

EXAMINING CERTAIN ASPECTS OF HUMAN-TIGER CONFLICT IN THE SUNDARBANS FOREST, BANGLADESH

▶ by Gertrud Neumann-Denzau and Helmut Denzau

Introduction

In the Sundarbans mangrove forest in the Gangetic delta (10,284 km²: 58.5% in Bangladesh, 41.5% in India) human-tiger conflicts are more frequent than in any other tiger area of the world. Only a limited number of tiger victim cases reach the public. The term victim is used here for people injured or killed by a tiger attack within the forest area.

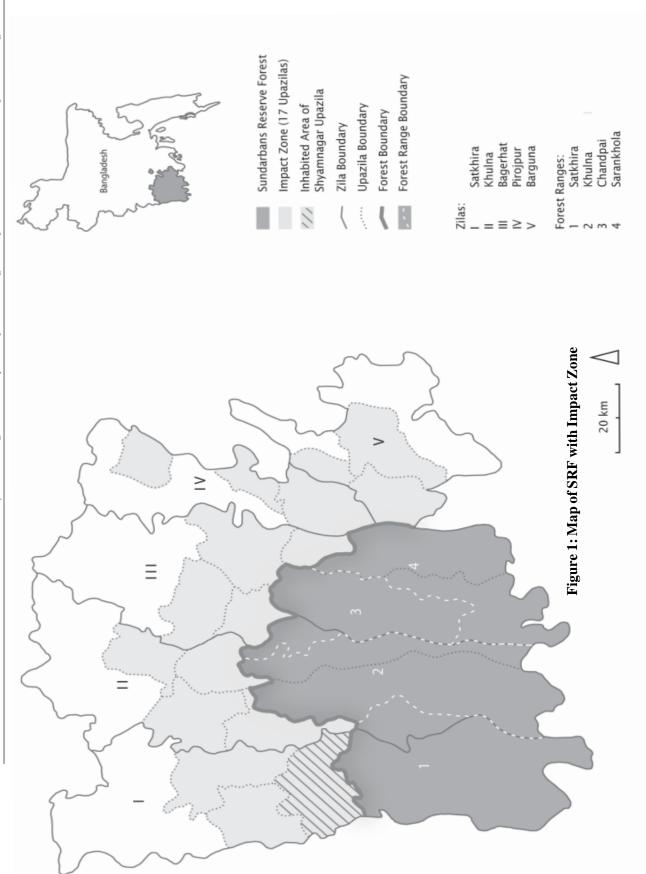
In a previous paper Neumann-Denzau and Denzau (2010) analysed reports of tiger attacks based on two independent data sets, listings of the Bangladesh Forest Department (BFD) and newspaper clippings, for the period 2003-2005 (36 months). One hundred seventy-seven casualties were reported, each identified by the name of the victim, age, profession, home village, as well as date and location of the incident. The listings of the BFD contain only cases of people who entered the forest with legal permission; the newspapers report without such limitation. A comparison of these data sets consisting of individual casualties allowed us to develop an extrapolation of the total number of tiger victims in the Bangladesh Sundarbans, which was found to be 168 as the annual average for the years 2003-2005. A high percentage were illegal entrants.

In this paper we used the same data base as in Neumann-Denzau and Denzau (2010). Our next aims were to localize the places of incident and discuss the different reasons for tiger attacks, e.g., disturbance by human intruders, changes in salinity and vegetation, tiger and prey densities, etc.

Furthermore, we considered the locations of the homes of the victims, used different sources to estimate the number and origin of resource extractors, and looked into peculiarities of the area most afflicted by human-tiger conflicts (i.e., Shyamnagar upazila). In addition to our two data sets for 2003–2005, we consulted an extended data base of the BFD for the period 1984-2005 to examine temporal changes of the places of incident.

Places of incidents

The Sundarbans Reserve Forest (SRF) belongs to 3 zilas (administrative units): Satkhira (I), Khulna (II) and Bagerhat (III), subdivided into 5 upazilas: (I) Shyamnagar; (II) Koyra, Dacope; (III) Mongla, Sarankhola. The Sundarban Impact Zone (5,128 km², BPC, 2005-2007b) consists of 17 upazilas belonging to 5 zilas (Satkhira: Assasuni, Kaliganj, Shyamnagar; Khulna: Batiaghata, Dacope, Koyra, Paikgachha; Bagerhat: Morrelganj, Rampal, Sarankhola, Mongla; Pirojpur: Bandaria, Mothbaria, Nessarabad; Borguna: Bammna, Borguna, Pathergatha) and was defined by the BFD (SBCP Baseline Study 2001) as the area surrounding the forest where most of the Sundarbans resource users live (Fig. 1). The forest itself is divided into 4 forest ranges (FR): Satkhira FR, Khulna FR, Chandpai FR and Sarankhola FR. The boundaries of the forest ranges are not congruent with the zila boundaries. For example: the Sathkira FR exceeds the boundaries of Satkhira zila and covers parts of Khulna zila.



Hendrichs (1975) reported 392 casualties between 1956 and 1970. Out of these, 365 were known by

place of incidence with 198 (54.2%) occurring in Satkhira FR.

Reza *et al.* (2002), basing their results on records of the BFD, found that 401 people were killed between 1984 and 2000; 45% in Satkhira FR.

JJS (2003) reported 181 casualties between January 1999 and March 2002 (39 months). One hundred and six (58.6%) of the victims were domiciled in the reclaimed region of Satkhira zila. Out of these, 96 (53.0% of the total victims) belonged to Shyamnagar upazila. One hundred and seventy-three of the attacks could be located by range and compartment, revealing that 111 (64.2%) occurred in Satkhira FR.

Islam *et al.* (2007) analyzed data of the BFD between 2000–2004 and found that 79.1% (87 out of 110) victims were killed in Satkhira FR.

The available data for certain time sequences are listed in Table 1.

Most of the available reports on casualties are accompanied by the name of the place of the incident. These names are not always correct. They might be also distorted by verbal transmission or by translation into English. We have used a combined approach to locate place names, taking into account the compartment numbers given by the BFD and references from 1: 50 000 maps (Curtis, 1933; BFD, 2002).

The majority of place names (164 out of 177 individually known casualties or 92.7%) could be localized either by compartment number or at least by forest range. For our data set for 2003–2005, we found that a high percentage of cases (94.5%) happened in Satkhira FR; 155 cases in total.

In order to find out if the number of tiger attacks in Satkhira FR was always higher than in other parts of the Bangladesh Sundarbans, data for 50 years (1956-2005) were analysed. Old FD data may sometimes include casualties from the fringe area. In the BFD data (1984-2005) used in this study we have considered only data from inside the forest.

Table 1: Casualties in Satkhira Forest Range (1956-2005)

Period	Number of casualties with known place of incident	Number of casualties in Satkhira FR* (absolute)	Number of casualties in Satkhira FR* (in %)	Type of Data	Source
1956-1970	365	198	54.2	FD	Hendrichs (1975)
1956-1983	554	265	47.8	FD	Siddiqi & Choudhury (1987)
1971-1983	189	67	35.4	FD	Difference between Hendrichs and Siddiqi & Choudhury
1984-2000	401	180	45.0	FD	Reza et al. (2002)
1999-March 2002	173	111	64.2	FD+NP+ IN	JJS (2003)
2000-2004	110	87	79.1	FD	Islam et al. (2007)
1984-1992	259	128	49.4	FD	This study
1993-1999	104	20	19.2	FD	This study
2000-2005	127	110	86.6	FD	This study
2003-2005	164	155	94.5	FD+NP	This study

(FD = Forest Department, NP = Newspapers, IN = Interviews, FR = Forest Range) *Satkhira FR differently defined (Comp.46-55 by Hendrichs (1975), Comp.41-44, 46-55 by Siddiqi and Choudhury (1987), Comp.41-42, 46-55 by all others) and therefore not entirely comparable.

At first sight (upper part of Table 1) it would seem that the portion of casualties in the Satkhira FR has always been high and has increased slowly since the investigations by Hendrichs (1975). When examining the available FD data in detail (see lower part of Table 1) it becomes evident that the percentage of casualties in Satkhira FR remained constant at c. 50% until about 1992. In the period 1993-1999, it dropped quite low (to c. 20%). Beginning in 2000, it has increased dramatically, reaching more than 90% for the first time in 2002.

From our 2003-2005 data we found that 94.5% of the casualties occurred in Satkhira FR. Table 1 shows that the portion of tiger incidences in Satkhira FR has fluctuated over a period of c. 50 years (1956-2005) between 19% and 94% and was by no means always the highest within the Sundarbans. What has caused these temporal changes?

Discussion of reasons for tiger attacks

First of all, it should be recognized that due to the amount of freshwater inflow, the salinity in the Bangladesh Sundarbans is increasing from east to west and from north to south. Satkhira is the forest range with the highest salinity and covers 32% of the Bangladesh Sundarbans forest (Hussain and Acharya, 1994).

Human intruders

The correlation between the number of resource extractors and tiger attacks has been discussed by different authors.

Hendrichs (1975) was the first to notice an increased percentage (54.2%) of casualties in this FR and suspected the higher degree of salinity as one possible reason for tigers showing abnormal behaviour. He deduced this idea from his data, gathered by personal communication, revealing that only 10% of the people (1,000 of about 10,000) inside the forest were found in Satkhira FR. He concluded that utilization of forest by men increases from west to east; occurrences of tiger casualties (except for man-eaters) increase from east to west and from north to south; while the salinity increases from northeast to southwest.

"The distribution of casualties during the day highest in early morning and afternoon – and during the year – highest in winter and in the months of honey collecting – is clearly related to the utilisation of the forest, i.e., to the availability of human prey." He also considered another factor at work besides this causal correlation, giving him occasion to classify tigers into categories for debating the maneater phenomenon. After comparing the relative number of casualties in each forest compartment, he claimed that the number of men engaged in forest operations in low salinity areas showed that the killing rate is not a question of availability of men, but that inside the high salinity zones the killing of men is correlated with their availability. We are not sure if Hendrichs' discussion is based on correct information regarding the number of people working at that time in each forest range. Even nowadays it is quite impossible to find complete temporal and spatial data along with the scale of all forest activities - a fact which prevents a direct correlation between the number of tiger attacks and the disturbance level.

In 1970/71, a high number of casualties occurred in connection with timber cutting operations in the low salinity zone. Hendrichs (1975) developed the theory that a single male tiger (Mara Passur maneater), responsible for a series of 32 casualties in 13 months in an area of about 150 km², might have moved in from the high salinity zone. Chakrabarti (1978) was another supporter of the roving maneater thesis, which was deduced from the analysis of the most vulnerable blocks regarding human casualties before and after 'Project Tiger' started functioning in the Indian Sundarbans. After the core area was closed for human access the most vulnerable blocks in the core area were replaced by blocks in the buffer zone. Chakrabarti believed that the man-eaters had followed the people in search of human prey. We think that another interpretation is also possible: due to the disturbances caused by increased human activities a local tiger could have turned into a man-eater. This would be contrary to Hendrichs' and Chakrabarti's theory of the migratory nature of man-eaters.

Migratory or transient tigers (males as well as females) are found in each tiger population. For instance, they were found to form a mean abundance of 7% of a well-studied tiger population in Chitwan, Nepal (Barlow *et al.*, 2009a). As transient tigers have not established their own territory they may face problems in hunting prey or in approaching sweet water ponds in the Sundarbans. This needs to be studied further.

Siddiqi and Choudhury (1987) found casualties in the high salinity zone of SRF to be significantly higher than those in the medium and low salinity zone for the period 1956-1973. But during the period 1974-1983, the differences in casualties between the low and high salinity zones became insignificant and the casualties in the medium salinity zone were significantly higher than those of the other two zones. They concluded: "This trend does not justify the hypothesis that the salinity of the water causes tigers to develop man-eating behaviour." The number of casualties among the Golpatta cutters was high throughout all forest ranges, while honey collection and Goran cutting logically revealed a strong correlation between yield per range and casualties, as the latter two are not practised in all ranges.

Salter (1984), after analysing another data set, found indications that "the frequency of mankilling is highest in areas and at times of heaviest concentration of people, suggesting that the mankilling and the frequency of man-tiger contacts are directly correlated".

JJS (2003): "... seems to suggest that there is a direct relation between the number of attacks and the number of people accessing these areas."

From our own observations in the Bangladesh Sundarbans, including 3 visits to working coupes of the Khulna Newsprint Mill (KNM) at Chora Betmore (headquarters at Comp. 4,7) and Ghushiangra (headquarters at Comp. 10,15) in 1992 and 1993, we know that Gewa (*Excoecaria agallocha*) cutting was often done in small and isolated sub-units and that the Gewa woodcutters were very often confronted with repeated tiger attacks, even in low and medium salinity zones. Before the Khulna Newsprint Mill closed in 2002, about 1,000 Gewa woodcutters were said to be under contract at the same time. The data obtained from the BFD show a killing series of 38 victims, most of them woodcutters, in Comp. 5,6 in the

low salinity zone, between 6 February 1988 and 14 March 1989. From Mr. Daruzzaman (KNM), we came to know independently about 22 tiger victims that correlated with Gewa cutting (1982: Comp. 18,19; 1983: Comp. 16; 1988: Comp. 5; 1989: Comp. 4,5; 1991: Comp. 12 A+B). The KNM shifted the headquarters of the felling activities from Chora Betmore to Ghushiangra in 1992. After March 1989, there were no more incidents in Comps. 4,5,6,7 until November 2005. We therefore conclude that a high level of disturbances by forest resource users may provoke man-eating behaviour among local tigers even in the low salinity zone. The series of killings 1988/ 89 in Comp. 5,6 listed by BFD directly correlates with our information regarding Gewa cutting operations by KNM in this area.

Salinity and vegetation

Besides salinity, additional environmental factors that influence the soil, water and vegetation are manifold such as geomorphological and hydrological components, chemicals, (including nutrients), pH value, tidal water flow and flooding, sediment load, and micro climatic factors. The vegetation is less diverse in high salinity zones, poor in the interior and richer at the forest margins. Floral composition and growth affect faunal composition and dynamics. The vegetation/herbivore relationship is a key for understanding the tiger/prey relationship.

Goran (Ceriops decandra) is a typical small mangrove of high salinity zones and forms dense thickets. Chakrabarty (1978) identified the habitat formation 'pure Ceriops' for the highest records of human casualties in the Indian Sundarbans, together with high records in pure and mixed Hental (Phoenix paludosa) stands. Deodatus and Ahmed (2002), who analysed the preference of tiger and prey for different forest types in the Bangladesh Sundarbans, found a high occurrence of tiger crossings in dense vegetation of Goran, Hental and some mixed forests as well. Dense undergrowth would require another kind of hunting strategy by the tiger than an open forest floor, if used for hunting at all, and not for prey consumption, birth giving, rearing and resting. Satkhira FR, rich in Goran and Hental, calls for inquiries into the activities, densities and links of tigers, prey and people in this vegetation type. The outcomes could result in a recommendation for resource users to avoid entry into certain forest types. This would benefit tiger conservation and save human lives.

It has often been suspected or claimed that the physiology of Sundarbans tigers is affected by high salinity. But as far as we know there is no scientific proof of this. It has to be kept in mind that inner organs like the kidneys can be investigated histologically only by pathologists, not by the local veterinaries who are usually called in for the autopsy of Sundarbans tigers. It is quite possible that Sundarbans tigers in high salinity zones suffer from hypertonicity, causing increased activity and aggressiveness. In order to detect hypertonicity it would be required to measure the blood pressure of live wild Sundarbans tigers for comparison with the blood pressure of tigers from other regions. This could be carried out when wild tigers come into the hands of man after narcosis for medical treatment, radio-collaring or translocation. In this connection, it is also recommended to check if Sundarbans tigers with easy access to sweet water ponds within the forest attack people less often than tigers with no such access.

Tiger and prey density

Three independent surveys investigated the banks of creeks to record the tiger crossing frequency in the Bangladesh Sundarbans. Deodatus and Ahmed (2002) covered big parts of all forest ranges (766 km along creeks). Two surveys conducted in 2007 and 2009 (Barlow et al. 2008, 2009b) covered the entire area of 1,201, resp. 1,207 creek km. All surveys found high track rates per creek kilometer in Satkhira FR. These were interpreted as an index of relative tiger abundance only. Another possible interpretation could be increased activity, meaning that the tigers are more frequently on the move as a result of hypertonicity, variations in prey availability, different hunting techniques or due to other factors, including human disturbance level. Either higher tiger abundance or different tiger behaviour, natural or man-induced, could explain the higher rate of tiger attacks in Satkhira.

Deodatus and Ahmed (2002) have investigated the relative density of spotted deer (*Axis axis*) and wild boar (*Sus scrofa*) – the most important tiger

prey species – counting footprints and pellets on transects and plots in many parts of the Sundarbans. They found an increase towards the west, with a relatively high abundance of both species in Satkhira FR. The wild boar track density in the northern fringes of Satkhira FR was remarkably high, while the deer track density decreased here. A more detailed relative prey abundance survey for the Bangladesh Sundarbans is in progress. Tiger density, prey density, frequency of human activities, kind of human activities, and human casualties can't be correlated as long as sufficient data are not available.

Presumably there is a coinciding of relevant factors which causes the high level of human-tiger conflict in certain areas of the Sundarbans.

Homes of victims

Out of our data source (2003–2005) the home places of the tiger victims were sorted according to zila for the Impact Zone (Table 2). The home villages of 138 victims are known, of whom 117 are from Satkhira zila. Of the victims known by their village, 78.3% come from the inhabited area of Shyamnagar upazila (hatched area in Fig 1).

Number of resource extractors

After learning of the high concentration of tiger victims living in Shyamnager upazila, it seemed reasonable to ask if an over proportionate number of people of this upazila enter the forest. In order to ascertain the total number of resource extractors of the SRF, we consulted the SBCP Baseline Study (2001) and different volumes of the Bangladesh Population Census (BPC).

The aim of the SBCP Baseline Study was to analyse the socio-economic conditions in the Impact Zone of the Sundarbans, which has a population of about 3.5 million people. The study consists of two parts, a village census and a household survey. The village census was conducted among 54 surveyed villages with 22,099 households being interviewed. As a result, 3,996 households (heads) were found to be dependent primarily on SRF resources. Out of these, 790 households were selected for a representative

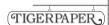


Table 2: Tiger victims' home places (2003-2005)

Year	Reported cases	Known villages of victims	Satkhira Zila	Khulna Zila	Bagerhat Zila	Pirojpur Zila	Barguna Zila	Outside Impact Zone	Shyam- nagar upazila in Satkhira
2003	83	49	45	3	0	0	0	1	43.0
2004	47	46	37	7	1	0	0	1	33.0
2005	47	43	35	5	2	0	0	1	32.0
Total number of victims	177	138	117	15	3	0	0	3	108.0
%		100	84.8	10.9	2.2	0	0	2.2	78.3

household survey. It was found that more than 68% of the households extracting the Sundarban resources were also involved in secondary occupations (also based on Sundarban resources).

In Bangladesh, the BPC for 2001 was held in zilas and upazilas. The results of the zilas and upazilas in the Impact Zone were published in 2005-2007. This is the latest statistical data set for the population of the Impact Zone.

The number of households depending on SRF was determined in the following way: for each of the 17 upazilas of the Sundarban Impact Zone, the population and total number of households were taken from BPC data. The percentage of households depending on SRF was taken from the SBCP Baseline Study (2001). This percentage is used to calculate the total number of households depending on SRF. The results are compiled in Table 3, zila-wise for the total Impact Zone and for Shyamnagar upazila in particular.



Figure 2: Woodcutters entering mangrove forest (Photo: Gertrud & Helmut Denzau)

Table 3: Population and households in the Sundarbans Impact Zone (SIZ) according to Bangladesh Population Census 2001 (BPC 2005, 2006a, 2006b, 2007a, 2007b) and percentage of households depending primarily on Sundarbans resource extraction, calculated with data from the SBCP Baseline Study 2001.

	Total SIZ 5 Zilas, 17 Upazilas	Satkhira Zila 3 Upazilas	Khulna Zila 4 Upazilas	Bagerhat Zila 4 Upazilas	Pirojpur Zila 3 Upazilas	Barguna Zila 3 Upazilas	Shyamnagar Upazila in Satkhira Zila in particular
Population in the SIZ	3,449,741	819,409	738,709	791,167	631,015	469,441	313,781
Households in the SIZ	712,977	163,333	150,080	166,320	132,801	100,443	58,885
% of households depending primarily on SRF within the SIZ of each Zila	average 15.9	20.2	23.8	14.2	4.4	15.3	20.4
Number of households	113,534	32,921	35,787	23,574	5,876	15,376	12,013
depending primarily on SRF as portion of the total SIZ	100.0 %	29.0 %	31.5 %	20.8 %	5.2 %	13.5 %	10.6 %

To estimate the total number of forest resource users nowadays, the data of Table 3 have to be used. Fifteen percent of all household heads in the Impact Zone (113,534 households total) declared earning their primary income from activities inside the forest. There are, however, four factors of uncertainty: a) it remains unknown how many members of the primary dependent households enter the forest for how many days per year; b) the group of secondary resource users, whose main income is generated outside the forest but who enter the forest occasionally, was not analyzed in the SBCP Baseline Study (it might be the bulk); c) the number of illegal entries is not available; and d) the number of persons who enter the forest from outside the Impact Zone is not recorded. The border of the Impact Zone was set up according to the distance from the forest (with the exception of Nessarabad in Pirojpur Zila) and is not a sharp dividing line between forest resource users and non-users. Furthermore, deep-sea fishermen employed in the winter season at Dublar Island

(within the Sundarbans) are mainly recruited from the Chittagong area in south-east Bangladesh, far away from the Impact Zone.

Kabir and Hossain (2007) found from interviews with honey collectors in the Impact Zone that there were 1.47 earners per household. Due to all these uncertainties, the attempt to estimate the number of people who enter the Bangladesh Sundarbans to earn their livelihood varies widely, amounting to a figure somewhere between 200,000 and 500,000 people (annual average).

According to Table 3, 12,013 households in Shyamnagar upazila are primarily dependent on Sundarbans resources; that is 10.6% of all forest resource users in the Impact Zone. Taking the same uncertainties into calculation as in the previous paragraph, the number of forest resource extractors in Shyamnagar roughly amounts to a figure between 20,000 and 50,000 people (annual average).



The data in Table 3 disprove that the absolute number of legal SRF resource extractors from Satkhira zila is higher than in the direct neighbourhood, although it is generally higher in the west of the Impact Zone. But what is different about Shyamnagar upazila? We investigated several aspects from within both the inhabited area and the forested area.

Peculiarities of Shyamnagar

Shyamnagar upazila has an area of 1,968.24 km² (437.71 km² inhabited area and 1,530.85 km² forested area). It has a population density (outside the forest) of 717 persons per km². That is 1.07 times larger than the average population density (673 persons per km²) in the Impact Zone. Shyamnagar covers 8.53% of the Impact Zone area and is inhabited by 9.1% of the Impact Zone population. The population densities for Shyamnagar upazila and the total Impact Zone were calculated using the population figures along with the size of the upazilas minus the size of the forested areas as published in the Bangladesh Population Census 2001 (BPC 2005-2007b, consulting tables C01 and not the erroneous upazila summary findings).

The population growth from 1991-2001 in Shyamnagar was listed as 18.4%; the average literacy rate was 39.7% for 2001, with a growth of 40.7% over 10 years (BPC 2007b). The population characteristics do not show any peculiarities.

The conversion of agricultural land into saltwater shrimp farms in the previous decades has been associated with serious negative environmental and social impacts.

The inhabited zone of Shyamnagar is delimited by the international border with India in the west and the SRF in the south. As the international border is officially closed, the region is an isolated pocket with an underdeveloped infrastructure. These factors result in a high poverty level in Shyamnagar.

The following outlines indicate that illegal activities in Shyamnagar upazila are more frequent than elsewhere.

Illegal activities

The aquatic resource users (fishermen, collectors of shrimp fry, crabs and shells) are obviously the resource users with the highest disposition for illegal activities. In a cross-tabulation of activity with profession, JJS (2003) found that 45.0% of the fishermen (48 cases in the period 1999-2001) were actually extracting wood at the time of the tiger attack. According to the SBCP Baseline Study (2001) 33% of the aquatic resource users admitted entering the forest without taking a permit. The same study brought to light that 41.7% of all resource users admitted to gathering firewood from the forest.

In the period 2003–2005, we identified 90 aquatic resource users among 126 tiger victims with known occupations. Seventy-four out of 90 casualties happened in Satkhira FR. Sixty-six of the 74 aquatic resource user victims had their domicile in Shyamnagar upazila and 8 in other upazilas of Satkhira zila. This means that 73% of the attacked aquatic resource users came from Shyamnagar upazila.

Poaching is obviously another precarious issue. In their interviews, JJS (2003) came across 160 deer hunters (amateurs, semi-professionals and professionals - all illegal) and found that Shyamnagar upazila had more hunters (40), than any other of the 9 upazilas in the Impact Zone. They go hunting deep in the westernmost parts of the Bangladesh Sundarbans where most of the tiger attacks occur. According to the collected newspaper reports covering deer poaching in Bangladesh Sundarbans between 2003-2008, 74% of the poachers (14 out of 19 cases) were based in Shyamnagar upazila. In a discussion on nature conservation in 2009, about 80% of approximately 100 students in a school in Burigoalini (Shyamnagar upazila) said that they had eaten deer meat in their lifetime. A scarcity of herbivorous prey, caused either by poaching or environmental factors, might increase the tiger's interest in human prey.

Satkhira is the only forest range in Bangladesh Sundarbans which attracts migratory wild honey bees (*Apis dorsata*) in considerable numbers. The season to harvest honey and wax is usually opened

by the BFD on 1st April. When following the permit holding honey collectors in Satkhira FR a high percentage of honey combs were found to have been harvested before 1st April, indicating that other forest resource users gather honey illegally as a profitable main or by-product. While following the honey collectors into the interior of the forest, a vast number of valuable Passur trees were found to have been felled. There was a rumour that the frontier defence authority, whose mission is to patrol the border in Satkhira, is involved in illegal timber felling. Both facts could also explain a higher human disturbance level and thus a higher number of tiger attacks in this forest range.

An unknown number of Bangladeshi nationals are crossing the border for illegal forest resource extraction in the Indian Sundarbans. This has been proven for the honey collectors. In a case witnessed in April 2009, a Bangladeshi honey collector was killed by a tiger on the Indian side, but the Bangladeshi news reported that it happened in Satkhira FR, which means that the authorities or media obviously try to suppress the sensitive issue of frontier violation. This case could signify that the locations of tiger attacks on Bangladeshis in the Indian Sundarbans are being projected into Satkhira FR, falsely inflating the number of incidences here.

Unequal management realities may give rise to increased legal or illegal resource exploitation and thus create higher disturbance levels in certain forest areas. It is unknown if the high number of tiger attacks in the Satkhira FR is due to management deficiencies.

Summary

The high level of disturbance by forest resource users seems to provoke man-eating behaviour among local tigers, despite all other aspects mentioned before. Therefore, the number of tiger victims can only be reduced if less people enter the forest.

Poverty is the most dominant factor for which all types of resource extractors are involved in their present jobs. When asked about what steps should be taken to reduce threats to the Sundarbans the most common answers were: stop illegal tree

felling; enforce laws; create alternative jobs; and increase supervision. About 91% of the Sundarbans resource extractors expressed positive responses in favour of their interest to be involved with alternative jobs; then they would not need to go into the forest (SPCP Baseline Study, 2001).

Shyamnagar upazila as the hot spot of humantiger conflict requires particular attention. The socio-economic and ecological situation of this problem zone will be examined in greater detail in a forthcoming paper. One of the most important issues for the locals here is juridical help for regaining control over the utilization of the land, now widely leased for shrimp production. The conversion of rice fields into shrimp farms in the previous decades has been associated with serious negative environmental and social impacts. The land is suitable for a sophisticated mixture of agriculture, aquaculture and tree plantations as a source of alternative incomes. The required reformation of land use should be as eco-friendly and labour intensive as possible. It needs to be accompanied by additional measures such as the construction of solid embankments, efficient drainage systems, ponds or tanks for rainwater harvest, the introduction of salt-tolerant crops, investments into education and training, and a general improvement of the infrastructure, which could inspire the foundation of new enterprises for the benefit of human resources.

Keeping people out of the tiger's habitat can be achieved by human resource management in addition to forest resource and wildlife management. The separation of tigers and humans in the Sundarbans forest is not only a question of nature conservation, but also a question of humanity.

Acknowledgements

We are grateful to numerous individuals and institutions for the collection of data and translations of relevant information from Bengali into English language. We would like to thank Guenter Loew for improving our English.

References

Barlow, A.C.D., Ahmed, M.I.U., Rahman, M.M., Howlader, A., Smith, A.C. and J.L.D. Smith.

- 2008. Linking monitoring and intervention for improved management of tigers in the Sundarbans of Bangladesh. *Biological Conservation*, 141: 2031-2040
- Barlow, A.C.D., McDougal, C., Smith, J.L.D., Gurung, B., Bhatta, S.R., Kumal, S., Mahato, B. and D.B. Tamang. 2009a. **Temporal variation in tiger** (*Panthera tigris*) **populations and its implications for monitoring.** *Journal of Mammalogy*, 90(2), 472-478.
- Barlow, A.C.D., Chakma, S., Hossain, A.N.M., Rahman, M., Howlader, A., Greenwood, C.J., Islam, M.A., Ahmed, I.U. and J.L.D. Smith. 2009b. **Bangladesh Sundarbans relative tiger abundance survey**. Technical Report 20th May 2009, Wildlife Trust of Bangladesh, Dhaka, 26pp.
- BFD 2002. **Bangladesh Forest Department, Map Sundarban Reserved Forest, Forest Types.** Sheet 1-10, 1:50000, February 2002
- BPC 2005. **Bangladesh Population Census 2001, Community Series, Zila: Pirojpur.** Bangladesh Bureau of Statistics, Dhaka, 159 pp.
- BPC 2006a. **Bangladesh Population Census 2001, Community Series, Zila: Barguna.** Bangladesh Bureau of Statistics, Dhaka, 143 pp.
- BPC 2006b. **Bangladesh Population Census 2001, Community Series, Zila: Bagerhat.** Bangladesh Bureau of Statistics, Dhaka, 223 pp.
- BPC 2007a. **Bangladesh Population Census 2001, Community Series, Zila: Khulna.** Bangladesh Bureau of Statistics, Dhaka, 275 pp.
- BPC 2007b. **Bangladesh Population Census 2001, Community Series, Zila: Satkhira.** Bangladesh Bureau of Statistics, Dhaka, 269 pp.
- Chakrabarti, K. 1978. Ecology of the Sundarbans tiger with particular reference to range of habitats and adaptability to changes. *Cheetal*, Vol.20, 3-15.
- Curtis, S.J. 1933. Working Plan for the Forests of the Sundarbans Division, for the period from 1st April 1931 to 31st March 1951. Calcutta, Vol.2: Compartment Maps.
- Deodatus, F., Ahmed, Z.U. 2002. Survey to determine the relative abundance of tiger, wild boar and spotted deer in the Bangladesh Sundarban Forest, December

- **2001 to March 2002.** Sundarban Biodiversity Conservation Project (SBCP), Technical Report No.17, Khulna, 36pp + 19 pp appendices.
- Hendrichs, H. 1975. The status of the tiger Panthera tigris (Linné, 1758) in the Sundarbans Mangrove Forest. Saeugetierkundliche Mitteilungen 23, 161-199.
- Hussain, Z. and G. Acharya (eds.). 1994. Mangroves of the Sundarbans, Vol.II, Bangladesh. IUCN Wetland Programme, Gland, 257 pp.
- Islam, M.W., Alam, M.S. and M.M. Islam. 2007. Study of human causalities by Bengal Tigers (*Panthera tigris tigris L.*) in the Sundarbans forest of Bangladesh. *Tigerpaper* 34(4), 11-15.
- JJS (Jagrata Juba Shanha) 2003. Human-Wildlife Interaction Study. Sundarban Biodiversity Conservation Project (SBCP), Internal Notes IN No.78, Khulna, 82pp.
- Kabir, D.M.H. and J. Hossain. 2007. Sundarban Reserve Forest, an account of peoples livelihood and biodiversity conservation. Study, Unnayan Onneshan, Dhaka, 62pp. (http://www.unnayan.org)
- Neumann-Denzau, G. and H. Denzau. 2010. Examining the extent of human-tiger conflict in the Sundarbans forest, Bangladesh. *Tigerpaper*, 37(2):4-7.
- Reza, A.H.M.A., Feeroz, M.M.and M.A. Islam. 2002. **Man-tiger interaction in the Bangladesh Sundarbans.** *Bangladesh J. Life Sci.* 14(1/2), 75-82.
- Salter, R.E., 1984. Status and utilization of wildlife, Integrated Development of the Sundarbans, Bangladesh. FO:TCP/BGD/2309(MF), FAO, Rome, 59pp.
- SBCP Baseline Study 2001. Socio-economic baseline study of the Impact Zone of the Sundarbans. Sundarban Biodiversity Conservation Project (SBCP), Khulna, 240pp.
- Siddiqi, N.A., Choudhury, J.H. 1987. Man-eating behaviour of tigers of the Sundarbans twenty-eight years' record analysis. *Tigerpaper* 14(3):26-32.

Authors' address: Zoological Society for Conservation of Species and Populations (ZSCSP, Munich), 24321 Panker, Germany; Email: denzau(at)t-online.de