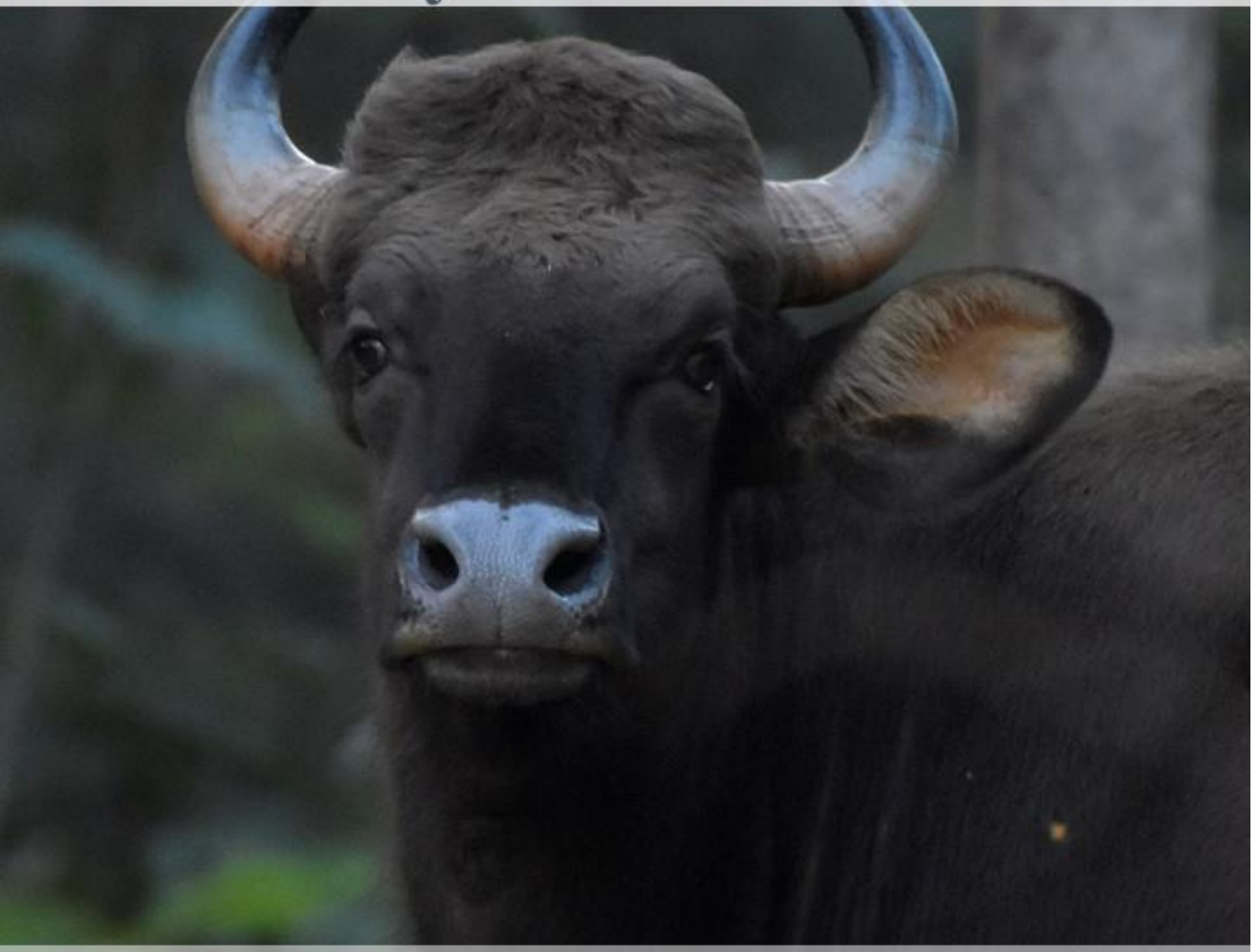
Assessment of human-wildlife conflict in Madei Wildlife Sanctuary and its buffer zone



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Assessment of Human-Wildlife Conflict in Madei Wildlife Sanctuary and its Buffer zone

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DECLARATION BY STUDENT

I hereby declare that the data presented in this Dissertation report entitled, "Assessment of Human-Wildlife Conflict in Madei Wildlife Sanctuary and its Buffer zone" is based on the results of investigations carried out by me in the Zoology Discipline at the School of Biological Sciences and Biotechnology, Goa University under the Supervision/Mentorship of Dr. Nitin Sawant and the same has not been submitted elsewhere for the award of a degree or diploma by me. Further, I understand that Goa University or its authorities will be not be responsible for the correctness of observations / experimental or other findings given the dissertation.

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COMPLETION CERTIFICATE

This is to certify that the dissertation "Assessment of Human-Wildlife Conflict in Madei Wildlife Sanctuary and its Buffer zone" is a bonafide work carried out by **Ms Sona Kishor Gaonkar** under my supervision/mentorship in partial fulfilment of the requirements for the award of the degree of **Master of Science** in the Discipline Zoology at the School of Biological Sciences and Biotechnology, Goa University.

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ABSTRACT

The study was carried out in each of the five sampling villages in Madei WLS in its buffer zone. It was aimed to identify areas, animals, types, and causes of human-wildlife conflict in Madei Wildlife Sanctuary and its buffer zone and to quantify the same. Caranzol, Sural, Satrem, Nanorem, Derodem and Copardem, Edorem, Charavne, Golauli, Maloli were identified as areas in the conflict in the PA and buffer respectively. PA reported 71.66% of conflict while buffer reported 88.33% of conflict. A total of twelve animals (megafauna) were reported to be in conflict. The practice of Kumeri (Slash and burn agriculture), Practice of Vanarmare, water availability for those animals, a shift from polyculture to monoculture agricultural practices and allelopathy were reported to be the causes of the conflict in the study area. Ancestral mitigation, Modern mitigation and mitigating practices carried out by the state forest department were been recorded. Mitigation techniques based on authentic scientific literature were suggested.

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CHAPTER 1: INTRODUCTION

Wildlife-associated conflicts are situations when wildlife comes into over common resources with humanbeings (Conover 2002; Graham et al. 2005). Wildlife as every non-domesticated animal and plant, domesticated and feral animals can also be included. The interactions between animals and man can be positive or negative, depending on the sharing of habitat, and resources. Man-animal conflict is a dispute between humans and wildlife wherein human or animal actions may have an adverse impact on the other (Jagadeesh et al. 2020). Human-wildlife conflict is the occurrence of conflict situations between humans and wildlife over livestock depredation, crop raiding, killing of people or predation on managed wild animal species (Woodroffe et al. 2005). Datta-Roy et al. (2009) describe human-wildlife conflict in any of the four situations: that being if there is a direct threat to human life, if there has been the destruction of property by wild animals, if there is direct competition for forage between domestic livestock and wild herbivores or if agricultural crops are damaged by wild animals.

In India wherein there is high degree of wildlife and people occurrence, prevention and mitigation of human–wildlife conflicts should be a top conservation priority (Karanth et al. 2013). World energy requirements and consumption patterns are changing dramatically, and the rising energy production, either from renewable or non-renewable sources, poses a great risk for both wildlife conflict as well as conservation strategies. Oil, natural gas, atomic energy exploration and exploitation, industrial solar installations directly impact wildlife populations (Jagadeesh et al. 2020). Over development and conservation priorities, human-wildlife around protected areas conflict in India has magnified social conflict (Johnson et al. 2018).

Agricultural land use and expanding human population and have considerably reduced the area available to wildlife in general resulting in conflicts (Santhiapillai, 1996). Many species are decreasing in abundance because of habitat destruction and may lead to the extinction of these

species (Sawant et al. 2013). As compared to generalist species, specialist species are more affected by habitat modification (Chaiyarat et al. 2021). The pressure for wild lands to be made available for livestock grazing and the close proximity of the cultivation to forest areas cause considerable animosity between wildlife and man in India (Sale and Berkmuller, 1988). The growth of the human population, intensified land use (Ngure, 1995), increase in population of animals (Smith et al., 1995), human pressure on animals, modification of natural resources, habitat fragmentation (Sukumar, 1994) some of the reasons driving the conflict. Over a period of time man has assumed superiority on the planet and this has resulted in alteration of ecosystem dynamics, elimination of various species and indisputable loss of human life, property, livestock and crops. The settlement of these conflicts is deciding the conservation and restoration of many species (Jagadeesh et al 2020).

The tremendous increase in global urbanisation accompanies the salient need to recognise the type nature of human–wildlife interactions. The benefits of human–wildlife interactions are becoming increasingly recognised, even though they are harder to quantify as compared to human-wildlife conflicts (Soulsbury and White 2015). With decades of significant financial resource investment and scientific research, we are still short in understanding the fundamentals of socio-ecological elements that propel human wildlife conflicts. In order to avoid a substantial loss to different species may that be in form of human lives, livestock harm or crop destruction and cases resulting in retaliation against wildlife it is the need of the hour that we create constructive prevention and mitigation techniques (Karanth et al. 2013).

The frequency of man-animal conflicts are on increase over food requirements and habitat mainly due to loss of natural habitats and the ever-expanding human population. Villages in and around the forest are more prone sites for man-animal conflict as human and wild animals intersect with these very places (Dutta et al. 2015). People housing in forest fragments as well

as in forests are more prone to human-wildlife conflict. Their requirements often overlap with those of the wildlife as the wildlife seek to fulfil their ecological, behavioural and nutritional needs (Sukumar, 1990). When rural people reside in close association with protected areas, the conflict is prone to be more serious (Mishra, 2001). Hence the reason for villages being most potent in man-animal conflict.

Identification of commonalities, gathering data on perceived conflict and compensation paid to affected people are all prime steps in this prioritization process (Madden 2004; Baruch-Mordo et al. 2009; Dickman et al. 2011; Karanth et al. 2012).

Goa with an area of 3,702 sq. km adjoins Karnataka in the south and the east and Maharashtra in the north. It houses 110 kilometres of Arabian Sea coastline in the west and 125 km long Western Ghats in the east. The state is distinctly marked by three landscapes that being is the Western Ghats, mid-highlands (Malabar plains) and the coastal plain (coast) (Baidya and Bhagat 2017). The average rainfall in the state is reported to be between 2500 to 3000 mm. The weather temperature is around 30^0 C and the maximum temperature is 36^0 C. The climate is humid throughout the year, with humidity levels ranging from 75%–95% in the monsoon. The southwest monsoon occurs from June-September (Jadhav et al. 2018).

About 10% of Goa is demarcated as Wildlife Sanctuary and National Park and this area includes seven large protected areas (Jalal 2019). The northern section of the Goa ghats holds formation of the Deccan Trap type and these are characterised by a horizontal top and vertical slopes frequently referred to as tabletops. These diverse amalgamations of diverse habitat result in Goa's rich biodiversity and distribution of species in the region (Baidya and Bhagat 2017).

This study aims to fill the lacuna of the human-wildlife conflict of Madei WLS.

1.1 Problem statement

A world of abating natural habitats of wildlife and an ever-expanding need for natural resources has brought in the challenges of coexisting with wildlife sharply into focus. Informed growth and development that makes space for wildlife is the need of the hour. Identifying and reporting animals in conflict and understanding conflict situations in the mentioned study areas will be onset of the process. Understanding perception of people in conflict and reporting influential factors and developing mitigation techniques are of prime importance.

The current work puts out a holistic approach to understanding issues of wildlife in conflict to understand the impact of conflict on mankind and to mitigating adverse human–wildlife encounters and devising a vision for future approaches to understanding and mitigating such encounters in the study area.

1.2 Objectives

1. To identify areas, animals, types and causes of human-wildlife conflict in Madei Wildlife Sanctuary and its buffer zone.
2. To report the current mitigation practiced by the locals and forest authorities in human-wildlife conflict areas and suggest mitigation techniques by using authentic scientific literature.

1.3 Scope of the work

1. The study will fill the lacuna of knowledge about the on-ground reality of human-wildlife conflict in Madei Wildlife Sanctuary and its buffer zone.
2. The study has critical implications for biodiversity and ecosystem health, in addition to the direct or indirect impact on the human welfare.
3. Collection and compilation of the data on the status of faunal components in conflict in the selected study area can serve as baseline for future research.
4. The study will set out as a baseline data for the policymakers to prepare a conservation action plan and to implement mitigation majors. This data will also serve as important evidence for habitat management programs.

1.4 Review of literature

A study was conducted by Chaturvedi et al. (2014) to perceive the man-monkey conflict and its management in Chitrakoot, Madhya Pradesh, India. They reported that tremendous increase in urbanisation and other anthropogenic activities has taken take a toll on wildlife and the on forest. Therefore, the macaque habitation faces problems which result in man-macaque conflicts.

A study conducted by Karanth et al. (2013) in 1371 villages in Karnataka covering five wildlife reserves in the Western Ghats showed that 64% of households reported crop loss that being cotton, sugarcane, coffee and rice. 15% of the surveyed households reported livestock loss which was associated with grazing inside the wildlife reserves. Averaging the losses, it was found INR Rs 23,010 for crop loss and INR Rs 5423 for livestock loss. For both livestock and crop, 31% of households were in possession of compensation receipts. It was learned that night watching (46%), fencing (34%) and scare devices (34%) were some of the common mitigation measures for the protection of crops and closer watch on animals (7%), guard animals (3%) and fencing (2%) for livestock protection. Across all five reserves, households closer to the reserves were noted to incurred higher losses.

A study conducted by (Dutta et al. 2015) among 104 villages in Barak Valley in the Southern part of Assam reported four conflict animals *viz*: Golden jackal (*Canis aureus*), Civets (*Viverricula indica, Paradoxus hamiltonis, Paguma larvata, Viverra zibetha*), Rhesus monkey (*Macaca mulata*) and Wild Pigs (*Sus scorfa*) that were associated with man-animal conflict in these very villages.

A study conducted by (Weladji et al. 2003) in Be´noue´ Wildlife Conservation Area, North Cameroon revealed that 86% of the surveyed households, with 31% of crop income lost on average suffered Crop damage. Elephants (*Elephas maximus*), Patas monkeys (*Erythrocebus*

patas), baboons (*Papio sp.*), Green parakeet (*Psittacara sp.*) and Warthogs (*Phacochoerus sp.*) accounted for 97% of crop damage, with the staple foods maize and millet were most affected. 28% suffered livestock depredation, with 18% of livestock income lost on average wherein civet cat was reported as the main predator. To reduce such conflicts and to promote sustainable conservation they have suggested the establishment of crop damage control teams, the promotion of tangible benefits to local people and co-management of wildlife involving all stakeholders.

As a policy solution to human-wildlife conflict as well as to ensure human security while protecting biodiversity, the Government of India introduced financial compensation for human-wildlife conflict (Johnson et al. 2018). The study was carried out in four protected areas in Rajasthan (Jaisamand, Sitamata, Phulwari, and Kumbhalgarh) to evaluate compensation as a mitigation policy for human-wildlife conflict. It revealed the shortcomings of the compensation policy. Firstly, being that it focuses on charismatic megafauna obscures the livelihood costs of human-wildlife interactions as reported by households, especially conflict perpetrated by non-priority herbivores like antelope. On contradictory to popular belief, the study argues that the compensation policy is primarily designed to internationally conserve threatened species and not to safeguard local livelihoods.

A study held in ten villages through Karnataka and Tamil Nadu border evaluated a loss of Rs.1.5 lakhs per year to agricultural crops by elephants (Sukumar, 1989; Sukumar, 1990). Appayya (1992) remarked similar conclusion on studying man-wildlife interaction in Karnataka. Likewise study conducted by Ishra (1971) and Datye and Bhagwat (1993 a) in Bihar and Balasubramanian et al. (1 993) and Ramesh Kumar and Sathyanarayana (1993) in Nilgiris reported similar findings.

A study conducted by Sengupta et al. (2013) on the Distribution and Conservation Status of the Bonnet Macaque (*Macaca radiata*) in Goa, India reported that rated *Macaca radiata* is the second most destructive, frequent and feared species, after *Semnopithecus hypoleucos*. They further reported Bonnet macaque (*Macaca radiata*), Gaur (*Bos gaurus*), Malabar sacred langur (*Semnopithecus hypoleucos*), Jungle cat (*Felis chaus*), Fox (*Vulpes bengalensis*) and wild pig (*Sus scrofa*) as crop destructive wildlife species. 87% of their respondent reported that Bonnet Macaque (*Macaca radiata*) visited their farms more often in summer. 53% of their respondent claimed that they cause damage to household structures such as cowsheds, roofs and kitchens. All respondents claimed that they never killed any Bonnet macaque in retaliation.

A study conducted by Sharma et al. (2010) claimed that the growth in the human population and the rise of anthropogenic activities such as urbanization, deforestation and agriculture has resulted in ever-increasing encroachment on wildlife habitats. This roots the depletion of habitats for wild animals into small marginal patches.

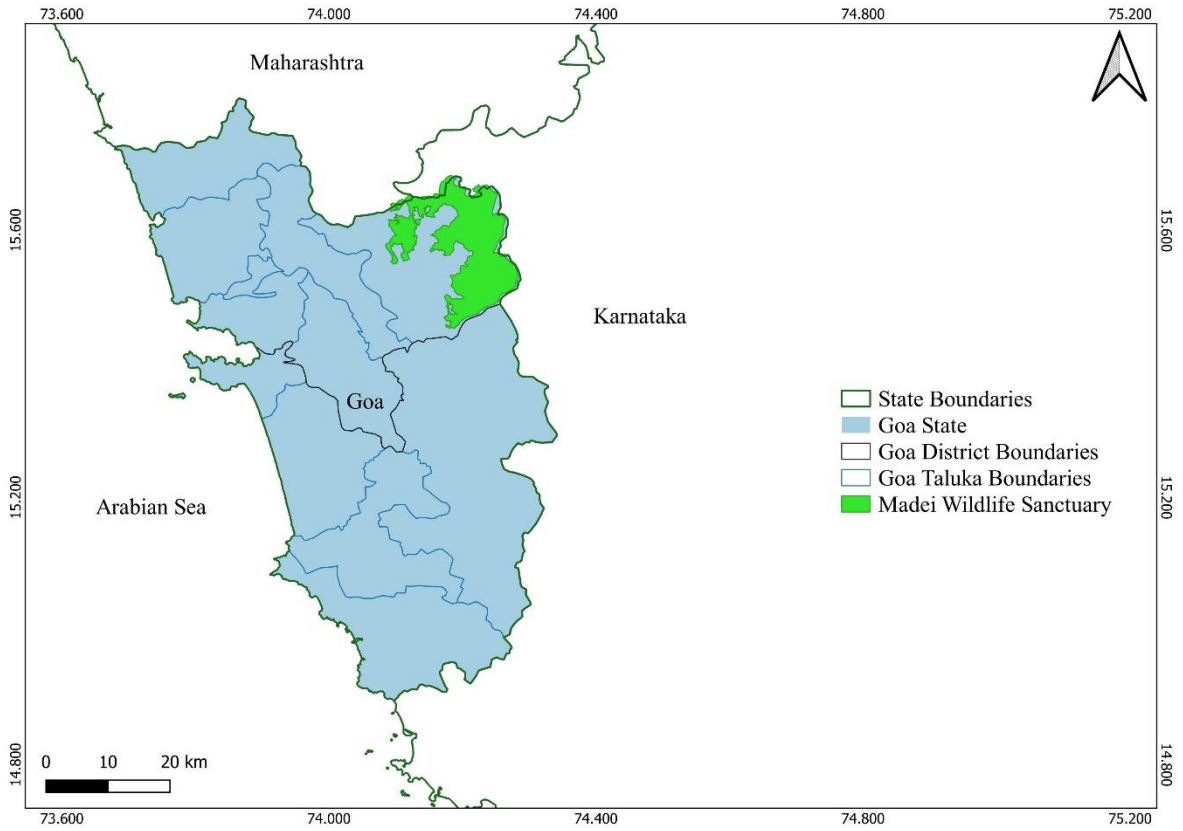
CHAPTER 2: MATERIALS AND METHOD

2.1 Study Area

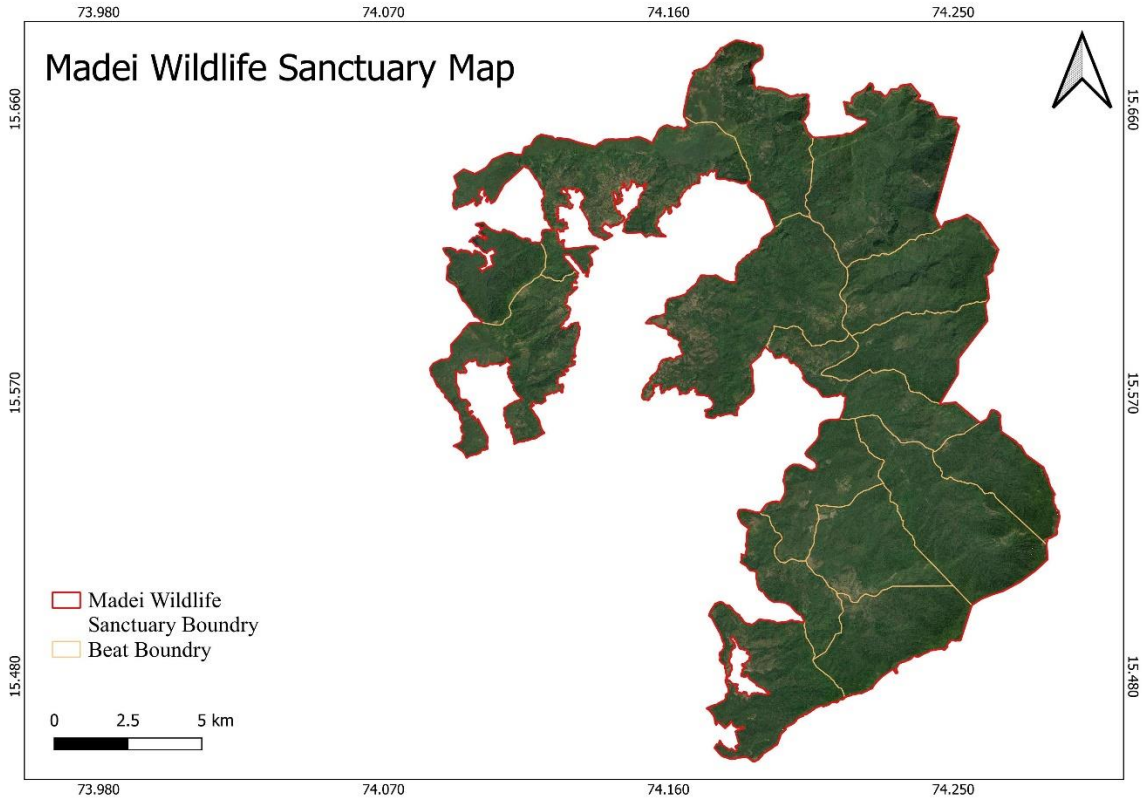
2.1.1 Protected Area

The study is carried out in Madei Wildlife Sanctuary. The Madei Wildlife Sanctuary is located in Sattari taluka of North Goa district, Goa with an area of 208.48 square kilometres. The Sanctuary harbours semi-evergreen, moist deciduous forest and patches of Evergreen (Baidya and Bhagat 2017).

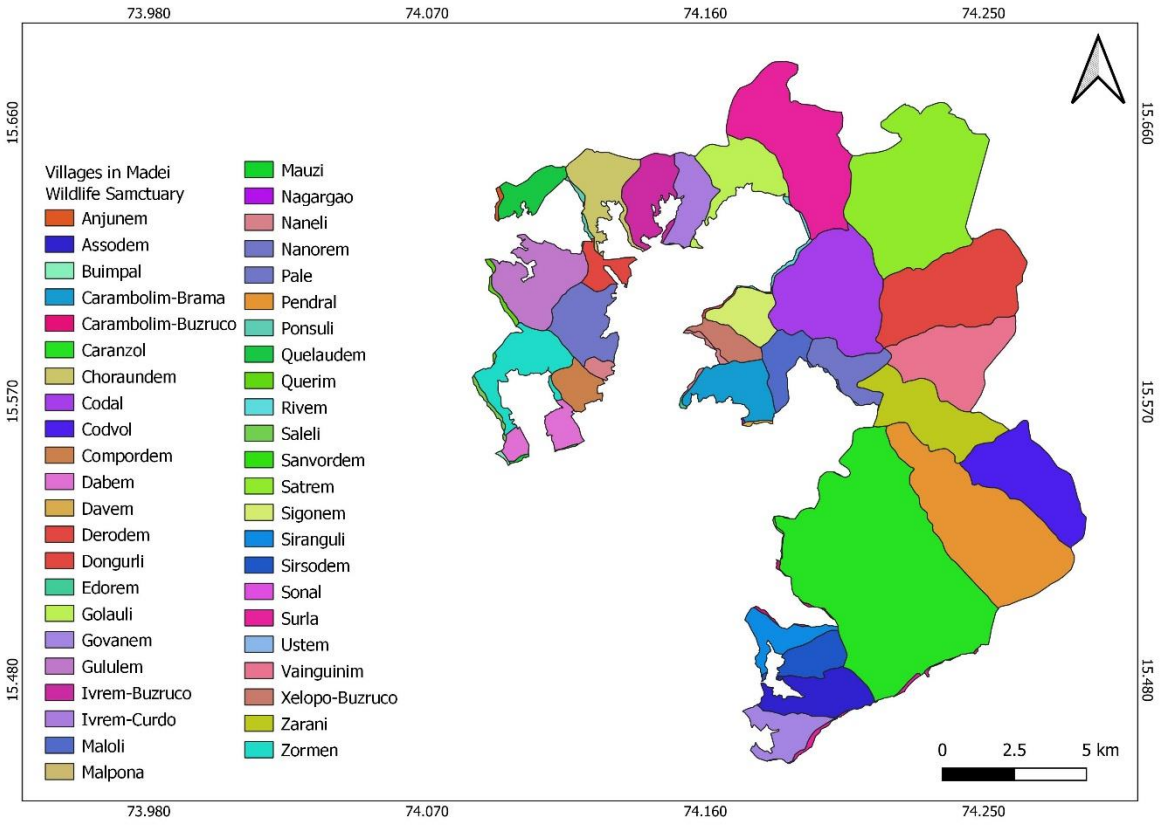
The major fauna of Madei Wildlife Sanctuary includes Spotted Deer (*Axis axis*), Sambar (*Rusa unicolor*), Barking Deer (*Muntiacus muntjak*), Mouse Deer (*Moschiola indica*), Malabar Giant Squirrel (*Ratufa indica*), Indian Giant Flying Squirrel (*Petaurista petaurista*), Common Langur (*Semnopithecus entellus*), Bonnet Macaque (*Macaca radiata*), Slender Loris (*Loris lyddekerianus*), Wild Pig (*Sus scrofa*), Sloth Bear (*Melursus ursinus*), Indian Pangolin (*Hystrix indica*), Ruddy Mongoose (*Herpestes smithii*), Wild Dog (*Cuon alpinus*), Jungle Cat (*Felis chaus*), Leopard Cat (*Prionailurus bengalensis*), Leopard (*Panthera pardus*), Tiger (*Panthera tigris*).



Map 1: Map showing demarcated Madei Wildlife Sanctuary on Goa Map



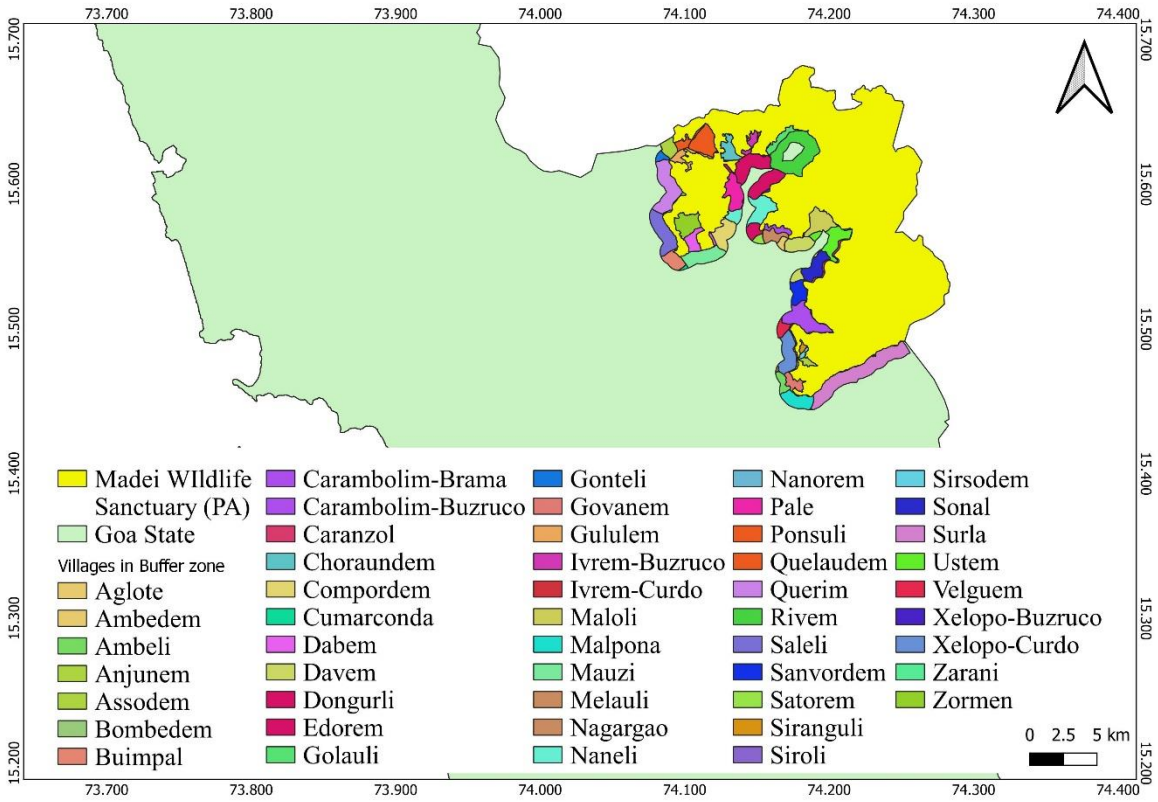
Map 2: Map showing Madei Wildlife Sanctuary



Map 3: Map showing PA Madei WLS

2.1.2 Buffer zone

The buffer zone of the Madei Wildlife Sanctuary is demarcated as 1 kilometre from the boundary of the Protected Area. The buffer zone has an area of 91.82 sq. km.



Map 4: Map showing the demarcated buffer zone of Madei Wildlife Sanctuary on Goa Map

2.2 Selecting sampling points/villages

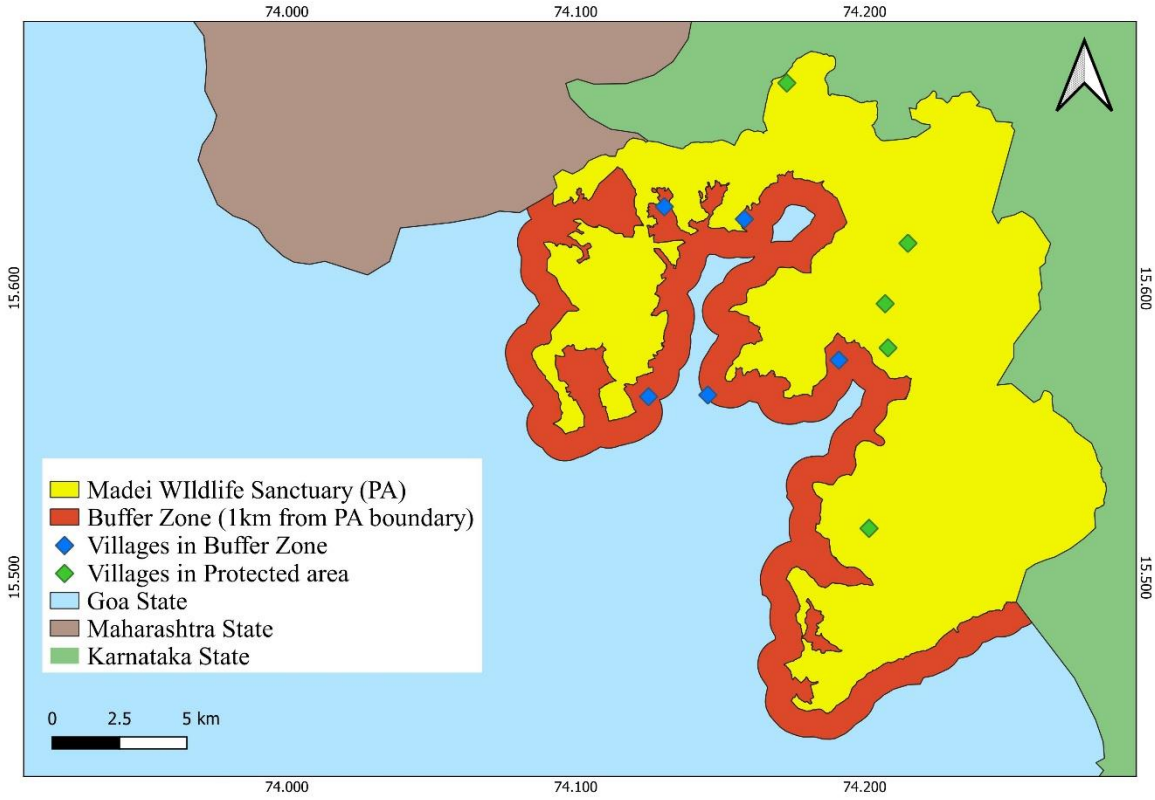
A pilot survey was held across all the villages of the sanctuary and its buffer zone. The selection of sampling points/ villages was carried out based on Simple Random Sampling. This method ensures that from the total population, all sampling units gets uniform chance of being selected (Acharya et al. 2013). Lottery method was followed wherein lots of all the villages within the sanctuary and its buffer zone were made. The total number of sampling points/ villages in the respective zone was taken as the upper limit. Respective lots were put in two bowls. Five lots from each of the bowl were selected (Sampling without replacement). After each selection proper swirl was given (Acharya et al. 2013).

The Sanctuary has fifty demarcated villages. This study attempted to sample ten villages in total accounting for 20% of the sanctuary. The first five selected villages from the respective zone were considered and ten households corresponding to each of the selected villages were visited and the residents were questioned about conflict animals causing problems. Thus, the total data obtained from 100 households was collected and analysed. Households with agriculture and livestock were the criteria for selection for survey. Each household accounted for a single sampling unit wherein the entire family (elderly male/female > children) contributed for a single response. In addition to this, informal interviews were also held with the rest of the household members and with other farmers in the area who would often gather at the sampling unit (Kumara et al. 2013). The study did not involve any sort of capturing or handling any of the species. No specimens were collected. The entire investigation was based on non-invasive methods.

A separate questionnaire was employed to survey the forest officials deputed in the Protected Area. It was to perceive their take on the conflict, queries concerning the same and the mitigation efforts practised by the state forest department.

2.3 Sampling points/villages

Caranzol, Sural, Satrem, Nanorem and Derodem were selected as sampling points/villages from the Protected Area while Copardem, Edorem, Charavne, Golauli and Maloli were selected as sampling points/villages from the Buffer zone.



Map 5: Map showing sampling points/villages

2.4 Data collection

Formal and informal discussions were carried in the study area with stakeholders in local languages *Konkani* or *Marathi* to perceive the status of conflict in the area of interest. The period per questionnaire administration was anywhere in between 30 minutes to 45 minutes. Personal details of the respondent noted during the interview was assured and guaranteed confidentiality. The discussions with the locals also involved using pictorial guides for collection of data. The surveys were structured to record and list down animals in conflict, the

type and the reasons for encountered conflicts and their current mitigation measures. The stakeholders of the mentioned study areas were interviewed on weekends from June 2022 to October 2022.

Figure 1: Figure showing data collection at House 6, Caranzol Village (PA)

2.5 Questionnaire

The survey on stakeholder's attitude towards human animal conflict was build applying the mixed-method approach of "mixing" qualitative and quantitative data collection methods (Decker et al., 2012). This study focuses on stakeholders understanding, perspective and experiences with species in conflict.

The questionnaire includes intensive structured questions and a few open-ended questions. During an unstructured survey, an interviewer's bias can affect the data which requires large amount of probing (Fowler, 2002). Hence in this study most of the questions were close-ended reducing the chances of interviewer bias.

Following the Lottery method, a village for a pre-test was selected. The pre-test was carried out to assess the validity and reliability of the questionnaire. The questionnaire prepared initially for this pre-test was used to collect data from the Vigine village. Based on the

preliminary survey, necessary modifications were made in the interview schedule and the final schedule was formulated.

The following questionnaire was accessed per household of each of ten villages in the study area along with pictorial guides.

Date:
Village:
Household:
Name:
Age:
For how long have you been residing in this area?
What was your ancestral occupation?
Did your ancestors practise Kumeri (Slash and burn agriculture)?
If you practice agriculture, how long do you spend to protect it?
Do you own any Cattle?
Do you own any Poultry?
Q. Are there any cultural significance of above-mentioned wildlife?

Sr.no	Species	Is there a conflict?	Level of Conflict?	Type of Conflict	Cause of conflict	Have you noticed any trend of their sightings in past decade?	Elaborate on the conflict	What do you think are threads for the species?	What was the ancestral way of mitigating the conflict?	What is the modern way of mitigating the conflict?	What could have been other ways for mitigating the conflict?
1											

Figure 2: Figure showing standardise questionnaire

Date: 16-07-2022

Village: Sural

Household: 01

Name: Vitho Pigle (M)

Age: 70 years

For how long have you been residing in this area? : Since birth

What was your ancestral occupation? : Agriculture and dairy farming

Did your ancestors practise Kumeri (Slash and burn agriculture)? : Yes (Millets)

If you practice agriculture, how long do you spend to protect it? : Not practicing

Do you own any Cattle? : Yes (Cowshed)

Do you own any Poultry? : No

Q. Are there any cultural significance of above-mentioned wildlife? :No

Sr.no	Species	Is there a conflict?	Level of Conflict?	Type of Conflict	Cause of conflict	Have you noticed any trend of their sightings in past decade?	Elaborate on the conflict	What do you think are threads for the species?	What was the ancestral way of mitigating the conflict?	What is the modern way of mitigating the conflict?	What could have been other ways for mitigating the conflict?
1	*Bos gaurus* (Gaur)	Yes	2	Crop destruction	Absence of Kumeri practice and fodder shortage	Yes, increased in sightings	Destruction in paddy and banana plantation	Decreasing feeding ground	Nil	Electric fencing	Nil

Figure 3: Figure showing a sample of filled questionnaire

2.5 Calculations

Ranking analysis was applied to perceive the extent of conflict caused by the animals by modifying Wiegand et al. (2012).

Economic loss (Unit = Rupees)	**Level of conflict**	**Points**
Rs. 5,000 per annum	Low	1
Rs. 5,001 - Rs 49, 999 per annum	Medium	2
Rs. 50,000 and above per annum	High	3

Table 1: Table showing ranking analysis

The above ranking analysis was implied to determine the average conflict in each of the sampling points/villages in the Protected Area and the Buffer zone. Here the economic loss reported in terms of money was converted into categorical data which were then converted into numerical significance.

CHAPTER 3: RESULTS

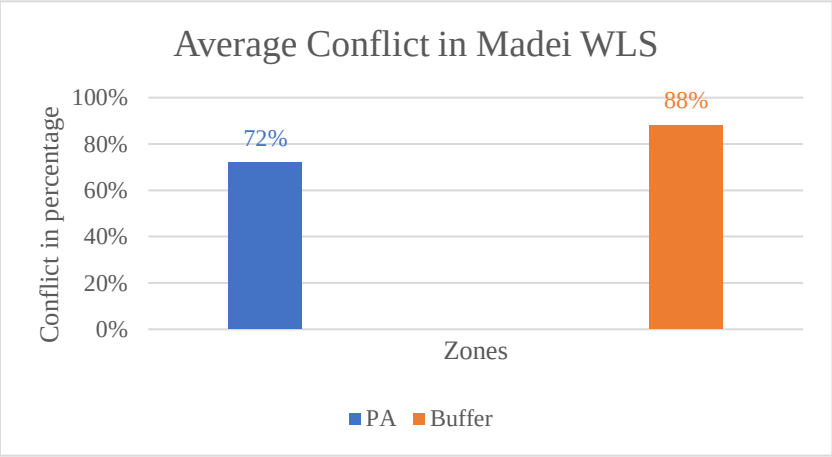
3.1 Areas in conflict

A total of 10 villages were selected to carry out the current study. Five villages in Protected Area of Madei Wildlife Sanctuary namely Caranzol, Sural, Satrem, Nanorem and Derodem and five villages in its buffer zone namely Copardem, Edorem, Charavne, Golauli and Maloli (Table 2).

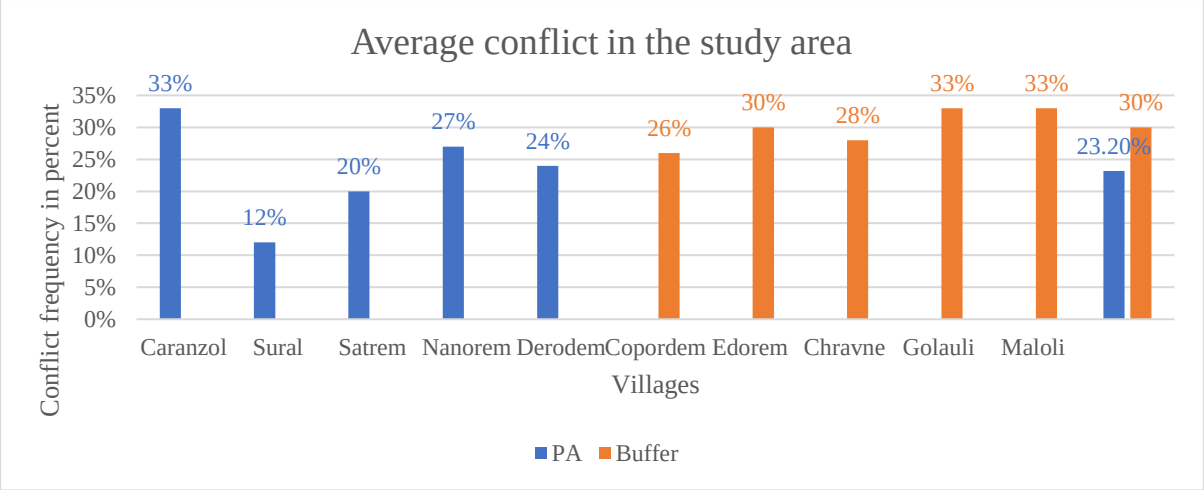
Sr no	**Area**	
	Protected Area	**Buffer**
1	Caranzol	Copardem
2	Sural	Edorem
3	Satrem	Charavne
4	Nanorem	Golauli
5	Derodem	Maloli

Table 2: Table showing sampling villages in the study area.

To perceive the conflict in Madei WLS, an average conflict frequency based on presence/absence data was derived in both zones. It was found that PA exhibits 72% of conflict while Buffer zones showed 88%. The buffer zone bared higher average conflict frequency than PA (Graph 1).



Graph 1: Graph showing average conflict in the study area



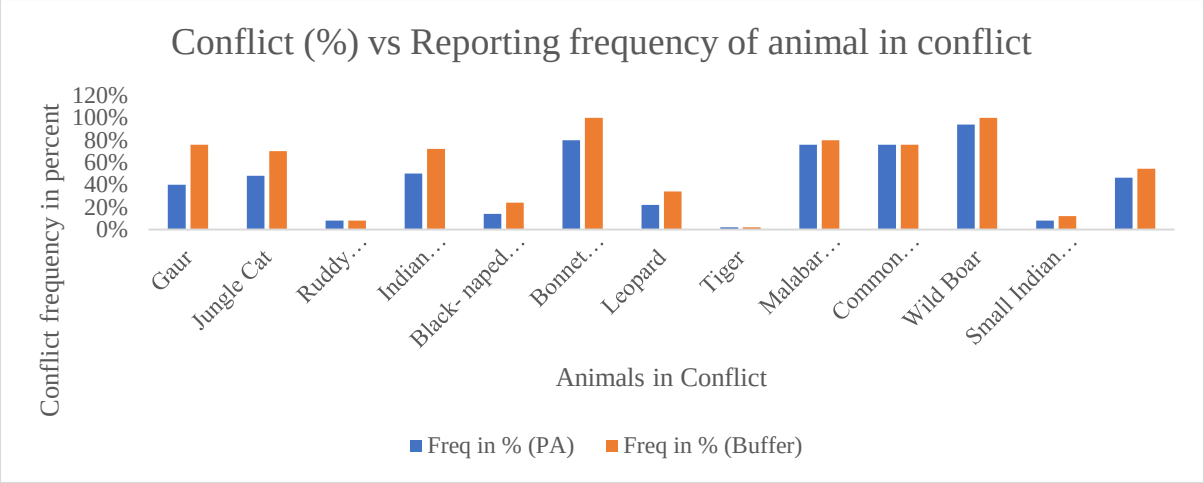
Graph 2: Graph showing average conflict in the study area.

Based on the ranking analysis performed average conflict caused by animals is calculated, PA showed an average of 23.2 % ± 7.8 conflict, with Caranzol having the highest value (33%), followed by Nanorem (27%), Derodem (24%), Satrem (20%) and Sural (12%). The buffer zone evinced a conflict average of 30% ± 3.08 with Golauli and Maloli villages with the highest value of conflict (33%), followed by Edorem (30%), Charavne (28%) and Copardem (26%). Higher average conflict frequency is present in the buffer zone compared to the PA (Graph 2).

3.2 Animals in conflict

A total of 12 animals (megafauna) were found causing conflict in the study area. Amongst all the animals involved in human-wildlife conflict, three animals are listed as a vulnerable category of the IUCN Red List *viz. Bos gaurus, Macaca radiate, Panthera pardus* and one animal is listed in the Endangered category of the IUCN Red List *viz. Panthera tigris* (Table 3).

By using presence-absence data, reporting frequency of animals causing conflict was calculated. In PA, the frequency of *Sus scrofa* (Wild Pig) in conflict was found highest (94%). Followed by 80% of conflict by *Macaca radiata (Bonnet Macaque)*, 76% by *Ratufa indica* (Malabar Giant Squirrel) and *Semnopithecus entellus* (Common Langur), 50% by *Hystrix indica* (Indian Crested Porcupine), 48% by *Felis chaus* (Jungle Cat), 40% by *Bos gaurus* (Gaur), 22% by *Panthera pardus* (Leopard), 14% by *Lepus nigricollis* (Black- naped Hare), 8% by *Herpestes smithii* (Ruddy Mongoose) and *Viverricula indica* (Small Indian Civet) and 2% by *Panthera tigris* (Tiger). In the buffer, the frequency of *Macaca radiata (Bonnet Macaque)* and *Sus scrofa* (Wild Pig) in conflict was 100%. Followed by 80% by *Ratufa indica* (Malabar Giant Squirrel), 76% by *Bos gaurus* (Gaur) and *Semnopithecus entellus* (Common Langur), 72% by *Hystrix indica* (Indian Crested Porcupine), 70% by *Felis chaus* (Jungle Cat), 34% by *Panthera pardus* (Leopard), 24% by *Lepus nigricollis* (Black- naped Hare), 12% by *Viverricula indica* (Small Indian Civet) , 8% by *Herpestes smithii* (Ruddy Mongoose) and 2% by *Panthera tigris* (Tiger). In PA the frequency of animals in conflict was estimated to be 46.36% and that of buffer was estimated to be 54.5%.



Graph 3: Graph showing conflict (%) vs Reporting frequency of Animals in conflict

Sr no	Order	Family	Scientific name	Common name	IUCN status	WPA Status	CITES
1	Carnivora	Herpestidae	*Herpestes smithii*	Ruddy Mongoose	Least concern	Schedule II (Part I)	Appendix III
2	Carnivora	Viverridae	*Viverricula indica*	Small Indian Civet	Least concern	Schedule II (Part I)	Appendix III
3	Carnivora	Felidae	*Felis chaus*	Jungle Cat	Least concern	Schedule II (Part I)	Appendix II
4	Carnivora	Felidae	*Panthera pardus*	Leopard	Vulnerable	Schedule I (Part I)	Appendix I
5	Carnivora	Felidae	*Panthera tigris*	Tiger	Endangered	Schedule I (Part I)	Appendix I
6	Artiodactyla	Suidae	*Sus scrofa*	Wild Pig	Least concern	Schedule III	No special status
7	Artiodactyla	Bovidae	*Bos gaurus*	Gaur	Vulnerable	Schedule I (Part I)	Appendix I
8	Primates	Cercopithecidae	*Macaca radiata*	Bonnet Macaque	Vulnerable	Schedule II (Part I)	No special status
9	Primates	Cercopithecidae	*Semnopithecus entellus*	Common Langur	Least concern	Schedule II (Part I)	Appendix I
10	Lagomorpha	Leporidae	*Lepus nigricollis*	Black-naped Hare	Least concern	Schedule IV	No special status
11	Rodentia	Hystricidae	*Hystrix indica*	Indian Crested Porcupine	Least concern	Schedule IV	Appendix III
12	Rodentia	Sciuridae	*Ratufa indica*	Malabar Giant Squirrel	Least concern	Schedule II (Part I)	Appendix II

Table 3: Table showing a checklist of animals in conflict in the study area

(a)

(b)

(c)

(d)

(e)

a : *Bos gaurus* (Gaur), b :*Macaca radiata* (Bonnet Macaque), c: *Ratufa indica* (Malabar Giant Squirrel), d: *Semnopithecus entellus* (Common Langur), e: *Viverricula indica* (Small Indian Civet)

Figure 4: Animals in Conflict

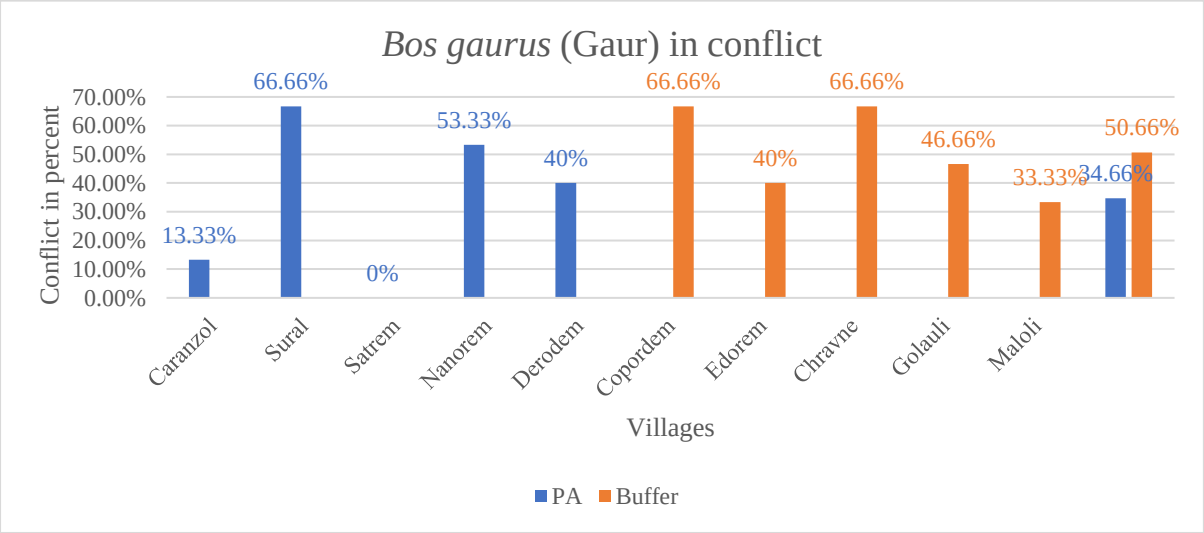
Sr no	Animals in conflict	PA					Buffer				
		a	b	c	d	e	f	g	h	i	j
1	*Bos gaurus* (Gaur)										
2	*Felis chaus* (Jungle Cat)										
3	*Herpestes smithii* (Ruddy Mongoose)										
4	*Hystrix indica (*Indian Crested Porcupine)										
5	*Lepus nigricollis* (Black- naped Hare)										
6	*Macaca radiata (Bonnet Macaque)*										
7	*Panthera pardus* (Leopard)										
8	*Panthera tigris* (Tiger)										
9	*Ratufa indica* (Malabar Giant Squirrel)										
10	*Semnopithecus entellus* (Common Langur)										
11	*Sus scrofa* (Wild Pig)										
12	*Viverricula indica* (Small Indian Civet)										

a: Caranzol, b: Sural, c: Satrem, d: Nanorem, e: Derodem, f: Copordem, g: Edorem, h: Chravne, i: Golauli, j: Maloli

Table 4: Table showing the presence of animals involved in human-wildlife conflict in the study area

3.2.1 *Bos gaurus* (Gaur)

It belongs to the order Artiodactyla of the family Bovidae, gaur is the largest living bovine confined to the oriental biogeographic realm of the world. The ancestors of gaur are known to have evolved in Asia around 20 million years ago (Grizmek, 1990). Gaur is one of the most impressive of wild cattle with its musculbuildilt and striking light eyes. It is known to inhabit tropical woodlands, tropical monsoon and dry forests, lowlands and tropical rainforests. Their habitat is characterized by large, relatively undisturbed forest tracts, hilly terrain, availability of water, abundance of bamboo, grasses, shrubs and trees (Prater, 1971).



Graph 4: Graph showing Bos gaurus (Gaur) in conflict in the study area

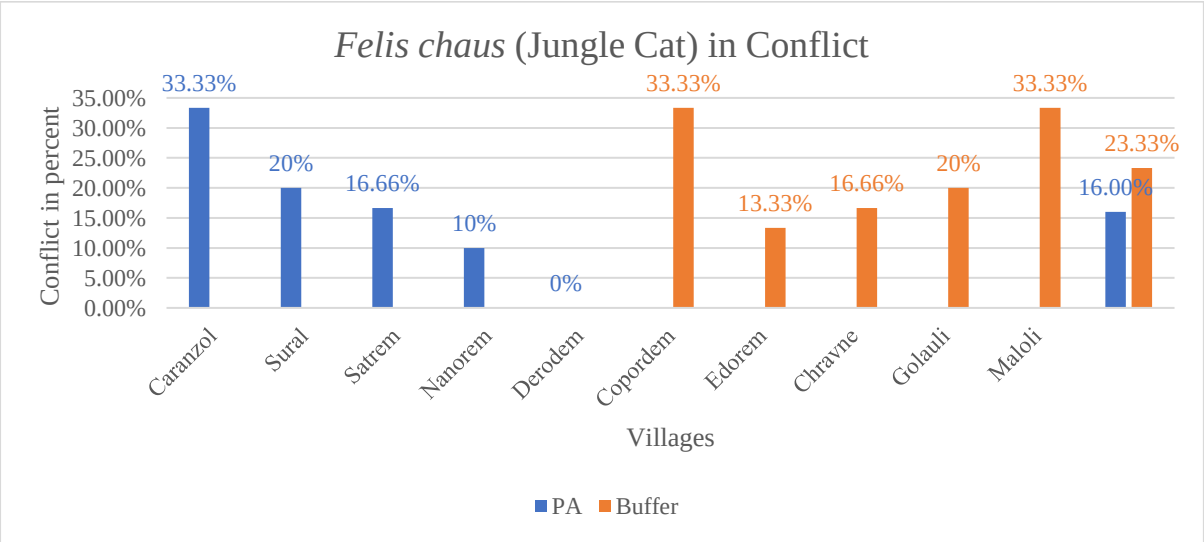
In PA the frequency of *Bos gaurus* (Gaur) in conflict was found highest in Nanorem (53.33%) followed by Sural (33.33) and Caranzol (6.66%). The frequency of *Bos gaurus* (Gaur) in conflict was absent in Satrem and Derodem.

In buffer zone the frequency of *Bos gaurus* (Gaur) in conflict was found highest in Copardem and Charavne (66.66%). Followed by Golauli (46.66%), Edorem (40%) and Maloli (33.33%).

The buffer zone held the higher frequency of *Bos gaurus* (Gaur) in conflict (50.66%) as compared to PA (18.66%).

3.2.2 *Felis chaus* (Jungle Cat)

Jungle cats prefer habitats near water with dense vegetative cover but can be found in a variety of habitats including deserts (where they are found near oases or along riverbeds), grasslands, shrubby woodlands and dry deciduous forests, as well as cleared areas in moist forests. They are commonly found in tall grass, thick brush, riverside swamps, and reed beds. They also adapt well to cultivated land and can be found in many different types of agriculture and forest plantations. Jungle cats are known to occur at elevations of up to 2500 m, but are more common in lowlands. ("International Society for Endangered Cats", 2001; Nowell and Jackson, 1996; Ogurlu, et al., 2010; Sunquist and Sunquist, 2002)



Graph 5: Graph showing Felis chaus (Jungle Cat) in conflict in the study area

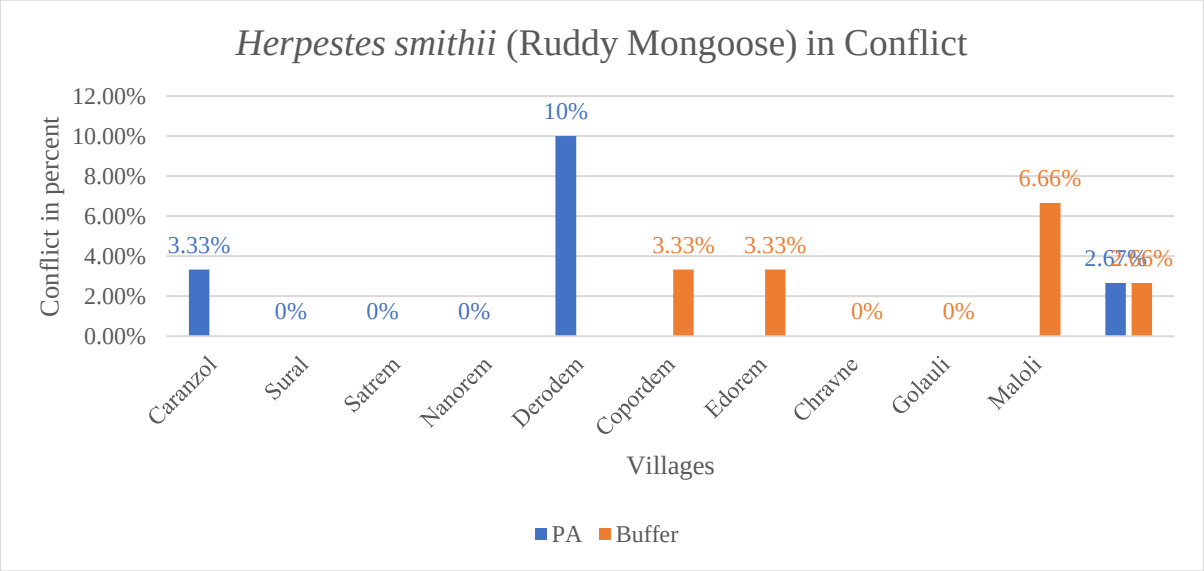
In PA the frequency of *Felis chaus* (Jungle Cat) in conflict was found highest in Caranzol (33.33%). Followed by Sural (16.66%), Satrem (20%) and Nanorem 130%). The frequency of *Felis chaus* (Jungle Cat) in conflict was absent in Derode.

In buffer zone the frequency of *Felis chaus* (Jungle Cat)in conflict was found highest in Copardem and Maloli (33.33%). Followed by Golauli (20%), Charavne (16.66%) and Hedode (13.33%).

The buffer zone held the higher frequency of *Bos gaurus* (Gaur) in conflict (23.33%) as compared to PA (15.99%).

3.2.3 *Herpestes smithii* (Ruddy Mongoose)

Herpestes smithii has black tipped tail which extends for 2-3 inches. It is found in forest and are been reported more in paddy fields as compared to open fields. It hunts by day and night like other mongooses.



Graph 6: Graph showing Herpestes smithii (Ruddy Mongoose) in conflict in the study area

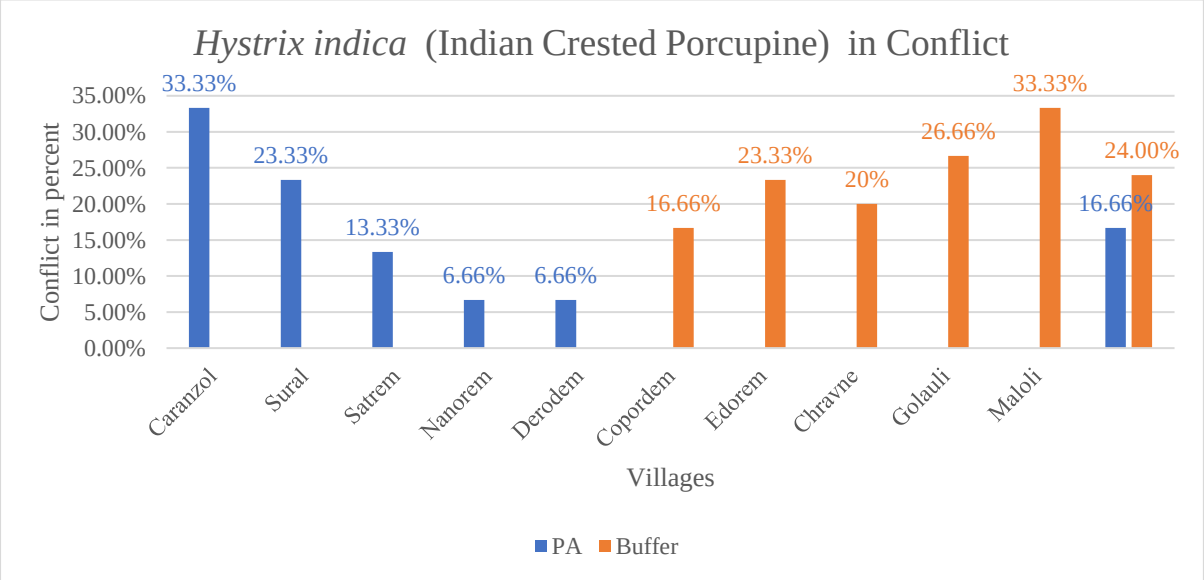
In PA the frequency of *Herpestes smithii* (Ruddy Mongoose) in conflict was found highest in Derodem with 10% followed by Caranzol with 3.33%. It was found to be absent in Sural, Satrem and Nanorem.

In the buffer zone, the frequency of *Herpestes smithii* (Ruddy Mongoose) in conflict was found highest in Maloli with 6.66%. Followed by Copardem and Edorem with 3.33% each. It was found to be absent in Charavne and Golauli.

The buffer zone held the equal frequency of *Herpestes smithii* (Ruddy Mongoose) in conflict with that of PA with 2.66%.

3.2.4 *Hystrix indica* (Indian Crested Porcupine)

The Indian porcupine is highly adaptable to multiple environments. Although they usually favor rocky hill sides, the species can also be found in tropical and temperate scrublands, grasslands, and forests. They are also found throughout the Himalayan mountains, reaching up to elevations of 2400 meters (Gurung and Singh 1996). On average, the Indian porcupine's head and body measure 70-90 centimeters (cm) in length, with the tail adding an additional 8-10 cm (Prater 1965). Its hair is highly modified to form multiple layers of spines. Beneath the longer, thinner spines lies a layer of shorter and thicker ones. Each quill is brown or black in color, with alternating bands of white. Spines vary in length, with the neck and shoulder quills being the longest, measuring 15 to 30 cm (Gurung and Singh 1996). The tail is covered with with shorter spines that appear white in color. Among these, are longer, hollow, rattling quills that are used to alarm potential predators (Ellerman 1961).



Graph 7: Graph showing Hystrix indica (Indian Crested Porcupine) in conflict in the study area

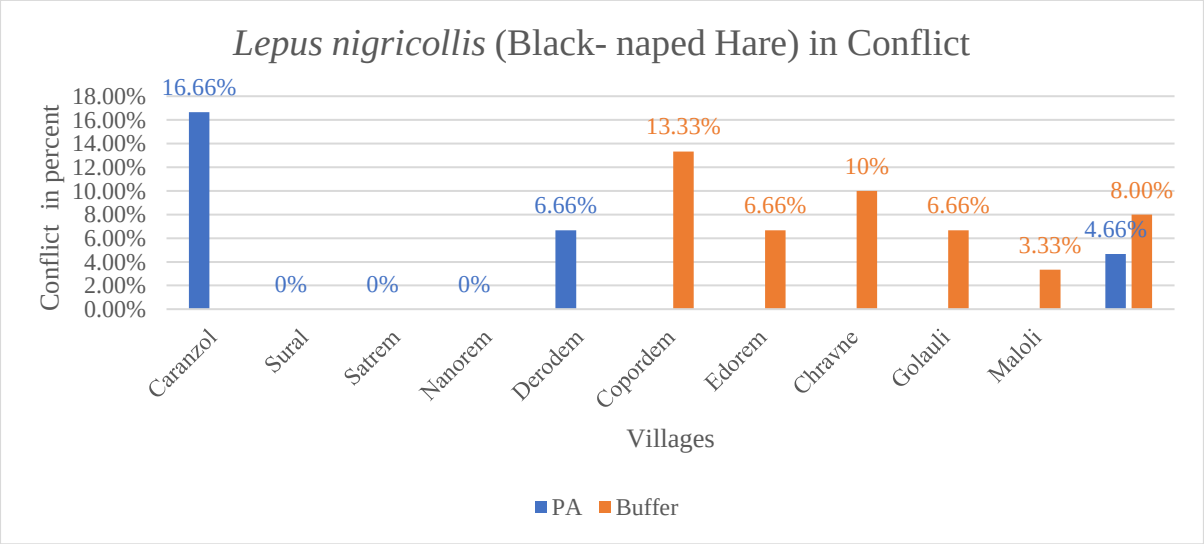
In PA the frequency of *Hystrix indica* (Indian Crested Porcupine*)* in conflict was found highest in Caranzol (33.33%). Followed by Sural (23.33%), Satrem (13.33%) and Nanorem and Derodem with 6.66% each.

In the buffer zone, the frequency of *Hystrix indica* (Indian Crested Porcupine) in conflict was found highest in Maloli (33.33%). Followed by Golauli (26.66%), Edorem (23.33%), Charavne (20%) and Copardem (16.66%).

The buffer zone held the higher frequency of *Hystrix indica* (Indian Crested Porcupine) in conflict (72%) as compared to PA (50%).

3.2.5 *Lepus nigricollis* (Black- naped Hare)

Lepus nigricollis are also called black-naped hares due to the patch of black fur that runs along the nape of the neck. The top of the tail is also black and the back and face are brown with black hairs scattered throughout. The underparts are white. Total length ranges from 40 to 70 cm and weight ranges from 1.35 to 7 kg. Like all hares, they have long ears and large hind feet which are well furred. There is some evidence that hares that have been introduced to islands are smaller than those in mainland India. Regardless of location, female L. nigricollis tend to be larger than males (Kirk and Bathe, 1994; Prakash and Taneja, 1969; Prater, 1965; Nowak, 1995).



Graph 8: Graph showing Lepus nigricollis (Black- naped Hare) in conflict in the study area

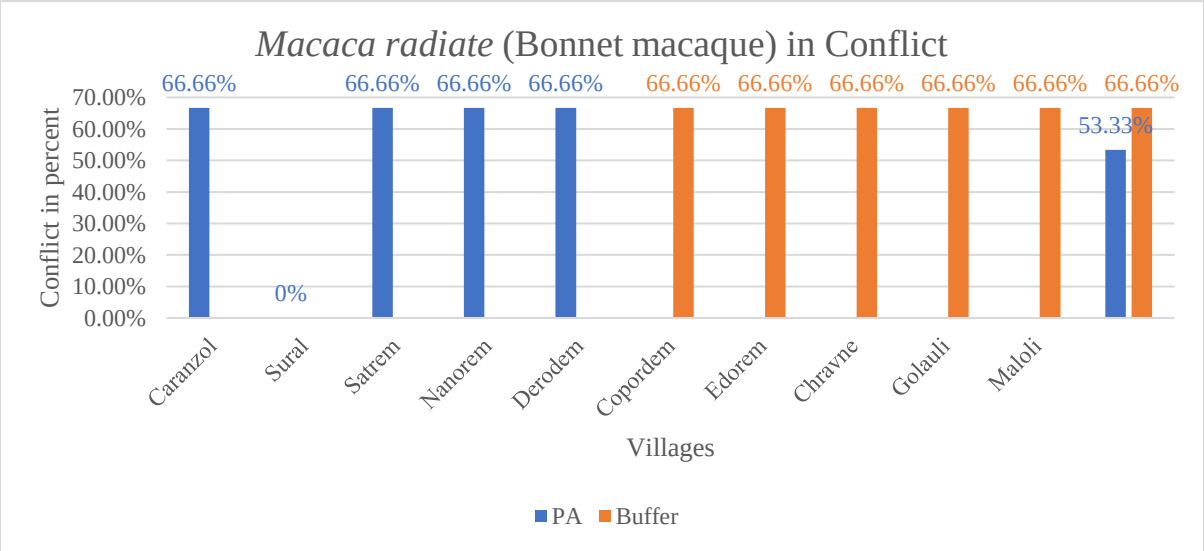
In PA the frequency of *Lepus nigricollis* (Black- naped Hare) in conflict was found highest in Caranzol with 16.66% followed by Derodem with 6.66%. It was found to be absent in Sural , Satrem and Nanorem.

In the buffer zone, the frequency of *Lepus nigricollis* (Black- naped Hare) in conflict was found highest in Copardem with 13.33%. Followed by Charavne (10%), Edorem and Golauli with 6.66% and Maloli with 3.33%.

The buffer zone held the higher frequency of *Lepus nigricollis* (Black- naped Hare) in conflict (7.99%) as compared to PA (4.66%).

3.2.6 *Macaca radiata (Bonnet Macaque)*

Bonnet macaques are found in a variety of habitats, including evergreen high forest and dry deciduous forest of the Western Ghat Mountains. They are highly arboreal and are strong swimmers. They often wander onto dry prairies, although it is not their preferred habitat. Bonnet macaques coexist with several primate species, including Nilgiri langurs (or hooded leaf monkeys Trachypithecus johnii), lion-tailed macaques (Macaca silenus), and Hanuman langurs (Semnopithecus entellus) (Dewar, et al., 1989; Johnson, et al., 2007; Sugiyama, 1971). Bonnet macaques live as commensals with humans and are most abundant on the outskirts of human settlements. In those areas they rely on trash and food generated by villagers and visitors. They are often found sleeping and eating in large Ficus trees which line roads near human settlements (Dewar, et al., 1989; Johnson, et al., 2007; Sugiyama, 1971). They are grayish brown or golden brown in color. They have hairless faces, which appear pink in the female (Dunbar and Badam, 2000; Fleagle, 1999; Johnson, et al., 2007; Sugiyama, 1971).



Graph 9: Graph showing Macaca radiata (Bonnet Macaque) in conflict in the study area

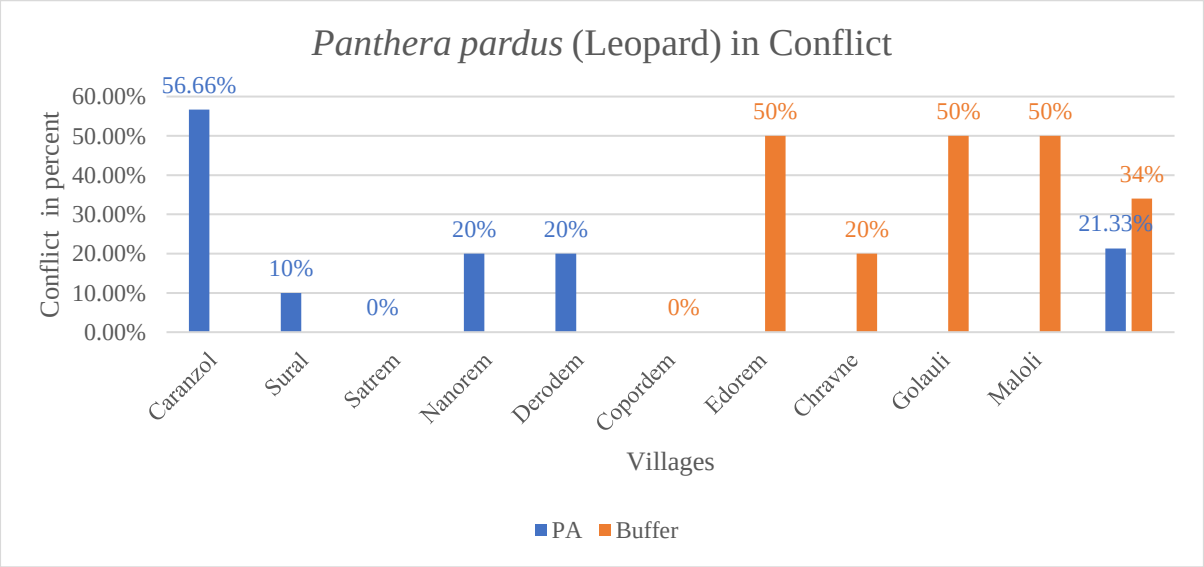
In PA the frequency of *Macaca radiata (Bonnet Macaque)* in conflict was found to be 66.66% in Caranzol, Satrem, Nanorem and Derodem. It was found to be absent in Sural.

In the buffer zone, the frequency of *Bos gaurus* (Gaur) in conflict was found to be 66.66% in all five sampling areas i.e. Copardem, Edorem, Charavne, Golauli and Maloli.

The buffer zone held the higher frequency of *Bos gaurus* (Gaur) in conflict (66.66%) as compared to PA (53.32%).

3.2.7 *Panthera pardus* (Leopard)

Leopards inhabit a variety of terrain. They are most populous in mesic woodlands, grassland savannas, and forests. They also occupy mountainous, scrub, and desert habitats. They favor trees throughout their entire geographic distribution, and have been recorded at 5638 meters on Mt. Kilimanjaro ("African Wildlife Foundation", 2009). Leopards have short legs relative to their long body. The leopard's scapula has specialized attachment sites for climbing muscles. Subspecies are distinguished according to unique pelage characteristics. Cubs have a smoky gray coat and their rosettes are not yet distinct. Each individual has a unique coat, which can be used for identification ("African Wildlife Foundation", 2009; "Thinkquest: Library", 1997; Hunter and Hinde, 2005; Nowell and Jackson, 1996).



Graph 10: Graph showing Panthera pardus (Leopard) in conflict in the study area

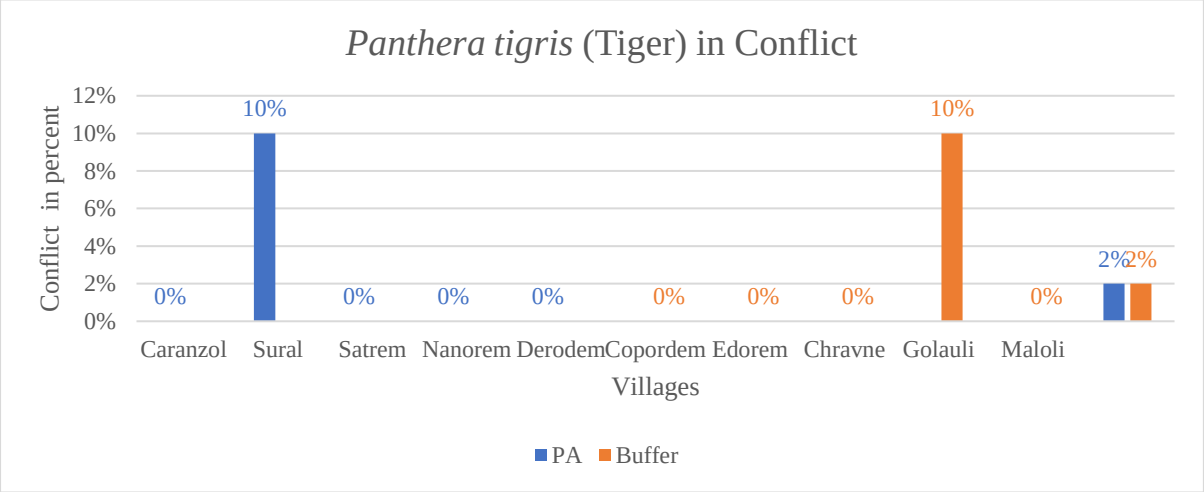
In PA the frequency of *Panthera pardus* (Leopard) in conflict was found highest in Caranzol (56.66%). Followed by Nanorem and Derodem at 20% each and Sural at 10%. The frequency of *Panthera pardus* (Leopard) in conflict was found to be absent in Satrem.

In the buffer zone, the frequency of *Panthera pardus* (Leopard) in conflict was found highest in Edodem, Golauli and Maloli with 50% each. Followed by Charavne (20%) and was found to be absent in Copardem.

The buffer zone held the higher frequency of *Bos gaurus* (Gaur) in conflict (34%) as compared to PA (21.33%).

3.2.8 *Panthera tigris* (Tiger)

Tigers live in a wide variety of habitats, suggested by their distribution across a wide range of ecological conditions. They are known to occur in tropical lowland evergreen forest, monsoonal forest, dry thorn forest, scrub oak and birch woodlands, tall grass jungles, and mangrove swamps (Mazak, 1981; Sunquist and Sunquist, 2002; Ullasa, 2001). Tigers are powerful animals, one is known to have dragged a gaur bull weighing 700 kg. Tigers have short, thick necks, broad shoulders, and massive forelimbs, ideal for grappling with prey while holding on with long retractible claws and broad forepaws. A tiger's tongue is covered with hard papillae, to scrape flesh off the bones of prey (Sunquist and Sunquist, 2002; Thapar, 2005; Ullasa, 2001).



Graph 11: Graph showing Panthera tigris (Tiger) in conflict in the study area

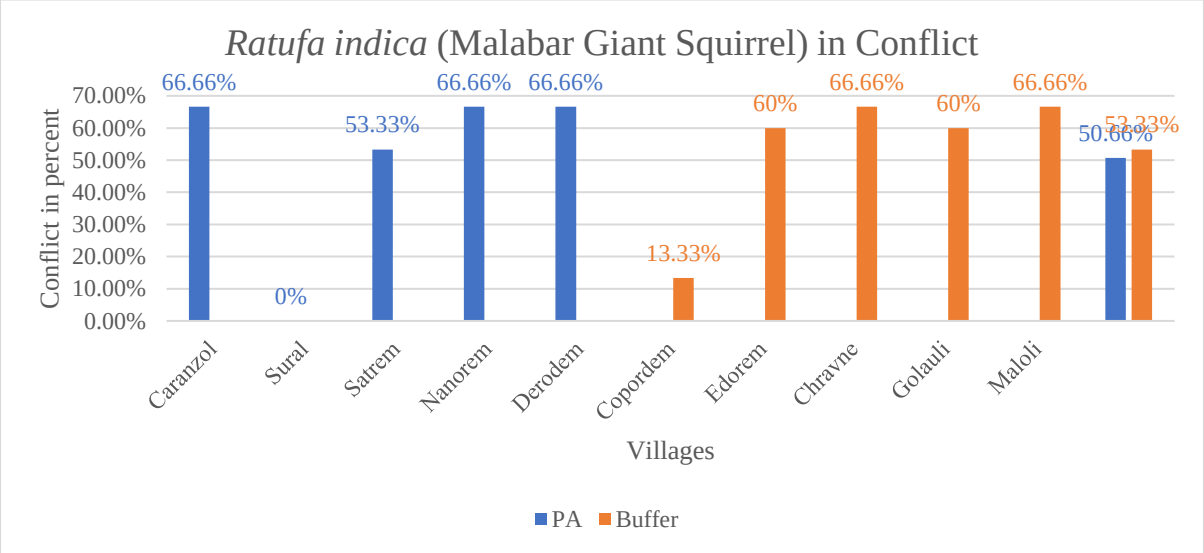
In PA the frequency of *Panthera tigris* (Tiger) in conflict was only found present in Sural at 10%.

In the buffer zone, the frequency of *Panthera tigris* (Tiger) in conflict was only found present in Golauli at 10%.

The buffer zone and the PA held an equal frequency of *Panthera tigris* (Tiger) in conflict at 2% each.

3.2.9 *Ratufa indica* (Malabar Giant Squirrel)

Ratufa indica is arboreal, spending most of its time in trees. It makes its shelter within holes in trees. Moving from tree to tree, *R. indica* can leap 6 meters or more. Giant squirrels rarely leave the trees, usually only to chase other squirrels during the breeding season. Giant squirrels are found primarily in moist tropical forests. It has dorsal coloration that varies from deep red to brown, the ventral fur is white. They have short, round ears, a broadened hand with an expanded inner paw for gripping, and large, powerful claws used for gripping tree bark and branches. Females can be distinguished from males by their three sets of mammae. Total body length varies from 254 to 457 mm and tail length is approximately the same as body length. These squirrels weigh approximately 1.5 to 2 kg (Nowak 1999).



Graph 12: Graph showing Ratufa indica (Malabar Giant Squirrel) in conflict in the study area

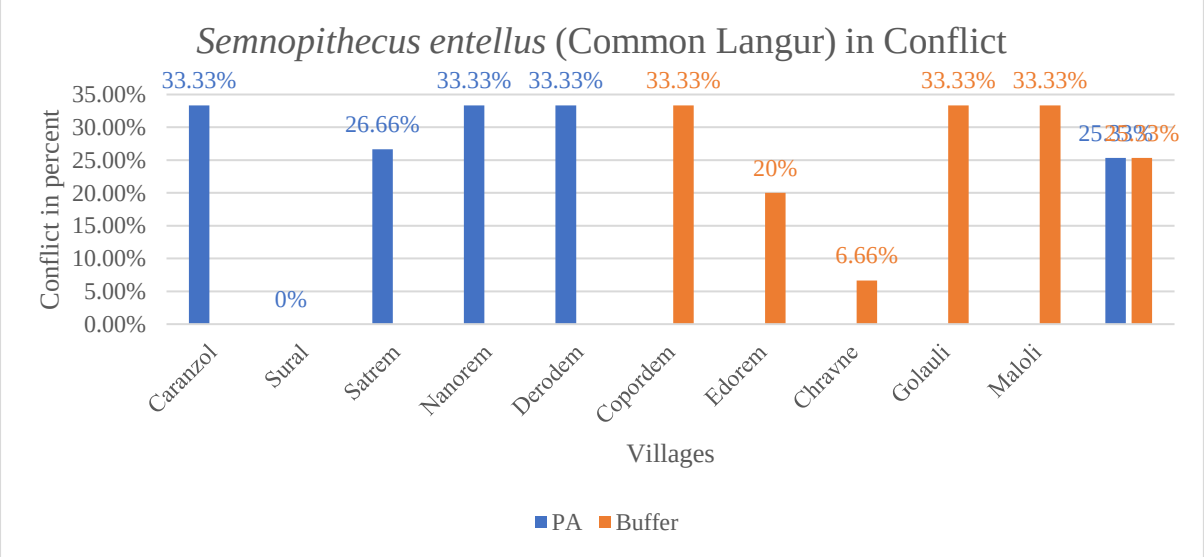
In PA the frequency of *Ratufa indica* (Malabar Giant Squirrel) in conflict was found to be 66.66% in Caranzol, Nanorem and Derodem followed by 53.33% in Satrem. The frequency of *Ratufa indica* (Malabar Giant Squirrel) in conflict was absent Sural.

In the buffer zone, the frequency of *Ratufa indica* (Malabar Giant Squirrel) in conflict was found to be 66.66% in Charavne and Maloli. Followed by 60% in Edorem and Golauli and 13.33% in Copardem.

The buffer zone held the higher frequency of *Ratufa indica* (Malabar Giant Squirrel) in conflict (53.33%) as compared to PA (50.66%).

3.2.10 *Semnopithecus entellus* (Common Langur)

Hanuman langurs are found in a wide variety of habitats, ranging from arid to tropical evergreen rainforests. They are also known to live in close proximity to humans, including the city of Jodhpur, India, which has over a million inhabitants (Gron, 2008). Hanuman langurs are able to withstand a wide range of temperatures, from -7˚C to 46˚C, and spend about 80% of their time on the ground (Carlson, 2004; Farid Ahsan and Reza Khan, 2006; Gron, 2008). Hanuman langurs have brownish gray fur, with a tinge of red on their dorsal surface and white fur on their ventral surface. Their feet, hands, face, and ears are black, and their face is framed with white fur. Their tail is usually longer than the body, with a white tip. ("Old World monkeys I", 2004; Gron, 2008).



Graph 13: Graph showing Semnopithecus entellus (Common Langur) in conflict in the study area

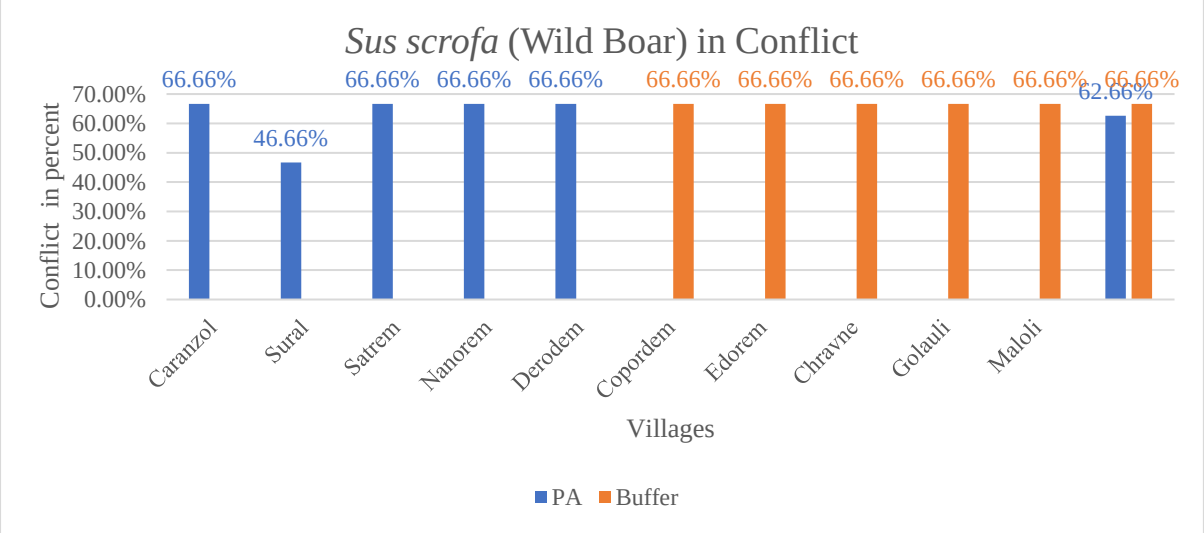
In PA the frequency of *Semnopithecus entellus* (Common Langur) in conflict was found to be 33.33% in three of the sampling areas i.e Caranzol, Nanorem and Derodem. Followed by 26.66% in Satrem and was found absent in Sural.

In the buffer zone, the frequency of *Semnopithecus entellus* (Common Langur) in conflict was found 33.33% in Copardem, Golauli and Maloli. Followed by 20% in Edorem and 6.660% in Charavne.

The buffer zone held the equal frequency of *Semnopithecus entellus* (Common Langur) in conflict as compared to PA (25.33%).

3.2.11 *Sus scrofa* (Wild Pig)

Wild boars range from 153 to 240 cm in total length and weigh 66 to 272 kg as adults. Females tend to be smaller than males of the same age, with the size difference becoming more apparent as the animals age. Adult wild boars have a thick, coarse coat of hair covering their bodies. Their coat ranges in color from black to brownish-red to white. Depending on their geographic location, they can have a speckled or solid pelage color. They may also have longer bristly hairs that grow down the middle of their backs. At birth, young boars generally have yellowish-brown stripes running down their backs that disappear into an even coloration within about 4 months. Wild boars can stand as tall as 0.9 m at their bulky shoulders, tapering off towards their hind quarters. Their tails measure 21 to 38 cm, and their ears are 24 to 26 cm long. Their upper canine teeth typically measure 5 to 10 cm and are generally larger than their lower canines. Their upper canines are usually visible even when their mouth is closed. Their dental formula is I 3/3, C 1/1, P 4/4, M 3/3 = 44 (Chapman and Trani, 2007; De Magalhães and Costa, 2009; Ickes, 2001; Webster, et al., 1985).



Graph 14: Graph showing Sus scrofa (Wild Pig) in Conflict in the study area

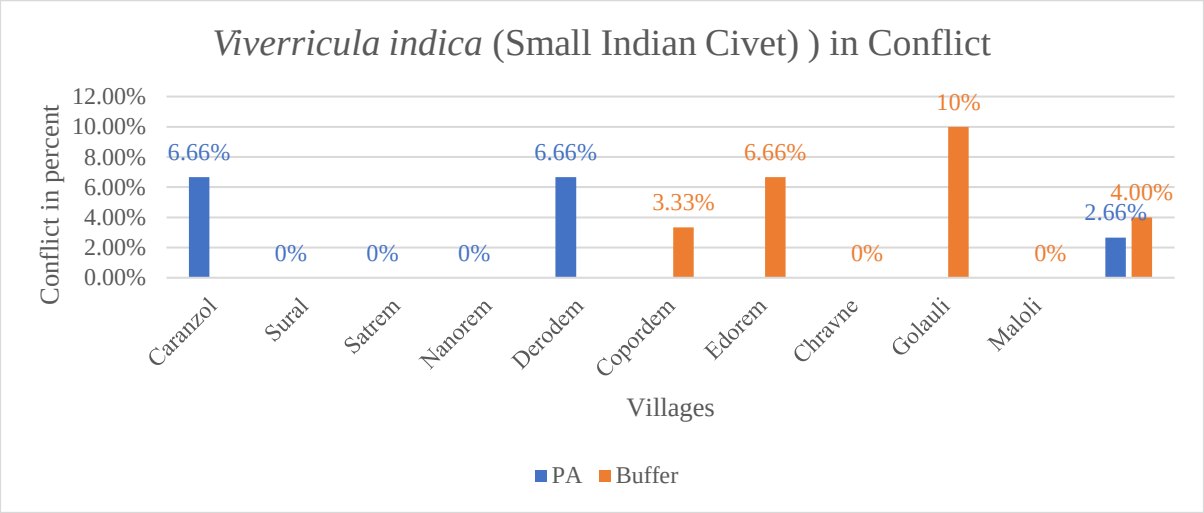
In PA the frequency of *Sus scrofa* (Wild Pig) in conflict was found at 66.66% in four of the sampling areas i.e Caranzol, Satrem, Nanorem and Derode. Followed by Sural at 46.66%.

In buffer zone held a 66.66% frequency of *Sus scrofa* (Wild Pig) in all five sampling areas.

The buffer zone held the higher frequency of *Sus scrofa* (Wild Pig) in conflict (66.66%) as compared to PA (62.66%).

3.2.12 *Viverricula indica* (Small Indian Civet)

The habitat of small Indian civets is highly variable, as they have adapted to a wide variety of different living conditions throughout their vast geographic range. In many places, they live in close proximity to humans, and have not suffered due to human encroachment. In fact, in many places they are most commonly seen feeding on poultry and living in gutters or outhouses or even garbage dumps(Duckworth, et al., 2008; Nowak, et al., 2005) . They have brown, yellow, or tawny orange pelage ornamented with black and white rings on their necks, small spots on the body which converge into six to eight dark stripes on the back toward the tail, and black-and-white banded tails. The paws are typically dark brown or black, and the breast is a lighter brown or gray, with few if any markings (Nowak, et al., 2005; Roots, 2006; Tate, 1947).



Graph 15: Graph showing Viverricula indica (Small Indian Civet) in conflict in the study area

In PA the frequency of *Viverricula indica* (Small Indian Civet) in conflict was found in Caranzol and Derodem at 6.66%. The frequency of *Viverricula indica* (Small Indian Civet) in conflict was absent in Sural, Satrem and Nanorem

In the buffer zone, the frequency of *Viverricula indica* (Small Indian Civet) in conflict was found highest in Golauli (10%). Followed by Edorem (6.66%) and Copardem (3.33%). The frequency of *Viverricula indica* (Small Indian Civet) in conflict was absent in Charavne and Maloli.

The buffer zone held the higher frequency of *Viverricula indica* (Small Indian Civet) in conflict (3.99%) as compared to PA (2.66%).

Animals	Caranzol	Sural	Satrem	Kodal	Derode
Bos gaurus (Gaur)					
Felis chaus (Jungle Cat)					
Herpestes smithii (Ruddy Mongoose)					
Hystrix indica (Indian Crested Porcupine)					
Lepus nigricollis (Black- naped Hare)					
Macaca radiateBonnet macaque					
Panthera pardus (Leopard)					
Panthera tigris (Tiger)					
Ratufa indica (Malabar Giant Squirrel)					
Semnopithecus entellus (Common Langur)					
Sus scrofa (Wild Pig)					
Viverricula indica (Small Indian Civet)					

(a)PA

Animals	Copardem	Edorem	Charavne	Golauli	Maloli
Bos gaurus (Gaur)					
Felis chaus (Jungle Cat)					
Herpestes smithii (Ruddy Mongoose)					
Hystrix indica (Indian Crested Porcupine)					
Lepus nigricollis (Black- naped Hare)					
Macaca radiateBonnet macaque					
Panthera pardus (Leopard)					
Panthera tigris (Tiger)					
Ratufa indica (Malabar Giant Squirrel)					
Semnopithecus entellus (Common Langur)					
Sus scrofa (Wild Pig)					
Viverricula indica (Small Indian Civet)					

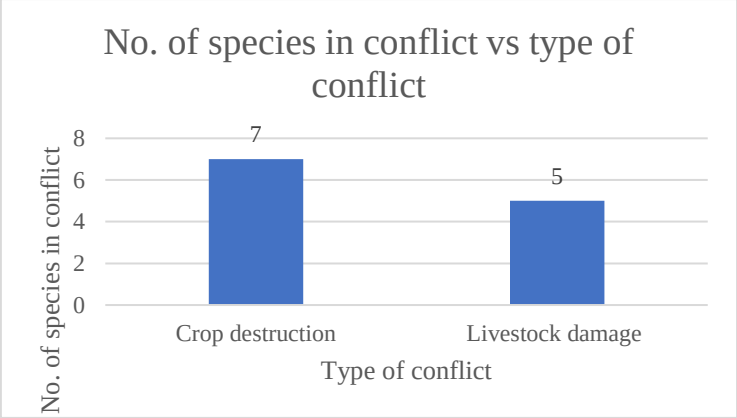
(a) Buffer

Conflict	
0%	
< 0% - >49%	
< 50% - >100%	
100%	

Table 5: Table showing sequential data visualisation matrix of conflict in the study area (a) PA (b) Buffer

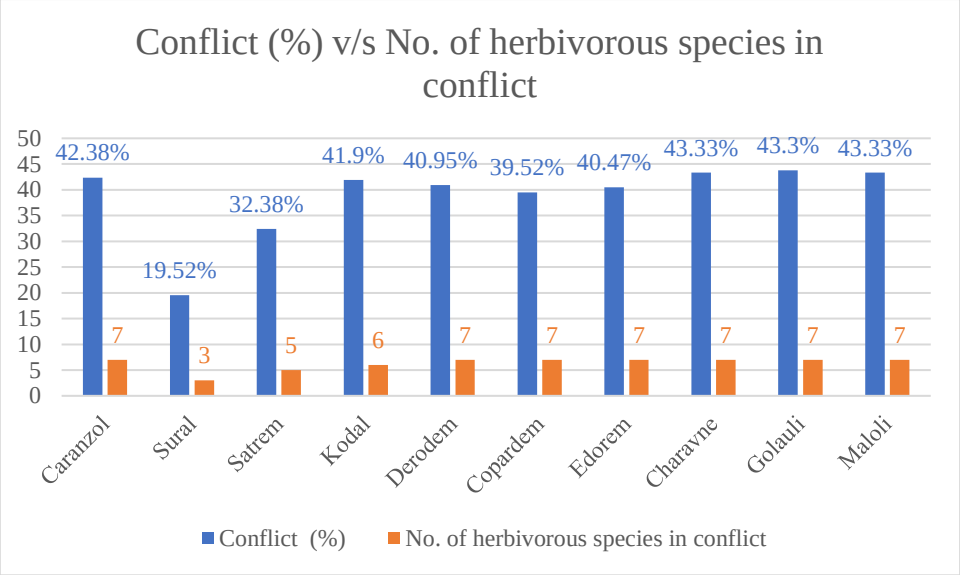
Sr no	Animals in conflict	Type of Conflict		Conflict
		Crop destruction	Livestock damage	
1	Bos gaurus (Gaur)			Destruction in paddy, banana and sugarcane plantations. Up-rootment of coconut saplings, cashew and aereca when they try to sharpen their horns. Their huge body adds to the damage.
2	Felis chaus (Jungle Cat)			Attacks and kills poultry
3	Herpestes smithii (Ruddy Mongoose)			Attacks and kills poultry
4	Hystrix indica (Indian Crested Porcupine)			Harms coconut roots. Feeds on fallen Aereca and Cashew
5	Lepus nigricollis (Black- naped Hare)			Feeds on emerging shoots of chillies and other vegetables
6	Macaca radiata (Bonnet Macaque)			Destruction in Cashew, Papaya, Jackfruit, Mango, Banana, Chillies, Vegetables, Arecanut and Custard apple plantation.
7	Panthera pardus (Leopard)			Attacks and kills cattle and dogs.
8	Panthera tigris (Tiger)			Attacks and kills cattle.
9	Ratufa indica (Malabar Giant Squirrel)			Destruction in cashew and coconut plantation.
10	Semnopithecus entellus (Common Langur)			Destruction in Cashew, Banana, Chillies, Vegetables, Papaya and Jackfruit plantation.
11	Sus scrofa (Wild Pig)			Destruction in paddy, vegetables and sweet potato plantation
12	Viverricula indica (Small Indian Civet)			Attacks and kills poultry

Table 6: Table showing type of conflict exhibited by animals in the study area



Graph 16 : Graph showing no. of species in conflict vs type of conflict in the study area

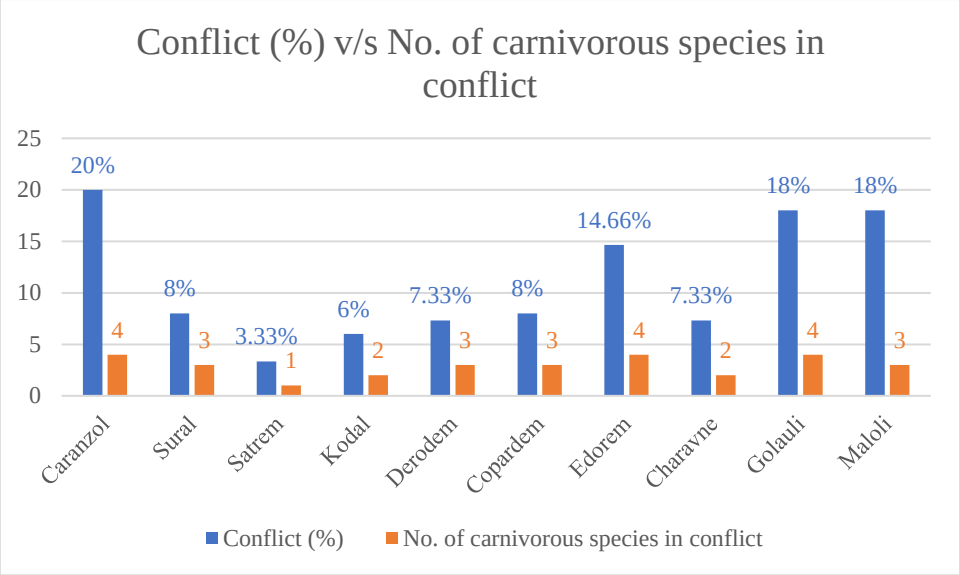
Two main categories of animal conflict in Madei WLS were identified that Crop destruction and Livestock damage. Out of total the animals identified in conflict, 7 animals were involved in crop destruction and 5 animals were involved in livestock damage (Graph 16 and table 6).



Graph 17: Graph showing conflict (%) v/s No. of herbivores in conflict in the study area

In PA sampling villages that being Caranzol, Sural, Satrem, Kodal and Derodem conflict of 42.38%, 19.52%, 32.38, 41.9% and 40.95% was reported by 7,3,5,6 and 7 herbivorous animals respectively. In buffer sampling villages that being Copardem, Edorem, Charavne, Golauli and Maloli conflict of 39.52%, 40.47%, 43.33%, 43.8% and 43.33% was reported by 7 herbivorous animals in all five sampling villages.

In PA and buffer, the conflict (%) is correlating with the number of herbivores in conflict. It is also been noted that all seven reported herbivores in conflict are found to be in conflict in all five sampling villages of the buffer zone.



Graph 18: Graph showing conflict (%) v/s No. of carnivores in conflict in the study area

In PA sampling villages that being Caranzol, Sural, Satrem, Kodal and Derode conflict of 20%, 8%, 3.33, 6% and 7.33% was reported by 4,3,1,2 and 3 carnivorous animals respectively. In buffer sampling villages that being Copardem, Edorem, Charavne, Golauli and Maloli conflict of 8%, 14.66%, 7.33%, 18% and 18% was reported by 3,4,2,4 and 3 carnivorous animals in the sampling villages.

Caranzol (PA), Edorem (buffer) and Golauli (buffer) have reported 4 carnivorous animals in conflict yet the conflict varies as 20%, 18% and 14.66% respectively. Similarly Sural(PA), Derodem(PA), Copardem(buffer) and Maloli (buffer) reported 3 carnivorous animals in conflict yet the conflict varies as 8%, 7.33%, 8% and 18% respectively. This result depends on the conflict reported at subsample levels i.e. households. Though the number of carnivorous animals reported in conflict in some sampling villages are same, the conflict varies with a wide range.

3.4 Causes of conflict

52% of respondents in the PA and 76% in the buffer loss of Kumeri practice (Slash and burn agriculture) was responsible for the rise in conflict of *Bos gaurus* (Gaur). 100% in the PA and 80% in the buffer loss of Vanarmare practice was responsible for the rise of conflict of *Macaca radiata (Bonnet Macaque)* and *Semnopithecus entellus* (Common Langur). 14% of respondent in the PA and 36% in the buffer reported that shift from polyculture agricultural practices to monoculture practices and 60 % of respondent in the PA and 56% in the buffer reported that allelopathy is the reason for the rise of herbivores in human wildlife conflict. 10% in the PA and 58% in the buffer reported that water availability to meet the thirst for the wild animals in the study area is the reason for the rise of human-wildlife conflict in the study area (Table 7).

Cause of conflict	Kumeri practice (Slash and burn agriculture)	Vanarmare practice	Shift from polyculture agricultural practices to monoculture practices	Allelopathy	Water availability
PA	52%	100%	14%	60%	10%
Buffer	76%	80%	36%	56%	58%

Table 7: Table showing causes of conflict in the study area

3.5 Mitigation

3.5.1 Ancestral mitigation

(a)

(b)

(c)

(d)

(e)

(f)

Figure 5: Figure showing ancestral mitigation practices in the study area

74% of respondents in PA and 84% in buffer reported that they used to cover the vegetable plantation with cloths (Figure 2a) which are now been replaced with plastic net (Figure 2b). 82% of respondents in PA and 88% in buffer reported barriers using the natural material compound to prevent the entry of animals was also reported (Figure 2c). 40% of respondents in PA and 54% in buffer reported that they use to install human dummies in the middle of the field which would aid in prevention to some extent (Figure 2d). 60% of respondents in PA and 68% in buffer reported night patrolling of the field was carried out by installing high raised platforms (Figure 2e). 20% of respondents in PA and 22% in buffer reported that use to house the calf near their own house to prevent them from attack (Figure 2f) or that they used to petrol at the cowshed at night, made use of guard dogs and even used to lit fire nearby to keep the predators at bay. To mitigate the macaque nuisance, 100% of respondents in PA and 80ofin buffer respondents reported that they use to make a loud noise, burn firecrackers or throw stones at them. However, they said that none of this practise seems to be effective against the macaque in today's time (Table 8).

Ancestral mitigation practices in the study area	Use of cloth to cover vegetable plantation with cloths	natural material compound as a physical barrier for the animals	Installing human dummies in the middle of the field	Installing high raised platforms to patrol the fields	Loud noise, burning firecrackers or throw stones at macaques
PA	74%	82%	40%	60%	100%
Buffer	84%	88%	54%	68%	80%

Table 8:Table showing ancestral mitigation practices in the study area

3.5.2 Modern mitigation

26% of respondents in PA and 30% in buffer reported that Electric fencing is been used to protect crops on agricultural land and property. As a mitigation practice encloses the farm and acts as a physical barrier to animals. The respondents reported that it requires high maintenance (Table 9 and Figure 3).

Modern mitigation practice	Fencing
PA	26%
Buffer	30%

Table 9: Table showing modern mitigation practices in the study area

(a) Electric fencing

Figure 6: Figure showing modern mitigation practice in the study area

3.5.3 Mitigation practices by the state forest department

(a) Developed waterhole

(b) Developed grass plots

(c) *Salt brick*

Figure 7: Figure showing mitigation practices practiced by the state forest department

The state forest department grants compensation on the account of loss to human life, permanent disability or injury and/or damage to cattle or property caused by wildlife (circular for which has been annex from page 73-76). The department has commenced an invasive weed eradication programme and banned further plantation of invasive flora such as *Acacia sp*. They maintain the natural pioneer sources of water and have developed 23 water holes in Madei WLS (Figure 4a). Similarly grass plots are maintained and grass plots are been developed at identified places in Madei WLS (Figure 4b). Salt bricks containing essential salts and ions are

been kept near the water holes (Figure 4c). The officials also noted that indigenous fruit trees such as *Syzygium cumini* are also been planted using seed bomb techniques.

RANGE FOREST OFFICE
Valpoi-Goa
Inward No. 138
Page No. 01
Date 27/04/2020

Government of Goa,
Forest Department
Secretariat, Porvorim – 403 521

Tel Nos: (0832) 2419443/2419792/2419697 E-mail: usforest-sect.goa@nic.in

F.No.7-5-2005/FOR/104 Dated: 24/04/2020

Read:-Notification No. 7-5-2005/FOR/310 dated 14-08-2012.

NOTIFICATION

In supersession of Notification No. 7-5-2005/FOR/310dated14-08-2012, the Government of Goa is pleased to revise the **"Scheme for grant of compensation on account of loss of human life, permanent disability or injury and/or damage to cattle or property caused by Wild Animals"** herein after called **"Compensation for damage by wild animals"** in order to simplify the procedure for determination and timely disbursement of appropriate compensation to the affected person(s). The term 'Wild Animal' will be as defined in the Wild Life (Protection) Act, (Central Act 53 of 1972).

2. The compensation for damage by wild animals for causing death/ injury to human and loss to cattle/damage to property will be determined and paid based on the terms and conditions and the rates as mentioned below.

Table- I

The rate of compensation on account of loss of human life or permanent disability or injury caused by wild animals

S. No.	Injury/ loss to human life	Compensation
1.	Ex-gratia payment for death / injury to human life	
(a)	Death	Rs.10,00,000/-
(b)	permanent disability (viz. loss of limb, eye, etc.)	Rs.5,00,000/-
(c)	Injury other than permanent disability	Rs.1,00,000/-, or the entire cost of treatment whichever is less

Plz Circulate to all Concerned (SDFO's/RFO's)

Contd...2/-

Table- II

The rate of compensation for loss of cattle or damage to property caused by wild animals

	Loss of cattle/ property	Maximum Compensation*
2.	Death of cattle	
(a)	Calf	Rs. 10,000/-
(b)	Local cow / buffalo / bullock	Rs. 25,000/-
(c)	Jersey Cow	Rs. 50,000/-
(d)	Pig / Sheep / Goat	Rs. 5,000/-
3.	Injury to cattle	Rs.15,000/-, or as per actual assessment, whichever is less
4.	Damage to House/ other property	Rs. 25,000/- or actual assessment, whichever is less

Note: * The amount of actual compensation to be paid should take into account factors listed at para 4 (vi) below and in no case should exceed the maximum amount notified in the table-II of the notification.

3. In respect of any other item not mentioned above, the DCF concerned shall decide the amount on merit after examining the case submitted by the RFO.

4. The procedure for assessment of amount of loss / damage and grant of compensation-

(i) The Compensation for attack on human being by wild animal will be admissible to bonafide residents of the area/ authorized visitors only if the incident has taken place inside any of the Wildlife Sanctuaries or National Parks. For attack outside Wildlife Sanctuary / National Park, the compensation shall be available to any person. However, in case of attack on cattle, the compensation shall be available even if the cattle was killed/ attacked inside Wildlife Sanctuary/National Park.

(ii) The cases of compensation shall be dealt by concerned Park Manager/ Deputy Conservator of Forests (DCF) (Wildlife & Eco-tourism) and the Range Forest Officer (RFO) (Wildlife) in case the incident has taken place within Wildlife Sanctuary / National Park or within Eco-Sensitive Zone of that particular Wildlife Sanctuary/National Park. For cases occurring beyond Eco Sensitive Zone, concerned DCF (Territorial) and the RFO (Territorial) shall deal the case.

Contd...3/-

(iii) The investigation in the incidence of attack by wild animal shall be initiated as early as possible by concerned RFO on receipt of the information. For the purpose of assessment of the loss/damage caused to the livestock/other property such as house, huts, livestock sheds etc., the applicant should report the claim to the nearest RFO of the Wildlife Division/ Territorial Division, as the case may be, within 3 days of the incident. The RFO shall forward the same immediately to the DCF alongwith his/her report and Damage Assessment Report from Veterinary Officer (in case of cattle etc.) / Assistant Engineer, PWD (in case of house and other property).

(iv) In cases of loss of human life, concerned DCF shall investigate the case and arrange to obtain the post mortem report from the Authorized Medical Officer and on satisfying on genuineness of the claim shall arrange to pay the compensation to affected person(s) within maximum 3 working days after receipt of post-mortem report. The compensation for loss of human life shall be granted in the following order of preference to:

(a) Wife or husband, as the case may be.
(b) Sons, unmarried or divorced daughters (equal share).
(c) Daughters (equal share).
(d) Grand children being children of sons or daughters (equal share).
(e) Father or mother.
(f) In case of any dispute as per the succession certificate issued by the competent authority.

(v) In case of death of cattle suspected to be caused by wild animals, the owner of the cattle shall submit the claim to the RFO alongwith the post-mortem report from the concerned Government Veterinary Officer within 3 days. The concerned nearest Veterinary Officer shall visit the site within 48 hours of the receipt of complaint and furnish certificate to the owner mentioning loss in Rupees taking various parameters mentioned at (vi) below.

(vi) The maximum amount of compensation to the owner/owners of the cattle due to the attack by wild animal has been given in Table–II. For determining the actual compensation payable in case of death or injury of cattle caused by wild animals, RFO shall record his finding that the death of the live-stock / cattle was entirely due to the attack by wild animal and not due to any other reason. The RFO shall record following information/ details in the report: —

a) Age of the animal.
b) Milk yield of the animal in case of female.
c) Maintenance cost of the animal by the owner.
d) Quantity of the animal dropping.

Contd...4/-

e) Health of the animal or its disease status.

f) Life history and productive capacity of the animal etc.

**Cattle include cow (including cross-bred cow), bullock, buffalo, calf, pig, goat, sheep, etc.

(vii) In cases of loss or injury of cattle/ damage to property, concerned DCF shall investigate the case and on satisfying on genuineness of the claim, shall arrange to pay the compensation to affected person(s) within maximum 3 working days after receipt of post-mortem report.

5. The expenditure shall be debitable under the appropriate Scheme/Head of Account of the Forest Department and arranged to be paid by the DCF/ Divisional Head.

6. To ensure immediate disbursement of compensation, an interest-bearing account dedicated for **"Wildlife Compensation Fund"** shall be opened under Goa Forest Development Corporation with initial corpus of Rs. 25 lakh. For this purpose, the Government shall provide fund from the appropriate budget- head of Forest Department or otherwise, which shall be recouped from time to time. This Wildlife Compensation Fund may also receive donation from corporate houses/societies.

7. After receipt of recommendations and sanction from concerned DCF, the Goa Forest Development Corporation shall affect the payment immediately in not more than 2 days from the **'Wildlife Compensation Fund'** to the affected party as recommended by DCF concerned.

8. DCF shall report all cases of loss/ damage by wild animals and payment of compensation to the Chief Wildlife Warden within three days of payment of compensation. The cases where time limits are exceeded due to any unforeseen circumstance, the same should be brought to the notice of the Chief Wildlife Warden.

This order issues with the concurrence of the Finance Department vide its U. O. No. 1400070882 dated 20-04-2020.

By order and in the name of the
Governor of Goa

(Shaila G. Bhosle)
Under Secretary (Forests)

To,

1. The Director (Printing & Stationery), Government Printing Press, Panaji with request to publish the notification in the next issue of Government Gazette.

Contd...5/-

CHAPTER 4 DISCUSSION

Wildlife-related conflicts are circumstances when wildlife comes into over common resources with humans. It is the occurrence of conflict situations between humans and wildlife over livestock depredation, crop raiding, killing of people or predation on managed wild animal species. This study was conducted in Madei Wildlife Sanctuary with a holistic approach to understand issues of wildlife in conflict and the impact of conflict on mankind. It aims to devise a vision for future approaches to understanding and mitigating such encounters in the study area. The results of this study are analysed, discussed and the significant inferences are outlined:

Based on the ranking analysis performed average conflict caused by animals is calculated, PA showed an average of 23.2 % ± 7.8 conflict and the buffer zone resulted a conflict average of 30% ± 3.08. The study reported the buffer zone to be at higher conflict as than that of the PA. The buffer zone houses generous human habitation as compared to the PA and hence the magnitude of wild animals intersecting with conflict is higher.

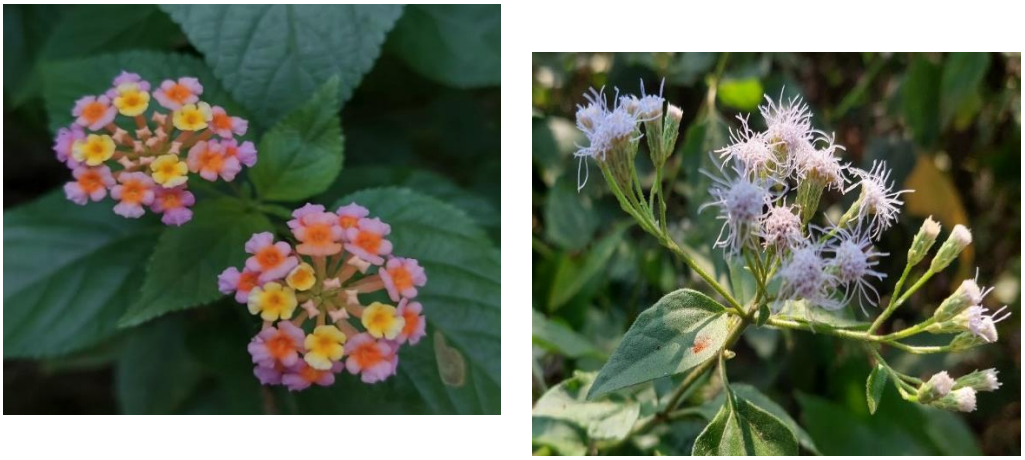
Amongst 12 megafaunas reported in human-wildlife conflict, three animals are listed as a vulnerable category of the IUCN Red List *viz*. *Macaca radiata* (Bonnet Macaque) causing 53.33% of conflict in PA and 66.66% of conflict in the buffer, *Bos gaurus* (Gaur) causing 34.66% of conflict in PA and 50.66% in buffer and *Panthera pardus* (Leopard) causing 21.33% of conflict in PA and 34% of conflict in the buffer. One animal is listed in the Endangered category of the IUCN Red List *viz.* *Panthera tigris* (Tiger) has reported to cause 2% conflict in each of the zones.

Based on reporting frequency, *Sus scrofa* (Wild Pig) and *Hystrix indica* (Indian Crested Porcupine) were reported in the conflict in all ten sampling points. *Bos gaurus* (Gaur), *Felis chaus* (Jungle Cat), *Macaca radiata* (Bonnet macaque), *Ratufa indica* (Malabar Giant Squirrel) and *Semnopithecus entellus* (Common Langur) were reported in the conflict in nine of the sampling points. *Panthera tigris* (Tiger) reported to be in uniform conflict in PA and in buffer.

Based on ranking analysis, *Sus scrofa* (Wild Boar) reported highest conflict in the study area with 64.66%. Followed by *Macaca radiata* (Bonnet macaque) with 59.99% and *Ratufa indica* (Malabar Giant Squirrel) with 52.00%.

Allelopathy, Kumeri practice (Slash and burn agriculture) and Vanarmare practices were reported for causes of conflict.

The allelopathy is described as biochemical interactions that inhibit the growth of nearby plants by another plant due to the release of chemical compounds (Molisch, 1937). The weeds are undesirable plants competing for moisture, light, water, nutrients and space with crop plants (Anonymous, 1994). It affects a crop growth dynamic by releasing chemical compounds called allelochemicals (Kadioglue et al., 2005). The root, rhizome, stolon, stem, leaves, branches, flower, fruit and seeds of weeds have allelopathic potentiality. These parts possess allelochemicals like phenolic compounds, flavonoids, terpenoids, alkaloids, amino acids and have an inhibitory or stimulatory effect on the seed germination of crop plants (Mali and Kanade, 2004 and Ghodakeet al., 2012). The leaf extract has much allelochemicals property studied by (kumbhar and Patel, 2012).



(a) *(b)*

Figure 8: Figure showing (a) Lantana camera (b) Eupitorium odoiata

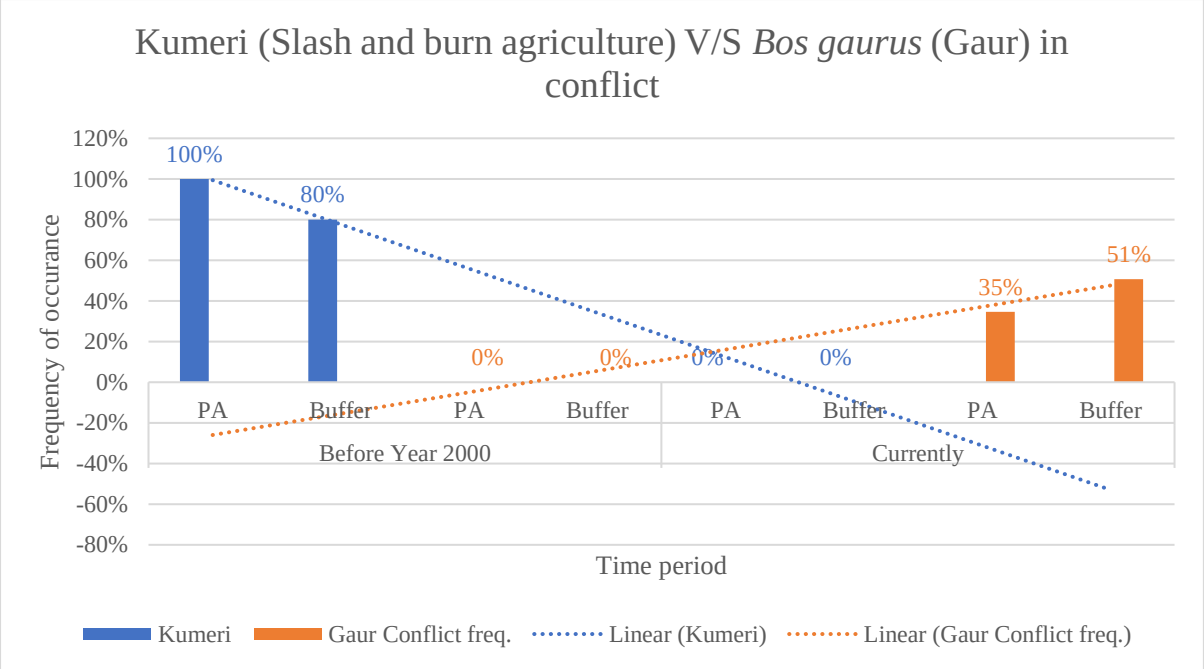
In the study area, three floral invasive species were reported namely *Acacia sp.* ,*Lantana camera, Eupitorium odoiata, Parthenium estropus.* These plants are highly allelopathic and suppresses neighbouring indigenous vegetation which indirectly decreases the indigenous fodder vegetation of herbivores.

Land use change is a process by which anthropogenic activities transform the natural landscape. It examines how the use of a specific area of land is converted from one to another. The shift from polyculture agricultural practices to monoculture practices maybe the driving force influencing the abiotic factors of the ecosystem. We hypothesis this could be one of the confounding factors driving the conflict.

The respondents reported that during the dry season when water gets dried up, the animals seek to move down to meet their thirst towards the villages which are been settled near the water source.

Slash and burn agriculture is locally recognised as Kumeri in Goa. Slash and burn agriculture or shifting cultivation is a traditional agricultural practice of adopting agriculture then was followed by the conversion of forests into farmlands. Agriculture was carried out on slashed and burned lands until the soil eventually became unproductive, prompting the farmers to clear new lands (Tschakert et al., 2007). Slash-and-burn agriculture typically involved the felling of native vegetation during the dry season and letting the felled vegetation dry before burning. The ash from burning fertilized and conditioned the soil for planting at the start of the ensuing rainy season (Vosti and Witcover, 1996). This study reported that the practice of Kumeri (Slash and burn agriculture) was carried out in all five sampling villages of the PA (100%) namely Caranzol, Sural, Satrem, Nanorem and Derodem and four sampling villages of buffer zone (80%) namely Copardem, Charavne, Golauli and Maloli. They reported that they use to burn and clear the forest on a hill to grow paddy and millet for the season and the place was left to fallow for about 2-3 years. For the next season they would move to another such place.

Responders reported that, the fresh shoots remaining from the harvest used to serve for the fodder for the *Bos gaurus* (Gaur). They further reported that this would take care of their nutritional need. On the declaration of Madei Wildlife Sanctuary in the year 1999 practice of Kumeri (Slash and burn agriculture) was prohibited and the practice was discontinued in the year 2000 in Madei WLS. They reported that *Bos gaurus* (Gaur) conflict frequency was negligible pre year 2000, which is approximated to zero. As reported earlier, the conflict frequency of *Bos gaurus* (Gaur) in PA was reported to be 34.66 % and 50.66% in the buffer zone. On quantifying this, there is a negative correlation between practice of Kumeri (Slash and burn agriculture) and the rise of conflict frequency of *Bos gaurus* (Graph 19).



**Gaur conflict frequency before year 2000 is considered to be negligible ~ 0*

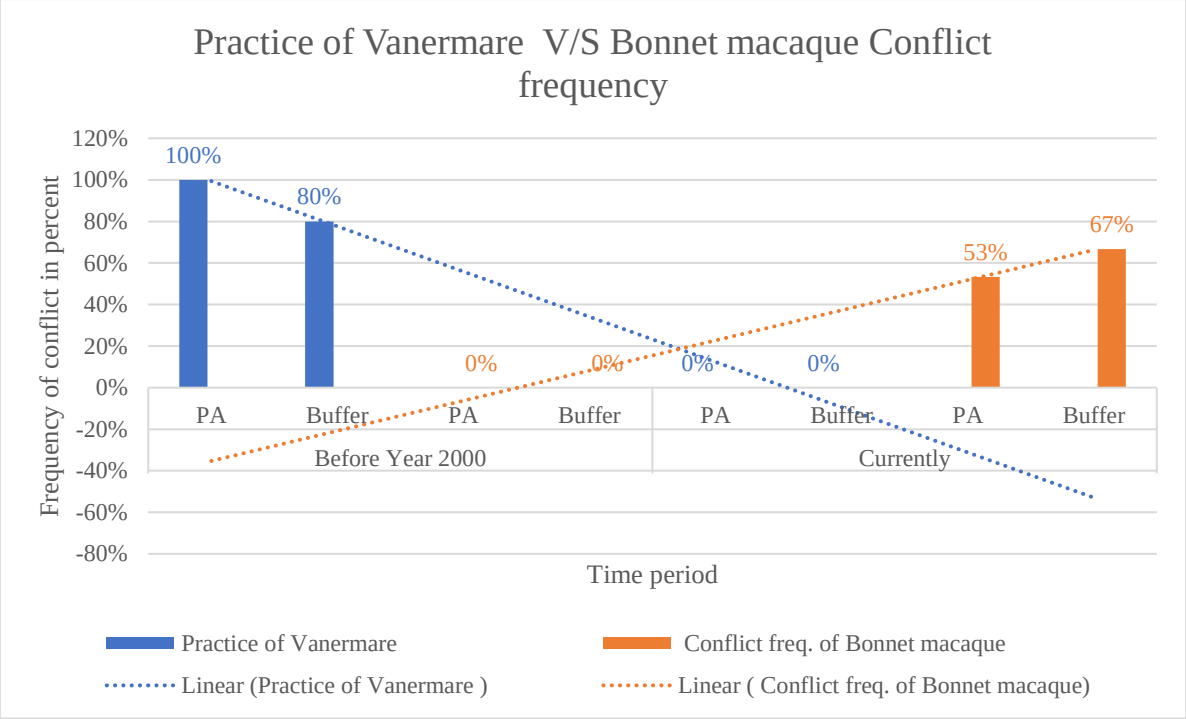
Graph 19: Graph showing Kumeri (Slash and burn agriculture) V/S Bos gaurus (Gaur) in conflict

100% of respondents from PA and 80% respondents from buffer reported that there has been increasing in the population of *Macaca radiata (Bonnet Macaque)* with augments with the observations of (Sengupta et al. 2013). Respondents from nine of the sampling villages reported that macaques that are near human habitation do not fear them while respondents from Sural village (PA) reported that the macaques are mostly restricted to the forest and do not show this behaviour. This is augments with the observations of Chaturvedi et al. (2014). They further reported that no mitigation technique in practice is effective against the macaques. A similar observation was made by Lee and Priston (2005). They also reported that shrinking natural habitat and inadequate availability of food is the reason for the rising conflict of *Macaca radiata (Bonnet Macaque)* in the study area. This was also reported by (Sengupta et al. 2013; Reddy et al. 2016). Sengupta et al. (2013) reported that of all the damage that occurs to the crop, only a quarter or less is eaten by the animals. The remaining is destroyed during play or fights. Similar observation was made by the respondents in the study area.

The ethnozoological practice of Vanermares was reported in the study area. Ethnozoology is a discipline that examines the environmental, economic, sociological, anthropogenic and historical aspects of the relationship between animals and humans. It structurally deals with natural and social sciences elements in the interactions that human culture maintains with animals (Alves et al. 2018). Vanermares translates to “monkey hunters” is a subtribe of the Katkari that inhabits the Konkan region of western ghats. They are known for their ancestral practice of killing macaques with archery for oil and meat.

Responders reported that, the Vanarmares used to hunt in a group wherein a few of the members would chase the monkey in one direction and the others would hunt them with archery. They further reported that this would functionally keep the population of macaques in check. On the implementation of the Wildlife Protection Act, 1972 the macaques are recognised under Schedule II and that which prohibits their hunting. They reported that the practice of Vanermare discontinued from the year 2000 in Madei WLS.

This study reported that the practice of Vanermare was carried out in all five sampling villages of the PA (100%) namely Caranzol, Sural, Satrem, Nanorem and Derodem and four sampling villages of buffer zone (80%) namely Copardem, Charavne, Golauli and Maloli. They reported that Bonnet macaque conflict frequency was negligible pre-year 2000, which is approximated to zero. As reported earlier, the conflict frequency of Bonnet macaque in PA was reported to be 53.32 % and 66.66% in the buffer zone. On quantifying this, there is a negative correlation between practice of Vanermare and the rise of conflict frequency of Bonnet macaque (Graph 20).



**Bonnet macaque conflict frequency before year 2000 is considered to be negligible ~ 0*

Graph 20: Graph showing the practice of Vanermare V/S Bonnet macaque Conflict frequency

Two main categories of animal conflict in the study area were identified that being Crop destruction and Livestock damage. Out of the total animals identified in conflict, 7 animals were involved in crop destruction and 5 animals were involved in livestock damage. It is inferred that herbivorous species are indulging in conflict to a greater extend as compared to carnivorous species. Two of the sampling areas in the PA and all five sampling areas of the buffer zone reported all 7 identified herbivorous species to be at conflict. Factors driving the herbivorous species in conflict should be tackled primarily to mitigate.

Caranzol (PA), Edorem (buffer) and Golauli (buffer) have reported 4 carnivorous animals in conflict yet the conflict varies as 20%, 18% and 14.66% respectively. Similarly Sural (PA), Derodem (PA), Copardem (buffer) and Maloli (buffer) reported 3 carnivorous animals in conflict yet the conflict varies as 8%, 7.33%, 8% and 18% respectively. Considering both these results, it is derived that the extent of conflict varies though the number of animals indulging in conflict is the same. It is important to consider this and areas with a greater extent of conflict should be prioritise. Factors driving these results can be further studied and monitored.

Suggested Mitigation

The study reported 35.426% of conflict by herbivorous animals in the PA and 42.09% in the buffer. Similarly, 8.932% of conflict was reported by carnivorous animals in PA and 13.198% in the buffer. Monitory this wildlife is crucial as it will aid in their protection as well as help in preventing the increasing human-wildlife conflict. During the study the following indigenous flora was identified which makes up for the diet of *Bos gaurus* (Gaur), *Macaca radiata (Bonnet Macaque)*, *Ratufa indica* (Malabar Giant Squirrel) and *Semnopithecus entellus* (Common Langur). They were reported to be in major conflict i.e > 50% in the study. We hypothesis that if these floras are proportionally propagated for the herbivores shall serve for their fodder in the study area and so the conflict will be reduced. Similarly, it is crucial to ensure the prey-predator ratio for the carnivore in the study area.

Local Name	Species	Floral part consumed	*a*	*b*	*c*	*d*
Sallay	*Aporosa indiana*					
Phanas	*Artocarpus heterophyllus*					
Kharvat	*Ficus exasperata*	Fruits				
Pipol	*Ficus religiosa*	Fruits				
	Gardenia latifolia					
	Grewia abutifolia					
	Helicteres isora					
	Hemidesmus indicus					
Aamo	*Mangifera indica*					
Mushing	*Moringa indica*	Leaves, Fruits				
Kusum	*Selera olusa*					
Karvy	*Strobilanthes callosa*	Leaves				
Karvy	*Strobilanthes ixiocephalus*	Leaves				
Kazaro	*Strychnos nux-vomica*					
	Symplocos racemosa					
Gothing	*Terminalia bellirica*	Leaves, Fruits				
Matti	*Terminalia elliptica*	Leaves				
Kinal	*Terminalia paniculata*	Leaves				
	Vitex negundo					

a: *Bos gaurus* (Gaur), b: *Macaca radiata (Bonnet Macaque)*, c: *Ratufa indica* (Malabar Giant Squirrel), d: *Semnopithecus entellus* (Common Langur)

Table 10: Table showing food preference

Extensive work has been carried out in elephant-human conflict and mitigation practices suggested could be implemented for Gaurs. Fernando et al. (2008) suggests the use of wire fences built with steel cables and iron girder, developed of ditches and trenches which are animal-proof such that it is be too wide for the animal to stride across and too narrow for it to get into. Commonly used dimensions of trenches are 3m wide at the top, 1m wide at the bottom, and 2m deep. Perera (2009) remarks Land-use planning as one of the crucial element to the mitigate with the conflict.

The use of bioacoustics that produces distress noise and scare away the monkeys, Immunocontraceptive vaccines and sterilization to control the population growth are some of the mitigation practices for suggested by Reddy et al. (2016) for mitigating the conflict with macaques.

Kartika et al. (2016) suggest livestock management, habitat and wild prey management relocation of human settlements in the conflict areas to mitigate human-tiger conflict. Bhattarai et al. (2019) further mention the practice of conservation education among the stakeholders as one of the ken mitigation practices.

From the current study data collected and its analysis have helped in concluding the problems involving human-wildlife conflict. Analysis of data in the form of identification of areas, animals, type, causes of conflict and suggested mitigations by using authentic scientific literature will help the competent authorities in effective planning of Management plan & Mitigation plan.

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