

Mitigating Human Wildlife conflict and climate change in Dudhwa Tiger Reserve, Uttar Pradesh through the approach of Carbon Finance

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ABSTRACT

Human wildlife conflict is a pressing issue in and around tiger reserves. The local communities face economic losses from conflict leading to retaliation against wildlife. Irrespective of governmental initiatives, many states still face lack of financial resources on a timely basis to mitigate the conflict. Carbon finance is one such mechanism which could help in generating additional finance required to manage this issue. It is necessary to understand the contribution of ecosystem services in carbon mechanisms such as Climate, community and Biodiversity Alliance (CCBA) to effectively use the mechanism. The study to understand the contribution of ecosystem services was undertaken in Dudhwa Tiger Reserve (DTR) where human wildlife conflict is high. The methodology to understand the contribution of the ecosystem services was based by valuing services provided by DTR such as firewood, minor forest produce, fodder and grazing, carbon sequestration and recreation. The total economic value of DTR was estimated to be INR 10.58 billion in 2019 wherein the value of ecosystem services was found to be eight times greater than the value of carbon. Including these benefits in the carbon finance shall yield 8 times more benefits as compared to the benefits from afforestation project.

Key words : *Tiger Reserves, Human wildlife conflict, Climate, Community and Biodiversity Alliance, Carbon Neutrality, Carbon finance*

Introduction

India is rich in its protected areas in the form of 104 national parks, 551 wildlife sanctuaries, 88 conservation reserves, 127 community reserves and 131 marine protected areas which cover about 5% out of the country's geographical area (MoEFCC, 2019). In the year 1973, the Government of India launched the Project Tiger program administrated by the National Tiger Conservation Authority to conserve the population of Bengal tiger (*Panthera tigris tigris*). Today, there are 50 tiger reserves formed under the

program which cover a total area of 71,027.10 sq km (MoEFCC, 2019). The success of the Project Tiger could be significantly seen as the tiger population, from 2226 in 2014 increased to 2967 in 2018 (Jhala, Qureshi, Nayak, 2019). Tiger reserves, in addition to providing habitat for tiger and associated species also provide several ecosystem services such as biodiversity conservation, carbon sequestration, air and water purification, pollination, fuelwood, fodder and soil conservation etc on which the local communities are dependent.

Forests in India play an important role in social,

economic and religious activities of the local communities. A majority of rural population in India stay around the protected areas such as tiger reserves and depend on forest resources for their day to day needs. This dependence is in the form of collection of non-timber forest produce and fuelwood and fodder for subsistence and livelihood purposes (Pandey *et al.*, 2016). The dependence on forest resources, make the local communities venture in the forest areas resulting in attacks from wildlife such as Leopards and Tigers. The agricultural fields in most of the tiger reserves being present around the reserve attract several herbivores species such as Deers, Wild boars, Blue bull, monkeys etc. resulting in destruction of crops (Agarwal *et al.*, 2016). This has resulted in increased cases of human wildlife conflict around the tiger reserves putting a threat to wildlife as well as livelihood of the communities.

Human-animal conflicts result in significant economic losses to local communities from either loss or injury to life, crop damage, and loss of livestock. This results in retaliation against wildlife leading to lynching of animals or poisoning of herbivores. Thus addressing the issue of human-animal conflicts is a challenge in India as large human settlements are around protected areas, which is also a challenge for ensuring successful wildlife conservation (Karanth *et al.*, 2008). In a study, blackbuck was identified to cause a loss of 48,600 Kg of Sorghum in a single season resulting in loss of INR 29,000 (Jhala, 1993). Similarly, Karanth *et al.* (2013) reported an annual loss of US\$ 155,246,546 from crop loss per household due to herbivores around key tiger habitats such as Kanha, Ranthambore and Nagarhole National Park. To address these costs and mitigate the conflicts, the Government of India (GoI) has implemented financial compensation in the form of ex gratia for losses resulting from conflict. The ex gratia policy differs from State to State but is mostly based on the factors such as damage to property, life or crops. Karanth *et al.* (2018) found that the total compensation payments paid in the year 2012-13 in 18 states were around \$5,332,762 of which the average expenditures per incident were \$47 for crop and property damage, \$74 for livestock, \$103 for human injury and \$3224 for human death.

Additionally, the government has also developed relocation policy for communities living inside core tiger habitat. So far, 12,327 families living in 173 villages from the core/critical habitat of tiger reserves have been resettled/ relocated with an expenditure

of Rs 1123.93 lakh till 2018-19 (NTCA, 2019). But mostly it is found that either the communities are unaware of the compensation mechanism or compensation doesn't really compensate for the actual economic loss (Johnson *et al.*, 2018). In many of the states, lack of resources to compensate the loss of the communities is a big challenge as it leads to boosting of antigovernment and wildlife sentiments resulting in killing of wildlife (Jackson and Wangchuk, 2001; Madhusudan, 2003; Gubbi, 2012). Thus there is a need for a dedicated finance mechanism which shall help mitigate the issue of human wildlife conflict in an efficient way.

Finance through carbon related projects could be an imperative solution to address the issue of finance crunch. Carbon finance projects could yield additional finance which is required to address the issues of mitigation strategies for human wildlife conflict and community alternative livelihood. Mechanisms such as The Climate, Community and Biodiversity Alliance (CCBA) Standards support land use projects in addressing climate change and conserving biodiversity making it a key mechanism to generate supplementary finance. But the mechanism fails to differentiate between the prices provided for carbon and ecosystem services. Development of an index can be useful to standardise the contribution of co-benefits of biodiversity conservation and livelihood enhancement in tiger reserves of India.

DTR, a significant Protected Area (PA) of India, is situated on Indo Nepal border and is a representative of the Terai ecosystem in the foothills of Himalayas. As per the Tiger Conservation Plan of DTR, there are few forest villages in the core of the reserve and more than 6 lakh people and 90,000 livestock is present in the zone of influence of the reserve which depend on the forest resources to some extent for their sustenance (UPFD, 2014). There is a dire need to identify solutions which would help reduce the pressures on the reserve and simultaneously benefit the local community. DTR faces issues with livestock as well as human depredation by carnivores such as leopards and tigers, and crop depredation by wild ungulates including elephants, spotted deer, nilgai and wild pig. Between the year 2000 and 2013, 151 human-wildlife conflict cases resulted in human deaths and injuries were recorded by the Uttar Pradesh Forest Department in this landscape. Around 90.1% of the cases involved leopards and tigers while an additional

474 cases involving leopards and tigers, which directly resulted in the death of livestock, were recorded between 2003 and 2012 (Chatterjee *et al.*, 2017). In the case of DTR, sugar cane (*Saccharum officinarum*) grasses in the agricultural fields, has proven to be an attractive habitat for tiger and leopard as they wander within these sugar cane plantation and surrounding scrub as a part of their home range (UPFD, 2014). This made it necessary to develop an index to standardise the contribution of co-benefits of biodiversity conservation and livelihood enhancement in PA's of India such as Dudhwa Tiger Reserve.

Methodology

About Dudhwa Tiger Reserve (DTR)

Dudhwa is the state's only National Park and one of the main tiger reserves of Uttar Pradesh that lies between latitude N 28°06' and 28°37' and longitude E 80°20' and 81°19'. It is said to be the last and best remnant of the terai ecosystem remaining in North India and Nepal (Semwal, 2005; Singh and Prasad, 2014). Dudhwa covers an area of 2201.77 sq. km, out of which 1093.79 sq. km is core and buffer area of 1107.98 sq. km. It is a protected area cluster of Dudhwa National Park (DNP), Kishanpur Wildlife Sanctuary and Katarniaghat Wildlife Sanctuary. It

also includes forest reserves of North Kheri and South Kheri, and covers a small area of Shahjahanpur in its buffer zones (Singh and Prasad, 2014).

Geographically, DTR is a part of two districts of state Uttar Pradesh- Lakhimpur-Kheri and Bahraich extending towards adjacent district of Shahjahanpur (Mathur and Midha, 2008). Woodlands of DTR cover 63.51% of area, whereas grasslands share 21.29% and 15.19% is shared by wetlands. The DTR consists of four types of forests according to Champion and Seth's revised classification of the Forests types, Northern Evergreen, North Indian Moist, Tropical Swamp and Northern Dry Forests (Singh and Prasad, 2014). DTR is dominated by Sal (*Shorea robusta*) forests interspersed with tall and short grasslands, several rivers and streams (Mathur and Midha, 2008; Chatterjee *et al.*, 2017; Singh and Prasad, 2014). The reserve is heaven for around 305 species of flora, 47 species of mammals, more than 450 species of resident and migratory birds, 30 species of reptiles, 10 species of amphibian, 24 species of fish and 120 species of Invertebrates.

Methods

The method to understand the contribution of the co-benefits was based on the economic valuation of the ecosystem services provided by DTR. When it

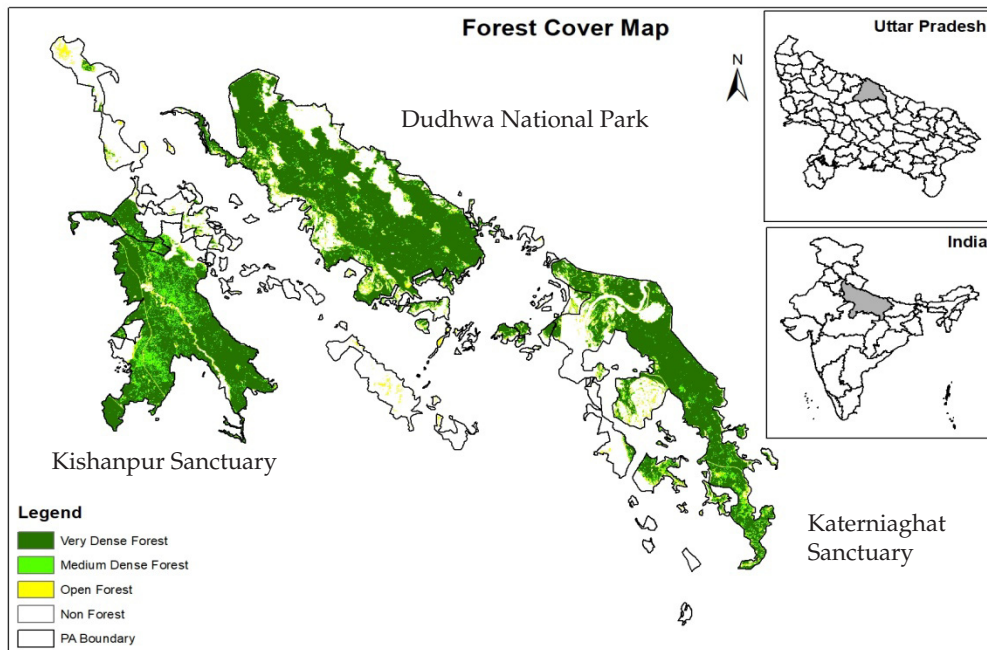


Fig. 1. Map of Dudhwa Tiger Reserve

comes to valuation and classifying ecosystem services, number of frameworks exist in literature, such as Total Economic Value (Pearce and Moran, 1994); Millennium Ecosystem Assessment (Hassan *et al.*, 2005); and The Economics of Ecosystems and Biodiversity (TEEB) to come up with the diverse values of national parks and further communicate it to policy-makers, non-governmental organizations and general citizens. Based on the literature review and discussion with key stakeholders such as Uttar Pradesh Forest Department, the ecosystem services identified for the study were fuelwood, fodder & grazing, minor forest produce, biodiversity conservation, carbon sequestration and recreation.

Most of the primary field studies were carried out in 2006 under Sharma (2009). To use the respective monetary values in our current study, the earlier figures have been discounted to take inflation into account. CPI (Consumer Price Index) has been used as a measure for changes in purchasing power or cost of living over the years 2006-2019. The average of year-on-year inflation rate using CPI in this period has been found to be 7.60%. This figure has been used to convert the monetary values to current, i.e. 2019 prices.

Fuel wood

The value of fuel wood provisioning service of the protected area was estimated using benefit transfer method from a study evaluating ecosystem services of Dudhwa National Park (Sharma, 2009). The primary data in the study conducted by Sharma (2009) was collected through survey of the villages in and around Dudhwa National Park (DNP) with the help of questionnaire, using market price method for fuel wood collection. The questions gauged in on the dependency of villagers on fuel wood for their energy requirements and employment. 5% of the people in the reserve were collect and sell around 40kg of fuelwood at the market price of Rs.1 for about 240 days a year. Per day 649,958 kg of fuelwood is extracted in the DNP whose annual monetary value comes out to be Rs 155,989,920 at 2006 prices. This annual monetary value for DTR for fuel wood was converted to 2019 prices based on the results from DNP using Consumer price index (CPI) inflation to be 7.60%.

Minor Forest Produce

The value of Minor Forest Produce (MFP) collected annually was estimated using benefit transfer

method from a study evaluating ecosystem services of DNP (Sharma, 2009). The study estimated the annual value of MFP collected by using primary and secondary data about demographic characteristics of the area as well as a questionnaire administered using random sampling of villages, gauging the number of families collecting MFP, the money earned through selling the produce in the market and their dependence on it for employment. According to the survey, the total number of families collecting minor forest produce was found to be 40103 of which 5% families collected MFP as a source of livelihood. The monetary value was calculated to be Rs. 52,411,633 keeping in mind the market price of the various produce. The annual monetary value for DTR for MFP was then converted to 2019 prices based on the results from DNP using CPI inflation to be 7.60%.

Fodder and Grazing

The monetary value of grazing and fodder sourced from the protected area has been arrived at, by benefit transfer method using Sharma (2009). The initial study adopted the market price method for calculating the monetary value of the fodder and grazing from DNP at the rate of two rupees per kilogram. The data was obtained using random sampling method of the villages through a questionnaire based on practices followed by the families such as dairying and use of whether fodder is sourced from agriculture or forests. The fodder requirement was calculated by converting the different components of cattle (buffaloes, goats and cows) to adult cattle unit whose requirement is 35 kgs of fodder per day throughout the year, which is partly sourced from agriculture and partly from the forest. According to the requirement of the 78,241 cattle in the 127 villages in the protected area and the market price of fodder, the monetary value of the fodder and grazing from the forest area came out to be Rs. 228,169,028 at 2006 prices.

This annual monetary value for DTR for fodder and grazing was converted to 2019 prices based on the results from DNP using CPI inflation to be 7.60%.

Biodiversity conservation

The value of biodiversity conservation of the protected area is calculated using benefit transfer method from a study evaluating ecosystem services of Dudhwa National Park (Sharma, 2009). The ini-

tial study was based on the parameters such as (i) Expenditure for the state and central government for conserving biodiversity through schemes (ii) Volume of timber harvest (Sal) as specified by Smithies and Howard (1923) which 5.95 cubic meter per hectare and (iii) potential value of timber production which was based on the revenue foregone from harvesting of timber after the area was declared as a PA. The Government is spending on the conservation of biodiversity for future generations, and also sacrificing the timber harvest for the conservation of biodiversity. This spending by the government has been around Rs. 3 crores. This figure is in addition to the potential value of Sal timber harvest, which comes out to be Rs. 3099189311 by valuing it at average royalty of Rs. 8880 per hectare and potential harvest calculated through proportion on forest area covered by Sal (66 %) and the volume of timber harvest (5.95 cubic meter per hectare).

The annual monetary value for DTR for biodiversity conservation was converted to 2019 prices based on the results from DNP using CPI inflation to be 7.60%.

Carbon Sequestration

To calculate the value of carbon sequestration, the mean annual increment rate per hectare for woodlands was identified as 5.45 tons per hectare. The mean annual increment rate was extrapolated to the entire area of woodland to understand the annual carbon sequestration rate. The total value of carbon sequestration was then estimated using the market price of carbon (\$12/ tCO_e) present in voluntary carbon market.

Recreation

The value of annual recreational services of the ecosystem is estimated using benefit transfer method from study done for Dudhwa National Park (Sharma, 2009). The initial study collected primary data from tourists using travel cost method. The costs incurred by tourists included expenses on their travel to DNP from their home (distance cost), fee of the park, lodging and boarding cost, cost of the time spent by tourists and other miscellaneous costs which have to be taken into consideration while estimating recreation value. The questionnaire also included questions about the purpose of the visit, demographic details and maximum willingness to pay for the entry fee. The average spending per tourist through this survey was found to be about

Rs. 6530. The latest available figure for the number of tourists visiting DNP annually is 19832 for 2013-14. The total estimated annual recreation value Rs. 129520866.6 at 2006 prices. The annual monetary value for DTR for recreation was then converted to 2019 prices based on the results from DNP using CPI inflation to be 7.60%.

The results of the study was used to compare the value of carbon sequestration with respect to all the other services to identify the value of contribution of the ecosystem services which are the co-benefits derived from forests.

Results and Discussion

The total economic value of the ecosystem services provided by the reserve includes both direct and indirect use values consisting of provisioning, regulating and supporting services. The estimates are indicators of the importance of the services.

The total economic value of DTR is Rs.10.58 billion annually (in 2019 prices). In order to estimate the index, the benefits arising from carbon sequestration and other ecosystem services were compared. The value of carbon sequestration potential of the forests is estimated as 1.11 billion which is 11% of the total economic value of DTR. The value arising from the other ecosystem services provided by the forests is estimated as 9.46 billion which is 89% of the total economic value of DTR. This implies that the value of ecosystem services other than carbon is 8 times greater than the value of carbon. Including these ecosystem services in the carbon finance mechanism shall yield 8 times more benefits as compared to the benefits from carbon, which could be used to mitigate the issue of human animal conflict in the reserve. Additionally this fact also indicates the need for better management and conservation of these ecosystem services to ensure improved contribution of these services in future.

The practice of fuel wood extraction from the tiger habitats has been widely carried out for years, and has resulted in high levels of human intrusion in the forests (Chanchani *et al.*, 2014). Humans venturing into forests to collect fuel wood are also reported to increase human wildlife conflicts. According to the Tiger Conservation Plan for Dudhwa Tiger Reserve, for the years 2000 to 2011 almost 30% of tiger attacks have been on humans collecting firewood. To mitigate such conflicts, working with local communities to reduce their dependence on for-

est resources is of paramount importance. It may be recommended to start providing biogas, LPG cylinders, solar cookers or fuel efficient smokeless stoves (chulhas) to the people, reducing their dependence on the forest for collecting fuel wood (IUCN, 2019). It is also seen that such interventions may also lead to a positive social impact such as increased safety of women as they will not have to venture into tiger habitats to collect fuel wood (WWF, 2011).

The protected area suffers from biotic pressures of overgrazing especially in areas which have low moisture, affecting natural regeneration of sal forests (UPFD, 2014). The Nepalese regularly drive their cattle into the Reserve for grazing and the pressure from across the border has increased over the years. Thus, besides pressure from within the country, the park is subject to pressure from across the international border. In the past decades, the human and cattle population in the settlements at the fringes has increased tremendously by several folds and hence their requirements are much greater but the same amount of resource is no longer available and cattle's grazing is being strictly prohibited within the core area. The protective measures adopted recently against trespass and grazing have so far proved to be quite effective though previously people had free access to all parts of the Reserve.

Changed land use patterns and other developmental activities around the PA have begun to impact the flora and fauna of the Reserve. According to UPFD Tiger Conservation Plan, changes in vegetation types can be seen in certain areas along the border and are also beginning to appear in more

remote areas. Encroachment from agricultural practices, developmental activities such as establishment of industrial units etc. may affect the biological diversity. Additional threats from forest fires, illegal logging, and proliferation of invasive alien as well as native unpalatable species, are causing degradation of wildlife corridors (Semwal, 2005). Over grazing and unplanned irrigation canals constructed inside the forests, degrade habitats of wild animals leading to man-animal conflicts in terms of increased instances of crop raiding, livestock depredation and human killings by wild carnivores.

Some infrastructure projects such as the barrage on the Suheli River near the Dudhwa Tiger Reserve caused inundation and loss of habitats in the protected area. Regeneration status of most species has not been documented. Effects of stoppage of felling, non-removal of NTFP and removal of elements of human intervention need to be studied and research and monitoring of ecological processes and population dynamics of key species is needed to be done (UPFD, 2014).

Reducing dependence of local communities on forests and promoting sustainable livelihoods, construction of underpasses along with roads for wildlife to pass through unharmed, construction of trenches around agricultural fields for mitigating human-wildlife or mainly human-elephant conflicts, controlling retaliatory killings by providing compensation for loss of cattle or crops are some positive measures which can be promoted in DTR as well. The finance required for the implementation of these strategies would be the result of such

Table 1. Total annual economic value of Dudhwa Tiger Reserve

Sr. No	Ecosystem Service	Type of Service	Value (Rs.)	Value (USD) ¹	% Contribution
1.	Fuel wood	Provisioning Service	1,007,171,667 or 1007.25 million	14,481,260.49 or 14.48 million	10%
2.	Biodiversity Conservation	Supporting Service	5,810,817,381 or 5810.81 million	83,548,776 or 83.54 million	55%
3.	Minor Forest Produce	Provisioning Service	338,403,351.9 or 338.4 million	4,865,612.53 or 4.86 million	3%
4.	Carbon Sequestration	Regulating Service	1,116,475,424 or 1116.47 million	16,052,845.79 or 16.05 million	11%
5.	Fodder and Grazing	Provisioning Service	1,473,206,604 or 1473.2 million	21,181,978.49 or 21.18 million	14%
6.	Recreation	Cultural Service	836,270,363.7 or 836.27 million	12,024,016.73 or 12.02 million	8%
	Total Economic	Value	10,582,344,792 or 10.58 billion	152,154,490.2 or 152.15 million	100

carbon finance projects. CCBA have developed standards, managed by Verified Carbon Standard (VCS), which focus on land management projects that deliver net positive benefits for climate change mitigation, local communities and biodiversity. It also ensures effective stakeholder engagement, good governance and holistic design to address social and environmental risks and opportunities & helps to build a more sustainable project that can achieve multiple objectives. Linking the index with the CCB Standards would help in developing carbon finance projects for critical habitats such as PAs and ensure suitable contribution of the co-benefits in the carbon projects.

Conclusion

Tiger Reserves in India ensures the highest degree of protection under the Wildlife (Protection) Act, 1972. The core/critical habitats of Tiger Reserves have to be maintained as “inviolable” under the Law for tiger conservation purposes, hence they remain highly protected. These untapped vast resources need to be mobilised for the benefit of communities which could be achieved through the development of a carbon market. In order to develop the carbon market, India should adopt a “Carbon Neutrality” policy for industries and other economic activities which adversely affect our environment. To effectively counter the impending threat of climate change, a policy on “Carbon neutrality” seems to be the need of the hour.

The local communities which face the consequence of wildlife conflict on a daily basis eventually develop unconcern towards the wildlife and forests. As stated under Article 21 of the Indian constitution “No person shall be deprived of his life or personal liberty except according to a procedure established by law”; PAs need to secure these fundamental rights of these communities. The Government is struggling to keep balance between the ecological needs of the country and people who suffered the damage due to wildlife due to paucity of financial resources. Payments for environmental or ecosystem services (PES) are now becoming an important means to support biodiversity conservation and community development (Gutman, 2007). Currently, the governments of countries such as China, Costa Rica, Mexico, Vietnam, Ecuador, South Africa, and United States have adopted the concept of payment for ecosystem services (PES) programmes or

PES-like schemes (Prokofieva, 2016) in their policy. The mechanism is used as a poverty alleviation tool to increase its efforts to direct payments to marginalized groups of the society to reduce their dependence on the forest resources.

The practice of valuing the ecosystem services paves a way in not only finding the economic value of the various intangible and tangible services but also leads to financing the conservation of the area. The carbon trading mechanisms value both the carbon sequestered through forest based projects and also take into account the co-benefits such as climate change mitigation and supporting local communities. The valuation of these co-benefits hence makes way for the first step in recognising the various benefits accruing through protected areas. This financing through voluntary carbon markets can be extended to the other protected areas in the country incentivising better management and leading to mitigation of anthropogenic pressures and environmental risks on biodiversity.

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