (Manral et al., 2016). Participants in this study described caging and relocation of tigers that repeatedly approached settlements, yet research from India warns that translocation is often ineffective for large felids, sometimes even increasing conflict after relocation. Athreya et al. (2011), for example, demonstrated that relocated leopards in Maharashtra exhibited wider ranging movements and heightened conflict risk post-release. Although species-specific, these findings support the reservations expressed by participants regarding the long-term effectiveness of relocation-based strategies. In addition, participants raised concerns about transparency in relocation decisions. While many appreciated the Forest Department's quick response during conflict incidents, some were uncertain about what happens to captured tigers afterwards, and expressed worries that relocated animals may return or that problematic tigers from nearby states might be introduced into

the local forests. These perceptions do not necessarily reflect management practice, but rather indicate gaps in communication and follow-up, regardless of whether they are accurate, which can contribute to mistrust.

The Forest Department and Panchayat representatives referred to the Jana Jagratha Samithi (JJS) as a participatory forum intended to improve coordination and early warning. However, consistent with Ramseena (2025), the present study found that while JJS improves information sharing, it has limited influence over decision-making, as the authority to act remains with the Forest Department. This reinforces a dynamic where community involvement exists, but without power-sharing, participation is perceived as symbolic rather than transformative. Compensation was widely known and appreciated in principle, but frequently described as delayed, insufficient, or unpredictably processed, as discussed in the above sections.

Preventive barriers such as trenches and fences were also reported, but their effectiveness was seen as inconsistent due to poor maintenance. Studies from elsewhere in India show that these structures can work initially but quickly fail if not regularly repaired (Karthick & Ramakrishnan, 2023; Chakraborty et al., 2025). Digging a trench has also been proven unsuccessful due to human error or environmental factors (Nath and Sukumar, 1998; Manral et al., 2016). Electric fencing, while potentially effective, is costly to install and requires continuous power and upkeep; when maintenance lapses, animals often learn to exploit weak points (Pragadeesh et al., 2025). Similarly, trenches only work when maintained to the required depth and width; once eroded or damaged, they are easily crossed, leading to reduced community trust in these measures (Prasad et al., 2025). However, most of this evidence comes from elephant conflict areas, and there is very limited research on how effective such barriers are against tigers. The Sundarbans is one exception, where nylon fencing has reportedly reduced tiger entry, though formal evaluations are still limited (Roy Chowdhury & Sambamurthy, n.d.). The use of MGNREGA (Mahatma Gandhi National Rural Employment Guarantee Act) funds to clear vegetation near the forest edge reflects emerging attempts to integrate rural development schemes into conflict mitigation, but the scale and coordination required for sustained preventive impact remain limited. Finally, the study highlights a supporting but less visible role of NGOs, particularly the Wildlife Trust of India (WTI), which has facilitated predator-proof livestock sheds and community-based alert networks through Predator Response Teams. They were also involved in awareness post-conflict events. Yet both NGO workers and Panchayat representatives noted that structured, pre-incident awareness and coexistence education remain

limited, reinforcing the finding that most formal adaptation remains short-term, event-driven, and reactive.

Taken together, the findings suggest that while formal strategies are operational and often well-coordinated during crisis events, their preventive and participatory dimensions are less developed. Consistent with national and global research, this points to a need for co-produced, locally embedded preventive approaches that complement reactive enforcement and compensation systems. Strengthening formal adaptation, therefore, requires shifting from a crisis-response model toward continuous prevention, so that interventions are experienced as routine risk reduction, not only emergency containment, supported by regular maintenance budgets, clearer communication around response decisions, and partnerships that enable communities to experience formal interventions as reliable risk reduction rather than only emergency containment. From an IAD perspective, this reflects a governance design where authority is centralised, but the benefits of prevention and participation are not yet experienced as consistent outcomes at the household level.

5.4.2 Informal Adaptation Strategies

This section addresses SO3 by arguing that informal adaptation dominates because it is immediately actionable, low-cost, and socially reinforced, making it the default form of everyday risk management.

Although a centralised formal adaptation system is in practice, the findings show that informal strategies form the primary and most widely used set of responses to tiger presence in Wayanad. These strategies are grounded in everyday behaviour rather than material infrastructure, and are shaped by local experience, risk perception, and available resources. Households commonly avoided night-time movement, reduced or stopped entering the forest alone, travelled in groups, and quickly alerted neighbours when animals were sighted. The use of guard animals and collective vigilance around livestock sheds was also widespread. The respondents also mentioned being vigilant even while sleeping at night. Evidence from other Indian contexts suggests that privately and individually owned fences can be more effective than government-owned fences against larger wild animals (Manral et al., 2016). However, structured and reinforced livestock enclosures, or private fencing, were least adopted due to their heavy investment costs and maintenance requirements. These behavioural adjustments reflect a flexible, low-cost approach to managing risk in daily life. Similar patterns have been documented in other large carnivore landscapes in India. In central India, households commonly adjust routines by stall-feeding livestock, shifting grazing times, and avoiding

high-risk areas at dawn and dusk, alongside increased vigilance near homesteads (Karanth et al., 2012; Meena et al., 2023). In Himalayan and trans-Himalayan regions, group herding, human supervision of livestock, and maintaining guard dogs are widely practised as a daily means of reducing encounters with carnivores (Sidhu et al., 2017; Meena et al., 2023). Among forest-fringe communities, informal warning networks, shared alert systems, and coordinated responses within neighbourhoods have also been noted as key elements of everyday risk management (Hussain et al., 2022; Alam & Nayak, 2024). Reinforced livestock sheds and electric fencing are also among the most consistently effective measures, but require budget and continued maintenance (Karanth & Kudalkar, 2017).

The persistence of these strategies suggests that coexistence with large carnivores is maintained not only through policy or enforcement but through socially embedded norms of caution, communication, and collective responsibility. Such practices are reinforced through shared memory of encounters, intergenerational knowledge, and frequent conversations about risk rather than formal training or external instruction (Karanth & Kudalkar, 2017). In Wayanad, tribal herders' practice of keeping constant watch during grazing reflects similar patterns observed among pastoral and forest-dependent groups in other carnivore-sharing regions, where mobility and presence are used as preventive strategies rather than physical barriers. Traditional ritual-based avoidance practices were reported to have declined, although some respondents mentioned prayer or faith as a source of psychological reassurance. Overall, informal adaptation has shifted toward practical and precautionary measures closely tied to household routines.

Overall, informal strategies in Wayanad are characterised by being low-cost, flexible, and socially coordinated, relying on behaviour and vigilance rather than external intervention or infrastructure. These strategies represent a form of everyday coexistence shaped by lived experience with wildlife and continuous negotiation of safety in shared landscapes. From a co-evolution perspective, this demonstrates rapid community-level adaptation to shifting risk, even when institutional prevention is experienced as limited.

5.4.3 Perceived Effectiveness of Formal and Informal Strategies

This section addresses SO3 by arguing that informal strategies are perceived as more effective because they reduce immediate day-to-day risk, while formal strategies are valued mainly for visible crisis response but criticised for limited preventive impact and weak follow-up communication.

The findings show clear differences in how communities in Wayanad evaluate formal and informal adaptation strategies. Informal strategies, particularly avoiding night-time movement, staying in groups, rapidly sharing sightings, and using guard animals, were perceived as more reliable for day-to-day safety. These behavioural measures are embedded in routine household decision-making and require limited external support, which likely contributes to their perceived practicality. Similar behavioural adjustments have been documented in other carnivore-sharing landscapes in central and Himalayan India (Karanth et al., 2012; Hussain et al., 2022; Meena et al., 2023), where vigilance, modified grazing schedules, stall feeding, and collective alert systems form the backbone of everyday risk management. The patterns of perception in the present study also align with spatial and temporal risk dynamics found in empirical work on tiger and leopard attacks, which show livestock and human vulnerability are highest during early morning and nighttime periods and along forest edges (Miller et al., 2016; Bargali & Ahmed, 2018).

In contrast, perceptions of formal strategies were mixed and more varied. Patrolling and rapid response operations were viewed favourably, particularly when capture teams responded quickly during critical events. However, respondents regarded these actions as reactive, activated only after a tiger has entered settlement spaces or caused damage. This is consistent with broader analyses of conflict governance in India, which note that state-led interventions tend to prioritise post-incident control rather than sustained prevention (Manral et al., 2016; Karanth & Kudalkar, 2017). The scepticism surrounding compensation aligns with longstanding issues of delayed disbursement, proof requirements, and mismatch between loss and reimbursement (Karanth et al., 2012; Meena et al., 2023). Although relocation of problematic tigers was viewed as one of the more effective formal strategies, the qualitative findings show that this confidence is mainly linked to the immediate relief it provides. People described relocation as reassuring because it is visible, quick, and signals that authorities are “doing something.” However, many respondents were unsure about what happens after the animal is captured. Some believed that the tiger might return, or that other problematic tigers might be brought in, reflecting limited communication and transparency about post-capture procedures. Although the department assures that the injured and unhealthy tigers will be either taken to the tiger Rehab or Zoo and only healthy tigers might be rereleased into deeper forests, people are still sceptical and unsure of the true things happening. Research also shows that relocation of large felids has been shown to result in wide post-release movements and, in some cases, elevated conflict levels in new areas (Athreya et al., 2011). This highlights a gap between short-term reassurance and long-term effectiveness, and the need for clearer communication and stronger preventive measures.

Infrastructure-based measures, such as trenches, electric fencing and streetlights, received the lowest confidence. Community concerns regarding poor maintenance and inconsistent functioning are well-supported by previous evaluations. Barriers often fail when power supply is unstable, vegetation grows over wires, or trenches erode during monsoon seasons (Fernando et al., 2008; Manral et al., 2016; Karthick & Ramakrishnan, 2023). The effect of these structures against tiger crossing is also less studied. While reinforced livestock enclosures have shown success in some targeted cases, including pilot installations by WTI in Wayanad, their scalability remains limited by cost and labour demands. Experimental evidence from the western Himalaya also suggests that low-cost deterrents and strengthened night enclosures can reduce depredation when maintained (Naha et al., 2020), indicating potential for expansion if resources and institutional support are sustained.

Emerging technological proposals further indicate limitations of the current reactive model. While communities and frontline staff rely on direct sightings, phone alerts, and physical patrolling, several studies and pilot interventions suggest that proactive early-warning systems could reduce surprise encounters. Field trials of AI-enabled camera traps integrated with automated image recognition and instant alert transmission in tiger corridors have demonstrated the feasibility of providing near real-time notifications to managers and local communities (Dertien et al., 2023). Similar approaches are being promoted in conflict management guidelines for leopard landscapes in India, which emphasise early detection and rapid response as core preventive strategies (Indo-German Biodiversity Programme, 2023). In Kerala, similar initiatives using drones, thermal cameras, automated Anider alarm systems, and machine-learning-based detection have been introduced in mostly the elephant conflict zones, although most remain in trial phases and require sustained evaluation (Kerala Forest Department, 2025). In Wayanad, conceptual models have been proposed for AI and IoT-based early-warning systems linking camera traps, GPS movement data, and predictive analytics to village-level alert networks (John, 2025). However, these systems remain early-stage and unevenly experienced at the household level, meaning that perceived safety still depends primarily on everyday behavioural caution rather than dependable preventive infrastructure.

Taken together, these findings highlight a structural division in adaptation responsibilities. Informal strategies operate as continuous, preventive, and community-led, while formal strategies are largely event-driven and institution-led. Households rely on their own behavioural caution to avoid encounters, whereas state agencies intervene after conflicts occur. The literature increasingly suggests that durable mitigation requires bridging this divide through co-produced preventive strategies that combine local knowledge, early-warning communication networks, and sustained investment in

livestock protection (Van Eeden et al., 2018; Dhungana et al., 2024). The results from Wayanad underscore this need: while neither formal nor informal strategies are wholly sufficient on their own, aligning institutional support with the preventive behaviours already practised by communities such as predator-proof sheds, lighting support, local facilitation for accessing compensation, and verified early-warning systems so that prevention does not remain the sole responsibility of households and this may enhance both perceived and actual conflict resilience. From an IAD perspective, this “division of adaptation labour” reflects how rules and resources allocate costs: households carry routine prevention, while institutions are judged mainly through crisis response and compensation outcomes. From a co-evolution perspective, everyday household adaptations adjust quickly to rising encounter risk, while preventive institutional measures and communication systems change more slowly, sustaining the gap in perceived effectiveness.

5.4.4 Perceptions of Co-existence

This section addresses SO3 by arguing that coexistence perceptions in Wayanad are shaped less by tiger presence alone and more by the combined experience of chronic insecurity, livelihood risk, and low trust in preventive governance, making coexistence feel involuntary rather than negotiated.

The findings of this study indicate overwhelmingly negative attitudes toward coexistence with tigers in Wayanad. Quantitatively, 93% of respondents rated coexistence as “poor” or “very poor,” with no respondents reporting positive perceptions. This pattern was consistent across both study wards, reflecting a shared sense of insecurity, irrespective of household location or demographic differences. Qualitative narratives further demonstrated that coexistence is perceived as increasingly untenable, shaped by fear of attacks, economic loss, psychological stress, and a perceived lack of adequate institutional protection. This result suggests that tolerance in Wayanad has crossed a “threshold” where tiger presence is no longer viewed as a negotiable risk but as chronic insecurity. In this sense, coexistence is not experienced as a shared arrangement with mutual safeguards, but as an imposed condition shaped by weak preventive capacity and everyday fear. These findings align with studies from tiger and leopard landscapes across India, where persistent conflict and livelihood vulnerability have been shown to substantially reduce community tolerance for large carnivores (Malviya et al., 2022; Alam & Nayak, 2024; Kichloo et al., 2023).

Similarly, in the Sundarbans landscape, Naha et al. (2014) found that economically marginalised fishing communities, who face high exposure to tigers and limited livelihood alternatives, held strongly negative attitudes toward coexistence, even though urban populations expressed more

favourable views. Inskip and Zimmermann (2009) also highlighted how poverty, low literacy, and recurrent conflict form a web of vulnerability that suppresses tolerance toward tigers. These parallels reinforce the situation in Wayanad, where forest-fringe households have high exposure and livelihood dependence at the forest edge, intensifying both perceived and lived risk, narrowing willingness to coexist.

The idea of a “threshold of tolerance” was a recurring theme. In many human-carnivore landscapes, tolerance is not simply about accepting wildlife presence but is strongly tied to perceived fairness, personal safety, and institutional support (Carter & Linnell, 2016). Residents expressed coexistence as acceptable only when encounters are rare; increasing frequency of tiger sightings was reported to push this threshold beyond what is considered livable. Similar patterns are documented in sub-Himalayan and Central Indian landscapes, where rising carnivore populations without proportional improvements in protection and compensation have resulted in declining tolerance (Datta et al., 2023; Rani et al., 2024). In the present study, even tribal communities, often described as possessing longstanding knowledge and cultural norms supporting coexistence, expressed reduced tolerance under current levels of conflict. This trend is consistent with findings from Kerala and other parts of India, where livelihood dependence on livestock and agricultural lands near forest edges has increased vulnerability and anxiety (Nair & Jayson, 2020; Govind & Jayson, 2021). While indigenous groups in southern India have historically maintained relational and negotiated forms of coexistence with wildlife, recent changes such as resettlement, reduced access to forest resources, and increased frequency of conflict have placed strain on these coexistence relationships (Jolly et al., 2022), leading to attitudes that increasingly resemble those of non-tribal communities facing similar risks.

Institutional trust emerged as a central factor shaping coexistence perceptions. While respondents acknowledged improvements in rapid response and tiger capture operations, these interventions were widely described as reactive rather than preventive. This reflects broader critiques of wildlife governance in India, where state-led strategies often prioritise post-incident control over sustained coexistence planning (Chaudhuri, 2013; Alam & Nayak, 2024). Many participants also perceived that wildlife protection was prioritised over human safety, a sentiment echoed in landscapes with successful carnivore recoveries, where local communities feel they shoulder the costs of conservation without receiving corresponding benefits (Malviya et al., 2022; Doubleday & Rubino, 2021). Such perceptions align with Baynham-Herd et al. (2018), who argue that conservation conflicts intensify when communities feel excluded from decision-making or perceive that their well-being is

undervalued. These power imbalances can deepen resentment and further reduce willingness to coexist, particularly in areas where economic loss and personal risk are already high.

The Kerala Forest Department's recent conflict management strategy provides important context for these perceptions. The state has formally identified 12 human-wildlife conflict landscapes, including Wayanad, and has introduced a suite of mitigation initiatives known as the "10 Missions", which include Mission Real-Time Monitoring, Mission Primary Response Teams, Mission Food-Fodder-Water, and Mission Habitat Restoration (Kerala Forest Department, 2025). These initiatives emphasise technology-assisted early warning, improved habitat quality, and proactive conflict response. While these represent meaningful institutional shifts toward preventive management, their effects have not yet been widely experienced at the household level and would take time. This may help explain why communities in this study did not report increased confidence in long-term coexistence outcomes. Similar technological and early-warning interventions proposed in Wayanad (John, 2025) and tested in tiger corridors elsewhere in India (Dertien et al., 2023) also remain in preliminary stages, with their ability to reduce conflict frequency rather than merely improve detection still unproven.

The convergence of quantitative and qualitative results indicates that coexistence is presently experienced not as a mutually beneficial relationship, but as an involuntary condition imposed on communities. This aligns with broader literature emphasising that coexistence is sustainable only where safety, compensation adequacy, institutional trust, and community participation are meaningfully ensured (Badola et al., 2021; Chaudhuri, 2013). The present findings suggest that without sustained preventive measures, livelihood protections, clearer communication, and avenues for shared decision-making, negative perceptions are likely to persist or intensify. Also, improving coexistence perceptions requires rebuilding trust and fairness alongside reducing physical risk. Without visible preventive capacity and participatory decision-making, communities may continue to view conservation as socially costly, further narrowing the tolerance threshold even if ecological conditions stabilise.

From an IAD perspective, the poor coexistence ratings reflect negative evaluations of governance outcomes (safety, fairness, predictability), which weaken the perceived legitimacy of formal systems and reinforce reliance on household-level coping strategies. From a socio-ecological co-evolution perspective, coexistence becomes "involuntary" when exposure and fear escalate faster than preventive governance and trust-building mechanisms.

5.5 Conclusion

This study examined the evolution and drivers of human-tiger conflict in Wayanad, community awareness and perceived effectiveness of formal and informal rules, and the adaptation strategies that shape coexistence perceptions. Rather than treating conflict as a simple outcome of rising tiger presence, this thesis takes the position that conflict intensification in Wayanad is best explained as a combined ecological-governance process. Changing landscapes and the increasing visibility and rapid circulation of encounter information shape both exposure and fear in ways that can outpace institutional adaptation.

With respect to SO1, the study concludes that perceived conflict severity is driven not by “tiger numbers” alone, but also by increasing landscape permeability and edge-level ecological stress linked to habitat degradation, invasive species, farmland abandonment, and blurred forest settlement boundaries alongside heightened documentation and sharing of encounter events that amplify uncertainty. This helps explain why conflict is experienced as frequent and unpredictable in daily life, even when some land-use change is gradual or not immediately visible.

For SO2, the study concludes that the key governance gap is not a total absence of formal rules, but a mismatch between rule awareness and rule usability. Communities broadly recognise legal protection under the Wildlife Protection Act, yet formal mechanisms, especially compensation and post-incident procedures, are often experienced as difficult to navigate, inconsistently delivered, and weakly communicated. As a result, formal rules are acknowledged but not socially embedded or trusted, which reduces their practical legitimacy and shifts everyday conflict management toward locally developed “rules-in-use.”

For SO3, the study concludes that adaptation in Wayanad is real but unevenly distributed: households carry most of the preventive burden through continuous informal strategies, while formal actors intervene mainly through event-driven responses. In other words, most formal responses are experienced as reactive, activated once risk is immediate or damage has occurred, while households rely on continuous, preventive informal practices to reduce everyday exposure. This contrast helps explain why communities view informal strategies as more reliable for day-to-day safety, even though it shifts the burden of prevention onto households. Informal practices such as group travel, avoidance of risky times, collective vigilance, and neighbourhood alert systems dominate because they provide immediate day-to-day safety, even though they also normalise a situation where communities must self-protect under chronic risk. This “division of adaptation labour” shapes coexistence perceptions

by making coexistence feel less like a negotiated arrangement and more like an imposed condition under limited preventive support. Perceptions of coexistence are therefore overwhelmingly negative, shaped by cumulative fear, livelihood vulnerability, psychological strain, and low institutional trust. From an IAD perspective, weak legitimacy and limited accessibility of formal mechanisms constrain meaningful participation in the action arena and reduce confidence in governance outcomes. From a socio-ecological co-evolution perspective, tiger movement patterns and community behavioural adaptation are changing faster than institutional systems can respond, and build trust, widening the gap between risk realities and governance capacity.

Overall, the thesis concludes that improving coexistence in Wayanad requires shifting from crisis management toward preventive, locally embedded, and trust-building governance. The central implication is that institutions must make preventive support and compensation more usable and predictable, while explicitly supporting (and not quietly relying on) the everyday preventive practices communities already employ. Strengthening preventive infrastructure and maintenance, improving transparency and timeliness of compensation, restoring habitats and managing edge permeability, investing in credible early-warning and communication systems, and enabling meaningful community participation are essential steps. Under current conditions, coexistence remains insecure and socially costly, strengthening it depends on aligning institutional mechanisms with the lived realities of forest-fringe households.

5.6 Recommendations

Based on the findings of this study, strengthening human-tiger coexistence in Wayanad requires a shift from predominantly reactive responses toward proactive, community-inclusive, and technology-enabled strategies. First, preventive approaches should be prioritised through sustained maintenance of vegetation buffers, livestock enclosure improvements, and habitat restoration to reduce edge permeability. Second, institutional mechanisms, particularly compensation, must be made timely, transparent, and accessible, supported by simplified application processes and community facilitation models similar to Wild Seve. Third, the integration of early-warning systems using AI-enabled camera traps, IoT devices, and predictive analytics should be piloted and scaled to reduce surprise encounters and support frontline decision-making. Fourth, community participation needs to be strengthened through genuine power-sharing platforms, regular joint planning meetings, and revival of local committees such as Jana Jagratha Samithis with clearer mandates. Finally, long-term coexistence requires continuous awareness programmes, livelihood diversification initiatives, and targeted support for vulnerable groups, ensuring that

conservation gains translate into tangible benefits for local communities. Together, these measures can help align institutional strategies with everyday realities, thereby enhancing both safety and social acceptance of coexistence.

5.7 Limitations of the Study

This study has several limitations that should be considered when interpreting the findings. First, the research was conducted in two wards within two panchayats in Wayanad, which may limit the generalisability of the results to other regions with different ecological, socio-economic, or governance contexts. Second, the cross-sectional design captures perceptions and experiences at a single point in time, even though conflict patterns and attitudes are dynamic and may shift rapidly with new incidents. Third, because the study relied on self-reported data, responses may be influenced by recall bias, situational emotions, or expectations toward authorities. Fourth, while qualitative interviews provided rich insights, certain voices—such as women, seasonal labourers, or highly displaced households, may still be underrepresented. Finally, the study did not independently verify ecological factors such as tiger movement patterns or habitat changes through primary field measures, instead relying on reported experiences and secondary sources. These limitations do not undermine the value of the study but highlight areas for deeper longitudinal, ecological, and multi-sited research in the future.

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Chapter 7 Appendix

7.1 Appendix 1: Tables and Statistical Results

Table 4.1 Frequency of Conflict Experiences (n = 274)

Conflict Type	Yes (n)	No (n)	% Yes
Livestock attacks	41	233	15.0
Human attacks / injuries	0	274	0.0
Fear of living	274	0	100.0
Need to relocate	82	192	29.9

Table 4.2 Mann–Whitney U (Wilcoxon) Test Results

Conflict Type	<i>W</i> Statistic	<i>p</i> -value	Effect Size (<i>r</i>)	Magnitude
Livestock attacks	2 423	< .001	0.39	Moderate
Need to relocate	4 398	< .001	0.45	Moderate

Table 4.3: Chi-Square Test Results for Association Between Perceived Conflict Severity and Conflict Experiences

Conflict Experience	χ^2	<i>df</i>	<i>p</i> -value	Association
Livestock attacks	38.89	1	< .001	Significant
Need to relocate	52.41	1	< .001	Significant

Table 4.4: Wilcoxon Signed-Rank Test Result

Variable	N (pairs)	V	<i>p</i> -value	Effect size <i>r</i>	Magnitude
Severity Before vs Today	274	0	< 0.001	0.90	Large

Test = Wilcoxon signed-rank (paired samples). V = test statistic.

Table 4.5: Descriptive Summary

Time	Median	Mean	SD
Before	1.00 (Very Low)	1.40	0.50
Today	4.00 (High)	4.29	0.60

Table 4.6 Respondents' Endorsement of Major Conflict Cause Categories

Category	% Any-Yes Endorsement	% Average Endorsement
Political	100.0	85.0

Ecological	100.0	31.9
Economic	100.0	25.0
Socio-Cultural	34.3	12.3

Table 4.7 Friedman test comparing perceived importance across cause categories

Variable	N	χ^2	df	p-value	Test Used
Score	274	571.0	3	<0.001	Friedman test

Note. Ranks were compared across four categories (ecological, economic, political, and socio-cultural).

Table 4.8 Pairwise Wilcoxon signed-rank tests (Holm-corrected)

Comparison	<i>V</i>	<i>p</i> -value	<i>p</i> (adj Holm)	Significance
Ecological vs Economic	20 577	0.178	0.178	ns
Ecological vs Political	73	< .001	< .001	****
Ecological vs Socio-cultural	26 244	< .001	< .001	****
Economic vs Political	0	< .001	< .001	****
Economic vs Socio-cultural	31 950	< .001	< .001	****
Political vs Socio-cultural	37 675	< .001	< .001	****

Note. Two-sided tests; Holm correction applied to *p*-values. “****” = *p* < .001; “ns” = not significant.

Table 4.9 Spearman correlations between cause categories and perceived conflict severity

Category	ρ (Spearman)	Interpretation
Socio-Cultural	0.40	Moderate positive relationship
Ecological	0.36	Moderate positive relationship
Economic	—	No variation
Political	−0.55	Negative relationship – lower severity when political issues emphasized

Note. Correlations are Spearman’s rho. Economic category showed no between-respondent variability, so rho is undefined.

Table 4.10 Descriptive Statistics for Formal and Informal Awareness Scores

Variable	n	Minimum	Maximum	Mean	SD	Scale Range	Description
Formal Rules Awareness	274	0.00	0.67	0.43	0.13	0–1 (scaled from 1–4)	Awareness of WPA, Compensation Schemes, and NTCA Guidelines
Informal Rules Awareness	274	0.75	1.00	0.99	0.04	0–1 (Yes=1, No=0)	Awareness of traditional and community-based practices

Note. Formal rule scores were computed as the average of three items scaled from 1–4 and rescaled to a 0–1 range. Informal rule scores were computed as the mean of four binary awareness items.

Table 4.11 Paired comparison of awareness levels (formal vs. informal)

Test	V	n (paired)	Median diff (informal – formal)	95% CI	<i>p</i>	Alternative	Result
Wilcoxon signed-rank	0	274	0.556	[0.556, 0.556]	2.41×10^{-50}	formal < informal	Significant

Notes. One-sided *p* reported for the directional hypothesis that formal awareness is lower than informal awareness.

Table 4.12 Spearman and Kendall Correlations Between Awareness of Formal Rules and Their Perceived Effectiveness (Reversed Scale)

Formal Rule	N	Spearman's ρ	p-value	Kendall's τ	p-value	Interpretation
WPA (1972)	269	–0.283	< .001	–0.283	< .001	Significant negative association — greater awareness linked to lower perceived effectiveness
Compensation Schemes	270	–0.106	0.082	–0.100	0.083	Weak, non-significant association
NTCA Guidelines	—	—	—	—	—	Not tested (no awareness or effectiveness data)

Note: Effectiveness ratings were collected on a 5-point scale (1 = Very effective, 5 = Very ineffective). To facilitate interpretation, this scale was reversed before analysis so that higher scores indicate greater perceived effectiveness.

Table 4.13 Spearman's correlations between adherence and perceived effectiveness of rules

Rule type	Variables	Spearman's ρ	p-value	N
Formal rules	Adherence vs. perceived effectiveness	0.039	0.528	269
Informal rules	Adherence vs. perceived effectiveness	0.378	< .001	274

Note. Effectiveness scale reversed (1 = very ineffective, 5 = very effective). A positive correlation indicates that greater adherence is associated with higher perceived effectiveness.

Table 4.14 Ward-level differences in awareness and perceived effectiveness of formal and informal rules

Rule Type	Variable	Test	W Statistic	p-value	Interpretation
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Formal Rules	Awareness	Mann–Whitney U	5419	<0.001	Chekady higher awareness
Formal Rules	Perceived Effectiveness	Mann–Whitney U	9008.5	0.851	No significant difference
Informal Rules	Awareness	Mann–Whitney U	9452	0.324	No significant difference
Informal Rules	Perceived Effectiveness	Mann–Whitney U	6769.5	<0.001	Chekady higher perceived effectiveness

Note. Effectiveness scale reversed (higher values indicate greater effectiveness)—differences tested using Mann–Whitney U due to non-normal distributions.

Table 4.15. Correlations between Awareness and Adherence for Formal and Informal Rules

Rule Type	Variables	Spearman's ρ	p-value	N
Formal Rules	Awareness vs Adherence	0.044	0.468	269
Informal Rules	Awareness vs Adherence	0.091	0.133	274

Note. All correlations are weak and non-significant, indicating that awareness does not necessarily predict behavioural adherence.

Table 4.16. Demographic Effects on Perceived Effectiveness of Rules

Rule Type	Factor	Test	p-value
Formal Rules	Gender	Mann–Whitney U	0.093
Formal Rules	Education	Kruskal–Wallis	0.408
Formal Rules	Proximity to Forest	Kruskal–Wallis	0.290
Informal Rules	Gender	Mann–Whitney U	0.118
Informal Rules	Education	Kruskal–Wallis	<0.001***
Informal Rules	Proximity to Forest	Kruskal–Wallis	<0.001***

Note. Only education and proximity to forests significantly influenced perceived effectiveness of informal rules, with higher trust observed among more educated respondents and those living closer to forests.

Table 4.17 Mean Effectiveness Ratings – Informal Strategies (lower scale=Higher effectiveness)

Rank	Informal Strategy	Mean Effectiveness	Interpretation
1	Use private fencing around fields	1.80	Perceived as very effective; physical barrier offers direct protection, though adoption is low due to cost.
2	Avoid getting out at night	2.05	Highly effective behavioral measure; reduces likelihood of tiger encounters during peak activity times.
3	Avoid entering forest areas	2.09	Effective avoidance strategy; limits exposure to tiger habitats.

4	Having guard animals	2.27	Considered effective as an early warning and deterrent system against tigers.
5	Immediate communication on tiger spotting	2.40	Effective in mobilizing quick community response and enhancing awareness.
6	Build stronger livestock enclosures	2.57	Moderately effective; provides some protection but may depend on design quality and maintenance.
7	Use light in livestock enclosures	3.07	Perceived as moderately effective; helps deter tigers but not foolproof.
8	Observe traditional warning signs	3.32	Limited effectiveness; traditional indicators are less relied upon in current contexts.
9	Use traditional methods	4.12	Rated low in effectiveness; traditional deterrents may be outdated or inconsistent.
10	Pray or have faith in God while near forest fringes	4.47	Least effective; reflects spiritual coping rather than a practical risk-reduction measure.

Table 4.18 Mean Effectiveness Ratings - Formal Strategies (lower scale=Higher effectiveness)

Rank	Strategy	Mean Effectiveness	Interpretation
1	Patrolling and monitoring of tigers	2.99	Most effective formal strategy; reflects trust in forest department vigilance.
2	Relocating or capturing problematic tigers	3.06	Seen as effective but dependent on timely intervention and after management
3	Compensation for human/livestock losses	3.46	Moderately effective — recognized but may face delays or administrative barriers.
4	Providing streetlights	3.65	Helpful but not directly preventing encounters.
5	Building fencing and trenching	3.67	Least effective; likely due to maintenance issues or limited coverage.

Table 4.19 Wilcoxon Signed-Rank Test Comparing Formal and Informal Adaptation Effectiveness

Statistical Test	Test Statistic (V)	Z / Continuity Correction	p-value	Significance	Interpretation
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Wilcoxon signed-rank test (paired)	2275	-	< 2.2 × 10⁻¹⁶	<i>p</i> < 0.001	Significant difference between informal and formal effectiveness ratings. Respondents rated informal strategies significantly more effective than formal strategies.
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Table 4.20 Kruskal–Wallis Test – Informal Strategies

Statistic	Value	Interpretation
Kruskal–Wallis H	727.74	Large test statistic indicating substantial variation among strategies
Degrees of Freedom (df)	9	10 strategies – 1
p-value	< 0.001	Statistically significant difference between at least two strategies

Table 4.21 Kruskal–Wallis Test -Formal Strategies

Statistic	Value	Interpretation
Kruskal–Wallis H	375.77	Large difference across strategies
Degrees of Freedom (df)	4	5 strategies – 1
p-value	< 0.001	Statistically significant difference in effectiveness ratings

Table 4.22 Dunn’s Post-hoc Test for Pairwise Comparisons of Informal Strategy Effectiveness (Holm-corrected)

Comparison	Z	Adjusted p-value	Interpretation
Avoid getting out at night – Pray / Faith	- 21.68	< 0.001	Avoiding nights rated much more effective
Having guard animals – Pray / Faith	- 18.30	< 0.001	Guard animals more effective than faith-based coping
Avoid entering forest areas – Pray / Faith	- 18.16	< 0.001	Avoiding forest areas much more effective
Immediate communication – Pray / Faith	- 17.10	< 0.001	Information sharing far more effective
Avoid getting out at night – Traditional signs	- 13.14	< 0.001	Avoiding nights > traditional signs
Avoid getting out at night – Lights in enclosures	- 11.83	< 0.001	Avoiding nights > lighting
Avoid entering forest areas – Traditional signs	- 11.07	< 0.001	Avoiding forests > traditional signs
Having guard animals – Traditional signs	- 10.15	< 0.001	Guard animals > traditional signs

Avoid entering forest areas – Lights in enclosures	-9.86	< 0.001	Avoiding forests > lighting
Lights in enclosures – Pray / Faith	-8.93	< 0.001	Lighting > praying

Table 4.23 Dunn’s Post-hoc Test for Pairwise Comparisons of Formal Strategy Effectiveness (Holm-corrected)

Comparison	Z	Adjusted p-value	Interpretation
Building fencing/trenching – Patrolling & monitoring	+14.65	< 0.001	Fencing rated far less effective
Patrolling & monitoring – Streetlights	-14.18	< 0.001	Patrolling more effective
Building fencing/trenching – Relocating problematic tigers	+12.81	< 0.001	Fencing less effective
Streetlights – Relocating problematic tigers	+12.34	< 0.001	Relocation rated higher
Compensation – Patrolling & monitoring	+9.91	< 0.001	Patrolling seen as superior
Compensation – Relocating problematic tigers	+8.07	< 0.001	Relocation seen as more effective
Building fencing/trenching – Compensation	+4.71	< 0.001	Fencing less effective
Compensation – Streetlights	-4.24	< 0.001	Compensation slightly more effective

Table 4.24 Statistical Test Results Assessing the Relationship Between Informal Adaptation Adoption and Coexistence Perceptions

Test	Purpose	Test Statistic	p-value	Interpretation
Spearman’s Rank Correlation	To test association between adoption proportion and coexistence perception	$\rho = 0.025$	$p = 0.676$	No significant association between adoption and coexistence perception
Kruskal–Wallis Test	To compare coexistence perception across Low, Medium, and High adoption groups	$\chi^2 = 3.61, df = 2$	$p = 0.164$	No significant difference among adoption groups

7.2 Appendix 2

7.2.1 Semi-structured interview

7.2.1.1 Section 1: Household Interviews (Community Members)

A. Socio-Demographic Profiling

1. Name.....
2. Age:.....
3. Gender: ☐ Male ☐ Female ☐ Other ☐ Prefer not to say
4. Education Level:
☐ No Formal Education ☐ Primary ☐ Secondary ☐ Diploma ☐ UG ☐ PG
5. Occupation: ☐ Farmer ☐ Daily Wage Worker ☐ Business ☐ Govt. Employee ☐ Other
6. Household Size: _____ (Total number of family members)
7. Annual Household Income (Approximate):
☐ Below ₹50,000 ☐ ₹50,000 - ₹1,00,000 ☐ ₹1,00,000 - ₹3,00,000 ☐ Above ₹3,00,000
8. Land Ownership: ☐ Yes ☐ No
9. Proximity to Forest: ☐ Less than 1 km ☐ 1-5 km ☐ More than 5 km

7.2.1.2 Section 2: Evolution of Conflict

- 1) Have you observed any of the following land use changes in your area? (Select all that apply)
☐ Deforestation ☐ Forest Encroachment ☐ Farmland expansion ☐ Urbanization (e.g., construction of buildings, roads) ☐ Plantation expansion (e.g., tea, coffee, rubber) ☐ Abandonment of agricultural land ☐ No significant change/other options
- 2) How would you rate this change that happened? (asked for each observed land use changes)
☐ No Change ☐ Very Slight Change ☐ Moderate Change ☐ Considerable Change
☐ Significant Change
- 3) Rate the severity of the tiger-human conflict in general:
10 years ago: ☐ Very Low ☐ Low ☐ Moderate ☐ High ☐ Very High
Today: ☐ Very Low ☐ Low ☐ Moderate ☐ High ☐ Very High
- 4) Have you or anyone in your household experienced tiger-related conflicts?
☐ Yes ☐ No
- 5) If yes, what type of conflict have you experienced? (Select all that apply)
a) ☐ Livestock attacks

b) ☐ Human injuries or fatalities

c) ☐ Fear

d) ☐ Need to relocate

☐ Other (please specify)

6) What do you think are the reasons for the increase in tiger-human conflicts? (Select all that apply)

A. Socio-cultural factors

☐ Increased human settlements near the forest

☐ Decline in the use of traditional tiger deterrents

☐ Cultural tolerance and traditional beliefs about tigers are disappearing

☐ Others

B. Economic factors

☐ Agriculture expansion around forest areas

☐ Increased livestock grazing around forest areas

☐ Financial loss due to tiger attacks

☐ Limited job opportunities and increased dependence on forest

☐ Others

C. Ecological factors

☐ Less prey availability inside forest

☐ Increased number of tigers due to strict conservation efforts

☐ Increased deforestation and fragmentation

☐ Abandoned agricultural land near forest fringes

☐ Effect of invasive species

☐ Climate changes affecting tiger behaviour (Example, less availability of water inside the forests)

☐ Others

D. Political Reasons

☐ Old laws prioritise wildlife over people without participatory planning

☐ Limited support from the forest department

☐ Poor and delayed compensation

☐ Use of conflict situations only during the elections

☐ Others

7.2.1.3 Section 3: Effectiveness of Formal & Informal Rules

A) Formal rules

1) Are you aware of the following rules related to tiger-human conflicts, and how well do you know them? (Tick all that apply and rate the awareness on a scale from 1-4 (1 = Not aware, 2 = aware (name only), 3 = Moderately aware, 4 = Well aware))

☐ Wildlife Protection Act (1972) (Protects tigers and bans hunting)

☐ Compensation Schemes (Gives money for cattle losses and human losses due to tiger attacks)

☐ National Tiger Conservation Authority (NTCA) Guidelines

☐ I don't know any of these rules

2) Who enforces these formal rules in your area? (Tick all that apply and indicate which rule by whom)

☐ Forest Department

☐ National Tiger Conservation Authority (NTCA) officials

☐ Local government (panchayat, district officials)

☐ other Non-Governmental Organisations (NGOs)

☐ I don't know

3) How strictly do you follow these rules (For each of the rules you know about, and rate them ((Never=1, Rarely=2, Most of the time=3, Always=4))?)

☐ Never ☐ Rarely ☐ Most of the Time ☐ Always

4) How well do you think these rules are applied in practice (asked for each of the rules as mentioned earlier that they know about and rate them (Very effective=1, Effective=2, moderate=3, Ineffective=4, Very ineffective=5)?)

☐ Very Ineffective ☐ Ineffective ☐ Moderate ☐ Effective ☐ Very Effective

5) If you think the rules are ineffective, what are the main reasons? (Tick all that apply)

☐ Lack of awareness among people

☐ Poor enforcement and corruption

☐ Laws are impractical and too strict

☐ Lack of resources (Fund and staffs)

☐ Conflicts between conservation policies and local livelihood

☐ I am not sure

☐ Other (please specify)

6) If you think the rules are effective, what are the main possible reasons? (open ended)

7) How was the effectiveness of these rules in the past (10 years before) compared to today?

☐ Rules were more effective before but weaker now

☐ Rules have improved over time

☐ No significant change in effectiveness

☐ Not sure

☐ No one enforces them properly

8) What suggestions do you have to improve the effectiveness of these rules?

B) Informal rules

9) Are you aware of the following traditional customs or beliefs related to tigers? (Tick all that apply)

☐ Tigers are sacred and should not be harmed (Religious belief)

☐ Killing a tiger brings bad luck or a curse (Taboo)

☐ People avoid entering deep forests to prevent tiger encounters (Custom)

☐ Use of traditional warning signs to avoid surprise encounters and tiger attacks (Custom)

☐ Use of ritual chants or prayers to ward off tigers (Custom)

☐ Entering the forest as a group (Custom)

☐ I don't know of any such beliefs or customs

☐ Any others

10) How strictly do you follow these traditional customs and beliefs about tigers (ask for each of the informal rules that they know about and rate them (Never=1, Rarely=2, Most of the time=3, Always=4))

☐ Never ☐ Rarely ☐ Most of the Time ☐ Always ☐ NA

9) How effective do you think these informal rules are in reducing tiger-human conflicts and rate them (Very effective=1, Effective=2, moderate=3, Ineffective=4, Very ineffective=5?)

☐ Very Ineffective ☐ Ineffective ☐ Moderate ☐ Effective ☐ Very Effective

11) If you think the rules are effective, what are the main possible reasons?

12) If these traditional customs and beliefs are not effective, what are the main reasons? (Tick all that apply)

☐ Younger generations are unaware, detached from the forest, and do not follow them anymore

☐ Government rules have replaced traditional rules

☐ Livestock depredation and attacks on people trigger emotional and economic reactions that undermine traditional restraint.

☐ Religious and cultural beliefs are changing over time

☐ Other (please specify)

11) How was the effectiveness of these informal rules in the past compared to today?

☐ Rules were more effective before but weaker now

☐ Rules have improved over time

☐ No significant change in effectiveness

☐ Not sure

☐ No one follows them properly

12) Who enforces these traditional customs and beliefs in your community? (Tick all that apply and indicate which rule by whom)

☐ Village elders ☐ tribal leaders ☐ Religious leaders ☐ Individuals themselves follow them

☐ others (specify) ☐ No one enforces them anymore

7.2.1.4 Section 4: Actor Adaptations & Responses

Key Actors Identified in the Formal Domain: State Forest Department, NGO, Local Government (Panchayat/Politicians)

Key Actors Identified in the Informal Domain: Local people, Tribal groups

Key Adaptation strategies followed in the formal Domain;

a) Patrolling and monitoring of tigers

b) Relocating or capturing problematic tigers

c) Compensation for human or livestock losses

d) Building Fences and trenches

e) Provision of streetlights

1) Which formal actors have played a role in managing tiger-human conflicts in your area? (Select all that apply)

☐ Forest Department ☐ Local Government (Panchayat/Politicians) ☐ NGOs

☐ Other (Please specify) _____

2) Which adaptation strategies are employed by each of the formal actors among the following list identified? (Select all that apply for each actor). Also, rate the effectiveness of each of the adaptation strategies against each of the actors (on a scale 1-5, Very effective=1, Effective=2, moderate=3, Ineffective=4, Very ineffective=5)

a) Patrolling and monitoring of tigers

b) Relocating or capturing problematic tigers

c) Compensation for human or livestock losses

d) Building Fences and trenches

e) Provision of streetlights

3) Which are the adaptation strategies followed by you among the following list of strategies identified? Select all that apply for you. Also, rate the effectiveness of each of the adaptation strategies (on a scale 1-5, Very effective=1, Effective=2, moderate=3, Ineffective=4, Very ineffective=5).

1. Avoid entering forest areas

2. Avoid getting out at night

3. Build stronger livestock enclosures

4. Having guard animals

5. Immediate communication on tiger spotting

6. Observe traditional warning signs (bird calls, tracks, etc.)

7. Pray/have faith in God while near forest fringes

8. Use light in livestock enclosures

9. Use private fencing around fields

10. Use of traditional methods (fires, sounds, crackers)

4) What is the reason for the effectiveness or ineffectiveness of each of the above-mentioned adaptation strategies?

7.2.1.5 Section 5 Perception on Co-existence

1) What is your perception of tiger-human co-existence?

☐ Very Poor ☐ Poor ☐ Neutral ☐ Good ☐ Very Good

7.3 Appendix 3: Key Informant Interviews

7.3.1 Evolution and severity of the conflicts

- 1) what are the socio-cultural, economic, ecological and political reasons behind the increasing tiger conflicts?
- 2) What are the different conflicts or problems you experience due to increasing Tiger conflicts in your area?
- 3) How severe is the conflict, give a comparison of the past(10 years before) and present.

7.3.2 Formal and Informal Rules

- 1) what are the formal and informal rules in practice related to tiger conservation and conflict mitigation?
- 2) Name the different actors who are responsible for the enforcement of each of these rules in the community.
- 3) Which of the above-mentioned rules is effective in reducing the conflict and why?

7.3.3 Actor Adaptation and Responses

- 1) What are the various adaptation strategies employed by each of the actors in the community?
- 2) What is the effectiveness of each of the above-mentioned adaptive strategies in reducing the conflicts?
- 3) What is the perception of people on tiger conservation and co-existence and what could be the future interventions made to improve the situation?

7.4 Appendix 4 Focus Group Discussions

7.4.1 Evolution and severity of the conflicts

- 1) what do you think as the major reasons behind the increasing tiger conflicts?
- 2) What are the different conflicts or problems that you face living in a conflict area?
- 3) How severe is the conflict, give a comparison of the past(10 years before) and present.

7.4.2 Formal and Informal Rules

- 1) Are you aware of the formal and informal rules in practice related to tiger conservation and conflict mitigation? If yes, can you kindly state them?
- 2) Name the different actors who are responsible for the enforcement of each of these rules in the community.
- 3) Which of the above-mentioned rules is effective in reducing the conflict?

7.4.3 Actor Adaptation and Responses

- 1) What are the various adaptation strategies employed by each of the actors in the community?
- 2) What is the effectiveness of each of the above-mentioned adaptive strategies in reducing the conflicts?
- 3) What is your perception of tiger conservation and co-existence, and what could be the future interventions made to improve the situation?

7.5 Appendix 5 : Code: Codes, Sub-themes, and Themes Generated from the Thematic Analysis

Theme 1: Ecology of Tiger–Human Conflict

Codes (Description of Codes)	Sub-themes (Clustering of Codes)	Themes
“Tiger sightings have increased”	Rising tiger presence near settlements	Ecology of Tiger–Human Conflict
“Tiger entering villages and sheds often”	Increased human–tiger proximity	
“Abandoned lands becoming mini forests”	Land-use change & vegetation thickening	
“Prey animals declining inside the forest”	Ecological drivers of conflict	
“invasive plants increasing inside forests”	Habitat degradation	
“livestock killed, humans are also attacked”	Conflict severity & frequency	
“People are afraid to go to fields even in daytime”	Everyday disruption due to risk	
“Settlements expanding near forest edges”	Human-driven landscape pressures	

Theme 2: Governance Effectiveness

Codes (Description of Codes)	Sub-themes (Clustering of Codes)	Themes
“We know the forest rules”	Awareness of formal rules	Governance Effectiveness

“We follow rules only because there are penalties”	Compliance influenced by enforcement	
“Forest Department responds fast mostly”	Improvements in rapid response	
“Compensation is delayed and insufficient”	Institutional constraints	
“Fencing does not work after sometime”	Low perceived effectiveness of infrastructure	
“Protection for people is less than protection for tigers”	Perceived bias in governance priorities	
“Meetings and awareness programmes are few ”	Limited community engagement	
“We don’t know what happens to relocated tigers”	Gaps in transparency & trust	

Theme 3: Actor Adaptations (Formal & Informal)

Codes (Description of Codes)	Sub-themes (Clustering of Codes)	Themes
“Avoiding night travel”	Behavioural avoidance	Actor Adaptations
“We always move in groups”	Collective vigilance	
“We warn neighbours immediately”	Community communication networks	
“We put lights around sheds”	Everyday preventive measures	
“Guard dogs alert us if tiger comes”	Early-warning through guard animals	
“People stopped going to the forest altogether”	Livelihood shifts due to risk	
“RRT comes and sets cages when tiger is often seen”	Formal reactive interventions	
“NGOs give metal sheds”	External support-based adaptive measures	
“Panchayat cleared dense vegetation in unmanaged farms”	Collaborative mitigation activities	

Theme 4: Perceptions of Coexistence

Codes (Description of Codes)	Sub-themes (Clustering of Codes)	Themes
“Living like this is not safe”	Fear & psychological stress	Perceptions of Coexistence
“We cannot go out after dark”	Routine disruption	
“Coexistence is only possible if tiger comes very rarely”	Threshold of tolerance	
“People want to relocate but cannot afford to”	Constraints to mobility	

“Coexistence is poor”	Negative attitude toward coexistence	
“Forest Department protects wildlife more than us”	Low trust in institutions	
“Tiger will always come back; nothing is changing”	Hopelessness & perceived inevitability	

The codebook was developed through manual thematic analysis using Braun and Clarke’s (2006, 2019) six-phase approach. KIIs and FGDs were transcribed (and translated where needed), read repeatedly, and coded using in-vivo and descriptive codes. Codes were grouped into sub-themes and then broader themes aligned with the study objectives, and were refined through constant comparison with the transcripts. Rigour was supported through an audit trail and triangulation with the household survey findings.

7.6 Appendix 6: Details of KII and FGDs

7.6.1 Details of KII

Interviewee	Date	Duration	Key areas discussed
NGO and NTCA Representative	25-03-2025	45 min	Role of NGO s, reasons behind the escalating conflicts, Rules existing , adaptation strategies taken
Panchayath President-Pulpally	27-03-2025	35 min	Role of Panchayath,current situation of conflicts, solutions and feedbacks, adaptation strategies taken.
Range Forest Officer-Chethalath Range	28-03-2025	30 min	State department interventions, reasons of escalating confclits, solutions and counter measures involved, Rules involved, adaptation strategies taken.
Panchayath President-Mullankoll	29-03-2025	37 min	Role of Panchayath,current situation of conflicts, solutions and feedbacks.
Ward Member-Chekady	01-04-2025	40 min	Reasons, current situation,Local level leader involvements,rules, adaptation strategies taken Perceptions among people on co-existence, future thoughts etc.
Ward Member-Channothukolly	01-04-2025	35 min	Reasons, current situation,Local level leader involvements,Perceptions among people on co-existence, future thoughts etc.
Beat Forest Officer	03-04-2025	1 hour 16 min	State Forest deptmt roles and interventions, reasons, causes, peoples attitude, adaptation strategies taken futue thoughts.
Forest Guard	03-04-2025	35 min	State Forest deptmt roles and interventions, reasons, causes, peoples attitude, adaptation strategies taken futue ththoughts.
Chekady resident 1	04-04-2025	25 min	Status of current conflicts,reasons, rules existing, perception on co-existence, adaptation strategies taken
Chekady resident 2	04-04-2025	30 min	Status of current conflicts,reasons, rules existing, perception on co-existence, adaptation strategies taken
Chanothukolly Resident 1	04-05-2025	46 min	Status of current conflicts,reasons, rules existing, perception on co-existence, adaptation strategies taken

Chanothukolly Resident 2	04-05-2025	20 min	Status of current conflicts, reasons, rules existing, perception on co-existence, adaptation strategies taken
NGO Representative	08-04-2025	45 min	Reasons behind escalating conflicts, people's perception, Rules existing, adaptation strategies taken etc

7.6.2 Details of FGD

Place	Date	Duration	Key areas discussed
Chekady	10-04-2025	30 min	Status of conflicts, reasons behind, Knowledge on rules existing, adaptation strategies taken, Co-existence perception etc
Channothukolly	05-05-2025	25 min	Status of conflicts, reasons behind, Knowledge on rules existing, adaptation strategies taken, Co-existence perception etc