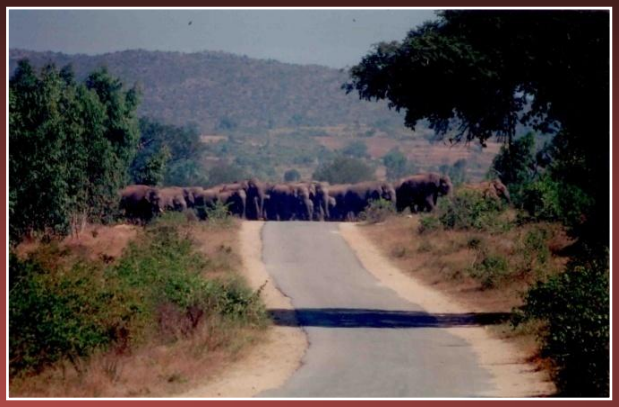
Human-Elephant Conflict in Mysore Forest Division

Patterns, causes and responses



Surendra Varma, K. G. Avinash and L. Vinay

Asian Nature Conservation Foundation

Karnataka Forest Department

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ANCF
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Status of Human-Elephant Conflict

Preface

The little known Mysore Forest Division, in southern India, significantly influences the status of Asian elephants in Bandipur and Rajiv Gandhi (Nagerhole) National Parks, two of the world's high density elephant habitats. Elephants use narrow stretches of forests in Mysore Forest Division that are contiguous with the forest boundaries of Bandipur and Rajiv Gandhi National Parks and cause considerable conflict with human communities. The Division has reported about 15,000 incidents of crop damages over five years. From 2004 to 2009, it has lost 16 elephants (60% of total elephant deaths) due to conflict related causes. Human injury and death due to elephants are also reported regularly. The knowledge developed on the status of elephants and human-elephant conflict in the Mysore Forest Division adds to our knowledge of conservation of elephants in the few remaining high density habitats.

It is important to note that the Division by itself is not a part of an elephant corridor or migratory route or elephant habitat. The total area under forest cover, and its spread, in the Mysore Forest Division, has no long-term ecological value for elephants. However, the elephants are seen in small groups during summer or during nonpeak conflict season. During peak conflict season the group size goes up to 80-100 individuals and causes various forms of human-elephant conflict in the Division.

Alarmed by the incidents of conflict and driven by the need to acquire good knowledge on the causes and the possible mitigation measures, officials from the Mysore Forest Division made contact with the Chairman of ANCF, Prof. Raman Sukumar. This interaction led to the initiation of a short-term investigation to gain specific knowledge on human-elephant conflict in Mysore Forest Division.

Information on the status of elephants and human-elephant conflict can be generated through a number of approaches. One approach is to extract information on crop/property damage and human/elephant death or injury from records maintained by the forest department. Knowledge gained from these records alone provides many insights into the nature and status of conflict. This was one of the approaches followed by the ANCF research team. Just five years of crop compensation payment records maintained by the department provided details on 15,000 crop damage incidents, identified the affected villages, their spatial location including distance from forest and water bodies and their cropping patterns. If this data obtained through existing records was supported by ground assessment of the actual status of conflict and assessment of functional efficacy of the mitigation measures followed, the quality of knowledge gained on the status of conflict will improve and the same would help in developing a mitigation strategy.

This investigation was carried out by using as its main basis an extensive study of crop damage compensation claim records and by visiting villages to assess the ground status of damages. Land use surveys were carried out, required geo-coordinates of landscape features were obtained, existing barriers of electric fences, elephant-proof trenches and the stone walls established by government and private individuals were visited on the ground and their functional efficacy was assessed. Forest department staff and farmers were interviewed to assess the status of elephant scaring squad. Different economic classes of villagers were identified from 30 villages. Villagers were interviewed to know their socio-economic status,

status of conflict, the mitigation measures followed and their perceptions of the human-elephant conflict.

The ANCF team received good support from the field staff of the forest department. A group of professionals from various disciplines provided volunteer support to the ANCF team. Social scientists, economists, software engineers, conservation educationists and wildlife biologists joined as volunteers and provided much valued support to the research team. The ground force traveled through the length and breadth of the landscape. While elephants chased the team away, the villagers welcomed them in. This investigation was truly an ANCF family project.

All these efforts have resulted in this document. There are eight sections in this document. Section I traces the need for carrying out this investigation. Section II is dedicated to the study methodology. Section III classifies the status of the land, incorporating the details of landscape elements, their extent and distribution. It records information on human communities, their resource gathering skill and their influence on the landscape. Section IV identifies the number and distribution of elephants. This was achieved by knowledge gained from Govt. of India's Synchronized Elephant Census, direct sightings made during the survey and information gathered from forest watchers and villagers.

Section V (part 1) recognises the conflict zones, seasons and months. It also tries to understand the mind of elephants in selecting the villages and time-periods for their visits. Section V (part 2) is a combination of both ground survey of crop damage and interaction with people who have lost property and crops during the survey period. This section identifies the villages that have been affected, number of elephants seen and the mitigation measures suggested by the community. Here, elephant track marks and dung pile measurements added some knowledge on the visiting elephants. Section VI travels through the existing elephant proof barriers to identify the causes and factors responsible for their contribution to the increase/decrease in the conflict incidents before or after establishment of barriers. Section VII is based on the results obtained by interacting with farmers on their perceptions in regard to human-elephant conflict. Section VIII lists out the literatures cited in the sections I to VII.

To manage human-elephant conflict there is a need to understand the pattern of conflict, its causes and stakeholders' responses. This document is the first of its kind on assessing the status of human-elephant conflict in this Division. It points towards the need for longer term studies to more fully comprehend the problems and its solution. It is hoped that the information presented herewith by the ANCF research team will be used by the forest department for the conservation of elephants and welfare of the human community; thus help in the peaceful coexistence of both wildlife and human beings.

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Dr. Baskaran, Senior Research Scientist at ANCF, helped in analyzing elephant census data. Discussions with **Dr. Thopsie Gopal**, Advisor, PREDICT India Project, ANCF, on the investigation of elephant poisoning in Mysore Division was very useful in understanding the causes of conflict. **Ms. Smitha Daniel** who initially joined as volunteer and later became Research Officer at ANCF, helped in analyzing data and assisted with report writing. **Ms. Shivani Agarwal**, GIS specialist at ANCF analyzed a part of the GIS data and developed comprehensive GIS maps.

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Executive Summary

Human-elephant conflict is one of the central conservation issues across Asian elephant habitats in India. Mitigation of conflict demands a detailed investigation of the status and patterns of conflict. Mysore Forest Division (MFD), located in southern India, borders two well known protected and high elephant density areas (Bandipur and Rajiv Gandhi (Nagerhole) National Parks). The MFD, except for having forest cover along the protected area and other small patches in the hills, does not have any significant expanse of forest cover to support a large number of elephants.

Elephants from the two National Parks use as refuge the forest cover along the boundaries of the Park and also forested small hills within the Division. This cover only acts as a day time shelter for elephants and at night they visit villages located within the Division and cause severe conflict. Prior to the current investigation, no studies to assess human-elephant conflict in this Division had been conducted. This investigation on Human-Elephant Conflict in Mysore Forest Division was carried out between September 2009 and March 2010 by the Asian Nature Conservation Foundation (ANCF), Bangalore at the request of the Karnataka Forest Department.

This investigation maps the past and current human-elephant conflict status, and is also an attempt to identify conflict mitigation strategies. This is achieved by evaluating the land use pattern, status of elephants, the efficacy of the current conflict mitigation efforts of the department and villagers' perception towards conflict. The study also makes recommendations aimed at upgrading protection and mitigation measures.

As part of the study, a ground survey of landscape elements was carried out and the land use classification was generated using ARC GIS 9.2 and ARCVIEW 3.2. Assessment of the status of elephant populations was done using data from Synchronized Elephant Census carried out in the period 2002, 2005, 2007 and 2010. The investigation on the status of human-elephant conflict was done using two methods: 1) analysis of patterns of conflict derived from compensation claim records and 2) assessment of conflict status through field investigations in some selected villages in the period September 2009 to March 2010.

A survey of the status of existing conflict mitigation measures was done through assessing functional efficiency of elephant proof barriers and elephant scaring squads. Farmers' attitude towards the problem was assessed by selecting 10 villages per Forest Range and interviewing three families from each of these 30 villages belonging to different economic classes.

Landscape elements classification based on satellite images shows four different categories: forests, water bodies, cropland and built-up areas. The agricultural land covers 78% of the land, forest constitutes 12%, water bodies 6% and built-up areas comprise 5%. The presence of forests (12% of Division area) and water bodies (6%) may

be largely responsible for inducing conflict in the cropland which covers 78% of the total area.

Elephant density estimated for the Division based on the synchronized censuses range from 0.1 to 0.65 elephants/km^2. This translates to 19 to 208 elephants for the division. The investigation discovered that during summer only small numbers of elephants with a maximum of three individuals frequently use this landscape and during the peak conflict season the elephant numbers reported in the villages within the Mysore Forest Division goes up to 60 to 70 individuals. A total of 27 elephants have died from 2004 to 2009, among them 59 % deaths were due to poisoning, electrocution and gun shot.

A total of 141 villages reported conflict (from 2004 to 2008). Across these five years, 58 villages reported conflict every year (41% of all villages that have reported conflict). Total number of incidents of crop damage for five years was 14,879. Based on the distribution of villages that report conflict, four distinct conflict zones (Zones A, B, C and D) could be identified. In terms of the number of incidents and intensity of the conflict, Zone A stands first in conflict status.

The highest numbers of conflict incidents were recorded for banana (*Musa* spp.), black eyed peas (*Vigna unguiculata*), coconut (*Cocos nucifera*), coriander (*Coriandrum sativum*), cotton (*Gossypium* sp.), green gram (*Vigna radiata*), horse gram (*Dolichos biflorus*), paddy (*Oryza sativa*), ragi (*Eleusine coracana*), hyacinth bean (*Dolichos lablab*) and sugarcane (*Sacharum officinarum*) reported only from Zone A. The elephants appear to move from the forest in Bandipur to the forest in Mysore Division and move up to the Chikkadevamma Betta (CDB) also known as Chikkadevamma hills causing severe damage in Zone A. CDB acts as a refuge during the daytime and has become one of the important sources of conflict.

For both Elephant Proof Trench (EPT) and Electric Fence together (48.6 km), a total of 226 incidents of damage to the barriers were recorded. This translates to 5 damages/km of barrier. About 35 different causes were identified for the breakages of these barriers. The combination of manmade and natural causes together contributes about 77% of breakages for both EPT and electric fence, the balance being attributed to elephant, wild boar and unknown causes. The 3.4 breakage recorded for every kilometer of the trench resulted from manmade causes, while elephants caused only 0.66 breakages/km.

According to the farmers, the major reasons for conflict between people and elephants were decreased forest area (20%) and habitat degradation (20%). In their opinion, the entire procedure of receiving the compensation money after submission of the application forms takes from 5 months to over a year, at times. Villagers are biased towards rubble wall and electric fence, in terms of their perception of efficacy. Among 14 different mitigation methods reviewed, about 15 per cent of villagers suggested killing of elephants.

Given the mixture of the highest level of forests and water bodies and surrounded by cultivated lands, Nugu region in Zone A has the highest level of conflict. It was found that the conflict occurs there throughout the year and during the peak conflict season (October to January) the elephant numbers rise up to 60 to 70 individuals (from the two important protected areas that adjoin the MFD). The conflict also results in the deaths of wild elephants. Stable conflict mitigation measures can be expected to prevent the death of elephants and provide scope for maintaining viable population in Bandipur and Rajiv Gandhi National Parks, the two important high density elephant protected areas of the world.

It is recommended that stable and long lasting elephant barriers should be established all along the boundaries of the adjoining Bandipur and Rajiv Gandhi National Parks. Elephants entering into the small hills should be prevented from damage by fencing these hills with effective barriers. At village level, individual farmers or villagers have to protect their crops primarily by electric fences. One broad based mitigation measure could be to restructure the boundaries of the MFD and the adjoining protected areas and include the boundary/ forest areas presently within the Mysore Forest Division into the Bandipur and Rajiv Gandhi National Parks.

Recommendations

The small hills located within the Mysore Forest Division act as a source of shelter and food for elephants by day. From these hills the elephants raid crops in surrounding areas at night. The presence of water sources adds value to this region in terms of meeting the elephants' requirements. These hills also act as a conduit linking natural forests (Bandipur and Nagarhole) to cultivations. It can be assumed that even with the availability of water and cultivated crops, the absence of small hills would have made it unsuitable for elephants to visit and damage crops. Given this situation, mitigation of conflict should be oriented to 'management' of these small hills.

- Fool-proof elephant barriers around the hills may reduce the conflict and it will improve the quality of the forest which is currently degraded by human exploitation and interference.
- Even before taking action to prevent elephants from entering the small hills it is important to make efforts to prevent them from venturing out of the protected areas adjoining the Division. This is important as the forest available within the Mysore forest division is very small and not part of an elephant habitat or corridor.

Permanent and effective elephant barriers should be used as the first line of defense for mitigation of human-elephant conflict.

1. Establishing effective barriers all along the boundaries of the adjoining Bandipur and Rajiv Gandhi National Parks.
2. Preventing elephants entering into the small hills by fencing these hills with effective barriers.
3. The elephant proof barriers along the forested boundaries and small hills may obstruct the local community that depends on the forests. This may lead to attitudes hostile to conservation interests among them. The community should be allowed regulated access to the natural resources: for example, cattle entry points may be established in a few locations. At village level, individual farmers or villagers have to protect their crops primarily by electric fences.

This investigation identifies distinct zones of conflicts or conflict 'hotspots'. Information provided based on this study on different conflict zones should enable the authorities to design a mitigation plan. Development of strong fool-proof barriers in Zone A can prevent elephant incursion into these villages; it also might help in improving the quality of forests. The other important conflict mitigation measure for this zone could be to prevent the movement of elephants to the hill, Chikkadevamma Betta (CDB).

This study estimated that for every 100 elephant entries into the villages from the protected forest areas, more than 60 entries can be assumed to be from Omkar and 40

entries from Sollepura and Metikuppe forest areas. Omkar region adjoining Bandipur lead the elephants into Nanjangud range (Depegoudanapura, Surahalli, Kasuvinahalli, Makanapura, Siddegoudanahundi, etc.) and Sargur range (Nugu regions-Puradakatte, Kothegala, Huvinkala, etc.) Omkar wildlife region is located near Hediyala in Sargur-Begur path.

- Establish a fool-proof barrier in Mullur betta region covering Nugu reservoir and Mullur betta. The barrier will traverse 9.5 km, starting from Hegdulu village covering Mullur betta up to the existing EPT near Hosavil (next to Hedayala village). For this proposed barrier to be established, and function effectively, a stretch of road passing through Mullur betta has to be closed and an alternative road has to be established.
- Closer to the Nagarhole forest (near Rajegoudanahundi village) is a 100 m trench which divides forest and village. Of this about 20-25 m is broken and 70-75 m is intact. This broken segment is the entry point for elephants. The trench must be repaired and sealed.
- Points of elephant entry into ranges play a very important role in determining the intensity of conflict and the chances of conflict mitigation. Nanjangud range has open entry near Omkar and HD Kote all along the boundaries of Sollepura and Metikuppe forest areas. A critical review of existing elephant barriers within these locations should be made to identify barrier segments in need of repair and /or renewal.

Although Mysore Forest Division is located close to Bandipur and Rajiv Gandhi National Parks, two high elephant density protected areas, the division by itself does not have much forest cover and does not form part of any traditional migratory route. Elephant movement into the division does not provide larger and longer term ecological resources for the species.

- One important mitigation measure might be to reorganize the boundaries of the MFD and the adjoining protected areas and include forest areas presently within the Mysore Forest Division (of Zone A and Zone B) into the respective protected areas.

If fool-proof boundaries are created along the protected forests and the area surrounding the hills, and are constructed properly and maintained well, there may not be any need for farmers to have their own conflict mitigation measures.

- Until permanent barriers are made, case-specific conflict mitigation measures need to be developed for small farmers as they cannot afford the loss incurred due to the elephant conflict.

- Fool-proof barriers can be of trenches or rubble walls or fences constructed from unused railway lines. Boundaries of small hills and protected areas run for a very long distance. Establishing electric fences along these boundaries may not result in reliable protection. Moreover, the cost and effort involved in maintenance is high.
- EPT of 8 feet width and 6 feet depth within which a rubble wall or solar fence could be established. Otherwise, rubble wall built within a trench of 8ft width and 6ft depth could be an effective barrier.
- Villagers suggest two small trenches running in parallel could help to mitigate the conflict problem. An incident worth noting occurred in Annur village falling within HD Kote range, where an elephant calf fell into the trench after which elephants stopped coming to that place thereafter.
- The current functional methods for dealing with raiding elephants using forest staff (even trained and experienced forest staff) to locate and drive away elephants is a primitive and dangerous approach to dealing with this problem. Focus should be more on stable elephant proof barriers as the foundation upon which operational strategies for driving/scaring elephants away can be conceived. Till that occurs, watchers and guards need to be trained on safe methods to chase elephants without harming elephants and also themselves.
- The forests, within and along the boundaries of Bandipur and Rajiv Gandhi National Parks, provide food and other resources for elephants. However, currently the forests in these regions are highly degraded and threatened due to encroachment. Strict enforcement of anti-encroachment measures should be implemented to prevent loss and degradation of forest habitats.
- The investigation of conflict cases by conflict mitigation squads is always useful in developing long-term solutions. The ANCF team identified many forest department ground staff positioned in conflict hotspots whose involvement, interest and concern about wildlife needs to be better recognized by the Forest Department. The knowledge level, including knowledge of GPS usage of some of the current ground staff from the Mysore Forest Division is highly commendable. Encouraging them will surely bring positive outcomes in human-elephant conflict mitigation.
- Farmers should be trained, through the Village Forest Committees, on how to collectively tackle and prevent the problem of conflict. VFCs should themselves receive training from expert groups consisting of government and NGO personnel.
- Village Forest Committees should be engaged effectively by the forest department to conduct regular meetings with the farmers, to train them on how to use and

maintain private fences, prevent entry of elephants and to chase elephants from the villages in an effective and safe manner.

- Use conservation NGOs to create motivation among the farmers to be supportive of departmental initiatives for conflict mitigation. NGOs should come forward in helping to generate funds for sealing the bigger boundary. Right planning and execution of the work are important first steps in conflict mitigation. With credible approaches and incentives, farmers could be encouraged to take more responsibility in implementing conflict mitigation strategies.

Section I:
The Need for the Study

The management of human-elephant conflict is a challenge in India's crowded elephant landscapes. Successful mitigation of conflict requires a detailed understanding of the status and patterns of conflict. Also relevant is an understanding of the efficacy of current mitigation procedures in use (Nath and Sukumar, 1998; Easa and Shankar, 1999; Basappanavar and Kaveriapa, 2007; Prabal et al., 2008). Mysore Forest Division (MFD), Karnataka, which previously included much larger forest areas, is now relatively small in size after some of the forested regions were included under other forest and wildlife divisions (Srinivasan, 2002). Currently the division has only 12% of area under forest cover (with a reported density of 0.46 elephants/km^2). MFD is surrounded by protected areas with high percentage of forest cover (90 to 95% AERCC, 1998) and high density (1.2 to 2 elephant/km^2) elephant habitats (AERCC, 1998; AERCC, 2002; AERCC, 2006, ANCF, 2007; CES, 2010). From these protected areas, elephants move out into the Mysore Forest Division, visit cultivated lands and cause conflict. Earlier, only 5-6 elephants were reported around the crop lands located in the landscape of the MFD and the problem used to be reported only during specific seasons. But currently, groups of elephants ranging in herd size of 40-50 raid the crops and this problem has been reported throughout the year. Many factors including the existing cropping pattern with the cultivation of cash crops such as sugarcane, banana etc that attract elephants, may be the reason for the increasing levels of conflict. No studies to evaluate human-elephant conflict in this Division had been conducted prior to the current investigation. This investigation on Human-Elephant Conflict in Mysore Forest Division was carried out by the Asian Nature Conservation Foundation (ANCF), Bangalore, at the request of the Karnataka Forest Department.

Objectives

The primary purpose of the study was to map the past and current human-elephant conflict status, and identify strategies to mitigate conflict. The study also looked at the specific problems faced both by the farmers and the forest department. It attempts to evaluate the land use pattern, status of elephants, the efficacy of the current conflict mitigation efforts of the department, villagers' perception towards conflict issue and makes recommendations aimed at upgrading protection and mitigation measures.

Section II:
Study Methodology

The study on human-elephant conflict in Mysore Forest Division was carried out between September 2009 and March 2010. It used five broad assessments.

1. A review of the status of the landscape, land use and human communities
2. Assessment of the status of elephant populations in the division
3. Assessment of the status of human-elephant conflict
4. Assessment of the efficacy of conflict mitigation measures
5. A rapid survey of villagers' perceptions and attitudes towards human-elephant conflict

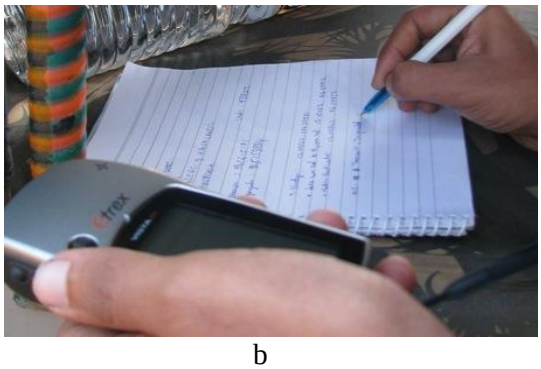
In addition to this, a workshop on human-elephant conflict and conflict mitigation measures was also conducted in February 2010 for forest department staff and community members of HD Kote subdivision of Mysore Forest Division (see Appendix 1 for more details).

1. Status of landscape and human communities

The study of landscape elements of the Division was carried out (Figures 1a, b and c) while in the field for collecting information on human-elephant conflict. This could be termed opportunistic sampling. In addition to this, exclusive ground truthing field trips were carried out. The ground truthing was done using Global Positioning System-GPS (Magellan eX-plorist 300 and Garmin Etrex vista).

c

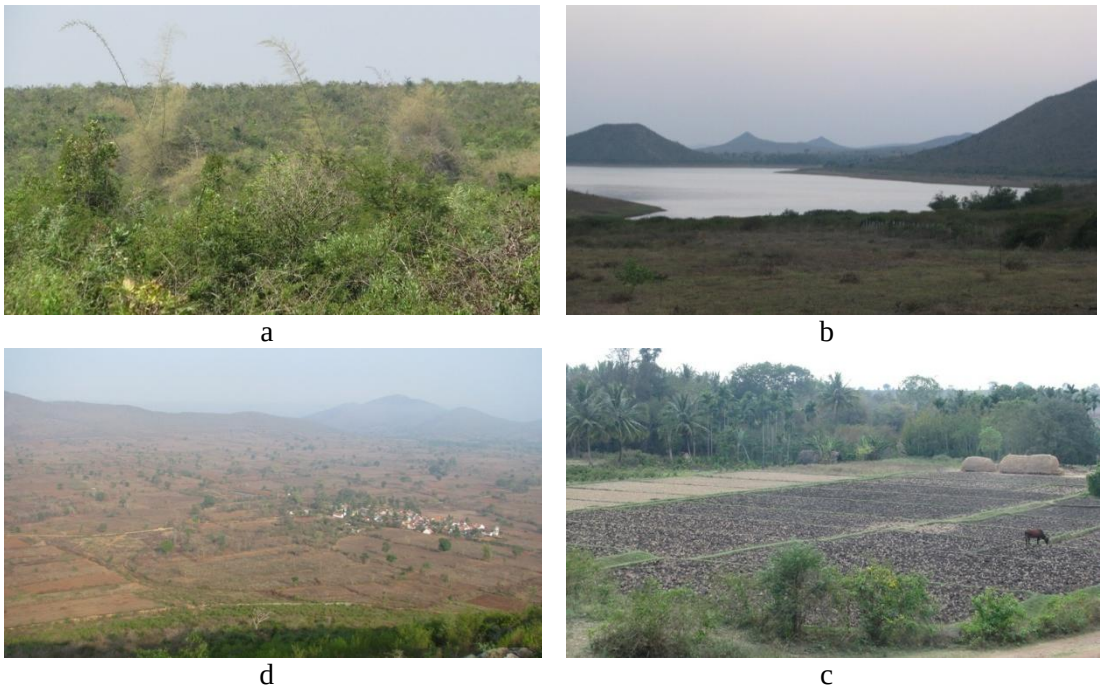
a



b

Figures 1a, b and c : Field investigations using Global Positioning System for identifying landscape elements

A ground survey of landscape elements such as forest cover (Figure 2a), water bodies (Figure 2b), area under cultivation, (Figures 2c and d), road network etc was carried out. Interaction with forest officials, community leaders and other relevant stakeholders was also organised.



a b d c

Figures 2a, b, c and d (clockwise): Examples of landscape elements such as forest (2a), water body (2b) and cultivated lands (2c and d)

The ecological history of the landscape was reviewed by visiting locations with records of past events. Information was also obtained through literature and forest department records.

A review of the land use in the Mysore Forest Division showed elements such as forests (dry deciduous forest, dry thorn forest, scrubland), plantation (acacia, teak, eucalyptus, mixed, rubber), agriculture and horticulture, river islands, barren rock, built-up, forest blanks, mining / quarrying and water bodies (tanks, reservoir and lakes).

However, it was proposed to consider only four categories viz., forest (dry deciduous, scrub forest, scrubland, acacia, eucalyptus, mixed, teak and rubber plantations, forest blank, barren rocky and river island), water bodies (tanks/reservoir/lakes), agriculture (agriculture plantation/horticulture, cultivated lands and mining/quarrying) and built-up area.

The GIS data on range boundary and land use was obtained from the forest department. Village locations were extracted from forest department records supplemented by information from forest department field staff. Land use data obtained from the department was verified during the field survey. These details of land use were

incorporated in ARC GIS 9.2 and ARCVIEW 3.2a. The projection used for land use classification was WGS 1984.

2. Assessing the status of elephant populations for the division

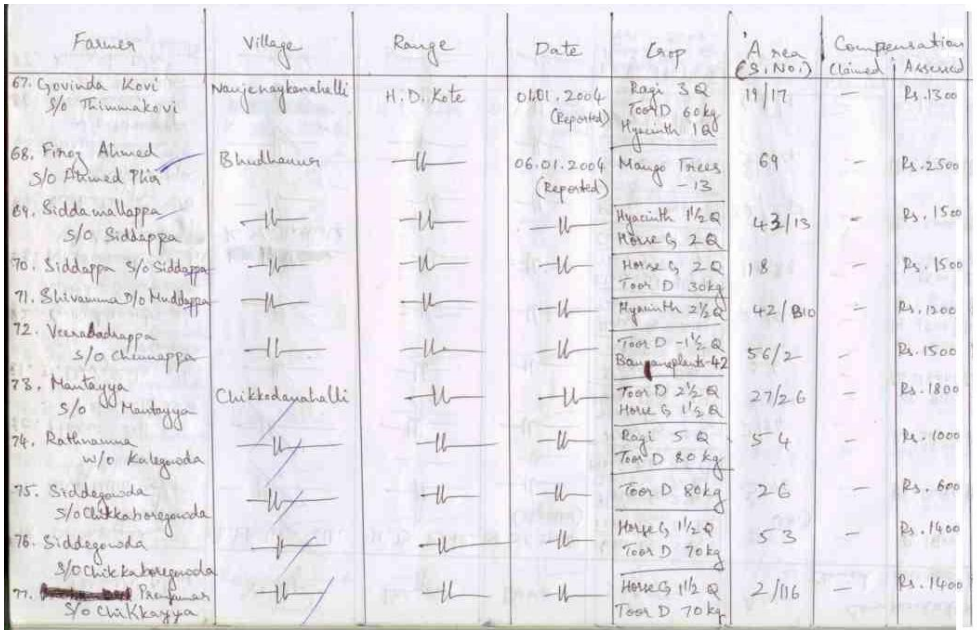
This was achieved by using the data obtained from the May 2010 synchronized elephant census. Data from Synchronized Elephant Census carried out in the periods 2002, 2005 and 2007 were also used. Results obtained by block count, line transect, indirect count and water hole count across these years were compared to derive information on habitat usage by elephants, population density, group sizes and population demography.

3. Assessing the status of human-elephant conflict

This was done using two methods: a) analysis of patterns of conflict derived from compensation claim records and b) assessment of conflict status through field investigations in some selected villages in the period September 2009 to March 2010.

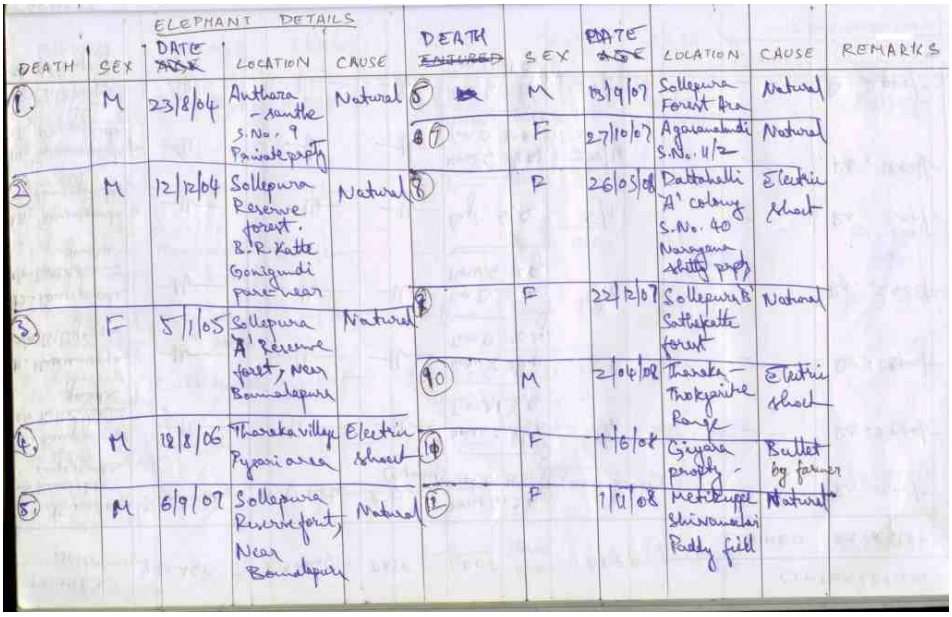
A. Information from compensation records: Like other forest divisions, Mysore Forest Division maintains systematic records of compensation claims for various purposes. These records provide specific knowledge about the nature and scope of conflict and related aspects. For this ANCF study, these records were used to develop a digital database related to the various aspects of conflict.

The data was also incorporated into a GIS framework to develop specific insights into the nature and scope of conflict. The data for five years (January 2004 to December 2008) was collected from each of the five ranges (Heggada Devana Kote known as HD Kote, Sargur, Nanjangud, Mysore and Tirumakudalu-Narasipura, known as T. Narasipura). Data included details of the village, the farmers, range, name of the crop damaged, its area, compensation claimed, assessed and paid. In addition to this, specific details of elephant death, date, sex, location, and cause were also extracted from official records (see Figures 3a and 3b for the details collected through the data collection format developed).



Farmer	Village	Range	Date	Crop	Area (S.No.)	Compensation Claimed	Compensation Assessed
67. Govinda Kovi S/o Thimmakovi	Nanjenayakanahalli	H.D. Kote	04.01.2004 (Reported)	Ragi 3Q Toor D 60kg Hyacinth 1Q	19/17	—	Rs.1300
68. Firoz Ahmed S/o Ahmed Pha	Bhudhanur	〃	06.01.2004 (Reported)	Mango Trees - 13	69	—	Rs.2500
69. Siddamallappa S/o Siddappa	〃	〃	〃	Hyacinth 1½Q Horse G 2Q	43/13	—	Rs.1500
70. Siddappa S/o Siddappa	〃	〃	〃	Horse G 2Q Toor D 30kg	18	—	Rs.1500
71. Shivamma D/o Muddappa	〃	〃	〃	Hyacinth 2½Q	42/B10	—	Rs.1300
72. Veerabadrappa S/o Chinnappa	〃	〃	〃	Toor D - 1½Q Banana plants-42	56/2	—	Rs.1500
73. Mantayya S/o Mantayya	Chikkodanahalli	〃	〃	Toor D 2½Q Horse G 1½Q	27/2G	—	Rs.1800
74. Rathnamma W/o Kalegowda	〃	〃	〃	Ragi 5Q Toor D 80kg	5-4	—	Rs.1000
75. Siddegowda S/o Chikkahoregowda	〃	〃	〃	Toor D 80kg	2-6	—	Rs.600
76. Siddegowda S/o Chikkahoregowda	〃	〃	〃	Horse G 1½Q Toor D 70kg	53	—	Rs.1400
77. [redacted] Prathapa S/o Chikkayya	〃	〃	〃	Horse G 1½Q Toor D 70kg	2/116	—	Rs.1400

Figure 3a: Format used for collecting details of crop damage and associated information



ELEPHANT DETAILS

DEATH	SEX	DATE	LOCATION	CAUSE	DEATH	SEX	DATE	LOCATION	CAUSE	REMARKS
1	M	23/8/04	Anthara - Santhe S.No. 9 Private prop	Natural	5	M	13/9/07	Sollepura Forest Area	Natural	
					6 7	F	27/10/07	Agaramandi S.No. 11/2	Natural	
2	M	12/12/04	Sollepura Reserve forest. B.R Kotte Gonigundi pond near	Natural	8	F	26/05/08	Dattahalli 'A' colony S.No. 40 Narayana Shetty prop	Electric shock	
					9	F	22/12/07	Sollepura 'B' Sattekatte forest	Natural	
3	F	5/1/05	Sollepura 'A' Reserve forest, Near Bamalapura	Natural	10	M	2/04/08	Thoraka - Thokyaithe Range	Electric shock	
4	M	18/8/06	Thoraka village Pyari area	Electric shock	11	F	1/6/08	Giyara property -	Bullet by farmer	
5	M	6/9/07	Sollepura Reserve forest, Near Bamalapura	Natural	12	F	7/11/08	Metikuppe Shivanasi Paddy field	Natural	

Figure 3b: Format used for collecting details of elephant deaths and associated information

The records were converted into digital format to analyse the patterns of conflict. In addition to this, details on land status/area, loss of human life and property damage were gathered. Specific surveys were conducted in those villages that claimed and received compensation. Geo coordinates of these villages were obtained to create a GIS and digital database.

The data was analyzed to know the number of villages affected per year, spatial trends in conflict, number of incidents across the years and mean number of incidents per village per year. The distance from the nearest forest to villages that reported conflict and the relation between the distance from the forest and numbers of incidents of crop damage were also calculated. The villages that did not have the details of compensation were identified to know their location and distance from forest. Insights into conflict zones, conflict months, specific dates of conflict were also obtained.

Animal movement extension to Arcview 3.2a (Hooge and Eichenlaub, 2000), generally used for delineating home ranges of animals, was used for creating conflict zones. These zones may identify the intensity or clustering of crop damage that have occurred around certain areas representing cluster of villages that report conflict. The zonation was done using Fixed Kernel Home Range Estimator, which considers probabilistic techniques for home range estimation (Hooge et al., 1999; Hooge and Eichenlaub, 2000). The estimate makes it possible to locate the core area, i.e, the zones, used most intensively by the animal. The intensity of usage was obtained based on the incidents of crop damages.

Data on incidents of crop damage was categorized using natural breaks based on Jenk's optimization (Brewer, 2006). The Jenks' natural breaks classification scheme determines the best arrangement of values into classes by iteratively comparing sums of the squared difference between observed values within each class and class means. The classification identifies breaks in the ordered distribution of values that minimizes within-class sum of squared differences.

B. Investigation through ground surveys: The most affected ranges of the Mysore Forest Division (HD Kote, Sargur and Nanjangud of HD Kote sub-division) were selected for the conflict assessment. The top 10 villages from these 3 ranges in terms of number of incidents of crop damage as indicated in the compensation payment records were selected. The selection was based on the intensity of conflict in these villages, irrespective of the frequency of elephant visits. The selected villages were sampled at least once a week by the research team and every week's status and quantum of damage were recorded.

The data related to elephant visits to the villages (e.g. number of elephants visiting, area of crop damage, total area of damage, infrastructural damage, economic loss, etc.) were assessed and documented on a specially designed data sheet. Supporting information from informers and local resource persons from each village was also recorded.

The crop damage assessments (Figures 4a, b, c and d) were done to know the exact amount of crop damaged and the mean number of elephants visiting. An attempt was also made to know elephants' age by measuring their foot prints. Dung piles were examined for elephant feeding behavior. This was done to calculate the relative proportions of forest food species and crop food species found in the elephants' diet.

a

b

d

c

Figures 4a, b, c and d: Assessments of the quantum of crop damage caused to cultivated crops by elephants

4. Assessment of the efficacy of conflict mitigation measures

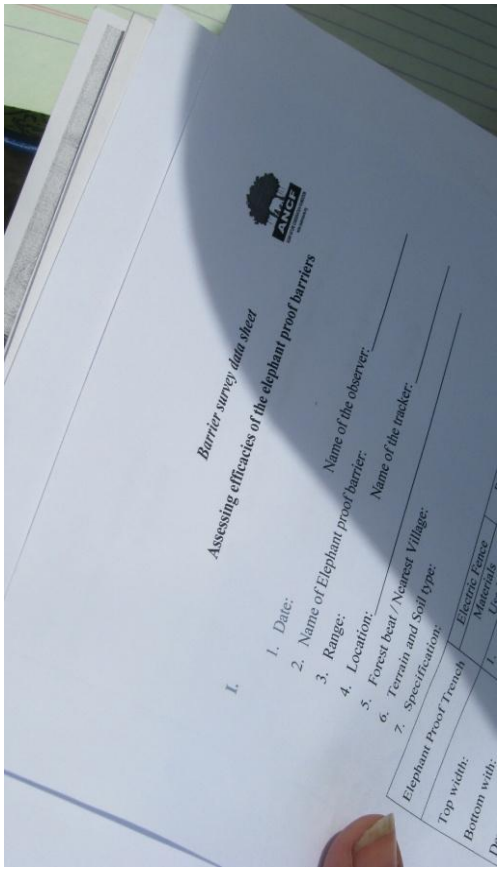
This study included a survey of the status of existing Elephant Proof Barriers (EPB) and their functional efficiency and quality of maintenance. A survey was conducted on the functioning of elephant scaring squads.

A. Survey of barriers: A survey was done to assess the status of existing elephant proof barriers (Figures 5a, b, c, d, e, f, g, h, i, j, k and l). The survey attempted to investigate the

current status and efficacy of the Elephant Proof Trench (EPT), electric fence and other barriers such as rubble wall.

a

c



b

Figures 5a, b and c (clockwise): Field assessment of the status of elephant proof barriers- obtaining GPS locations of the damage (a), assessing the width and height of elephant proof trench (b) and recording the details in a data sheet specifically designed for data collection (c)

The EPT and Electric Fence together extending over a total of 48.6 km (34.7 km of EPT and 13.9 km of Electric Fence) was surveyed. The total length of the EPTs and Electric Fences established by the forest department were surveyed. Only five electric fences (constituting 10% of the total length) belonging to villagers were studied.

In HD Kote and Sargur ranges 100% sampling was done, and for Nanjangud only part of it was assessed. The other measurements as part of the barrier survey included identification of the location of barriers, their distances from the village, distances from crop land, total length of barrier and breakage points.

d

e

f

i

h

g

Figures 5d, e, f, g, h and I (clockwise): Identifying the causes (d), consultation with the forest staff (e), investigating the status of damage (f), measuring the height of the poles used for establishing electric fences (g and h) and battery used for charging electric fence (i)

j

l

k

Figures 5j, k and l: Assessing status and dimensions of stone walls established to prevent elephant entry from forest

The different barriers were surveyed on foot and mapped with the help of GPS. The foot survey assessed information on type of damage, cause of damage, status of damage, year of establishment of the barrier, status of nearest forest cover, the distance to nearest cultivation, type of cultivation and distance to nearest village. Irrespective of the breakages, the status of forest near the barrier, distance to nearest cultivation, type of cultivation, status of elephant barrier and the distance to nearest village were also collected at half hour intervals of the survey.

B. Scaring of elephants: Interviews were conducted with forest staff (Figure 6a) involved in the elephant scaring operations to assess the efficacy of the methods followed in the division. In addition to this, farmers, or labourers (Figure 6b), who work for farmers, engaged in elephant scaring operations were also interviewed.

Details on number of staff involved, degree of involvement in the elephant scaring operations, duration of driving operation, and other related aspects were collected.

This was an opportunistic sampling as only a small percentage of staff involved in the operation was interviewed.

a

b

Figures 6a and b: Interactions with forest staff (a) and villagers (b)for assessing the elephant scaring operations carried out by them

5. A rapid survey of community perceptions and attitudes towards human-elephant conflict

Farmers' attitude towards the problem:

For this study component (Figures 7a, b and c) the most affected ranges such as HD Kote, Sargur and Nanjangud (HD Kote sub-division) were selected. Ten villages per range were randomly selected. Three families from each of these 30 villages belonging to different economic classes were selected.

Three categories of village families (poor, middle class and rich) were selected. The

a

c

b

Figures 7a, b and c : Assessment of villagers' (farmers') perception of human-elephant conflict

classification of poor farmers was based on the quality of the house (see figures 7d and e). Middle class farmers were defined as those having a property of area of around 600 sq. ft, including the house and its surroundings and compound wall. These usually were independent houses (see figures 7f and g).

d

e

Figures 7d and e: Examples of houses belonging to the category ‘poor’

f

g

Figures 7f and g: Examples of houses belonging to the category ‘middle class’

Economically well-off farmers were identified as those having a big, newly built modern house with relatively large area within the compound wall. They may also have vehicles such as cars, tractors, etc. (see figures 7h and i).

h

i

Figures 7h and i: Examples of houses belonging to the category ‘rich’

From these categories, a total of 90 villagers were interviewed. The type of data collected included crops grown, amount spent on cultivation, average loss of crops and economic

loss caused to them by elephants every year and alternative income sources if crops were damaged. Views of the villagers on responses of forest department in terms of mitigation measures, and their opinion about forest conservation and elephants were also noted.

Section III:
Status of Landscape, Land Use and the Human Community

Background

The nature of land use within a forest division or the areas surrounded by it has strong influence on how the land has to be managed. The presence of different landscape elements, their sizes, shapes and locations determine to a large extent the land use of the region (Franklin & Forman, 1987; Fuentes et al., 1989; Hansson & Angelstam, 1991; Varma, et al., 2008a). Assessing the status of land use within a forest division is not difficult, but very rarely is this concept incorporated into ground conservation evaluations. Moreover the precise influence of the status of land use within a forest division on conservation issue is not well known. Although the details or even the list of landscape elements for a given landscape may be available, their relationship to conservation objectives may not be clear. For example, quality, size and contiguity of forest near human habitation play important roles in the status of human-elephant conflict (Ratnam, 1984; Smith and Kasiki, 1999; Sitati, et al., 2003). If elephants have to spend 18 hours a day in feeding (200-250 kg food/animal/day), they cannot fulfill their forage needs solely within croplands (Sukumar, 1989). The results from assessment of actual crop damage by elephants do not confirm whether they are able to consume the optimally required food from the cropland (Prabal, et al., 2008). If the landscape element 'cultivated land' is located close to another landscape element 'forest land', both elements may be used by elephants to fulfill forage needs. The forest cover near cultivated areas may provide daytime shelter and forage and the cultivated land may witness conflict at night. Understanding landscape parameters such as the land use pattern, profile of human community and their socio-economic status in Mysore Forest Division helps in understanding human-elephant conflict in this division.

Mysore Forest Division

Earlier, Mysore Forest Division (MFD) was comprised of a much larger area including Yelandur Range, Srirangapatna Range, Metikuppe Range and Kakanakote Range. Subsequently, Srirangapatna Range was included in the Mandya Forest Division and during 1992, Yelandur was included in Chamarajanagar Wildlife Division. Metikuppe and Kakanakote ranges were included in Nagarhole National Park of Hunsur Wildlife Division. At present Mysore Forest Division is spread over parts of Mysore and Chamarajanagar districts (Srinivasan, 2002).

MFD is bounded on the north by Mysore City, on the east by Kollegal Forest Division, on the south by Bandipur National Park and on the west by Hunsur Territorial and Hunsur Wildlife Divisions. The tract under study lies between latitudes 11^{o} 48' to 12^{o} 22' N and between longitudes 76^{o} 15' to 77^{o} 8' E. The division has three sub-divisions, namely, HD Kote sub-division with headquarters at HD Kote, Mysore sub-division and Sandalkote sub-division both with headquarters at Mysore (Srinivasan, 2002).

Mysore division has the following ranges (Figure 1) under three sub-divisions

I. Mysore sub-division:
   i. Mysore range
   ii. Greening urban area range
   iii. T. Narasipura range

II. HD Kote sub-division
   i. HD Kote range
   ii. Sargur range
   iii. Nanjangud

III. Sandalkote sub-division consists of one Assistant Conservator of Forests, one Range Forest Officer and other field staff

The landscape around MFD has 2 main high density elephant habitats (Bandipur and Nagarhole) and the boundaries of MFD fall within these 2 habitats (AERCC, 1998). HD Kote, Nugu and Omkar region of Bandipur, Metikuppe region of Nagarhole form boundaries for Mysore Forest Division. Nugu Wildlife Sanctuary is situated north of Bandipur National Park (see Appendix 2 and 2a for the details of Bandipur and Rajiv Gandhi National Parks and Nugu Wildlife Sanctuary and some of the important mammals reported in the protected areas and Mysore Forest Division).

The forest boundaries of the protected areas adjoin human habitations and cultivated areas (Figure 2), and they in turn are connected by small hills (Figures 3a, b and c). Some of these small hills are found within 2-3 km intervals of the forest boundary.

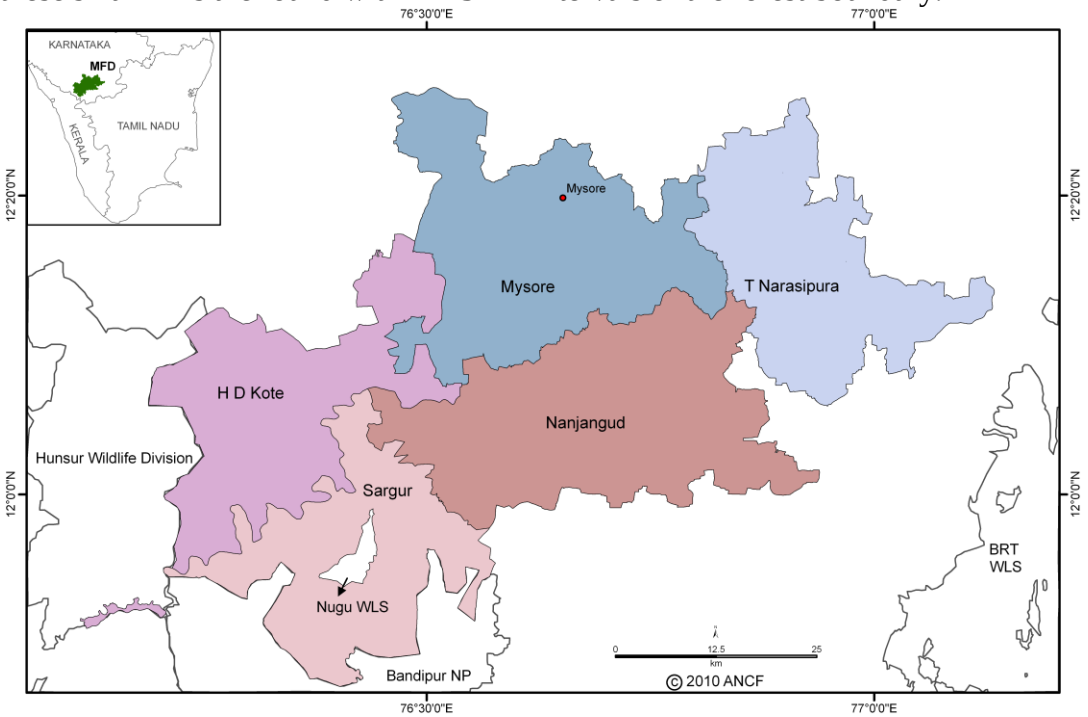


Figure 1: Map showing Mysore Forest Division (MFD), forest ranges within the division and national parks and wildlife sanctuary adjoining the division

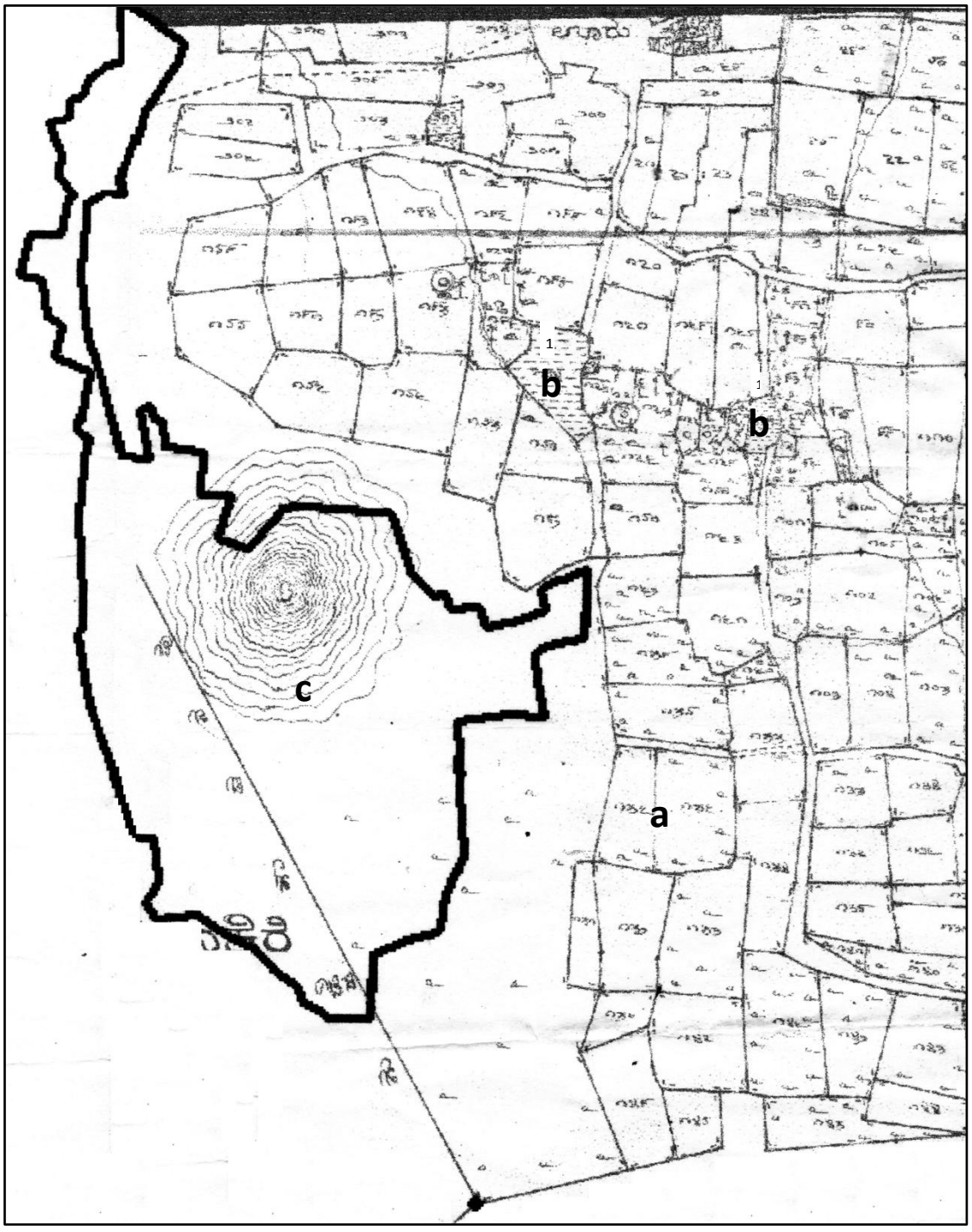


Figure 2: Cadastral map showing cultivation (a), water bodies (b)and small hill with its contour (c)

a

c

b

Figures 3a, b and c: Forest boundaries adjoining cultivated lands and human settlements

The hills fall into the category of land unsuitable for cultivation (Class D). Hills have primarily dry, scrub forest that has dry, thorny species. Xerophytes are also visible (Figures 4a, b and c).

a

c b

Figures 4a, b and c (clockwise): Forest status (a) presence of xerophytes (b) and cultivated lands around small hills within Mysore Forest Division (c)

In many cases, the hills are associated with temples (Figures 5a, b, c, d and e); notable among them are Chamundeshwari hill, Chikkadevamma Betta, Karyada gudda, etc. Towards the foothills of these hills, dry cultivation such as ragi (*Eleusine coracana)*, cotton (*Gossypium sp.)*, toor dal (*Cajanus cajan* - see Appendix 3 for the scientific names of the crops) etc., are seen (Srinivasan, 2002).

Geography

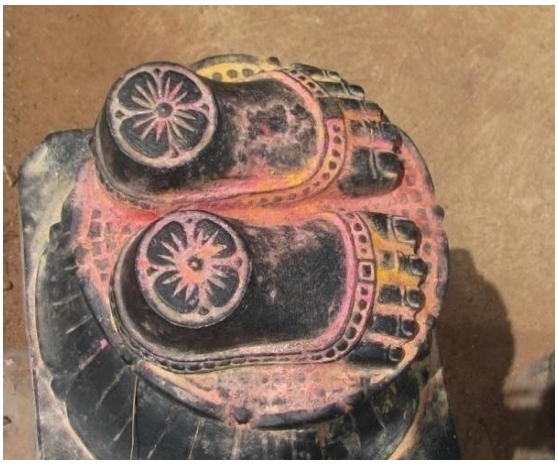
The terrain is generally undulating. Nearly the whole of the tract is negotiable by wheeled traffic. The highest point is about 1074 meters above mean sea level (at the highest point of Chamundi hills).

a

b

c

e



d

Figures 5a, b, c, d and e: Small hills and their associations with temples and other religious significances

The lowest altitude is 634 meters (Figure 6) above mean sea level (at Talakadu sand dunes (Kukkur locality)). The entire area drains into the Cauvery River through its tributaries. The soils are predominantly red loam and are derived from granites and gneisses and vary from pure sandy soils to typical black cotton soils. There are patches of schist in Tirumalkudlu Narasipura areas. HD Kote area is covered with red shallow gravelly soil. The summer season is from March to end of May and is followed by the southwest monsoon season that lasts up to the end of September. October and November may be termed as the retreating monsoon season.

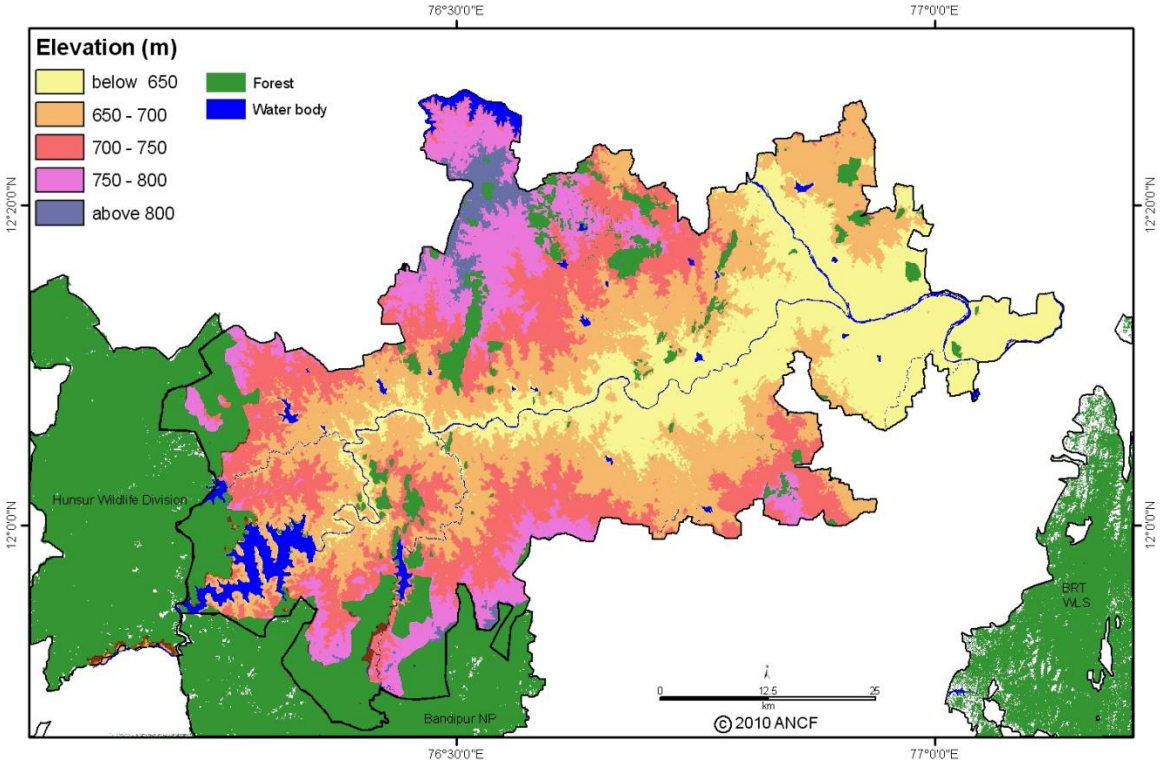


Figure 6: Map showing elevation ranges for Mysore Forest Division

The annual rainfall is 600 mm to 700 mm which is spread over a period of seven calendar months from the latter half of April to the end of October. October is the rainiest month (month of maximum rainfall). The rainfall received from June to September constitutes only 40% of the annual rainfall (Srinivasan, 2002).

a

b

Figures 7a and b: Examples of water body and water hole found in Mysore Forest Division

There are 3 main reservoirs (Figure 7a): Tharaka, Kabini and Nugu along with other small water bodies (lakes and ponds - figure 7b) such as Hebbala etc. throughout the Division. There is also the presence of Nugu and Kabini water channels (Figures 7c and d) flowing out of the reservoirs and passing through many villages. All the water bodies

are maintained by the inland water department. Nugu reservoir surrounded by mountains is in turn connected to Bandipur National Park (Srinivasan, 2002).

c

d

Figures 7c and d: Water channels and cultivation pattern around them

Vegetation types

The forests can be classified as dry deciduous forest and scrub forests.

I. Southern - Tropical dry deciduous forest (Group 4A-C2 of Champion and Seth)
II. Scrub forest (Group 5 Sub-group 5B-DS1)

Figure 8a: Tropical dry deciduous forest of the Mysore Forest Division

Southern tropical dry deciduous forest: This type of forest (Figure 8a) is confined to HD Kote range. This tract comprises of the following species, *Acacia catechu, Adina cordifolia, Anogeissus latifolia, Cassia fistula, Chloroxylon sp., Dendrocalamus strictus, Emblica officinalis, Randia dumetorum, Santalum album, Terminalia chebula, Zizyphus spp.* The rainfall received is mostly from southwest monsoon averaging 700 mm.

Scrub forest: This type of forest (Figure 8b) is found in HD Kote and Sargur ranges and some of the important species found in this forest type are *Acacia catechu, Albizzia*

Figure 8b: Scrub forest type found in Mysore Forest Division

odorotissima, Azadirachta indica, Cassia auriculata, Cassia fistula, Diospyros melanoxylon, Diospyros montana, Elaedendron glaucum, Gardenia gummifera, Madhuca indica, Santalum album, Terminalia chebula, Vitex altissima, Zizyphus xylopyrus and thorny species like *Pterolobium indicum* and *Randia dumetorum* (Srinivasan, 2002).

Landscape elements and land use pattern

Landscape elements classification based on satellite images for the purposes of this study region recognises four different categories (Figure 9): forests, water bodies, cropland and built-up areas.

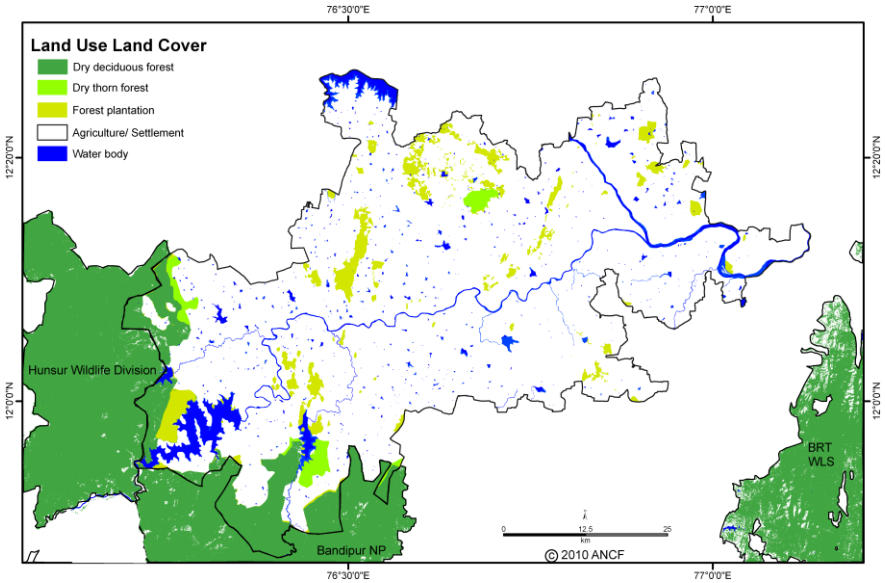


Figure 9: Landscape elements identified and their spread in Mysore Forest Division

As mentioned earlier, the forests include dry deciduous, scrub forests, scrub lands, forest blanks and plantation (mixed species, teak, acacia and eucalyptus). Water bodies are tanks, reservoirs, lakes and river islands. Croplands include agricultural plantation, horticulture croplands, and used or unused lands of mining and quarrying. The built-up areas are defined as areas with construction, primarily buildings or houses.

The extent of area for each landscape element is given in figure 10. Agricultural land covers about 78% of the land, forest constitute 12% and 6% water bodies and the details for other landscape elements are given in the figure 10.

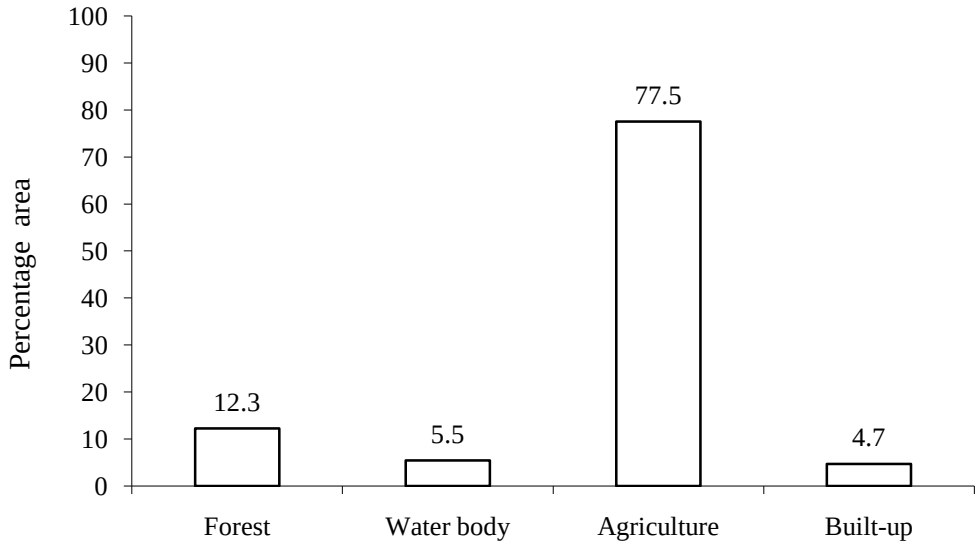


Figure 10: Major landscape elements reported for Mysore Forest Division

The classification of land use could be obtained for six regions of the Division. Details are given in Table 1.

Table 1: Percentage of landscape elements reported for 6 regions of the Mysore forest Division.

Type of landscape elements	HD Kote	Mysore	Nanjangud	Nugu	Sargur	T Narsipura
Forest	21.7	9.3	1.8	72.2	31.0	1.7
Water bodies	7.3	4.6	2.6	17.1	7.3	6.7
Agriculture	69.1	74.1	92.7	10.7	60.2	87.8
Built-up	1.9	12.1	2.9	0.0	1.6	3.8

Except in Nugu region, in all other regions agricultural lands dominate covering 60-93% of the land area. For HD Kote and Sargur, after agricultural lands, forests dominated

followed by water bodies. In Nanjangud, Mysore and T.Narsipura, the forest cover was small.

For all regions, the ratio of forest to agricultural land was biased towards agriculture except in the case of Nugu. The ratio of water to forest was biased towards water in Nanjangud and T.Narsipura (Table 2)

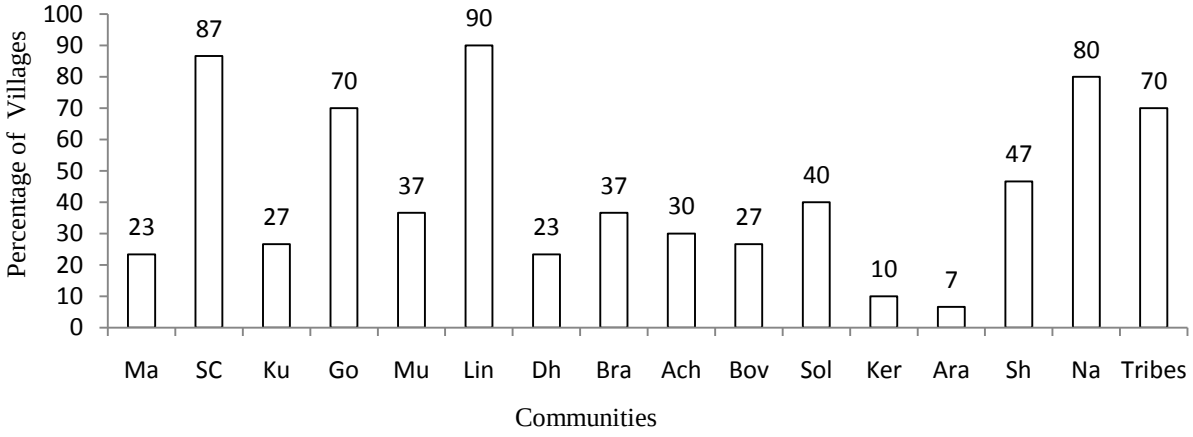
Table 2: Ratio of Forest to Agriculture and Water bodies to Forest in different regions of Mysore Forest Division

Ratio of landscape elements	HD Kote	Mysore	Nanjangud	Nugu	Sargur	T Narsipura
Forest: Agriculture	0.3	0.1	0.0	6.7	0.5	0.0
Water-body: Forest	0.3	0.5	1.4	0.2	0.2	3.9

Community profile

The survey recorded sixteen communities in the villages that fall within the Mysore Forest Division. The mean of the number of villages containing individuals belonging to a community was 13 (SE=2.09) ranging from 2 (7%) to 27 (90%) villages per community.

The Lingayats were found to be the dominant community (90% of the villages) followed by the Scheduled Caste (87%) and the Nayaks (80%). The Aradhyas were found in only 7% of the villages. The mean of number of communities present per village was 7(SE=0.6), ranging from 2 to 16 communities per village (Figure 11).



Ma - Madwa, SC - Scheduled Caste, Ku - Kuraba, Go - Gowda, Mu - Muslim, Lin - Lingayath, Dh - Dhobis, Bra - Brahmin, Ach - Achars, Bov - Bovis, Sol - Soligas, Ker - Keralites, Ara - Aradhya, Sh - Shetty, Na – Nayaks

Figure 11: Distribution of ethnic communities among villages of MFD

The village-wise distribution of the communities showed that HD Kote and Bheemanahalli contained individuals belonging to all the 17 communities whereas Bommanahalli (12%) contained individuals belonging to just 2 communities (Figure 12).

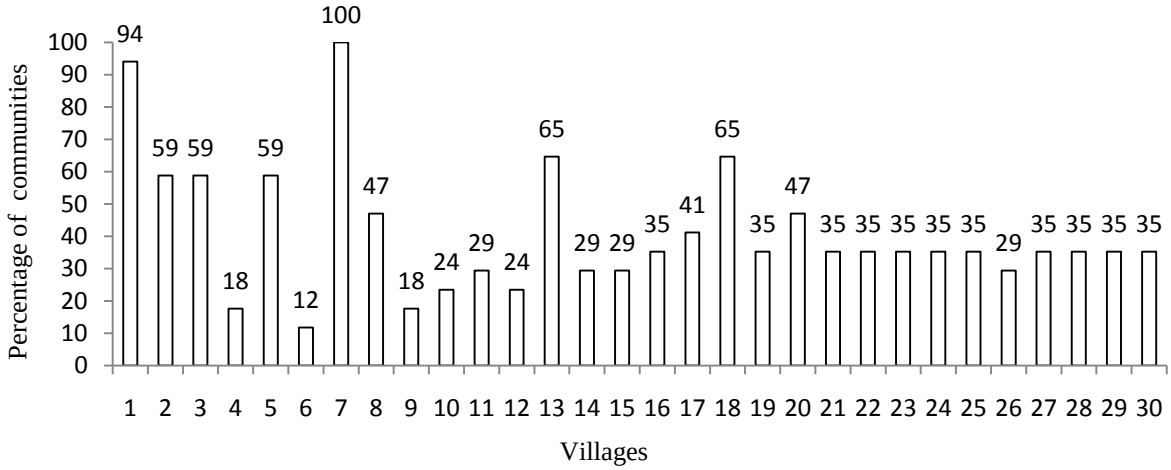


Figure 12: Percentage of communities per village (refer Appendix 4 for names of the villages)

Socio-economic profile of villagers

Dependents

Dependents per family ranged from 1 to 20 with 53% of the families having 6-10 dependents (Figure 13) per family and 31% of the families having 11-15 dependents per family.

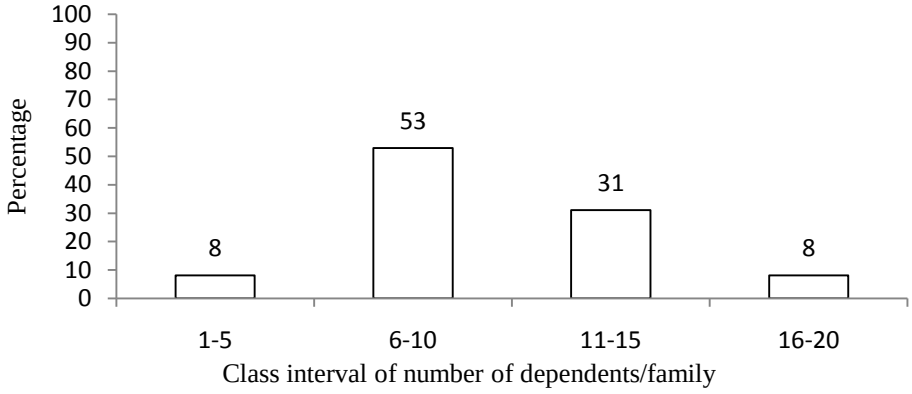


Figure 13: Dependents per family in villages selected for the survey in Mysore Forest Division

Sources of income

The major source of income of the villagers (79%) was through agriculture and 7% of the villagers had additional income based on daily wage work or by working in simple

salaried jobs (Figure 14). The villagers also obtained loans to buy inputs needed for agriculture (such as seeds, fertilizers, insecticides, etc.).

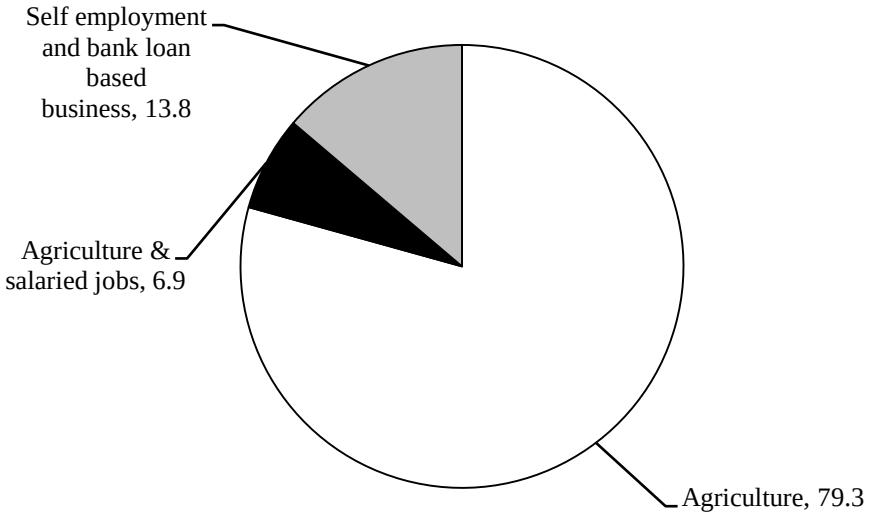


Figure 14: Source of income of the local community

Anthropogenic influences on the landscape

The landscape is dominated by red-grey exposed soil, gentle slopes and dry land cultivation such as ragi, coconut etc., cultivated in villages which are closer to the forests, generally within 2 km, due to water scarcity. The rainfall is around 600 to 700 mm in these areas, which are subject to occasional droughts. Borewell based areas and areas having reservoirs, lakes or ponds and water canals have cultivation based on irrigation (wet cultivation). The existing status of forest indicates that the forests have been subjected to excessive exploitation (Figures 15a and b) in the past due to their proximity to human habitation (Srinivasan, 2002).

a b

Figures 15a and b: Current status of forest in Mysore Forest Division; note the absence of tree cover

Tobacco cultivation needs a special mention here. According to the villagers, tobacco *Nicotiana tabacum)* entered the landscapes in the 1930s. About 2 tons of wood are needed to process an acre of tobacco. Currently, wood comes from depots in Hunsur and Mysore. According to local villagers, tobacco cultivation has damaged the fertility of the soil and lowered the water table. The Govt. of India established the Tobacco Board in 1975, with a view to bring about an all-round development of the tobacco industry. The support from the board through its branch in HD Kote range also promotes the cultivation of tobacco.

Forests and their related resources have been extensively used for tobacco processing (Figures 16a, b, c, d and e). Many of the villagers suggest that the extension of the tobacco cultivation, primarily motivated by the support from the Tobacco Board could adversely impact soil fertility, water resources, forest resources and thereby the economy of the farmers.

a

b

c

e

d

Figures 16a, b, c, d and e (clockwise): Tobacco cultivation (a), dependency on wood for processing tobacco (b, c, and e) and the status of forest around tobacco cultivation

Encroachment is one of the most important factors causing loss and damage to forests of the division. Release of large extents of forest areas in the past was the result of extreme pressure on land for cultivation. The villagers who are mainly agriculturists and agricultural labourers use the forests excessively to meet their various needs. The villagers cut both natural forests and plantations for their needs such as firewood (Figure 17a), wood for agricultural implements, construction wood for repair of their huts and for fencing. The forests are also subjected to illicit felling and smuggling activities by the surrounding villages. For example, during the study period it was noticed that a group of 8-10 people regularly entered the forest everyday for cutting and carrying firewood; 1-2 bullock cart load of fire wood/day or 5-7 vehicles/week carrying firewood and timber wood are reported to be seen coming out of the forests. Small hills around the human habitation are also not free from degradation; this is also due to the low rainfall and the extensive use of natural resources of the hills by the villagers for cattle grazing (Figure 17b) and due to indiscriminate collection of forest products. Earlier, unchecked charcoal operations were also carried out here. In general, forests along the village boundaries are degraded and devoid of mature trees. Forest patches have bamboo clumps or one or two big trees. Otherwise, the land is barren with vast areas having woody plants and scrub. Growth of small bamboo (*Dendrocalamus strictus*) has been badly affected due to biotic interference (Srinivasan, 2002).

a b

Figures 17a and b: Dependency on forest for various purposes; forest products (a) and for cattle grazing (b)

With the increase of livestock and the conversion of grazing lands for farming and other purposes, forest lands are under a lot of pressure and are facing serious grazing problems. Graziers, cart-men, honey collectors and poachers cause damage to the forests by setting fire within forest limits. The cattle population is more than twice that of the human population in some villages, especially in the areas adjacent to forests/plantations where cattle are left for free grazing. Most of these cattle are dry and are reared for cow dung to be sold as manure in the adjacent States. A large number of cattle regularly enter the forest and as a consequence the trenches are destroyed. The compaction of the soil due to frequent trampling leads to erosion of the topsoil and also does not allow any regeneration. Due to overgrazing and intermittent fires, natural regeneration is very poor.

Conclusion

The presence of forests (12% of Division area) and water bodies (6%) may be largely responsible for inducing conflict in the cropland which covers 78% of the total area. This forest cover acts as an important shelter for elephants. In addition to the extent of areas of forests and water bodies, the distribution of these two important landscape elements influences the status of conflict. Given the combination of the highest level of forests and water bodies, it is expected that Nugu region will have the highest level of conflict followed by Sargur and HD Kote. In Sargur region, the availability of forests and small hills may induce conflict there. Even with relatively low forest cover, the presence of water bodies in Nanjungud, Mysore and T.Narsipura may play a role in conflict. Nanjungud and T.Narsipura have relatively low forest cover. Contiguity of these regions with their respective landscape elements of forests, water bodies and croplands may also further influence conflict status in MFD.

In aggregate terms, small farmers own a larger percentage of the landscape. Most of their land comes under 'infertile land' status. Crops are cultivated only based on seasonal rains (rain fed crops). Rainfall is relatively low; their crops are attacked by elephants and other wildlife. Influence of agricultural practices from Kerala is evident. Kerala farmers have taken land for lease from the local farmers to grow ginger (*Zingiber officinale*). In Kerala, ginger cultivation is affected by fungal disease; so this cultivation practice is being increasingly adopted in parts of Karnataka. However, the impact of ginger cultivation on the fertility of dry land is not known.

Overall, people depend on forests for firewood, for construction wood for tobacco processing and cattle grazing. Submerging of forests to create reservoirs also has reduced the extent and quality of forests serving as wildlife habitats. Overall economy of the villagers, primarily farmers, is greatly influenced by current land use practices. The economy of the farmers is oriented towards paying of loans and the marriage expenses of their daughters. Both the marriage expenses and money needed for cultivation are through loans. Cultivation is managed by loans through banks or societies or loans from richer farmers. The income from agriculture is used to repay loans and enable sustenance. Health conditions appear to be poor and communities live surrounded by unhygienic conditions. This is primarily due to poor drainage, sewage and sanitation system and lack of knowledge of the importance of hygiene. The social, economic and cultural influences weigh heavily on the nature of response that the farming community makes in regard to the problem of human-elephant conflict.

Section IV:
Status of Elephants in Mysore Forest Division

Background

South India supports around 10,000 elephants (about 50% of the Indian population of Asian elephants and 20% of the global Asian elephant population) in the wild (Directorate of Project Elephant, 2008). A substantial part of the elephant habitat of southern India falls under the Nilgiris and Eastern Ghats Elephant Reserve (Alva, 1994; AERCC, 1988; Directorate of Project Elephant, 2009). This elephant reserve has the highest elephant density regions of the world including the Rajiv Gandhi National Park and the Bandipur National Park (Sukumar, 1989; AERCC, 1998; CES, 2010). The eastern part of the Rajiv Gandhi National Park and northern part of Bandipur National Park have a common boundary with the Mysore Territorial Forest Division (known as Mysore Forest Division–MFD, Srinivasan, 2002). Elephants from these two protected areas move into the MFD to use the forest cover and also to visit villages located along the boundaries of the protected areas and the territorial forest division. The MFD, except for having forest cover along the protected area and other small patches in the hills, does not have a large and continuous forest cover to support a large number of elephants. The forest cover within the Division is under tremendous anthropogenic pressure (Srinivasan, 2002). Elephants appear to use this forest only as a daytime shelter and at night they visit villages for raiding crops.

Given the existing forest cover, networks of reservoirs, water canals and ponds (within the village limits) the crops cultivated based on these water sources are important factors inducing elephants to use this landscape. However, there is no scientific study available on the number of elephants using the landscape and the damage to cropland. No reliable estimates of the animals found in the Division are available. What information is available comes only from farmers or forest staff or the indirect signs encountered. Four synchronized elephant censuses that were carried out in 2002, 2005, 2007 and 2010 by the Project Elephant, Ministry of Environment and Forests (MoEF), Government India (AERCC, 2002, AERCC, 2006, ANCF, 2007, CES, 2010), are the only other sources of information about the species. The elephants are found in all the five ranges of the Division. Three ranges do not have forest cover and elephants visit these villages only for raiding crops. The census operations have been carried out only in two ranges. The information obtained from these operations and from observing the encounter rates of elephant dung piles provide some data on location specific elephant density (in specific years) and some details on population demography.

Elephant number and distribution

Elephant number estimated through census operations

In May 2010, the MFD was part of the synchronized elephant census. Sample blocks were selected for block count, line transect indirect dung count and waterhole count were carried out in HD Kote and Sargur ranges. For the block count a total of 7 blocks covering an area of 29.7 km^2 was selected. Out of 7 blocks, 4 blocks covering Sollepura beats A and B, Rajegowdanahundi and Edathore (also known as Yadathore) near

Nanjenayakanahalli (also known as N.N.Halli) encountered a total of 9 elephants. Of the 9 elephants, 5 were adult males, 1 was a sub-adult male and 2 were adult females. During the water hole count, 10 elephants were encountered in 4 waterholes (out of 5 waterholes selected). The waterhole count was also biased to adult males and seven adult males and 3 adult females were counted during this operation.

During the line transect indirect count, at five locations (or transects) elephant dung piles were encountered. Only near B.R.Katte and Sollepura fresh dung piles were observed indicating the presence of elephants during the census period. Encounter rate of dung piles/km ranged from 3 to 7 dung piles/km with a mean of 7.9 (SE=2.5, N=5). Elephant dung encounter rates calculated based on information from 4 synchronised censuses (2002, 2005, 2007 and 2010) are given in table 1.

Over all, mean elephant dung encounter rates for 10 locations estimated by indirect dung count showed that these varied from 3 to 20.8 dung piles/km and across the years it ranged from 3.5 to 34.5/km. Locations such as Kottenahalli, near Basavarajanakatte (also known as B.R Katte) and Sollepura beat showed more dung piles, and elephants seem to be using these locations more.

Table 1: Encounter rate (Er) of dung piles/km estimated during 4 synchronised elephant census operations (2002, 2005, 2007 and 2010). Estimates are based on line transect indirect dung count method

Locations	**Encounter rate (Er) of dung piles/km**				**Mean**
	2002	**2005**	**2007**	**2010**	**Er (per km)**
Hunasanahally	6.5	13.5	3.5	3.5	6.8
Kamarivada				6.5	6.5
Kothanahalli	7.0	34.5			20.8
Lanke			4.0		4.0
Near B.R.Katte				17.0	17.0
Rajendrahadi				3.0	3.0
Sargur			5.5		5.5
Sollepura			8.5	10.5	9.5
Sollepura A	3.5				3.5
Sollepura B	7.5	20.5	24.0		17.3

The block count method used for four synchronized census operations for two different ranges of Mysore forest division suggests that elephants are directly sighted in 8 different locations across the years. Elephant density for specific locations ranged from 0.1 to 2 elephants/km^2 with the mean density of 0.5 (SE=0.1, N=15).

Locations or beats such as Heguadilu (Sargur beat), Sollepura B and Hunasehalli showed more elephants. Number of elephants sighted across the locations and years ranged from 1 to 24 animals with the mean group size of 5.5 (SE=1.3, N=15) animals. More

frequently encountered elephants were solitary followed by three individuals together (Table 2).

Table 2: Location of elephants sighted, area of beat or block, group size and elephant density (in /km^2) per location arrived at based on the block count method during 4 synchronised elephant census operations (2002, 2005, 2007 and 2010).

Year	Sl. No.	Range	Name of the Beat	Area	No. of elephants	Elephant density (in per km^2)
2002	1	HD Kote	Sollepura A Beat	22.2	7	0.3
	2	HD Kote	Sollepura B Beat	24.6	6	0.2
	3	Sargur	Nagapura beat III	14.1	5	0.4
	4	Sargur	Heguadilu (Sargur beat)	5.4	10	1.9
2005	5	HD Kote	Sollepura A Beat	19.2	7	0.4
	6	HD Kote	Sollepura B Beat	24.6	3	0.1
	7	Sargur	Chikkadevamma Betta Forest	9.6	1	0.1
2007	8	HD Kote	Sollepura A Beat	19.2	7	0.4
	9	HD Kote	Sollepura B Beat	24.8	24	1.0
	10	Sargur	Hunasehalli Beat	4.6	3	0.7
2010	11	HD Kote	Sollepura		4	
	12	HD Kote			2	
	13	HD Kote	Sollepura	10.0	1	0.1
	14	HD Kote	Rajegowdana hundi	4.8	1	0.2
	15	HD Kote	Edathore (near N.N.Halli)		1	
				Mean	5.5	0.5
				SE	1.3	0.1

Data on elephants sighted during the waterhole count in different waterholes in Mysore Forest Division during 4 synchronized elephant census operations (2002, 2005, 2007 and 2010) are presented in the table 3. Total number of elephants that visited waterholes ranged from 2 to 28 animals, and more elephants visited the waterhole located in Sollepura beat B. Results of block count, line transect indirect count and waterhole count suggest this region to be an important location for elephants of the Division.

Table 3: Age & sex classification of elephants sighted at waterholes during 4 synchronized elephant census operations (2002, 2005, 2007 and 2010).

		Age and Sex classification							
Year	**Name of the location**	**AM**	**AF**	**SAM**	**SAF**	**JM**	**JF**	**Calf**	**Total**
2002	*	10	12					6	28
2005	Hebella		1					1	2
	*	4	5					2	11
2007	Sollepura A	2	1	2	1			1	7
	Sollepura B	4	5	2	4	3	4	2	24
	Hunasehalli	2	1	0					3
	Hebella	2	2	1	2		1		8
2010	*	6	13						19
	Sathe katte		2						2
	*	2							2
	Hoodapura katte	2	1						3
	Gurugal	3							3

AM: Adult Male, AF: Adult Female, SAM: Sub-adult Male, SAF: Sub-adult female, JM: Juvenile Male, JF: Juvenile Female, *Names of the locations are not available

Range wise elephant distribution

Range wise elephant distribution or habitat use by elephants across the years indicate that, the encounter rate of dung piles, estimated by line transect indirect count method was consistently high for HD Kote range, except for the year 2002. The encounter rate ranged from 4.5 to 37 dung piles/km for this range, while it was from 4.3 to 24 dung piles/km for Sargur range (Figure 1).

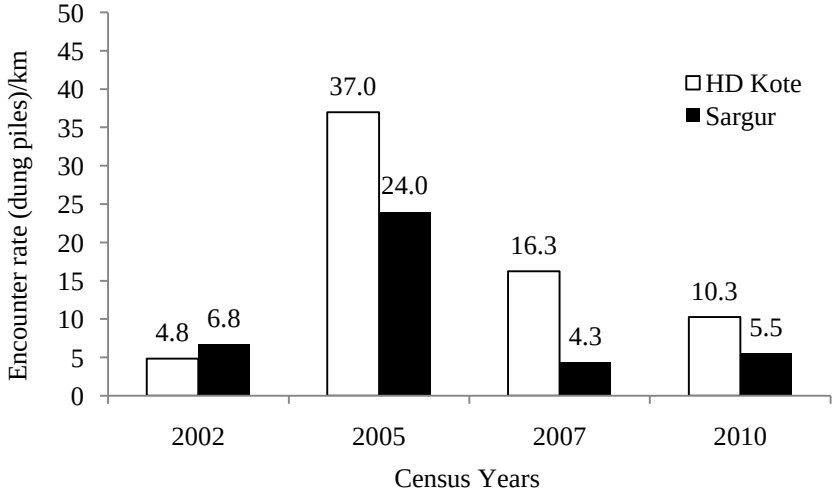


Figure 1: Encounter rate of dung piles estimated across years for different ranges in Mysore Forest Division

Elephant density

Elephant density estimated for the Division based on the synchronized censuses range from 0.1 to 0.65 elephants/km^2 (Table 4). This translates to 19 to 208 elephants for the division. Number of elephants estimated by the Karnataka Forest Department (KFD) for 2007 appeared to be on the higher side. This may be due to the differences observed in the elephant numbers or total area reported across the years. If the area figure of 2010 is used with the estimated density figure of 2007 to calculate total number of elephants, then a total of 61 elephants could be estimated for the year 2007. With this approach, a number ranging from 20 to 90 elephants could be estimated for the Division.

Table 4: Census estimates of elephant density in Mysore Forest Division

Year	Area sampled km^2 (No of block sampled)	Number of elephants counted	Total area km^2	Mean density/km^2	Total number estimated	Lower confidence Level (LCL)	Upper confidence interval (UCL)
2002	* (12)	72	104	0.65	68	49	87
2005	67 (4)	11	132	0.16	17	11	47
2007	57 (5)	34	177	0.59	105	34	208
2010	146 (7)	9	146	0.1	11	3	19

*: detail on area for 2002 not available

Elephant numbers reported by villagers and forest staff

According to both forest staff and the farmers who were interviewed, more frequently seen elephant groups appeared to be in groups of 2, 10 and 15, followed by single individuals or groups of 3, 7, 20 and 30. Group size of 5, 6, 40 and 60 were also reported but they were relatively less encountered groups in the village limits. Overall, elephants reported in this region are of 1, 2, 3, 7, 10, 15, 20, 30, 40 individuals. Groups of 30-35 elephants were seen 4-5 times in a year.

Elephant deaths

A total of 27 elephants have died from 2004 to 2009. Among them 59% (16) deaths were due to conflict-related causes that included: poisoning, electrocution and gun shot. Overall deaths (including from conflict) was biased towards males (59%) and data on age of elephants dead was available for only 9 male and 2 female elephants (out of 27).Their age class ranged from 5 to 30 years. Data on conflict related deaths suggest that more male elephants die, and the age classes of male elephants killed due to conflict ranged from 6 to 30 years. It can be seen from figure 2 that since 2008 more elephants have died due to conflict related causes. For two male elephants dead in 2009, the cause of death has been reported as poaching (killed for tusks); however it is suspected that these animals died due to other conflict related causes, and the tusks were later removed by some people.

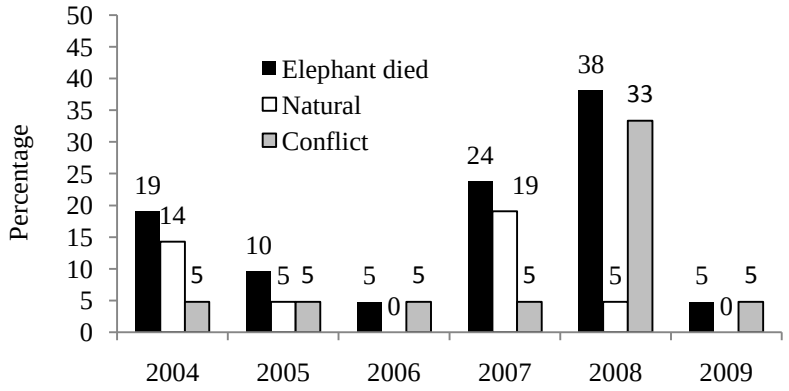


Figure 2: Elephant deaths reported across different years in Mysore Forest Division
(Data source: Mysore Forest Division)

Conclusion

Except for the information from elephant census operations, no systematic scientific knowledge on the elephants of MFD is available. It is important to note that census operations are carried out by volunteers and ground staff and their knowledge about the species, interest in rigorously following the methodology provided are some of the important factors that determine the reliability of numbers. However, during the elephant census operations, the maximum number of animals sighted in a single group was 24 and more frequently sighted group numbers were 1, 3 and 7. Group sizes of 10 and 24 were seen only once. However, if both waterhole and block count estimates are pooled together, frequently seen group numbers are 3, followed by 2. The maximum number of animals seen goes up to 28. Interestingly, details obtained from farmers or forest staff indicate that the numbers go up to 60-70 individuals in a group. This has been confirmed by photographic evidence.

It was reported to the ANCF research team that, during the summer (May), only small numbers of elephants with a maximum of three individuals use this landscape frequently. This may be also related to cropping patterns. The landscape is dominated by rain fed crops and number of elephants visiting croplands during summer (when rainfall is low) will be very low. The conflict is reported throughout the year and during the peak conflict season (October to January) the elephant numbers reported in the villages within the Mysore Forest Division go up to 60 to 70 individuals. These numbers originate from the two important protected areas that adjoins the MFD. Deaths of wild elephants due to conflict with humans appear to be more than deaths from natural causes, especially in the case of males. Effective conflict mitigation measures could also prevent the death of elephants and provide scope for maintaining viable population (Sukumar, 1989; Bhaskaran and Desai, 2000; Arivazhagan, 2005) in Bandipur and Rajiv Gandhi National Parks, the two important high density elephant protected areas of the world.

Section V:
Status of Human-Elephant Conflict
Part 1:
Insights from Compensation Payment Records

Background

Comprehensive information on the nature and scope of human-elephant conflict in a given forest region or division is vital for conservation planning for the region or division (Blair, et al., 1979; Barnes, et al., 1995; Tchamba, 1996; Nath and Sukumar, 1998; Newmark and Hough, 2000; Rajeev, 2002; Prabal, et al., 2008). This information could be obtained through a number of approaches. The forest department maintains systematic records on the status of villages that are affected by elephants or other wildlife and such records provide many insights into the problem (Nath and Sukumar, 1998; Prabal, et al., 2008). For example, five years of conflict records provide information on about 15000 incidents of such conflict. It provides scope for identifying villages that are most affected and their spatial distribution in relation to other landscape elements of the Division. Other information that can be derived from the data include the distance elephants travel from forest to croplands, extent of property damage, human injury and deaths by elephant, elephant deaths due to electrocution, poisoning or gunshot and the pattern of visits of elephants (Nath and Sukumar, 1998; Rajeev, 2002; Varma, and Prabal, 2008).

However, it is important to note that the quality or reliability of records are influenced by a number of factors having to do with the applications for compensation and recording of case details. This process sometimes results in a reluctance of communities to apply for compensation to the Forest Department. Despite this, it is observed that the major proportion of villages that experience conflict approach the forest department for compensation (Prabal, et al., 2008; Varma and Prabal, 2008). In applications there may be discrepancies or exaggerations of the amount claimed. However, it is unlikely that there is manipulation in the details of incidents occurring for each village, crop and season. Very rarely are incidents that have not occurred reported. Even with 80% reliability the specific patterns could be derived that could be used in designing conflict mitigation strategies.

Villages affected by the human-elephant conflict issue

Compensation records studied for the patterns of elephant visits indicate that a total of 141 villages reported conflict (from 2004 to 2008; see Appendix 5 for the details of villages and crop damage incidents across the years), ranging from 75 to 105 villages per year with a mean of 81 (SE= 6.1, N= 5) villages.

Total number of incidents of crop damage for five years was 14,879 (See Appendix 5). Mean number of incidents of crop damage per year was 2972 (SE= 453.1, N=5) and it ranged from 1886 to 4293. Mean number of incidents reported per village per year ranged from 23 to 39 (Figure 1).

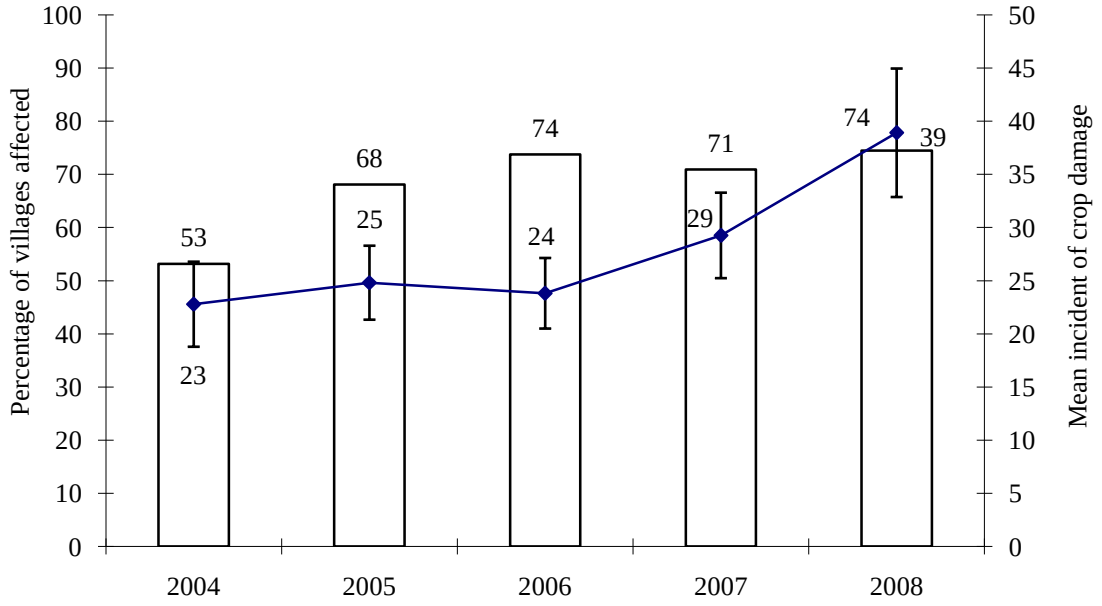


Figure 1: Crop damage incidents across the years in Mysore Forest Division

There has been a steady increase in percentage of villages affected since 2004. Although the mean number of incidents of damage per village in 2008 is seen as greater than that of 2004, the result of increase or decrease of incidents across the years may not be statistically significant. Across the 5 years, 58 villages reported conflict every year (41% of all villages that have reported conflict). The distance from the forest to these villages ranged from 0 to 10 (with a mean of 2.6 (SE=0.24)) km and 57% of the villages fall within the range of 0 to 2 km. Among 58 villages, villages that report mean of above 100 incidents/ year fall within 0 to 4 km from the forest and 0 to 2 km from water bodies.

Eighty per cent of villages fall within 0 to 2 km of the forest and all the villages fall within 0 to 2 km from the water. The spatial distributions of the villages that are affected by crop damage incidents every year (Figure 2a) and across the years are given in figure 2b.

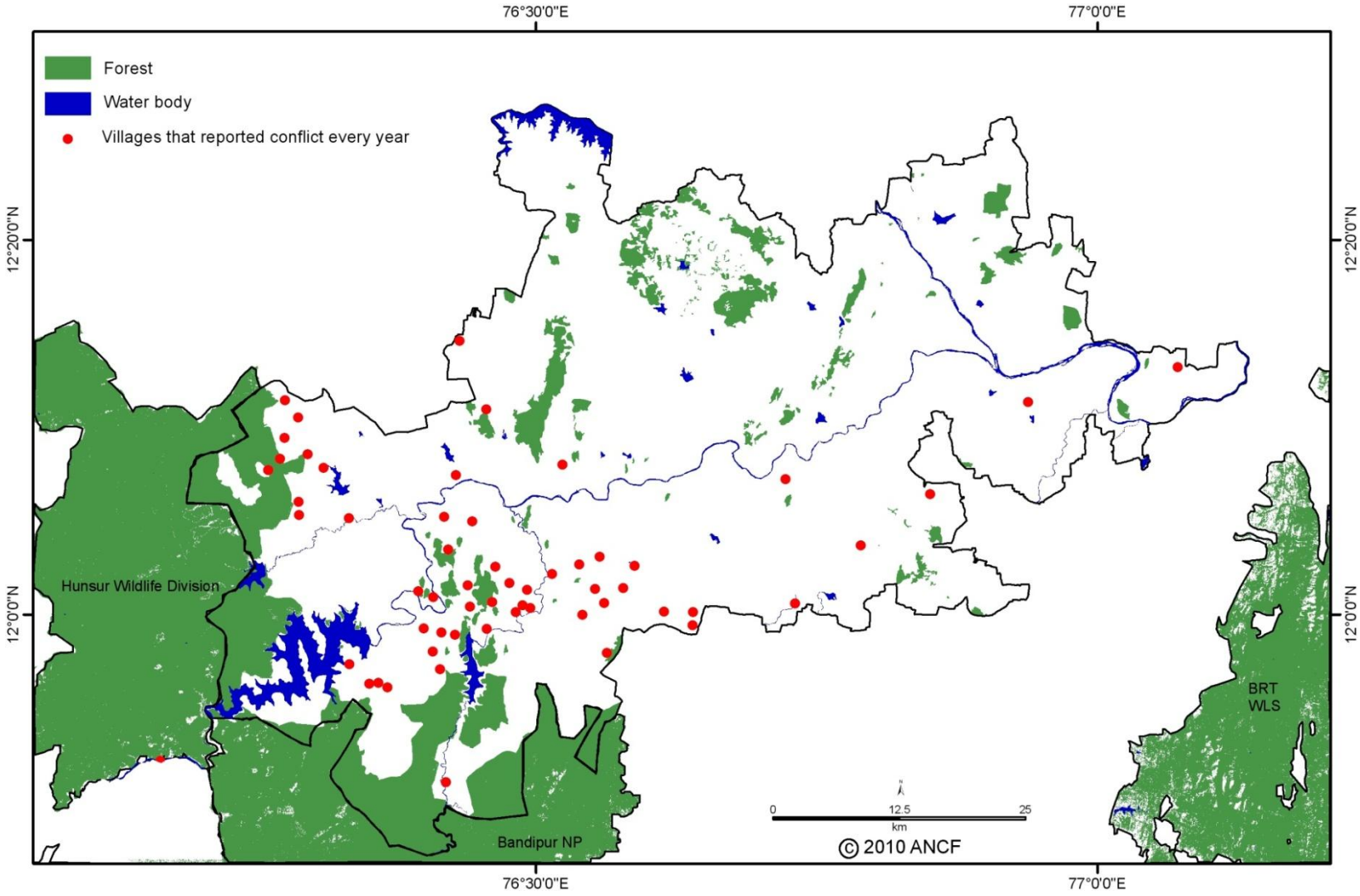
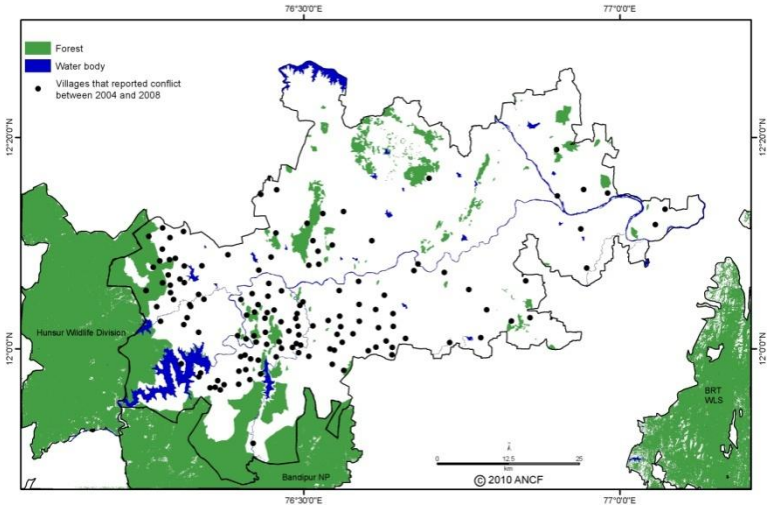


Figure 2a: Map showing the spatial distribution of villages that reported crop damage incidents every year



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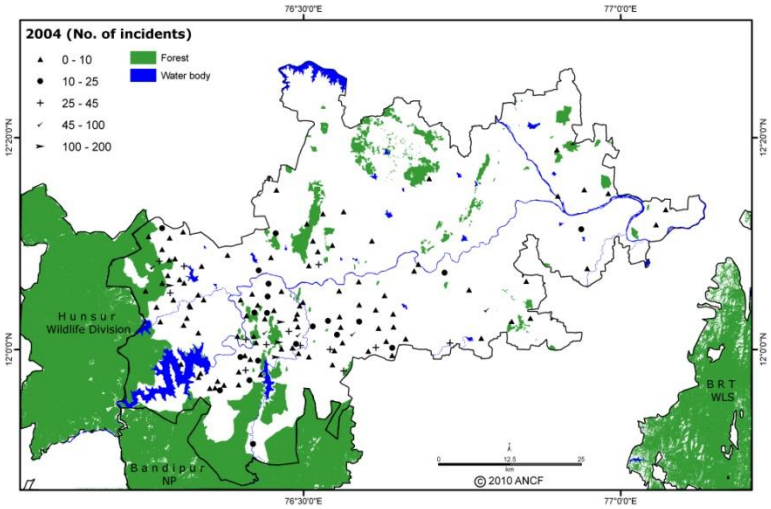

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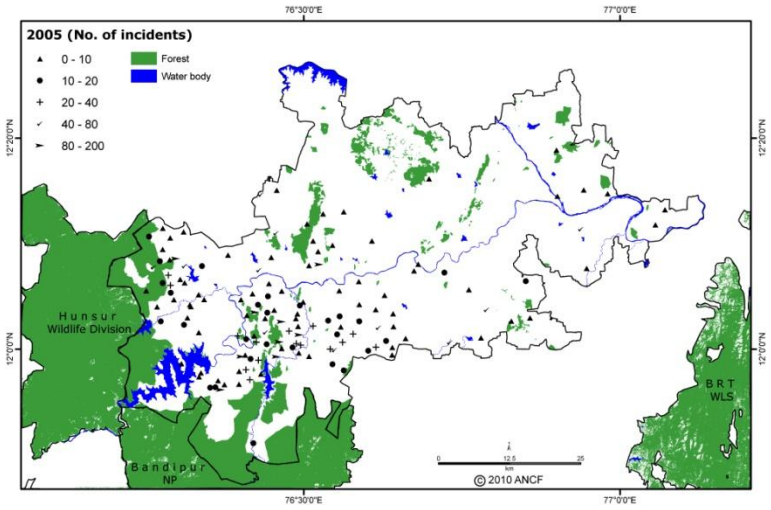

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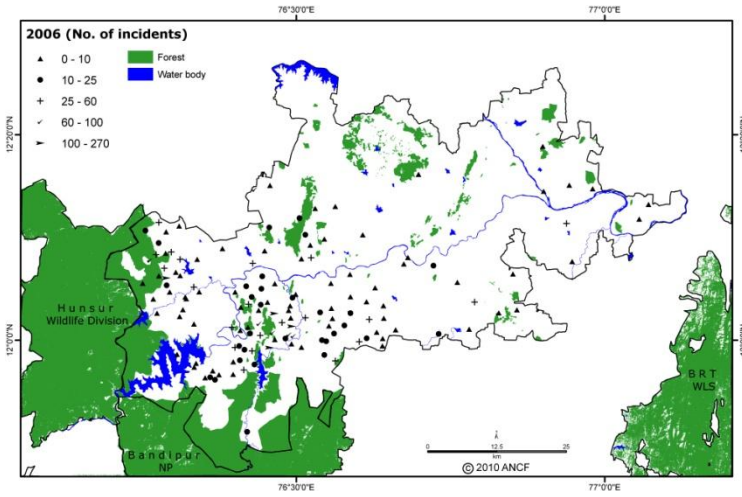
Figures 2b, c, and d: Maps showing the incidents of crop damage from 2004 to 2008 (b), during 2004 (c) and 2005 (d)



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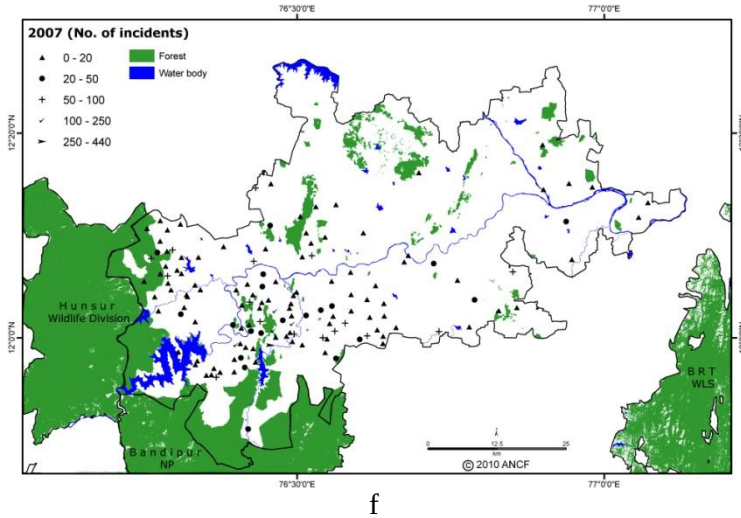

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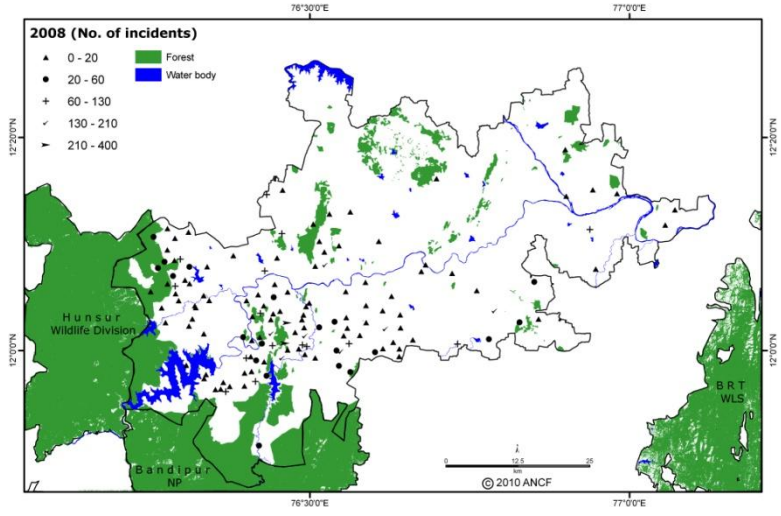
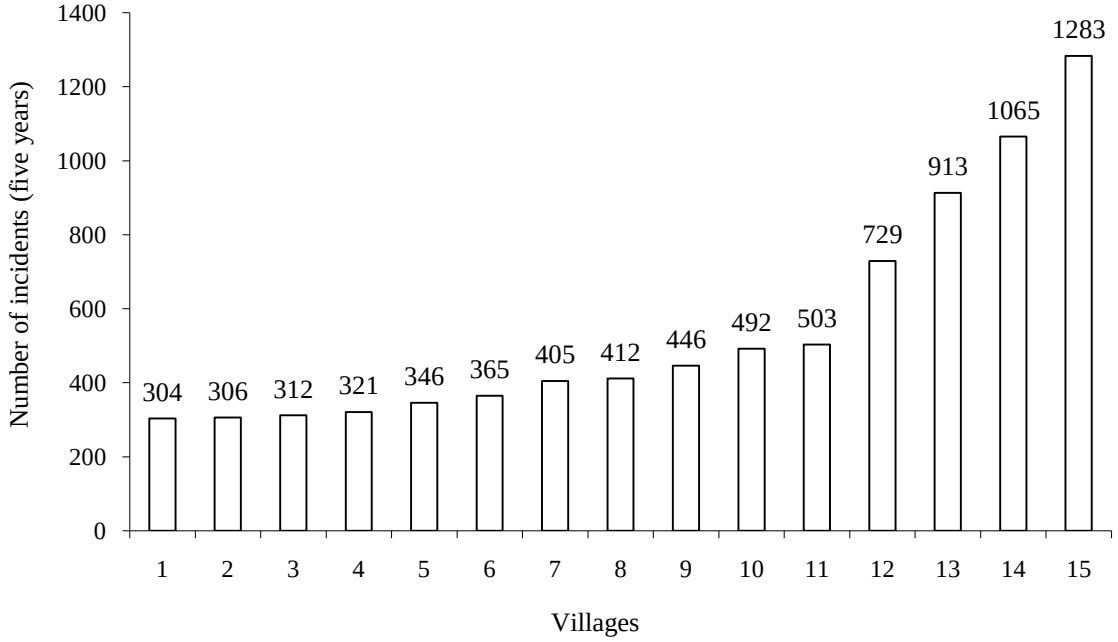


g

Figures 2 e, f and g: Maps showing the incidents of crop damage during 2006 (e), 2007 (f) and 2008 (g)

As mentioned elsewhere, all the years together, a total of 141 villages reported crop damage incidents. Figures 2c, d, e, f, and g give the details of the spatial distribution of all the villages that report crop damage incidents all the years together and across the years.

The number of incidents across the villages that were affected all the five years ranged from 13 to 1283 with a mean of 225 (SE=34, N=58). Halasur (1283) was affected the most followed by Lanke (1065), Huvinkala (913), Katte Hunsuru (729), Chakgaudanahalli (503), Hunsahalli (492), Managanahalli (446). The patterns for the other villages are given in figure 3.



1: Kalihundi, 2: Nanjapura, 3: Hunuganahalli, 4: Hegganuru, 5: Kothegala, 6: Bhudanur, 7: Sargur, 8: Depegowdanapura, 9: Managanahalli, 10: Hunasehalli, 11: Chakgaudanahalli, 12: Katte Hunsuru, 13: Huvinkala, 14: Lanke, 15: Halasur

Figure 3: Number of incidents reported for some of the villages that encountered conflict every year between 2004 and 2008 in Mysore Forest Division

However, the appropriate way of identifying the villages that are most affected would be to determine the total area occupied by all crops and area occupied by specific crops cultivated in a given village and assessing the extent of damage to the crops in each village. Such details for each village are currently not available. In the absence of the data on the total area of crop lands, the data available for total area of each village is used to compare the relative extent of damage of crop for each village.

The result suggests that Halasur is affected most by the incidents of elephant related crop damage, followed by Hunasehalli, Kothegala and Lanke. Details for other villages are

given in table 1. It should be noted that, even with just the data on number of incidents, Halasur is affected the most.

Table 1: Details of villages affected by crop damages in Mysore Forest Division

Sl.no	Village	Area of village (km^2)	Total number of incidents for 5 years	Crop damaged/km^2
1	Depegowdanapura	10.5	412	39.3
2	Hegganuru	6.6	321	48.3
3	Sargur	8.1	405	50.0
4	Huvinkala	11.9	913	76.6
5	Kalihundi	3.6	304	84.9
6	Bhudanur	4.1	365	89.9
7	Managanahalli	4.7	446	94.5
8	Chakgaudanahalli	4.9	503	101.9
9	Hunuganahalli	3.0	312	103.9
10	Nanjapura	2.1	306	147.9
11	Katte Hunsuru	4.9	729	149.2
12	Lanke	6.9	1065	154.0
13	Kothegala	2.2	346	156.0
14	Hunasehalli	3.2	492	156.1
15	Halasur	6.4	1283	199.3

It should be noted that the area calculated for each village may include other land use elements of the villages, and it may not provide the actual area of crop land cultivated for each village.

Elephant visit to the crop fields in relation to the distance from the forests

The elephants move up to 10 km from the forest, with a mean distance of 3 km (SE=0.18, n=140) ranging from 0-10 km. The distance range of 1-2 km shows highest incidents of damage followed by 3-4 km and 2-3 km. About 70% of the visits fall within 4 km (Figures 4a and b).

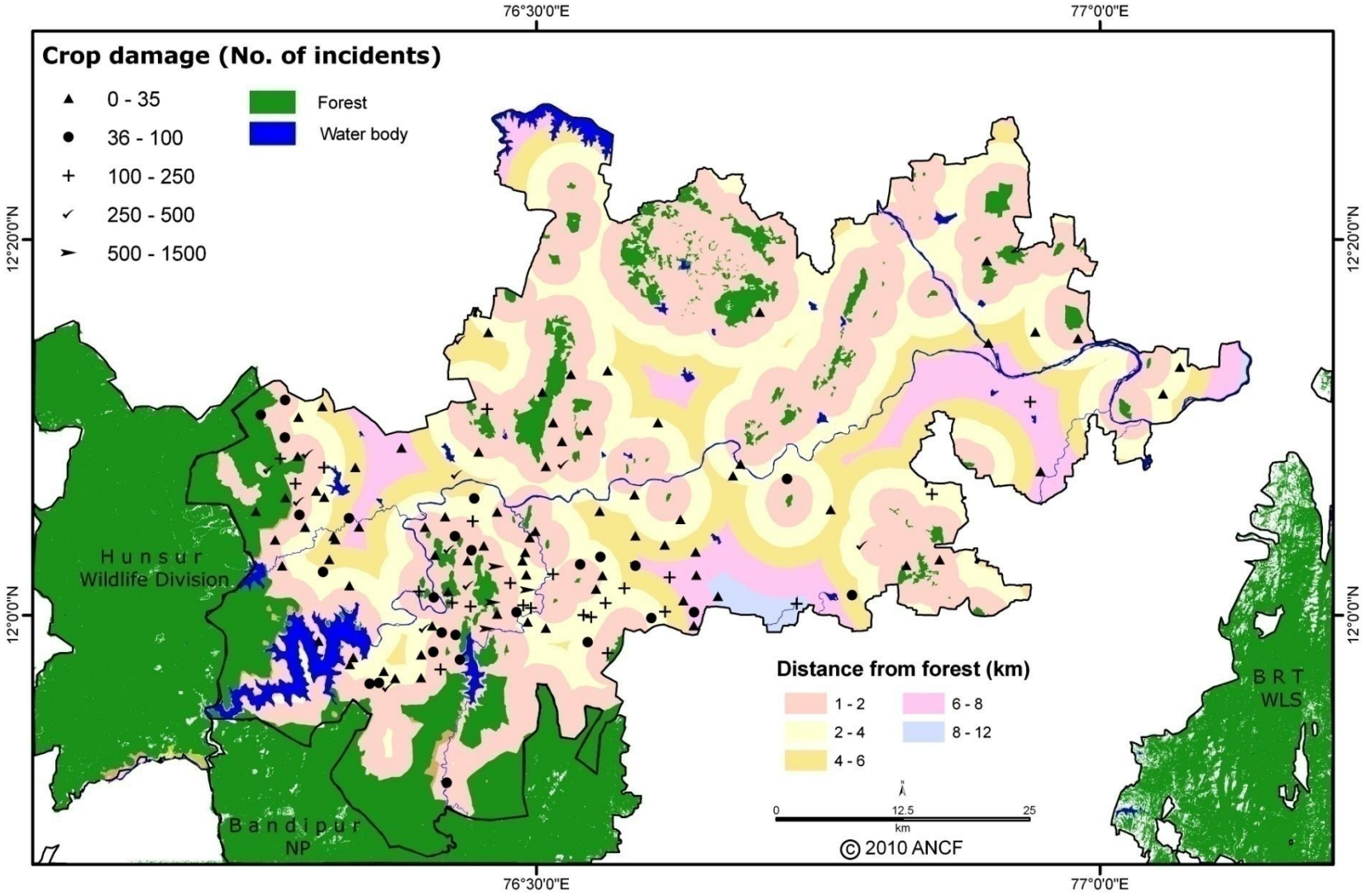


Figure 4a: Map showing distances from forest to villages that report conflict incidents in Mysore Forest Division

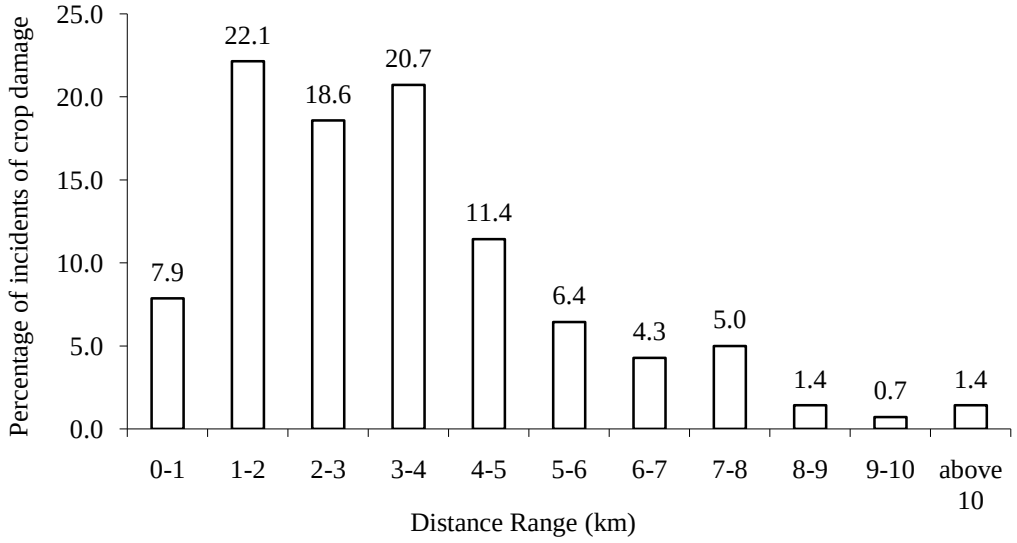


Figure 4b: Percentage of incidents of elephant damage to crop reported across different distances

Figure 5 attempts to draw out the correlation between the distance traveled by elephants from the forest and the number of incidents. It is evident from the figure that almost all the incidents fall within the range of 1-500. There may not be any significant correlation between the distance traveled by the elephant and number of conflict incidents.

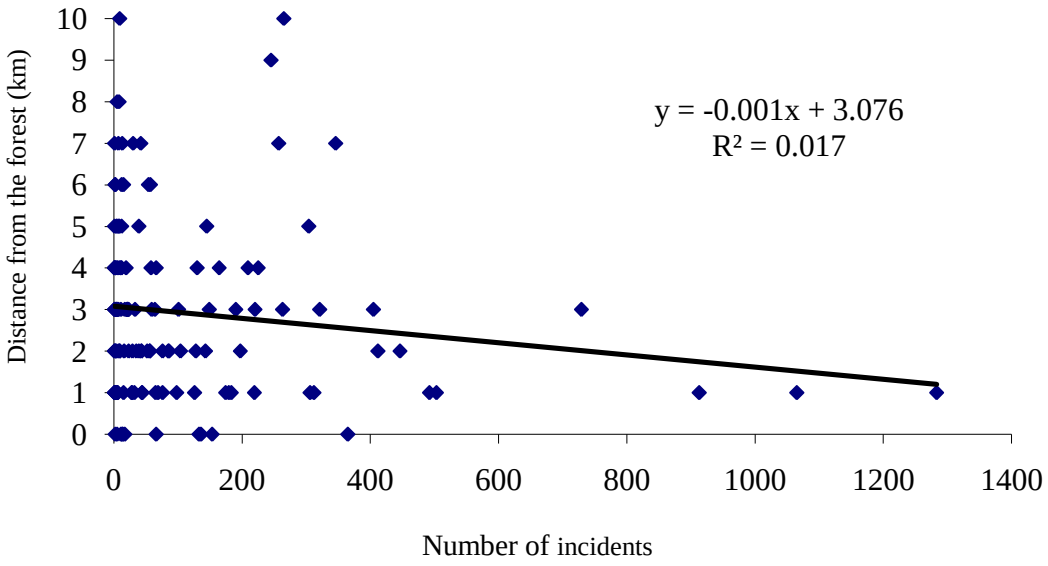


Figure 5: Relationship between number of incidents of crop damage and the distance from forest

The mean numbers of incidents along with higher and lower values are given in table 2. It is also evident from table 2 that the mean number of incidents at 1-2 km was highest followed by 7-8 km and 3-4 km.

Table 2: The mean numbers of incidents of crop damage (higher and lower values) reported across different distances from the forest

Distance Range (km)	Mean number of incidents	SE*	L*	U*
0-1	83.2	34.9	2.0	365.0
1-2	202.6	59.8	1.0	1283.0
2-3	80.8	22.7	1.0	446.0
3-4	94.1	30.7	1.0	729.0
4-5	57.4	20.4	1.0	225.0
5-6	58.4	36.3	1.0	304.0
6-7	23.7	11.3	2.0	57.0
7-8	99.4	57.6	1.0	346.0
8-9	6.5	2.1	5.0	8.0
9-10	_	_	_	_
above 10	137.0	181.0	9.0	265.0

*SE: Standard error, L: lower limit, U: Upper limit; _: insufficient number of incidents to obtain mean value for this range

The compensation amount claimed across villages

The number of claims per village ranged from 1 to 239 over a period of 5 years from 2004 to 2008. A mean of 32 claims per village (S.E= 4.5, n=107) annually was observed. A mean of Rs.36,133 (ranging from Rs.4618 to Rs.47553) was claimed. Amount of claimed money ranged from Rs. 21 to Rs. 23,000. In terms of number of claims, villages such as Halasur (239), Lanke (233), Depegowdanapura (216), Huvinkala (167), Katte Hunsuru (144), Managanahalli(114), Hunasehalli (112) had high number of claims. The number of claims per year ranged from 23 to 48 in these villages.

Interestingly, the results show that Halasur has been exposed to maximum conflict in terms of the total number of claims over 5 years, number of claims per year and total amount of compensation claimed in 5 yrs. However, the amount claimed per year by Halasur, is lower than Killipura, Nanjanpura, Surahalli and Mallahalli. In relation to the number of incidents and the total amount claimed for 107 villages, the results fall within Rs.1, 25,000 for around 90 villages (Figure 6). The amounts paid fall within 1 lakh rupees. There could be a relation between number of incidents and the amount claimed. As the number of claims increases, the total amount claimed also increases.

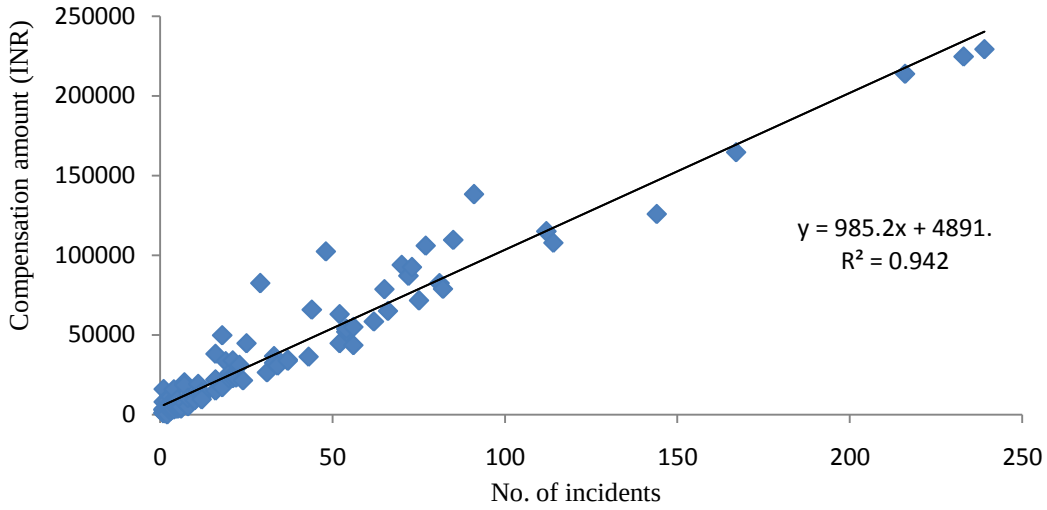


Figure 6: Incidents of crop damage and the amount paid as compensation

Status of compensation claims

The status and distribution of villages that report crop damage incidents and apply for compensation for crop damage is given in Figure 7. It was found that details of compensation claims against crop damage were not available for some of the villages. Non-availability of details of compensation for villages may be related to many factors. However, if this is linked to farmers' low motivation towards applying for the compensation, that may have negative impact on the conflict mitigation measures. The results or locations for those villages that do not have details (even after submission of compensation claims) are given in the Figure 7.

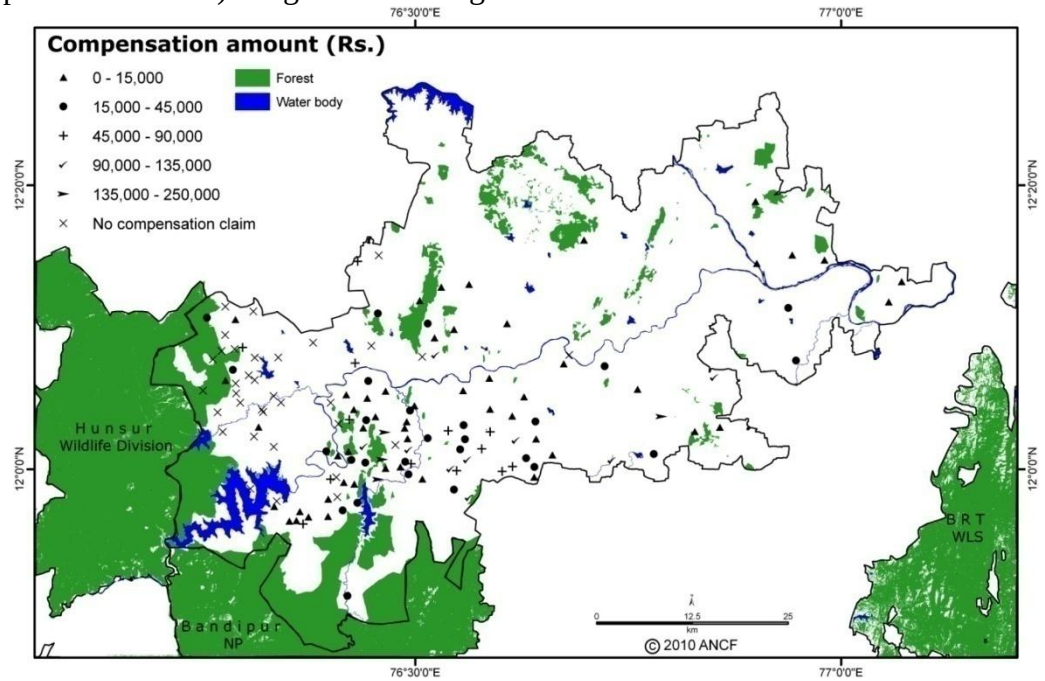


Figure 7: Spatial distribution of the villages that reported crop damage incidents, villages that have details on compensation claims and villages that do not have details

It can be seen from the data that such villages were located closer to the forest regions where the Mysore Forest Division's boundary adjoin with Rajiv Gandhi National Park (70% of them within a distance of 3 km from the forest). Complex compensation procedure may be the reason for the low or no motivation shown by farmers living close to the forest in not giving details. It may be because no effort is made by the authorities to procure details about claims. This could add to the problem of an already poor relationship between the local community and the forest department.

Conflict zones

"Conflict zones" were identified using the home range estimator (see methods section for details). Zones were delineated as 20%, 40%, 60%, 80% and 95% of the volume of the probability distribution derived from the kernel estimation. These conflict zones have been qualitatively assigned as "intense, high, medium, low and minimal" respectively (Figure 8).

It is important to note that the home range delineation method considers the spatial distribution of points, that is, in this case, the locations of villages where crop damage has been reported. However, the figure 8 conveys two pieces of information 1) the spatial distribution of the crop damage incidents and 2) magnitude of crop damage incidents at each point.

Eighteen villages fall under the intense conflict zone and 5624 incidents of crop damages have been reported for 5 years from all 18 villages. A mean of 312.4 (SE=99.1) incidents per village and a mean of 62.5 (SE=19.8) incidents per village per year was reported for this zone. Density of incidents for this zone was 87.9 incidents/km^2 for all the years and 0.97/km^2/year. Distances from forests and water bodies were extracted for each village point location and the values were averaged to give the mean distances from forests or water bodies for villages in different conflict zones. Mean distance from the forest to villages that report crop damage incidents in this zone was 1.7 (SE=0.3) km, for water 1.3 (SE=0.1) km and these distance appeared to be determining the conflict status in the intense zone of conflict. Details for other zones are given in table 3.

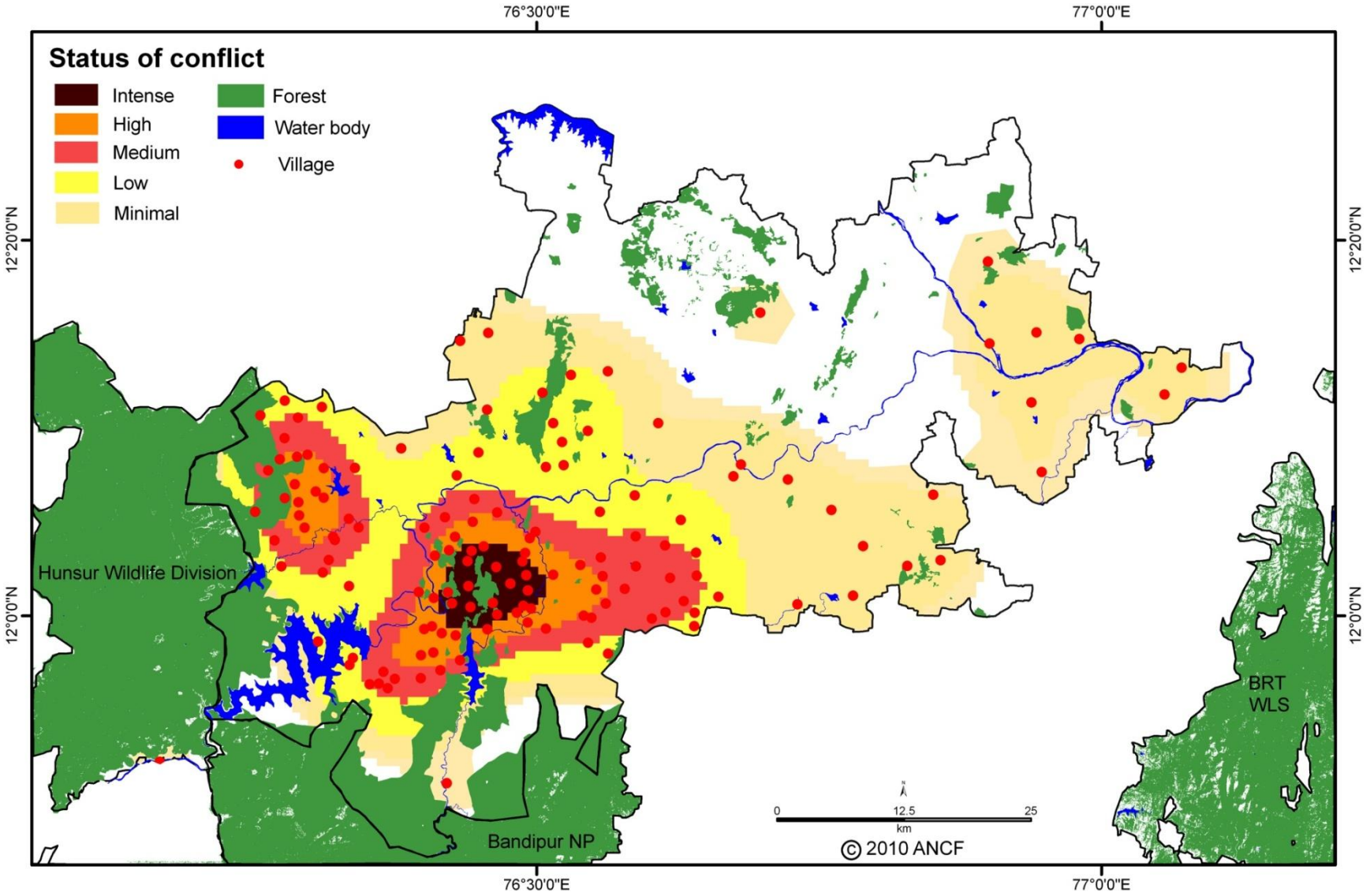


Figure 8: Map showing conflict zones delineated as intense, high, medium, low and minimal of the volume of the probability distribution derived from the kernel estimation

Table 3: Status of conflict in conflict zones that have been qualitatively assigned as "intense, high, medium, low and minimal".

Status of conflict	Area	No of villages	Total no of incidents	Mean incidents/village (SE)	Mean incidents/year (SE)	Density of incidents/ km^2	Density of incidents/ year/km^2	Mean distance from Forest (SE) (in km)	Mean distance from water (SE) (in km)
Intense	64	18	5624	312.4 (99.1)	62.5 (19.8)	87.9	0.97	1.7 (0.3)	1.3 (0.1)
High	164	29	2742	94.6 (23,1)	18.9 (4.6)	16.7	0.11	2.3 (0.3)	1.2 (0.1)
Medium	323	40	2561	64.0 (13.7)	12.8 (2.7)	7.9	0.04	3.3 (0.4)	1.4 (0.1)
Low	600	27	2187	84.0 (24.7)	16.2 (4.9)	3.6	0.03	2.9 (0.5)	1.3 (0.1)
Minimal	1200	26	1726	66.4 (23.2)	13.2 (4.6)	1.4	0.01	4.0 (0.5)	1.4 (0.1)

Conflict management zones

In addition to creating conflict zones, four broad zones of conflict management or conflict mitigation (Zones A, B, C and D) were also developed and polygons (.shp) were created to form boundaries for these zones (Figure 9).

Zone A

Zone A has forests of Mysore Forest Division and the boundary of Bandipur National Park on the southern side. It is surrounded by human habitation and cultivation in all the other three directions. The Zone also includes the Chikkadevamma Betta (CDB) and the areas surrounding it. It is important to note that in terms of land classification CDB comes under category of “Section D” which is unfit for any cultivation. However, cultivation can be seen at the foothills and surrounding areas. The past and current human activities have led to degradation of the forest to shrub status. This zone has two reservoirs viz., Kabini and Nugu. The forest type within the Mysore Forest Division and Bandipur National Park consists of mixed deciduous and dry thorn forest.

Zone B

The forests of the Mysore Forest Division and Nagarhole National Park are located on the western side of Zone B and the zone is surrounded by human habitation and cultivation on the other three sides. It is devoid of major reservoirs. The forest type consists of mixed deciduous forest.

Zone C

The surrounding areas are dominated by human habitation and cultivation. The forest type within the zone is mixed deciduous. This zone is also devoid of reservoirs.

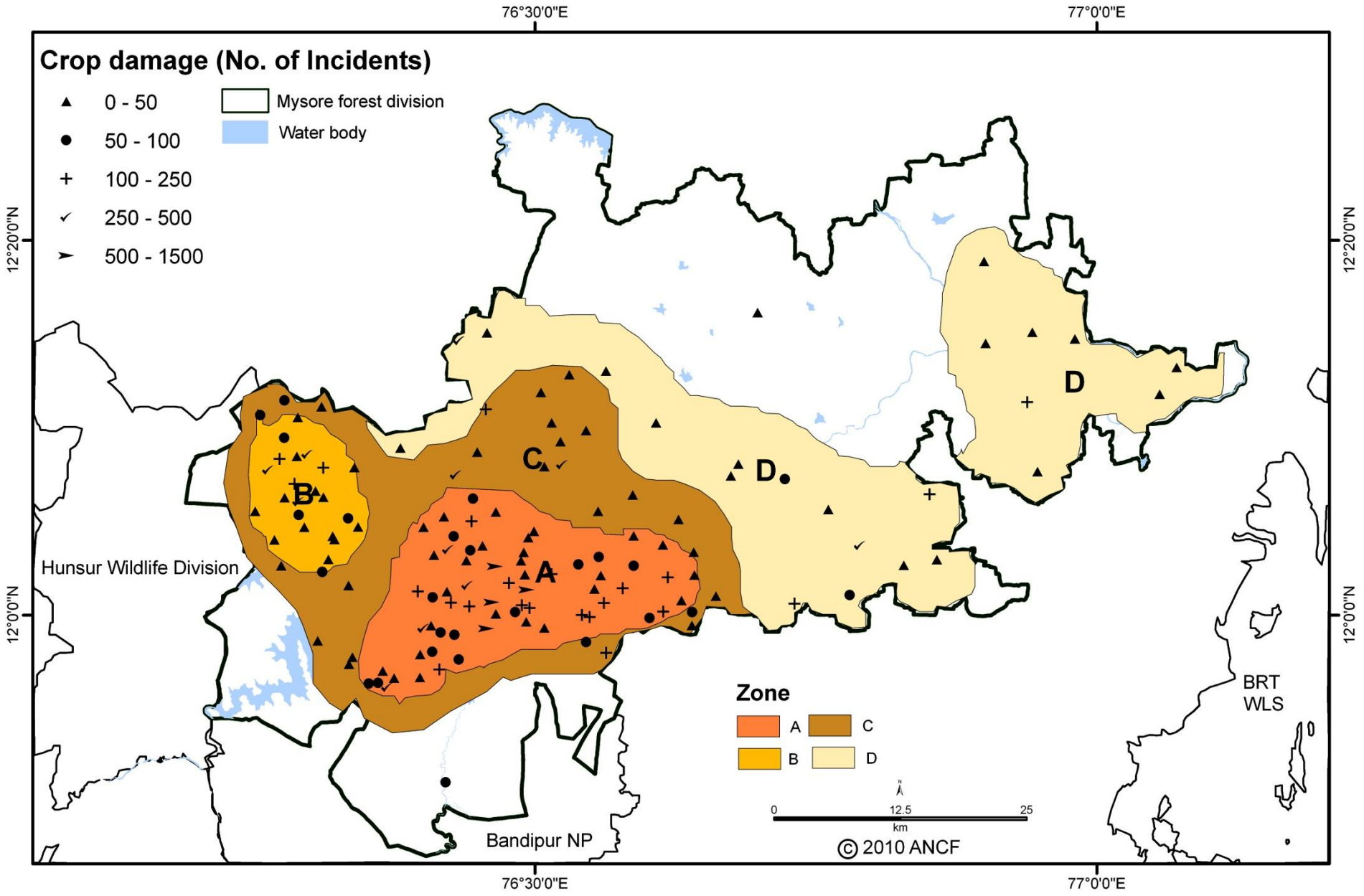


Figure 9: Map showing different zones of conflict management or conflict mitigation arrived based on the results from home range estimator

Zone D

Except for two small hills, Zone D is devoid of forest cover and reservoirs. This zone has the BRT on its east. All other directions are dominated with human habitation and cultivation. The nearest forest is present at a distance of 30 km from this zone.

Status of conflict in zones

To identify the status of conflict across the zones, the incidences of conflicts have been classified into 5 different size classes (categories) which can be seen in figure 10. Categories are arranged in descending order and the category I indicates the highest level of crop damage incidents.

1	Category I	The highest	▲
2	Category II	Second highest	●
3	Category III	Third highest	+
4	Category IV	Fourth highest	✓
5	Category V	Fifth highest	➢

Figure 10: Classification of conflict intensity

In terms of the number of incidents and intensity of the conflict, Zone A stands first in the conflict status. Number of incidents of crop damage for all the years in the range of 500 – 1200 (category I) is seen only in this zone. All five categories (refer Figure 9) are dominated by zone A. The remarkable pattern of the conflict in zone B is the absence of the incidence range of 500-1200. Zone C has relatively less incidents and is dominated by incident range of 1-35 (Category V) followed by 250-500 (Category II). The zone D has very few incidents of conflict with incidents ranging from 1-35. Only one instance of range 250-500 is observed in this zone. The intensity of conflict in Zone A might be due to the presence of the CDB.

The distances from forest to the villages that are affected by conflict range from 0 km to 10 km. The distances, from forest to villages that are affected by conflict in Zone B, fall within 4 km. The maximum conflict incidents were observed within 1-2 km from the forest. The elephants travel up to 9 km from the CDB forest. The incidents of crop damage were maximum within a distance of 2 km. There could be an overlap between the movement of elephants within Zone A and C. No distinct pattern of conflict could be observed in relation to the distance from the forest. The farthest distance traveled by the elephants may be due to the presence of forest adjoining Bandipur or CDB.

The elephants appear to move from the forest in Bandipur to the forest in Mysore Division and move up to the CDB causing severe damage in Zone A. CDB acts as a shelter during the daytime and this might help the elephants to move up to 9 km west of CDB. The non-availability of small hills with forests around Zone B, might be a reason

for the decrease in conflict when compared to Zone A. The elephants in Zone B appear to travel shorter distances when compared to those of other zones.

Zone-wise pattern of distance traveled and incident occurred

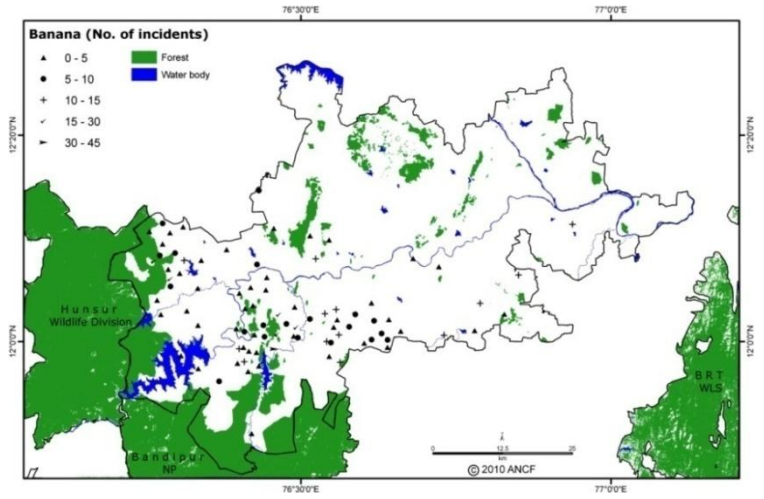
The number of villages that reported conflict incidents in Zone A was 76 and their distances from the forest ranged from 0-10 km with a mean distance of 3 km (SE=0.23, n=76). The number of incidents of crop damage reported in these villages ranged from 1-1283 with a mean of 134.9 (SE=27.0, n=76). The number of villages that reported crop damage incidents in Zone B was 29 and their distance ranged from 0-8 km with a mean distance of 3 km (SE=0.4,n=29). The number of incidents of crop damage ranged from 1-503 with a mean of 7.3 (SE=23.1, n=29).

The number of villages that reported crop damage incidents in Zone C was 13 and the distance ranged from 0-7 km with a mean distance of 2.3 km (SE=0.6, n=13). The number of incidents ranged from 1-446 with a mean of 83.5 (SE=43.9, n=13). The number of villages that reported crop damage incidents in Zone D was 17 and the distance ranged from 1-10 km with a mean distance of 4.2 km (SE=0.6,n=17). The number of incidents ranged from 1-412 with a mean of 72.5 (SE=30.3, n=17).

There could be a relation between zones A, C and D. It can be strongly assumed that the conflict for A, C and D may have originated from the areas adjoining A. The total number of conflict villages falling within zones A, C and D is about 106 (76% of the villages that have claimed compensation). As mentioned elsewhere, Zone A appeared to be the conflict 'hotspot' for Mysore Forest Division. Strong mitigation measures initiated at the forest regions closer to Zone A may reduce the conflict in villages falling within zones A, C and D.

Patterns of damage of individual crops

The patterns of damage of selected crops are given in figures 11a, b, c, d, e, f, g, h, i, j, k and l). The highest conflict incidents (category I) for banana (*Musa* spp.), black eyed peas (*Vigna unguiculata*), coconut (*Cocos nucifera*), coriander (*Coriandrum sativum*), cotton (*Gossypium* sp.), green gram (*Vigna radiata*), horse gram (*Dolichos biflorus*), paddy (*Oryza sativa*), ragi (*Eleusine coracana*), hyacinth bean (*Dolichos lablab*) and sugarcane (*Sacharum* sp.) is reported only in Zone A. Except for cotton, hyacinth bean, ragi, the second highest incidence (category II) was reported for all other crops in Zone A. For cotton and ragi equal numbers of category II conflict was reported in Zones A and B and the pattern is same for Zone A and B for hyacinth bean. The third highest incidence (category III) for all crops was reported for Zone A. This category was absent for green gram in Zone B, mango (*Mangifera indica*) in Zone C and coconut, green gram and mango in Zone D. Except for coriander, Zones A, B and D reported fourth highest incidence. This category is absent for green gram, hyacinth bean and paddy for Zone C. Category V (see figure 10 for the definition of categories) was reported for all zones and crops.



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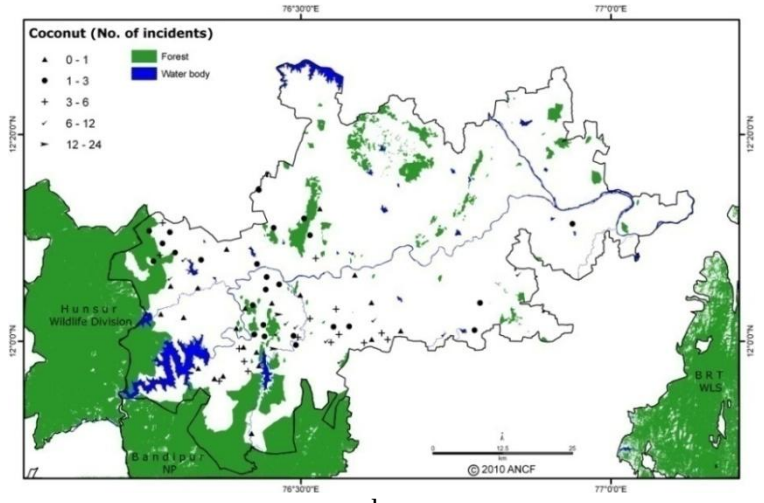

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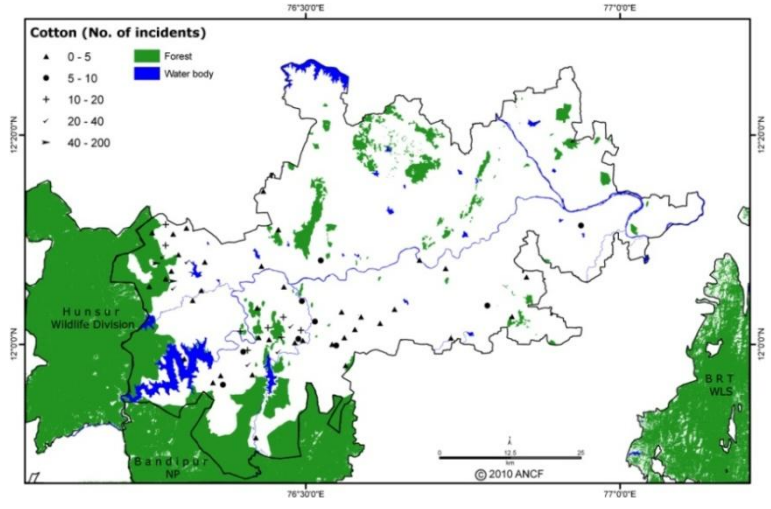
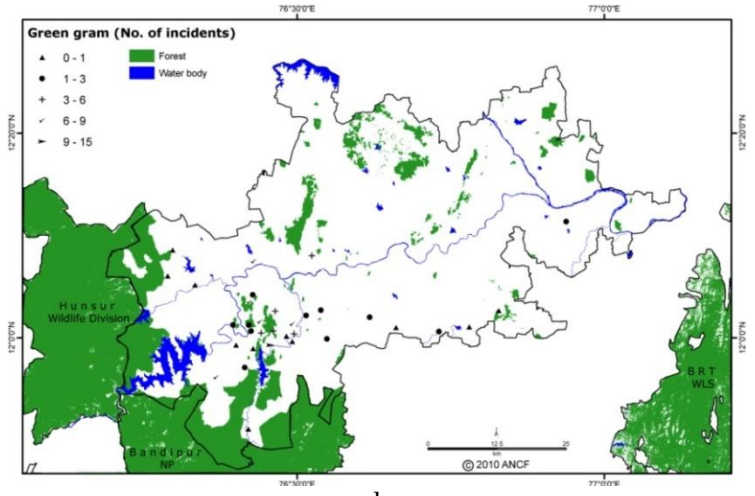


c

Figures 11a, b and c: Maps showing the incidences of damage for Banana (a) and Coconut (b) and Cotton (c) from 2004-2008 in Mysore Forest Division



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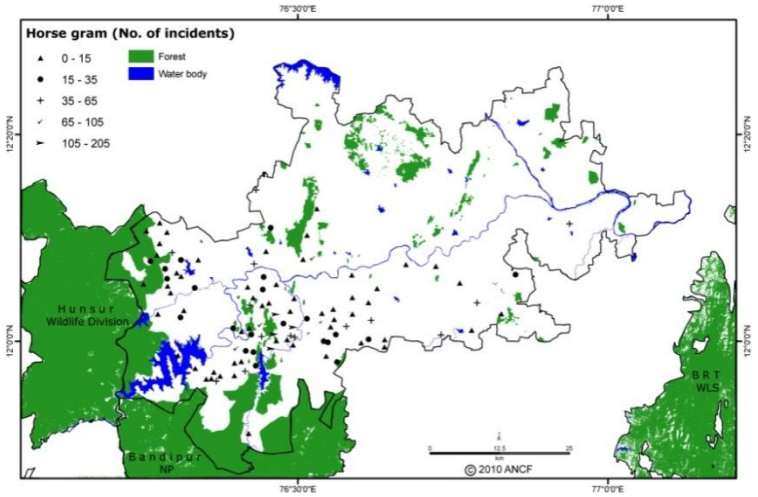

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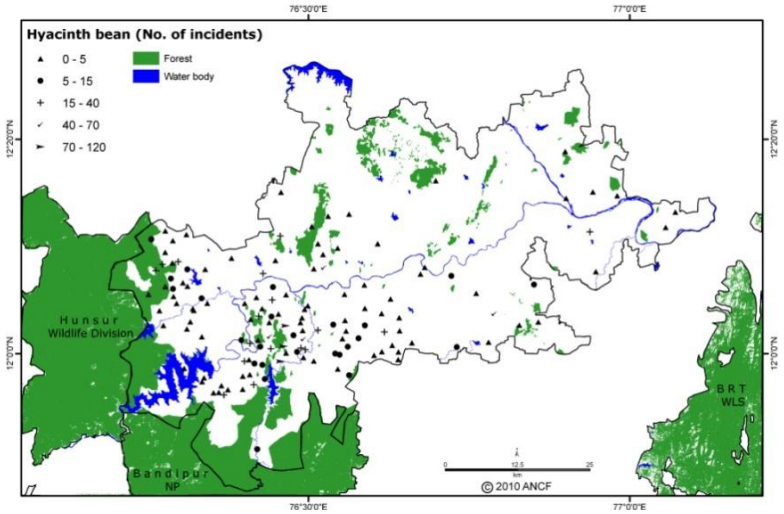

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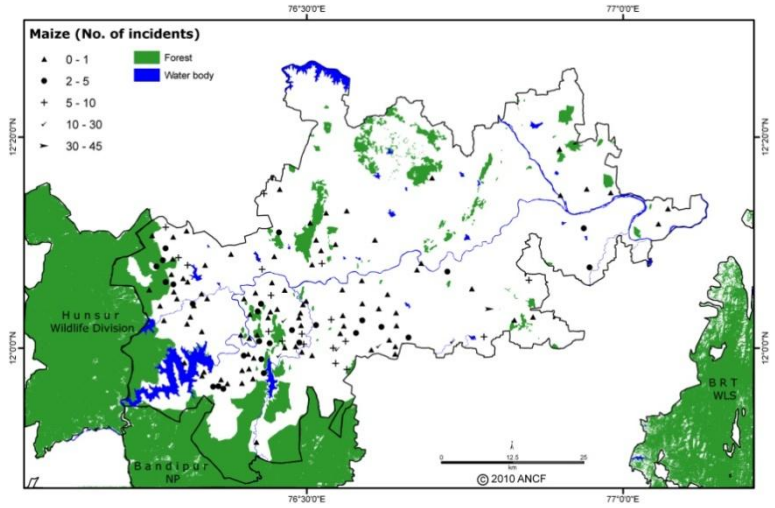
Figures 11d, e and f: Maps showing the incidences of damage for different crops Green gram (d) Horse gram (e) and Hyacinth bean from 2004-2008 in Mysore Forest Division



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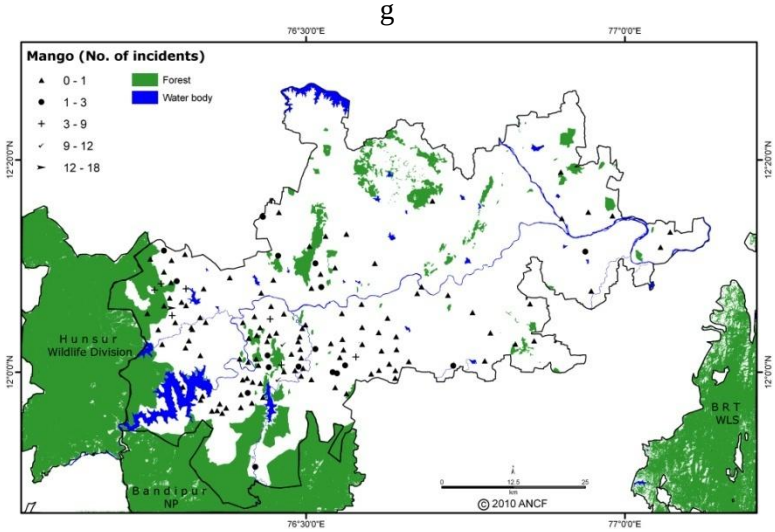

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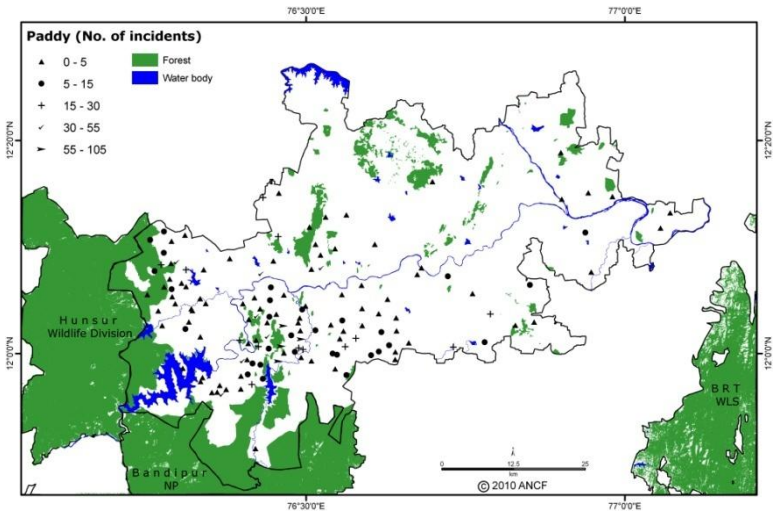

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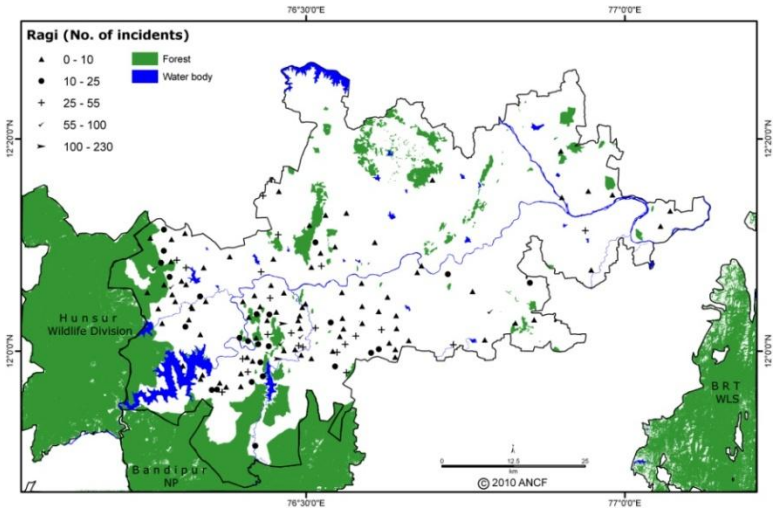
Figures 11g, h and i: Maps showing the incidences of damage for different crops Maize (g) Mango (h) and Paddy (i) from 2004-2008 in Mysore Forest Division



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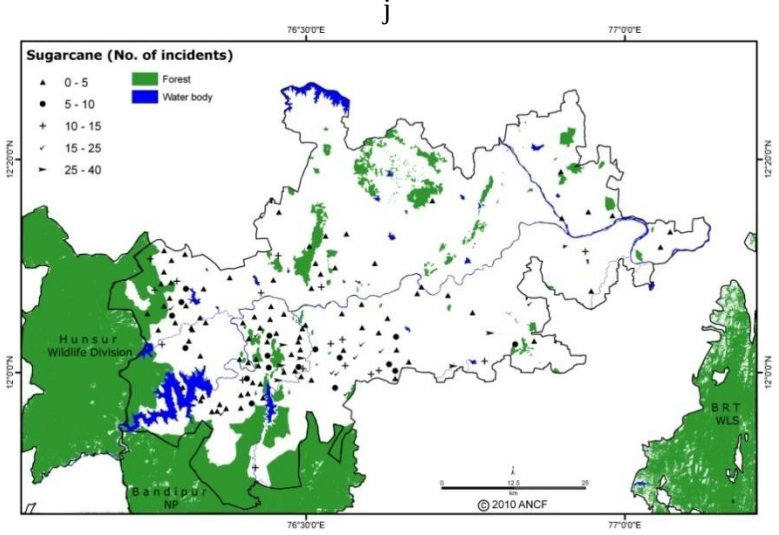

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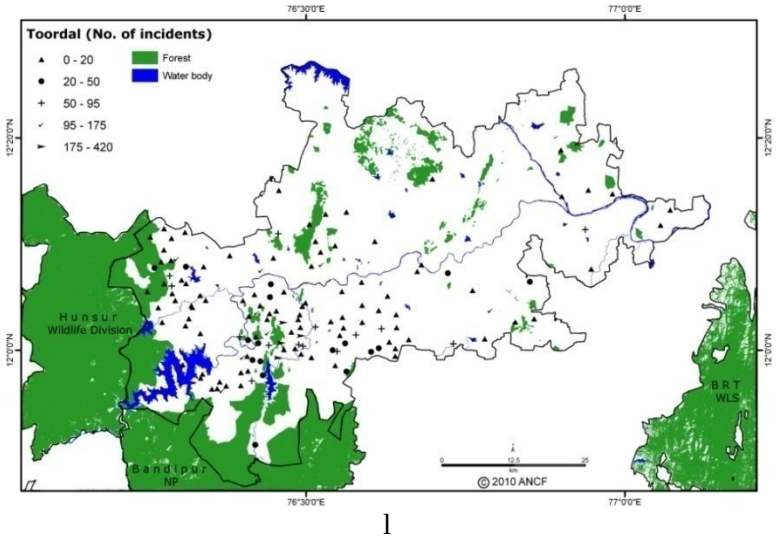


l

Figures 11j, k and l: Maps showing the incidences of damage for different crops Ragi (j) and Sugar cane (k) and Toordal from 2004-2008 in Mysore Forest Division

coconut, green gram, horse gram, hyacinth bean, paddy, ragi and coriander first category of damage was distinctly absent in Zones B, C and D. For maize (*Zea mays*), the highest category was found only in Zone D and distinctly absent in Zone A, B and C. The incidents taking place in Zone D cannot be ignored as the highest range of incidents for maize is reported only in Zone D.

Interestingly, the highest range of conflict incidents for cotton and mango was reported only in Zone B and are totally absent in Zone A, C and D. However, the second highest conflict range for mango occurs in Zone A and is absent in Zone B and Zone D.

The table 4 summarizes the incidence of crop damage in the four zones, for 13 crops. Highest level (category I) of damages reported in each zone. For all the crops the second highest (category II) level of damage was also from zone A. For crops such as cotton and mango, the highest incidence was reported from zone B and for maize, the highest incidence was from zone D.

Table 4: Summary of the intensity of crop damage in the zones

		Categories				
Sl. No.	**Crops**	**I**	**II**	**III**	**IV**	**V**
1	Banana	A(1)	A(4) B(2)	A B C D	A B C D	A B C D
2	Black eyed peas	A(1)	A(3)	A B C D	A B C D	A B C D
3	Coconut	A(2)	A(6) B(2) D(2)	A B C	A B C D	A B C D
4	Coriander	A(2)	A(2) C(1)	A B C D		A B C D
5	Cotton	B(2)	A(3) B(3)	A B C D	A B C D	A B C D
6	Green gram	A(1)	A(4) C(2)	A C D	A B D	A B C D
7	Horse gram	A(4)	A(2) C(1)	A B C D	A B C D	A B C D
8	Hyacinth bean	A(3)	A(2) C(2) D(1)	A B C D	A B D	A B C D
9	Maize	D(1)	A(4) D(1)	A B C D	A B C D	A B C D
10	Mango	B(1)	A(2)	A B	A B C D	A B C D
11	Paddy	A(4)	A(5) B(1) C(1)	A B C D	A B D	A B C D
12	Ragi	A(2)	A(2) B(2) D(1)	A B C D	A B C D	A B C D
13	Sugarcane	A(4) D(2)	A(8) B(1) C(1) D(1)	A B C D	A B C D	A B C D

I, II, III, IV, and V are levels of conflict incidents. The highest range of crop damage incidents being indicated by I, the lowest being V. Zones of conflict are indicated by A, B, C and D. The number of occurrences of significant damage is shown only for categories I and II.

Incidents of conflict across villages for different months

Mean number of incidents per village was highest in October (40) followed by January (38), September (21), February (16.3), November (16.3) and December (12). From this data, it can be concluded that September to February could be regarded as the major conflict period. The results for January and October (Figure 12) may not be statistically different and these two appear to be the peak conflict months in these regions.

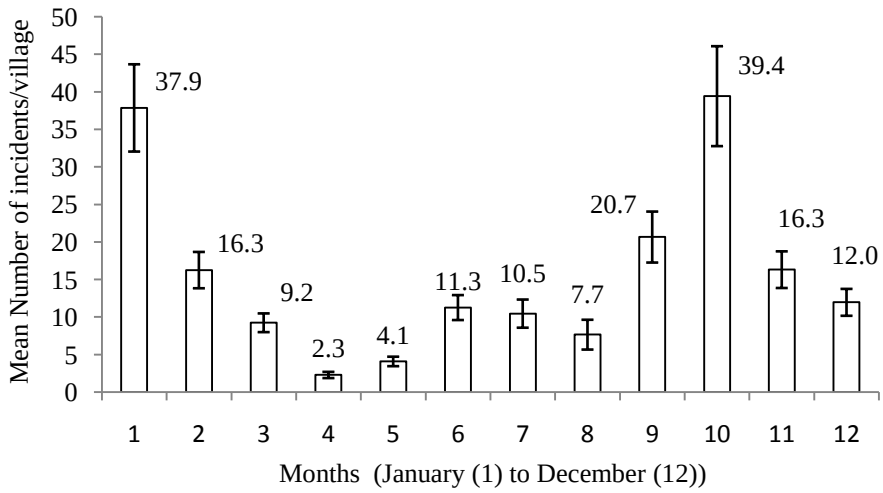
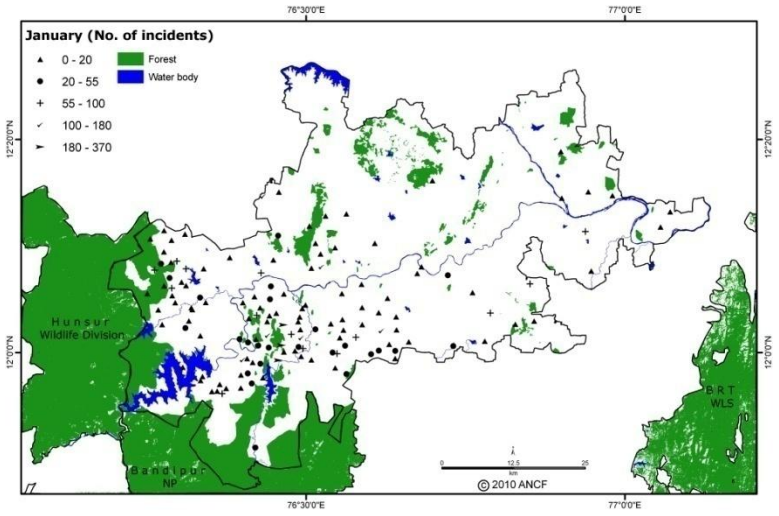


Figure 12: Crop damage incidents across villages during different months in Mysore Forest Division

Damage to different crops across various months

A total of 48 crops were damaged by the elephants. Among these, damage in about 8 different combinations of crops, for example, ragi/toor dal (*Cajanus cajan* - split pigeon peas), horse gram/toor dal/ragi, tamarind (*Tamarindus indica*)/mango trees etc., were also identified. Out of these 48 crops, 39 crops were damaged in January for all the years (Figures 13a, b, c, d, e, f g, h, i, j, k, and l), followed by 33 in February, 31 in October, 30 in November, 27 in December and 24 in September. This may also suggest September to February to be conflict months. In March, June and July about 20-23 crops are damaged.



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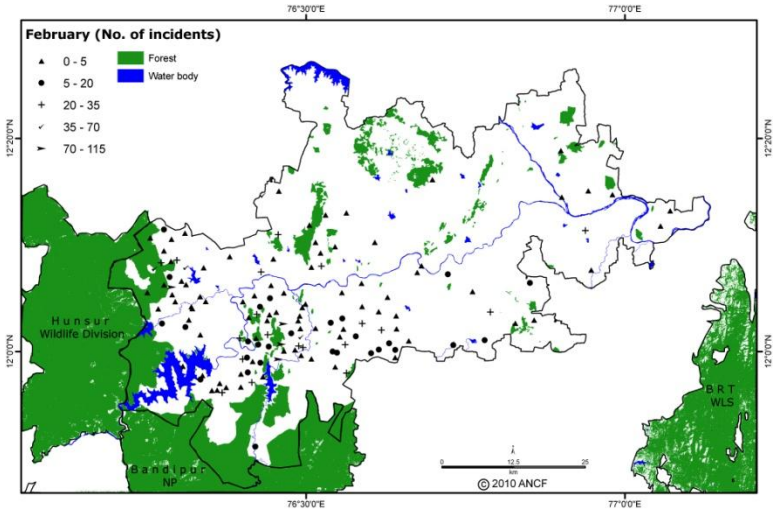

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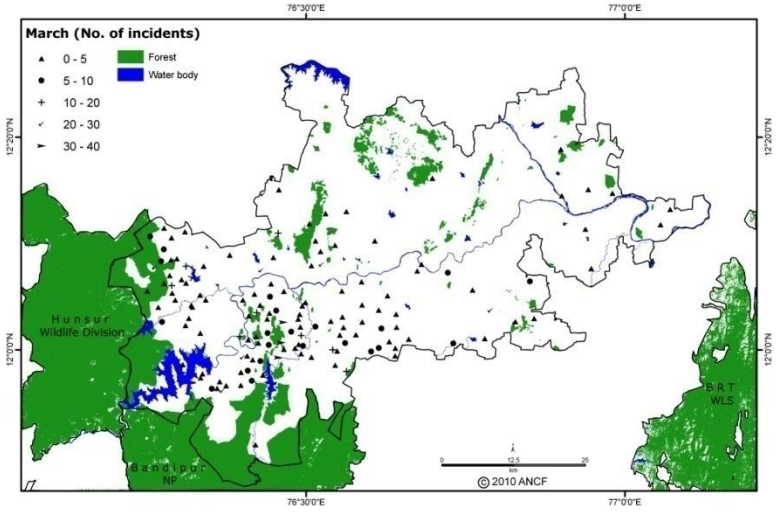

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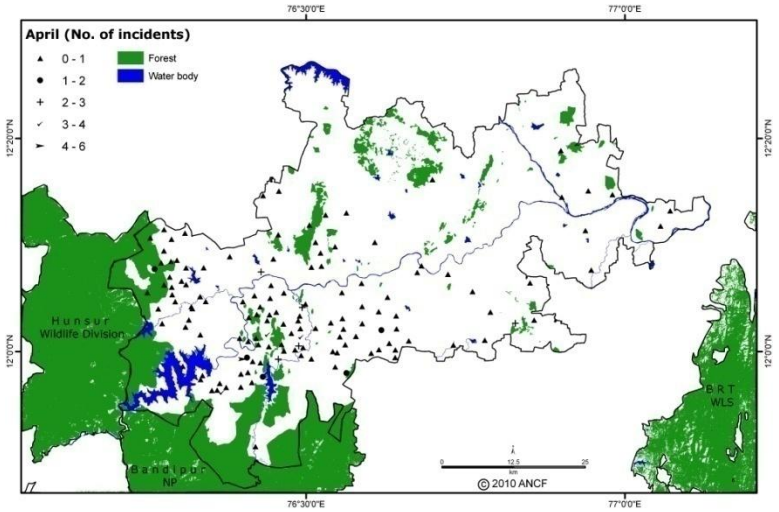
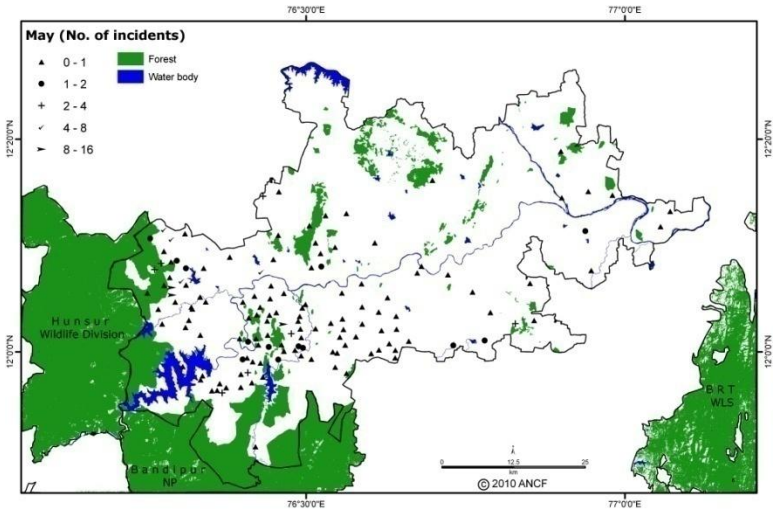


d

Figures 13a, b, c and d: Maps showing the incidents of crop damages reported during different months January (a) and February (b) March (c) April (d) from 2004-2008 in Mysore Forest Division



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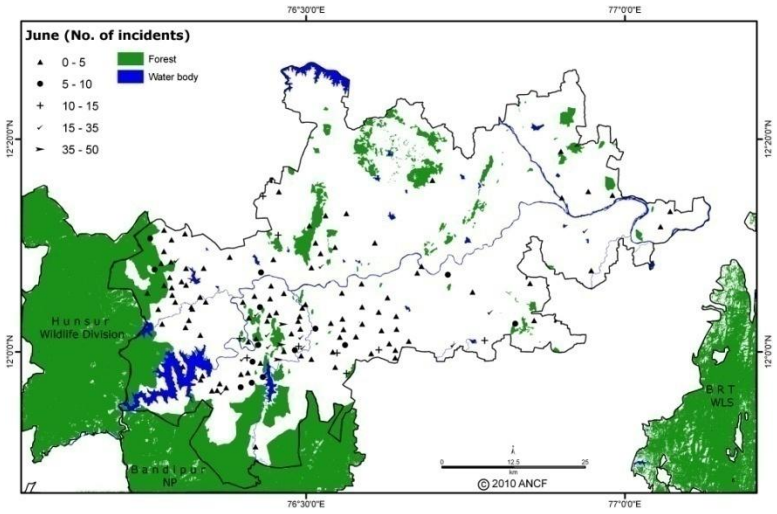

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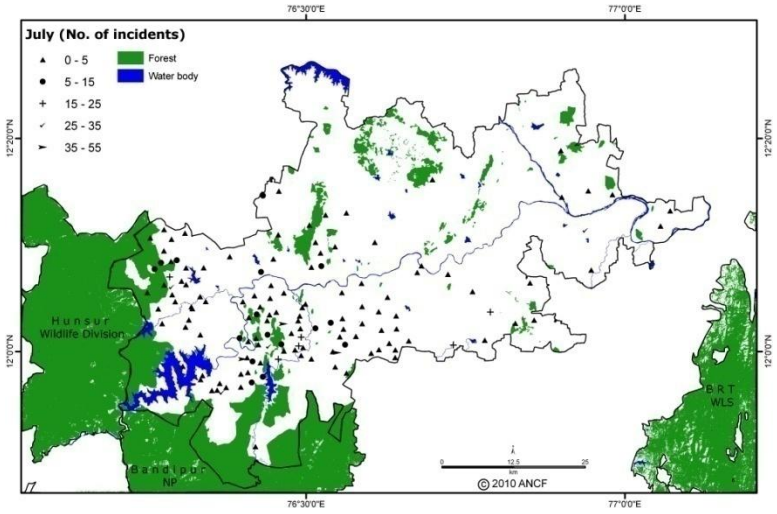

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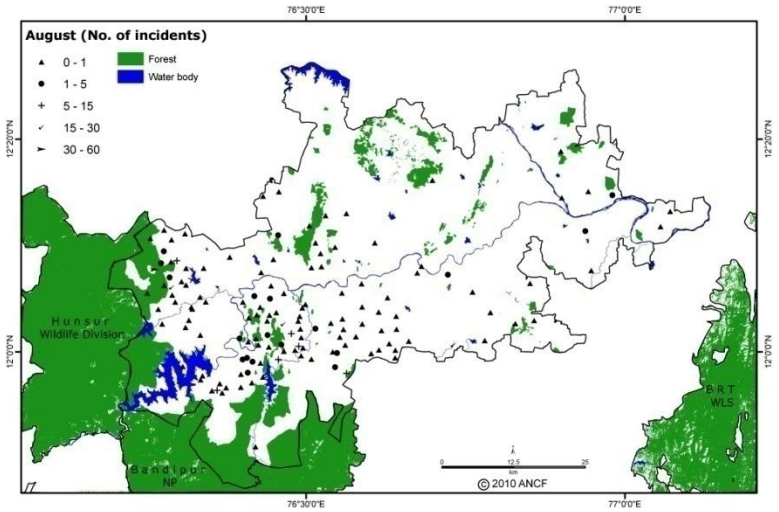
Figures 13e, f and g: Maps showing the incidents of crop damages reported during different months and May (e) June (f), July (g) from 2004-2008 in Mysore Forest Division



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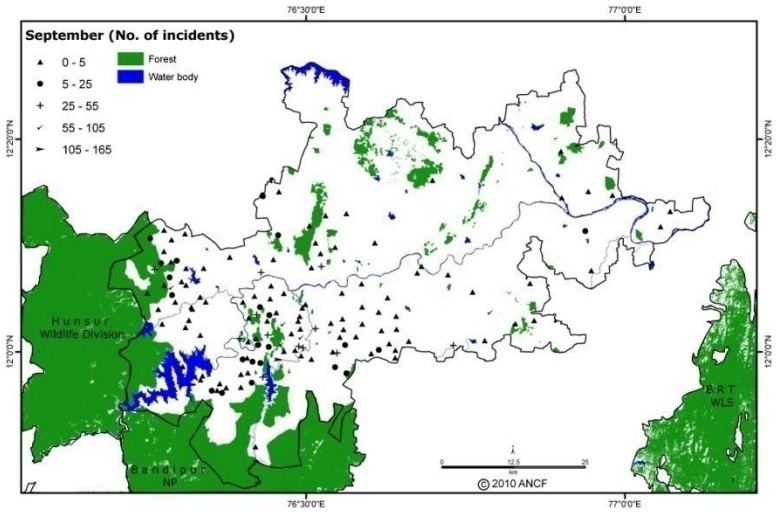

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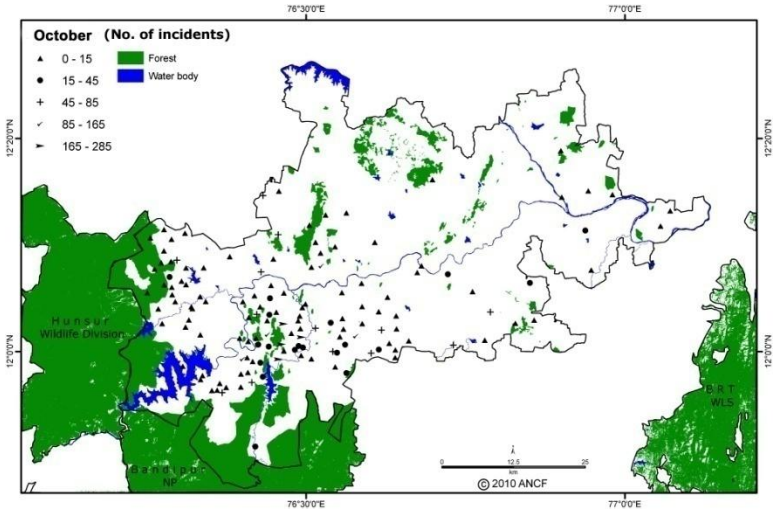

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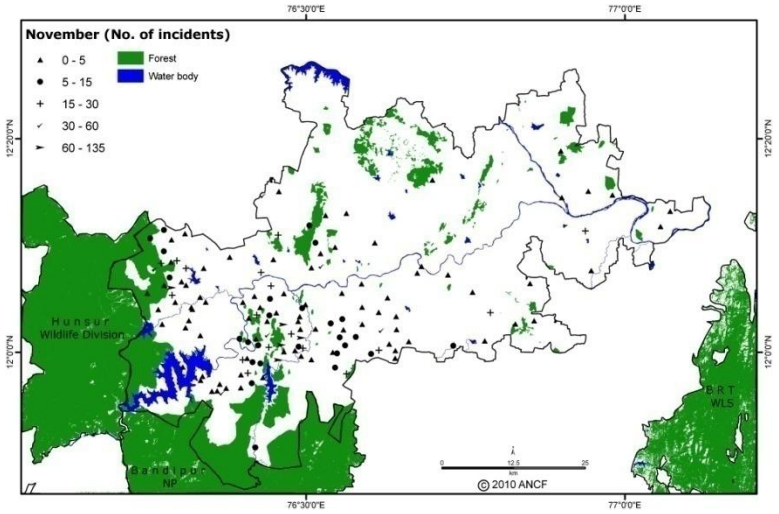
Figures 13h, i and j: Maps showing the incidents of crop damages reported during different months August (h), September (i) and October (j) from 2004-2008 in Mysore Forest Division



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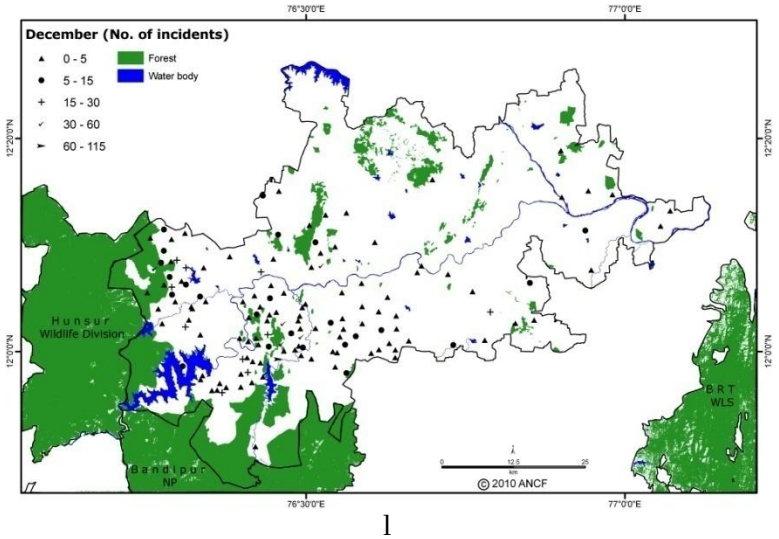


l

Figures 13k and l: Maps showing the incidents of crop damages reported during November (k) December (l) from 2004-2008 in Mysore Forest Division

Except in April, the damage to coconut, maize, black eyed pea is reported throughout the year. For coconut, peak being January and February followed by October and November. For maize, peak being January followed by February, October and November. For cotton, peak being February, followed by November and September. For black eyed pea, peak being January followed by October, February, September and November. Paddy has been damaged throughout the year. About 300 incidents have been observed in January.

Toor dal, ragi, banana, sugarcane, hyacinth bean and horse gram were damaged throughout the year. For ragi, peak being January and October followed by November and September. For toor dal, peak was in January followed by October, November, September and February. For banana, peak being January followed by February, November and September. For sugarcane, peak being January, followed by October,

February and November. For hyacinth bean, peak being January, followed by October, September, November and February. For horse gram, peak being January followed by October, September, November and February.

The analysis of the data suggests January to be the peak conflict month for all the crops except for cotton whose peak conflict month is February (Table 5). October is the second peak conflict month for 8 crops and February for 2 crops and November for one crop. This also suggests October, November, January and February to be the peak months of conflict.

Table 5: Crop damage incidents for various crops across different months in Mysore Forest Division

Crop	Coconut	Black eyed pea	Maize	Banana	Cotton	Sugarcane	Paddy	Hyacinth	Ragi	Horsegram	Toordal
January	**1 (100)**	**1(82)**	**1(77)**	**1(178)**	4(82)	**1(219)**	**1(313)**	**1(374)**	**1(479)**	**1(712)**	**1(1179)**
February	**2(41)**	3(26)		**2(91)**	**1(148)**	3(109)		5(84)	4(224)	5 (196)	5(364)
March	-			5(43)							
April											
May											
June			4(40)								
July			3(44)								
August					5(74)						
September	5(18)	4(25)	5(39)		3(105)	5(60)	4(108)	3(120)	5(191)	3(253)	4(387)
October	3(32)	**2(69)**	**2(74)**	3(58)		**2(118)**	**2(259)**	**2(302)**	**2(480)**	**2(553)**	**2(1040)**
November	4(30)	5(21)		4(48)	**2(142)**	4(68)	3(161)	4(100)	3(272)	4(224)	3(410)
December							5(102)			6 (169)	

Number of days elephants visit per month

On an average elephants visited villages for 24 days in January, followed by 22 days in October, 20 days in November and 18 days in February. The patterns in the other months can be seen in figure 14.

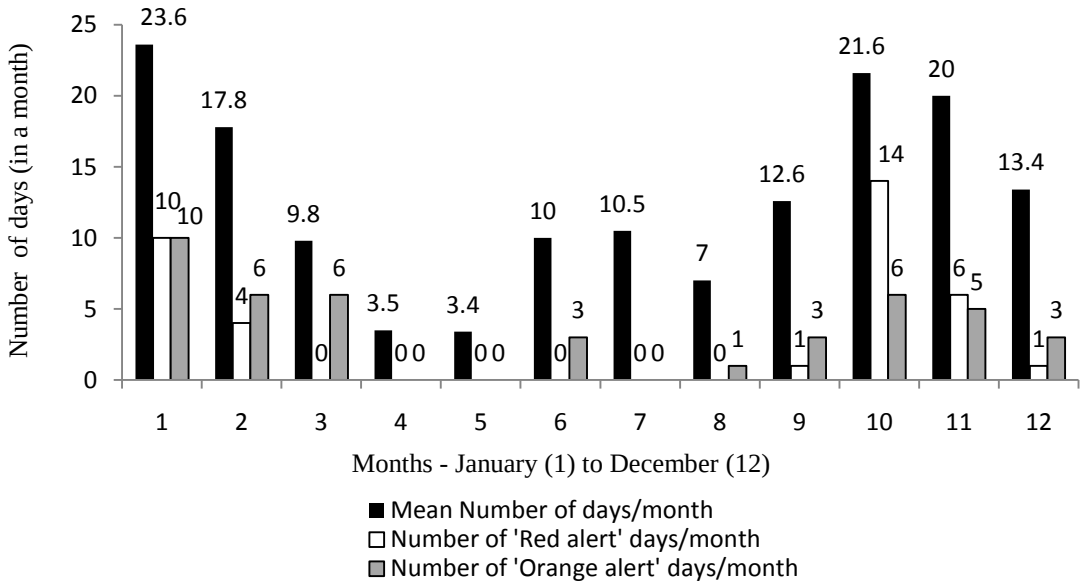


Figure 14: Patterns of elephant visits across different months in Mysore Forest Division

Elephant visits on specific dates for specific months

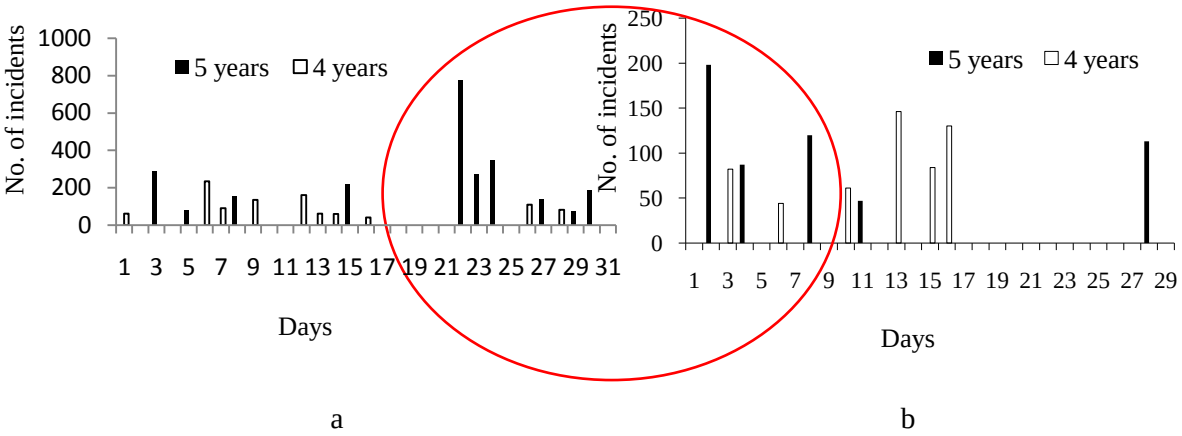
The pattern of elephant visit on a specific date of a specific month can be brought under the concept of Red and Orange alert days. The usage of the terms Red and Orange are based on the consistency of elephant visits on a given date of a given month across the years 2004 to 2008. The red alert days are defined as the specific dates of given month during which the elephants visited the villages consistently for all 5 years. The Orange alert days are defined as the specific dates per month during which the elephants visited the villages consistently for 4 out of 5 years. The Red and Orange Alert dates identify important conflict dates. For example, if we consider January, the red alert days appeared to be on the 22nd, 23rd, 24th, 27th, 29th and 30th of the month, for February 2nd, 4th, 8th and 11th appear to be the key dates. Four Orange alert days fall in between the red alert days viz., 26th and 28th of January and 3rd and 6th of February. The cluster of red alert days and orange alert days put together forms the conflict days wherein the incidence of elephant visits are the highest.

January

From the 5 year data (2004-2008), it was evident that the elephants had visited the crops every year in the month of January. Their visit duration ranged from 18 to 31 days in the month. There is a gradual increase in the number of days they visited per year from 2007. There seems to be a pattern in the specific dates of visit in the month of January. They appear to be visiting on 22nd, 23rd and 24th every year with an incidence range of 272 to 775. Another pattern was observed on 3rd, 5th and 8th of January every year. The range of incidence is 250 to 280. Other key dates are January 27th, 29th and 30th of every year with number of incidents ranging from 70 to 180. The dates 3rd, 5th, 8th and 15th of January are also Red alert days, but the intensity of incidents are different from that of 22nd to 25th of January. However, the above mentioned 10 days can be considered as the red alert days for January.

February

The elephant visits have been reported in each of the years. The duration of visit ranged from 12 to 29 days in the month. There is a gradual increase in the number of days they visited per year from 2006 onward. Their patterns for specific dates are not as distinct as that of January. They appear to be visiting on 2nd and 4th of the month every year with incidents ranging from 80 to 200. With the results of January and February, it can be assumed that 22nd January to 8th February (highlighted by a circle) is the red alert period (Figures 15a and b). The dates 8th, 11th and 28th February are also red alert dates. This result might be related to the reproductive stage or the harvesting stage of different crops.



Figures 15a and b: Elephant visits for the months of January (a) and February (b)

March

The pattern of elephant visits is not as distinct as that of January and February. However the elephant visits have been reported every year with the range of 2 to 16 days. There are no red alert days, but on 4th, 15th, 18th, 20th, 23rd and 26th of the month the elephants have visited consistently for 4 years (Figure 16).

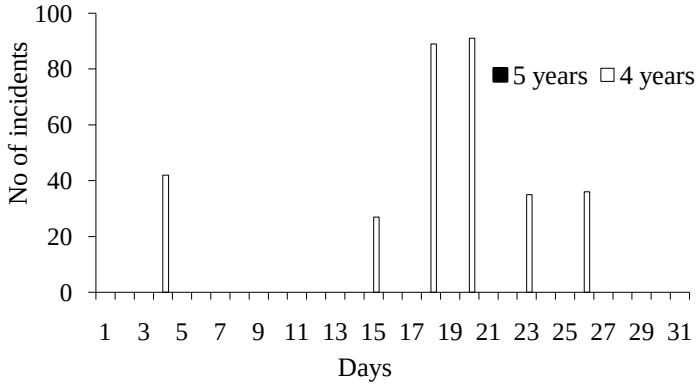


Figure 16: Elephant visits for the month of March

April and May

The elephants have been reported only during 3 years with an incidence range of 1 to 5 days for April and May. There were no red and orange alert days for April and May with number of days of elephant visits and incidents in these two months being the fewest among all the months.

June and July

The elephants have been reported every year with an incidence range of 2 to 19 days. June can be considered as the second peak of conflict. No red alert dates have been observed for June; however 4th and 11th have been the most prominent dates for 4 years (Figure 17). For the month of July, the elephants have visited every year. The dates range from 2 to 17 days. There are no red and orange alert dates.

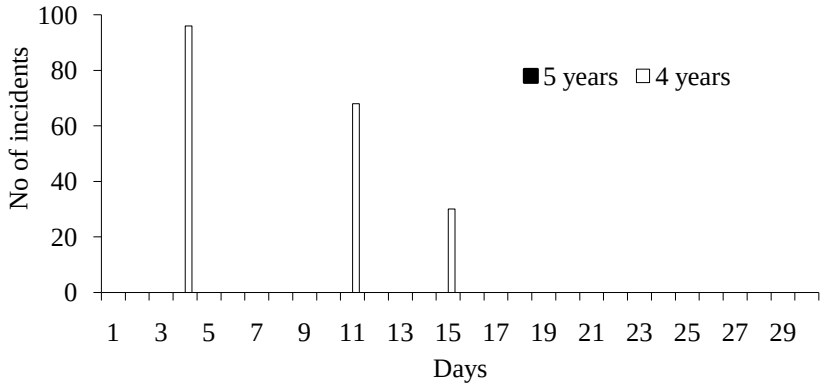


Figure 17: Elephant visits for the month of June

August

The elephants have been reported every year. The number of days range from 1 to 13 days. There are no red alert dates and out of 5 years, only for 4 years elephants have visited during this month (Figure 18).

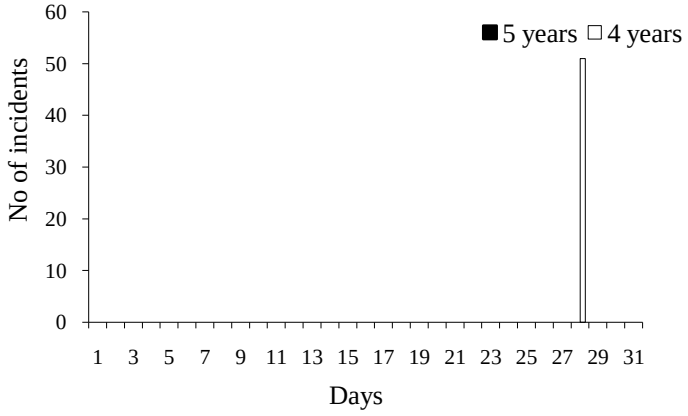


Figure 18: Elephant visits for the month of August

September

The elephants have been reported every year (Figure 19). The number of days of visit ranges from 3 to 27 days. The red alert date in September is 30th.

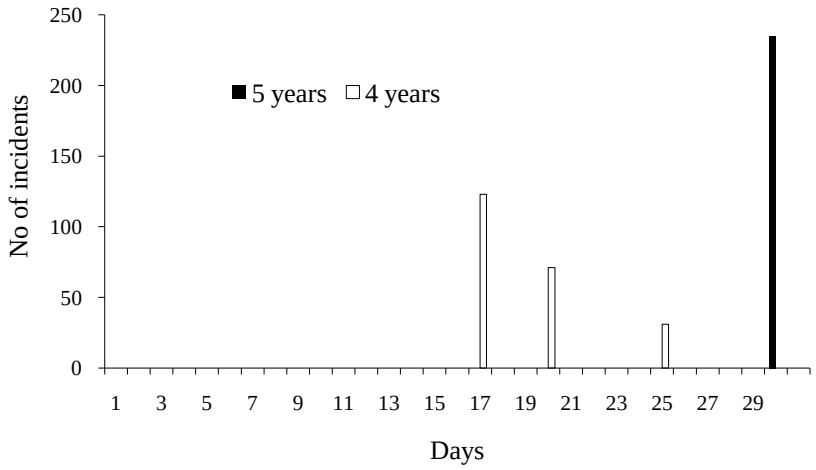


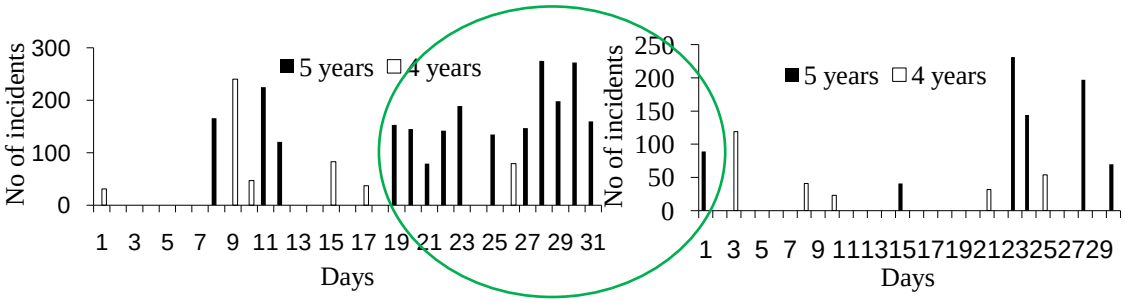
Figure 19: Elephant visits for the month of September

October

The elephants have been reported every year. The number of days of elephant visit ranges from 19 to 27. The dates 19th, 20th, 21st, 22nd, 23rd, 25th, 27th, 28th, 29th, 30th and 31st can be considered as the red alert dates. Discounting the significance of the absence of elephants on October 24th and 26th, it is clear that the period between 19th and 31st appears to be clear conflict period. The range of conflict incidents is 80 to 275. October 8th, 11th and 12th also are red alert dates, with the range of incidents being 121 to 225.

November

The elephants have been reported every year. The number of days ranged from 17 to 27. 23rd and 24th are the red alert dates with an incidence range of 140 to 230. November 28th and 30th are also red alert dates with incidence range of 70 to 200. With the results of October and November, it can be assumed that 19th October to 3rd November (highlighted by a circle) is a red alert period (Figures 20a and b).



a b

Figures 20a and b: Elephant visits for the months of October and November

December

The elephants have been reported every year. The dates range from 2 to 26 days. December 4th is the red alert date with 100 incidences. With the results of November and December, it can be assumed that 23rd November to 4th December is a red alert period (Figure 21).

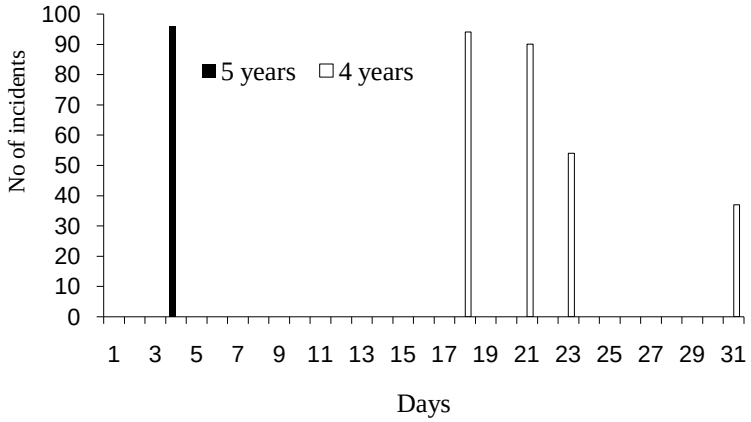


Figure 21: Elephant visits for the month of December

The results indicate that there are specific dates in which elephants visit every month. Combination of both red and orange alert may help in knowing the defined dates on which the elephants visit the villages. If this result is seen for all the years it is expected that the elephants not only know the villages and the cropping patterns but also the specific time to visit. Factors like farmer alertness may also influence the pattern of visit and crop damage. This kind of understanding may also help in creating specific mitigation measures.

Range-wise patterns of crop damage

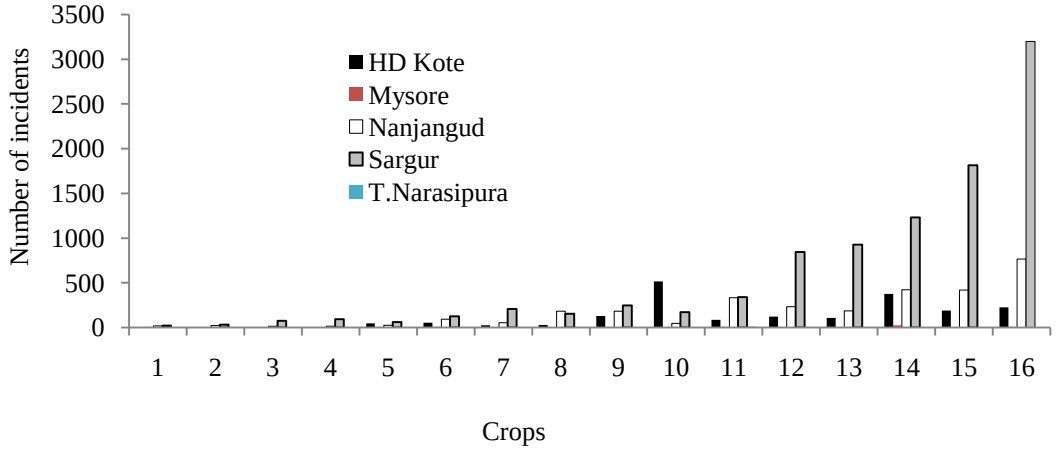
Across the five ranges, the number of damage incidents (2004 to 2008) ranges from 21 to 9761 (Table 6) with the highest incidence reported in Sargur (9761) followed by Nanjangud (3093), HD Kote (1967), Mysore (73) and T. Narasipura (21).

Table 6: Range-wise patterns of crop damage

Range	2004	2005	2006	2007	2008	Total
HD Kote	454	264	549	385	315	1967
Mysore			37	3	33	73
Nanjangud	361	488	427	695	1122	3093
Sargur	1088	1826	1740	2280	2827	9761
T.Narasipura	3	2		10	6	21
Total	1906	2580	2753	3373	4303	14915

The crop-wise damage across the ranges showed that toor dal experienced highest level of damage in Sargur (Figure 22), followed by horse gram, ragi, hyacinth bean, paddy, sugarcane and banana. In Nanjangud, the highest damaged crop was toor dal followed by

horse gram, ragi and sugarcane. In HD Kote, highest amount of damage was seen in cotton followed by ragi, toor dal and horse gram. The patterns of crop loss in different ranges are given in the figure 22.



1: Tomato, 2: Ground Nut, 3: Coriander seeds, 4: Green gram, 5: Mango, 6: Coconut, 7: Black eyed pea, 8: Maize, 9: Banana, 10: Cotton, 11: Sugarcane, 12: Paddy, 13: Hyacinth beans, 14: Ragi, 15: Horse gram, 16: Toor dal

Figure 22: Number of incidents of damage to different crops in Mysore Forest Division

Conclusion

Data obtained based on compensation claim records for 2004 to 2008 reveal a total of 141 villages reporting conflict. There is a steady increase in percentage of villages affected since 2004. Total number of incidents of crop damage for five years was 14,879. Based on distribution of villages that report conflict, four distinct /major conflict zones were identified. In terms of the extent and intensity of the conflict, Zone A stands first in the conflict status. Zone A has mixed deciduous forests of Mysore Forest divisions and the boundary of Bandipur National Park. It also has the Chikkadevamma Betta (CDB) hill range. This zone has two reservoirs viz., Kabini and Nugu. The elephants appear to move from the forest in Bandipur to the forest in Mysore Division and move up to CDB causing severe damage in Zone A. CDB acts as a shelter during the daytime and this aids the elephants to move up to 9 km west of CDB. The non-availability of small forests around Zone B, might be a reason for the lower level in conflict when compared to Zone A. The elephants in Zone B appear to travel shorter distances when compared to those of the other zones.

Interestingly, the villages that do not have details of compensation amounts claimed were located close to Zone B. Although the conflict is reported throughout the year there could be two peak periods of conflicts. Conflict may start from September and end in February reaching the highest intensity in October and January. The month of January reports high incidents of damage for all the crops except for cotton. However, crop damage incidents have been reported for all months. The presence of reservoir, water canal and village ponds seem to play an important role in creating conditions for conflict to occur throughout the year.

Section V:
Status of Human-Elephant Conflict:
Part 2:
Insights from Ground Investigation

Background

Many reasons have been put forward to explain the causes of human-elephant conflict. These include increase in habitat fragmentation, the spread of human settlements and their crop fields, changes in land use patterns around elephant habitats, foraging requirements or attraction towards some crop species by elephants (Sukumar, 1989; Treves, 1998; Easa and Shankar, 1999; Nath and Sukumar, 1998; Prabal, et al., 2008; Varma, et al., 2008a). Increases in the extent and intensity of conflict may be indications of the increasing pressure on the already strained relationship between humans and elephants. Causes of conflict are relatively well known but when elephants visit a village, the degree of damage they do to a farmer's socio-economy is not well understood. When one tries to explore the damage from the farmers' perspective, they themselves appear to be unaware of the extent of damage or tend to exaggerate it. Given this situation, it is important to develop an approach that provides some knowledge of actual damage done by elephants. Developing such frameworks for analysis to know the extent of conflict has two distinct benefits. First, it may allow us to understand the actual intensity of conflict. Second, the procedure for measuring the actual damage in the case of crops can be used subsequently to assess the actual damage for paying compensation to the victims.

Studies have shown that it is possible to measure the actual crop damage done by elephants: for example, if details on total area of crop cultivated and damage done to the crop by elephants for each village are available, it can be used to arrive at the extent of damage to crops in a given village (Bell, 1984; Prabal a 2008; Varma and Prabal, 2008). In addition to this, when elephants come and raid crops they leave distinct signals or clues. For example, their tracks and dung. The measurement of circumferences of dung piles gives some indication of the specific age class of elephants that visited the crop lands. Investigation of the dung piles may even provide detail on the proportion of crop and non crop materials consumed by elephants (Varma, et al., 2008c). Information obtained through actual ground survey of the damage and identifying the animal responsible, along with the details of farmers and location of villages that are exposed to conflict, may help in developing a conflict mitigation plan.

Villages selected for the investigation on conflict status

Villages selected by the research team for measuring the actual conflict status (Figure 1) fall within a mean distance of 2.5 (S.E. =0.40, N=27, ranging from 0 to 7) km from forest and 1.2 (S.E=0.09, N=27, ranging from 1 to 2) km from water bodies.

About 48% of the villages come under intense and high conflict zones, 33% under medium and 18% under low to minimal conflict zones. The compensation claim by these villages suggested that a mean of 192 (SE=60.0, N=27, ranging from 1 to 1283) incidents per year and mean of 64(SE =20, N=27, ranging from 3 to 427) incidents of crop

damages in every village. Among those villages selected 73.7% of them reported crop damage incidents, and these villages come within a mean distance of 2.67 (S.E=0.44, N=21) km from forest and 1.2 (SE=0.09, N=21) km from water bodies.

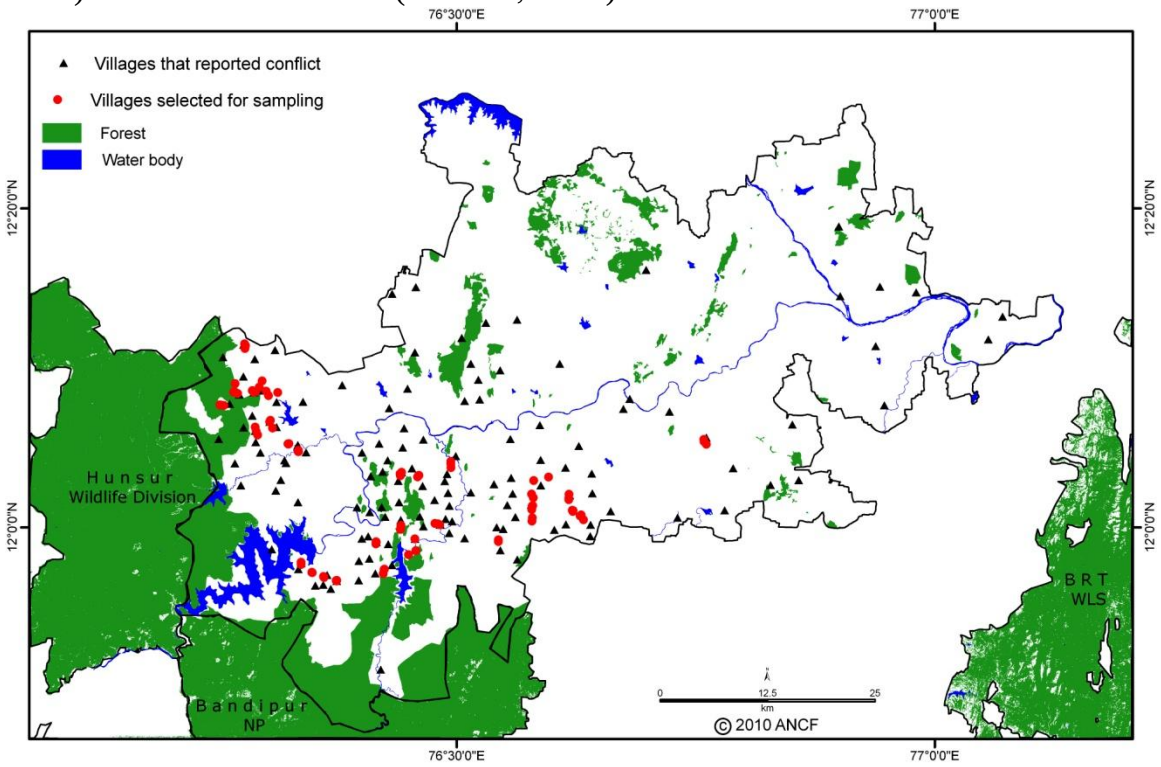


Figure 1: Map showing villages that reported crop damage incidents and villages selected for sampling to assess human-elephant conflict in Mysore Forest Division

Pattern of crop damage in villages (as reported by farmers who experienced crop damage incidents during the study period)

The distribution of economic loss among the villagers as revealed by the survey of farmers in the period from September 2009 to February 2010 indicates that the following villages Chakgaudanahalli, Depegaudanapura, Bhudnur and Kasuvinahalli are the top 4 villages affected by crop damage related conflict (Table 1).

The annual economic loss (for 2009) from crop damage by elephants for all villages together ranges from Rs. 2,500 to Rs. 70,000 with a mean of Rs. 17,026 (SE= 3489) per year. Twenty six per cent of damage falls within Rs. 2500 to Rs. 5500 and 22% falls within the range of Rs. 5500 to Rs. 10,500 and another 22% fall within the range of Rs. 21,000 to Rs.25, 000 (Table 1).

Table 1: Annual economic loss due to crop damage reported across different villages

S.No	**Village Name**	**Economic loss (in Rs.)**
1	Kalegaudanahundi	2,500
2	Mallahalli	2,800
3	Halasur	3,000
4	KG Hundi	3,500
5	K Yadathore	5,000
6	Siddegaudanahundi	5,300
7	Theranimunti	6,800
8	Hunasehalli	7,500
9	Nanjenayakanahalli	8,000
10	Lanke	9,100
11	Manuganahalli	9,500
12	Hosahalli	10,300
13	Makanapura	10,600
14	Huvinkala	16,300
15	Siddayyanahundi	21,800
16	Heggudilu	22,000
17	Hallare	22,500
18	Surahalli	23,300
19	KG Hundi	25,000
20	Kasuvinahalli	31,200
21	Bhudnur	35,000
22	Depegaudanapura	40,600
23	Chakgaudanahalli	70,000

A total of 296 acres of crop land was damaged by elephants in the villages investigated with an average of 4.63 (SE=0.36) acres, ranging from 2 to 15 acres per field. Figure 2 shows the range of damage in the fields that were surveyed. Maximum damage was observed in fields that ranged from 2-5 acre.

Given the total area of each village and the compensation for damage paid to each village, the compensation paid/km^2 of village ranged from Rs. 466 to Rs. 14,173 with the mean of Rs. 3231 (SE= 852, N=17). Using this assessment framework it was clear that compensation paid was most for village Chakgaudanahalli, followed by Bhudnur, Theranimunti and Depegaudanapura. Details for other villages are given in the table 2.

Table 2: Names of the villages that incur economic losses, their area and compensation amount paid per km^2 of village area.

Sl. No	Village Name	Economic loss (in Rs.)	Area of village(km^2)	Compensation paid/km^2 of village
1	Halasur	3,000	6.4	466.0
2	K Yadathore	5,000	9.7	513.6
3	Kalegaudanahundi	2,500	3.6	698.3
4	Lanke	9,100	6.9	1315.5
5	Huvinkala	16,300	11.9	1367.6
6	Nanjenayakanahalli	8,000	4.9	1624.7
7	Mallahalli	2,800	1.7	1635.3
8	Manuganahalli	9,500	4.7	2012.3
9	Hunasehalli	7,500	3.2	2379.2
10	Surahalli	23,300	8.1	2863.1
11	Makanapura	10,600	3.5	3056.6
12	Kasuvinahalli	31,200	10.0	3105.3
13	Heggudilu	22,000	6.6	3312.3
14	Depegaudanapura	40,600	10.5	3871.6
15	Theranimunti	6,800	1.7	3907.6
16	Bhudnur	35,000	4.1	8620.9
17	Chakgaudanahalli	70,000	4.9	14177.3

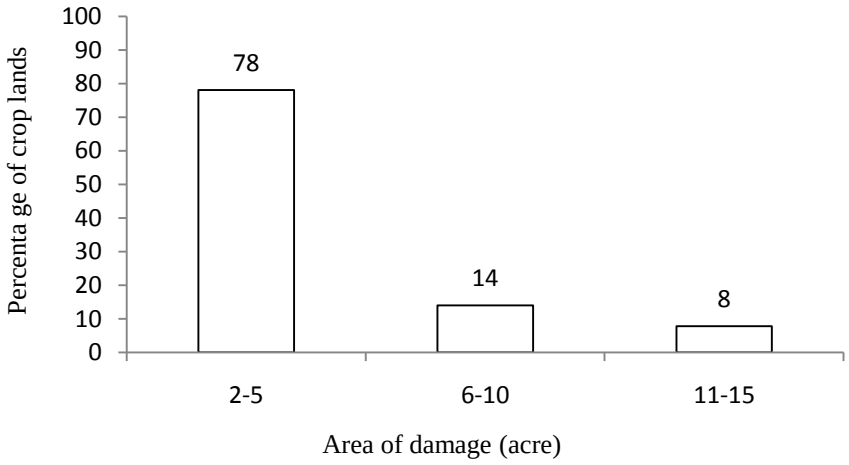
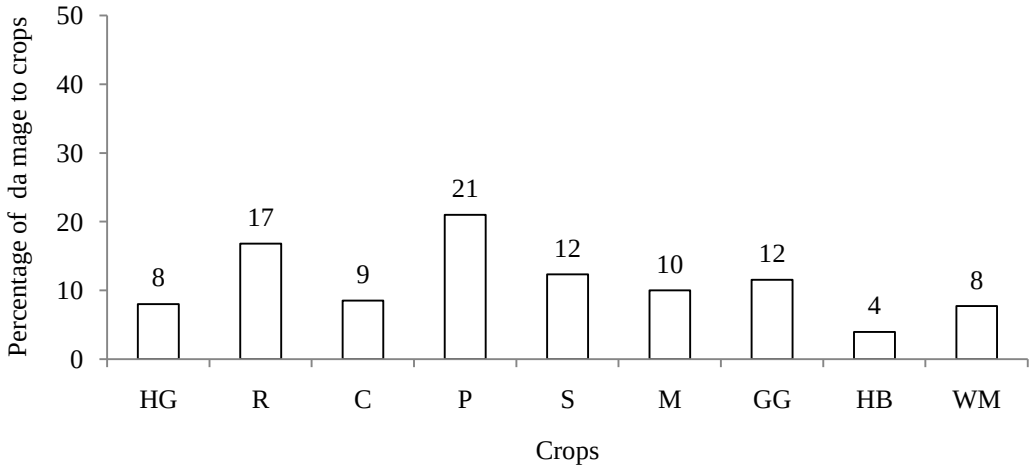


Figure 2: Crop lands damaged by elephants as reported by villagers

The assessment of damage for different cultivated crops suggested that the maximum damage was to paddy followed by ragi and sugarcane. The patterns of damage of the crops can be seen in figure 3. Plants such as banana and coconut also were destroyed by

the elephants. The intensity of damage to the banana plants was comparatively greater as compared to the other plants.



HG: Horse gram, R: Ragi, C: Cotton, P: Paddy, S: Sugarcane, M: Maize, GG: Green Gram, HB: Hyacinth Bean, WM: Water Melon

Figure 3: Percentage of crop damage reported by villagers for different crops

Crop damage incidents assessed by the research team

Distance from the forest to the villages that reported crop damage (for annual and seasonal crops) during the investigation ranged from 0 to 7 km and the highest incidents (43%) of damages were within the distance of 0 to 1 km, followed by 2 to 3 km (19%), 1 to 2 km (14 %) and 6 to 7 km. The distances from the villages that reported crop damage incidents to the water bodies fall from 0 to 2 km and 81% of the incidents of crop damage reported fall within 0 to 1 km. The patterns of crop damages for both annual and seasonal crops are given in figure 4

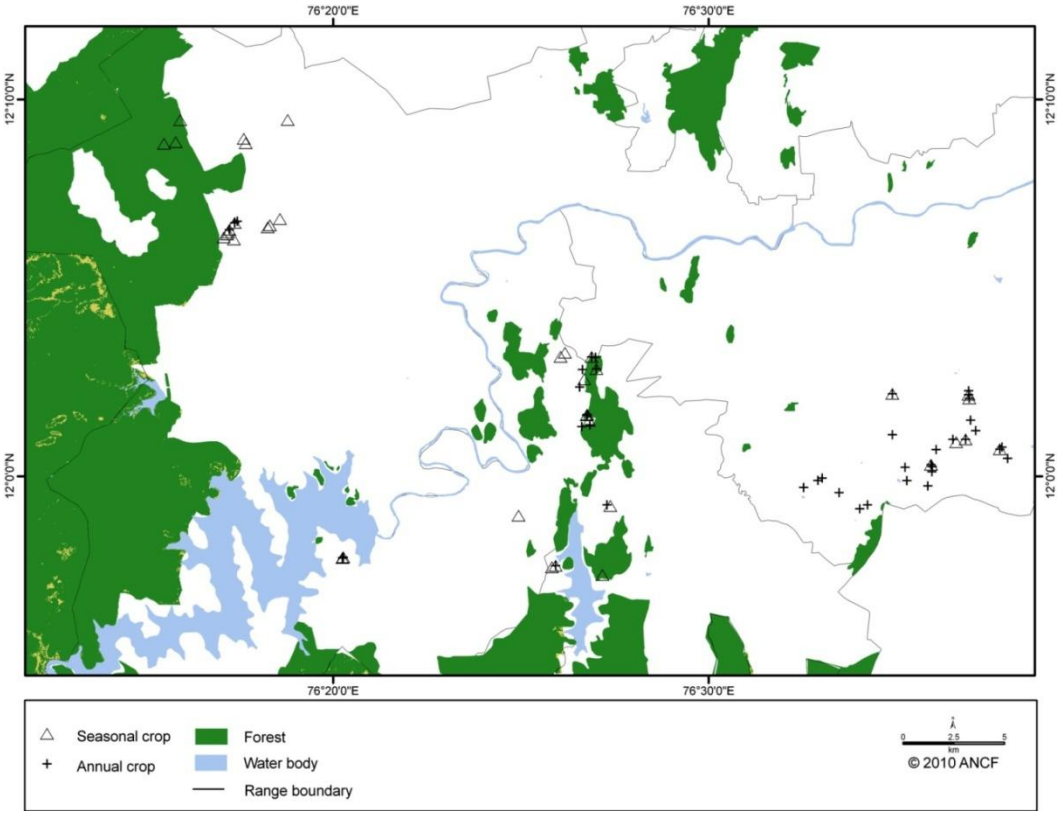
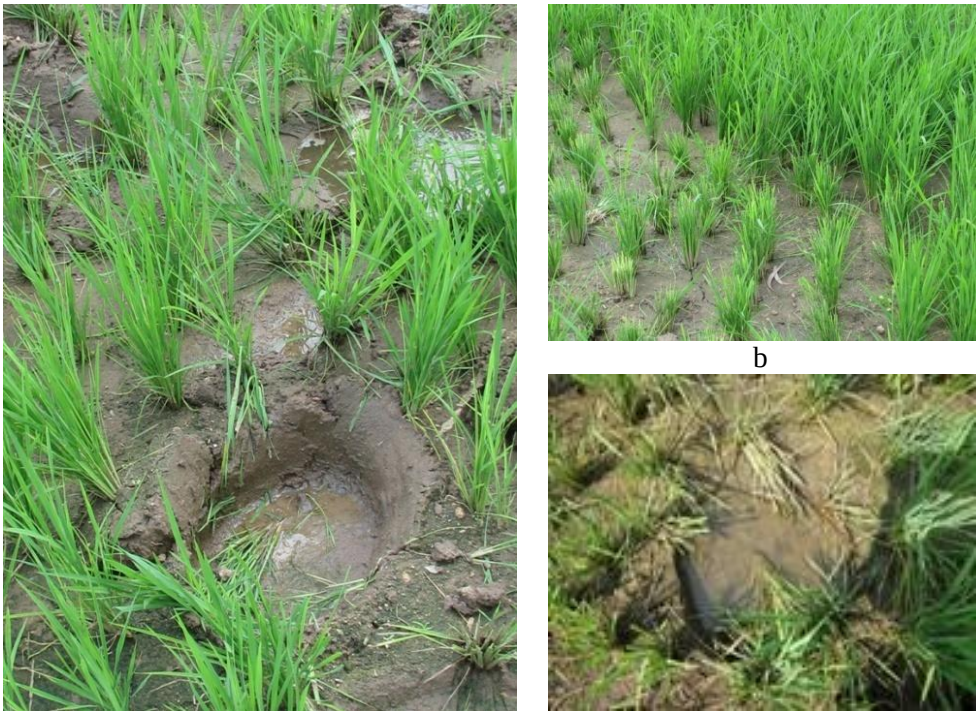


Figure 4: Map showing the distribution patterns of seasonal and annual crops damaged by elephants in sampled villages during the study period in Mysore Forest Division



a b c

Figures 5a, b and c: Damage to paddy by elephants during the study period

The actual area of damage suggested that the damage to paddy (Figures 5a, b and c) was highest. This was followed by ragi and horse gram (Figure 6).

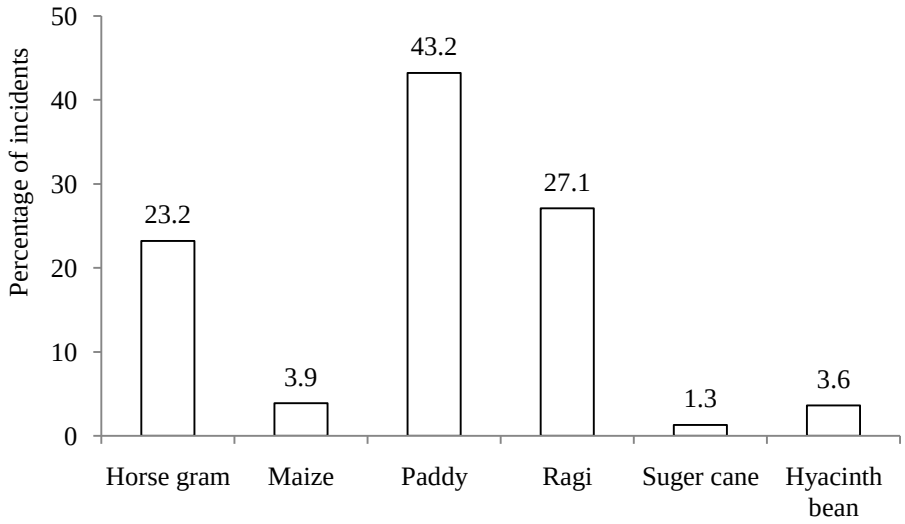


Figure 6: Damage to six different crops (in m^2)

Figure 7: Damage to banana plants by elephants during survey period

Plants such as banana, cotton and toor dal also have been damaged by elephants. Elephants damage banana (Figure 7) more in relation to other crops followed by cotton and toor dal.

The extent of damage to crops by elephants per visit varied from 6 to 1000 m^2, with a mean of 115 (SE = 10.6, N= 155) m^2. A total of 155 incidents of crop damage were reported during the study period and during a single visit 1 to 15 plots (or locations) were damaged (with the mean of 5, SE=0.46, N=34).

The area of crop damage during the survey period was dominated by the class interval of 15 to 20 m^2. The distribution pattern of crop damage for different class intervals in terms of m^2 is given in Figure 8.

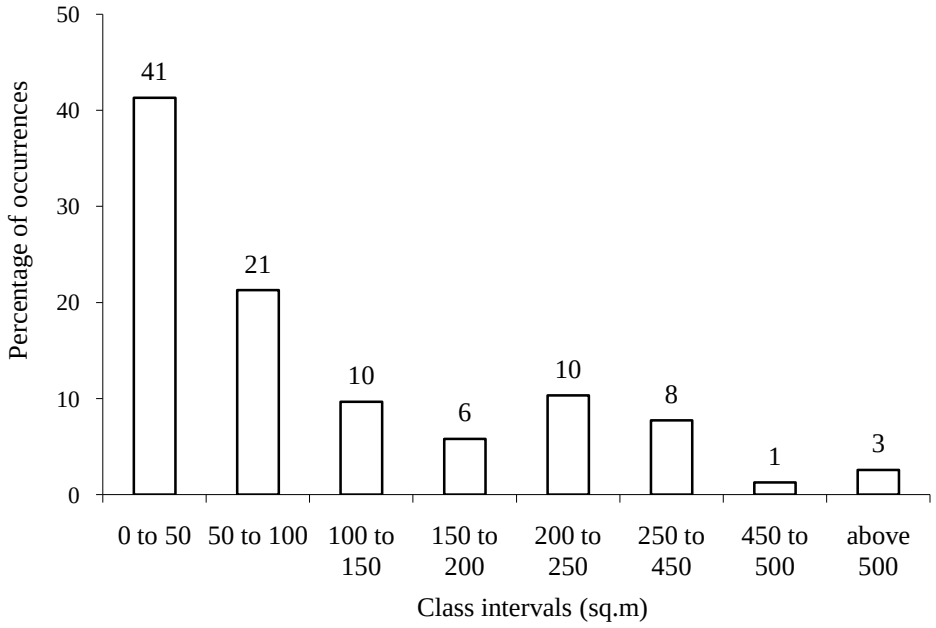


Figure 8: Damage assessed for different crops in the study period

There may not be any relationship between number of plots damaged per visit and the total area damaged (Figure 9). The maximum plots damaged per visit fall within 6 and the area damaged was 200 to 500 m^2.

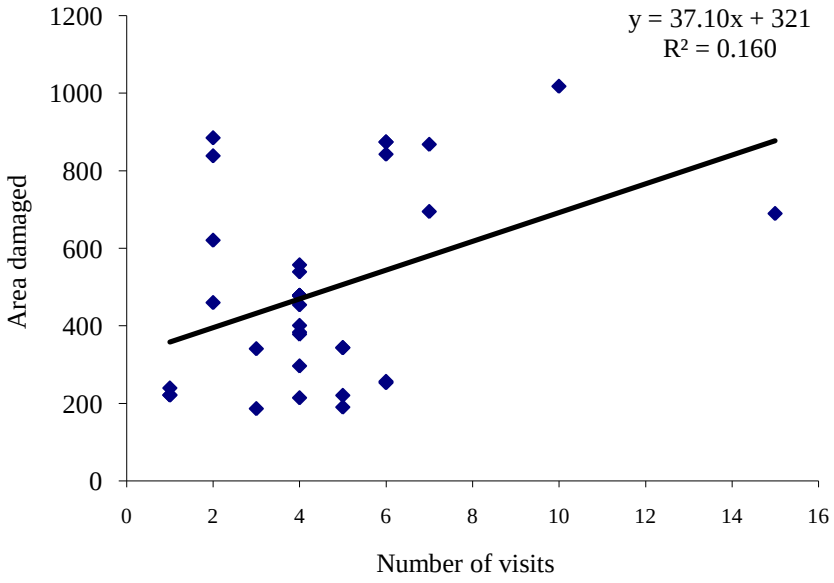


Figure 9: Correlation of number of visits and area damaged for the different crops of the villages selected for the investigation

The patterns for the extent of damage for different crops indicated that the plots of horse gram (Figure 10) were damaged to the largest extent followed by paddy and ragi. The results for paddy and ragi may not be significantly different.

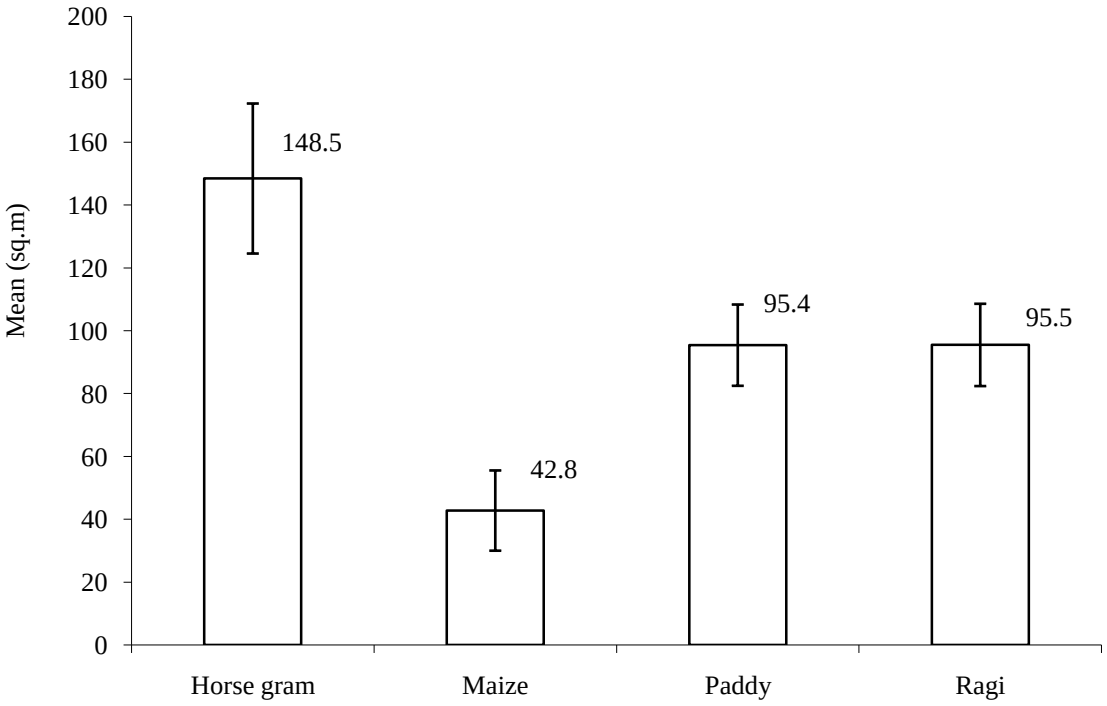


Figure 10: Extent of damage for different crops

Village wise crop damage

Total area damaged

Village and individual crop wise data for total area damaged and mean area of damage are given in the tables 3 and 4. The result of total area damaged across all crops indicate that Chakgaudanahalli encountered most damage followed by Heggudilu, KG Hundi, Hosahalli and Theranimunti. The total area damaged range from 1000 to 3399 m^2. Damage to ragi was highest followed by rice and horse gram. In Heggudilu the damage to paddy was reported. In KG Hundi, horse gram and hyacinth bean was damaged. In Hosahalli ragi was damaged most followed by rice and damage to sugarcane was reported in Kasuvinahalli.

Mean area damaged

When the mean area damaged by elephants is assessed a different trend is indicated. Theranimunti reports more damage in terms of mean area of crop damaged, followed by KG Hundi and Halasur. In all these villages the mean area damaged for horse gram was high. In addition to horse gram, hyacinth bean and rice crops were damaged in KG Hundi. Considering both mean and total area damaged, KG Hundi appeared to be affected most by crop damage problem.

Table 3: Total area (m^2) of crops damaged in different villages selected for the investigation

Village	Horse gram	Hyacinth bean	Maize	Paddy	Ragi	Sugarcane	Total
Hunasehalli	186.6						187
Hallare	214.6						215
Halasur	460.7						460
Surahalli	220.8		256.8				478
Kalegaudanahundi				478.6			479
Makanapura	478.6						479
Lanke	341.1				190.4		532
K Yadathore				874.4			874
Manuganahalli					918.0		918
Nanjenayakanahalli				948.5			948
Huvinakala	557.4				401.2		959
Kasuvinahalli						1000	1000
Theranimunti	1106.6						1107
Hosahalli				478.6	1187.0		1666
KG Hundi	838.7	621.0		383.8			1843
Heggudilu				2086.2			2086
Chakgaudanahalli	940.2			1144.2	1314.8		3399
Total	**5345.3**	**621.0**	**256.8**	**6394.3**	**4011.4**		**17628**

Table 4: Mean area (m^2) of crops damaged in different villages selected for the investigation

Village	Horse gram	Hyacinth bean	Paddy	Ragi	Mean
Hosahalli			119.7	107.9	111.0
Manuganahalli				114.8	114.8
Heggudilu			115.9		115.9
Kalegaudanahundi			119.7		119.7
Makanapura	119.7				119.7
Huvinakala	139.3			100.3	119.8
K Yadathore			145.7		145.7
Halasur	230.1				230.1
KG Hundi	419.3	310.5	95.9		230.4
Theranimunti	368.9				368.9

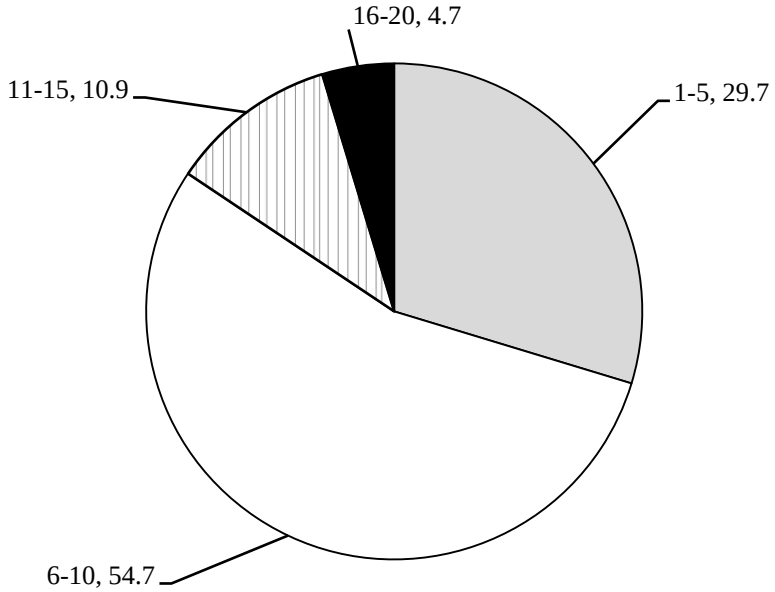


Figure 11: Group sizes of elephant visiting cultivated crops

Elephant group sizes

Elephant group sizes ranging from 1 individual to 20 (Figure 11) were reported visiting crops. The group size of 6 to 10 appeared to be dominating; this is followed by the group size of 1 to 5.

Photo source: *Andolan* news paper

Figures 12a: A large elephant group entering cropland

Elephants come in big herds (Figure 12a and b) and get broken into smaller groups with different groups visiting particular areas. Elephants, up to 12 in number, stay in small hills which act as shelter, source of food during day time. According to the forest staff, elephants are observed to be feeding on different parts of plant species such as *Acacia concinna* (locally called seege), *Acacia leucophloea* (nayibela), *Givotia rottleriformis* (bettadore or bettathavare), *Bambusa arundinacea* (bamboo), *Mangifera indica* (mango) *Shorea roxburghii* (jala) and *Tectona grandis* (teak). All these plants may be very scarce in forests near village boundaries.

Figures 12 b: A large elephant group entering cropland

Elephants were observed (Figures 13a, b and c) by the ANCF team using small hills (small forest patches) from 11 a.m. - 5 p.m. in the evening and within this time period, they were observed to move only less than 200 m. Elephants seem to be meeting their day needs within the hills, the distance traversed by them during the day time was very short. Late in the evening they come down to the water bodies and then go into the cropland in which they travel up to 4 km at night. Water storage tanks, ponds in villages are also one of the main reasons for elephants to come into villages. Water sources within the villages are well maintained whereas there is no convenient water source in forests. According to forest staff, until 1986-87 elephant population and conflict was small. These have now increased primarily because of decrease in forest area.

a

c

b

Figures 13a, b and c: Elephants observed in Mullur Betta near Nugu Reservoir

Animal details

The survey revealed that 44% of the foot prints discovered in and around the damaged fields ranged from 121-140 cm in circumference. Assuming elephants which possess footprints with circumferences ranging from 30-80 cm are juvenile elephants, while the elephants possessing footprints with circumferences ranging from 81-120 cm are sub-adults, or adult females and all elephants possessing footprints with circumferences greater than 120 (cm) could be expected to be adult males, the survey revealed that most of the elephants raiding the crops were adults. Figure 14 depicts the range of sizes in the foot prints seen in and around the damaged fields.

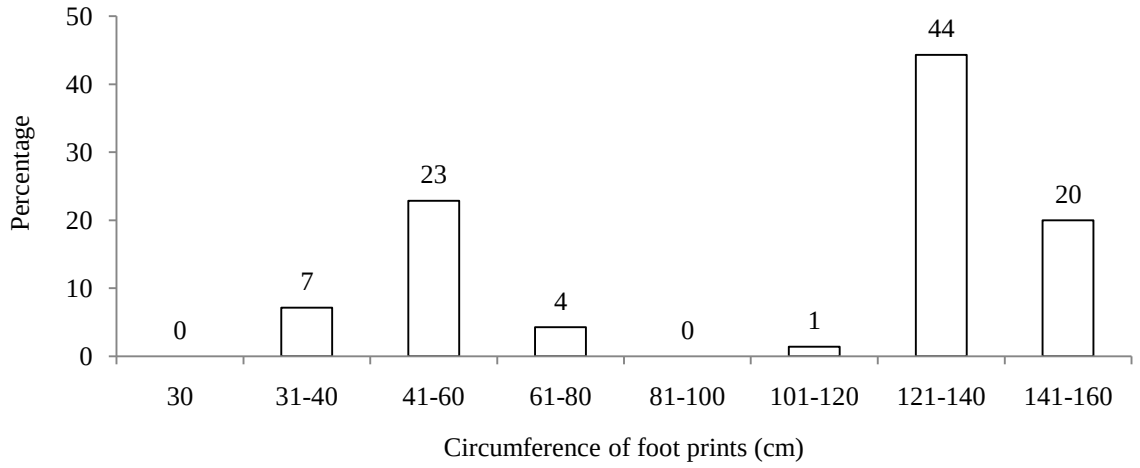


Figure 14: Range of circumference of foot prints found in and around the damaged fields

The survey of the dung piles in and around the vicinity of the damaged fields revealed that 55% of the dung piles ranged from 1 to 10 droppings. Figure 15 shows the range of number of dung piles in and around the damaged fields.

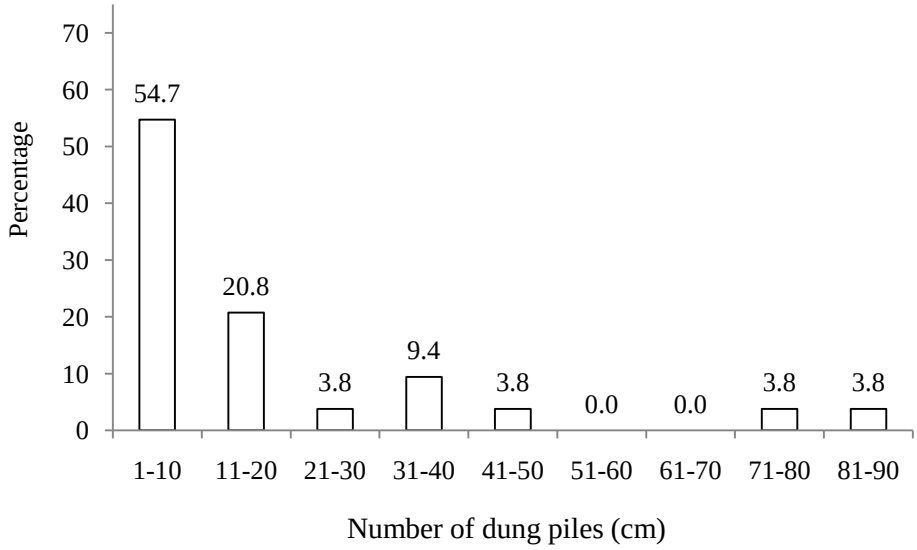


Figure 15: Range of dung piles in and around the fields

Seventy three per cent of these dung piles had circumference which ranged from 36 to 40 cm followed by 16% which ranged from 41 to 45 cm (Figure 16).

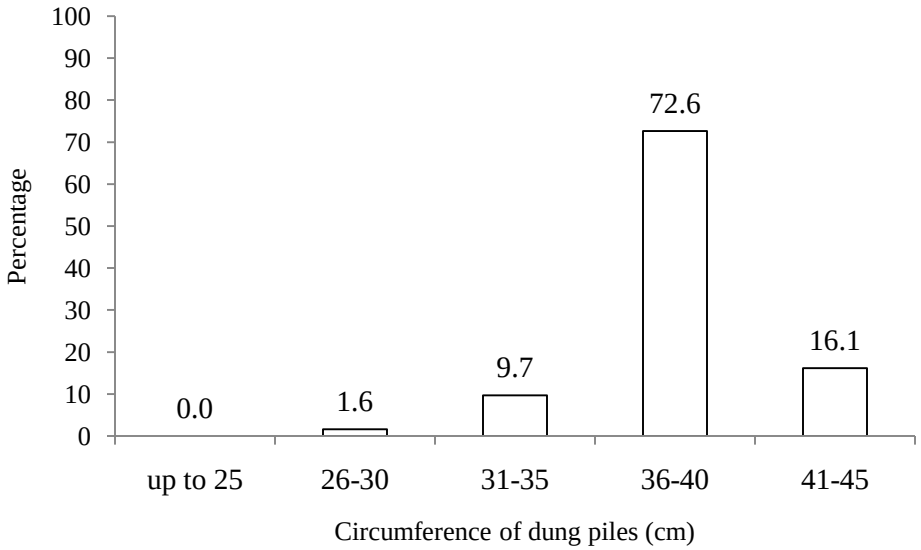


Figure 16: Range of circumference of dung piles in and around the damaged fields

Comparison of the results with the known age class of captive elephants (see Appendix 6), suggests that the circumference of dung piles measuring above 31 cm are estimated to be from elephants above 15 years of age. Elephants that visited crop fields during the investigation were adults and were accompanied by a few young ones (2%). The indication of adult elephants visiting crop lands is also supported by foot print measurements (see figure 14) carried out by the ANCF team.

Frequency of elephant visits

Of the villagers interviewed, 84% revealed that elephants visited the fields daily, 13% said thrice a week and 3% said elephant visit villages six times a month. They visit the fields after dark or during the evening hours and stay till dawn. The duration of stay of the elephants in the fields is shown in figure 17.

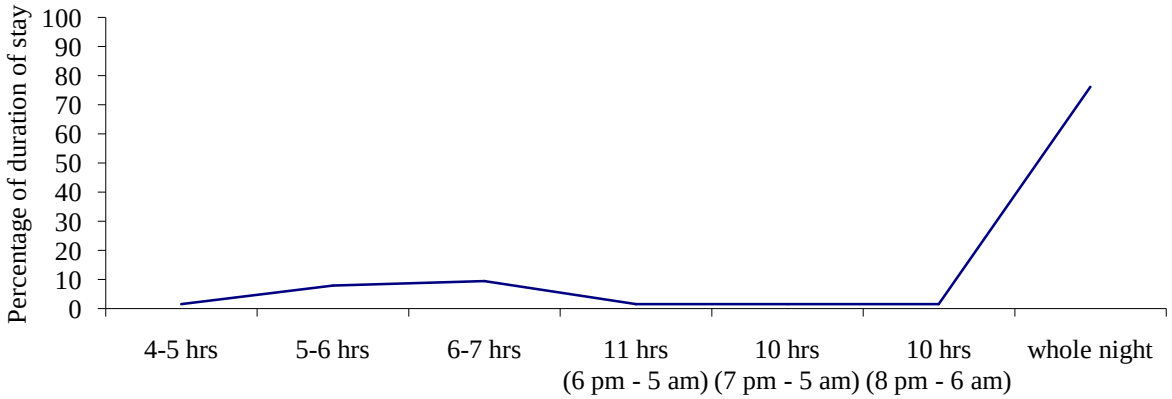


Figure 17: Percentage of the duration of stay in the fields

Methods of mitigation and their efficacy

Villagers used methods such as machans, torch lights, crackers, fire and noise to drive away the elephants (Figure 18a). The majority (44%) of the farmers depended on machans. Machans (Figures 18b and c) are temporary tree houses built by farmers for night watching. One or two villagers stay in it and when they hear or spot elephants, they use high beam torches initially and later make noises through drums, crackers and shout loudly to scare away elephants. Machans are mainly used for 1) spotting elephants, 2) initiating the elephant scaring operation. In some cases a combination of different methods proved to be effective. However the efficacy of all the methods followed as perceived by the villagers was 'medium' in terms of value.

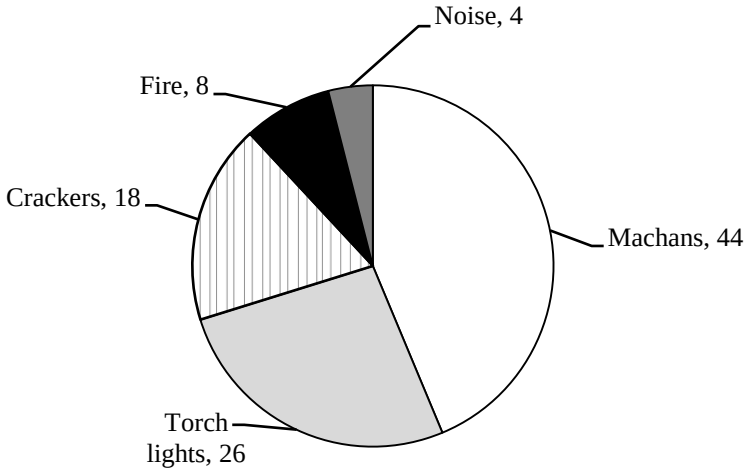
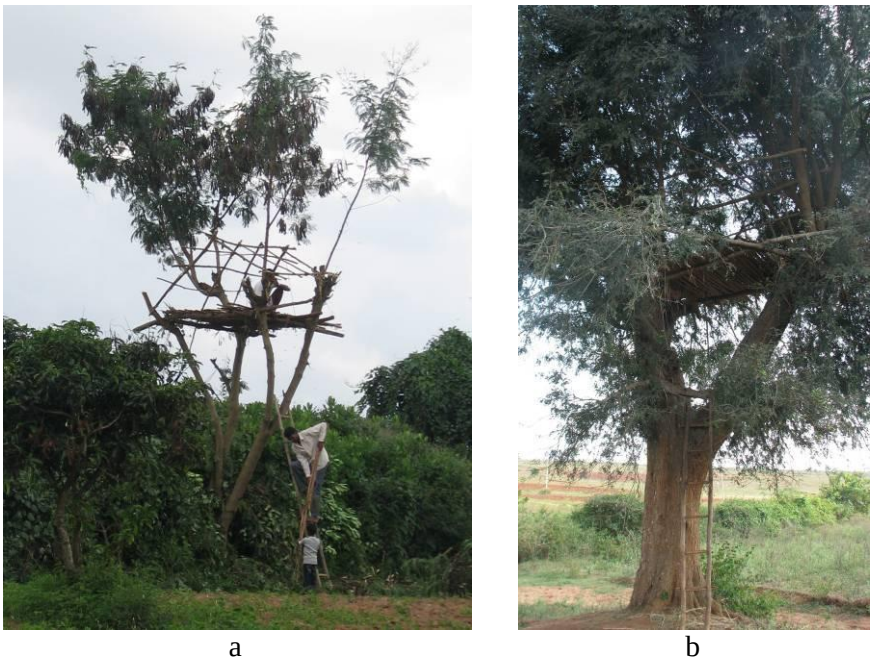


Figure 18a: Methods used to mitigate conflict



a b

Figures 18b and c: Types of *machans* used for locating and chasing elephants from crop lands

Conclusion

A total of 23 villages were selected for the study carried out from September 2009 to March 2010. All the villages reported conflict during the study period. In terms of compensation paid, and the total area of crop damage, the village Chakgaudanahalli reported the highest conflict. The patterns obtained from the village interviews during the same study period also indicated similar results. However if one considers the mean area of crop damage reported for the villages, HG Hundi reported the highest conflict. A study over one season or a one season based ground survey may not accurately reflect the actual status of conflict. Depending on the cropping patterns or crop available to elephant, the pattern of conflict in a given village may change. This calls for long-term studies for monitoring villages. However on the ground, monitoring of many villages for a long time is not possible as that generally leads to limiting the number of villages surveyed in the available time frame. Even with this approach, those particular villages may or may not be exposed to conflict during the survey period.

Under these circumstances, details obtained from crop or property damage compensations payment records may reflect a truer pattern for multiple villages. These villages can be brought under one comprehensive list of villages that are affected every year and specific patterns of conflict could be arrived at. However reporting of crop damage, compensation assessment and payment are flawed by many factors and the quality of information obtained from this record may be compromised. It is therefore important to balance between assessing the ground status of the actual crop damage assessment and information gathered from the compensation records. Improving the information on the quality of the crop or property damage and compensation assessment and payment, would improve the quality of information available for analysis of conflict.

Elephant number or density may be related to cropping season, crop availability, crop growth stage when they are consumed. The number of incidents of conflict taking place may be linked to the number of elephants using the habitat. The general trends of group size of elephants observed by the investigation follows the patterns observed in the wild. In the wild, elephants are known to split into smaller groups during dry season and the group size increases during the first and second wet seasons. They appear to maintain the large group size across the wet seasons (first and second) and these seasons coincide with peak conflict months in Mysore Forest Division. Interestingly, the big groups entering the villages come as a large group and split into small units while raiding crops. This lessens their chance of detection while raiding the crops or it could be that the big groups cannot effectively exploit the limited areas of crops available. Elephants appear to be deciding their size of group for the villages to visit. These group sizes may also be linked to daytime shelter available to them near croplands.

Conflict is reported in the villages during October, November, December, January and February. From the high density elephant regions, during summer, elephants move to Coorg region in Karnataka. Elephants appeared to use their natural forests only during the first wet season (May, June, July, and August). During the first wet season, grasses may be more palatable and in the second wet season (from September to December) the same become coarser and unpalatable and during the dry season (January to April) forest may

not provide enough food, water and shade. Seasonally changing resources, loss of habitat and corridors, attraction towards the crops, all these factors may make the elephants to not use the forest during the second wet and dry seasons and but force them to move towards crop lands (Sukumar, 1989; Low, 2000). If elephants use habitat only for crop raiding, they should be prevented at the source itself by effective mitigation measures. Otherwise, they may be killed due to conflict related deaths. As mentioned earlier, situation in Mysore forest division is unique as the conflict of elephant with human beings may not be linked to them using the habitat as part of their corridor. This may create negative conservation interest among local community and will have a severe effect on the world's largest elephant population.

Section VI:
Status of Human-Elephant Conflict Mitigation Measures

Background

The presence of cultivated crops on a large scale, attractive to elephants, supported by rivers, reservoirs, and other water bodies near high elephant density regions makes for suitable conditions for human-elephant conflict (Bell, 1984; Barnes, et al., 1995; Nath and Sukumar, 1998; Easa and Shankar, 1999; Hoare, 2000; Sitati, 2003; Prabal, et al.,2008; Varma, et al., 2008a). Cultivation of crops supported by different sources of water make crops available to elephants throughout the year creating serious challenges in preventing elephants' incursion into crop fields (Newmark and Hough, 2000; Sitati,et al., 2003; Varma et al., 2008b). The presence of ground forces during the conflict season by way of elephant scaring squads provides confidence to local communities. The local community is also in a position to understand the constraints involved in mitigating conflict and also recognizes the effort the forest department puts in. However, the idea of using watchers is to alert the farmers but if it works with constraints such as limited manpower, no resources or no planning, it could be ineffective and more importantly put the lives of forest staff in danger (Kumar, 2008). The effectiveness of elephant proof barriers which are used to deal with a few elephants, or only for a specific season, decreases when they have to deal with a large number of elephants throughout the year. More importantly, the speed with which the barriers are established (or spread to other areas) is not as fast as the spread of the cultivation practice. This further forces the wildlife authorities to work hard in developing new mitigation measures (Tchamba, 1996; Sitati, et al., 2003; Parker and Osborn, 2006; Varma, et al., 2008b). The Mysore Forest Division has a programme of paying compensation for crop and property damages, and human injury and death by elephants. It has established several kilometers of elephant proof barriers and has a very active ground force termed as 'elephant scaring squads' to deal with incidents of human-elephant conflict (Srinivasan, 2002). There is therefore a need for assessing the efficacy of these mitigation strategies followed in the Division.

Status of elephant proof barriers

Elephant Proof Trenches (EPT)

EPTs used in the MFD fall into two categories. The first one was established using human labour and the second by using machines (high speed tractors or excavators, also called 'JCB machines' manufactured by JCB-India). HD Kote range has a total length of 12 km of barrier and it has been established in 3 locations. Out of three, one is manmade and other two are by machinery. These trenches cover Sollepura and Metikuppe forests preventing elephants' entry into villages from Nagarhole forest. The trenches are located near the villages Chakgaudanahalli-Metikuppe, Hosahalli and RG Hundi villages. According to the forest staff, elephants move from the barrier covering villages Hosahalli, RG Hundi, Chakgaudanahalli, Bhudnur, Bommalapura, Nanjenayakanahalli, K Yadathore, BR Katte and Basavanagirihadi.

Sargur range has a total of 24.5 km of trenches in two locations. They cover Nugu forest regions preventing elephants' entry into villages from Bandipura forest. The trenches are present in Kothegala hill and Chikkadevamma betta (hill, CDB) regions. Elephants move

from the barrier up to a radius of 10-12 km into villages like Puradakatte, Huvinkala, Halasur, Hunasehalli, Kundur, Dadadahalli, Lanke, Kothegala and Chamegaudanahundi. Nanjangud has a total of more than 10 km length of trenches established. These trenches cover Omkar Wildlife regions preventing elephant entry into villages from Bandipura forest. Elephants move from the barrier into villages Depegowdanapura, Siddegaudanahudi, Makanapura, Kasuvinahalli, Siddayyanahundi, Surahalli and Mallahalli. The major crops cultivated in all these villages are horse gram, ragi, cotton, paddy, toor dal, sugarcane, banana, maize and watermelon *(Citrullus lanatus)*.

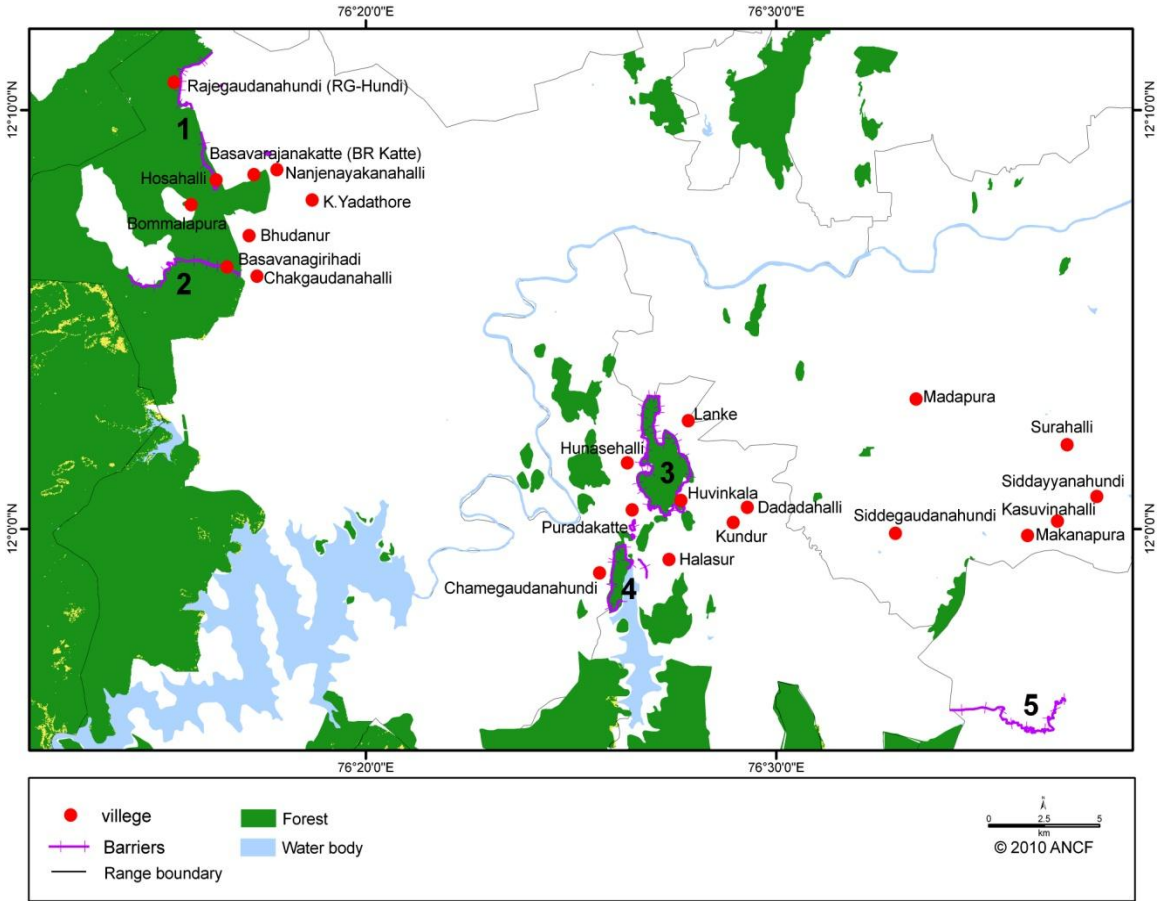


Figure 1: Map showing the locations of elephant proof barriers, villages around the barriers and sample code (number) assigned for the barriers in Mysore Forest Division

In general, trenches adjoin agricultural land or forest region or a combination of both. Forested region adjoining elephant proof barriers are generally degraded, conspicuous by the absence of big trees. Forest patches have bamboo clumps, one or two big trees. Otherwise land is barren with most or vast area under woody plants and scrub. Overall, EPT covers regions such as Sollepura, RG Hundi, Puradakatte, Chikkadevamma Betta, and Dasanabetta. EPTs were established in 4 different periods from 1981 to 2008-09 and 45 % of the EPTs were established between the years 2007 and 2008 (Figure 2).

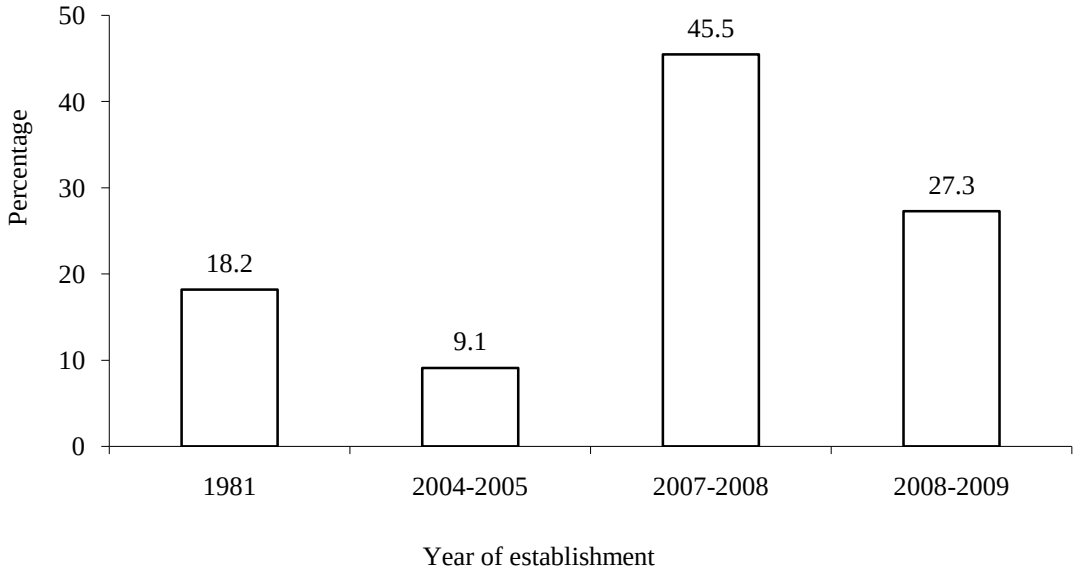


Figure 2: Year of establishment of EPT around villages or crop lands

The EPTs cover a total distance of 34.7 km with a mean length of 3.59 (SE=0.55) km. The EPTs had a mean top width of 2.41 m (SE=0.22), bottom width of 1.04 m (SE= 0.11) and depth of 3.23 m (SE=0.36) (Figures 3a, b and c). The forest department has spent Rs.8.36 crore for establishing these barriers.

a

b

c

Figures 3a, b and c: Location, alignment and dimensions of Elephant Proof Trenches (EPT) surveyed

Electric fence

Electric fences have been established by both the forest department as well as the farmers. Forest department has established one fence, covering 8.7 km. There are more than 50 fences established by farmers present in HD Kote, Sargur and Nanjangud. The forest department or government solar fence was not part of Mysore Forest Division, but was established by the Metikuppe Wildlife Range of Rajiv Gandhi National Park during 2007 and 2008. The fence covers Sollepura and Metikuppe forest in HD Kote preventing elephants' entry into villages from Nagarhole forest.

The fence is present in Chakgaudanahalli-Metikuppe junction. Electric fences cover regions of Chakgaudanahalli, Nanjenayakanahalli, RG Hundi and Puradakatte. Elephants move from the barrier into the following villages: Chakgaudanahalli, Bhudnur, Bommalapura and Basavanagirihadi. Major crops cultivated in these villages are horse gram, ragi, cotton, paddy, toor dal, sugarcane and banana.

The electric fences were established in 4 different periods, starting from 2005 to 2009. A total length of 13.9 km was sampled for the survey, which included 8.7 km of fence established by the forest department and five fences established by farmers. The mean length of fence established by the farmers was 0.78 (SE=0.17) km ranging from 0.45 to 1.3 km. The details of cost of maintenance incurred by the forest department were not available. The villagers reportedly spent Rs.1500 to 3000/year for the maintenance of the privately established fence.

Out of 5 fences belonging to farmers that were sampled, 2 solar fences were from HD Kote and established between 2005 and 2009. Both fences together cover a length of 1.3 km preventing entry of elephants into their farms from Nagarhole forest. The fences are present in RG Hundi and Nanjenayakanahalli villages. Crops cultivated in these farms are sugarcane, banana, coconut and ginger. Three other fences belonging to farmers are from Sargur range and they cover a length of 2.6 km and were established in the period between 2003 and 2005.They prevent entry of elephants into farms from the forests of Bandipur National Park. The fence is present in Puradakatte village. Crops cultivated in these farms are sugarcane, banana, vegetables, toor dal and mango.

Different designs of electric fences were used by the farmers (Figures 4a, b, c, d, e and f). The wire used in these fences varies from 7-10 layers. If it is a 10-layered fences, three layers of wires viz. bottom, top and the third or fourth are connected to the power supply. The power supply in the bottom layer is intended to tackle the damage the elephants do with their legs, the top layer for dealing with the head of the elephant and the middle layer to deal with any part of the elephant body including the trunk.

a

b

c

f

d

e

Figures 4a, b, c, d, e and f: Types and designs of electric fences sampled

If power supply is given to all the layers the power stored may not be enough. If solar panel is charged it works for 4-5 days (2-3 days on cloudy days). Some electric fences have 7 strands, with the earth wire at the bottom. Except the bottom wire all the others have power supplied to them. Four to five elephant visits are observed every season.

In addition to the electric fence, there are very simple approaches followed (Figures 5a, b, c, d, e and f) by local villagers to prevent elephants' entry into crop lands in places where the elephant proof barriers are broken. A string is tied between two poles. Tin containers or plastic covers with stones are hung from the string, and the containers made of tin sheets or the plastic bags with stones, make a lot of noise when the wind blows. The string with the tin containers and plastic bags is placed at the entry point where elephant proof barrier is broken. Fire is lit at the other side of the string. People do keep big stones (boulders) in the entry points. In a number of locations a pile of small stones are arranged to prevent the elephants from entering the croplands.

Damage to barriers

For both EPT and Electric Fence together (48.6 km), a total of 226 incidents of damage were recorded.

Classification of the causes of breakages of elephant proof barriers

Causes for the breakage of elephant proof barriers encompass a wide range of factors. The various reasons are also unstructured, thus making them difficult to understand. Hence, classification of the causes in this context has twin-fold advantage. Since these are varied, grouping them under relevant categories helps to identify the root cause of barrier inefficiency. This also assists in channelizing the collective efforts of stakeholders in a certain direction to address the problem. By classifying the reasons as per the survey, a general idea on the various possibilities of combination of causes could be ascertained.

Several complexities were encountered during the classification process. Firstly, the task involved closely examining the uncertainties in some of the causal agents. For example, when no further data is available, it is difficult to assume that the term 'water' implies only rainwater. This may also be water from canals or riverlets, thus leading to a certain degree of ambiguity. Secondly, when a combination of factors is involved, it is essential to figure out the primary and the secondary agents. For example, rainwater causing mudslide has been placed under the water sub-category of nature and not mudslide. Moreover, this should be distinguished from trench damage caused exclusively by mudslide. These when not reflected correctly would affect classification. Taking these constraints in to consideration, the causes have been classified into various categories (Table 1).

a

b

c

f

e

d

Figures 5a, b, c, d, e and f: Additional approaches followed by villagers to prevent elephant entry into crop lands in locations where elephant proof barriers are broken

Elephants, by themselves, or along with wild boar cause significant damage to the barriers. They decrease the depth of the trench by shoving mud into it. This action creates a slope in the trench area thereby enabling animals to cross it. Rainwater from forest or farmland gets washed into the trench along with mud and soil. This, in combination with elephants that push soil into the trench, also assists in decreasing the depth of the trench. The effectiveness of the barrier may be reduced by villagers who create mud paths into the forest for cattle grazing and to collect forest by-products. Villagers also dump excess soil from their farmlands into the trenches or remove soil from the trenches for their use. Other miscellaneous factors include establishment of improperly planned trenches, dumping mine waste and garbage into them, and joining of two or more trenches which decreases their viability.

While mudslide and landslide cause considerable damage, the efficiency of elephant proof barriers, particularly elephant proof trenches (EPT) is predominantly reduced by the action of water and rainwater on them. Water channel and flood along with mud, created by rainwater flowing from farmland or forest, break into the trenches. The depth thus decreased is reportedly utilised by villagers to create vehicle and mud path into forest for cattle grazing. The reduction in the efficacy of barriers has also been attributed to wild animals, such as wild boar, that shove mud into the trench. Besides acting on their own, they also work in tandem with humans and nature to cause significant damage to the barriers. It is to be noted that in some cases, the cause for the damage of trenches and fences remains unknown and may only be speculated upon.

Patterns of breakages to elephant proof barriers

In Mysore Forest Division about 35 different causes were identified for the breakages of elephant proof barriers and the results for the causes for four trenches and one electric fence have been presented in Table 1 (see Appendix 7 for more details). This includes breakage by elephants, cattle entry points or paths made for cattle's entry into forest, decrease of the depth of barrier, soil filled into the barrier (Figures 6a, b, c, d, e, f, g, h, i, j and k), rock slide into the barrier, soil removed by the villagers for their use (in the case of electric fence), and other such causes.

Out of the 32 causes identified, cattle related causes dominated. These causes were in the forms of path created by cattle, cattle path used by people for entering into forest to bring out forest products, excess rainwater flow into trench from the forest or agricultural land creating cattle path, and mud slides decreasing the depth of the trench and becoming a cattle path. Such cattle related causes for the breakages of barriers range from 15-38% (Table 1). Other important causes found were mudslides, rockslides, water flow that decreases the depth of the trench, using trench for filling garbage, soil taken for farmers' use. For individual barriers, the elephant related causes contribute 8-15%.

Table 1: Causes for the damage of elephant proof barriers (in percentage)

Sl. No		CAUSES FOR DAMAGE OF ELEPHANT PROOF BARRIERS	Trench No. 1	3	4	5	Fence No. 2
		I ELEPHANTS					
		EXCLUSIVELY BY ELEPHANTS					
1	1	Elephants	8	6	18	50	31
		ELEPHANT AND WILD BOAR					
2	2	Elephants and wild boar	1	1	0	0	0
		ELEPHANT AND NATURE					
3	3	Elephants, water, soil and flood	4	4	0	0	0
4	4	Elephants, rockslide and rain decreasing depth	1	11	3	0	0
		II MAN-MADE					
		BY FARMERS					
5	1	Farmers using trench for forest path	1	0	0	0	0
6	2	Farmers draining out rain water into trench	1	0	0	0	0
7	3	Farmers dumping soil from farmland into trench	1	0	0	0	0
8	4	Farmers removing soil from trench	1	0	0	0	0
		FOR CATTLE PATH					
9	5	Cattle path into forest	21	38	10	0	25
10	6	Cattle path and collection of forest products	27	0	0	0	0
11	7	Cattle path and mudslide decreasing depth of trench	0	3	0	0	0
		FOR FOREST PRODUCTS					
12	8	Trench closed for vehicle path into forest	5	9	5	17	0
13	9	Trench not constructed and used by public	6	9	3	33	0
		MISCELLANEOUS					
14	10	Trench closed by mine waste	0	1	0	0	0
15	11	Hole in trench used for dumping garbage	0	1	0	0	0
16	12	Rocks in trenches yet to be removed by dynamite	1	0	0	0	0
17	13	Trenches joining together decreasing viability	0	1	0	0	0
18	14	Establishment of improperly planned trenches	0	1	0	0	0
		III NATURE					
		MUDSLIDE					
19	1	Mudslide	0	3	0	0	0
		LANDSLIDE					
20	2	Landslide	1	0	8	0	0
		WATER					
21	3	Water	3	1	10	0	0
22	4	Water and cattle path	0	0	20	0	0
23	5	Rainwater	0	0	5	0	0

24	6	Rainwater and flood causing mudslide and breaking trench	0	6	3	0	0
25	7	Rainwater and soil flood	5	0	5	0	0
26	8	Rainwater from forest creating water channel and breaking into trench	5	3	0	0	0
27	9	Rain water and water channel creating cattle path	1	0	3	0	0
		MISCELLANEOUS					
28	10	Growth of Lantana plants in trench	1	0	1	0	0
		IV WILD ANIMALS					
29	1	Wild boar	1	1	3	0	0
		V COMBINATION OF AGENTS					
30	1	Trench depth decreased by animals, man, nature	1	0	0	0	0
		VI CAUSE UNKNOWN					
31	1	Trench broken but cause unknown	1	0	3	0	0
32	2	Trench broken; maybe due to animals, humans and rainwater flood	3	0	0	0	44
		Total number of breakages	78	79	40	6	16
		Total length of the barrier	7.6	17	7.5	2.9	8.7
		Encounter rate of breakages/km	10.3	4.6	5.3	2.1	1.8
			100	99	100	100	100

a b

Figures 6a and b: Types of damages caused by different agents; cattle entry path (a), and plant growth (b)

c

d

e

h

f

g

Figures 6c, d, e, f, g and h (clockwise): Rocks and stone (c), water flow (d), mud slide (e and f), water and plant growth (g) and barrier not constructed (h)

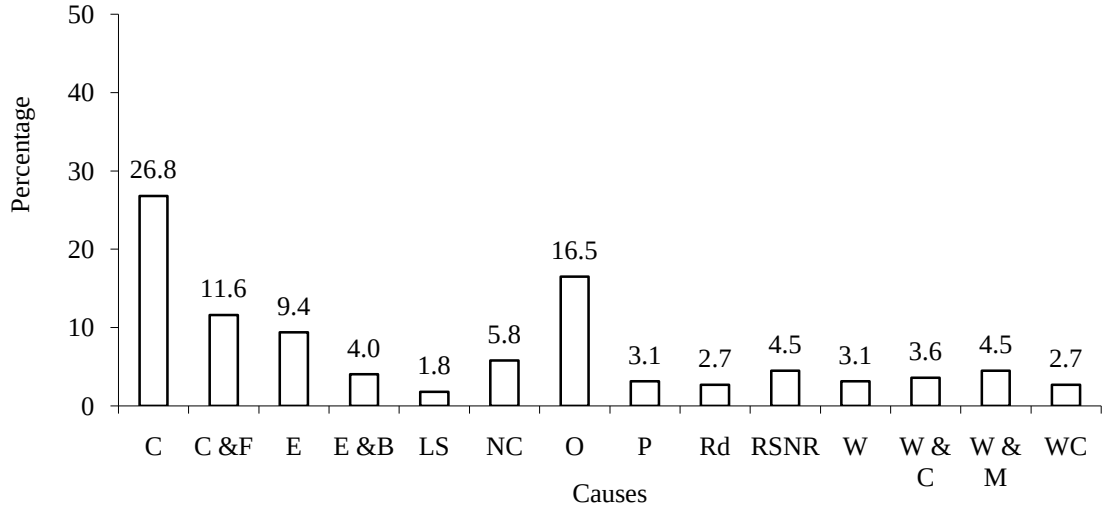
i

j

k

Figures 6i, j and k (clockwise): Poles damaged by elephants (i and j) and cattle entry (k)

Overall, the assessment of damages by different causes indicated that cattle and their entry into forests appeared to be the dominant cause for barrier breakage and that elephants contributed to only 9% of the incidents of damages. If we consider the causes of damage by elephants and wild boar, elephants contribute 13% of overall causes (Figure 7).



C: Cattle path, C & F: Cattle & collection of forest products, E: Elephants, E&B: Elephants and wild boars, LS: Landslide, NC: Not constructed, O: Other cause, P: Path, Rd: Road passing through, RSNR: Rocks and stones not removed, W: Water flow, W& C: Water flow & cattle path, W & M: Water & mud flow, WC: Water flood & water channel connecting

Figure 7: Causes of damages to the elephant proof barriers in Mysore Forest Division

For both elephant proof trench (EPT) and electric fence, all the causes can be brought into seven categories (see table 2) and in the case of EPT, 59% of causes were associated with manmade activities, followed by natural causes that contribute about 18%. Elephant, wild boar and other wildlife cause 13% of those breakages and elephant exclusively causes only 9%. For the electric fences alone, manmade causes dominate (61%) followed by elephant and wild boar 26%.Unknown causes make up the rest 13% (Figure 8).

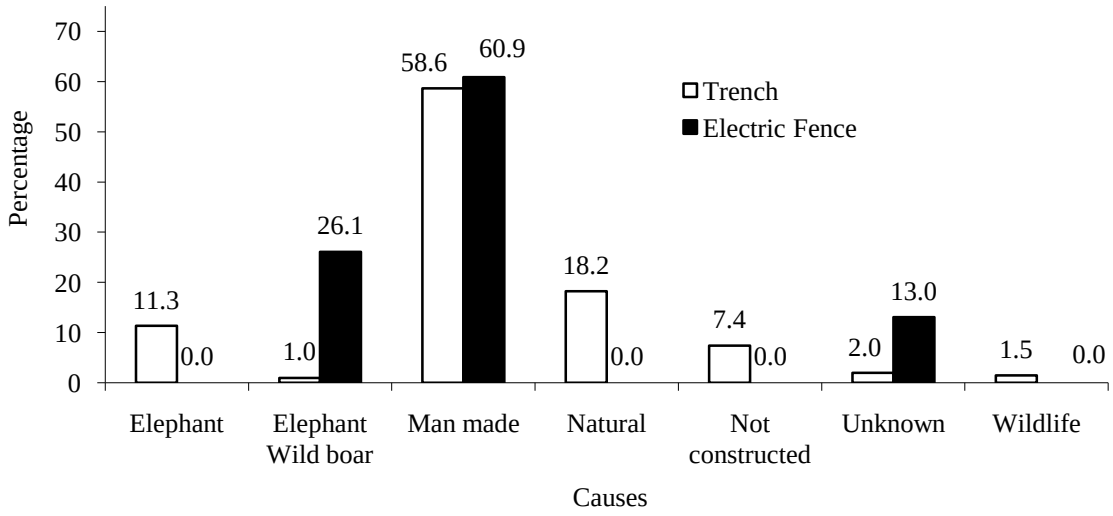


Figure 8: Causes of damages to the elephant proof barriers - EPT and Electric fence - established in Mysore Forest Division

Breakages for different trenches

An analysis of causes for breakages for all the trenches suggests that manmade causes dominate (Figure 9) followed by elephant (21%) and natural (15%). Elephant, wild boar and other wildlife cause mean of 2% breakage. The categories 'Manmade' and 'trench not constructed' together contribute 52% of breakages. If one includes 'natural causes' the amount of breakage accounted for goes up to 70%.

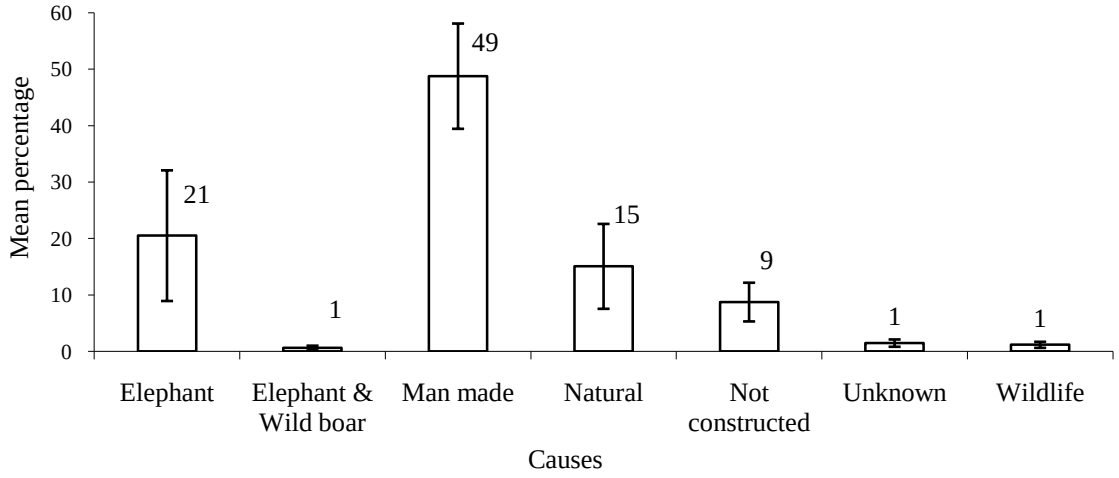


Figure 9: Causes reported for damage to Elephant Proof Trenches in Mysore Forest Division

To understand the pattern for individual trenches and fences, they were brought under specific codes of numbers (see figure 1) and numbers 1, 3, 4 and 5 denote trenches and number 2 denotes one 8.7 km electric fence. The other fences are smaller in size, established along with trenches as second lines of defense. Their locations overlap with each other and the details about them are given less priority.

Trench number 1 (Figure 10) was primarily established to form a barrier against elephants from Rajiv Gandhi National Park. This barrier experiences breakages due to different causes. Elephant related damage contributes 8%, while development of cattle path results in about 40%. Encounter rate of breakage per kilometer by manmade cause is 7, and 1 per kilometer by elephants.

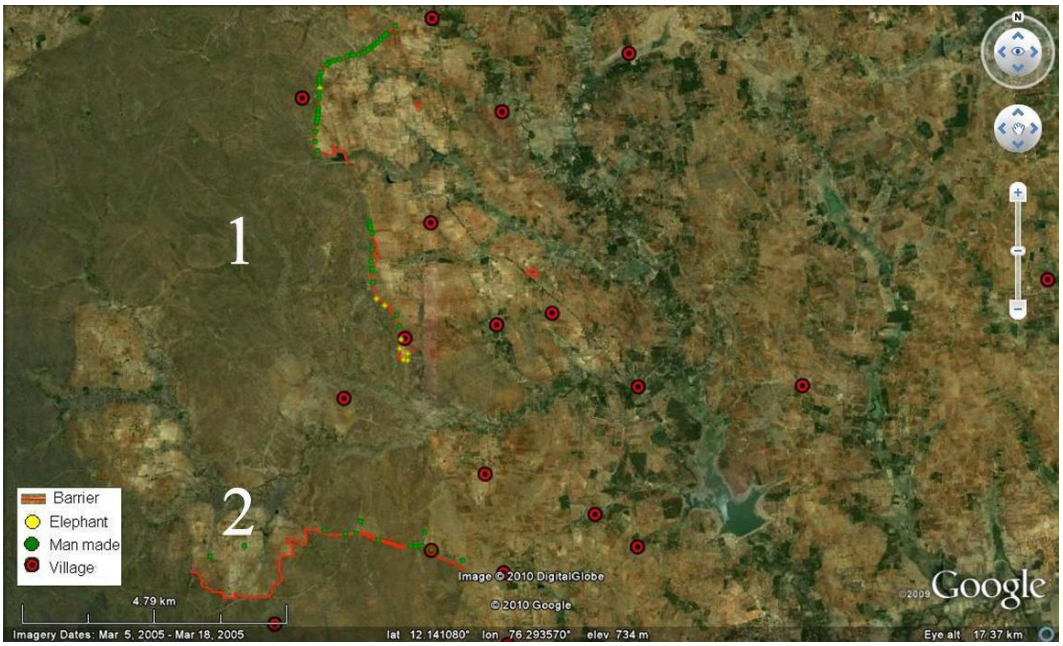


Figure 10: Map showing location of EPT no. 1 its breakages due to various reasons, and the villages around the barrier

For the trench number 3 (Figure 11), that covers CDB which act as a shelter for elephants during the daytime, 62% of breakages are due to manmade causes and elephants contribute only 6%. Mudslide, water flow are also some of the specific causes. Here the breakage per kilometer reported by manmade causes was high (3.0/km) and elephant, wild boar and other wild life cause 0.5 breakages per kilometer.

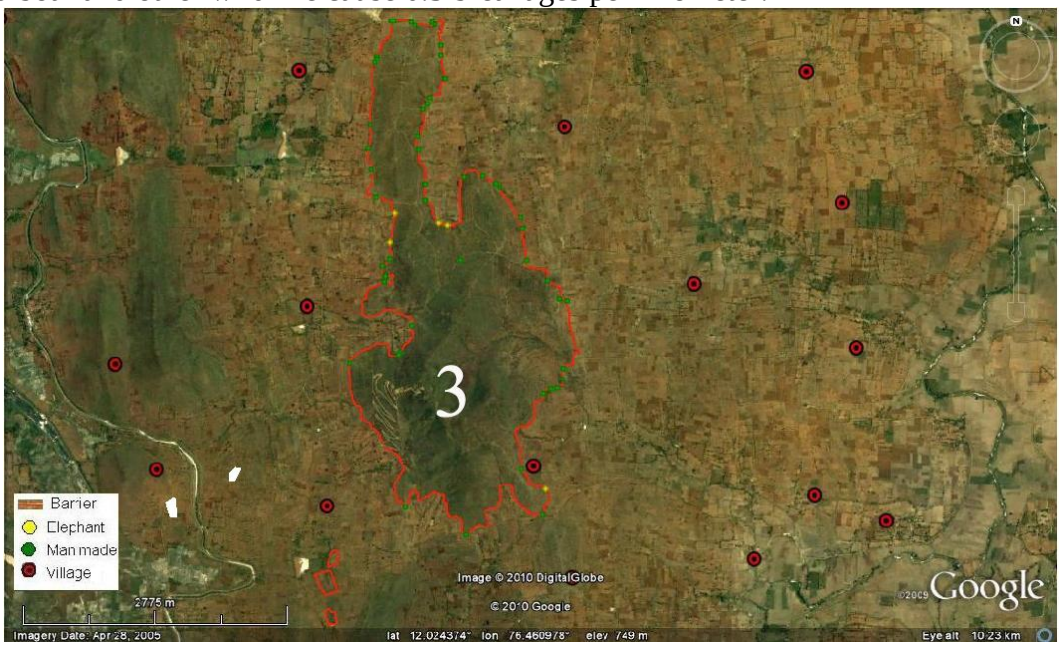


Figure 11: Map showing the location of barrier no. 3, damaged due to various reasons, and the villages around the barrier

Trench number 4 (Figure 12) is 6 km in length, 15% of the breakages for the trench are by cattle, and cattle path and water flow together cause 45% of breakage. Elephants in this location cause 18% and the encounter rate of breakage by elephant is 1/km. Both natural and manmade causes have two breakages per kilometer (Table 2).

Figure 12: Map showing the location of barrier no. 4, damaged due to various reasons, and the villages around the barrier

Trench number 5 (established to prevent elephant entry from Bandipur, figure 13) reported 50% of breakages caused by elephant. This was followed by causes such as trench not being constructed and mud-slides into it.

Figure 13: Map showing the location of barrier no. 5, damaged due to various reasons, and the villages around the barrier

Interestingly, the locations where the intensity of conflict incidents is high are known to have crucial entry points for elephants. The percentage of damage by elephant may be very high (as seen from 16%-50% breakages by elephant) where they enter from the forest (see table 1). The incidence of barrier breakages by elephants where they use forest for the daytime shelter maybe lower. This is evident from CDB, where elephants are known to use the hill during day time and it has only 6% breakage by elephants. The elephants appeared to put extra effort to come out of the forests and human causes facilitate their entry to daytime shelters resulting in more damage to crops.

Table 2: Breakage percentage and breakage encounter rates for Elephant Proof Trenches in Mysore Forest Division

Cause	Percentage of breakage					Encounter rate of breakage/km				
	1	**3**	**4**	**5**	**Overall**	**1**	**3**	**4**	**5**	**Overall**
Elephant	10.1	6.1	15.9	50.0	11.3	1.1	0.3	0.9	1.0	0.7
Elephant/Wild boar	1.3	1.2	0.0	0.0	1.0	0.1	0.1	0.0	0.0	0.7
Man made	63.3	62.2	36.4	33.3	58.6	6.8	3.0	2.1	0.7	3.4
Natural	13.9	14.6	31.8	0.0	18.2	1.5	0.7	1.9	0.0	1.0
Not constructed	7.6	8.5	2.3	16.7	7.4	0.8	0.4	0.1	0.3	0.4
Unknown	1.3	2.4	2.3	0.0	2.0	0.1	0.1	0.1	0.0	0.1
Wildlife	1.3	1.2	2.3	0.0	1.5	0.1	0.1	0.1	0.0	0.1
Total incidents						79.0	82.0	44.0	6.0	203.0
Total length						7.4	17.0	7.5	2.9	34.7
Encounter rate/km						10.7	4.8	5.9	2.1	5.8

The damages of 3.4 breakages for every kilometer were due to manmade causes, while elephants caused only 0.66 breakages/km. The combination of manmade and natural causes of barrier damages makes the problem more challenging. Together they contribute towards 77% of the breakages. If the cause of ‘not constructed’ is included then about 83% of the causes are accounted for by these three types. In addition to dealing with elephants, major percentage of energy and effort has to be spent on the causes related to manmade and natural reasons of barrier breakage that may require specific planning and strategies.

a

b

Figures 14a and b:
Elephant foot prints observed along
the barriers surveyed

The overall result suggests that elephants do not cross the trench at all locations and they keep walking along the trench and try to ingress only in the weaker locations (Figures 14a and b).

c

d

Figures 14c and d: Elephant dung piles observed at the entry points of the barriers surveyed

The number of elephant defecations observed near breakage points (Figures 14c and d) suggests that elephants may be spending a lot of time in these locations or waiting for a long time before they use the breakage points to enter the village or crop lands. They appear to know these locations very well. Every entry point appears to have dung piles.

It also appears that they come as a group and stand near the entry points. The dung piles have distinct age-size classes. But when they are in a hurry to escape from people chasing them, they are known to cross at any location irrespective of the trench being intact (Figure 14e).

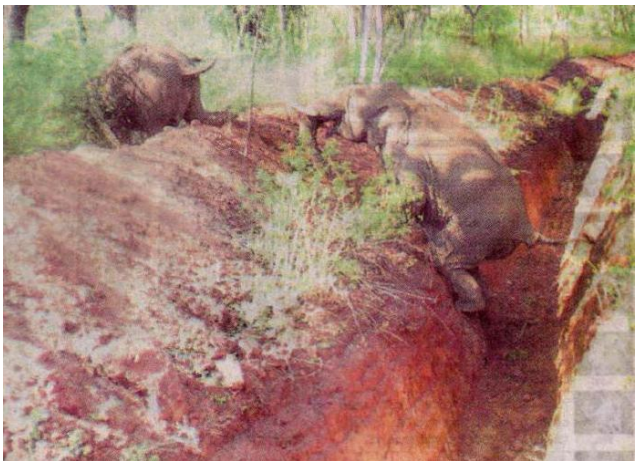


Figure 14e: An elephant crossing an unbroken EPT. Photo source: *Vijaya Karnataka*

Breakage for electric fences

Details for one 8.7 km fence (code no.2) suggest that elephants cause 31.3% of the damages to the electric fence and manmade causes contribute 69%. This is in the form of breakages made for cattle path, and/or fence broken completely, but cause unknown. For fences, the breakages done by elephants are clearly identifiable and clues for other causes are difficult to identify. Details of causes of breakages for individual fences are given in Table 3.

Table 3: Percentage and mean breakages from different likely causes of breakages for electric fence established in Mysore Forest Division

Causes	1	2	2a	Overall	Mean	SE
Elephant	0	0.0	0.0	0.0	0.0	0.0
Elephant & wild boar	0	31.3	25.0	26.1	18.8	11.7
Man made	0	68.8	75.0	60.9	47.9	29.4
Natural	0	0	0.0	0	0.0	0.0
Not constructed	0	0	0.0	0	0.0	0.0
Unknown	100	0	0.0	13	33.3	40.8
Wildlife	0	0	0.0	0	0.0	0.0
Total incidents	2.0	4.0	16.0			
Total length	0.5	4.7	8.7			
Encounter rate/km	4.4	0.9	1.8			

The electric fences established by private owners generally are over short distances say 2-3 km. With manpower they are able to attend to each damage, whatever may be the cause, and are able to effectively maintain the fence well. However there are different problems associated with electric fences and depending on the manufacturer, the quality and the cost of fence varies. Buying from an established company, the cost of electric fence of 1 km distance is about Rs. 1.5 lakh and a total of at least Rs. 3 lakh per km is needed for a farmer to establish electric fence around his crop land. The farmers generally prefer to sacrifice quality to save resources for fences that would otherwise cost Rs.1.5 to 2 lakh per km. It was observed that some fences use sub-standard materials. In

addition to this, stone pillars that serve as supporting poles are prone to elephant attacks. It is reported that flexible poles are relatively better as when elephant attacks the pole moves towards the elephant so the elephant may not be in a position to handle such situations. Farmers who have little personal resources, but depend on loans can afford only inferior quality fences having stone pillars, low quality wires, insulators and weak batteries. The knowledge and interest levels of farmers are low in terms of selection and maintenance of fence. Combination of inferior barriers along farm boundaries surrounding the hills and the inability of farmers to develop their own preventive measures makes conflict a serious economic, safety and conservation issue.

If we increase the sample size of the privately owned fences and compare them with government owned electric fences, the breakage to government owned fences may be much higher than for fences established by farmers. Many reasons could be attributed to this. Farmers generally have shorter length fences, and these fences may be attended regularly with manpower appointed specifically for the purpose. The government owned fences are long, with inadequate manpower for maintenance. Forest staff, with other responsibilities, are made to guard the fences. The distance that an individual forest staff has to traverse to maintain fences is very high. For example, if a fence is 8 km in length, that has to be monitored twice a day, the watcher has to walk 16 km every day. This may be achieved by having more manpower. However, due to lack of coordination among the forest staff and their involvement in other responsibilities, the approach to maintaining a long government-owned fence is currently unviable. The local people also appear to show no responsibility towards the maintenance of official property that is for the common good.

Efficacy of elephant proof barriers in preventing incidents of crop damage by elephants

Efficacy of elephant proof barriers can be assessed in a number of ways. If the year of establishment of a given barrier is known, the status of conflict before and after establishment of the same could be reviewed. However, even without the details of the year of establishment the overall changes in the number and extent of crop damage incidents reported across years and villages could be used for assessment. Efficacy can be also assessed by obtaining the details of increase, or decrease or stable status of conflict incidents for villages for the last 4, 3, 2 and 1 years (from the available data for the years 2004 to 2008). Villages falling within the 5 km buffer of each barrier can also be identified and analyzed to obtain information on the spatial and temporal distribution of conflict.

Results of conflict across the years for all villages

The data available on incidents of crop damage across the years suggest that there is no significant change in the conflict incidents. Although there are variations in the mean number of incidents (Figure 15), reported each year for a given village, the mean number incidents of crop damage across the years may not be significantly different.

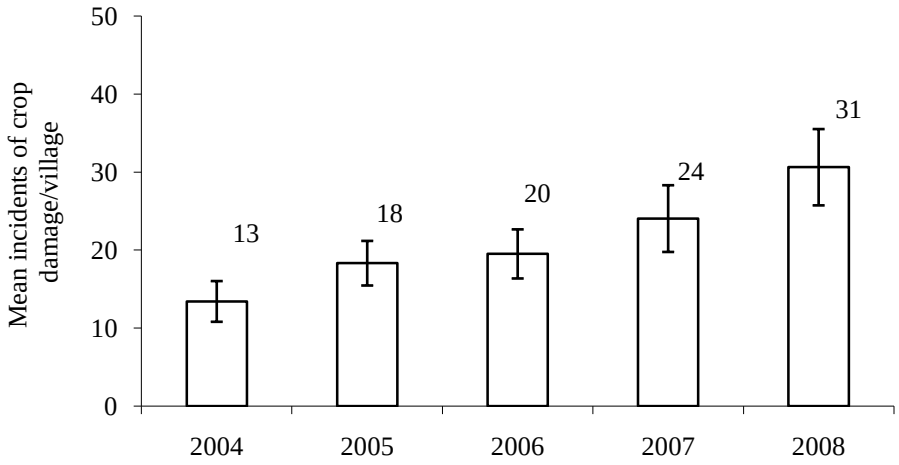


Figure 15: Mean crop damage incidents per village across the years in Mysore Forest Division

Mean conflict incidents for villages over the years and across barriers are given in table 4. Although there appears to be some variations in the numbers of villages affected, the variation may not be statistically significant. This may suggest that barriers have little influence in preventing crop damage incidents.

Table 4: Mean conflict incidents for villages across the years

		Mean (SE) incidences of damages/village				
Barrier Number	**Number of villages***	**2004**	**2005**	**2006**	**2007**	**2008**
1	10	19.1 (9.9)	24.2 (11.0)	30.9 (9.0)	22.2 (8.8)	24.4 (8.0)
2	9	19.1(14.7)	8.1 (4.0)	25.2 (18.3)	11.0 (7.7)	19.2 (14.1)
3	26	27.2 (9.3)	30.1 (8.9)	35.2 (10.2)	40.5 (12.4)	56.0 (18.7)
4	10	24.5 (18.0)	41.1 (22.0)	43.7 (26.1)	70.2 (45.1)	47.0 (21.2)
5**	1	28.0	17.0	29.0	51.0	54.0

* Number of village falling within 5km buffer

** Only one village falls within the buffer of barrier no.5; and the results are actual number of incidents

The patterns of conflict (increase or decrease or stable) across villages are given in table 5. There are 85 villages located within the 5 km buffer of barriers. Results from all the villages (irrespective of buffer) and their conflict status for last one year (2008) show increase in crop damage incidents in about 70 villages, decrease in conflict in 57 villages and crop damage incidents being stable in 14 of them.

From the results of increase or decrease or stable level of conflict incidents given in table 5, it can be found that 5 villages showed increase in all the four years (2005 to 2008) and only one village showed a decrease (2005 to 2008) of incidence of crop damage.

Table 5: Results of status of conflict across the years

	Number of villages			
	2005 to 2008	2006 to 2008	2007 and 2008	2008
Increase	5	7	11	70
Decrease	1	4	10	57
Stable	0	0	4	14
	6	11	25	141

In relation to the status of conflict (increase, decrease or stable) across specific barriers, about 50% of the villages in barrier 1 have reported increase in conflict, barrier 2 has shown a decrease of conflict (Table 6) in 44% of villages, and barrier 3 and 4 have shown an increase in conflict incidents in about 60% percentage of villages.

Table 6: Results of status of conflict across the various barriers

	Barriers Numbers				
	0	1	2	3	4
	Number of villages				
Increase	40	5	3	16	6
Decrease	37	3	4	9	4
Stable	8	2	2	2	
Total	85	10	9	27	10

These results may indicate the low efficacy of elephant proof barriers established by the Mysore Forest Division.

Point of elephant entry into ranges plays a very important role in conflict intensity and conflict mitigation. Nanjangud range has open entry near Omkar and HD Kote range all along the boundaries of Sollepura and Metikuppe forest areas. Sargur range has the facility of the small hills for the elephants. For every 100 elephant entries into the villages from protected forest area, it can be assumed that more than 60 entries will be from Omkar and 40 entries from Sollepura and Metikuppe forest areas. Omkar region adjoining Bandipur leads the elephants into Nanjangud range (Depegowdanapura, Surahalli, Kasuvinahalli, Makanapura, Siddegoudanahundi, etc) and Sargur range (Nugu regions-Puradakatte, Kothegala, Huvinkala, etc.)

Three layers of barrier have been built in Omkar region-

- Solar/electric fence: non-functional (Figure 16a) at the time of study (2009-2010).
- Trench has been broken in many places. Nearly 6 breakages for a stretch of 3 km.
- Rubble/stone wall constructed where the trenches have been damaged (Figure 16b).

a b

Figures 16a and b: Status of electric fence and stone wall in Omkar region

In addition to the many conflict mitigation measures and establishment of new elephant proof barriers, the Mysore Forest Division has recently come up with specific mitigation measures in specific locations. One such measure is focused in Zone A, covering Nugu reservoir and Mullur Betta. The plan is to establish a 'fool-proof barrier' starting from Hegdulu village covering Mullur Betta up to the existing EPT near Hosa Birval (next to Hediyala village).The proposed fool-proof barrier is expected to cover 9.5 km (Figure 17).

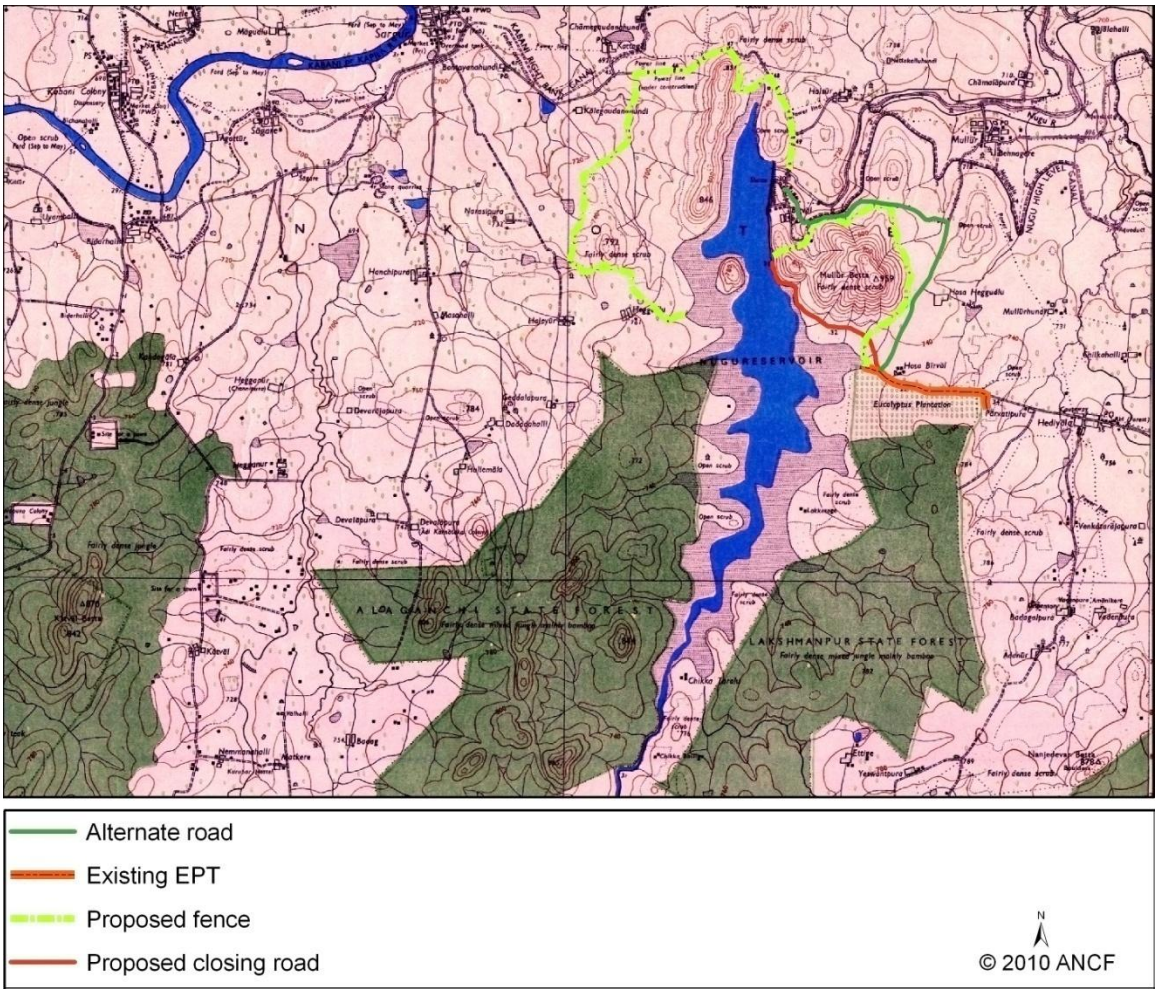


Figure 17: Map showing a specific mitigation measure of establishing a 'fool-proof barrier' near Nugu Reservoir and Mullur betta regions of Mysore Forest Division

It is important to note that if this proposed 9.5 km barrier is to be established and function effectively, a stretch of road passing through Mullur betta has to be closed and an alternative road has to be established. The department has come up with a plan for an alternative road and the proposed new road starts from Hosa Birvil via Hosahegdulu and connecting Birvil and will eventually join Hediyala-Sargur Road. It is essential to note that with the existing resources, the forest department alone cannot achieve this plan of establishing this fool-proof barrier. Support from other agencies (particularly multinational companies or institutions interested in wildlife conservation) are also needed. This proposed fool-proof barrier is expected to reduce conflict incidents in this division. The failure or success of this fence will help to develop a mitigation strategy for other areas which may also be important elephant entry points.

Compensation

Payment of compensation for crop and property damage, human death and injury is one of the conflict mitigation measures adopted by the Mysore Forest Division. Details of number of incidents of elephant visits to different villages and crops, and amount paid as compensation across the years (from 2004 to 2008) is given in the Section III. Here a brief description of the current status of compensation payment is given. Compensation rates for crops damaged by elephants have been revised (Table 7) from 2009 (on 05/06/2009) and new orders have been released on the demand from farmers.

Table 7: Revised compensation rates for crops damaged by elephants in Mysore Forest Division (from 2009 (on 05/06/2009))

Sl.No	Name of the crop	Old Rates	New Rates
1	Coconut	Rs.250/tree	Rs.1000/tree
2	Coffee	Rs.30/kg	Rs.100/kg
3	Banana	Rs.20/plant	Rs.80/plant
4	Paddy	Rs.250/Quintal	Rs.660/Quintal
5	Maize	Rs.200/Quintal	Rs.620/Quintal

Assistant Conservator of Forests can sanction an amount of up to Rs.1 lakh. Up to Rs.5,800 full amount is to be sanctioned. From Rs. 5,800 to Rs. 27,000, 50% of total amount assessed will be given and from Rs. 27,000 to Rs. 60,000, 30% of amount assessed will be given as compensation. Human death compensation has been increased from Rs.1 lakh to Rs. 1.5 lakh. For human injuries (by elephants), a sum of Rs.30, 000 will be sanctioned. For any property damage by elephants a sum of Rs.7, 000-13,000 will be sanctioned depending on the amount of damage.

Scaring of elephants

In addition to compensation schemes and elephant proof barriers, the forest department has human-elephant conflict mitigation squads. Forest staff is regularly involved in elephant scaring operations using a group of watchers as scaring squad (Figures 18a and b). The scaring squad, on an average, has five forest watchers who have 2-5 yrs of experience. The scaring operation is done during both day and night. Night scaring is done from 8 pm to early morning 4 am, seven days a week. A total of 13 members are in the scaring squad for HD Kote with 5-10 yrs of experience. They work in four villages Yelehundi, RG Hundi, Bheemanahalli and Mahadeshvara colony. One member will cover a village once in two nights and in case of any conflict the whole squad will reach the site.

In HD Kote region, 5 points (Machan, Boargallu, Sathekatte, Doddaladamara, at the end of trench) in a stretch of 3 km have been identified as sensitive regions and watchers belonging to the scaring squad are regularly assigned to monitor these locations. The watchers use crackers for scaring away the elephants. About 100 crackers are given for 2 days for a group of watchers. They have search lights whose light can reach up to a kilometer and also carry regular torches whose light which can reach up to 400 m.

Villagers from RG Hundi, Bheemanahalli, Yelehundi support the forest department. They help in chasing elephants, one person from each house joins the department's watcher squad. A register is maintained in which signatures are taken from farmers for constructing machans and chasing elephants. Private farm owners have watchers; they also participate in elephant chasing operations. These watchers are given a salary of Rs. 2500/month with accommodation. These watchers have 10 to 12 years of experience in chasing elephants. They form or engage small groups, and about 30-32 times in a year they go for chasing elephants from farm to forest. They work from 7 p.m. to 6 a.m. every day. They use torches to chase elephants. If elephants are not controlled by this approach,

a b

Figures 18a and b: Human-elephant conflict mitigation squads of Mysore Forest Division, discussion among team members (a) and forest staff inspecting elephant presence along the village boundary (b)

then they inform the forest department who bring their forest force with vehicles and help in chasing elephants away. According to the scaring squad members, the farmers are not supportive of the department's efforts. They do not take any preventive measures to protect crops that are not their own.

The watcher squad, while it is on the operations, is often attacked by elephants. One watcher was attacked 4-5 times by makhnas and once by a tusker in 1987, but was lucky to escape serious injuries. One watcher was attacked by tuskers twice, but escaped. According to the watchers, male elephants (tuskers or makhnas) are dangerous when they are single than when they are in a herd. Makhnas are known to be more aggressive, attacking and very unpredictable.

Conflict mitigation squad

The ANCF investigation recognized that Mysore Forest Division has very experienced and qualified manpower resources, and their level of understanding of the issue of human-elephant conflict is very deep. This squad (given details below) has also played a very critical role in developing current conflict mitigation measures.

- Mr.Thammaiah- ACF, HD Kote subdivision. He has been associated with the Mysore Forest Division for a long time. He has a very good working knowledge about crop cultivation, more specifically on the influence of recent changes in cropping patterns and their effects on conflict, elephant movement in and around the forest and villages. His strength lies in his vast experience of being in the field for a long time. His skills of working with sub-ordinates are well known and he is known for his command over the ground staff.

- Mr. Jaykumar- RFO, Nanjangud Range. He has been working in this range for many years. He has developed good leadership qualities and gained specific knowledge about the problem by being in the field. He conducts regular awareness programs in schools and is also involved in regular meetings with village committees.

- Mr. Mohankumar- RFO, Sargur Range. He has been working in this range for many years. He is known for his skill in handling problems and issues with villagers as his administrative range is most affected by the conflict issue. He has also developed specific knowledge about elephant behaviour by being in the field for a long time. Although considered to be a tough officer, he is known for his skill in managing ground staff effectively.

- Mr.Ramesh- Forester, Mysore Range. He has been working in this range for many years. He is also known for his working knowledge of GPS and developing GIS based maps for various projects of the Division. He appears to be interested in incorporating use of new technology in his work and is interested in sharing his knowledge with his colleagues and co-workers.

- Mr. Kempaiah- MRO watcher, Sargur range. He covers the area of Nugu and Chikkadevamma Betta. He has been working in the department for more than 20years. Being from a local village and working with department, he knows the landscape and problems related to human-elephant conflict fully. He is known for his hard work and knowledge about elephant movement in the field and shares his knowledge with others. He has been a member of the elephant scaring squad for more than 7 years and is involved in chasing elephants from farmland/villages into the forests. He has experience of encountering 20-25 incidents of elephants/season. He is known for his interaction and relationship with the villagers.

- Mr.Kalaiah- MRO watcher, HD Kote range. He covers the area of Bheemanahalli, Rajegoudanahundi and its surrounding area. He has been working with the

department for more than 20years. He is also from a local village, and known to have the knowledge of elephants and villagers. He is a member of the scaring squad for more than 5 years He has experience of encountering 10-15 incidents of elephants/season. He is also known for his interpersonal interaction and relationship with the villagers.

- Mr.Ramanayaka- Watcher, Sargur range. He covers the area of Chikkadevamma Betta. He has an experience in the department for more than 10 years. He is also a local person who knows the landscape completely. He is very hard working in the field. He works mainly to avoid forest fires during the summer season.

- Mr.Raicha- Watcher, HD Kote range. He covers the area of Chakgoudanahalli,Bhudnur, Bommalapura and its surrounding area. He has more than 15 years experience in the department. He has good skill of interacting with the villagers.

Conclusion

In comparison with other forest divisions and protected areas in Karnataka, the total length of elephant proof barriers (EPB) established in Mysore Forest Division is low. These barriers are also broken frequently to make paths into the forest for cattle grazing and for collecting forest products such as sand, timber etc. Elephants and other wild animals particularly wild boar, have also destroyed the barriers in many places. The breakages in the barriers appear to be high (about 6-8 breakages/km) near forest boundary (protected area) whereas the barriers in the small hills have less breakages (about 3-4 breakage/km). The trenches with more depth and width which have been recently constructed are much more effective as compared to the older, small trenches. Even with these initiatives, the conflict situation on the ground is increasing and more and more elephants and people are becoming victims of patchy and unviable approaches.

Including all the causes, about 5 breakages for both EPT and electric fence are reported per kilometer. These may contribute only a small proportion of damages to the total 1000 m barrier. It is also important to accept that a major part of the barriers is still usable. Therefore specific plans need to be in place to repair these breakages in timely manner. It is not very clear if breakages are actually caused by elephants followed by people starting to use them or it is people who create the breakages that facilitate elephant entry into cropland. However, if man made and elephant-made causes are addressed other important challenges to be addressed are the causes induced by natural phenomena. This would now lead to looking at the problem from 3 layers of expertise.

1. Elephant ecology and behavior
2. Understanding the natural causes of barrier damage
3. Understanding socio-economic status and motivations of the local human community.

This expertise may not be available to the FD from any one institution and this calls for working with a multi-disciplinary team with expertise covering these three important

aspects. Based on the expertise a specific plan could be drawn and that plan would help forest department and other stakeholders to mitigate human-elephant conflict in Mysore Forest Division. This suggestion may be applicable to other regions also where human-elephant conflict is a major conservation issue. It is interesting to note that, the effort, energy and resources put in conflict mitigation measures by the public and private sectors are very high. However, without any specific review of the efficacy of existing barriers, new barriers or conflict mitigation are adopted. If breakages reported are considered as 'hotspots' for elephant entry into the villages and if all damage to the barriers is done by elephants then it can be easily concluded that barrier mechanism does not work in those areas. However, it is not only elephants to be blamed, because people are mostly responsible for the breakages to the barriers. Farmers also mention that trenches are not properly constructed with very low depth and width, and fences are constructed with low quality materials. A combination of poorly established barriers and villagers breaking them are the cause for the conflict to increase. Ineffective and poorly built barriers are not at all serving the intended purpose.

Section VII:
Farmers' perspectives on human-elephant conflict

Background

In most cases, farmers are the first layer of people who suffer as a result of elephant-human conflict (Blair, et al., 1979; Hoare, 1995; Easa and Shankar, 1999; Varma, et al., 2008a). The conflict is not only related to economic loss but also the socio cultural identity of the local community (Mitchell and Slim, 1991; Newmark and Hough, 2000; Prabal et al., 2008). The local community with small land holdings, poor resource gathering or management skills is not able to sustain lives and livelihoods amidst conflict. Any conflict mitigation strategy should incorporate local communities' knowledge and draw on their perceptions about conflict (Mitchell and Slim, 1991; Mehta and Kellert, 1998; Ogutu, 2002; Gadd, 2005; Basappanavar and Kaveriappa, 2007; Prabal et al., 2008). A review of the knowledge of the local community on human-elephant conflict is important as this provides a true picture of their strengths or weaknesses in understanding and addressing the problem (Prabal et al., 2008). Understanding community knowledge or perceptions is possible only through a sustained empathetic investigation. Farmers' perceptions of conflict take full account of the ground realities. The fact is that community knowledge or perceptions are not systematically gathered or well utilized. Along with the farmers' perspective on the status of conflict, details such as structure of communities, their sources of income, land holdings, crops cultivated and exposure of crop to damage, mitigation measures adopted, support expected on conflict mitigation measures, may also help in developing conflict mitigation strategies (Basappanavar and Kaveriappa, 2007; Prabal et al., 2008).

Profile of the villagers

The distribution of the different income class of people sampled for assessing villagers' perspectives on human-elephant conflict is given in figure 1. For this investigation, the research team gathered views from people whose ages ranged from 32 to 78. The average age of the male was 53 (years) and the female was 55 (years). Most of the opinions were taken from farmers in the age group of 51-60. Very few females from farming households were available to consult due to cultural reasons and they belonged to the age group of 46-64 (Figure 2).

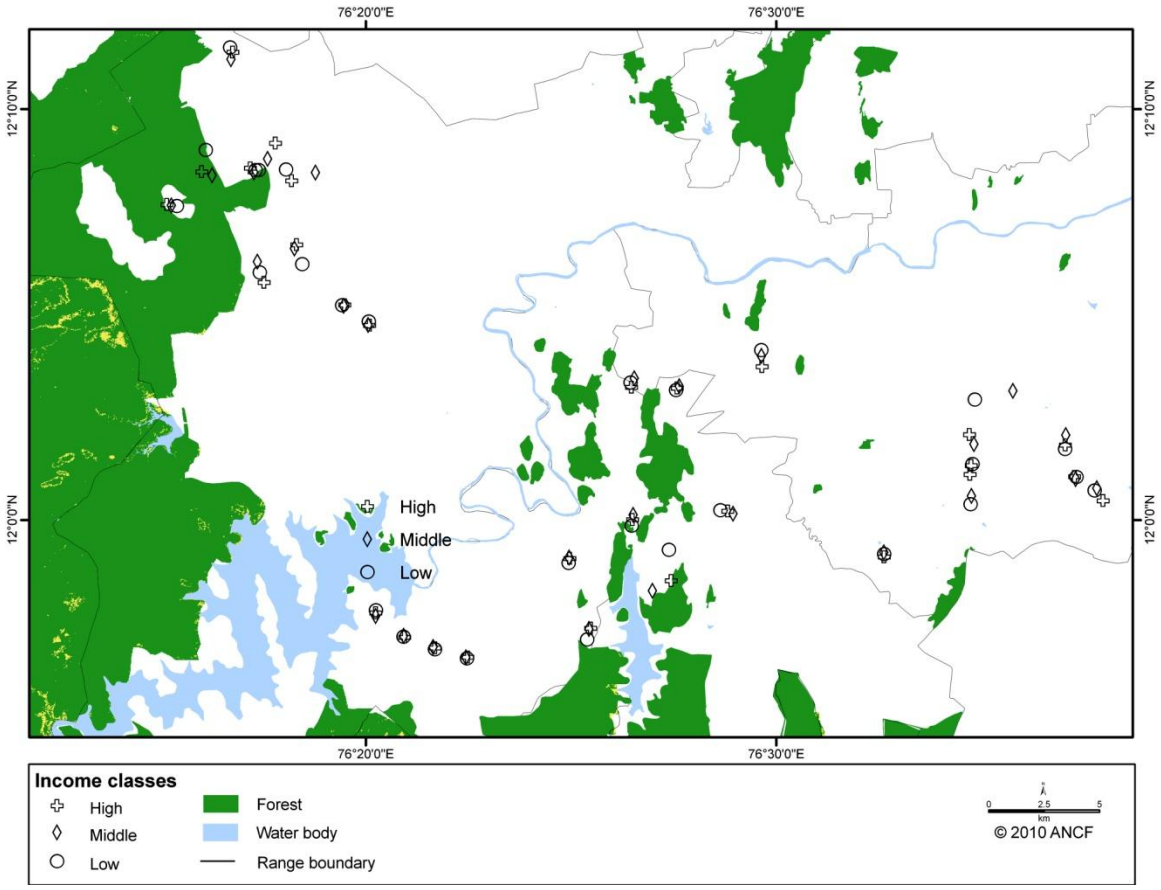


Figure 1: Map showing the distribution of people, belonging to different income classes, sampled for assessing villagers' perspectives on human-elephant conflict in Mysore Forest Division

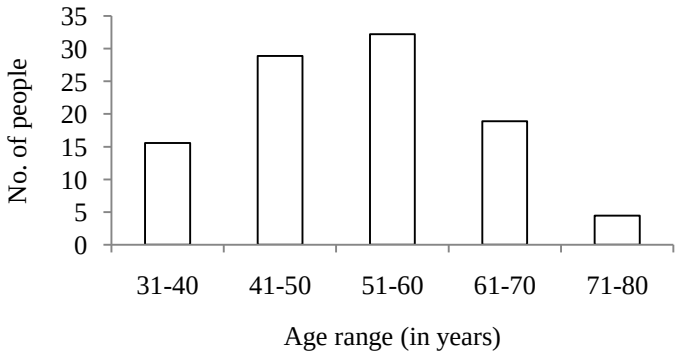


Figure 2: Age group of the people interviewed

It is important to note that farmers in the age group of 32-40 years are beginners in the profession and those in the age class of 70-80 years may have stopped working. Farmers in the age class of 40-60 years may be in the prime age of experience in this profession and have specific knowledge about elephants, conflict and associated aspects.

Population status

A total of 37,550 individuals were present in 30 villages, with a mean of 1252 (SE=129), ranging from 3500 (HD Kote) to 100 (Bommalapura) individuals per village. Seventy per cent of the villages have population ranging from 1000 to 1500 individuals. Table 1 shows the list of villages and their population.

Table 1: Estimated human population in villages selected for the investigation

Sl. No.	Village	Population
1	HD Kote	3500
2	Krishnapura Colony	1300
3	K Yadathore	3000
4	Nanjenayakanahalli	933
5	Chakgaudanahalli	1433
6	Bommalapura	100
7	Bheemanahalli	1933
8	Hosahalli	850
9	Basavarajanakatte	450
10	KG Hundi	1033
11	Halasur	1133
12	Puradakatte	1233
13	Haleheggudilu	1433
14	Kalegowdanahundi	833
15	Bidarahalli	783
16	Kandegala	650
17	Theranimunti	1667
18	Chennapura	867
19	Kundur	1600
20	Lanke	1933
21	Chandrawadi	1333
22	Hallare	1867
23	Siddayyanahundi	1133
24	Makanapura	900
25	Surahalli	1267
26	Chennapatna	867
27	Allayyanapura	1067
28	Haginawalu	767
29	Devanuru	617
30	Kasuvinahalli	1067

Crops cultivated

A total of 18 different crops (Figures 3a, b, c, d, e and f) were found to be cultivated by the villagers. The major crop cultivated was ragi (15%) followed by sugarcane (13%) and banana (12%). Crops like hyacinth bean, mango, areca nut *(Areca catechu)*, green gram, and vegetables are cultivated to a small percentage (1%).

a

b

f

c

e

d

Figures 3a, b, c, d, e and f: Patterns of crop cultivations practiced in villages around Mysore Forest Division

Table 2: Crops cultivated

Common Name	Percentage
Horse gram	5
Toor dal	5
Sugarcane	13
Turmeric	4
Maize	8
Ragi	15
Cotton	10
Black eyed peas	2
Tobacco	6
Hyacinth bean	1
Paddy	6
Banana	12
Mango	1
Coconut	6
Areca nut	1
Watermelon	2
Vegetables	1
Green gram	1

Land holding

The land holding ranged from 1 to 40 acres. Fifty percent of the farmers' land ranges from 1 to 4 acre indicating the landscape dominance of marginal farmers (Figure 4). Thirty eight per cent of the crops were cultivated for commercial purposes while 25% were for subsistence whereas 19% were for commercial and subsistence. Thirteen percent were cultivated for sale and subsistence and 6% were for sale (Figure 5).

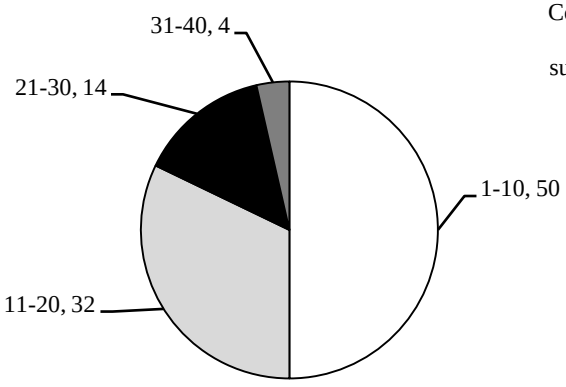


Figure 4: Size of land holdings (in acres)

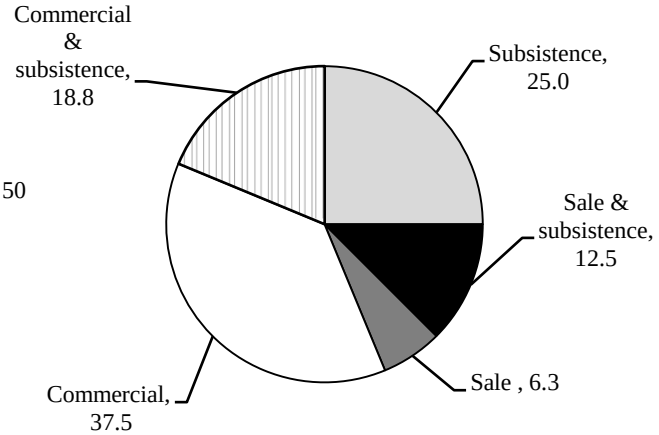


Figure 5: Utilization of crops for different purposes by farmers

Nature of forest around the village and villagers' dependency on forest

The survey included the farmers' perception of the nature of forest around their villages. Forty nine per cent of the villagers interviewed felt that the forest around their villages were disturbed, 36% felt forest was degraded and 15% said the forest comes under reserved forests category. The results show that 38% of people have access to the forest while 62% do not have any access because of the strict restriction from the forest department in certain areas. Many farmers take firewood and other wood from Mysore or Hunsur wood depots for their use.

The forest is mainly used for cattle grazing (28%) and for firewood (10%) while 62% of people claim not to use any forest products (Figure 6) such as firewood. The perception indicates that only a small percentage of villagers depend on forest and if a larger percentage of villagers depended on the same, this would have further degraded the existing nature of the forest around the villages.

Figure 6: Villagers' perspective on usage of forest and forest products (in percentage)

Status of human-elephant conflict

Pattern of elephant visits

Animal response

The elephants raided the crops in small herds with a mean group size of 3(SE=0.16), ranging from 1-5 individuals, or in large herds with a mean of 47 (SE=0.88), ranging from 30-65 individuals per herd. The maximum raids by elephants were in herds ranging from 1-5 (50%) individuals, followed by herds ranging from 36-40 (21%) individuals. Figure 7 shows the number of elephants per herd visiting the fields.

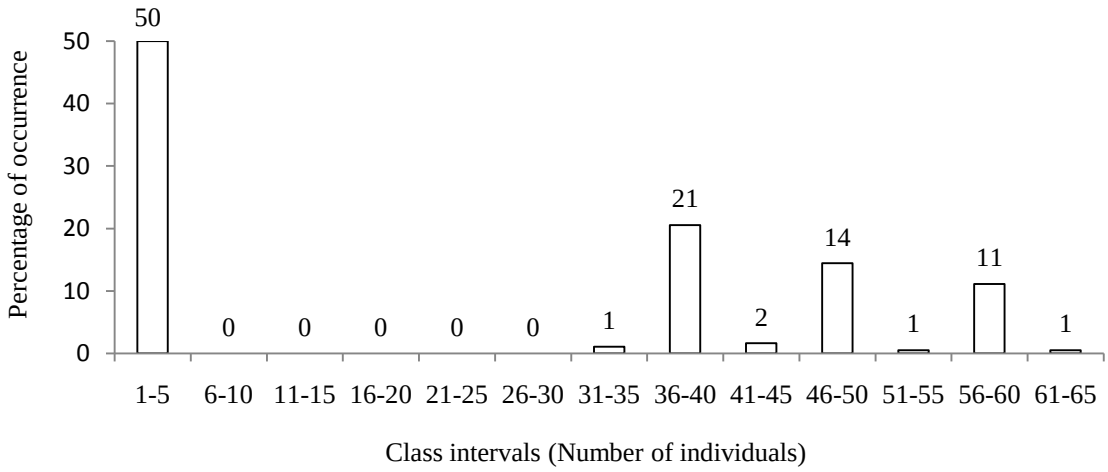


Figure 7: Number of elephants / herd

Frequency/reason for visits

The elephants visit the fields for crops and water. According to the survey, 64% of the villagers interviewed cited cultivated crops as the reason for elephants visiting villages while 36% felt it was for both crop and water. Forty one per cent of the villagers interviewed said September to February were the conflict months, while 30% felt that the elephants visited the crops daily or once in a season depending on the crops grown in that season. Figure 8 shows the frequency of the elephant visits.

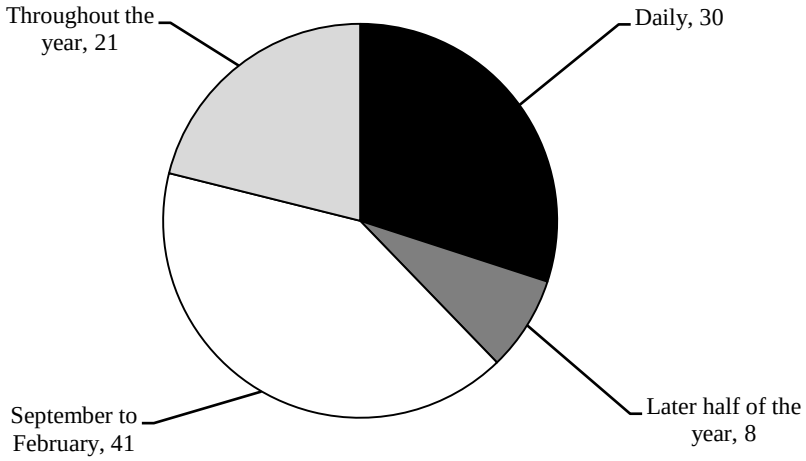


Figure 8: Frequency of Elephant visits (in percentage) as reported by villagers interviewed

Damage in relation to elephant visits

For the question of naming the crops attacked by elephants, ragi figured consistently in a majority (67%) of the villagers' response. While the rest (33%), named paddy, sugarcane and banana as the crops damaged by elephants. Table 3 shows the types of crops damaged by the elephants in each village. Damage to ragi occurred in 7 out of 12

villages, while sugarcane, banana and paddy were damaged in five villages. Cotton was damaged in 3 villages, toor dal in 2 and maize, mango and hyacinth bean in one village.

Table 3: Crops damaged in surveyed villages

Sl No	Village	Crops damaged
1	Bheemanahalli 1	Banana, paddy
2	Bheemanahalli 2	Maize, paddy, banana
3	Bommalapura 1	Ragi, cotton
4	Bommalapura 2	Sugarcane, ragi
5	Bommalapura 3	Mango, banana
6	Chakgaudanahalli	Ragi, cotton
7	Halasur 1	Ragi, paddy, toor dal
8	Halasur 2	Sugarcane, banana, paddy
9	Hallare	Sugarcane, maize, ragi
10	Hosahalli	Cotton, hyacinth bean, ragi, paddy
11	Krishnapura Colony	Sugarcane, maize, ragi
12	Puradakatte	Ragi, sugarcane, banana, toor dal

Damage in relation to group size of elephants is presented in Figure 9. With the information collected from the villagers, it is clear that the group size ranged from 3 to 35 and with size of group the level of damage is not apparent (Figure 9). For group size of 35 individuals, damage ranged from 0.5 to 5 acres. Names of the villages sampled (1 to 14) are given in Appendix 8.

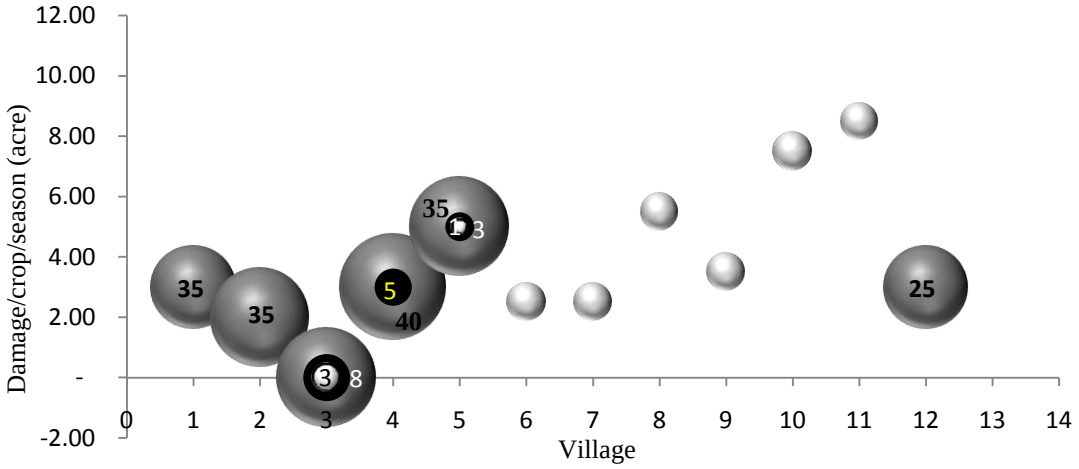


Figure 9: Crop damage/Animal groups; the figure represents the crop damage reported by each village. The X-axis represents the villages and the Y-axis denotes the acres of crops damaged for each crop per season. The sizes of the bubbles represent the most frequent sizes of the elephant herds raiding the crops. The blue, green and the purple bubbles represent the sizes of various elephant herds whereas the orange bubble denotes that the number of animals in the herd is unknown.

Economic impact

The results obtained from the villagers suggest that village 9 (Hosahalli) experienced the largest economic impact due to elephants damaging the crops. The mean economic loss of crop per year was Rs. 49,250 (SE=18059), ranging from Rs. 10,000 to Rs. 2, 00,000. Average money spent to prevent economic loss was Rs. 11,786 (SE=3196), ranging from Rs. 2,000 to Rs. 50,000 (Figure 10 and Appendix 8). The amount projected by the farmers for the mean economic loss of crop/season should be read with caution.

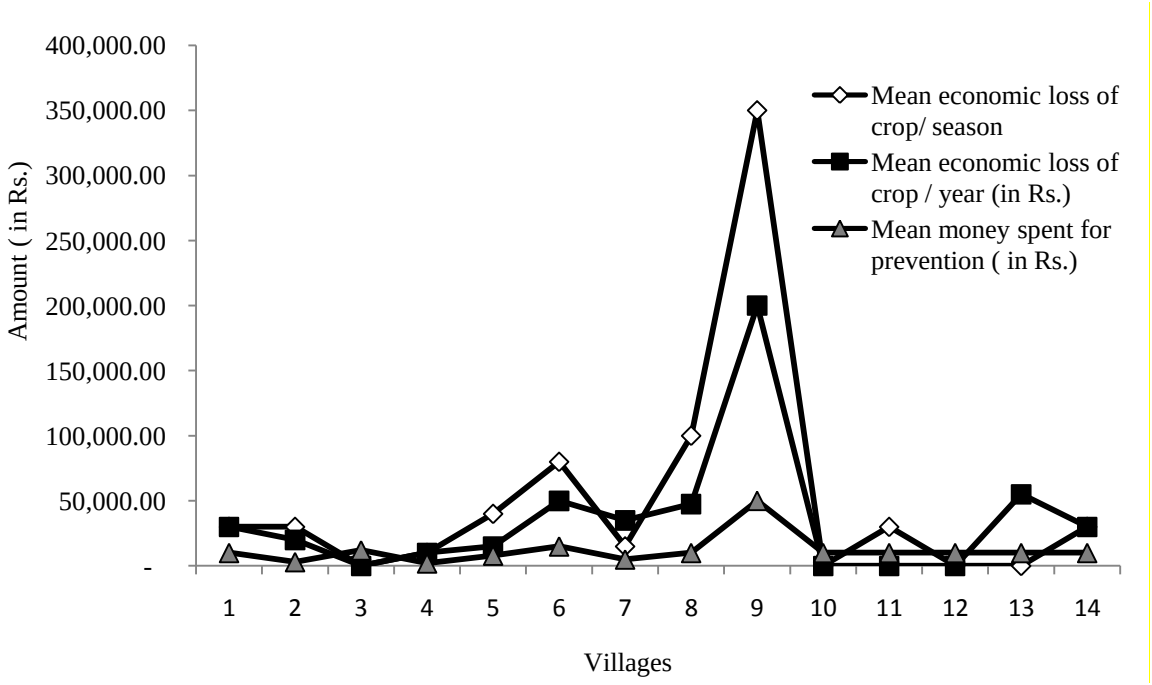


Figure10: Economic Impact

Reasons for conflict between humans and elephants

According to those interviewed, the major reasons for conflict between people and elephants were decreased forest area (20%) and habitat degradation (20%). Figure 11 shows the perceived reasons for the conflict. According to the villagers, the pressure on the forests was due to the influence of outsiders (people who come from other regions-43%), and a few (21%) believed it was from both the outsiders and the tribal people. Thirty six per cent of the individuals refused to give their opinion.

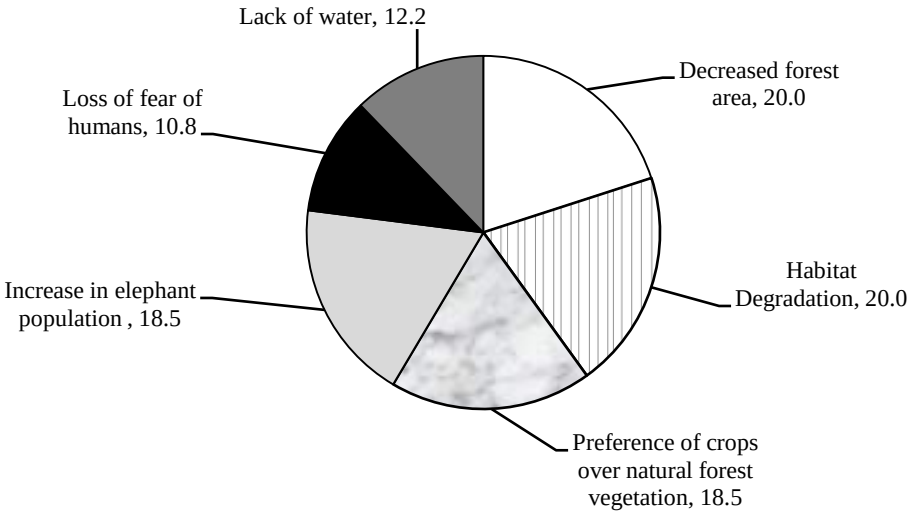


Figure 11: Reasons for Human-Elephant Conflict (in percentage) as reported by villagers interviewed

Compensation

The Government provides compensation to the villagers whenever the elephants damage their crops. The amount provided to them varies from Rs. 500 to Rs. 9,000 depending on the extent of damage. The villagers claim for compensation one to five times a season depending on the frequency of the damage. The entire procedure of receiving the compensation money after submission of the application forms takes from 5 months to over a year, at times. Though the procedure is complex, almost all the villagers who apply do receive compensation. Figure 12 shows the compensation provided to the villagers by the Government per year (see Appendix 8 for the details of villages (1 to 14) sampled).

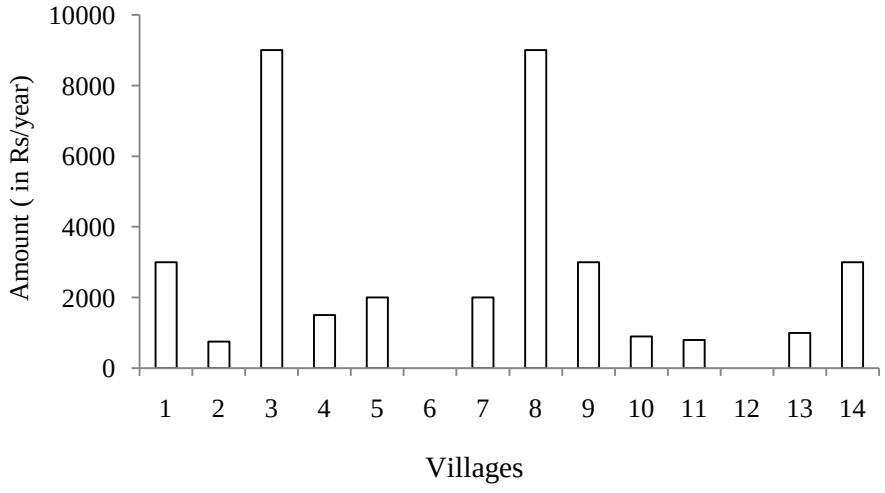


Figure 12: Compensation provided to the villagers for crops damaged by elephants

Mitigation

Currently the farmers use solar fence (36%), crackers (27%), hand torches (23%), daily wage watchers (9%) and lights (5%) for driving away the herd of elephants attacking the fields (Figure 13).

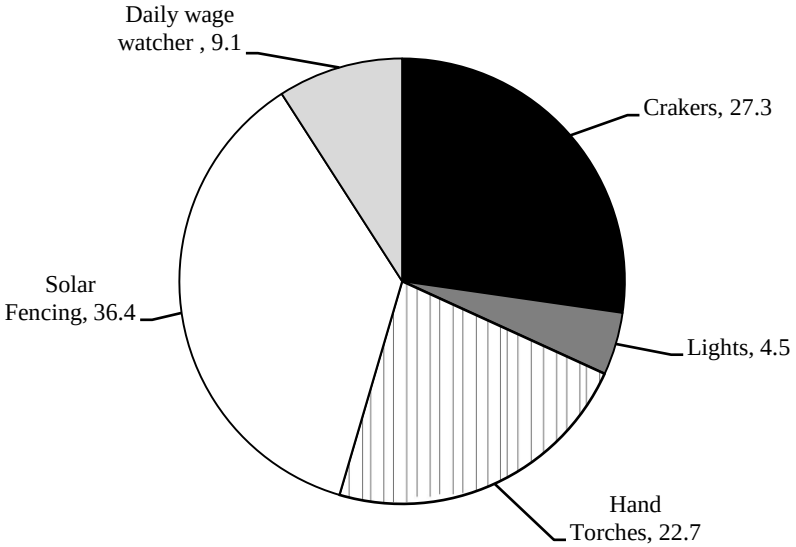


Figure 13: Current methods of mitigation

The mean amount spent on mitigating the problem of elephant attacks (Figure 14) is Rs. 11,643 (SE=3659), ranging from Rs. 2,000 to Rs. 50,000. Village 9 (Hosahalli) had spent the largest amount for mitigation (see Appendix 8 for the details of villages 1 to 14 sampled).

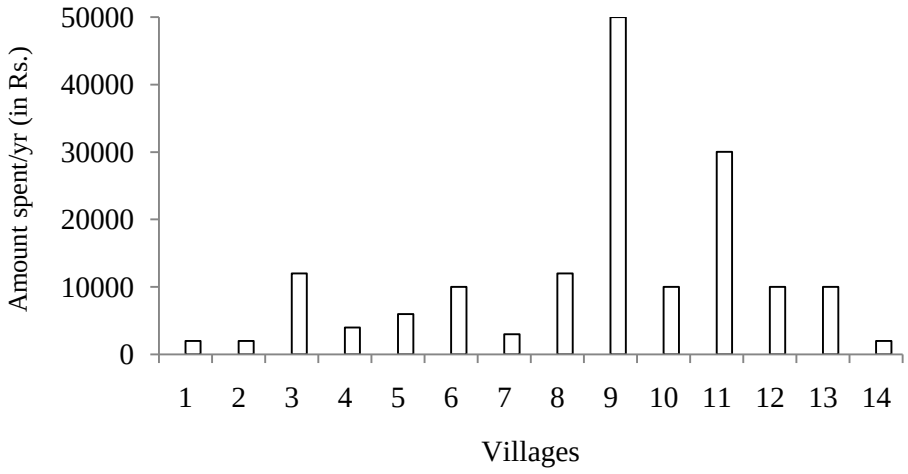


Figure 14: Amount spent on mitigation

Suggested methods of mitigation

Although mitigation measures such as usage of crackers, lights, hand torches, solar fencing and engaging watchers were employed, a majority of the villagers (29%) suggested having wall with gate and watchers, followed by trenches, electric fence and fencing around the forest. A small percentage (6%) also suggested using guns (Figure 15).

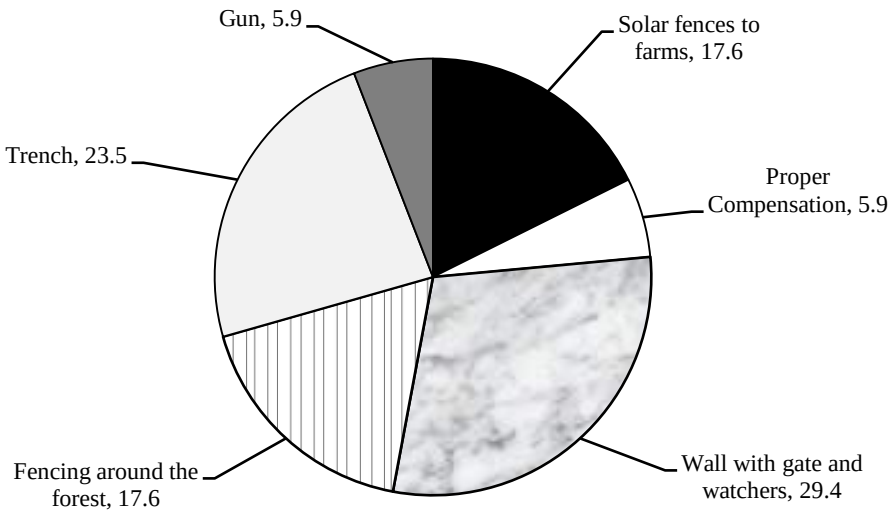


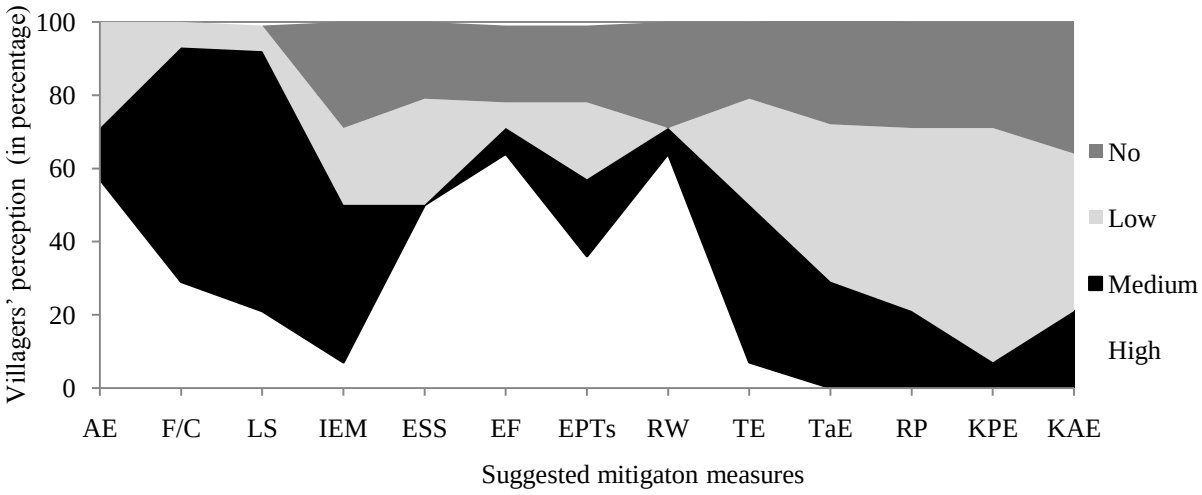
Figure 15: Mitigation measures as suggested by villagers

A survey was carried out among the villagers to rate the effectiveness of the methods used to mitigate the problems that cause conflict between people and elephants. The results can be seen in figure 16. Table 4 gives the list of methods of mitigation used in the questionnaire survey.

Table 4: Methods of conflict mitigation

Sl. No.	Methods for Mitigation
1	Avoiding elephants
2	Fire/crackers
3	Loud sounds
4	Information on elephant movements
5	Elephant scaring squads
6	Electrified fences
7	EPTs
8	Rubble walls
9	Translocation of elephants
10	Taming elephants
11	Relocation of people
12	Killing of problem elephants
13	Killing all elephants

Villagers interviewed appeared to be biased towards rubble wall and electric fence, in terms of their perception of efficacy. These approaches are rated highly (Figure 16). Interestingly, killing all elephants and even killing problem elephants are of low to no level of preference (Figure 16).



AE: Avoiding elephants; F/C: Fire/crackers; LS: Loud sounds;
IEM: Information on elephant movements; EF: Electrified fences; EPTs: Elephant Proof trench;
RW: Rubble walls; TE: Translocation of elephants; TaE: Tame elephants; RP: Relocating people;
KPE: Killing problem elephants; KAE: Killing all elephants

Figure 16: Farmers' perspective on conflict mitigation measures (in percentage)

Suggested remedies

The farmers generally were of the view that the human-elephant conflict could be reduced by building permanent physical barriers (32%), translocation of 'problem elephants' (14%), providing compensation for the loss due to damage by elephants (14%), providing assistance to chase the elephants (9%) and building solar fencing around the farms (2%). However, 30% of the farmers felt that regular meetings should be held to inform them of effective options for mitigation. They felt that the best method of receiving information on elephant movements was through information sharing at local meetings (48%), television (41%) and news paper (10%). Twenty per cent of the farmers felt that protective measures needed to be taken to prevent damage to their crops whereas 77% felt that the measures were not required.

Overall, regular meetings, provision of compensation for crop damage, permanent physical barriers, translocation of elephants, assistance to chase elephants and solar fence around the farms are some of the mitigation measures expected by the farmers from government agencies. Among these suggestions regular meetings and permanent barriers (Figures 17) are the most favored approaches required by them.

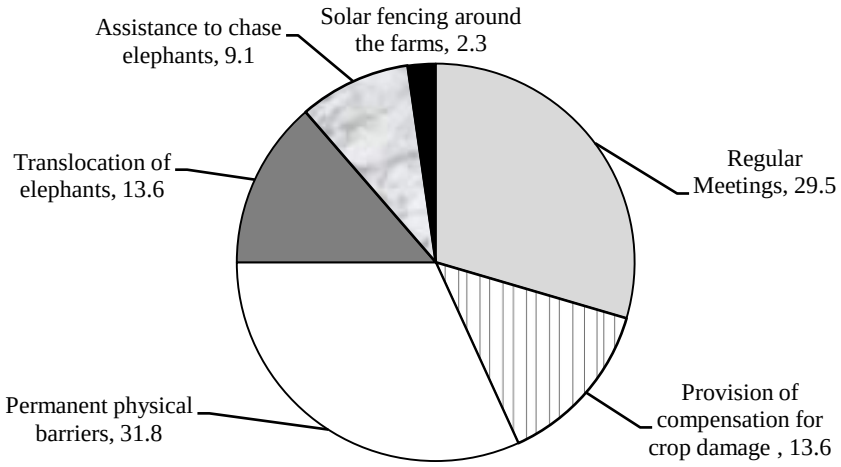


Figure 17: Assistance from Govt. to mitigate HEC (in percentage) as reported by the villagers interviewed

Conclusion

All the communities surveyed were involved in crop cultivation. The source of income was from agriculture and only a small proportion of villagers depended on salary based jobs. The land owning is about 1-5 acres. Some farmers feel elephants come for water. They also feel decrease of forest cover and habitat destruction as being the causes of conflict. Among 14 different mitigation methods recommended, about 15 per cent of the villagers suggested killing of elephants. Rubble wall and establishing electric fence around the villages are some of the suggestions given by the farmers. Farmers also suggest building permanent fool-proof physical barriers along the sensitive elephant entry points. Farmers expect the authorities to conduct regular meetings to share information about elephants and conflict mitigation measures. They also feel this can be achieved by conducting meetings at local level or through the television. Even though killing of elephants is met with low level of acceptance among the farmers interviewed, such a view does figure among the overall farming community. Hence, this may require a high level of commitment from the conservation community to mitigate conflict.

Section VIII: References

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Appendix 1:

Workshop on human-elephant conflict & conflict mitigation measures

With the support of the Mysore Forest Division, ANCF conducted a workshop on Human-Elephant Conflict for Forest department staff and village community members of HD Kote subdivision. It was held at the Centre for Institutional Development and Organizational Reforms (CIDOR) training centre of MYRADA, Handpost, HD Kote, on 20th February, 2010. The workshop commenced at 10.30 in the morning with the lighting of the lamp (Figures 1a, b, c and d) by the Chief Guest, Mrs. Shashwathi Mishra, DCF, Mysore Division. Also present were Mr. Thammaiah, ACF, and HD Kote subdivision, Mr. Surendra Varma, Research Scientist, Asian Nature Conservation Foundation (ANCF) and Mr. William D'Souza, Director, Myrada Training Centre.

a

b

d

c

Figures 1a, b, c and d: Workshop on Human-Elephant Conflict for Forest department staff and village community members of HD Kote subdivision, inauguration by lighting lamp (a and b) and followed by presentations by the forest department officials (c and d).

After the inauguration that had speeches by the Chief Guest and other guests, Mr. D. Rajkumar, Wildlife Conservation Foundation, Mysore, spoke to the participants on elephant conservation in Karnataka. Dr. P. Marutham, Clinical Psychologist, shared her experiences as a volunteer, of the project, who was involved in studying farmers'

perspective on human-elephant conflict, and Mr. L. Vinay, Researcher, ANCF, gave a presentation (Figures 2a, b, c and d) on the study of human-elephant conflict carried out in the division.

a

b

d

c

Figures 2a, b, c and d: Presentations and discussions by experts and researcher on human-elephant conflict

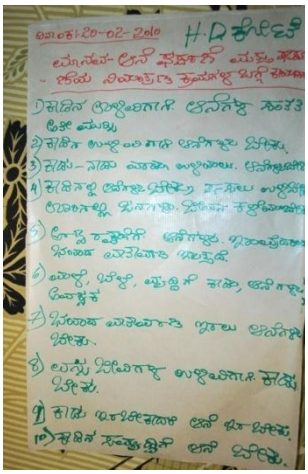
After the presentations, farmers and the forest department staff were placed in two teams and were given an exercise that included discussions (Figures 3a and b) on the following topics: the role and importance of elephants in the landscape, the importance of the forest and why forests should be conserved, and the measures that could be taken to solve the problem of Human-Elephant Conflict.

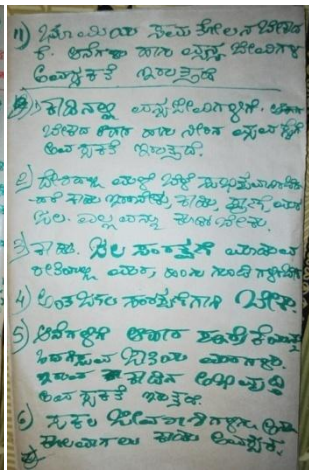
a

b

Figures 3a and b: Group discussions by forest staff and local villagers on topics related to human-elephant conflict, forest and elephant conservation

Listed below are some of the points mentioned by the local people and the forest staff (Figures 4a, b and c):





a b c

Figures 4a, b and c: Presentations on the subjects discussed by forest staff and local villager

- Forest should be conserved for improving underground water storage.
- Elephants and other species are required for the forest to grow.
- Elephants can create fear in humans and prevent them from moving into the forest.
- Forest should be developed in such a way that it provides basic requirements such as food and water to all the insects, birds, animals and other living beings.
- Water storing bunds should be made inside forest.
- Forest area should be increased for the well being of animals.
- Trees which are the main source of food for the elephants should be grown.
- People should take responsibility in matters relating to conservation along with the forest department with the understanding that elephants are everyone's property and its conservation is everyone's responsibility.
- Buffer areas around the forest should be created to provide timber and firewood to the local community.
- People/farmers should be trained on the importance of elephants along with other animals and forest, and about their conservation.
- Solar fencing to the forest boundary and to the farms in subsidy should be provided.
- People should be appointed from every village to protect the fences allotted near their villages.
- Training on the maintenance of solar fences should be given.

After the exercise was completed, Mr. Avinash, ANCF, gave a presentation to Forest Staff on the basic knowledge of GPS usage and its importance in their management activities (including human-elephant conflict). The forest staff was then taken to the field and the practical use of GPS was demonstrated to them.

Appendix 2:

Protected areas around Mysore Forest Division

Bandipur National Park

The Bandipur National Park is situated in Mysore and Chamarajanagar districts of Karnataka state. The total area is 880 km^2. Bandipur National Park situated at the confluence of the Eastern and Western Ghats serves as a central link in the seasonal migration of elephants from Mudumalai Wildlife Sanctuary (325 km^2) and Sathyamangalam Forest Division (1360 km^2) of Tamil Nadu. The park lies in east and south east of Rajiv Gandhi (Nagarhole) National Park (643 km^2) of Karnataka, and in the west and north west of Wayanad Wildlife Sanctuary (350 km^2) of Kerala. Bandipur National Park is a significant component of the 5500 km^2 Nilgiri biosphere reserve which is one of the largest biodiversity conservation areas.

Rajiv Gandhi (Nagarhole) National Park

Nagarhole National Park is named after *nagar* (snake) *hole* (river), which runs eastwards through its centre. The park has been renamed as the Rajiv Gandhi National Park. Originally it was constituted as a Wildlife Sanctuary, in the year 1955, covering an area of 285 km^2 and subsequently some more areas were added to it. Now it extends over an area of 643 km^2 and was given the status of a National Park in 1983. This park also forms a part of the Nilgiri Biosphere Reserve, which includes besides this National Park, Bandipur National Park, Mudumalai Wildlife Sanctuary and Wayanad Wildlife Sanctuary.

Nugu Wildlife Sanctuary

Nugu Wildlife Sanctuary is situated north of Bandipur National Park. This small sanctuary has an area of 30 km^2. The backwaters of Nugu dam form a part of the Nugu Wildlife Sanctuary and lie on the western side of the sanctuary. On the south west side, the area touches Alaganchi State Forest which comes under Bandipur National Park (Project Tiger area). During the summer when the backwater recedes, the Foreshore area becomes vast temporary grassland and due to the availability of fodder and water, the elephants migrate from the adjoining areas and congregate on the Foreshore area. Reservoir of Nugu dam forms a major water source for the wildlife. In addition to this there are eight tanks and most of them are seasonal.

Appendix 2a:

List of animals reported for Mysore Forest Division, Bandipur National Park, Rajiv Gandhi (Nagarhole) National Park and Nugu Wildlife Sanctuary

Sl.No	**Common Name**	**Scientific Name**
1	Tiger	*Panthera tigris*
2	Wild dog	*Cuon alpinus*
3	Jackal	*Canis aureus*
4	Striped hyena	*Hyaena hyaena*
5	Sloth bear	*Melursus ursinus*
6	Otter	*Lutra sp.*
7	Jungle cat	*Felis chaus*
8	Leopard cat	*Felis bengalensis*
9	Small Indian civet	*Viverricula indica*
10	Malabar civet	*Viverra megaspila*
11	Common palm civet	*Paradoxurus hermophroditus*
12	Elephant	*Elephus maximus*
13	Spotted deer	*Axis axis*
14	Gaur	*Bos gaurus*
15	Indian Muntjac (barking deer)	*Muntiacus muntjak*
16	Mouse deer	*Tragulus meminna*
17	Wild pig	*Sus scrofa*
18	Sambar	*Cervus unicolor*
19	Hanuman langur	*Semnopithecus entellus*
20	Bonnet macaque	*Macaca radiate*
21	Slender loris	*Loris lyddekerianus*
22	Indian porcupine	*Hystrix indica*
23	Indian hare	*Lepus nigricollis*
24	Pangolin	*Manis crassicaudata*
25	Flying fox	*Ptreopus giganteus*
26	Common mongoose	*Herpestes edwardsi*
27	Stripe-necked mongoose	*Herpestes vitticollis*
28	Giant flying squirrel	*Petaurisla petaurisla*
29	Indian giant squirrel	*Ratufa indica*
30	Three striped palm squirrel	*Funambulus palmarum*

Appendix 3:

Scientific names of crops mentioned in the text

Sl.No	Common Name	Scientific Name
1	Areca nut	*Areca catechu*
2	Banana	*Musa spp.*
3	Black eyed pea	*Vigna unguiculata*
4	Coconut	*Cocos nucifera*
5	Coriander	*Coriandrum sativum*
6	Cotton	*Gossypium sp.*
7	Coffee	*Coffea arabica or Coffea robusta*
8	Ginger	Zingiber officinale
9	Green gram	*Vigna radiate*
10	Horse gram	*Dolichos biflorus*
11	Hyacinth bean	*Dolichos lablab*
13	Maize	*Zea mays*
14	Mango	*Mangifera indica*
15	Paddy	*Oryza sativa*
16	Ragi	*Eleusine coracana*
17	Sugarcane	*Saccharum officinarum*
18	Tobacco	*Nicotiana tabacum*
19	Tamarind	Tamarindus indica
21	Tomato	*Lycopersicon esculentum*
22	Toor dal	*Cajanus cajan*
23	Turmeric	*Curcuma longa*
24	Watermelon	*Citrullus lanatus*

Appendix 4:

Villages surveyed during the course of the study for assessing the status of human communities

Sl. No	Village
1	HD Kote
2	Krishnapura colony
3	K Yadathore
4	Nanjenayakanapalya
5	Chakgaudanahalli
6	Bommalapura
7	Bheemanahalli
8	Hosahalli
9	Basavarajanakatte
10	KG Hundi
11	Halasur
12	Puradakatte
13	Heggudilu
14	Kalegaudanahundi
15	Bidarahalli
16	Kandegala
17	Theranimunti
18	Chennipura
19	Kundur
20	Lanke
21	Chandawadi
22	Hallare
23	Siddayyanahundi
24	Makanapura
25	Surahalli
26	Chennapatna
27	Allayanapura
28	Haginawalu
29	Devanuru
30	Kasuvinahalli

Appendix 5:

Incidents of crop damages reported in study villages across the years (2004 – 2008)

Sl. No	Village Name	Range	2004	2005	2006	2007	2008	Total
1	Adahalli	Sargur		7	11	9	17	44
2	Akala	Nanjangud	3	4	1		3	11
3	Allayyanapura	Nanjangud	14	9	10		11	44
4	Althalhundi	HD Kote			1		3	4
5	Ambale	Nanjangud	12	12	18	4	8	54
6	Anagattta	HD Kote			3			3
7	Ankanathapura	HD Kote		1				1
8	Annur	HD Kote	5	5	20	10	3	43
9	Arasinakere	Mysore				2	2	4
10	Ariyuru	Nanjangud		1				1
11	Badanekuppe	HD Kote			1			1
12	Basavanagirihadi	HD Kote				18	17	35
13	Basavanapura	Nanjangud		10	6			17
14	Basavarajanakatte	HD Kote	3	1				4
15	Bettabidu	Mysore			11		2	13
16	Bheemanahalli	HD Kote	11	3	33	6	12	65
17	Bhudanur	HD Kote	98	46	98	70	53	365
18	Bommalapura	HD Kote			9	11	13	33
19	Bonthakaladahundi	Sargur		21	39	15	51	126
20	Chakahalli	HD Kote	7		2			9
21	Chakgaudanahalli	HD Kote	128	32	158	68	116	503
22	Chakkur	Sargur	2	5	10	3	2	22
23	Chamalapura	Sargur	19	53	21	33	93	219
24	Chamegaudanahundi	Sargur	12	25	28	15	18	98
25	Chandrawadi	Nanjangud		12	9		7	28
26	Chennapatna	Nanjangud		16	18		30	64
27	Chennapura	Sargur	1	3	2	1		7
28	Chikkereyuru	HD Kote			8			8
29	Chunchunahalli	Nanjangud			7		21	28
30	Dadadahalli	Sargur	20	26	76	18	80	220
31	Daripura	Mysore					4	4
32	Dasanapura	HD Kote		1		5		6
33	Depegowdanapura	Nanjangud	68	50	56	45	193	412
34	Devanuru	Nanjangud			2		9	11
35	Dodda abbagalu	T. Narasipura					3	3

36	Doddahundi	Mysore					1	1
37	Doddakaturu	Mysore				1		1
38	Duggahalli	Nanjangud	10	7	11	21	36	85
39	Gaddehalli	Sargur		10	12	13	4	39
40	Gattavadi	Nanjangud		3	4	9	23	39
41	Gujjegowdanapura	Mysore					9	9
42	H. D. Kote	HD Kote	3	5	38	9	2	57
43	Hadya	Nanjangud	5	14	1	59	51	130
44	Haginawalu	Sargur	8	12	11		6	37
45	Halasur	Sargur	177	194	265	439	207	1283
46	Haleheggudilu	Sargur		5	21	15	28	69
47	Haleyuru	Sargur	14	27	33	37	63	174
48	Hallare	Nanjangud	57	39	22	75	16	209
49	Hanchipura	Sargur	2		3	8	10	23
50	Hanumanapura	Nanjangud			1			1
51	Haradanahalli	Nanjangud	1	2	3	3		9
52	Harathale	Nanjangud			1		3	4
53	Harohalli	Mysore			20		12	32
54	Hegganuru	Sargur	16	98	18	62	127	321
55	Hirohalli	HD Kote	6	1				7
56	Horalahalli	T. Narasipura				1		1
57	Hosahalli	HD Kote	27	11	38	25	35	136
58	Hosakukkuru	T. Narasipura				2		2
59	Hosapura	Nanjangud				5		5
60	Hullahalli	Nanjangud			1			1
61	Hunasehalli	Sargur	70	78	96	103	145	492
62	Hunuganahalli	Sargur	13	97	43	74	85	312
63	Hura	Nanjangud	29	20	11	65	23	149
64	Huskuru	Nanjangud	2	1		2		5
65	Huvinkla	Sargur	148	133	99	246	285	913
66	Ibjala	Nanjangud	18	1	17	30		66
67	Itna	HD Kote	33	6	6	14	17	76
68	K.Belathur	Sargur				5		5
69	K.G.Hundi	HD Kote	5		7	1	4	17
70	K.Yadathore	HD Kote	45	68	38	18	28	197
71	Kadburu	Nanjangud			1	1		2
72	Kaggaluru	Nanjangud	6	3	2	10		21
73	Kalegowdanahundi	Sargur	4	7	18	7	20	56
74	Kalihundi	Sargur	22	65	45	67	105	304
75	Kalihundi (TN-PURA)	T. Narasipura					1	1
76	Kallambalu	Sargur	31	34	72	63	63	263
77	Kandegala	Sargur	1	10	8	9	15	43

78	Kappusoge	Nanjangud	1	2		3		6
79	Karigala	HD Kote				3		3
80	Kasuvinahalli	Nanjangud	38	27	11	61	4	145
81	Katte Hunsuru	Sargur	84	159	158	164	164	729
82	Kattemanaganahalli	HD Kote			1		1	2
83	Katuru	Nanjangud	4		5	6		15
84	Killupura	Nanjangud	28	17	29	51	54	179
85	Kithur	Sargur	2	2	3	12	4	23
86	Kongalli	Nanjangud	1		2	1	2	6
87	Kothegala	Sargur	55	65	65	59	102	346
88	Krishnapura	Nanjangud	3	3	1	2	4	13
89	Krishnapura Colony	HD Kote		1				1
90	Kugaluru	Nanjangud	13	2	5	9	13	42
91	Kulya	Sargur				2		2
92	Kundur	Sargur	3	35	23	41	31	133
93	Kunnapattana	Sargur	7	15	11	12	7	52
94	Lanke	Sargur	193	112	200	169	391	1065
95	M Kungalli	Nanjangud	8	7	1	5	8	29
96	Madapura	Nanjangud	1	6	6	31	15	59
97	Madikehundi	Nanjangud		2		5	4	11
98	Mahadevapura	HD Kote				2		2
99	Makanapura	Nanjangud		11	43	27	20	101
100	Malkundi	Nanjangud	2	28	11	57	66	164
101	Mallahalli	Nanjangud	27	47	19	77	95	265
102	Managanahalli	Sargur	39	118	47	72	170	446
103	Mandanahalli	Mysore					2	2
104	Masahalli	Sargur	3	2	8	6	2	21
105	Mavinahalli	Mysore			5			5
106	Megalakoppalu	T. Narasipura					1	1
107	Metikuppa	HD Kote				5		5
108	Motha	HD Kote		5	2	4	4	15
109	Muddanahalli	Sargur	18	15	18	38	54	143
110	Muguru	T. Narasipura	3	2		1	1	7
111	Mulluru	Sargur	10	13	10	36	7	76
112	Mushkere	HD Kote			6		2	8
113	Nallikalapura	Nanjangud		1		3	2	6
114	Nanjangud	Nanjangud		2	4	6	8	20
115	Nanjapura	Sargur	4	99	51	76	76	306
116	Nanjenayakanahalli	HD Kote	24	21	22	27	10	104
117	Narasipura	Sargur	18	62	37	35	88	245
118	Neelasoge	T. Narasipura				4		4
119	Nettagalahundi	Sargur	2	2	3	4	8	19
120	Penjahalli	HD Kote		16				16

121	Puradakatte	Sargur	31	10	37	41	64	183
122	Rajegaudanahundi	HD Kote	34	21	31	35	7	128
123	Rajuru	Nanjangud		7	16	10	33	66
124	Sagare	Sargur		2	2		8	12
125	Sargur	Sargur	9	130	30	137	99	405
126	Sauvey	HD Kote		8				8
127	Shanthipura	Sargur	21	36	50	40	43	190
128	Shettyhalli	Nanjangud	1	3			10	14
129	Shiranahundi	HD Kote		6	6	45	1	58
130	Siddapura	Sargur	11	8	10	37	20	86
131	Siddayyanahundi	Nanjangud		13	2	1	14	30
132	Siddegaudanahundi	Nanjangud		45	25		155	225
133	Sonehalli	HD Kote	26	8	15	5	2	56
134	Sosale	T. Narasipura				2		2
135	Surahalli	Nanjangud		47	37	3	170	257
136	Theranimunti	Sargur	5	33	38	44	33	153
137	Thoravalli	HD Kote					1	1
138	Volageri	Nanjangud		3			9	12
139	Yalachagere	Nanjangud			1	2	6	9
140	Yechagundla	Nanjangud			3	8	1	12
141	Yelehundi	HD Kote	1	3	8	7	2	21

Appendix 6:

Circumferences of dung piles of known age class of captive elephants to determine the age class of elephants that visit crop fields

The details provided on the known age class of elephants were obtained from captive elephants kept at forest camps in Mudumalai Wildlife Sanctuary and Indira Gandhi Wildlife Sanctuary and National Park in Tamil Nadu, southern India. The data was collected as part of an all India captive elephant survey carried out from 2005 to 2010. For each elephant, data on origin of the animal and circumference of dung piles were collected during the survey. The data on its origin included date of birth, capture, transfer and purchase. In addition to the above, details such as age at capture, transfer and purchase were also obtained. These details were utilized in comparing the circumferences of dung of elephants obtained near/in the crop field. Through this the age class of elephants that visited crop lands was determined.

		Circumference of dung pile (cm)			
Name of the Elephant	**Age (years)**	**Dung pile 1**	**Dung pile 2**	**Dung pile 3**	**Mean**
Masini	0.2	22.8	22.2	*	22.5
Chellamal	2	23.5	23.5	28.0	25.0
Abinaya	2.5	27.0	27.5	28.0	27.5
Tamilan	3	24.3	24.3	24.3	24.3
Bullu	4	27.4	27.4	27.4	27.4
Udayan	8	31.0	31.5	34.0	32.2
Vikram	8	32.0	30.5	31.0	31.2
John	14	31.0	31.0	33.0	31.7
Sumangala	18	30.4	30.4	*	30.4
Jambu	20	42.0	43.5	39.0	41.5
Cheran	21	43.5	34.5	45.0	41.0
Venkatesh	21	41.0	45.6	45.6	44.1
Barani	22	53.2	45.6	42.6	47.1
Ashwini	22	22.8	21.9	18.5	21.1
Kapil dev	24	45.6	45.6	45.6	45.6
Karthick	25	48.6	48.6	51.7	49.7
Pari	26	48.6	50.2	51.7	50.2
Kalpana	26	48.6	45.6	46.2	46.8
Wasim	28	58.0	57.0	49.0	54.7
Suriya	33	42.6	41.0	41.0	41.5
Sujai	35	47.5	46.5	48.0	47.3
Senthilvedivu	35	42.6	36.5	45.6	41.5

Vijay	35	53.2	54.7	56.2	54.7
Thaiyal nayaki	36	49.2	48.5	48.7	48.8
Ganesh	37	48.6	50.1	50.1	49.6
Shankar	37	41.5	43.5	45.0	43.3
Santhosh	37	48.6	45.6	48.64	47.6
Ram	37	54.7	54.7	50.16	53.2
Kaleem	41	33.7	33.4	33.4	33.5
Mudumalai	44	48.6	48.6	50.2	49.1
Nanjan	46	49.2	50.2	50.2	49.9
Moorthy	47	53.0	53.5	51.0	52.5
Selvi	47	45.6	45.6	*	45.6
Anna	49	51.7	48.6	54.7	51.7
Kamachi	49	45.6	44.1	41.4	43.6
Saradha	52	42.6	39.5	48.6	43.6
Subramani	53	51.7	52.3	52.9	52.3
Pallavan	53	42.6	42.6	51.7	45.6
Vijayalaksmi	54	42.6	42.6	45.6	43.6
Indhar	55	42.0	42.0	42.0	42.0
Sivakami	56	48.6	48.6	51.7	49.7
Bhama	58	37.5	39.5	43.5	40.2
Dev	62	53.2	54.7	54.7	54.2
Valli	62	42.6	47.1	42.6	44.1

*Data not available

Appendix 7:

Causes for damage of elephant proof barriers (EPT and electric fence) in Mysore Forest Division

I Elephants

1. Mud shoved into trench by **elephants** thereby creating a slope and enabling them to pass through
2. Trench broken by **elephants and boars** by pushing soil/mud into it thereby creating a slope or steps for animals to cross the trench
3. Trench damaged by **elephants** that dump mud into it and by the action of **water** and **soil** carried by **rainwater flood** on the trench
4. Trench closed completely or depth decreased by **elephants** shoving mud into it, **rockslide** and **rain**

II Man-made

5. Trench broken by **farmers to create path into forest** for various reasons such as cattle grazing and collection of forest by-products
6. Trench broken by **farmers to drain out excess rain water** from their farmlands into the trench
7. **Farmers dumping soil into trench** from farmland which is not necessary for cultivation
8. Soil which acts as side walls of the trench **taken away by farmers** for their own use. This weakens the strength of the structure and may collapse if neglected
9. Trench broken by villagers to create a path to take **cattle** into forest for grazing
10. Trench broken by villagers for creating path into forest for cattle grazing and to carry forest by-products
11. Decrease in the depth of the trench due to creation of **cattle path** and **mudslide** due to rain water
12. Trench closed by **villagers to create mud path for vehicle transport** into forest to collect forest by-products
13. **Trench not constructed** at some places mainly around Chikkadevamma hill leaving path for visit to temple and collection of forest by-products
14. **Trench closed by mine waste** for a distance of nearly 100 m near Lanke plantation area beside the road
15. **Big hole used for dumping of garbage** near Chikkadevamma hill where trench is not present for 30m
16. **Rocks left inside the trenches** which are still in the process of removal using dynamites
17. **Trenches joining together** at places around Chikkadevamma hill (near anti-poaching camp) that decease the viability of original trench. (Extra trenches are assumed to be made illegally by farmers or department for encroachment of land.)
18. **Establishment of improperly planned trenches** at places that have plantation towards the farmland and cultivation towards the forest side. This leads to easy illegal encroachment (near anti-poaching camp behind Chikkadevamma hill)

III Nature

19. Flow of mud with rainwater causing **mudslide** and decreasing the depth
20. Trench closed by **landslide** in places where these are constructed along the slopes such as bottom of the hills etc. making them non-viable
21. & 22. **Water** assumed to be sourced from canals, riverlets (nallahs) or rain flowing into the trench due to lack of bunds on both sides and causing damage. In addition, water could create **cattle path** or water could flow into existing cattle path resulting in the breakage of trench
23. **Rainwater** from forest and farmland getting into trenches causing damage
24. Trench broken due to **rainwater** and **flood** causing mudslide
25. & 26. **Rainwater creating water channel** that passes perpendicular to the trench causing the breakage of trench
27. Trench broken by **rainwater** and **water channel** connecting farmland and forest thereby creating cattle path
28. **Growth of lantana** and other thorny waste plants inside the trench and damaging it

IV Wild animals

29. Mud shoved into the trench by **boars** thereby creating a slope and decreasing the depth of the trench

V Combination of Agents

30. Trench not broken but the depth is decreased by the accumulation of mud inside it by **rain, animals and farmers**

VI Cause Unknown

31. Trench broken but **cause unknown**
32. **Trench broken completely** but cause unknown. This may be due to damage by animals, humans or rain water flood

Appendix 8:

Village code (1 to 14) used in figures [9 (Crop damage/animal groups), 10 (economic impact), 12 (compensation) and 14 (amount spent on mitigation)] of Section VII: Farmers' perspectives on human-elephant conflict

S.No	**Village Name**
1	Krishnapura colony
2	Chakgaudanahalli 1
3	Chakgaudanahalli 2
4	Bommalapura 1
5	Bommalapura 2
6	Bommalapura 3
7	Bheemanahalli 1
8	Bheemanahalli 2
9	Hosahalli
10	Halasur 1
11	Halasur 2
12	Puradakatte 1
13	Puradakatte 2
14	Hallare

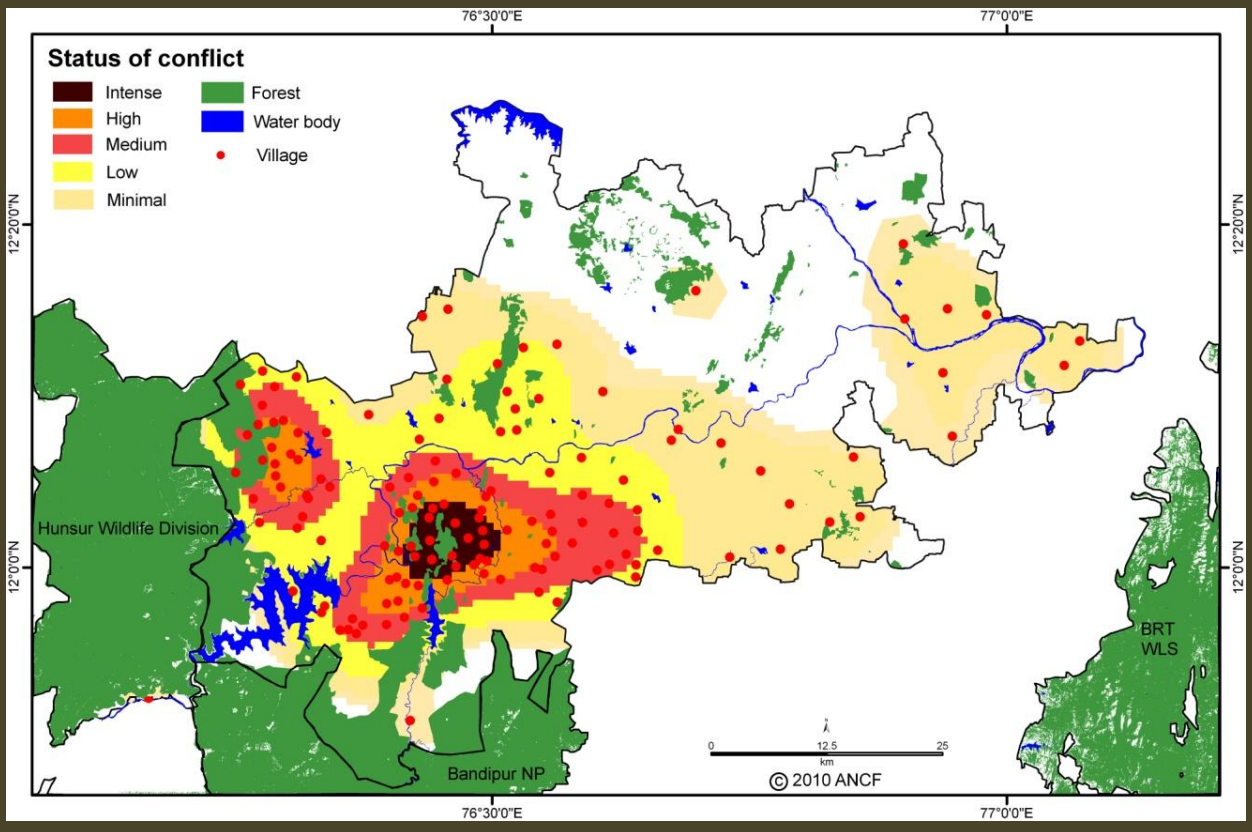
Karnataka Forest Department was established in 11.1.1864 with a complement of five officers. The main aim of the department is to protect, conserve and promote sustainable development of the forests and biodiversity of the State and to promote tree based farming in support of soil and water conservation on agricultural lands. The department protects the forests and wildlife from various types of pressures and threats. The main protection activities include fire protection, boundary consolidation, prevention and removal of encroachment from the forest area, prevention of illicit cutting of timber and firewood, indiscriminate harvest of non timber forest produce, prevention of poaching of wild animals etc. The Department undertakes regeneration, soil and moisture conservation work, habitat improvement, wildlife management, etc. The department aims at increasing the productivity of the forests to meet the growing demands of the people. Afforestation is done on degraded forest lands, community lands, C & D class lands, fore-shore areas and other institutional lands.

Asian Nature Conservation Foundation (ANCF) is a non-profit public charitable trust set up to meet the need for an informed decision-making framework to stem the loss of biological diversity in India and other countries of tropical Asia. The Foundation undertakes activities independently, and in coordination with governmental agencies, research institutions, conservation NGOs and individuals, in all matters relating to the conservation of natural resources and biodiversity.

Photo source:

Section II- Figures 5b, c and f; Section VII- Figures 3c, 4b and 14e Vinay, L.
Section VI- Figure 12a: Andolan news paper.
Section VI- Figure 12b: a villager from Hediyala village.
Section VII- Figure 14e: Vijakarnatak newspaper
All other photographs: Surendra Varma.

The **Mysore Forest Division (MFD)** shares borders with the Bandipur National Park and the Rajiv Gandhi (Nagarhole) National Park, two of the highest elephant density areas of Asia. Elephants from both these Parks use as refuge, stretches of narrow forest that lie contiguous with the common boundary and cause considerable conflict with human communities within the Division. From the records of the Division it is apparent that over 15,000 incidents of crop damage have been caused over the past 5 years. In turn, 16 elephants have been lost through conflict related causes. A short term investigation (September 2009-March 2010) on human-elephant conflict in the MFD was carried out by the Asian Nature Conservation Foundation (ANCF), Bangalore, at the request of the Karnataka Forest Department. The study mapped the past and current patterns of conflict and looked at a range of factors (land use patterns, elephant population density and structure, current mitigation methods used, community perceptions of conflict factors) that initiate and enhance conflict. The study makes recommendations aimed at upgrading protection and mitigation measures.



Karnataka Forest Department

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