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PERSPECTIVE OPEN ACCESS

The Pachyderm Dread: A Case Study of Human-Elephant Conflict in the Fringe Areas of Sonai-Rupai Wildlife Sanctuary, Assam

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Abstract

The conflict between man and animal has been a problem since time immemorial. However, this problem has been increasing day by day with the advancement of technology like the construction of rail and road networks through the forest, establishing stone quarries near the forest, etc. and the increase of population. Human-animal conflict may occur with leopard, wild buffalos, tigers or even with rhinos. However, the most common encounter of human occurs with the largest mammal on earth, the pachyderm. Perhaps, a conflict with wild elephant kills more people than the others. The Asiatic elephant is gradually becoming an endangered species due to the fast decrease of its population. Human-elephant conflict is one of the major causes of decreasing elephant population.

Moreover, loss of animal habitat even in protected area poses a threat to their habitat and also becomes a cause for a decrease of the elephant population. Sonai-Rupai Wildlife sanctuary is one of the most suitable abodes of Asiatic elephant. However, rapid deforestation has compelled the elephants to enter into the human settlements, which leads to human-elephant conflict. This study attempts to understand the nature of the human-elephant conflict in the fringe areas of Sonai-Rupai Wildlife Sanctuary and to explore the reasons behind such conflicts. It focuses mostly on those human-wildlife conflicts that result from a direct interaction among humans and wildlife.

Keywords: Human-elephant conflict, deforestation, protected area, fringe area, Assam, India.

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Introduction

Human-elephant conflict (HEC) represents a widespread, complex, and intractable challenge to conservation (Das, Lahkar and Talukdar, 2012 Chen, 2016; Chang'a, 2016; Dabare, 2015; Goswami, Vasudev and Oli, 2014; Gubbi, 2014; Hoare, 2001; Jasmine, Ghose and Das, 2015; Panja and Mistri, 2018; Sitati, 2003; Thapa and Dhakal, 2014; Wilson, 2013). It is well established that HEC results in crop damage by elephants, damage to the house and household properties and injury or death to people (Ngure, 1995).

The increasing population pressure is one of the critical drivers of man-animal conflict. This increase in population leads to activities, such as the expansion of agricultural and settlement area, increasing rate of deforestation and degradation of forest areas even inside the protected areas, etc, which stand as threats to wildlife and biodiversity. The state of Assam is regarded as one of the strongholds of Asian elephant conservation (Stracey, 1963; Santiapillai and Jackson, 1990; Choudhury, 1999; Bist, 2002).

The notion of HEC has received importance in Assam (Das, Lahkar and Talukdar, 2012; Wilson, 2013). Nevertheless, there has been serious concerns worldwide as to how to minimise damage both for humans and the elephants arising as a result of HEC (Chen, 2016; Chang'a, 2016; Dabare, 2015; Goswami, Vasudev and Oli, 2014; Gubbi, 2014; Hoare, 2001; Jasmine, Ghose and Das, 2015). Studies have put forward various suggestions to reduce the HEC conflict. For instance, introduction of chili fences; cultivation of apiculture (beekeeping) in the transitional areas of elephant zones; partial cutting of the tusks so that the elephants fail to break fences; introduction of automated system aiming at remote elephant tracking through the use of Wireless Sensor Network (WSN), which in turn would act as warning against the potential presence of elephant, and thereby prevent potential HEC conflict (Mutinda et al, 2014; Ramkumar, Dev and Ranjana, 2014; Panja and Mistri, 2018). Interestingly, the North-East Frontier Railway (NFR) has downloaded the sound of honeybees from the internet and introduced the sound through micro-phone (electronic buzzer) in the sensitive elephant zones of Assam to keep the elephants away from railway tracks and thereby reduce their potential life at risk.[1] The idea has been implemented only in 2017, and as such the positive results are yet to be witnessed. In the light of this background, the central purpose of this study is to probe the nature of the HEC in the fringe areas of Sonai-Rupai Wildlife Sanctuary and to make a nuanced examination of the causes leading to such conflicts.

By its geo-spatial location in the foothills of Arunachal Himalayas, the forest-rich district of Sonitpur provides a suitable habitat for Asiatic elephants. Sonai-Rupai Wildlife Sanctuary (WLS) is the largest protected forest area in the district. However, with the continuous decrease of forest in the district and severe encroachment inside the forest area, man-animal conflict is steadily growing. As per report from the government of India, Sonitpur district records the highest degree of forest degradation and encroachment in the entire state of Assam. Although the forest fringe areas of other parts of the district like Behali reserve forest and Gohpur reserve forest are experiencing a high incidence of man-animal conflict, it has taken a severe turn in the Sonai–Rupai WLS.

The research begins with a description of the study area. Following this, it discusses the methodology. The findings are presented in the results and discussion section.

[1] Sound of bees to keep elephants off rail tracks creating a buzz (2018, 11 May). Times of India, retrieved 10 July 2018 from, http://timesofindia.indiatimes.com/articleshow/64121334.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

The Study Area

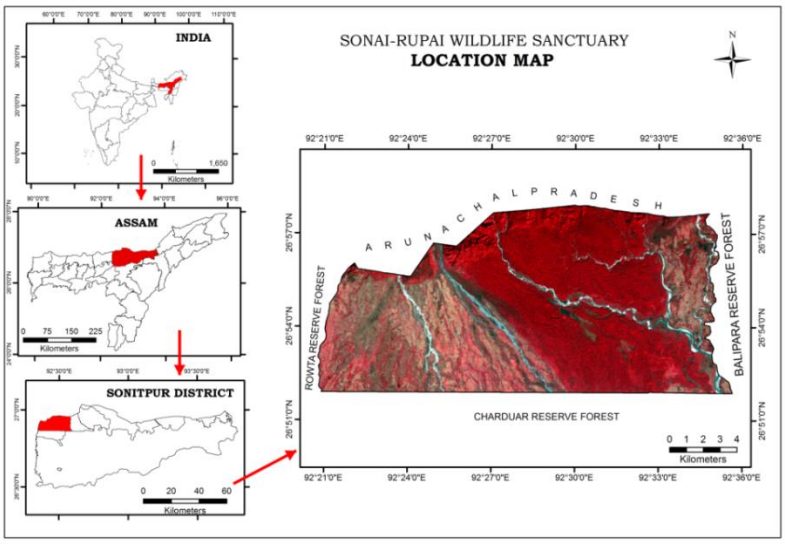


Figure 1: Location of Sonai-Rupai Wildlife Sanctuary
Source: Authors

For the study, Sonai-Rupai Wildlife Sanctuary of Sonitpur district has been selected, as the sanctuary provides the most suitable habitat for Asiatic elephant. The area falls under Dhekiajuli Revenue circle. Covering an area of 220 sq. km, the sanctuary is situated in the extreme north-western part of Sonitpur district of Assam, and it lies between 26˚ 51´ N to 26˚ 57´N latitudes and 92˚ 20´ E to 92˚ 35´ E longitudes (Figure 1). Its eastern boundary is formed by the Gabhoru river and the western boundary by Panchnoi river. To the further west, the sanctuary is surrounded by Rowta reserve forest. In the north, there is Kameng reserved forest of West Kameng district of Arunachal Pradesh and in the south by Charduar reserved forest. The prime reason to select this WLS area is that Sonitpur is one of the highly degraded and encroached districts of Assam. The selected area is once used to be a small part of Charduar reserved forest. However, due to the occurrence of its rapid deforestation, the Ministry of Environment and Forests, Government of India in 1998 declared northern part of the forest as a wildlife sanctuary with the aim of further reducing deforestation and encroachment. Despite the declaration of a wildlife sanctuary, the wildlife division of forest department[2] has failed to check deforestation, and people continue to exploit the forests and its resources as before. As a result, nearly 50% of the forest or animal habitat is lost within a period of 10-15 years. This results in food shortage for the animals in the forest, and they come out from their territory to the settlement area in search of food, which often leads to human-animal conflict in the fringe areas of the wildlife sanctuary.

Data and Methodology

In order to accomplish the objectives of the study, both primary and secondary data have been applied. Secondary data like conflict details including causalities of human and wildlife during the conflict have been collected from the forest department. The study also involves the collection of information about the approximate number of elephants in the sanctuary from the forest department. The survey has been conducted during 2013-2017 in 219 households of seven fringe villages

[2]There are two divisions of forest department, viz. territorial and wildlife. The administration of both these divisions falls under the government of Assam. As wildlife division is responsible for protection of sanctuaries, the name of forest department is highlighted as the concerned division—an implementing agency of government plans for wildlife sanctuaries.

which are very near to the forest. Primary data have been collected from the villages through interaction with the villagers. These data are further analysed to conclude conflict and its consequences. Supervised classification of satellite images of two different years, that is, 1988 and 2014 has also been undertaken to observe the changes in the forest cover in the study area using image processing techniques. These images are further verified by visiting the field using hand-held GPS so that maximum accuracy could be retrieved. Various statistics related to classification accuracy as well as overall Kappa statistic are also computed in this research (Table 3). The next section discusses the findings.

Results and Discussion

HEC occurs when both interfere with each other's territory or whenever actions of human or wildlife cause harm to each other. Similar is the case with the fringe areas of the Sonai-Rupai Wildlife Sanctuary. It has been observed that almost all the cases of man-animal conflicts that occurred in the area have been with elephants. It happens due to the dominance of the elephant in the sanctuary. Due to severe encroachment inside the wildlife habitat, the elephants come out from the forest in search of food, and further conflict occurs. However, the situation has been found to be considerably better during the last few years after the declaration of the wildlife sanctuary. As such the elephant count which was 161 in 1997 increased to 196 in the year 2002 and continued to remain the same up to the year 2007. Although no scientific measures have been applied for the collection of elephant data during first three years, except based on the visual count, the increase in the number of elephants in these years may be because of the availability of fodder inside the forests. However, the number of elephants in the sanctuary dropped down to 93 in 2010 and further decreased to 84 in 2017 (Table 1). This is primarily attributed to severe encroachment carried inside the protected area especially between 1998 and 2006. Moreover, decrease in elephant count could be due to massive degradation inside the forest, which caused harm both to animal habitat and fodder availability to the big mammals and thereby turned out to be the leading cause of growing HEC in the fringe area of the Sonai-Rupai Wildlife Sanctuary.

Table 1: Elephant Counts in Sonai-Rupai Wild life Sanctuary in During 1997-2017

Animal	Numbers in different Year				
	1997	**2002**	**2007**	**2010**	**2017**
Elephant	161	196	196	93	84

Source: Forest Range Office, Kalamati.

With the decrease in fodder in the forest, the elephants have started coming out in search of food to the nearby villages. To defend their houses, the villagers counter attack the elephants and causalities occur in the area. During conflict, many houses have been damaged with consequent death or injury of human and wildlife (Figure 2). In the year 2003, only one house was reported damaged by the elephants. One case of human death was also reported in the same year. However, the number of households damaged had increased to 57 in the very next year (2004). Death of one elephant and one human were also recorded in that year (Table 2). The highest number of household damage had been recorded in the year 2005, when 164 houses have been completely destroyed by elephants (Figure 3). In the year 2006, the forest department constructed electric fencing in and around some selected elephant corridors to stop the elephants to come out from the forest.

Figure 2: Humans Injured and House Breached by Elephants in Sonai-Rupai WLS Fringe Villages
Sources: Field survey and Forest Range Office, Kalamati

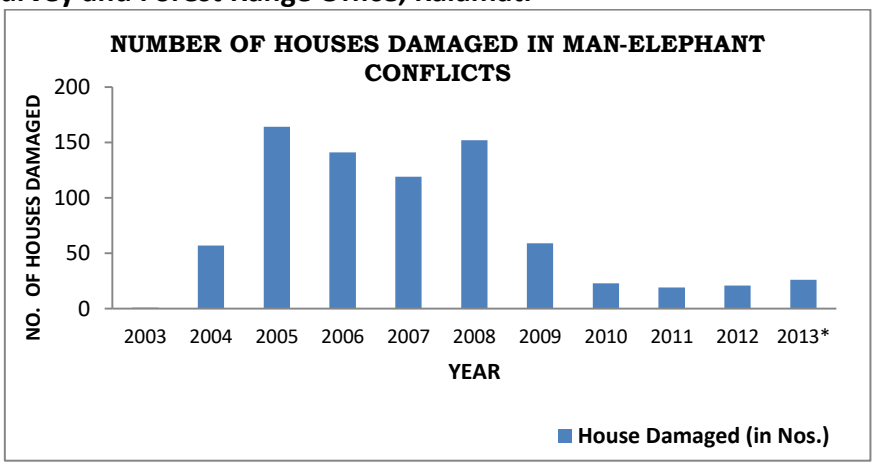


Figure 3: Number of Houses Damaged in HEC during 2003-2013
Source: Based on the Data Provided by Forest Range Office, Kalamati

Table 2: Human and Animal Loss in Human-Elephant Conflict During 2003-2013

Casuality		Loss/Injury of Human/Animal/House (Year)											Total
		2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	
Human	Death	1	1						2				4
	Injured						2				2		4
Animal	Death		1										1
No. of Houses Damaged		1	57	164	141	119	152	59	23	19	21	26	782

Source: Forest Range Office, Kalamati.

As a result of the construction of electric fences, the number of damage of households in conflict decreased to 141 and 119 in 2006 and 2007 respectively. However, the causalities again increased in 2008, when 152 households damaged and two persons were injured in conflict (Table 2). One of the explanations for these increased causalities could be that the elephants learnt that their tasks fail to conduct electricity and therefore, they were quickly able to break these fences. This observation bears resonance to the arguments as put forward by Mutinda et al. (2014).

Nonetheless, the Forest Department again took the initiative to construct electric fencing all around the forest which led to a significant decrease in conflict during the later years. The number of houses damaged by elephants decreased to 59 in the year 2009, 23 in 2010, 19 in 2011 and 21 in 2012. However, there were one human death and one injury reported in between 2010 and 2012. HEC also caused enormous damage to the crops cultivated by the villagers. However, due to several reasons like lack of accurate calculation of the volume of loss, ignorance by the Forest Department to compensate against damaged crops, the victims now do not show interest in reporting it to the concerned authorities, and hence no data regarding crop damage could be collected. Another socio-economic problem faced by the native people, due to HEC, is that the male members of the families even cannot go out of their homes in search of a job in the nearby city leaving the female members at home. It is a serious concern as most of the people have to stay at the home despite having an employment opportunity in nearby town.

Causes of HEC in the Area

In a study of Human-Animal Conflict (HAC) in southern India, Gubbi et al., 2014, uncovered four broad factors, that is elephant densities, forest cover, length of government installed physical barriers (electric fence and elephant proof moat, popularly called elephant proof trenches) and forest perimeter in Protected Area (PA) divisions, to verify if these act as drivers/deterrents to conflict. In their research, they observed that some of the divisions that do not contain any natural habitats for holding even small populations of elephants now experience repeated annual damage of crops and human life. In a similar context, this research reveals that the key causes of HAC are:

a. Rapid loss of animal habitat inside forest: The forest cover in North-East India is disappearing at an alarming rate. Human population has occupied nearly 50 per cent of the forest area to practice agriculture or build settlements. Choudhury (1999) observed that in Sonitpur district, which is a part of Sonitpur Elephant Reserve, an organised encroachment has resulted in severe habitat destruction within a very short period. Evidence suggests that more than 1000 sq. km. of forests are being destroyed annually (Choudhury, 1999). A massive reduction in forest cover, of about 145.24 sq. km., was also observed during a study carried out by Saxena et al., 2014, in the north-western part of Sonitpur district during, which includes the present study area. As human populations remain on the rise, the population of elephants continues to decline as a result of loss and degradation of forest habitat, fragmentation of breeding populations and an increase in human-elephant conflict (Hoare, 1999; Perera, 2009). Loss and degradation of elephant habitat due to human activity is considered as the most potent cause of growing HEC in Assam (Talukdar and Barman, 2003). For a very long period, before the demarcation of Sonai-Rupai Wildlife Sanctuary and when it was a part of Charduar Reserved forest, most of the people of the fringe villages of the sanctuary used to depend on the forest. They were collecting fuel-wood either for domestic use or for sale in the nearby market. They were also using the forest as grazing land, and the majority of the people cleared the forest for agricultural land (Figure 6). All these activities have led to severe degradation of forest inside the sanctuary along with the loss of elephant habitat. Observing the rapid degradation, the government has decided to declare a part of the reserved forest as a wildlife sanctuary to

restrict the entry of people inside the forest and to stop deforestation. However, due to several reasons, the encroachment and exploitation inside the forest continue, and almost two decade later the dense forest cover inside the sanctuary has been reduced by more than 40 per cent (Bhuyan and Kar, 2018).

Supervised classification of satellite images of the year 1988 and 2014 (Figure 4 and Figure 5) reveals the degradation of more than 86 km^2 of the dense forest area of the sanctuary. On the other hand, nearly 53 sq. Km. of sanctuary area has been converted into agricultural land (Table 4).

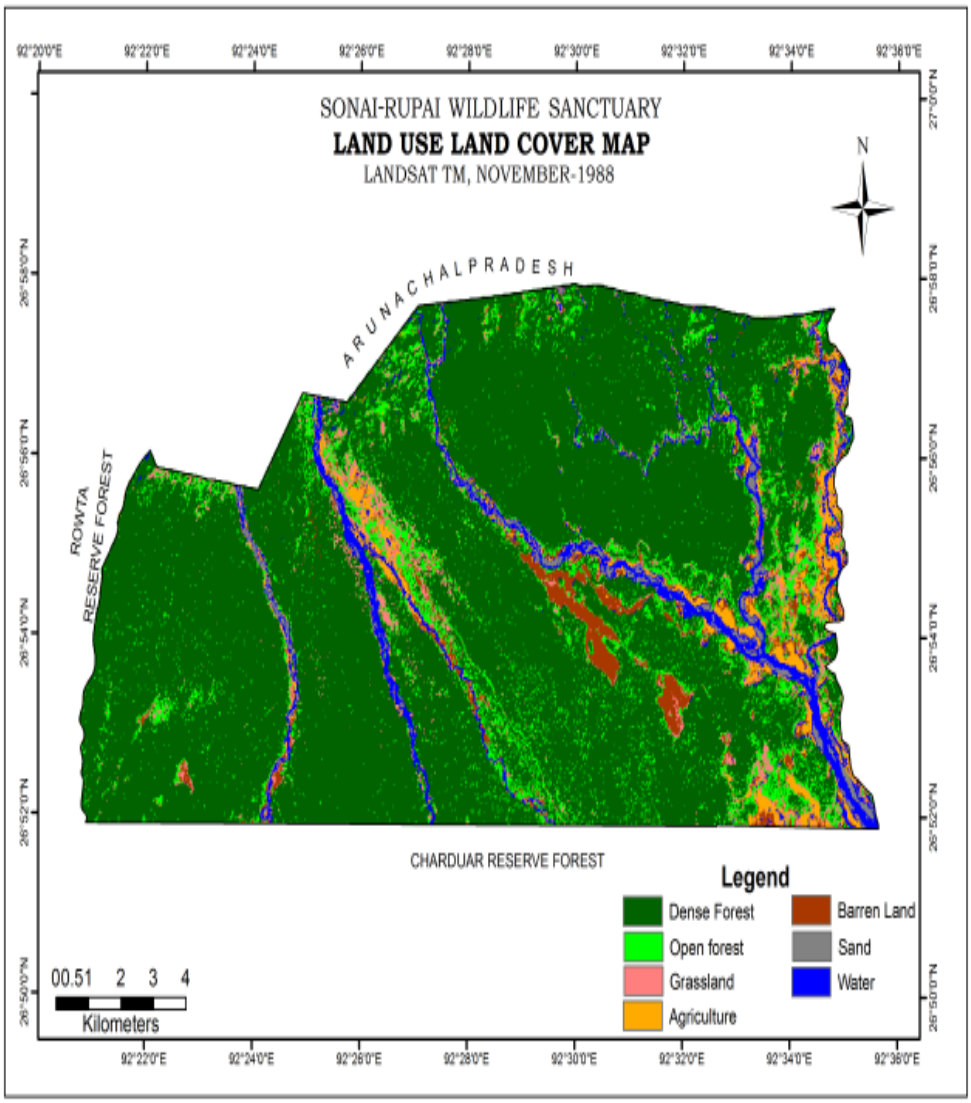


Figure 4: Land Cover of SRWLS in 1988
Source: Classification Based on Satellite Image Obtained from GLCF

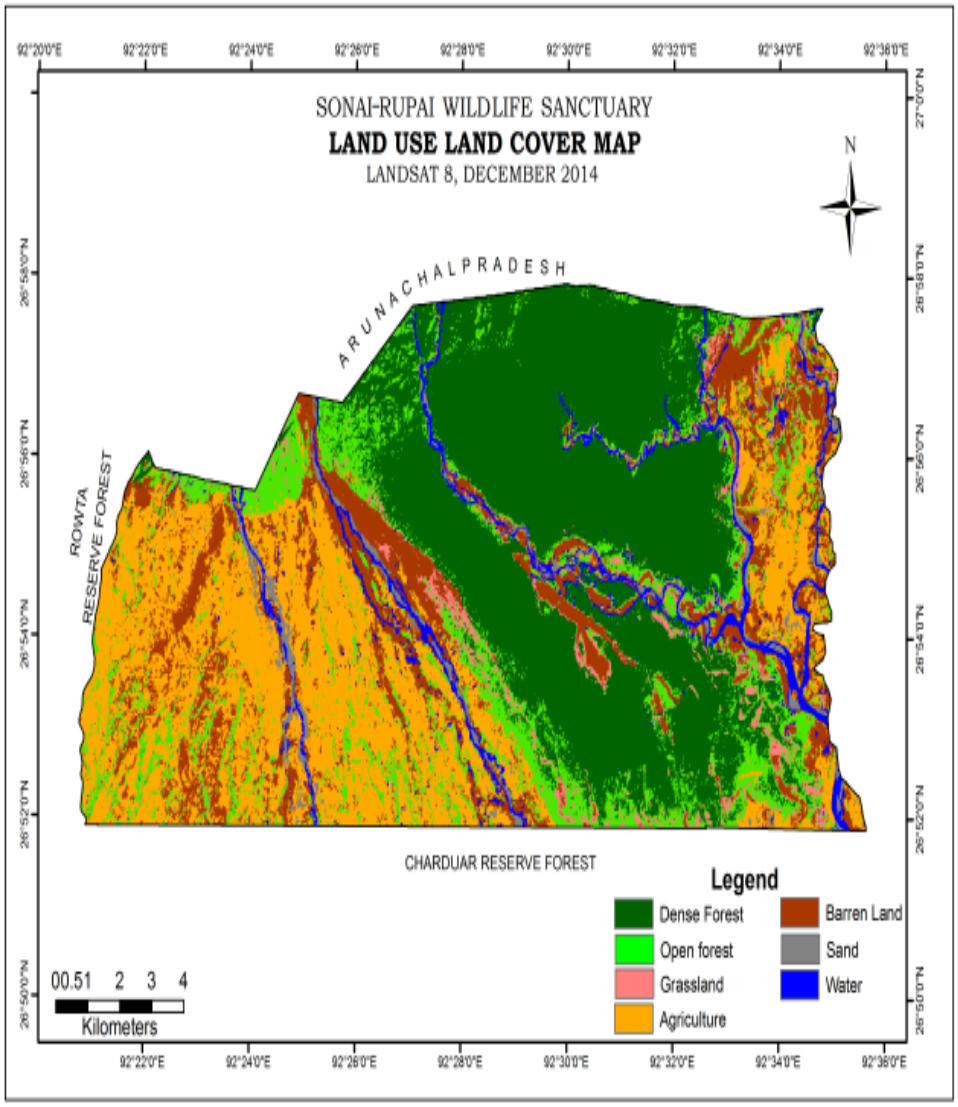
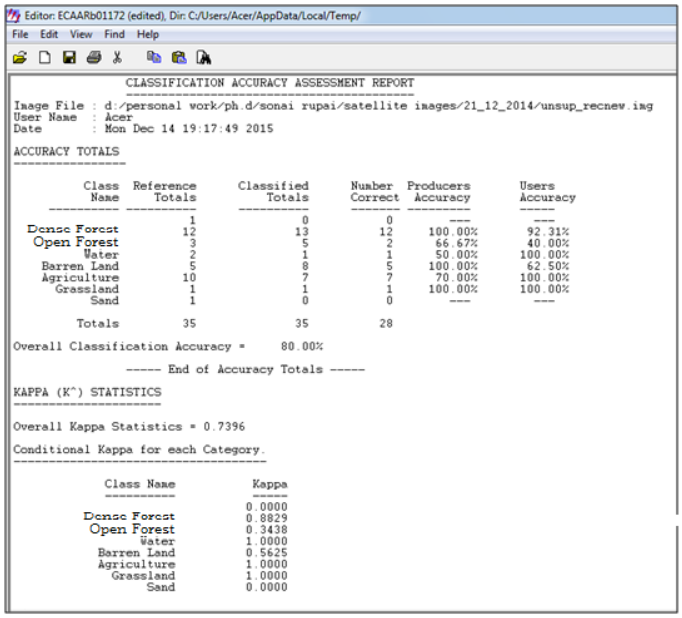


Figure 5: Land Cover of SRWLS in 2014
Source: Classification Based on Satellite Image Obtained from GLCF

Another significant observation about the land cover is the increase in barren land inside the forest. There is again a high probability that this barren land might soon get converted into agricultural land. Map being prepared based on google earth image (Figure 7) reveals the construction of houses inside the forest boundary in the western side and gradually spreading inside the sanctuary. As a result of such changes in land cover of the sanctuary, elephants lose their habitat in the forest and move either towards north to Kameng reserved forest or towards the settlement area in search of food and fodder.

Elephants raid the agricultural fields which are practised very near to the forest boundary and in some places inside the boundary also. In order to protect the crops, the people throw sharp objects, fireballs or make some loud sounds of fire-crackers. This makes the elephant or herds scared and thereby the conflict arises. Moreover, practising agriculture very close to the sanctuary (Figure 6) also increases the chances of crop raid by the elephants.

Expansion of settlement area inside the forest is also a cause for HEC. Along with the clearance of the forest, people simultaneously started construction of houses inside the forest boundary.



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CLASSIFICATION ACCURACY ASSESSMENT REPORT

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ACCURACY TOTALS

Class Name	Reference Totals	Classified Totals	Number Correct	Producers Accuracy	Users Accuracy
	1	0	0	---	---
Dense Forest	12	13	12	100.00%	92.31%
Open Forest	3	5	2	66.67%	40.00%
Water	2	1	1	50.00%	100.00%
Barren Land	5	8	5	100.00%	62.50%
Agriculture	10	7	7	70.00%	100.00%
Grassland	1	1	1	100.00%	100.00%
Sand	1	0	0	---	---
Totals	35	35	28		

Overall Classification Accuracy = 80.00%

----- End of Accuracy Totals -----

KAPPA (K^) STATISTICS

Overall Kappa Statistics = 0.7396

Conditional Kappa for each Category.

Class Name	Kappa
	0.0000
Dense Forest	0.8829
Open Forest	0.3438
Water	1.0000
Barren Land	0.5625
Agriculture	1.0000
Grassland	1.0000
Sand	0.0000

Table 3: Accuracy Report of LULC 2014, Created on ERDAS Platform

Table 4: Changes Occurred in Forest Cover of the Sanctuary					
LULC Class	**Area (in sq. km)**		**Area (in %)**		**Net change (1988-2014) in sq. km**
	1988	2014	1988	2014	
Dense forest	165.73	79.49	75.35	36.13	-86.27
Open forest	20.67	32.47	9.40	14.76	11.8
Water body	9.87	9.44	4.49	4.29	-0.42
Agriculture	6.17	59.14	2.80	26.88	52.97
Grassland	8.25	8.78	3.75	3.99	0.53
Barrenland	6.82	25.13	3.10	11.42	18.31
Sand	2.5	5.55	1.14	2.52	3.05
TOTAL	220.00	220.0	100	100	
Source: Based on the Classification of Satellite Images.					

Figure 6: Practice of Agriculture inside the Protected Area
Source: Fieldwork

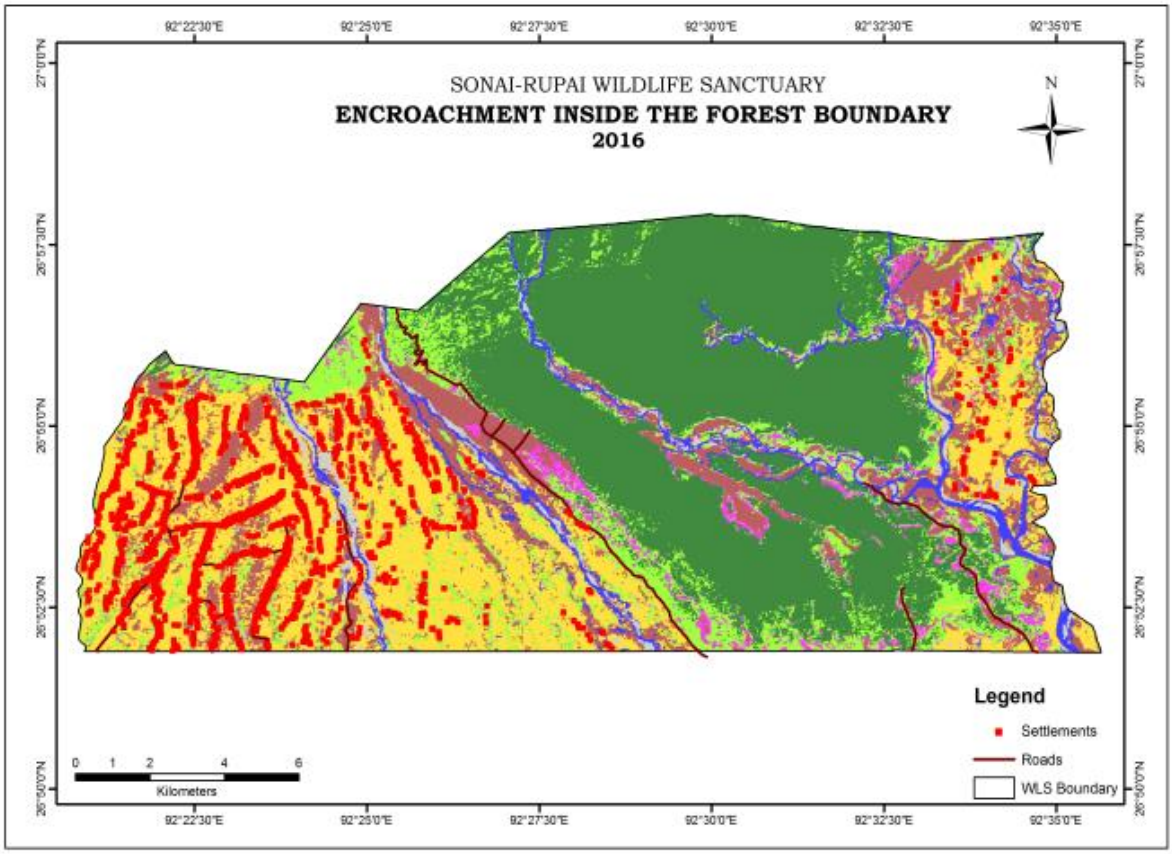

Figure 7: Settlement Inside the Forest Boundary
Source: Classification Based on Satellite Image Obtained from GLCF

b. The conflict between elephants and the people result when elephants feed on crops, destroy farms or houses, or injure or kill people, and when people retaliate against these losses, the conflict between human and elephant takes place.

c. Excessive dependency of villagers on Forest Department: Many factors other than land-use change influence conflicts, including elephant behaviour, human attitudes, and management tactics (Hoare, 2000; Dublin and Hoare, 2004). One of such factors is over dependency of people of the fringe villages on forest department. People depend more on the forest department to get themselves protected from wild elephants. Moreover, people do not understand or could not manage to protect their fields from elephant raids. The Forest Department has only two trained elephants to counter a herd of elephants. Whenever elephants enter the villages, people wait for forest officials to arrive and look at action it takes. Sometimes it takes a very long time to take any action by the forest department to drive out elephant herd and thus the conflict rate increases.

d. The smell of home-made liquor: One of the primary reasons for the elephant attack in the house, apart from searching for food, is the smell of home-made liquor. Most of the fringe villages are dominated by tribal people who prepare liquor in their home itself. Elephants are fond of this home-made liquor. Whenever elephants enter the villages in search of food, they can sense the availability of liquor through smell. Therefore, they break the wall to drink even the same. In the field survey, it was found that the elephants mostly damage the kitchen of the houses or where the people generally store their liquor.

Challenges to Reduce Conflict

The rate of conflict is increasing every day with the encroachment inside the forest and loss of habitat for wildlife. It has become an urgent matter before the Forest Department to check the growing conflicts. However, there arises certain complicacy to take immediate steps. Some of the challenges faced by Government as well as Forest Department are:

a. Balancing social values: The people living in the fringe areas depend on the forest for their livelihood. They practise agriculture near the forest boundary. It was, however, the failure of the forest department that it could not check encroachment inside the forest. Now the encroachment inside the protected areas has extended to such an extent that the government has not been able to stop inhabitants from practising agriculture inside the boundary immediately because of several acts— Tribal Act, Forest Policy 1980, etc. Enormous administrative support and force would be required to evict the settlers from the forested land.

b. Increasing fodder inside the forest: In order to prevent the elephants from coming out of the sanctuary, there is a need to increase the food for elephants and other wildlife inside the forest. However, it has become a difficult job on the part of forest department of Assam. Although it initiated replantation programme inside the sanctuary for several times, it failed because of non-cooperation from the neighbouring state of Arunachal Pradesh. Moreover, some miscreants often set on fire the entire plantation area or cut down the plants. The situation has become such that the houses constructed inside the forest have now become part of permanent settlements, and as such it has now become difficult on the part of the forest department to take some aforestation programme in those areas.

c. Provisions of Forest Acts and Laws towards conservation: The Assam Forest Policy, 2004, states that forests, being an open-access resource, are vulnerable to various kinds of pressures like encroachment, illicit felling and smuggling of timber, fire, grazing and shifting cultivation. The main reasons for increasing pressure may include rehabilitation of flood and erosion affected people in the forest land for settlement; inter-state boundary disputes with neighbouring states, and so on. However, in the study area, no such rehabilitation programme for flood victims has been done, but most of the people have arrived in this area

from some unknown places which are perhaps the people affected by floods. There is also the occurrence of a dispute with neighbouring state Arunachal Pradesh who claims that a part of sanctuary belongs to them.

Assam Forest Protection Force Act, 1986 has given enormous power to the forest officials. They have the power to arrest anybody without any warrant, who is involved in any forest-related offence like smuggling, encroaching, etc. and caught on the spot. They can also search any suspect's house without any search warrant. However, despite having such powers, they have not been able to check ongoing deforestation. This happens due to several other acts like Forest Regulation Act 1980 with the amendment made in 1988, which states that people who are living in forest areas before 25th October 1980 (before the enactment of the Forest Regulation Act, 1980) should be regularised.

Further, Forest Rights Act, 2006 has also given power to the forest-dependent scheduled tribe dwellers to use the forest resources for grazing, for collection of minor forest products and construction of school, dispensary, and so on in forest land. However, for such purposes, they can only cut down a maximum of 75 trees. Such forest acts prevent the forest officials from taking any strict steps against the encroachers.

Moreover, lack of awareness among the people regarding the importance of forest and wildlife also stands as a barrier in minimising the conflicts as well as encroachments. Most of the people in the surveyed villages do not want forests. They believe that due to the presence of forest only most of the conflicts are taking place in the area. They say, 'had there been no forest, there would not have any conflict'. Only 53 per cent of the fringe villagers want that the forests should be there, while the remaining 47 per cent either spoke against the forest or keep themselves neutral (Table 5). Hence, one can conclude that HAC would continue primarily because of this lack of awareness among the forest villagers and only possible steps need to be taken up for minimising/reducing the conflict.

Table 5: Perception of People Regarding the Existence of Forest

Village	HH as per 2011 census	% of HH surveyed	% of HH want the forest	% of HH do not want the forest	% of HH that remained neutral
Bengenajuli	140	19.29	40.74	25.93	33.33
Dighaljuli	164	22.56	62.16	29.73	8.11
Rikamari	281	16.73	48.94	31.91	19.15
Belsiri	36	41.67	53.33	33.33	13.33
Kathalguri	83	40.96	55.88	11.76	32.35
Dighaljuli Bengali	49	40.82	55.00	35.00	10.00
Naharani	241	16.18	53.85	12.82	33.33
Total	**994**	**22.03**	**52.97**	**24.66**	**22.37**

Sources: Census of India and Fieldwork

Conclusion

The principal aim of this study was to examine the HEC in the Sonai-Rupai Wildlife Sanctuary. The problem of conflicts persists because of the absence of an appropriate approach in public participation and lack of awareness among the public regarding wildlife conservation. To mitigate the HAC in an area, it is essential to understand the ecological processes that drive HAC, along with the attitude, expectations, and tolerance level of the local people living in the vicinity (Jesmine et al., 2015). There is a need for better understanding and awareness about the nature and complexity of factors contributing to HAC including land use, agricultural practices and wildlife management initiatives. As already stated, Rajkumar *et al*.,

2014 suggest very fruitful measures to minimise HAC by using remote elephant tracking method where some sensor generates an alarm by detecting the seismic waves that are generated by the movement of elephants. This alarm can make the people as well as forest department to know about the arrival of elephants. Although the forest officials have evolved some measures to minimise the conflicts in the recent years, it cannot be considered as a permanent solution, as it is a single measure, that is, the methods applied are no way fruitful for the elephants. Until and unless sufficient fodder is provided to the elephants, the conflicts will continue and people will continue to suffer.

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