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Feasibility Study for Strengthening Elephant Corridors in Northern West Bengal through Reforestation

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Abstract. We carried out a viability study of elephant corridors at three possible sites in northern West Bengal and an economic analysis of providing forest cover to these corridors. Corridor boundary and land-use types were mapped by taking multiple GPS points. A preliminary analysis indicated that the total profit from forest plantations is 2,557,000 Rs./ha which is much higher than the 440,000 Rs./ha from the tea gardens over a 20-year period. Our preliminary study brings out the importance of new ways of approaching the issue of strengthening wildlife corridors which take into account both economic and social factors.

Introduction

Conservation of Asian elephants (*Elephas maximus*) is of global concern as they lost most of their habitat in the recent past (Leimgruber *et al*. 2003; Sukumar 2006). Human settlements that adjoin and encroach upon forests within the range of Asian elephants continue to degrade their existing natural habitat through extensive firewood collection, illegal felling, and cattle grazing. Because of habitat shortage, elephants are forced to stay in smaller fragmented forest patches.

Our approach to solve this problem is through the existing habitat as well as free movement of elephants in the existing range. Fragmented patches should be linked for formation of a large habitat for long-term conservation of the elephant.

The habitat in northern West Bengal is highly fragmented with developmental activities like conversion of forests into tea plantations, settlements, agriculture and exploitation of timber in the past and extraction of wood for railway sleepers after cutting the prime natural forest (Lahiri-Chowdhury 1975; Barua & Bist 1995; Chowdhury *et al*. 1997; Sukumar *et al*. 2003; Roy 2010).

Our aim is to develop plantation forests on the land currently being used for growing tea and show it to be more profitable than producing tea and to connect one forest patch to another for the free movement of elephants, help conserve sustainable biodiversity, reduce the level of human-elephant conflict and ensure the socio-economic development of the local people. The objectives of the study specifically are:

- To study the feasibility of developing plantation forest (fast-growing plant species non-palatable to elephants) in the current tea garden areas and ascertain if it is financially more viable than the tea gardens' normal business.
- If this is not viable, how will the ecosystem service compensate the landowner if he permits to convert the tea plantation into plantation forests for an elephant corridor? Or to conserve wildlife and its habitat, declare any private or community land not comprised within a national park or sanctuary as a community reserve or conservation reserve.

Methods

Study area

Northern West Bengal in north-eastern India is

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bound by Nepal on the west, Bhutan in the north, Assam in the east, and Bangladesh towards the south, covering a total area of 9394 km^2. The study area lies within N 27.218576º, E 88.011095º; N 26.639646º, E 88.172676º and N 26.734619º, E 89.862003º; N 26.332775º, E 89.809966º. The total range of the elephants in NW Bengal is 3051 km^2 and the forest cover is 1954 km^2 (Barua & Bist 1995). The elevation of the area varies from 60 to over 2000 m above sea level. The natural vegetation is primarily tropical moist forest with grasslands along the floodplains of rivers. Major land-use types in the study area are forest, cultivation, and tea gardens.

Climatic conditions vary from tropical to sub-tropical. A cool, dry period occurs from November to March (11–23°C) followed by a warm, pre-monsoon period during April – May (16–30°C), a hot, monsoonal period from June to August (25–32°C), and a moderately warm, late-monsoonal period during September – October (21–31°C). The coldest months are December and January (11–12°C). Seasonal rainfall in the Darjeeling area is generally over 3500 mm, whereas Dooars receives about 3000 mm (Sukumar *et al*. 2003).

Survey of land-use types

Surveys were done by bicycles with one or two field researchers and one or two field assistants in each project corridor site. Each corridors' area was surveyed by cycling through tea garden roads to assess ground reality. To link the corridor and outer boundary the east-west axis and north-south axis were marked with red ribbon. GPS points of the outer boundaries were collected to map the actual corridors. GPS points were collected at intervals of 100 m to map the corridors' outer boundary and record the land-use types inside. For various land use types like old aged tea garden (OTG, >15 years), medium aged tea garden (MTG, 3–15 years) and young aged tea garden (YTG, 1–3 years), blank land, agriculture shrub etc. GPS points were collected and mapped with the help of ArcGIS. Google Maps was also used to study the corridor areas. The surveys were done from 2007 to 2012.

Comparative economic analysis

We conducted a comparative economic analysis of tea production and forest plantation. The profit from tea plantations is arrived at based on input from tea garden managers and ground forest officers. The economic analysis was carried out on the basis of that data.

Results

Basra-Titi corridor

The Basra-Titi corridor includes the Bharnobari, Dalsinghpara and Beech tea gardens (Table 1) and

Table 1. Details of the tea gardens in the three corridors (source: Tea Board of India).

Corridor	Date	Tea Estate	Company	AA (ha)*	GA (ha)*
Basra-Titi	20.7.1940	Bharnobari	Bharnobari Tea & Indus Ltd.	725.12	867.12
	10.5.1959	Dalsinghpara	Octavious Tea & Industries Ltd.	792.47	1504.20
	1.4.1953	Beech	The Dibrugarh Company Lim.	785.63	934.66
			Total:	2303.22	3305.98
Chaparamari-Neora	4.1.1953	Kilcott	Duncan Inustries Ltd.	424.23	632.44
	4.1.1953	Indong	Indondg Tea Company Pvt. Ltd	472.54	750.00
	18.3.1972	Aibheel	Goodricke Group Ltd.	816.34	1625.44
	9.10.1977	Nagaisuree	Duncan Inustries Ltd.	622.03	964.19
	20.12.1976	Zurantee	Darjeeling Dooars Plantation Group Lim.	504.99	742.46
	4.1.1953	Soongachi	Soongachi Tea Industries Pvt. Lim.	681.39	1052.10
	3.5.1962	Meenglass	Goodricke Group Ltd.	639.40	928.56
			Total:	4160.92	6695.19
DGHC Tatari-Mechi	1.4.1953	ORD Terai	Duars Union Tea Co. Ltd	439.78	578.78
	24.4.1984	Panighatta	The New Terai Asso. Ltd	408.35	617.86
	1.4.1953	Panighatta	New Terai Asso. Ltd	440.53	617.86
	28.10.1957	Belgachi	Belgachi Tea Co.Ltd	446.11	919.70
	5.3.1935	Manjha	Coronation Tea Co. Ltd	169.76	251.13
	10.3.1956	Marapur	Deonar Tea Plantations Pvt. Ltd.	151.75	151.75
			Total:	2056.28	3137.08

* AA = applied area, area officially given on lease; GA = grand area, actual area occupied/used

is situated in the Jalpaiguri - Alipurduar Districts. This corridor connects Basra Reserve Forest of Buxa Tiger Reserve West Division, West Bengal to Titi Reserve forest of Jalpdapara National Park of Jaldapara Wildlife Division, West Bengal. The radio telemetry study conducted by the Indian Institute of Science from 2001–2006 confirmed frequent elephant movements in this corridor as well as various non-collared elephant herds (pers. obs.). The Bharnobari, Dalsinghpara and Beech tea gardens and Gopal bh basti (settlement) south side and Torsa river floodplains fall on corridor areas. Basra forest consists of mixed plantations, Khair-sissoo and Basra river floodplain areas. The Titi forest consists of dense mixed, mixed plantation and semi evergreen types of forest, Torsa river floodplains and Howri river floodplains. The length of the Basra-Titi corridor is 9.9 km. The details of land use inside of Basra-Titi corridor are given in Table 2 and Figure 1.

Table 2. Land-use in the Basra-Titi corridor.

Strata	Area (ha)
Old tea garden	736.83
Young tea garden	57.64
Waste land	19.70
Forest	258.45
Grassland	93.63
Total	1166.25

Chaparamari-Neora corridor

The Chaparamari-Neora corridor in the Jalpaiguri Sadar District includes seven tea gardens (Kilocott, Indong, Aibheel, Nageswari, Zurantee, Nakati, Dalimkote, Table 1). It connects the Chaparamari Wildlife Sanctuary of Gorumara Wildlife Division, West Bengal to the Neora Reserve Forest of Kalimpong Forest Division, West Bengal. Chapramari is a mixture of dense mixed, open mixed and mixed plantation with floodplains of Jaldhaka and Murti rivers. Neora Reserve Forest is a mixture of dense mixed, open mixed and degraded forest and floodplains of Neora and Mal rivers. The Kilcott, Indong, Aibheel, Nageswari, Zurantee, Soongachi (Nakati Division) and Meenglass (Dalimkote Division) tea gardens fall on corridor land. The study by the Wildlife Institute of India (1995–1997) and observations of elephant herds confirm elephant movement in this corridor. The length of the Chapramari-Neora corridor is 10.9 km. The details of land-use inside of Chapramari-Neora corridor are given in Table 3 and Figure 2.

DGHC Tatari-Mechi corridor

The DGHC Tatari-Mechi corridor in the Darjeeling - Terai District includes the Panighatta, Belgachi, Marapur and Manjha tea gardens (Table 1). It connects DGHC Tatari Forest of Kurseong Forest Division, West Bengal to Mechi Reserve Forest, Kurseong Forest Division, West Bengal. The radio-telemetry study by the Centre for Ecological Sciences, Indian Institute of Science (2001-2006) confirmed elephant movement in this corridor. The elephants move from Mahananda WLS towards Mechi Reserve Forest (RF) bordering eastern Nepal via Lamagumpha RF, Rakti RF, Bamanpokhri RF and Balasan RF/ Manjha RF from where they move either to Dalka RF or to DGHC Tatari RF. From the latter, they move to Mechi RF via ORD Terai,

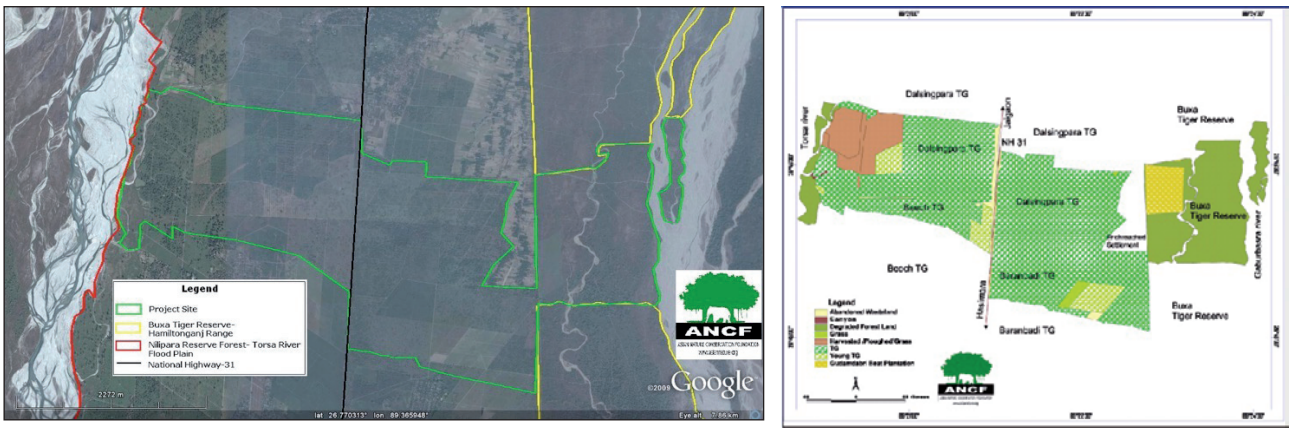

Figure 1. Maps of the Basra-Titi corridor.

Table 3. Land-use areas (in ha) in the Chapramari-Neora corridor.*

Tea garden	OTG	MTG	YTG	AG	SET	AG/SH	BL	RB	Total
Kilcott Tea Estate	135.5	14.0	0.0	0.0	0.0	0.0	0.0	11.6	161.1
Indong Tea Estate	441.5	86.1	17.3	104.0	14.9	66.1	15.7	29.2	774.7
Aibheel Tea Estate	14.0	0.0	0.0	0.0	8.8	27.3	11.8	0.0	61.8
Nageswari Tea Estate	377.9	13.0	10.0	0.0	6.9	0.0	25.5	0.0	433.1
Zurantee Tea Estate	120.9	40.8	0.0	64.0	21.2	0.0	0.0	22.7	269.6
Soongachi Tea Estate	66.3	0.0	0.0	25.9	51.9	0.0	0.0	4.7	148.9
Meenglass Tea Estate	40.7	14.0	0.0	42.6	0.0	0.0	0.0	6.7	104.0
Total area	1196.8	167.9	27.3	236.5	103.6	93.4	52.9	75.0	1953.3

*OTG = old tea garden (>15 years); MTG = medium aged tea garden (4-15years); YTG = young tea garden (1-3 years); AG = agricultural land; SET = Settlement; AG/SH = agriculture/scrub; BL = blank land; RB = river bed.

Panighatta, Belgachi, Marapur and Manjha tea gardens, and further to Bamandangi village on the Nepal side. The length of the DGHC Tatari-Mechi corridor is 3.6 km. DGHC Tatari includes mixed plantation, teak plantation and riverine floodplain of the Balasan river. Mechi forest consists of mixed plantation, degraded forest and riverine floodplain of the Mechi river. The details of land inside of DGHC Tatari-Mechi corridor are given in Table 4 and Figure 3.

Economic analysis of tea gardens

At present, the average tea production (processed dry tea) in these areas is 2000 kg/ha/year. If the tea is auctioned at 110 Rs./kg, the total realization will be 220,000 Rs. (3235 US$, 1 US$ = 68 Rs.). The expenditure on production-related activities is 90% of the proceeds leaving a profit of about 10%. A profit of 22,000 Rs. (324 US$) is thus realized per hectare annually (Source: Beech TG Manager Data, 2009). After 20 years, the total profit per hectare will be 440,000 Rs. (6480 US$).

Economic analysis of forest plantations

Each hectare incurs an expenditure of 30,000 Rs. (441 US$) (Source: Data Range Officer, Chalsa, Jalpaiguri, West Bengal, 2013) to raise

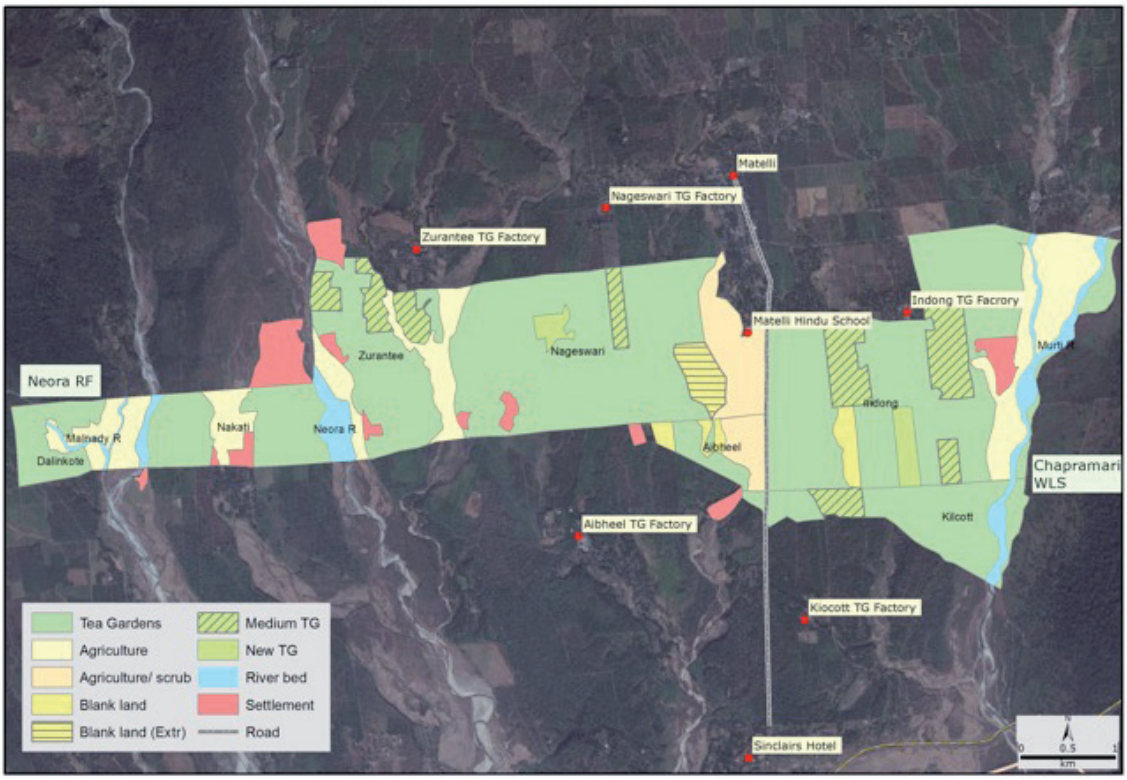

Figure 2. Map of the Chapramari-Neora corridor.

Table 4. Land-use area in the DGHC Tatari-Mechi corridor.

Type	Name	Area (ha)
Part A (west of Kadma more-Panighatta road)		
Tea gardens	Panighatta	138.2
	Belgachi part 1	163.4
	Belgachi part 2	105.2
	Marapur	155.6
	Manjha	110.8
Settlements	Marapur	3.1
	Marapur	3.1
	Belgachi 2	0.9
	Marapur	0.5
	Belgachi 2	15.0
	Tukra basti	32.1
Rivers	Chenga & Manjha	15.2
Forest	Mechi RF	213.8
Part B (east of Kadma more-Panighatta road)		
Tea garden	ORD-Terai part 1	43.6
Forest	DGHC Tatari RF	498.4

the plantation and the caretaker wages for 1 person/10 ha, labour for up to 5 years and later, labour is needed to protect illegal felling or against cattle grazing. After 20 years, one hectare will yield a merchandisable wood of about 150 m^3 and 50 stacks of fuel wood (1.5 m * 1.6 m * 1.2 m). The realization from their sale would be 3,025,000 Rs./ha (@ 20,000 Rs./m^3 and @ 500 Rs./stack of fuel wood). The expenditure on cutting trees and transportation per m^3 would be 1500 Rs./m^3 (Source: Range Officer, Chalsa, Jalpaiguri, West Bengal, 2013). Maintenance and caretaking for 20 years would be 108,000 Rs./ha (Table 5). After this the profit is estimated at 2,557,000 Rs./ha (37,602 US$/ha).

After 20 years one hectare of tree plantation gives a profit of 37,602 US$ and one hectare of tea plantation will have made 6480 US$ profit (324 US$/year). Therefore, after 20 years the forest plantation will give 30,822 US$/ha more than a tea plantation.

Discussion

A preliminary analysis indicated that the total profit from forest plantations is 2,557,000 Rs./ha (37,602 US$/ha) which is much higher than the Rs. 440,000 Rs./ha (6480 US$/ha) from the tea gardens over a 20-year period (22,000 Rs./ha/year). Thus, we should find an economic means of raising plantation forest in some of the key elephant corridors. However, the nature of plantation forests, the key partners and stakeholders are yet to be examined. A comprehensive economic analysis that takes into consideration the wages of tea labour and staff and the cost of other infrastructure development is needed, to assess the viability of this project.

Our preliminary study brings out the importance of new ways of approaching the issue of strengthening wildlife corridors which take into account both economic and social factors. Some tea gardens are not functioning smoothly because of management issues or poor profitability. The managements are disinterested in linking the corridor. They are also not aware of the economics of tea and plantation forests.

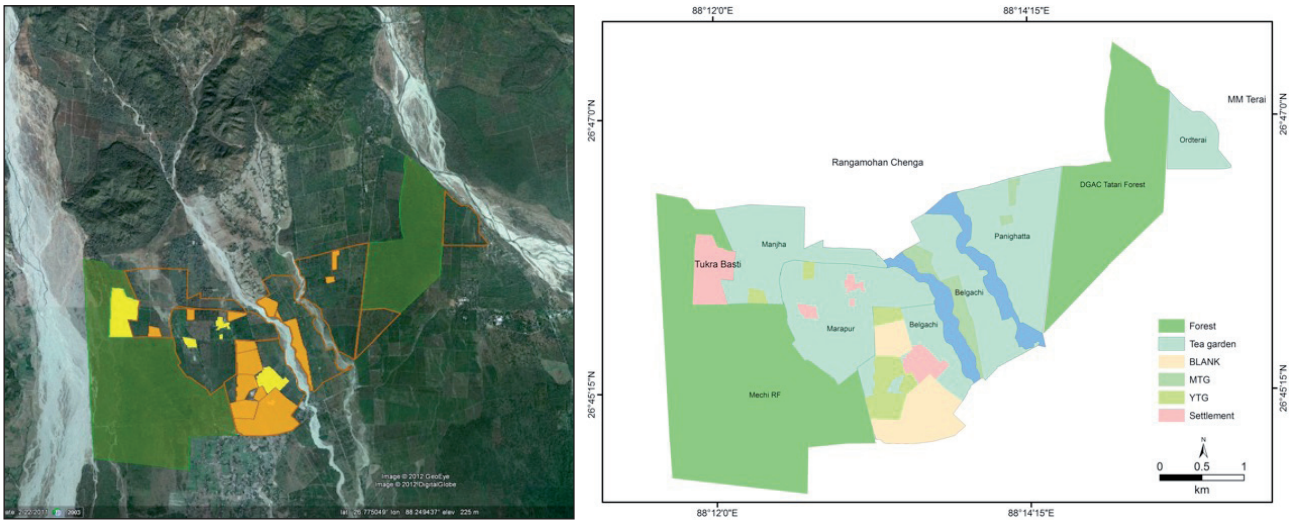

Figure 3. Maps of the DGHC Tatari-Mechi corridor.

Table 5. Revenue (in Rs.) per hectare from the sale of wood and firewood after 20 years.

Item	Volume	Expenses	Income	Profit
Plantation generation cost /ha		30,000		
Maintenance & guarding /ha up to 20 years		108,000		
Miscellaneous expenses /ha up to 20 years		30,000		
Wood cutting and transportation /ha		300,000		
Total plantation generation expenditure /ha		468,000		
Merchandisable volume @ 20,000 Rs./m^3	150 m^3		3,000,000	
Fuel wood cost @ 500 Rs./stack	50 stack		25,000	
Total revenue generated /ha			3,025,000	
Net profit per ha of plantation				2,557,000

Our study shows that plantation is more profitable than tea. A more substantial feasibility study could be conducted before attempting the change of land-use and, very important, such intervention should be accompanied by monitoring programs to assess the effectiveness of the reforestation of tea garden corridors for elephants.

The state government can also declare this important corridor land as a community reserve to conserve wildlife and its habitat by formation of a community reserve management committee and drafting a management plan to take steps to ensure protection of wildlife and habitat.

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