



## **Community Attitude and Religious Bonding in Human-Wildlife Conflict Mitigation: A Study of Kilpura-Khatima-Surai Corridor, Terai Arc Landscape, India**

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### **Authors' contributions**

*This work was carried out in collaboration between both authors. Authors KNB and MA designed and executed the study and performed the statistical analysis. Authors KNB and MA manage the literature searches and author KNB wrote the first draft of the manuscript. Author MA improved and finalized the first draft of the manuscript. Both authors read and approved the final manuscript.*

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### **ABSTRACT**

Religious and cultural beliefs among the communities residing on the edge of forests areas are important in developing human-wildlife conflict mitigation measures and conservation of various endangered species. Kilpura-Khatima-Surai wildlife corridor is an important linkage between national and trans-boundary wildlife habitats. The present study was conducted to understand the people attitude toward wildlife conservation through structured questionnaire survey of households in Terai Arc Landscape. Our finding reveals that though the wildlife corridor has been severely altered due to various anthropogenic activities, however, the mythological understanding of the inhabiting community has a major role in driving the attitude toward wildlife conservation. These profound beliefs constitute flexible behaviour

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towards a particular wild animal even if they are facing conflicts with them. Such understanding would be important to implement community based conservation and management inputs, as well as in achieving the desired conservation goals.

**Keywords:** Community based conservation; Devipura-Majhaon; Terai arc landscape; wildlife corridor.

## 1. INTRODUCTION

### 1.1 Human-wildlife Conflict

Human-Wildlife Conflict (HWC) is a critical threat to the long-term survival of various endangered species of wild fauna. It has also been one of the major threats to the survival of local human population and their livelihood in the vicinity of wildlife habitat [1]. HWC issues are illustrated as ever-increasing global problem [2-4] and not restricted to particular bio-geographical and climatic regions. Moreover, the issue is similar in all areas with the co-existence of human and wildlife for sharing of habitat resources [5]. As a consequence the surviving wild population of various endangered as well as other wild species has dramatically declined during the last few decades [6-9]. Major reasons behind declining wild population of various key species and increasing conflicts are recognized globally [10-11]. Among these reasons, degradation, fragmentation and reduction of natural habitat [7, 12-13] increasing encroachment, over-exploitation of resources and changing agricultural practices are important [13-15].

The conversion of forest land for settlement and agricultural purposes is characterized by huge population pressure and poverty in wildlife habitats [16]. Human dependency on forest resources for food, fodder, fuelwood, grazing by livestock and ever-increasing demand of shelter and crop production has shrunken and degraded natural habitat [10,17]. The HWC situations consist of many parallel causes and effects [10] as well as trends and challenges [11,18-20] and a variety of inferences can be made from these situations. A number of mitigation measures are in practice to mitigate the impacts of HWC [11, 21] however, permanent solutions are still lacking.

### 1.2 Wildlife Corridors

Wildlife corridors are important for movement of wildlife species from one habitat to another. These are crucial part of habitat of mega-fauna such as long ranging elephants and dispersing tigers, and their functionality defines the quality

of a particular ecosystem [22-24]. Corridor provides cover to the animals during movement from one place to another and helps wildlife species in extending their habitat range. Corridors build resilience to some of the adverse effects of habitat fragmentation, as these facilitate dispersal species between substantive habitat patches, allowing constant gene flow [25-26]. However, many of these important habitat linkages have shrunk over the years and their functionality has diminished [24-26]. Conserving such linkages, in order to ensure overall habitat functionality around the major conservation areas has always been helpful in conserving the core habitats [22,27-29]. These conservation efforts are vital in minimizing the isolation effects [28] and maintaining population, demography, survival and birth of a particular species.

### 1.3 Religious Belief and Conservation

Indigenous communities hold a direct relationship with nature and natural resources due to inheritance of their religious and cultural values. Many wildlife species such as elephant, tiger, bear, monkey and langur are considered as sacred or spiritual identity and are worshiped [30] in some religions. Such beliefs usually encourage people in neglecting a species as nuisance animal and illustrate a degree of empathy [31-32] toward these animals. These mythological driven values, play a significant role in developing management strategies for the conservation of species and their habitat. Moreover, these conservation values are also crucial to supporting appropriate HWC mitigation strategies [30,33-34] and the success of any conservation inputs undertaken by management agencies [21,35]. Generally, such values build community's tolerance up to an extent with respect to particular HWC incident, which ensure willingness to support conservation inputs [10, 20]. However, willingness to support conservation depends on how religious understanding is put into the practices.

### 1.4 Terai Arc Landscape and Conservation Challenges

Terai Arc Landscape (TAL) is spread over three state of India namely Uttarakhand, Uttar Pradesh

and Bihar which provides suitable habitat to a number of wildlife species of mammals, birds, reptiles and other fauna [36]. These habitats include Protected Areas (PAs) and other reserve forest divisions, connected through important wildlife corridors throughout the landscape [37]. In recent years increasing forest encroachment has threatened these wildlife habitats including wildlife corridors and paced the rate habitat fragmentation with alteration of ecological services [38]. Increasing human interference in TAL has affected the resource availability for wildlife and impels them to approach human habitation and agricultural land [24,29,39]. As a consequence of increasing human-wildlife interaction huge economic loss has been observed among the local communities in the region [29]. Human-wildlife conflict has been one of the major conservation issues throughout the landscape and conflict with elephant, leopard and tiger are widely reported [40].

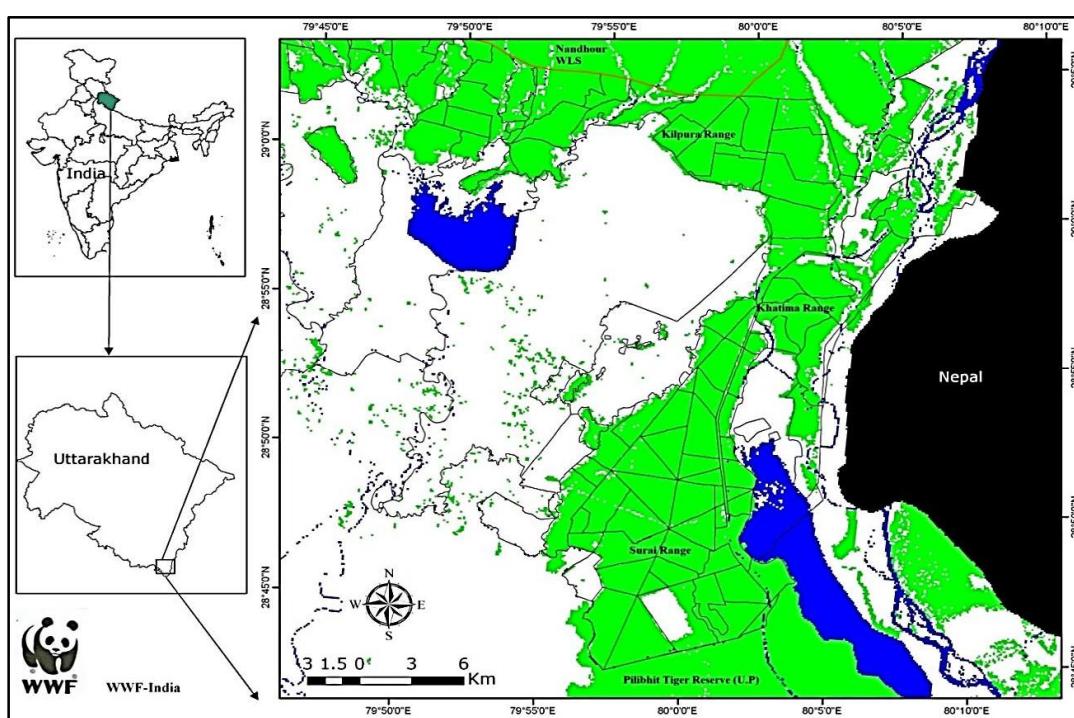
The landscape has recently witnessed recovery in tiger population [41] but increase in loss of wildlife corridors functionality also observed as a result of anthropogenic activities [36]. In this scenario Human-wildlife conflict are supposed to

increase in the landscape. In the present study information were gathered on wildlife movement, HWC issues in an encroached human settlement of Kilpura-Khatima-Surai (KKS) corridor and attempts were made to understand community response to conservation of wildlife species with an objective to understand the challenges in corridor restoration.

## 2. METHODS AND MATERIALS

### 2.1 Study Area

KKS corridor is critical in terms of wildlife movement between Nandhaur Wildlife Sanctuary of Uttarakhand and Pilibhit Tiger Reserve of Uttar Pradesh state (Fig. 1). This corridor is also important for the trans-boundary wildlife movement of wildlife between India and Nepal [36]. A number of faunal species including tiger *Panthera tigris*, leopard *Panthera pardus*, elephant *Elephas Maximus*, jungle cat *Felis chaus*, sloth bear *Melursus ursinus*, wild boar *Sus scrofa*, nilgai *Boselaphus tragocamelus*, Chital *Axis axis*, civets *Paradoxurus spp.*, etc, are important wildlife species using the corridor [42].



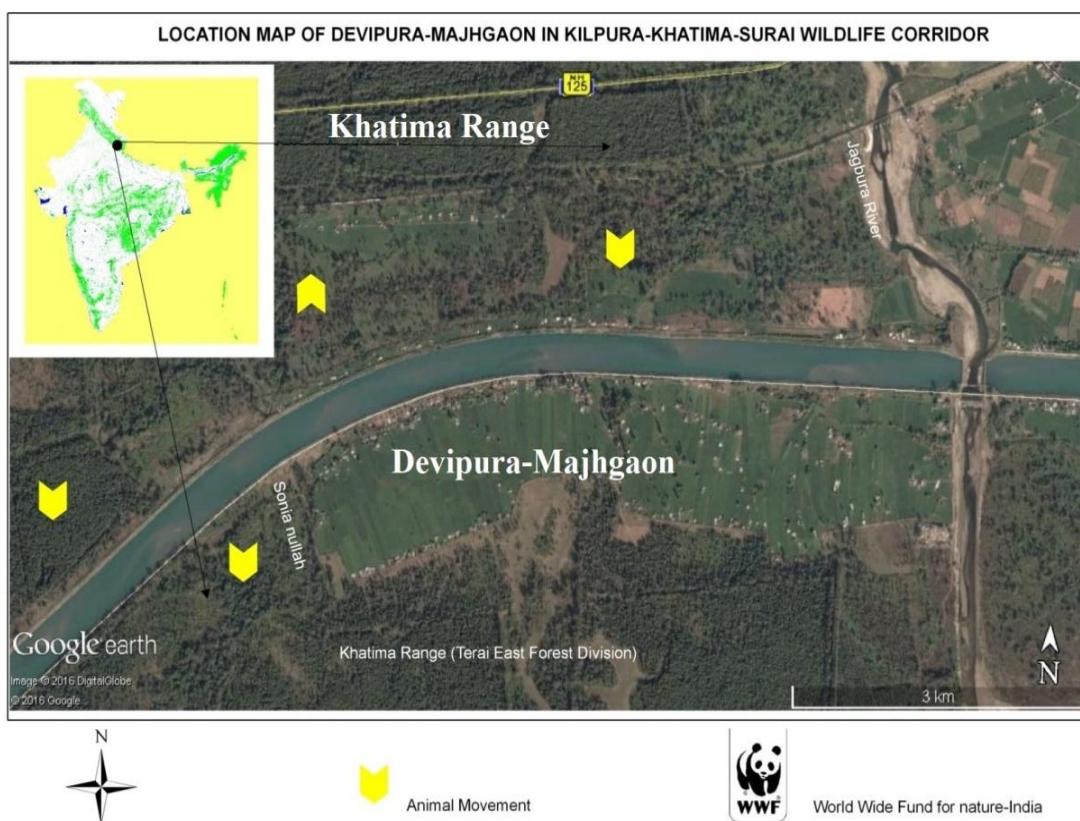
**Fig. 1. Map depicting the connectivity of KKS corridor with Pilibhit Tiger Reserve and Nepal**

In KKS corridor, Devipura village panchayat is an important habitation having more than 350 households. In this village panchayat two villages namely Devipura, which is on the revenue land and Devipura-Majhgaon on encroached land [43] are situated. It is situated between  $28^{\circ}55'52.77''N$  and  $80^{\circ}03'06.51''E$  with an elevation range 220-250m asl under the Khatima range of Terai-East Forest Division, in the Uttarakhand state of India (Fig. 2). East to West, this encroached settlement lies between Jagbura River and Sonia Nullah. Sharda canal restricts its boundary in the North while Sal Shorea robusta covers southern boundary mixed forest and Teak *Tectona grandis* plantations. The KKS corridor is severely altered and destroyed by anthropogenic disturbances such as encroachment, linear infrastructure development, human settlement and agriculture expansion and deforestation.

## 2.2 Methodology

To understand the landholding pattern and human-wildlife conflict within the encroached

habitation of Devipura-Majhgaon, a Focused Group Discussion (FGD) was conducted and information was collected on land holding and issues of HWC. The FGD was followed by a semi-structured questionnaire survey in April-May, 2016, to understand the average landholding of households, crops grown and productivity, extent damage to crops in each season, loss of property, livestock depredation, and human injury or mortality among the families. The information was also collected on community's responses to particular wild animal as well as strategies to mitigate the HWC. A total of 105 key informants or respondents, among all households residing along with the periphery (except the houses along with the canal side) were considered for the questionnaire survey. However, the selected respondents were mostly the head of family or person of older age, having some understanding on wildlife movement in the region.



**Fig. 2. Map depicting location of Devipura-Majhgaon village and other linear infrastructure**

### 3. RESULTS

#### 3.1 History of Encroachment and Characteristics of Respondents

A total of 105 household were interviewed and considered for the study in Devipura-Majhgaon village. Among the interviewed households, 11% were residing for last ten years while more than 65% household were residing for 10-20 years and 18% for last 20-30 years. Only 6% of households were residing in the village for more than 30 years (Fig. 3). The household residing history reflected that the expansion of settlement

and encroachment has been paced during last twenty years in the area.

Among the surveyed respondents (N=105), 13% were between 18-25 age groups, 16% were between 26-35, 27% were between 36-45, 28% between 46-55 and 8% respondents between 56-65 years while 8% of more than 65 years of age category (Fig. 4). The survey considered more than 70% respondents of more than 35 years ago to understand the wildlife movement within last 25-30 year in the area. However, respondents below 35 years were also important as the settlement is newly established.

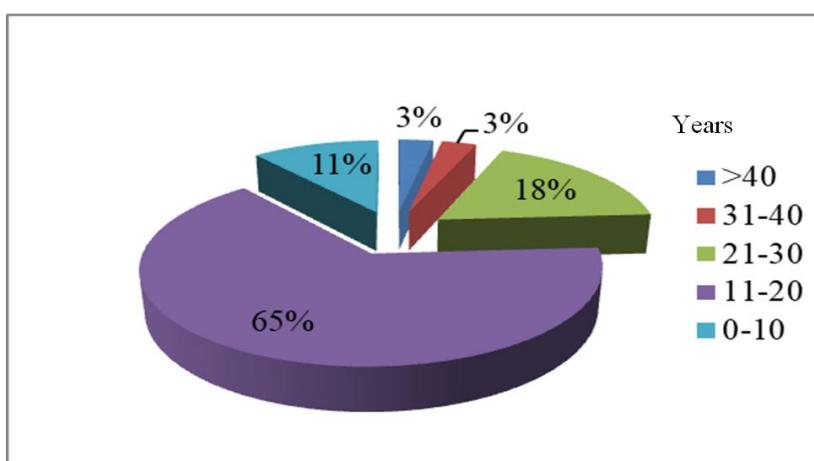


Fig. 3. Categorical representation of households based on year of encroachment on the forest land

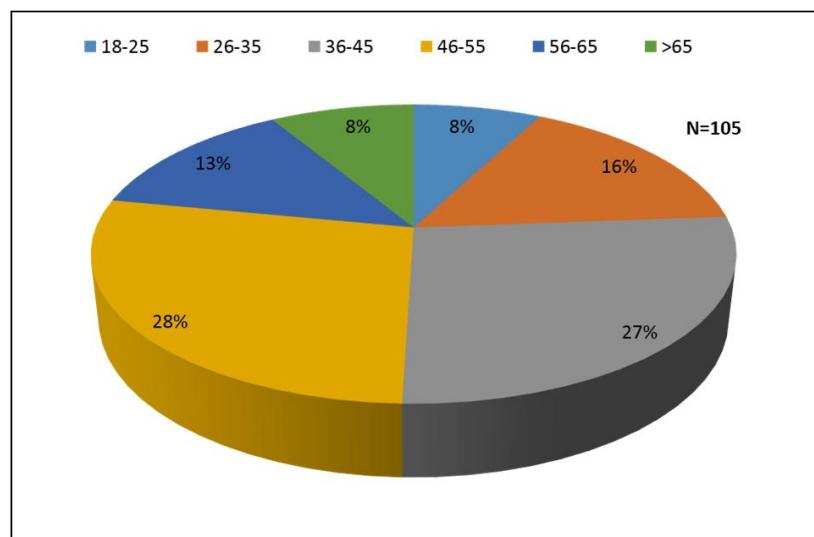


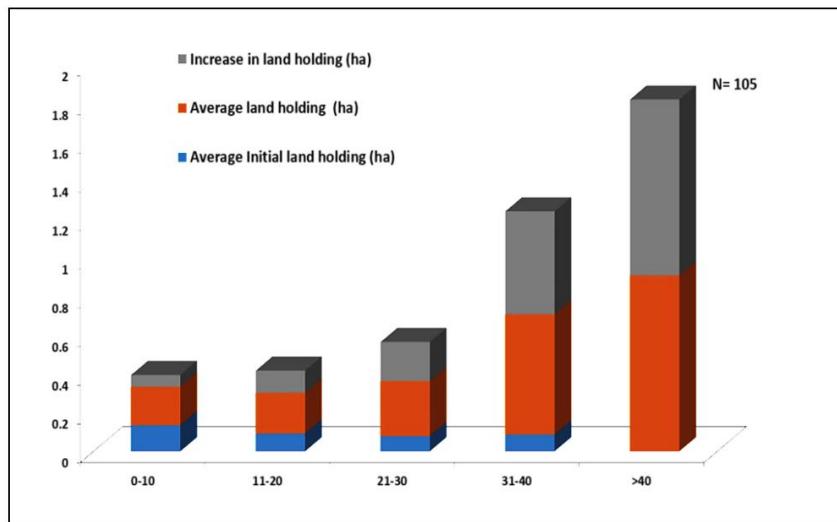
Fig. 4. Percentage of age category of respondents

### **3.1.1 Land holding pattern**

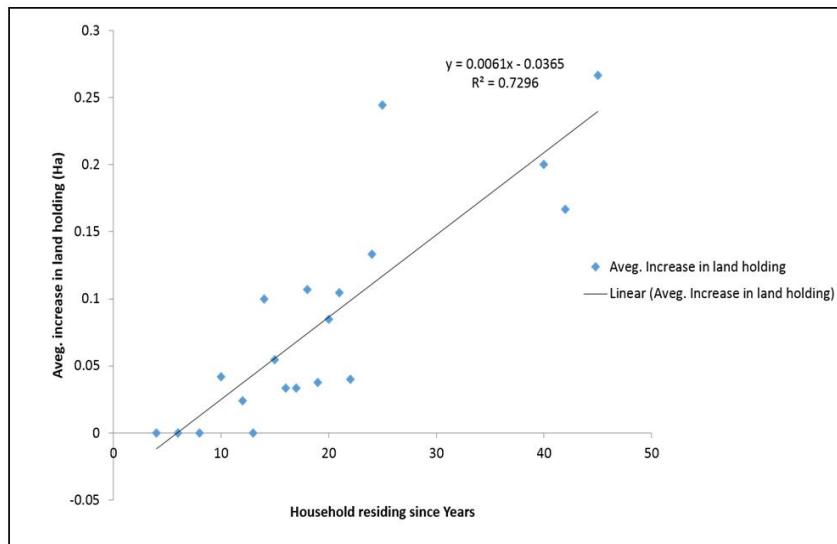
The residing history of the households in the village also reflects from the landholding pattern of each category and increase in average landholding (Fig. 5). The average landholding pattern varies as per the household residing history. Households residing for last 0-10 years have increased their average landholding about 30.87%, while 55.24% increase has been observed among the household residing since 11-20 years. Increase in landholding has also been observed among the households residing

over last 21-30 years (71.6%), 31-40 years (85.74%) and 100% with more than 40 years.

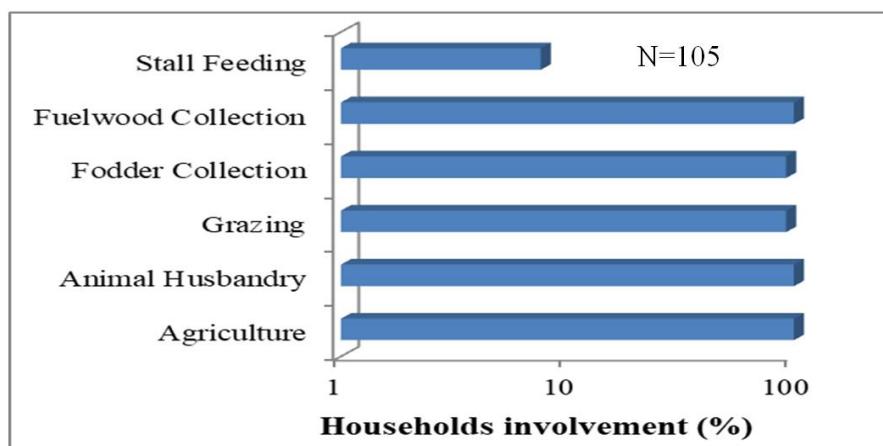
The households residing within last 20 years have purchased some part (average 0.116 ha/household) of their present landholding from other families living for more than 20 years and which has been increased more than 43% to an average of 0.204 ha/household. The increase in average land holding shows an increasing trend with residing household history and has been led by growth in encroachment in Devipura-Majhaon (Fig. 6).



**Fig. 5. Increase in landholding over the years among the households**



**Fig. 6. Trends of increase in average land holding through encroachment**



**Fig. 7. Households involved in livelihood related practices**

### 3.2 Livelihood and Resource Utilization Pattern

The households in the village are agriculture dominant and grow major crops of grains (*wheat Triticum spp.* and rice *Oryza spp.*) and pulses. They also grows seasonal vegetables like brinjal *Solanum melongena*, tomato *Solanum lycopersicum*, beans *Phaseolus vulgaris*, butter guard *Momordica charantia*, ladyfinger *Abelmoschus esculentus*, onion *Allium cepa*, garlic *Allium sativum*, piper *Pipper spp.*, and capsicum *Capsicum spp.*, for substantial use. However, some families sell their excessive production within the village or nearby local market. All of the interviewed households were involved in agricultural and animal husbandry practices, while 92.38% households among them are involved in grazing on forest land. Only 7.62% practiced stall feeding to their cattle and livestock while rests of the 93.33% were involved in fodder collection from forest (Fig. 7). Fodder collection is largely practiced by women members of household by covering a distance of 4-5 km in the nearby forests of Khatima range of Terai East FD. Fodder crops like Barseem *Trifolium alexandrinum*, Sorghum *Sorghum bicolor*, Maize *Zea Mays*, are also grown in agriculture field mostly by the households practicing stall feeding.

All households are engaged in fuelwood collection (7-8days/month) from nearby forest for cooking purposes, by covering a distance of 3-5 km into the woods. The woods are stored for cooking in monsoon and winter as well as space heating in winter. Communities residing in the area also used wooden logs and branches for

making a barrier to protect their crops from wild animals.

### 3.3 Wildlife Movement Related Information

Most of the respondents provided information on change or occurrence of wildlife species in the area. Species like the elephant, tiger, leopard, nilgai wild pig, chital, monkey *Macaca mulatta*, porcupine *Hystrix indica*, hare *Lepus spp.*, and jackal *Canis aureus* are reported to be sighted within the forest and nearby the village. The crocodile *Crocodylus palustris* were said to be sighted from last 2-3 years in Sharda canal. A total of 17.37% of respondents informed that wildlife species such as elephant, tiger and leopard use Jagbura river for their East-West movement toward forest up to Sharda river and vice-versa. Out of these respondents, only 5.71% (6 individuals) indicated elephant movement through the area up to Nepal, as news of crop raiding by elephants in Chandani, Kanchanpur and Mahender Nagar of Nepal are common immediate after crop raiding in and around of their village. The movement of elephant has also been recorded through camera traps deployed for monitoring of KKS corridor (Fig. 8).

### 3.4 Human-wildlife Conflict and Mitigation Measures

The local communities often encountered animals in the areas where human co-share resources within wildlife habitat. In Devipura-Majhaon, respondents have also accepted that during resource exploitation from forest area interaction with wildlife is common but human



Fig. 8. Elephant movement record through camera traps in KKS corridor

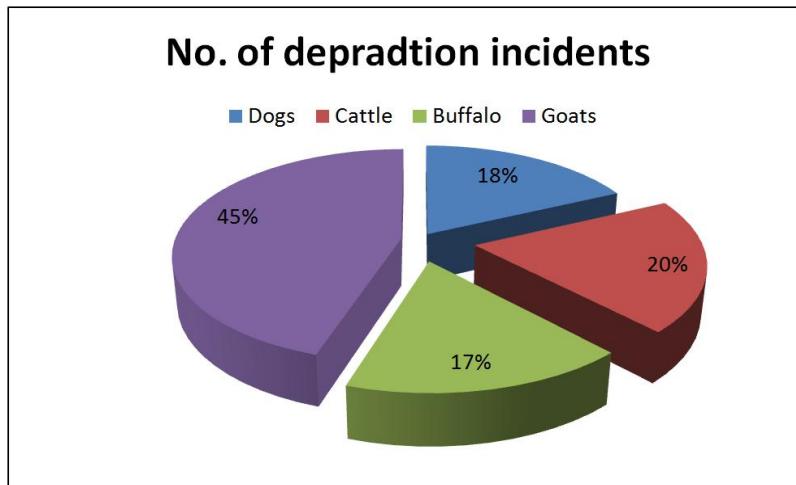


Fig. 9. Livestock depredation in Devipura-Majhgaon

injury and mortality has not been occurred since last five years. However, people faced livestock depredation, crop raiding incidences and partial damage to property because of wildlife movement. It is estimated that within last five years a total of 74 livestock depredation incidents by leopard and tiger, including cattle (20%), Buffalo (17%), goat 45%) and dog (18%) have occurred in the village (Fig. 9).

Out of these livestock depredation incidents, 48.65% incidents occurred within the forest (mostly cattle, buffalo and goats), while 51.35% cases (mostly killing of dogs) occurred within the

human habitation. The respondents have indicated that tiger and leopard were among the carnivores involved in livestock depredation in the village, however most of the time the predator could not be ascertained.

On crop raiding incidents, species like elephant, nilgai and wild pig are among the significant crop raiders. A total of 98% households out of a total 105 surveyed households, residing in the periphery of the village (from where crop raiders enter in the village), have been affected with crop raiding events in the village and faced substantial economic loss. Elephants usually raided crops 8-

10 times during each cropping season while nilgai and wild pigs are common crop raider with a herd size of 5-6 individuals (Fig. 10). On an average approximately 23.5% (0.06 ha/household) of total cropping land (0.25ha/household) is damaged in a single season. However, the extent of damage varies with some raiding incidents and time. It has a direct impact on reduction in crop production of two major crop wheat (1.424Qntl/household) and rice (1.753Qntl/household) each year.

The people in the Devipura-Majhaon used various HWC mitigation measures among which making noise, using burning *Masala* (a wooden log covered with cloth and dipped in Kerosene and burn when wild animal enter in the village), beating drums and chasing the wild animals using dogs and making groups are prevalent to scare away the animal. In case of crop raiding by elephant herds, prayers are performed with blowing *Sankh* (Conch shell used in Hindu rituals) by farmers and request are made to leave their crop field after taking his share.

### **3.5 Perception of Wildlife Conflict and Conservation Attitude**

Community holds different approach regarding conservation of a particular species and generally like the nuisance species outside their crop field and village until the damage takes place. Most of the respondent (88.57%) favoured conservation of all species. However, aggressiveness has been observed towards tiger, leopard, nilgai and wild pig due to more incidences of conflicts in their villages and crop fields. The reason for aggressiveness was described as that of the presence of these animals in the surrounding having a risk of life threats to people. Other animals are generally neglected, as damage caused by them is very little. The community respect elephant even it damages a significant fraction of their crop during both *Rabi* and *Kharif* cropping season. The respect toward the animal is much interesting among the households in the village that people used the word "Ganesh Ji" (Lord Ganesha of Hindu mythology), instead of the elephant, in response to each question regarding it. Moreover, the community believes that elephant only takes his share of the crop which they should dedicate to the god. Such belief driven attitude toward conservation of this endangered species and therefore securing its corridor is

critical and also for developing conservation strategies.

The perceptions were recorded to rank the particular wild animal as per extent of damage caused by these animals. Elephant, nilgai and wild pig are major crop raiders in the village, however, elephant was described the most damaging animal by 50.47% of respondents while nilgai as second most harming animal by 49.52% of respondents. Wild pig, chital, monkey, porcupine, mongoose and hare were among the other crop raiders in the village but caused very less damage in comparison to elephant and nilgai.

## **4. DISCUSSION**

Human-wildlife conflict is a growing issue among the communities residing adjoining to protected and other wildlife habitat [44]. Restoring landscape connectivity is vital for conservation of several large carnivores [45] including herbivores. Maintaining corridor functionality is among the major conservation challenges in Terai Arc Landscape [43]. The KKS corridor and the region has been recognized one of the important linkage or wildlife movement route between national as well as international protected areas network [37,40,43,46,47] in TAL. However, increasing encroachment and infrastructure development in newly settled villages have deteriorated this corridor over the past few decades [36-37,40,43]. The present study also revealed that the encroachment is continued in the area and resource extraction for livelihood is deteriorating the habitat quality. HWC incidents like crop raiding by herbivores, livestock kills by large carnivores and news of crop raiding in the villages of Nepal indicate the presence and functionality of the corridor at present. Despite, the human-wildlife conflict issues are prevalent in the area, and significant damage can be observed specially in terms of crop raiding. Beside of residing on the encroached land which seems to be obstructing natural wildlife movement, is an indirect threat to wildlife, however, the community responses were more oriented towards their conservation. These responses were observed greatly influenced with religious belief to a particular species such as elephant (despite causing most of the crop-raiding incidents) and empathy towards other animals. Moreover, the general perception among the community that wildlife only arrive in



**Fig. 10. Crop raiding by an elephant in Devipura-Majhgaon**

the villages and foray crops when they have limited resources in the forest, reflects their understanding toward animal behaviour. However, none of the respondent realizes and accepted that the crop raiding events in the area only occurring as a result of farming over the wildlife corridor which reflects lack of awareness on the wildlife conservation issues.

The scientific community has recommended restoration of KKS corridor, as it will enable wildlife movement within their historical range using adjoining associated forested habitats [40, 42,44]. To achieve the restoration goal, community attitude toward conservation of critical species and their habitat is essential [48-49] and need to be understand by the policy makers. The attitude based on mythological understanding and belief could play a crucial role in restoration KKS corridor in TAL, however, providing alternative livelihood options to the communities residing in the vicinity of the passage would be important. Such a planning would help in reducing community pressure on corridor resources, essential for wildlife foraging, supporting wildlife species and providing cover to them in their natural habitat. The approach would enable corridor functionality throughout the historical movement range of large mammalian species with connectivity to adjoining PAs. Restoration of wildlife corridors is necessary to sustain the gene flow and also for mitigating human-wildlife conflict. However, an appropriate policy intervention such as declaring wildlife corridor with a status Protected Area or considering them deemed to be PAs, where

limited human intervention is allowed is the need of time or relocating peoples from these corridors. This would be significant for restoration, management and sustainability of the wildlife corridors anywhere and consequently for wildlife conservation and human-wildlife conflict mitigation.

#### **4.1 Management Implication in KKS Corridor**

The encroachment has been a severe problem in order to ensure the corridor functionality in KKS area and its increasing trends are depriving conservation inputs. Devipura-Majhgaon has been identified for restoration and to make it functional for wildlife movement. As HWC issues are prevalent in the area and communities faced severe economic loss which is sometime compensated by forest department. To mitigate the HWC issues in the active wildlife corridor and to prevent continuous encroachment, integrated measures through involving local community and providing livelihood alternatives to them are necessary. WWF-India has identified solar power fencing on the village boundary as an effective measure to mitigate HWC incidences and to limit the encroachment expansion on forest land, until appropriate actions taken by management authorities. Alternative livelihood opportunities such as alternate energy option, promoting fodder cultivation and stall feeding are also planned to be implemented in the adjoining habitations of the corridor. Such management and conservation inputs would be crucial for long-term conservation support and outcome.

## 5. CONCLUSION

It is essential to monitor human habitations on a critical wildlife corridor to minimize its further expansion and degradation of core habitat. KKS corridor is vital for the movement of endangered species between Protected Areas (PAs) network of India as well trans-boundary protected area in Nepal. Over the time, various barriers such as ever-increasing settlements, continuing infrastructure development, degradation of water bodies and deforestation have resulted in an increase in wildlife conflicts with human, are critical for survival of both the wildlife species and human. Understanding the trends in HWC issues and implementing appropriate mitigation measures are necessary to sustain the corridor functionality and gene flow of a species across their habitat range. However, local community perceptions are essential to be considered for any conservation input and its outcome. Moreover, promoting religious and cultural values among the local people, linking these with species conservation plan and equitable sharing of benefit on commercial utilization of biological resources in the area are the keys to achieve desired conservation goal.

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## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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