Environmental Survey and Photographic Documentation of a Forest Edge Hamlet Situated in Buxa Tiger Reserve, India

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Abstract

Buxa Tiger Reserve (BTR) is situated in *Alipurduar* district of West Bengal, India and is considered as one of the significant tiger reserves of India. The Reserve lies between Latitudes 23º30′ N to 23º50′ N and Longitudes 89º25′ E to 89º55′ E. It has 37 forest villages and 4 fixed demand holdings, 46 revenue villages and 34 tea gardens in and around it. The survey work was done in May, 2015 by visiting a forest edge village (*Bhutia Basti*) on the banks of *Jayanti* River in Buxa Tiger Reserve. It is the only village that has ever been relocated from the core area of Buxa Tiger Reserve. The position of the village is ecologically crucial as it is situated near the elephant corridors of Buxa. Primary data were gathered through field survey and direct contact with common people and authorized centres of the region. Structured and semi-structured questionnaire was administered in the village area. Surveys on the demography, agriculture, livestock management, water management, education, culture, health, waste management, disaster management, transport, biodiversity, joint forest management activities, Non-timber forest product usage and human animal conflict were done in this area. Human animal conflicts were studied in *Bhutia Basti*, as the village is periodically disturbed by the encroachment of elephant, rhinoceros and leopard. Biodiversity of the forest was documented by visiting the adjacent forest areas. Photographs were taken, analysed and interpreted in light of the survey data collected from the study area. There is an urgent need for implementing an integrated sustainable development system for the conservation of forest ecosystems and traditional human settlements in BTR.

Keywords: Forest, Biodiversity, Photography, Sustainability, Survey

Introduction

The *Dooars* are the biodiversity-rich extensive floodplains and foothills of the eastern Himalayas in North-Eastern India. The *Dooars* region

politically constitutes the plains of Darjeeling District, the whole of *Jalpaiguri* district and *Alipurduar* district and the upper region of Cooch Behar district in West Bengal. The *Dooars* valley has several wildlife sanctuaries like *Gorumara* National Park, *Chapramari* wildlife sanctuary, *Buxa* Tiger Reserve and *Jaldapara* Sanctuary, which altogether represent the ecological wealth of the region (Dooars, 2015).

Buxa Tiger Reserve (BTR) is situated in *Alipurduar* district of West Bengal, India. Buxa Tiger Reserve is located in the north-eastern corner of *Jalpaiguri* district, West Bengal. The Reserve lies between Latitudes 23º30′ N to 23º50′ N and Longitudes 89º25′ E to 89º55′ E (Figure 1). It comprises of the entire forest area of the erstwhile Buxa Forest Division (Created in 1877 – 78) and some territory of the erstwhile neighbouring Cooch Behar Forest Division (Buxa Tiger Reserve, 2015). It covers an area of 760 km^2, with a core area of 385 km^2 and a buffer zone 375 km^2. The northern and eastern boundaries of the reserve border Bhutan and Assam respectively. The western and southern boundaries are bordered by tea gardens and agricultural fields. It has 37 forest villages and 4 fixed demand holdings, 46 revenue villages and 34 tea gardens in and around it. The habitat of BTR is primarily tropical moist deciduous forest dominated by *Sal* tree (*Shorea robusta)* (Bhattacharya et al., 2016).

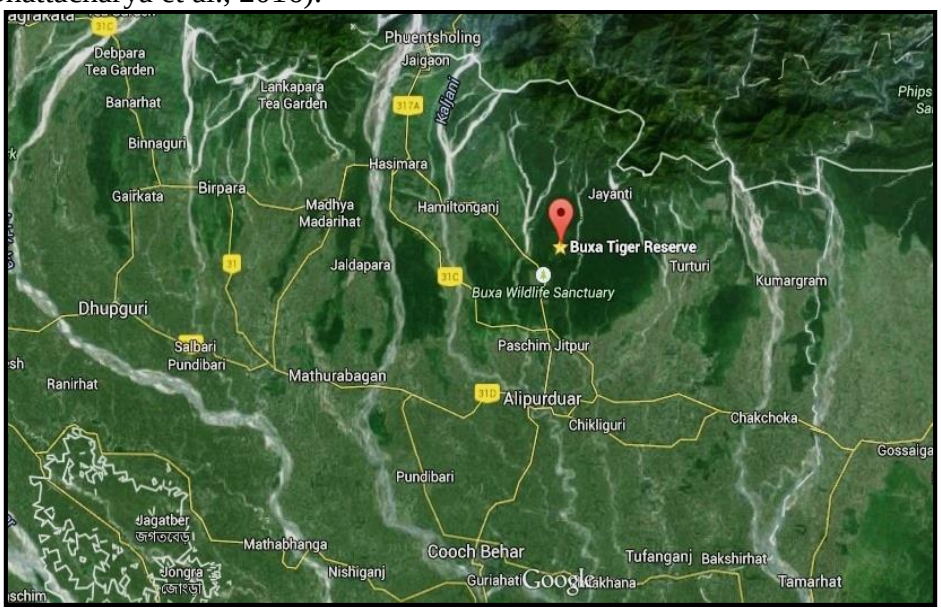

Figure 1: Google map showing the position of Buxa Tiger Reserve.

In BTR, evergreen, semi-evergreen and riverine forest, scrub and grasslands are also found, along with plantations of sal, teak (*Tectona grandis*), jarul (*Lagerstroemia reginae*) and mixed plantations of native trees (Sivakuma et al., 2006). BTR is located at the confluence of three major bio-

geographic zones: The lower Gangetic plains, Central Himalayas and the Brahmaputra valley (Das, 2012).

BTR is biologically very rich and supports several elements of the biodiversity of north-east India and is one of the most biodiverse regions in the country [6]. About 60% of the total floral endemic species of north-east India are observed in BTR. It has a network of many perennial and seasonal rivers, which are the water sources of wild animals and plants. This is an international corridor of elephant migration (Das, 2009).

Jayanti village is one of the oldest towns in the BTR region (Figure 2). Before independence of India, the dolomite mines of nearby Bhutan hills were excavated and dolomites were brought to *Jayanti* from where trains were used to supply the materials in other parts of the country (Mukherjee, 2013). Gradually the forest area was reserved for the wildlife and the railway stopped its operations. *Jayanti* slowly became a large village inside the Buxa Tiger Reserve.

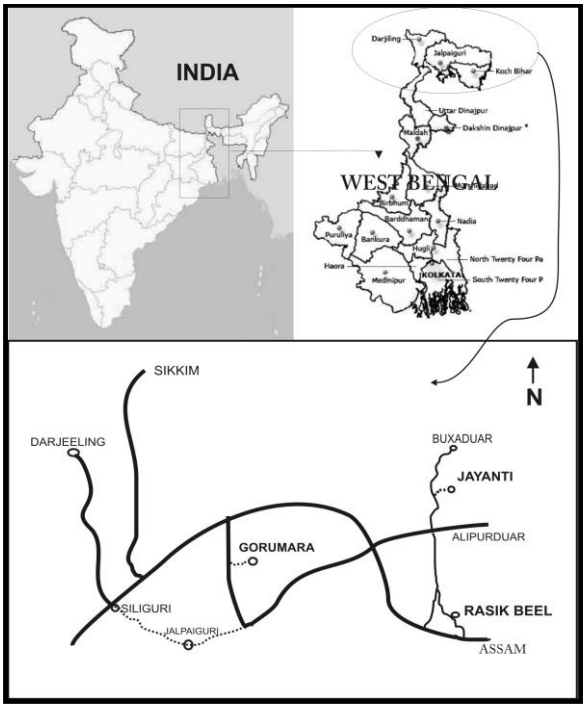

Figure 2: Position of *Jayanti* Area and Buxa Tiger Reserve in *Alipurduar* District.

Figure 3: *Jayanti* River bed in Buxa Tiger Reserve.

The river bank of *Jayanti* (Figure 3) is one of the most attractive tourist destinations of North Bengal in recent times. The river naturally forms a border between India and Bhutan. *Bhutia Basti* is a small village situated at the river bank of *Jayanti*. *Bhutia basti* forest village is under the jurisdiction of *Bhutia basti* beat of *Jayanti* Range, East division of BTR. Nepali community is the predominant ethnic group in *Bhutia basti*. These settlements were built by employees of a dolomite mining firm, whose operations were suspended in 1983 after Buxa was declared a tiger reserve. It is the only village that has ever been relocated from the core area of Buxa Tiger Reserve. The reason of the relocation was the floods of 1993 which swept away the jungle settlement (Mukherjee, 2013). The position of the village is ecologically crucial as it is situated near the elephant corridors of Buxa.

Objectives of the survey work

The developmental perspectives depend on socio-economic settings and environmental status of an area. The survey work was done in May, 2015 by visiting the *Bhutia Basti* village area on the river bank of Jayanti. The objectives of the study are:

1. To explore the socio-environmental structure of the village.
2. To explore the economy and livelihood status of the village inhabitants.
3. To explore the health and hygiene status of the villagers and the medical facilities of the area.
4. To explore the water and waste management facilities and to address the management problems.

5. To explore the cultural and educational status of the area.
6. To explore the biodiversity status of the ecologically important zone and to explore the human-biodiversity interactions in social, environmental and economic perspectives.
7. To propose sustainable management policies for the betterment of socio-environmental condition of the area.

Materials and methods

The survey work was done in May, 2015 by visiting *Bhutia Basti* village on the river bank of *Jayanti* in Buxa Tiger Reserve. During the survey work, primary data were gathered through field survey and direct contact with common people and authorized centres of the region. Structured and semi-structured questionnaire was administered in the village area. Surveys on the demography, agriculture, livestock management, water management, education, culture, health, waste management, disaster management, transport, biodiversity, joint forest management activities, Non-timber forest product usage and human animal conflict were done in this area. Demographic information was collected from the village area and from the local *panchayat*. Census report was collected from the local *Panchayat* Office. Health and education information was collected from the local schools and local sub health centers. Information regarding the transport system was collected from the local transport office and syndicate. Religious and social festival information was collected from the local people. Information on agricultural activities is collected from the local villagers and the agricultural activities were observed and documented at field. Information on environmental activities like using sustainable agricultural practices and waste management policies is collected through surveys in the villages. Human animal conflicts were studied in the village area, as the area is periodically disturbed by the encroachment of elephant and leopard. Biodiversity of the region was documented by visiting the adjacent forest areas, accessing the database of West Bengal Forest Department Office and visiting the nature interpretation centre situated at Buxa Fort. Photographs were taken, analysed and interpreted in light of the survey data collected from the study area.

Results and discussion

Climate

The climate of the northern West Bengal region can be divided into four seasons: (a) cool dry; (b) warm pre-monsoon; (c) hot monsoon; and (d) warm late-monsoon. In Buxa, Temperature varies from 15^{o}C to 39^{o}C and rainfall varies from 3570 mm to 5600 mm. The lowest point is 125 meter above mean sea level and highest point is 1750 meter above mean sea level

(Roy and Sah, 2012). Most of the rainfall is received during June to September. Pre-monsoon showers occur during May season. The Tiger Reserve remains adequately humid throughout the year, as is located in the foothills of the outer Himalayas. Maximum relative humidity varies between 80% – 95%, seldom below 75% with a maximum in June to September and minimum in December to February (Buxa Tiger Reserve, 2015).

Soil

The Northern West Bengal region shows the typical sub-Himalayan geological formation (Wadia, 1919). The Sub-Himalayan foothills, at an elevation ofabout 1200 meter, are made up mostly from the erosion of geologic material from the rising Himalayas mountains formation. The Buxa landscape is mostly covered with alluvial soil, except for a narrow belt of hard rocks exposed along the northern border of the area contiguous with the Bhutan hills (Das, 2000). In hilly area of *Jalpaiguri* District, soil is divided into seven types. Among these, Coarse Loamy type of soil is predominant in Buxa, *Jayanti* and *Bhutia Basti* area.

The study area is almost entirely covered with alluvial soil, boulder and pebble beds, stones with clay, quartzite, dolomite, banded ferruginous rock, shale, gneiss etc. All the riverbeds in those areas are rising by the deposition of huge sediments that are carried down with rainwater due to massive deforestation in the upper catchments areas.

Population

Since 1999, 2,919 families of diverse ethnic groups are residing in the forest villages of BTR (Das, 2009; Das, 2005). A substantial proportion of the population comprises tribes such as *Rava, Garo, Mechia, Oraon, Madesia (Santhal), Rajbanshi, Nepali, and Bhutia*. Among them, the *Nepali* and *Rabha* communities are the two most dominant ethnic groups. The human population of these villages is 95,049 (1991 Census) (Das, 2009). Migrant Hindus, Muslims and *Rajbanshis* are the predominant ethnic groups in revenue villages of the reserve.The people till their own land or work as labourers in other farms and tea gardens. The *Rava, Mechia, Oraon, Rajbanshi and Madesia* reside on the southern part of the forest, *Dukpas* live in extreme northern hilly areas bordering Bhutan, Nepalese are scattered all over.

At *Bhutia Basti*, there are 33 houses with population of 112 inhabitants with an average family size of 3.39. The male female sex ratio is 1: 0.89 (Figure 4, Table 1). Population of this area consists of 99% Nepali community and 1% local *"Adibasi"* community (Figure 5).

Table 1: Number of males and females		
Total population	No. of males	No. of females
112	59	53

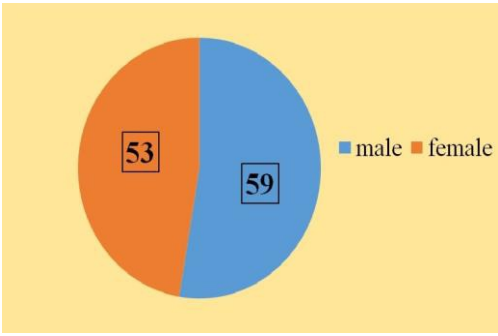

Figure 4: Male:Female in *Bhutia Basti*.

Figure 5: Nepali inhabitant in *Bhutia Basti* village.

Occupational Status

Agriculture and live stock farming are the main econamic sources in *Bhutia Basti*. Agriculture & live stock are the main occupation of the 80% of the total people. 15% of total people depend on loading and unloading of stones for economic purposes as daily labourers. However, this work stops during the monsoon season. 5% of the total people are migrated to other states or city for earning money (Figure 6).

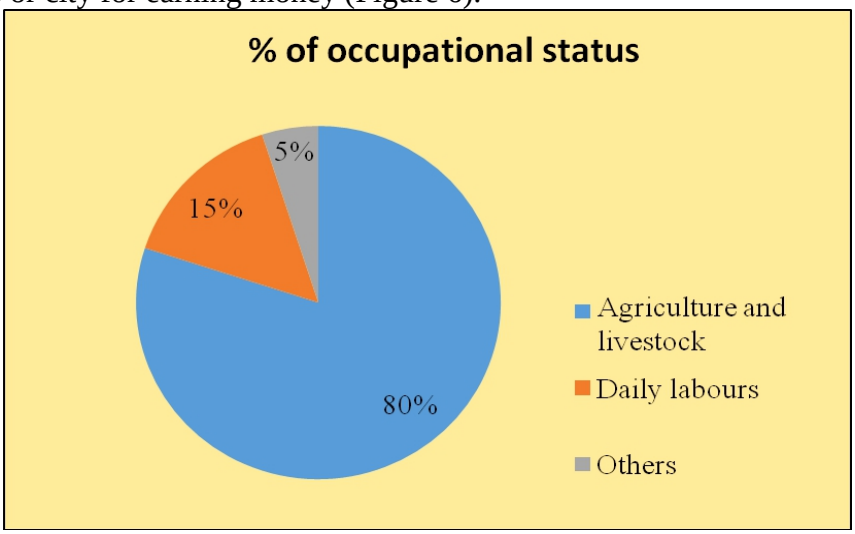

Figure 6: Occupational status of *Bhutia Basti* village.

Economy

Employment opportunities for both forest villagers and fringe dwellers in BTR reduced substantially due to the ban in clear felling coupes and artificial regeneration (CFC) operation and boulder collection with the creation of the tiger reserve in 1983. Prior to 1983, villagers of both forest and fringe are as used to be employed in timber harvesting and plantation work for nearly 100-120 days a year. It is observed that the employment generation of 5.9 lakh person days during 1984 has dwindled to 2.775 lakh person days in 1991 (Das, 2009).

The entire Buxa region and its community depends on provisioning services such as: (1) Natural Products (2) Fuel wood (3) Fodder and (4) Water. The village is far from technologies & industry. The agriculture process is very old and the production rate is also low. People are mainly dependent on stone loading and unloading in the *Jayanti* River bed for earning money. The monthly average per capita income of the villagers is approximately 4000 -5000 INR. Agricultural production, NTFP collection and livestock products are main sources of income (Figure 7).

As in all protected areas in India there is a strong relation between the people and the forests because the people living in and around the forests are considerably dependent on the forest resources for subsistence, commercial and cultural purposes. NTFPs collection is another important source of income for the villagers of *Bhutia Basti*. They use small timber for house construction; thatch for roof; edible roots and tubers, mushrooms, leaf litter and leaves, flowers and fruits as substitute of staple foods especially during lean seasons; medicinal herbs for healing etc (Das, 2005). The minor forest produce including aquatic products such as roots and shoots of various plants used as food and medicine, fishes, etc, supplement their routine food requirements. About 90% of total population in *Bhutia Basti* collect NTFPs for sale. NTFP collection and selling is the primary occupation for 26% families of this village (Das, 2005).

Agriculture is one of the main economic sources of the inhabitants of *Bhutia Basti* village in Buxa. The people used to sell the agricultural and livestock products in the local markets of *Alipurduar*. Crop husbandry, animal husbandry, wild biodiversity and rural economy are subsystems of the integrated traditional resource management system.

Communities are dependent on local markets for other essentials like rice, pulses, fruits, eggs, fishes etc. The market link is also limited and located at the opposite side of the *Jayanti* River, *Santhalabari* and nearby *Alipurduar*.

Interestingly, the tourism potential of the region is found to be increasing. The sharp rivers, mountains, forest and biodiversity is attracting tourists from outside. Both Buxa and *Jayanti* are attracting large number of

tourists and the villagers have started developing rural housing where the tourists come and stay. The local flora and fauna offer great attraction to the tourists.

Agriculture and Livestock

In *Bhutia Basti*, the inhabitants have 3.68 cattle per family in average. They have 2.34 *bighas* of cultivable land per family. The community is largely dependent on rainwater for irrigation. Canal irrigation and rain-fed irrigation are done in the agricultural fields. The common cultivable vegetables are Rice, Maize, Mustard, Potato, Radish, Garlic, Cabbage, Cauliflower, Tomato, Chilli pepper etc (Figure 8).The people of *Bhutia Basti* usually practice organic farming and use cowdung as fertilizer in the agricultural fields. Most of the cultivable crops are mainly used for personal consumption rather than earning money from the products. Most of the families have cultivable lands adjacent to the houses. The common livestock are local breeds of cows, buffalo, goat and chicken. Eggs and milk are the main livestock products which are among the important economic sources. People regard domesticated animals like cattle an asset, which is a useful source of income during events like diseases, marriages, festivals, disasters. Livestock encroachment in the forest areas are controlled by the villagers, mainly due to the risks of wildlife attacks.

Water Management

Jayanti River used to be a perennial river which has now become shallow because of mining in the upper region and breaking of stones by the strong currents (Figure 9). The villagers reported to have had big catch of fish in the past which has now shrunk because of drying up of the river during dry seasons. There are localized water bodies within the river where fishes are found and the villagers catch those using different traditional methods of nets, rods and embanking.

The village suffers from serious infrastructure and civic amenities deficiencies. The households do not have adequate toilet facilities within their houses and the drinking water is provided from the streams and rivers.

The main water sources of *Bhutia Basti* in Buxa are natural streams ("*jhora*") situated at the hilltops. Network of pipeline distributes the water in the villages and water is stored in small reservoirs in the village area. The stream water is used for drinking purpose, which is collected in small reservoirs within the village and sometimes is used after purification. The water becomes wispy in rain season. Rain water in mainly used for agricultural practices during rainy season. The main river in the village area is *Jayanti* River. For most of the season the river is dry; however in rainy season (June- September) the river is filled with rain water. Rainfall

measurement shows that the month of July receives heavy rainfall while December receives least amount of rainfall. Water crisis occurs during the period of March-April. No rainwater harvesting structure is found in the village for water conservation. However, our previous studies showed that numerous rainwater harvesting structures are generally found in different mountain and forest hamlets of North Bengal like *Lava, Rishop, Tinchuley and Chatakpur* (Bhattacharya et al., 2014; Bhattacharya & Ghosh, 2014; Bhattacharya et al., 2015

Figure 7: Occupational status in *Bhutia Basti*.

Figure 8: Agriculture in *Bhutia Basti.*

Figure 9: *Jayanti* river has now become shallow.

Figure 10: Plastic Pollution problem in *Jayanti* Area.

Waste Management

In Bhutia Basti village in Buxa, the common waste materials generated are solid wastes, including plastic packets, paper boxes, plastic bottles, glass bottles, vegetable wastes etc. Every house their own burning places where they used to burn all the solid wastes once in a week. The unburned materials are generally buried in the ground. However, burial of the waste materials can affect the biodiversity of the forest area, and can affect the wildlife as well (Bhattacharya et al., 2015b). Plastic and glass bottles are generally recycled by selling in the local markets after use. A dog was observed to be chocked by a plastic jar in the Jayanti River bed during the survey period (Figure 10). Some of the houses in Bhutia Basti village have separate sanitation system and toilets.

Education, culture and health

There is no school in *Bhutia Basti*; children have to go at *Jayanti* High School situated at the opposite side of the river bank. For higher education, they have to go to *Alipurduar* city.

There is no hospital or medical shops in *Bhutia Basti*. People used to go to *Kalchini* and *Santalbari* Sub Health Centers for basic treatments. 4 nurses and 2 doctors are available in *Kalchini* and 1 nurse in *Santalbari* health centers. For emergency cases people used to go Alipurduar hospital, where operation and emergency treatment facilities are available.

Most of the houses situated in *Bhutia Basti* are made of wood. The wood is generally collected from the forest areas; however, the collection is restricted. The other materials used for construction purpose are bricks, stones, mud etc. Most of the families use forest wood as domestic fuel, approximately 5% of the total families in *Bhutia Basti* use LPG or kerosene for cooking.

An interpretation center is an establishment for dissemination of local knowledge of natural or culture heritage of a place. A Nature Interpretation Center is present in Buxa Fort area (around 10 km. from *Jayanti* River). The interpretation center executes the history and tradition of the Buxa Fort; and the social, cultural and economic dimensions of the Buxa villages and about the traditional knowledge. Various objects of local importance are preserved in Buxa Nature Interpretation Center, such as- *Jajee* (Container for keeping Wine), *Chasum* (Utensil for making tea), *Churu* (Type of necklace used by Women), *Chebete* (Container to keep water during Puja), *Phup* (Used for writing purpose), *Chaka Timi* (For keep Supari), *Chempa* (Lamp / Diya), *Koma* (Part of dress of Women), *Doji* (Put on after wearing the dress), *Timi* (For keeping lime for paan/betel leaf), *Chanso* (Put on Brewing Wine), *Bakhu / Dobigulla* (Dukpa dress for males), *Kera / Dobigulla* (Dukpa dress for females) etc.

Disasters

Dooars of North Bengal are under rapid habitat destruction due to several anthropogenic pressures and developmental activities including hydro-electrical projects, road development, establishment of tea gardens, mining activities, landslides, forest fire etc (Das, 2005). These factors gradually have increased the fragility of the Himalayan Mountains, leading to an increase in the incidence of landslides in the region.

The area in which Buxa lies is proclaimed to be at seismic risk, in Zone V of the earthquake hazard conation (Bandyopadhyay & Neogi, 2011). Seismicity of this area loosens the hill sides, causing rock slides and siltation in the river beds.

As BTR is located in the foothills of eastern sub-Himalayan West Bengal bordering Bhutan in the northern side, several rivers and streams originate and flow southwards, intercepting the reserve. They rise and fall frequently and constantly change their courses, which consequently have huge negative impact on the reserve. BTR has a long history of devastating floods causing massive damage to the forest and agricultural lands of villagers. The present course of Buxa *jhora* shifted after the 1993 flood and is presently cutting into the base of the table-top mountain (Bandyopadhyay & Neogi, 2011). The major earthquake in 1897 at shilling has changed the course of many rivers.

River erosion is a serious problem in this area. Excess volume of water in the huge riverbed increased friction and erosion of banks, frequent flooding is one of the major disasters faced by the Buxa villagers. An estimate suggests that in few places silting occurs at an alarmingly high rate of 2 to 4 feet per year (Khalid & Patel, 1999). It was also revealed that about 1,596 hectares of forest area were damaged due to the changing course of streams (*jhoras*) and rivers of the reserve. Devastating floods have been reported in 1950, 1952, 1954, 1968 and 1993, causing massive damage to the habitat of the reserve (Das, 2012). The wildlife habitat has been destroyed several times due to recurrent floods in the flood-plains of these rivers. A massive landslide occurred in the sub-Himalayan slopes due to a destructive flood in 1954, when all river basins were affected by rapid rise of river bed bank erosion. Another destructive flood occurs in 1993 causing maximum damage to the Buxa area (about 200 deaths, loss of habitats) (Das, 2012). The flood of 1993 washed off many villages situated at the river bank of *Jayanti*. *Bhutia Basti* is the only village that has ever been relocated from the core area of Buxa Tiger Reserve. The reason of the relocation was the floods of 1993 which swept away the jungle settlements.

Transport and Connectivity

Jayanti area is very remote area where communication facility is dependent on the Government transportation (NBSTC), the arrival time of the bus from Alipurduar Station at 7:00 AM and arrival time from *Jayanti* at 9:00 AM. Again the bus arrives from the same place at 2:00 PM. and return time from *Jayanti* at 4 PM. *Jayanti*.

In and around the village area, the most popular mode of public transport is bus. Almost every people in *Bhutia Basti* area uses cycle for their daily convenience. The opposite side of the river bank is well connected with *Coach Behar, Jaldapara, Rajabhatkhawa, Siliguri* etc. However, at the river bank where *Bhutia Basti* is situated, the connectivity problems are of major concern.

Biodiversity

Buxa Tiger Reserve is biologically very rich. It represents several elements of biodiversity of northeast India, one of the most biodiverse Indian regions. Eleven landscape elements were identified in Buxa, which include, 1) Semi-evergreen vegetation forest, 2) dense evergreen forest, 3) deciduous forest, 4) dry thorn forest, 5) mixed vegetation and plantations, 6) degraded forests, 7) tea gardens, 8) teak plantations, 9) flood plains of the different rivers present in the reserve, 10) water bodies and 11) cultivation/settlements (Asian Nature Conservation Foundation, 2015).

More than 50% of the plant species of India are represented in northeast India; of these, 60% are endemic. Most of the floral endemic species of northeast India are encountered in Buxa Tiger Reserve. Presently there are 283 species of trees, 31 species of shrubs and herbs, 33 species of climbers, 150 species of orchids, 36 species of grasses and reeds, and 7 species each of cane and bamboo. The most common species found within the forest is Sal (*Shorea robusta*), which is one of the ecologically and economically significant trees of BTR. The lofty Sal trees occur with their usual associates, viz. Champ (*Michelia champaca*), Chilaune (*Schima wallichii*), Chikrashi (*Chukrasia tabularis*), Bahera (*Terminalia beterica*), Sidha (*Lagerstroemia parviflora*), Toon (*Cedrella toona*), Laii (*Amoora wallichii*), Lausuni (*Amoora rohituka*), Lampati (*Duabanga sonneratioides*), Simul (*Bombax ceiba*) etc (Das, 2000; Chaudhury, 2015). In areas adjoining the rivers Simul, Sirish (*Albizzia* sp.), Sissoo (*Dalbergia sissoo*) and Khair (*Acacia catechu*) are the most common species. The commonly found hill forest species are Katus (*Castenopsis indica*), Mandane (*Acrocarpus fraxinifolius*), Bhalukath (*Talauma hodgsoni*), Phalame (*Walsura tubulata*) associated with Kimbu (*Morus laevigata*), Panisaj (*Terminalia myriocarpa*), Gokul (*Ailanthus grandis*), etc. The savannah woodlands are also characterized by tropical trees of Kumbhi (*Careya arborea*), Tantari (*Dillenia pentagyna*), Jamun (*Syzygium cumini*), Palash (*Butea monosperma*) and Kul (*Zizyphus* sp.) (Indian Bird Conservation Network, 2015).

In case of Buxa Tiger Reserve, diversity of trees is least in comparison to herbs or shrubs, whereas species richness index of shrubs is higher than trees. It showed that species richness index of herbs is higher than shrubs. Here highest dominance was observed in case of *Ampelocissus latifolia* (Roxb.) Planch. (31.92), followed by *Trachelospermum lucidum* (D. Don.) Schum (12.22), whereas lowest dominance of shrubby species was observed in case of *Mikania micrantha Kunth.* (1.1) (Figure 11).

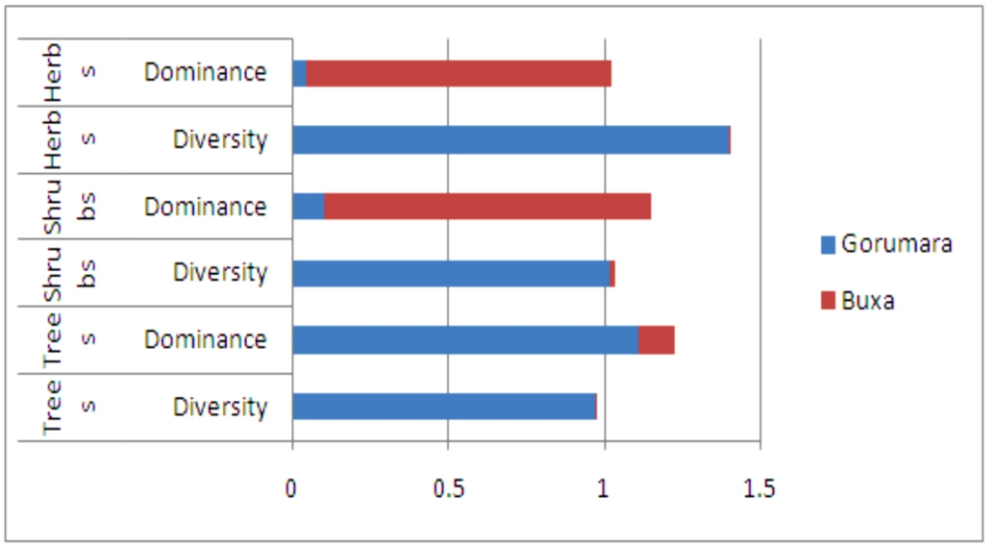

Figure 11: Comparative account of Diversity and Dominance Indices of species (Herbs, Shrubs and Trees), of Gorumara and Buxa.

Figure 12: Lizard in Jayanti area.

Fig. 13: Common Gull (*Cepora nerissa*) in BTR.

The faunal diversity of BTR includes 230 species of birds, 73 species of mammals, 37 species of reptiles, 32 species of fishes, 4 species of amphibians and 353 species of identified entomofauna.

Buxa Tiger reserve is also enriched with butterfly diversity. Common Crow, Chocolate Albatross, Common Gull (Figure 13), Grass Yellow, Lemon Emigrant, Paris Peacock, Common Bluebottle, Common Beak, Lesser Zebra are some of the examples of butterfly species found here.

Among reptiles, tortoise, lizards (Figure 12), various kinds of Snakes such as King Cobra, Russel's viper, Black Krait, Banded Krait, Indian Python (*Python molurus*) and Reticulated Python (*Python reticulatus*), Chinese pangolin are found in this region. Gharial (*Gavialis gangeticus*) and Mugger (*Crocodilus palustris*) are reported in 6th Working Plan of Buxa

Division (1965-66 to 1974-75), but these are not seen now-a-days (Buxa Tiger Reserve, 2015; Chaudhury, 2015).

Among the wetlands of BTR, *Narathali* is a significant one where 3 big shallow lakes harbour a good number of migratory ducks including Schedule-I species like whistling Teal as well as common Teal, Pintail, white eyed pocherd, shoveller etc. The swift streams of *Jayanti* & *Raidak* harbour Mergansers. The migratory birds appear during the end of Monsoon and fly away before summer. The migratory birds include the beautiful Ibis Bill, Pretty Minivets, Yellow Crested Sultan Tits, Streaked Spider Hunter, Snipes, Wagtails, Leaf Warblers, Sandpipers. Endangered birds like Great pied Hornbill start nesting in *Pukhuri* area in *Phaskhawa* block of BTR during spring season (Sivakumar et al., 2006; Chaudhury, 2015). Five threatened and two near threatened species were recorded in BTR in a previous study: Lesser Adjutant [*Leptoptilos javanicus*] (Vulnerable), White-rumped Vulture [*Gyps bengalensis*] (Critically Endangered), Slender-billed Vulture [*Gyps tenuirostris*] (Critically Endangered), Chestnut-breasted Partridge [*Arborophila mandellii*] (Vulnerable), Rufous-necked Hornbill [*Aceros nipalensis*](Vulnerable), Ferruginous Pochard [*Aythya nyroca*] (Near Threatened) and Great Hornbill [*Buceros bicornis*] (Near Threatened).

The main carnivores of BTR are Indian Tiger (*Panthera tigris*), Leopard (*Panthera pardus*), Clouded Leopard (*Neofelis nebulosa*), Hog Badger (*Arctonyx collaris*), Jungle Cat (*Felis chaus*), Leopard Cat (*Felis benghalensis*), Sloth Bear (*Melursus ursinus*), Fishing Cat (*Felis viverrina*), Civet Cat (*Viverricula indica*), Hyaena (*Hyaena hyaena*), Jackal (*Canis aureus),* Wolf (*Canis lupus*), Mongoose (*Herpestes edwardsi*), Fox (*Vulpes benghalensis*), etc. The predominant herbivores of the reserve are Elephant (*Elephas maximus*), Gaur (*Bos gaurus*), Sambar (*Cervus unicolor*), Chital (*Axis axis*), Barking Deer (*Muntiacus muntjak*), Hog Deer (*Axis porcinus*), Wild Pig (*Sus scrofa cristatus*), Hispid Hare (*Caprolagus hispidus*), Giant Squirrels (*Ratufa indica, R. bicolor*), and Pangolins (*Manis crassicaudata, M. pentadactyla*). Endemic Indo-Malayan species such as Clouded Leopard, Chinese Pangolin, Reticulated Python (*Python reticulatus*), and Black-necked Crane (*Grus nigriocollis*) have been reported in BTR (Buxa Tiger Reserve, 2015; Chaudhury, 2015).

Some of the endangered species found in the reserve are Indian Tiger (*Panthera tigris tigris*), Asian Elephant (*Elephas maximus*), Regal Python (*Python regius*), Chinese Pangolin (*Manis pentadactyla*), Hispid Hare (*Caprolagus hispidus*), Hog Deer (*Axis porcinus*), Slender-billed Vulture (*Gyps tenuirostris*) etc (Buxa Tiger Reserve, 2015; Chaudhury, 2015; Indian Bird Conservation Network, 2015).

Human wildlife conflicts

Human-wildlife conflict is in limelight in recent times as it causes a major threat to survival of many wild animal species in different ecological zones. Human-Wildlife Conflict (HWC) occurs when wildlife requirements overlap with those of human populations, creating costs both to residents and wild animals (WPC, 2003). Man-animal conflict has been in existence for as long as human existence, and wild animals and people have shared the same landscapes and resources (Lamarque, 2008). With increasing population and pressure on forest areas, human-wildlife interaction and resultant conflict is also increasing (Zubri & Switzer, 2001).

BTR forest with periphery of 330 km. is surrounded by numerous tea gardens and cultivated land of villages. Over the decades there have been large scale changes in the landscape outside the forests by way of intensive cultivation, growth of human habitations in villages and towns and in tea gardens (Buxa Tiger Reserve, 2015). Many of the tea gardens in these areas are important corridors of wildlife. The tea gardens and revenue villages situated on the periphery witness highest intensity of human wildlife conflict, especially of elephant depredation. Since, elephants have wide home ranges, typically between 100 and 1000 km^2, a fragmented habitat or obstruction to traditional migration path is bound to bring many human-elephant conflicts resulting in damage to agricultural crops, property, household and injury and mortality to both humans and elephants (Roy & Sah, 2012). Cultivated crops are easy source of forage for elephants which is nutritious and healthy too. Crop damage is positively correlated with migration patterns of elephants (Roy & Sah, 2012). In Buxa Tiger Reserve, elephants damaged 4.6% of the cultivated area during 2001 and 3.4% during 2002 (Asian Nature Conservation Foundation, 2015). The proportion of cultivated crops damaged by elephant in Buxa Tiger Reserve is more than double the proportion damaged by elephants in a southern Indian population (Asian Nature Conservation Foundation, 2015). The northern West Bengal landscape experiences one of the highest levels of elephant–human conflict across Asia (Lahiri Choudhury, 1975). The conflict has increased since 1980 and the number of human deaths rose from 34 in 1987 to 59 in 2004.

Bhutia Basti village in Buxa Tiger Reserve is a part of the Buxa forest and an important area of elephant corridor. In the village, the man animal conflict is mainly centred on the attacks of elephants in the agricultural fields. Besides, there are examples of the attacks of wild pigs and wild dogs on human population, agricultural fields and livestock. Leopard attacks on humans are very rare, but they used to kill the livestock in the villages. The village people of *Bhutia Basti* used to protect the crop fields from elephant attacks by burning woods in the night time, burning firecrackers, beating drums and metal cans etc. Several watch towers are

constructed in the *Bhutia Basti* village to monitor the encroachment of the elephants in the agricultural fields with communications (ex. whistles) to alert other farmers. Crop fields are protected by fences made up of thorny bushes, which are the initial resistant that can be used to hinder the entry of elephant in the agricultural fields. Search lights are used in the night time to resist the attacks of wild animals (Roy & Sah, 2012). Figure 14 shows the position of elephant watch tower in *Bhutia Basti* village in BTR. Most of the houses in *Bhutia Basti* are constructed using wooden pillars, maintaining a considerable height from the ground for avoiding elephant attacks (Figure 14).

The actual damage by elephants could not be accurately judged in some previous studies in the case of *Bhutia Basti* during the maize season, as cattle were allowed to consume most of the remaining crops. The villagers in these settlements usually claim that the raiding is so intense that it is better to allow cattle to eat the maize.

Figure 14: House with wooden pillars in *Bhutia Basti*.

Figure 15: Buxa Tiger Reserve Forest.

Joint forest Management

Joint Forest Management (JFM) is the official and popular term in India for partnerships in forest management involving both the state forest departments and local communities. The policies and objectives of Joint Forest Management are detailed in the Indian comprehensive National Forest Policy of 1988 and the Joint Forest Management Guidelines of 1990 of the Government of India (Joint Forest Management, 2015). Villagers agree to assist in the safeguarding of forest resources through protection from fire, grazing, and illegal harvesting in exchange for which they receive non-timber forest products, eco development works and a share of the revenue from the sale of timber products.

The creation of the Buxa Tiger Reserve (Figure 15) in 1983 resulted in a ban on fodder collection and cattle grazing, threatening the very survival of the inhabitants residing in and around the BTR (Das, 2008). Restrictions on resource use, often leads to conflicts among park managers and villagers. To reduce pressures and conflicts, the IEDP was launched by the Forest

Department, West Bengal, with assistance from the World Bank and the Global Environment Facility in 1996. The project addresses the issues regarding participatory management of PAs through a strategy of eco-development. It deals with reducing negative interactions of local people with biodiversity and increasing their collaboration in conservation. It aims at involving local people by supporting sustainable alternative income-generating activities with mutual understanding on controlled grazing, stall feeding, fodder regeneration outside forest areas, reduction of cattle, replacement of scrub cattle by improved cattle and castration (World Bank, 1996). Forest Department provides employment opportunities to the people in various forestry works as Plantation Watchers**,** Fire Watchers**,** Eco Guides**,** AntiDepredation Helpers etc.Recently some initiatives were taken by the Eco-development committee of BTR for the socio-economic development of the local people like training in Jute toy making, jute and cane bag making, local handloom and handicrafts, sewing training, jute and carpet making training and computer training programmes.

The various Eco-development activities and forest village development activities in Buxa Tiger Reserve Divisions are:-

1. Infrastructure development through construction and maintenance of road, culvert, and drinking water supply.
2. Imparting training on *Jari,* Weaving, Apiculture, Soft toy making, improved agriculture practices, improved cattle rearing, vermicompost, bag making, and training the Tourist Guides.
3. Rural electrification.
4. Distribution nursery for providing seeding to the local people and various institutions.
5. Construction of hut for forest villagers.
6. Distribution of furniture to schools.

In India, more than 41 million tribal and forest dwellers derive their earnings from these products after consuming about 60% of collected NTFPs for personal use (Prasad, 1985). NTFP is potentially obtainable from about 3000 species found in the forests of India. NTFP collection, an important source of income for forest dwellers and rural poor, varies from state to state ranging from 5.4 to 55 percent. Moreover, 60% of NTFP isconsumed as food or as a dietary supplement especially during lean season by forest dwellers (Das, 2005). In *Bhutia Basti*, the main NTFPs are Mushrooms, *Timboor, Teenphali, Lali fruits; Odal; Chilauni, Narkeli, Ritha, Malagiri, Amloki, Kainchipata,* Broom sticks etc. Approximately 83% of the family members in *Bhutia Basti* are dependent on the NFTPs. The average income from sale of NFTPs in *Bhutia Basti* is 35-70 INR/Family/Day or 3500-9000 INR/Family/Year (Table 2).

Table 2: Relative contribution of NTFPs on annual income of sampled families of *Bhutia basti* (Das, 2005)

Range of annual family income (INR)	Percentage of family	Mean family income (INR)	Relative contribution on annual income			
			Agriculture%	NTFP%	Milk%	Others%
Upto 9000	22.73	7800	32.82	39.74	6.41	22.31
9000-11000	31.82	10207	33.73	37.23	9.24	19.80
11001-13000	13.64	11993	27.37	43.30	18.83	15.36
13001-15000	13.64	14800	38.29	31.98	10.36	19.37
Above 15000	18.18	17775	32.91	38.11	14.06	14.91

Sustainable management recommendation

Several forest villages of *Dooars* area in North Bengal have become the attractive tourist spots for pleasure trips, biological and geographical excursions and medical research works. In spite of getting so much attention in the recent times, the forest edge hamlets are not adequately managed. There is an urgent need for implementing sustainable management systems in the areas for the betterment of the socio-environmental and economic structures. Several environmental, social and economic problems were highlighted in the present survey work in *Bhutia Basti* village, which should be addressed for sustainable management of the village area. Some management strategies can be considered for *Bhutia Basti*, which are mentioned below:

1. For reducing the water crisis in *Bhutia Basti* in the dry seasons, traditional rainwater harvesting structures should be constructed in the houses. In our previous studies, we observed in some mountain hamlets of North Bengal, the roofs of the houses have aluminium gutters at the corner for collecting rainwater. The rainwater falling on the roof top can be collected through these gutter channels. Pipes are connected with the gutters through which water can be collected in the cisterns and containers. Similar kind of harvesting structures can be implemented in *Bhutia Basti* area for rainwater conservation. Filtering systems should be provided to the local inhabitants so that they can use the rainwater for drinking purpose after purification.

2. Adequate health services should be provided to the local inhabitants of *Bhutia Basti* village. Local Sub Health centres with doctors, nurses and basic medical facilities should be established in the village.

3. Local training centres should be established in *Bhutia Basti* for teaching the local people about the importance of biodiversity resources of

Buxa Tiger Reserve. The initiatives of the local people can effectively protect the natural assets of the areas. Implementation of joint forest management programme and integrating the concept with the local economy can improve the socio-biological conditions of the village. Proper study is necessary to enumerate different NTFPs and to estimate the average production.

4. The carrying capacity assessment and sustainability of tourism in the circuits identified is an important component of the ecotourism study as it will form the basis for resource allocation and future development (Karmakar, 2011). The balance between ecotourism development and carrying capacity could develop the social, cultural and economic status of the forest villages like *Bhutia Basti*.

5. There is lack of gross knowledge among villagers on the advantages of afforestation in the forest and hill areas. Specific training and awareness efforts from the Forest Department should be given to educate people on the effects of deforestation, with special focus on the long term effects of deforestation on climatic conditions. Focus should be given on areas critically important to floral and faunal habitat, water catchments and areas important with social and cultural values. A better understanding of corridor management can reduce the incidences of elephant encroachment and attacks.

The communities in Buxa do not seem to be adequately informed of the implications of the new Acts/rules of biodiversity. Their access to the biodiversity, according to them, is unrestricted. Similarly the government officials, concerned with the implementation of bio-diversity Act and Rules are also not clear about the implications and follow this as a bureaucratic process. The policy framework and the stakeholders need to be compatible with each other in relating to the issues and potentials of biodiversity and in appreciating the long term implications of the policy framework viz-a-viz the community and their rights.

6. Organic farming is one of the several approaches found to meet the objectives of sustainable agriculture. Organic farming is a production system that sustains the health of soils, ecosystem and the people. Encouraging and supporting the farmers of *Bhutia Basti* towards organic farming can promote sustainable development.

7. The effects of climate change are more devastating in the Himalayas compared to the other regions (IPCC, 2007). The annual and seasonal temperature trends in the Kanchenjunga landscape indicate an increase at the rate 0.01 – 0.015 °C/year, with higher altitudes experiencing greater warming (Singh et al., 2011). Likewise, among the administrative units, Darjeeling was the most vulnerable compared to Sikkim, eastern Nepal and western Bhutan. Extensive studies on the effects of climate change on

Bhutia Basti village and adjoining areas of BTR should be done, as it represents one of the significant biodiversity zones of India.

8. The adjoining forest areas of *Bhutia Basti* suffer from illegal cattle grazing, firewood collection, encroachment on the fringes and poaching. More intense survey works and management practices should be done for mitigating the anthropogenic threats in BTR.

9. Natural habitats were converted to *Teak* and *Jarul* (monoculture) plantations in many areas of the reserve like *Sankosh, Kumargram, Bholka, Rydak, Dima, Rajabhatkhawa, Santrabari*, *Bhutri, Bharnabari,* and *Gudamdabri* blocks as well as in National Park areas during the sixth and the seventh Working Plan period before formation of BTR. *Teak* and *Jarul* plantations occupy 34% of total plantation of the Tiger Reserve, which is not congenial for wild animals. Natural carrying capacity of the habitat is reduced considerably on account of such adverse changes (Chaudhury, 2015).

10. Roads and infrastructure are development priorities that also pose inevitable threats to biodiversity and to the animal movement corridor outcomes in particular. Road networks and tourist inflow would enable easier access to the area but would also open the site to commercial development, which would hamper the ecology of the site. A number of PWD roads, including a National Highway, NH 31C, pass through the BTR. Consequently, wild animal death cases due to accidents have also increased. Railway and road construction in BTR area should be inspected thoroughly after proper study on the corridor networks and their management strategies (Chaudhury, 2015).

11. Separate waste collection and disposal system should be operated by the government for safeguarding the sensitive ecosystems of BTR. Effective management design should be done for plastic wastes generated in the forest edge villages like *Bhutia Basti*.

12. The vehicles used in the adjoining areas should be monitored regularly for proper mitigation of air pollution in the forest area. Installation of the modern devices in the vehicles for pollution control should be done and routine checking system should be implemented.

13. An alternative fuel policy should be evolved and implemented in the forest villages like *Bhutia Basti* for reducing the pressure on the forest resources and the drudgery. Large scale installation of solar panels in these areas would be beneficial (Bhattacharya et al., 2015a). Biogas is a cheap, pollution free alternative energy source. It can also reduce the annual emission of CO_2 from households. Implementation of biogas plant *Bhutia Basti* areas can reduce the pressure on fuel wood and can safeguard the forest resources.

14. While dolomite extraction from the riverbed has environmental implications, it keeps the river bed clear during heavy rains in the catchment and mitigates flood risk to some extent. This inherent dichotomy needs to be addressed through judicious planning, in terms of disaster risk mitigation, heritage and ecological conservation and safe development of the area. The restoration and conservation plan for the site should incorporate inputs from disaster management professionals, environmentalists and conservation architects. Extraction of boulders from river beds has been resumed recently near *Santrabari* in BTR. The ban on boulder extraction from river beds had raised the river beds, to levels higher than the adjoining road, thus increasing risks of floods and river bank erosion. The resumption of extraction, on a restricted scale can be a favourable initiative.

15. Over the years, the incidences of cattle grazing in the villages of BTR have exponentially multiplied. A study placed the number of cattle grazing in the forest every day at about 150,000 cattle graze in the forest every day. Excluding some blanks and steep slopes, the intensity of grazing is 2.5 cattle per ha. The number of households increased by about 66% from 1970 to 1999 (Joint Forest Management, 2015). With the increase in households, cattle numbers have also increased rapidly. Reduction in cattle grazing in the forest areas can increase the soil stability, can reduce erosion and can balance the ecosystems. However, a management strategy, like rotational grazing of livestock, might be an alternative instead of sticking to the strategyof reduction of cattle and curtailing villager's rights overforests especially within the protected areas.

16. National and International cooperation and grants should be enhanced for the conservation of Buxa Tiger reserve and its village communities. Research grants should be raised for exploring the social and biological status of the area. Training programmes, seminars and workshops should be organized for highlighting the conditions of Buxa Tiger Reserve in international platforms.

Conclusion

In spite of being positioned in a diverse and sensitive ecological zone, the *Bhutia Bati* village in Buxa is not adequately managed. The forest communities, who are residing for years and sustain livelihood from forest resources, are getting more vulnerable and marginalized. To reduce the threat faced by villagers especially in a protected area like BTR, there should be some area-specific policy involving legal changes to deal with the land scarce area circumscribed by national parks and sanctuaries as well as rivers that originate from hills causing severe damage and erosion of forest lands. More functional participation and cooperation of the local people can create trust and confidence and can reduce conflicts with forest authority which can

further help to preserve bioresources. Attention should also be given to marginalized tribals who are the worst sufferers during relocation. Active coordination between the revenue and forest departments in dealing with this kind of situation is extremely important. Active participation and collaboration of India and Bhutan government for integrated management of the *Jayanti* river bed and adjoining hills and streams of Bhutan could help to maintain environmental balance in the region.

It is unquestionable that the hill and forest areas of India have major contributions in maintaining climatic and ecological balance in the country. For a long time, these areas have not received their due emphasis on development issues. The present work is the first ever socio-environmental study done at *Bhutia Basti* village of Buxa Tiger Reserve so far. Extensive investigations at other forest areas of North Bengal should be done so that the places could be highlighted for conservation in future.

Photographs

All the photographic documentation is done by Dr. Sayan Bhattacharya. Nikon D5100 Digital SLR and Nikkor 18-140 mm. VR lens were used for capturing the images. All rights reserved.

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References:

Asian Nature Conservation Foundation (2015, September 4). Asian Nature Conservation Foundation [Online]. Available: http://www.asiannature.org/sites/default/files/2003%20Buxa%20Final%20%20Report%20to%20Ortenberg.pdf

Bandyopadhyay, C., Neogi, B. 2011. A Regional Approach to Risk Mitigation of Cultural Heritage: A Case of Buxa Fort and its Environs. Journal of South Asia Disaster Studies 4(1): 1-18.

Bhattacharya, S., Ghosh, G., Banerjee, T., Goswami, S., Das, P. 2015a. Socio-environmental survey of an ecologically important hamlet of Darjeeling district, West Bengal, India International Letters of Natural Sciences 33: 51-72.

Bhattacharya, S., Ghosh, U.C. 2014. Socio-Environmental Surveys of Tinchuley and Takdah: Two Emerging Ecotourism Hamlets of North Bengal, India. International Letters of Natural Sciences 23: 9-26.

Bhattacharya, S., Maity, R., Sarkar, G., Ghosh, G., Mukherjee, D., Mukhopadhyay, C. 2016. Socio-Environmental survey of an ecologically

important forest edge hamlet in Buxa Tiger Reserve, West Bengal, India. International Letters of Natural Sciences 52: 67-83.
Bhattacharya, S., Shome, A., Dutta, A., Majumder, G., Banerjee, R. 2015b. Environmental, economic and agricultural surveys of an ecologically important forest edge hamlet in Darjeeling district, West Bengal, India. World Scientific News 5: 66-80.
Bhattacharya, S., Shome, A., Sarkar, S., Purkait, D., Ghosh, U.C. 2014. Socio-Environmental Survey of two ecologically important hamlets of North Bengal, India. International Letters of Natural Sciences 28: 102-118.
Buxa Tiger Reserve (2015, July 11). Buxa Tiger Reserve [Online]. Available: www.buxatigerreserve.com
Das, B.K. 2005. Role of NTFPs among Forest Villagers in a Protected Area of West Bengal. Journal of Human Ecology 18(2): 129-136.
Das, B.K. 2008. The Policy of Reduction of Cattle Populations from Protected Areas: A Case Study from Buxa Tiger Reserve, India. Conservation and Society 6(2): 185-189.
Das, B.K. 2009. Flood disasters and forest villagers in Sub-Himalayan Bengal. Economic and Political Weekly 44(4): 71-76.
Das, B.K. 2012. Losing Biodiversity, Impoverishing Forest Villagers: Analysing forest policies in the context of Flood Disaster in a National Park of Sub Himalayan Bengal, India. Occasional Paper, 35. Institute of Development Studies, India: Kolkata.
Das, S. C. 2000. Management-cum-Working Plan 2000-01 to 2009-10 for the Buxa Tiger Reserve. Office of the Field Director, Buxa Tiger Reserve, Alipurduar, India.
Das, S.C. 2000. Biodiversity in Buxa Tiger Reserve, West Bengal, India: An overview. Tiger Paper 27(1): 29-32.
Dooars (2015, May 21). Available: Ecotourism [Online]. Available: http://www.ecotourism.co.in/dooars.html
Indian Bird Conservation Network (2015, October 11). IBA Book: West Bengal [Online]. Available: http://ibcn.in/?page_id=119
Intergovernmental Panel on Climate Change (IPCC). 2007. Climate Change 2007: Impacts, adaptation and vulnerability. Cambridge University Press: Cambridge, UK.
Joint Forest Management: A handbook (2015, September 30). Ministry of Environment and Forests [Online]. Available: http://rtmoef.nic.in/Docs/JFM_Booklet.pdf
K. Chaudhury, Wildlife management in Buxa Tiger Reserve (2015, September 14). Rhino Resource Centre [Online]. Available: http://www.rhinoresourcecenter.com/pdf_files/138/1382156557.pdf
Karmakar, M. 2011. Ecotourism and its impact on the regional economy- A study of North Bengal, India. Tourismos 6(1): 251-270.

Khalid, M.A., Patel, S. 1999. Ecological Assessment of Habitat Loss due to Boulder/Bed Material Deposit in Rivers of Buxa Tiger Reserve. A Research Report, Department of Forests, Government of West Bengal.

Lahiri Choudhury, D. K. 1975. Report on elephant movement and crop depredation in Jalpaiguri district and part of Madharihat Range of Cooch Behar Division in June–July 1975. Submitted to the West Bengal Government. 60 p.

Lamarque, F. 2008. Human-Wildlife Conflict in Africa- An Overview of Causes, Consequences and Management Strategies. Working Paper of IFCW and FAO, Rome.

Mukherjee, K. 2013. Bhutia Basti: A relocation effort in futility? Retrieved From: http://timesofindia.indiatimes.com/city/kolkata/Bhutia-Basti-A-relocation-effort-in-futility/articleshow/20723278.cms, Retrieved on 23rd April, 2016.

Prasad, B.N. 1985. Regional Non Wood Forest Product Industries. Forest Industries Development Group. Asia Pacific Region, FAO, Kualalampur.

Roy, P.B., Sah, R. 2012. Economic loss analysis of crops yield due to elephant raiding: A case study of Buxa Tiger Reserve (West), West Bengal, India. Journal of economic and sustainable development 3(10): 83-88.

Singh, S.P., Bassignana-Khadka, I., Karky, B.S., Sharma, E. 2011. Climate Change in the Hindu Kush-Himalayas: The State of Current Knowledge. International Centre for Integrated Mountain Development, Kathmandu, Nepal.

Sivakumar, S., Varghese, J., Prakash, V. 2006. Abundance of birds in different habitats in Buxa Tiger Reserve, West Bengal, India. Forktail 22: 128-133.

Wadia, D. N. 1919. Geology of India. New Delhi: Tata McGraw–Hill Publishing Company.

World Bank, Staff Appraisal Report. 1996. India Eco-development Project. South Asia Department II, Agriculture and Water Division.

WPC recommendation 20. 2003. Preventing & mitigating human-wildlife conflicts. IUCN-World Park Congress.

Zubri, C., Switzer, D. 2001. Crop raiding primates: searching for alternative human ways to resolve conflict with farmers in Africa. People and Wildlife Initiative Wildlife Conservation Research Unit, Oxford University, UK, 2001.