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Anthropogenic Influence on Protected Areas: A Case Study of Achanakmar Tiger Reserve (ATR), Chhattisgarh, India

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ABSTRACT

India's broad network of protected areas, which encompasses 4.93% of the country's geographical area, is exposed to immense anthropogenic pressures that can create an imbalance and also hinder the prime objective of wildlife conservation and protection. The present study assesses some of these problems in relation to the Achanakmar Tiger Reserve (ATR). The main anthropogenic influence in ATR is the presence of eighteen core villages, five buffer villages, and 49 fringe villages in the periphery of the reserve area. The population density of the core zone was higher (16.0 people/km^2) as compared to the buffer zone (7.41 people/km^2). Another important disturbance in the protected area is state highway 8 which bisects the entire core zone into two halves. This highway also connects the neighboring state of Madhya Pradesh and there is the continuous movement of traffic, which hampers the smooth movement of wild animals. ATR also has a wide network of tourist roads of 192 km passing through the core zone. The average population density of livestock in ATR is relatively high compared to the average population of wild ungulates. It creates competition between wild ungulates for food, and they are also under constant threat of infectious diseases. The livestock depredation by apex predators is one of the major reasons for man-wildlife conflict in ATR. The cattle kill incidences by both the apex predator (tiger and leopard) was 378 during the period of three years (2015 to 2018) and these incidences were recorded more in the core zone as compared to the buffer zone. In the present study, anthropogenic effects on ATR have been studied and evaluated. It concludes that for effective management and conservation of tigers in ATR, these aspects need to be considered. To restore the tiger population in ATR, there must be a proper balance between human (anthropogenic) approaches and conservation benefits for the effective sustainability of the protected areas.

INTRODUCTION

The world has lost 95% of the tiger population (Thompson 2010) four subspecies and 93% of their historical range (Thatte et al. 2018) in the last century. Wild tigers continue to be threatened by poaching, habitat destruction and loss (Jhala et al. 2015), depletion of prey, diseases, and trade in body parts (Dinerstein et al. 2007, Sunquist 1999). Tiger is one of the critically endangered mammals of the Felidae family and is known for maintaining ecological sustainability.

The largest population of global wild tigers (*Panthera tigris tigris*) is found in India, having a population of 2,967. The charismatic megafauna Royal Bengal Tiger bears the position of India's national animal and is spread across 20 states (Jhala et al. 2020). About 40% total tiger population in India is restricted to the Central Indian landscape (Jhala et al. 2011).

The Achanakmar Tiger Reserve (ATR) is a part of the Central Indian Landscape and acts as a conduit for movement for tigers from many different tiger reserves and protected areas of the region, thereby promoting genetic exchange and dispersion of the wild tiger population. The corridors connect ATR with many important tiger reserves of Central India such as Kanha Tiger Reserve, Pench Tiger Reserve, and Bandhavgarh Tiger Reserve. The ATR is also well linked with Guru Ghasidas Tiger Reserve on the northern side. On South Western side, ATR connects with Phen Wildlife Sanctuary and Bhoramdev Wildlife Sanctuary.

ATR is also an integral part of the Achanakmar Amarkantak Biosphere Reserve (AABR) situated in the lap of the Maikal ranges and is enriched with a rich pool of germplasm. It is the 32nd tiger reserve in India and the third tiger reserve in Chhattisgarh State. ATR owes its name to the village called Achanakmar, which lies within the green limits of the Maikal ranges. The word 'Achanakmar' means

'sudden attack'. This protected area has a long history of conservation. Considering, the uniqueness and richness of biodiversity, Achanakmar declared a Wildlife Sanctuary in 1975 under the Wildlife (Protection) Act, of 1972. Due to the presence of magnificent carnivores and endangered tiger species, Achanakmar was declared a tiger reserve in the year 2009.

The ATR is constantly exposed to anthropogenic influences. At the time of its formation, 24 villages existed within the core zone. In addition, five buffer villages and many fringe villages are situated outside the reserve area which directly or indirectly affects the sole objective of conservation. To create an inviolable space for the movement of wildlife, six forest villages (Jalda, Kuba, Bahud, Bakal, Bokra Kachhar, and Sambhar Dhasan) were relocated from the tiger reserve in December 2009 as the first phase of relocation.

Kumari et al. (2020) and Angulo et al. (2016) reported that the Tiger reserve areas are subjected to various types of anthropogenic disturbances which are threatening its biodiversity. Seidensticker et al. (1999) illustrated that tiger abundance is determined by the quality and quantity of available habitat. The cumulative effect of population density, land-use patterns, roads, and railways results in a highly resistant landscape for tiger movement (Dutta et al. 2016, 2018). The major threat is habitat loss due to the rapid conversion of natural habitats outside protected areas resulting in isolation (DeFries et al. 2005) and poaching.

Previous studies also suggest that the ATR area bears high anthropogenic disturbance (Mathur et al. 2011) and high levels of poaching (Jhala et al. 2011). The settlements and the roads are the greatest disruptions to wildlife (Kumar et al. 2014). The present paper is an overview of the anthropogenic influence of ATR on effective management and protection for the wild tiger population.

STUDY AREA

The geographical extent of the Achanakmar Tiger Reserve area lies between 22°17' and 22°38' North latitudes and 81°31' and 81°57' East longitude. It extends over an area of 914.017 km^2, out of which 626.195 km^2 falls under the core zone (critical tiger habitat) and 287.822 km^2 comes under the buffer zone (Fig. 1 & Fig. 2). It is located in the Lormi tehsil of the Mungeli district. 113 beats of the ATR area is covered under ten territorial ranges which includes Achanakmar, Belghana, Chhaparwa, Gaurela, Khuriya, Kota, Lamni, Lamni (Tiger Reserve), Lormi, and Surhi range.

Champion & Seth (1968) categorized forest vegetation under Northern Tropical Moist Deciduous and Southern Dry Mixed Deciduous Forest. Sal (*Shorea robusta*) is the dominant tree species in the area, followed by Sal mixed

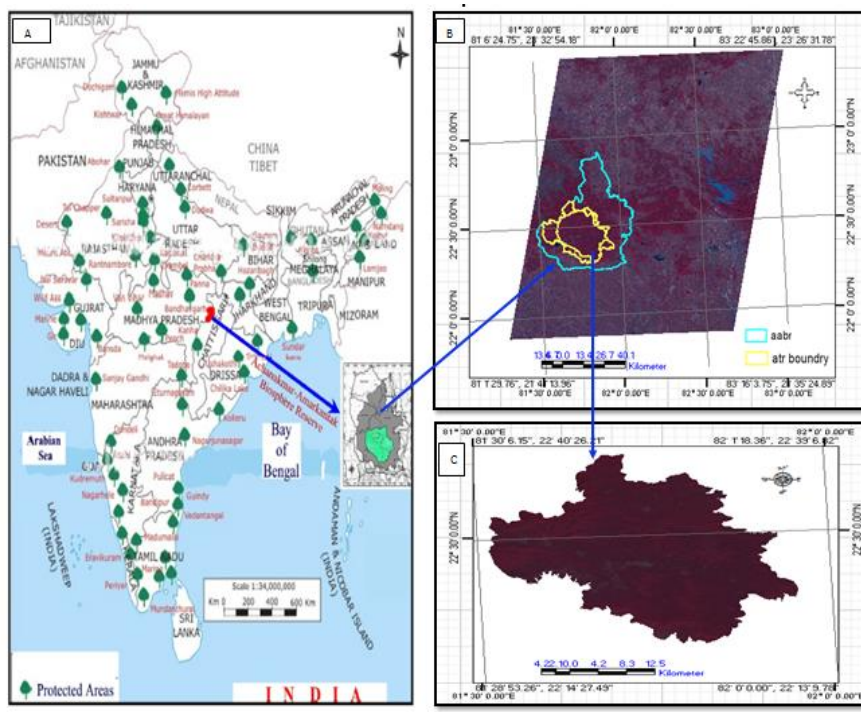


Fig. 1: The location map of ATR A-Protected Areas of India, B- Location of AABR and ATR in IRS LISS III image, C-Location of ATR Area.

forest, which includes tree species such as Saja (*Terminalia tomentosa),* Tendu (*Diospyros melanoxylum),* Haldu (*Adina cordifolia),* Bija (*Pterocarpus marsupium),* Mahua (*Madhuca indica),* Dhaora (*Anogeissus latifolia),* Teak (*Tectona grandis* (plantation)). Bamboo (*Dendrocalamus strictus*) is also found in higher and lower slopes with miscellaneous tree species (Mandal et al. 2017).

MATERIALS AND METHODS

- The Achanakmar Tiger Reserve boundary was obtained from Forest Department, Govt. of Chhattisgarh.
- A preliminary interpretation of the study area is done on topographical sheets. For digitalization, the Survey of India (SOI) topographic maps of 64F10, 64F11, 64 F14, and 64F15 on 1:50,000 scales published by SOI, Dehradun have been used.
- Detailed information on the villages within the core and buffer zones is collected from ground truthing and also from the forest department.
- Demographic details such as census data were downloaded from the Government of India's official website for the years 2001 and 2011. Population Density for core and buffer villages was calculated with the help of the following formula:

$$\text{Population Density} = \frac{\text{Number of people}}{\text{Land area in sq. km}}$$

- The data on cattle predation and conflicts within ATR were obtained from the C.G Forest department. The limitation of such secondary data is that they only include the cases that have been recorded or registered by the forest department.
- IGIS Version 1.0 was used for image processing such as layer stacks, a subset of the study area, preparation of the base map, road network map, identification of core, buffer, and fringe villages, etc.
- The road networks within the ATR area have been prepared with the help of IGIS software and Survey of India (SOI) toposheets as primary roads (state highway), and secondary roads (all other roads such as unmetalled roads, cart track roads/footpaths, etc) which crisscross this landscape (Fig. 5).
- Field data, including the field photographs and the ground control points, have been collected during the field survey.
- For identifying the actual location GPS (Global Positioning System) - Garmin (eTrex 10) and the "Trimble Geo Explorer" series with an accuracy of 2-6 m have been used.

RESULTS AND DISCUSSION

Protected areas of India are under constant threat and pressure from anthropogenic influence. Kerley et al. (2002) used human population density and transportation networks (roads and railways) as anthropogenic variables in their study because tigers are known to avoid human settlements and roads. In most forested areas, anthropogenic disturbances and a lack of prey bases do not allow the existence of wild tigers (Karanth & DeFries 2010). High human population density causes increased anthropogenic pressure on large mammals, which can lead to a decrease in their numbers (Harihar & Pandav 2012).

The ATR is also under the influence of many anthropogenic pressures such as villages, roads, and livestock populations causing overgrazing of vegetation, human-wildlife conflict, etc.

Settlements Inside the ATR Area

Eighteen villages (Fig. 3) are still in the core zone and five buffer villages are situated inside the ATR area. The main inhabitants of these villages are Baiga followed by Gond, Kol, Oraon, and Yadav communities. The population density of the core zone ranges from 12.64 inhabitants/km^2 during the year 2001. Despite of relocation of six villages in the first phase of relocation (2009), the population density increased in the year 2011 to 16.05 inhabitants/km^2. On the other hand, the human population density of the buffer zone increased from 6.12 people/km^2 to 7.41 people/km^2 between 2001 to 2011.

The activities and dependence of core villagers on forests affect the management of the tiger reserve. The villagers

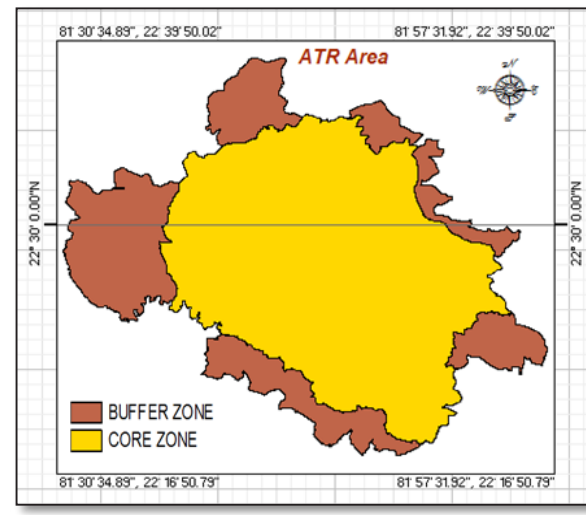


Fig. 2: Zonation map of ATR showing core and buffer zone.

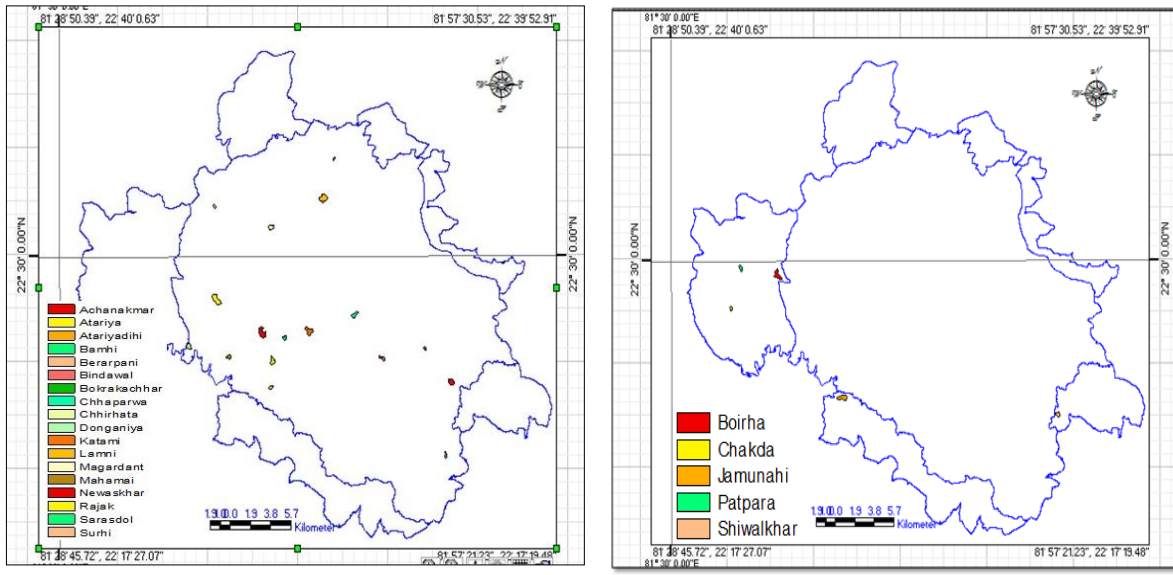


Fig. 3: Location of core and buffer villages of ATR a) Core villages of ATR b) Buffer villages of ATR.

are mainly dependent on forests for their livelihood. They are employed in forestry activities such as road repairing, engineering works, fire safety, wildlife protection, etc. The tribes residing inside the ATR area, cultivate rain-fed annual cereal crops, especially rice. The rise in the human settlement near the forests leads to a decline in wildlife population and

Agricultural land of Achanakmar village

Forest village sarasdol

Core village Bindawal

Housing pattern of Chhaparwa village

Fig. 4: (A to D) Core villages of ATR.

degradation of its natural environment. People residing in the reserve area directly or indirectly depend on the forest for wood, firewood, and non-timber forest products (NTFPs) as there is little to no alternative for them.

The tribes residing inside the ATR area grow annual cereal crops, especially rice. But, the presence of wild animals such as langur, deer, sambhar, etc often leads to crop damage in the core, buffer, and fringe villages.

ATR has a very low human population density as compared to other tiger reserves such as Kaziranga (437 people/km^2) and Namdapha (27 people/km^2). In India, human population density around the tiger reserves did not correlate with the success or failure of the reserves (Post & Pandav 2013).

The main reason behind the success of tiger reserves like Corbett, Kaziranga, Kanha, and Nagarhole is that their core area remains inviolate despite human interference at the periphery of the reserve area (Post & Pandav 2013). Harihar & Pandav (2012) observed that to create an inviolate breeding space for tigers, villages must be relocated from the reserve area. Resettlement has been used in India for over 30 years to remove human settlements from the habitat of tigers and Lions which has resulted in significant recovery of the carnivore population and conflict at many locations (Karnath et al. 1999). Lasgorceix & Kothari (2009) examined the relocation and displacement of core villagers from protected areas and tiger reserves in India and reported a maximum displacement of 24 villages each from Kanha National Park and the tiger reserve (around 650 families) in 1973-74 and Kuno Wildlife Sanctuary, M.P (1400 families) between 1996-2002.

In contrast, human use has favored biodiversity as found in Kanha Tiger Reserve (KTR), M.P (Maan & Chaudhry 2019). Here, the existence of villagers in forests has led to the formation of open grasslands. The forage availability increased for herbivores and these grasslands were managed regularly by using fire and pruning techniques even after village relocation. However, controlled extraction of resources from the reserve area has proven to be sustainable.

Transportation Network

The highways have a serious impact on wildlife and their habitats. Roads are the main cause of habitat fragmentation and there have been increased anthropogenic activities in these areas. A network of main roads and villages was used to understand the spatial pattern of human pressures in the landscape. Proximity to road networks and human habitations is known to have negative effects on habitat quality (Dutta et al. 2016, Joshi et al. 2013).

A large number of roads exist within ATR (Fig 5). State highway 8, approximately 55 km from south to north is the largest and busiest road within the Tiger Reserve. It divides the entire tiger reserve area into two halves. This highway, which runs from south to north, divides the ATR into a larger western area and a smaller eastern area. A stretch of this highway passes through ATR which starts at Shivtarai, the first forest check post, and ends at the last checkpoint of the reserve at Keonchi. In between, there are four other checkpoints. These checkpoints are in the order Shivtarai Barighat Achanakmar Chhaparwa Lamni Keonchi. The authorities are trying to keep unwanted elements out by

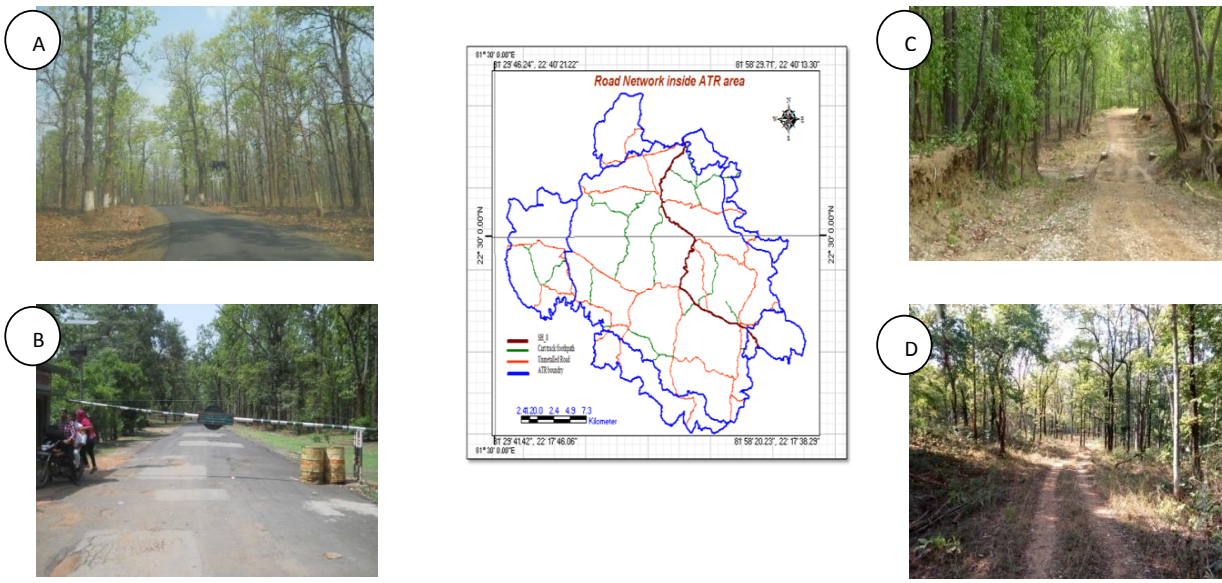


Fig. 5: Road network inside ATR (A & B) State Highway 8 passing through Chhaparwa, (C & D) unmetalled road and tourist road inside ATR.

making the crossing to Keonchi compulsory when entering Shivtarai. Despite the alternative route Ratanpur- Majwani-Kenda-Kevchi (RMKK) route and Bilaspur - Pendra Road - Amarkantak road people often use state highway to reach Amarkantak (an important tourist and religious place).

ATR also has a wide network of tourist roads that facilitate the transportation of safari vehicles. The entire tourist road in ATR is divided into two areas. One is 90 km long in the Achanakmar range. The other road 102 km long is situated in the Chhaparwa range. NCTA guidelines limit tourism to 20% of the core area (Tyagi et al. 2019). But in ATR all the tourist roads are situated in the core zone which hampers the smooth movement of wild animals.

Tyagi et al. (2019) examined the anthropogenic disturbance especially tourism in two tiger reserves of the Central Indian Landscape (Bandhavgarh Tiger Reserve & Kanha Tiger Reserve) and the physiological stress responses of tigers. Their study concluded that the concentration of fecal glucocorticoid metabolite (FGM) was significantly higher in tigers during the tourism period as compared to the non-tourism period. Thus, research has proven that anthropogenic influence not only influences the natural behavior of tigers (dispersal, hunting, and breeding) but also causes physiological changes.

Livestock Population

The villagers residing in and around the protected areas are largely dependent on livestock (Mann & Chaudhry 2019). The tiger reserve area has a large livestock population of around 9000 (Mandal et al. 2017). A high livestock density ($25.44 \pm 11.10/km^2$) in ATR areas has deleterious harmful effects on wild ungulates and their habitat (Mandal et al. 2017). Cattle grazing affects the forage available in the area and the presence of a high density of livestock can lead to competition between wild ungulates for food, resources, etc. Since, ATR area is having low wild ungulate prey density ($32.5/km^2$) (Mandal et al. 2017) as compared to other protected areas such as Sariska Tiger Reserve ($103.4/km^2$) and Rajaji National Park ($90.8/km^2$) (Harihar et al. 2009) which sustain similar predators such as tiger, leopard and striped hyena (Mandal et al. 2017).

The main livestock in the area is buffalo (*Bubalus bubalis*), Cow (*Bos indicus*), and goat (*Capra hircus*) (Fig 6). Few livestock camps have also been reported in the core zone of ATR by local newspapers as well as by Management Effective Evaluation Report, 2010-2011. Yadav families generally prefer to raise cattle for milk production and trade.

These cattle usually graze in the forest area and often lead to livestock deaths from predators like tigers and leopards. The uncontrolled grazing by cattle can lead to the removal of biomass and younger seedlings from the forest. The regeneration of forest tree species is adversely affected due to soil loss through the trampling of the forest floor. Mann & Chaudhry (2019) reported that the 500 families of buffalo herding Maldharis tribe were relocated from the core zone of Gir National Park, Gujarat as a result, the number of cows predated by lions decreased.

Fringe Villages and Their Influence on the ATR Area

There are many forms of anthropogenic pressure on protected areas of India. The main biotic pressures include the felling of firewood, harvesting of timber, grazing and browsing of domestic livestock, lopping of fodder species, and collection of broom grass by fringe villagers thereby causing negative pressure on wildlife and their habitat. There are more than 49 fringe villages within 5 km of the ATR border. The peripheral areas of Tiger Reserve area are under the pressure of heavy grazing.

Conflicts in ATR

Indian protected areas support a huge array of wildlife that is prone to conflict with humans. The expansion of human

Fig. 6: View of livestock population (a &c) cattle grazing in the core zone and (b) construction of the bamboo house for livestock.

activities in and around protected areas has led to major cases of conflict (Karnath et al. 2012, Packer et al. 2005). Several studies have been carried out on the human-animal conflict (Treves & Karnath 2003, Struebig et al. 2018). Livestock depredation is the main reason for human-wildlife conflicts worldwide (Singh et al. 2015, Graham et al. 2005).

High livestock depredation is reported in the ATR area by both tigers and leopards. Major livestock losses are associated with grazing animals both within and near the proximity of the protected areas. Due to the high livestock population, there is an increased possibility of human-wildlife conflict (Mandal et al. 2017) and this is a common phenomenon in both core and buffer areas. No human casualty has been reported by tigers in the reserve area in the past seven decades. The cattle kill incidences by both the apex predator (tiger and leopard) was 378 during the period of three years (2015 to 2018) (Fig 7). Several conflict cases have been published in local newspapers by a sloth bear, leopard, etc.

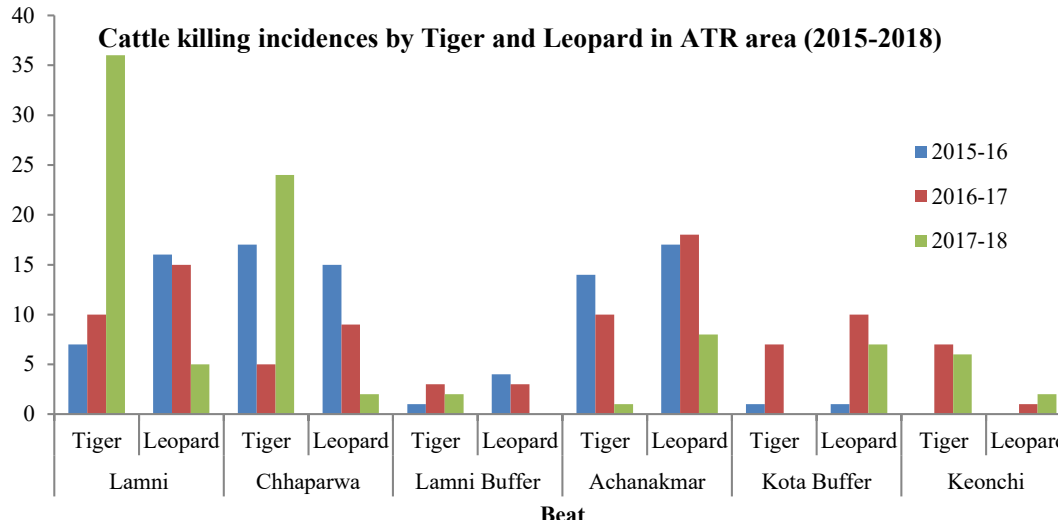
Man-wildlife conflicts still arise as the crop-raiding herbivores such as chitals (*Axis axis*), nilgais (*Boselaphus tragocamelus*), wild boars (*Sus scrofa*), etc often graze the agricultural field of the villagers. The incidences of crop raiding are more in the fringe areas as compared to the core and buffer because of limited agricultural operations in the area.

The Kaziranga Tiger Reserve recorded 518 cattle kills by tigers over three years (2008-2011) (Borah et al. 2018). Chouksey et al. (2018) examined the human-wildlife conflicts near Bandhavgarh Tiger Reserve and the study reported that maximum conflicts were reported by jackals (37.57%), followed by sloth bears (27.64%), wild boars (20.99%), tigers (8.84%), leopards (3.31%) and 1.65% by other carnivores during the year 2001 to 2011. Singh et al. (2015) studied the human-tiger conflicts in pastoral villages adjacent to Ranthambhore Tiger Reserve between 2006-2011 and reported that maximum conflicts (88.5%) between humans and tigers are due to attacks on domestic animals. Leopard is the main carnivore involved in cattle killings in the Kanha-Achanakmar corridor (Ahmed et al. 2012).

To address the human-animal conflict between the villagers who have lost their livestock, WWF-India has taken steps to provide the villagers with immediate interim financial aid. The compensation from the forest department helps to reduce the initial anger and hostility of the people. Compensation is not the only solution, but it is an important conservation strategy to reduce the retaliatory killing of tigers (Bose et al. 2011). Another permanent and cost-effective solution needs to be implemented for the sustained survival of tigers.

CONCLUSION

The status of anthropogenic influence of core, buffer, and fringe villages of the ATR area was examined to study the degradation in the ecosystem and habitats around the tigers. An uncontrolled human intrusion and traffic movement within the entire reserve area is threatening the conservation goals of ATR. Since tigers avoid locations closer to human settlements, the presence of 18 core villages and 5 buffer villages restrict the movement of tigers in the core zone. Another problem with this tiger reserve is habitat fragmentation, as The State Highway 8 of 55 km



(Source: C.G Forest Department)

Fig. 7: Livestock depredation incidences in different beats of ATR (2015-2018).

divides the entire ATR into two halves. Regular movement of vehicles hinders the smooth movement of wild animals. Thus, vehicular movement should be regulated and restricted. The presence of a large livestock population increases the competition between wild ungulates for fodder and cattle depredation by apex predators can accelerate the conflict between humans and animals.

ATR area can support a good population of tigers by minimizing anthropogenic activity in the core, buffer, and fringe areas. This is possible by village relocation to provide inviolate space for tigers and movement of vehicles in the SH 8 should be restricted as an alternative route is available. The area should be managed properly with proper allocation of resources, land use planning, and sustainable management of natural resources. There is a need to reduce the livelihood dependency on the resources of the reserve area and subsequent anthropogenic pressure to protect the habitat of apex predator *Panthera tigris tigris* and several other rare and endangered flora and fauna.

RECOMMENDATIONS

1. Relocation of core villages from the reserve area.
2. In the dry summer months, special attention should be paid to the availability of water for wild animals.
3. The economic valuation of cattle must be increased by improving their breed to improve the economy of cattle owners and the removal of old and unproductive cattle can reduce the impact of grazing on the nearby forest area.
4. To reduce the impact of heavy grazing by domestic livestock and wild animals, artificial water sources must be created in less-used habitats.

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