

**No Living Space? Shrinking Habitat and Human Elephant Conflict in Assam, India**

**Final Report**



## **No Living Space? Shrinking Habitat and Human Elephant Conflict in Assam, India**

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Habitat destruction is a universal conservation problem brought about by a variety of factors. While the reasons underlying HEC in Assam are fairly easy to identify - the prime agent being habitat loss - quantifying the amount of habitat destruction that has occurred is less easy and was thus one of the main objectives of the RSG project. Using satellite data during 1994-2007 substantiated by extensive ground truth verification the habitat loss has been quantified.

Although the project had initially stated that the focus would be on the western and northern portion of the Sonitpur district of Assam, the entire district covering an area of 5324 kilometres was assessed in terms of habitat losses, since leaving the eastern portions of the district would provide an incomplete picture. However there was a focus on the western and northern portions during ground truth verification. GPS readings of using a handheld PDA-GPS were used during most of the field surveys.

Habitat characteristics were necessary to be understood on two counts:

- (a) to quantify losses and identifying those in need of immediate protection
- (b) to identify alternative habitats if any within the area

During the ground truth verification process encroacher settlements were identified, particularly those in close proximity to forested sites.

The extent of habitat loss goes much beyond classification, ground truth verification and accuracy assessments since attributes of the habitat such as the number of patches, distance between patches, and the degree of fragmentation of the habitat are equally important landscape characteristics. Using the widely used Fragstats software that allows such an understanding we took a closer look at the habitat characteristics.

To assess the magnitude of the problem, and the trials and tribulations of the villagers a survey of 28 select villages using a semi-structured questionnaire was conducted. The questionnaire was largely based on that developed by the AESG, with certain modifications.

### **The Study Area**

Sonitpur lies between 26° 30'N to 27° 01'N latitude and 92° 16'E to 93° 43'E longitude. Spread across an area of 5324 square kilometres. The district is sandwiched by the Brahmaputra River to the south and the Himalayan foothills of Arunachal Pradesh to its north. The area is characterized by lowlands with elevation varying between 10-80 meters, 80-100 and 100-200 meters. A small strip of low hills on its northern limits with elevation ranging between 200-500 meter exists on its north western margin. Several rivers flowing parallel to one another in a north-south trend dissect the district as they flow down the foothills to the Brahmaputra river. Rainfall is quite high at 1384 mm (GoA, 2004).



### Forest Divisions

As per Government of Assam records the area under Reserved Forest in Sonitpur West Forest Division ~ the focus of this RSG project~ was 46164.690 hectares and that in Sonitpur East was 52674.770 hectares (GoA,2004).

### Population and Encroacher Settlements

Since the early 1990s the forest cover has been at the receiving end and studies (Srivastava et. al. 2002) have observed trends of rapid loss of forest cover. The prime agent was a shift of population that was engineered by certain communities with a view to gaining political control in the area. While the trend of new settlement in an organised manner does not seem to be operating, the aftermath of encroachers settling in cleared forest land ~ in several instances within protected areas (PAs) themselves~ continues. In such settlements human elephant conflicts occur. Elsewhere in fairly old settled and established villages, HEC occurs due to a different set of reasons, but closely linked to the activities of these forest encroachers (that cause forest/habitat loss and force elephants to seek food outside of their habitat and into human settlement areas).

### HEC

The dimensions of HEC in western Sonitpur particularly the area are as follows:

Death of humans:

Year	No. of Deaths
2002-03	11
2003-04	11
2004-05	8
2005-06	7
2006-07	10

Injuries to people:

Year	No. of Injuries
2002-03	2
2003-04	7
2004-05	1
2005-06	4
2006-07	4

Elephant deaths:

Year	No. of Deaths
2002-03	13
2003-04	12
2004-05	10
2005-06	6
2006-07	5

Source: Forest Department (Sadar Range), Tezpur



Crop damage was assessed at 640 hectares during 2005-06 affecting 1121 small farmers/landholders; during 2006-07, 355 hectares belonging to 530 landholders were damaged by elephants as per Forest Department (Sadar Range) data. Additionally damage to 285 and 221 houses was caused by elephants during the years 2005-06 and 2006-07 respectively.

### **Land use and land cover change**

Available land use data for the Sonitpur district pertain to 1999-2000 (provisional) and relevant to this project, the data for forest area is placed at 29% of the total geographical area (GoA, 2004); it would seem that these statistics are not very accurate, and also not sufficiently disaggregated. To generate an accurate assessment of forest as well as overall land use/ land cover conditions the following datasets were used:

### **Satellite imagery used:**

- i) Landsat Thematic Mapper and
- ii) Landsat Enhanced Thematic Mapper+

Resolution: 30 m

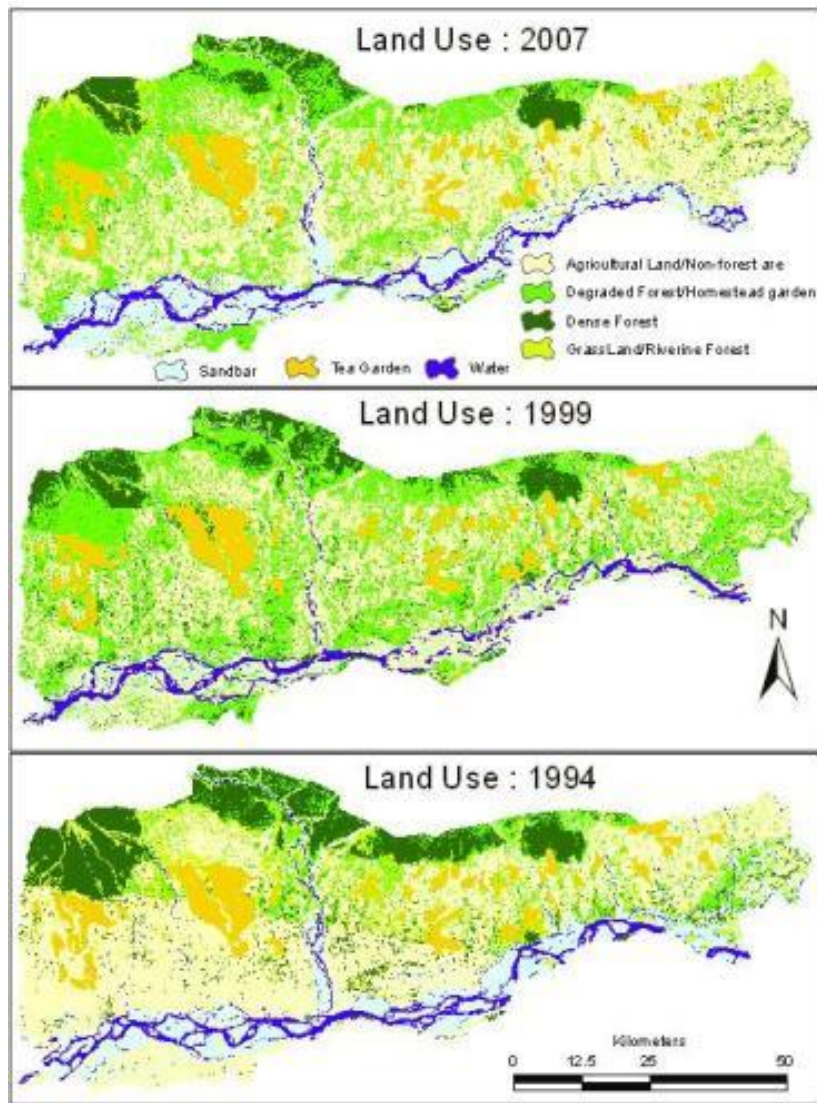
Data Type	Path-Row	Acquired on
Landsat TM	136- 41	25 January, 1994
Landsat TM	136- 42	25 January, 1994
Landsat TM	136- 41	27 January, 1999
Landsat TM	136- 42	27 January, 1999
Landsat ETM+	136- 41	23 January, 2007
Landsat ETM+	136- 42	23 January, 2007

Based on these datasets substantiated by extensive ground truthing in which more than 300 GPS points were taken over a 2 month period, the following land use categories were delineated with standard accuracy assessments above 80%.

Land use Category	Area ( in hectares)		
	1994	1999	2007
Tea Garden	38,693.66	38486.11	38565.81
Dense Forest	75,457.98	44061.39	32241.24
GrassLand/Riverine Forest	36,725.12	3680.14	13380.93
Agricultural Land/Non-forest area	231,897.41	189454.22	215,154.63
Degraded Forest/Homestead garden	44,395.21	190240.71	144147.33
Water	26,156.78	26308.53	23230.53
Sandbar	75,019.79	36132.21	61663.68
Total area	528,345.95	528,363.31	528,384.15

**Two results are apparent:**

1. Sharp declines in the dense forest category have occurred
2. Degraded forest/homestead gardens have increased substantially.



Land use change 1994-2007: The following changes were identified

Land use Category	Change 94-99 (Hectares)	Change 99-2007 (Hectares)	Overall Change 94-07 (Hectares)
Tea Garden	-207.55	-79.70	-127.85
Dense Forest	-31396.59	-11820.15	-43216.74
GrassLand/Riverine Forest	-33044.98	-9700.79	-23344.19
Agricultural Land/Non-forest area	-42443.19	-25700.41	-16742.78
Degraded Forest/Homestead garden	+145845.50	-46093.38	+99752.12
Water	-151.75	-3078.00	-2926.25
Sandbar	-38887.58	+25531.47	-13356.11

The dense forest category of recorded a loss of 43216.74 hectares. This has an adverse effect on elephant habitat and other changes in land use (viz. increases in spatial extents of degraded forests / or the near static position of tea estate areas) are much less important to the HEC equations in western and northern Sonitpur.

Land use Category	PLAND	
	1994	2007
Degraded Forest/Homestead garden	8.40	27.28
Dense Forest	14.28	6.10
GrassLand/Riverine Forest	6.95	2.53
Agricultural Land/Non-forest area	43.89	40.71
Water	14.20	11.67
Sandbar	4.95	4.40
Tea Garden	7.32	7.30

PLAND= percentage of landscape measures the proportion of the landscape occupied by that patch type, or that class.

PLAND data for 1994 and 2007, in the dense forest category ~ the ideal elephant habitat~ dropped from 14 to 6% ; in terms of spatial extent this loss amounted to a staggering 43216 hectares.

This loss in dense forest is the underlying cause of HEC in Sonitpur.

### Decline in quality of the dense forest

Along with forest loss in real terms the quality of the dense forest has declined, as quantified below, using the Fragstats landscape characterization program:

2007

patch size (hectares)	area	NP	MPS	% to total area	% to total patches
0-5	3624.03	6147	0.589561	11.25	95.54
5-10	1059.48	159	6.663396	3.29	2.47
10-20	946.17	67	14.12194	2.94	1.04
20-50	877.05	30	29.235	2.72	0.47
50-100	576.09	8	72.01125	1.79	0.12
100-200	2134	14	152.4286	6.63	0.22
200-500	566	2	283	1.76	0.03
500+	22417	7	3202.429	69.62	0.11
	32199.82	6434	5.004635		

1994

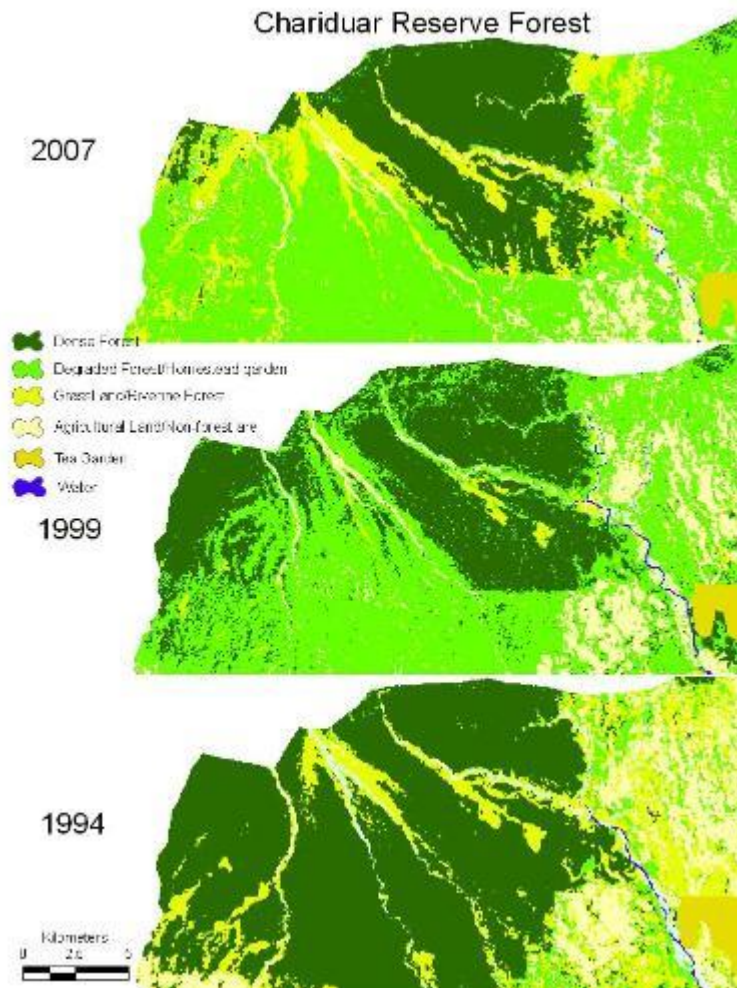
patch size (hectares)	area	NP	MPS	% to total area	% to total patches
0-5	5087.541	7489	0.679335	6.89	92.15
5-10	2280.346	330	6.91014	3.09	4.06
10-20	2311.511	166	13.92477	3.13	2.04
20-50	2772.709	92	30.13814	3.76	1.13
50-100	1759.077	26	67.65681	2.38	0.32
100-200	1180.685	9	131.1872	1.60	0.11
200-500	2657.8	8	332.225	3.60	0.10
500+	55776.2	7	7968.029	75.55	0.09
	73825.87	8127	9.084025		

Where, NP= number of patches and MPS= mean patch size (in hectares)

The losses in MPS, NP and the increase in the proportion of smaller size patches within the dense forest category (and conversely the losses in larger patch size classes) indicate a reduction in the quality of the elephant habitat during 1994-2007.

## Forest loss in critical areas:

The area under forest has registered a sharp change, and this is particularly disturbing when we consider forest loss specific to the important reserve forest (protected forest) areas. The losses under dense forest of Chariduar over 1994-2007 are as shown below:

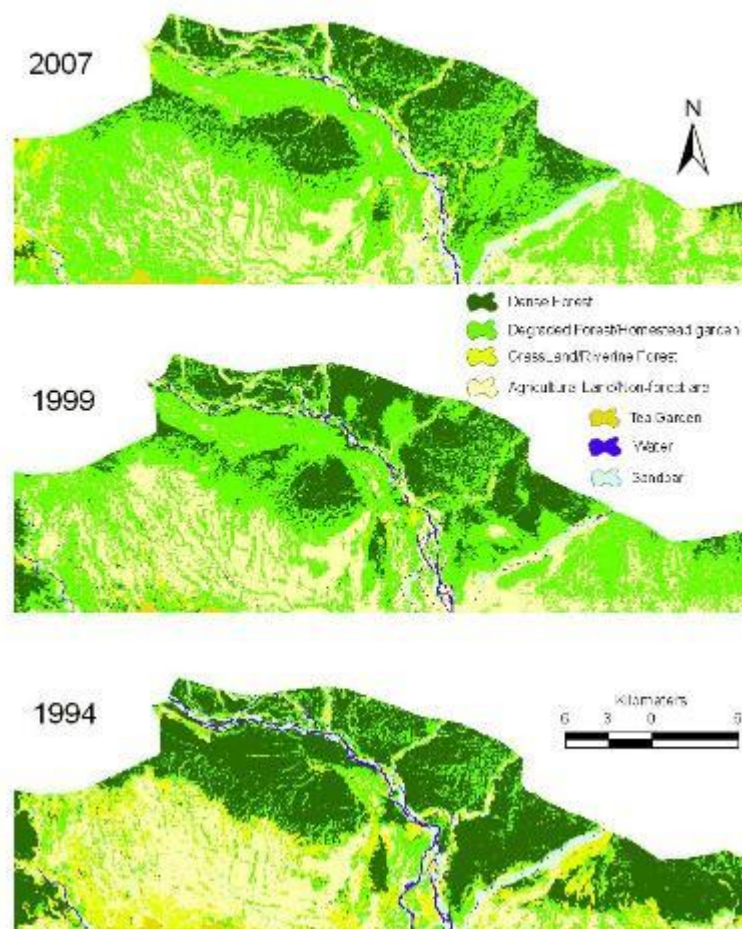


Chariduar, once the 2<sup>nd</sup> largest reserve forest in Asia, has experienced substantial forest loss and encroachment within its official boundaries is rampant. Forest loss, encroachment and resultant fragmentation of forests has adverse consequences on elephant habitat.

Forest loss in Chariduar is indicative of the pattern of land use change across the entire western and northern areas of the district: encroachment, clearing of forest patches for cultivation and expanding homesteads. Human elephant conflict (HEC) naturally follows in its stead. As observed elsewhere, HEC occurs in the fringes of forest/ protected areas “where natural vegetation gives way to increasing human density and cultivation” (Sitati and Walpole, 2006).



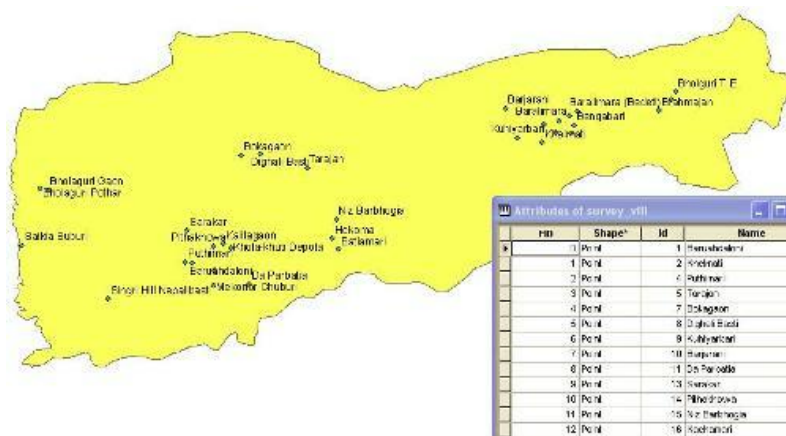
## Nameri National Park / Balipara Reserve Forest



As with Chariduar, the loss in dense forest area in the Nameri/ Balipara protected areas is quite stark. In the maps above, the Bhareli river separates the Balipara Reserve Forest (to its left) from the Nameri National Park (to the river's immediate right).

### Primary survey to gauge local perceptions of villagers affected by HEC

A primary survey was carried out in 28 sample villages to gauge perceptions of villagers regarding/affected by HEC. A questionnaire along the lines of that used by the IUCN's African Elephant Speciality Group, with certain modifications was used.



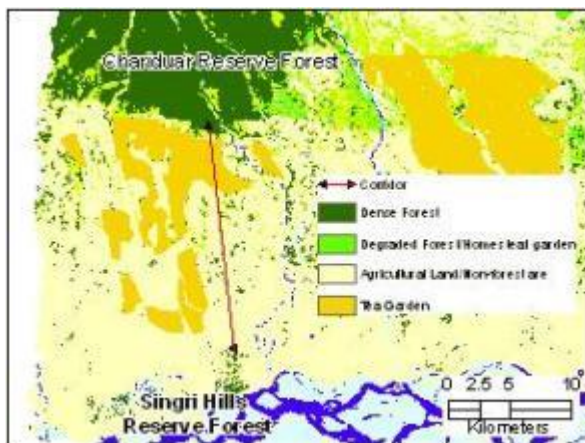


Compensation cases were reasonably good in terms of speed of delivery, but the record was a mixed bag. In one case compensation had been received the very next day; while there were instances of no compensation being received at all. Certain villages were unaware that no compensation was liable to settlers that simply encroached/set up villages based on illegal clearing of forest lands.

The main grouse of the villagers seemed to be that elephants were of little use and that methods such as electric fences should be erected to fence them in: the redundant and impracticability of such methods were lost on such opinion holders. Such perceptions are quite normal and have to be seen in the context of difficulties, impatience with slow results forthcoming from human wildlife conflict research in general (Treves, et.al. 2006). At the same time there was general agreement that loss of forest areas and encroachment/settlements was the major causes of HEC.

### Elephant Corridors:

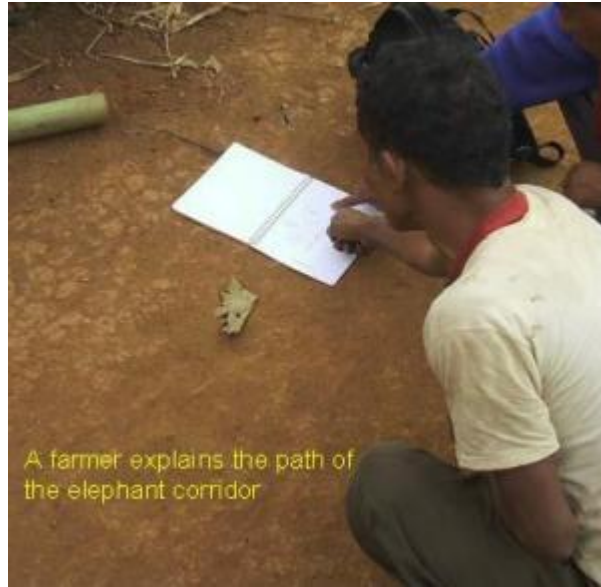
Certain corridors have almost disappeared with the forest cover. A previous study (Tiwari et.al. 2005) by a premier institute, the Wildlife Trust of India, pointed out the importance of the Chariduar-Singri Hills corridor (Map shown below).



An earlier corridor (After Tiwari et.al., 2005)

Today this corridor has vanished and elephants no longer use the route since the Singri Hills Reserve Forest has all but disappeared and the distance between forest patch has become so fragmentary, with a prohibitive patch distance between them that the elephants simply cannot use it as a corridor. The indication is that a shift of about 10-12 kilometres east of the Singri Hills, centre around Bihaguri (Kalitagaon-Dipota area) en route to the water source at Arimora Sapori has become occurred to become the new corridor, via the Rupajili-Dolongguri stretch.





Taking GPS readings, where a protected forest once existed.



Elephant's tracks pass by the villager (left) and render the land unfit by impacting of the soil.



Tree stumps in the Balipara Reserve Forest.



An elephant corridor, from Chariduar Reserve Forest to a satori (lowland/river bank) that ends at a water source, where cattle during the day and elephants at night share the water.



Sale of firewood (in the fringe of a reserve forest) is easy money and the forest and habitat suffer as humans encroach.



Large expanses of reserve forest areas have been decimated and illegally settled for agriculture.



With residents of a village that has lies in the edge of the corridor. Chilli farming would be acceptable, but at some places, they fear the land is too low-lying for chilli cultivation (stagnant water is injurious to the chilli plant). However most villages would like to cultivate chilli, particularly if some marketing assistance/buy back scheme could be worked out.



This farmer is perched on a tree top at night to protect his crops. Like others, he is unaware that chilli-dung bricks and chilli-grease fences are used profitably as elephant deterrent elsewhere.



Chilli-dung bricks along chilli-grease fences with are an option that needs to be promoted using awareness campaigns. However, experience in other parts of the world shows that farmers need to grow their own chilli for this to be a low-cost option



### Summing up:

- In India where the density of humans and settlements is high, the point of no return for effective land use planning may have been reached (Riddle, 2007) and while there is no doubt that at the heart of HEC in Assam land-use/land cover change is the chief protagonist the fact remains that this cannot be undone. This is particularly true since political compulsions in evicting encroachers exist and degradation of forest by encroachers is not something that is likely to be easily reverted. However there is an urgent need to maintain status quo in terms of land use-land cover and ensure further losses in forest cover do not result.
- This loss in dense forest to the tune of 43216 hectares (1994-2007) is the underlying cause of HEC in Sonitpur. Dense forest declined from 14% in 1994 to 6% by 2007. Measures to arrest this trend are most urgent.
- Elephant habitat has deteriorated over 1994-2007 in both qualitative and quantitative aspects. Attributes such as mean patch size, number of patches and the increase in the proportion of smaller size patches within dense forest landscape indicates a reduction in the quality of the elephant habitat during 1994-2007. Spatial decline from 14 % to 6% in terms of dense forest completes the quantitative decline.
- Additional encroachments in forest areas must be prevented, since these are the only elephant habitat areas that remain. Stretches in the immediate vicinity of elephant corridors and the foothills areas ~ along with the important reserve forest areas such as the Chariduar and Balipara Reserve Forests ~ need urgent attention.

- Alternative deterrent methods such as chilli fences and burning of chilli-dung bricks as profitably employed in Zambia and Kenya must be used to supplement elephant deterrence. Since the area is home to the world's hottest chilli, the 'bhut-jolokia' (ghost pepper) the adoption of such deterrence methods needs to be promoted. Hopefully this will reduce methods such as the use of arrows and country made pipe-guns: methods that do more harm than deter elephants.

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### **Planned work:**

The data on habitat loss and fragmentation forms the basis of a scientific publication being finalised. It was felt a peer-reviewed publication provided to the Forest Department, Government of Assam this would serve as being more authentic than write-ups in a local daily ~ several such write-ups have appeared in the local press but have had little effect on state policy on HEC and its major driver, i.e. habitat loss.

One of the team members has registered for a Ph.D. on the theme of human elephant conflict in the study area covered by this project and has received a fellowship from the Indian Council for Social Science Research (ICSSR), New Delhi. This will enable him to continue fieldwork in additional villages for a more detailed understanding of the problem and thus the project started by the RSG will continue.

A possibility of acquiring additional satellite data from the European Space Agency is also being explored.

Discussions initiated between village representatives and an NGO/Trust to encourage chilli farming (with assured post harvest sale prices & chilli crop buy back options with the assistance of the latter) to facilitate chilli-based deterrent methods will be followed up.