

The Economic Value of Forests: An Analysis of the Provisioning Services of Laokhowa and Burhachapori Wildlife Sanctuaries of Assam, India

Economic valuation is a process of ascribing monetary values to the unquantifiable social and environmental services of the eco-system. The need for valuation arises since the intangible services of an ecosystem are not taken into account while making environmental decision making leading thereby to missing markets and eventually to their exploitation and loss. This paper seeks to estimate values of provisioning services of the forest ecosystem of Laokhowa and Burhachapori Wildlife Sanctuaries of Assam in North East India. Once good repositories of floral and faunal diversity the sanctuaries suffered huge setback during eighties of the last century and presently grappling for survival due to huge anthropogenic pressures. Using primary data from 302 fringe households, the study identifies nine important provisioning services harvested by the fringe people. Besides providing nutritional security, these services fulfil occasional cash shortage of the collectors. Using market price method, this paper quantifies the value of the provisioning services of both the sanctuaries together to be ₹ 8.7 million. The paper further attempts to estimate the per hectare value of the sanctuaries on account of the provisioning services, including grazing, and finds it to be worth ₹ 7685.6 (\$106).

Key words: Economic valuation, Environmental services, Missing market, Ecosystem services (ESS), Anthropogenic pressure.

Introduction

In last decade, concerns have arisen about proper valuation of the world's forests, which is one of the vital components of nature. While some of these concerns are related with market distortions for timber products or inadequate data on non-timber forest products (NTFPs), an additional issue has been the challenge of uncovering the economic worth of non-market services, such as watershed protection, maintenance of the productivity of soil, checking siltation, etc. provided by forest ecosystem (Kramer *et al.*, 1992). In other words, economic valuation is an attempt to assign quantitative values to the goods and services provided by ecosystems. It is generally measured in terms of what one wishes to pay for the commodity less the costs of its supply (Kumar and Kumar, 2008).

It has been noticed over the years that though the services, both tangible and intangible, provided by different ecosystems, which is described as ecosystem services (ESS) by Millennium Ecosystem Assessment (MEA, 2005), are the lifeline of the human beings however, they are often taken for granted and overlooked in environmental decision-making. The primary reason, says Pearce (1996), is the missing markets for most of such forest services. Kumar *et al.* (2000), in this regard says that several thousand tons of NTFPs are extracted annually from the forests of India most of which are consumed or bartered away and not valued at all. Millennium Ecosystem Assessment comprehends that there has been no serious effort to evaluate the

Though the forests across places are facing similar problems but each and every individual forest area needs separate attention. Our paper emphasises on empirical researches on the level of people's dependence on forests and determinant factors on lesser known forest areas.

**KULEN CHANDRA DAS AND
MRINAL KANTI DUTTA¹**

Nowgong Girls' College, Haibargaon,
Nagaon, P.S. Road, Amolapatty,
Nagaon, Assam
E-mail: kulen1das@gmail.com

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¹Humanities and Social Sciences, Indian Institute of Technology Guwahati, Guwahati.
E-mail: mkdutta69@gmail.com

intangible contribution of forests to ecological security. It is because the current markets shed light only on the value of a small subset of ESS that are transacted in the markets (MEA, 2005) and thus creating a case of missing markets for such services and thereby market failure. The implicit ruling price is zero in missing markets and there is a possibility that forests with high non-market value will lose out in near future. Brander *et al.* (2010) says that depreciation or degradation of the ESS and biodiversity has associated with social costs and if not imputed the policy would be misguided and the society would be worse off due to misallocation of resources. In this context, Groot *et al.* (2012) report that though the importance of ecosystems to human society has many dimensions (ecological, socio-cultural and economic), expressing the value of ecosystem services in monetary units is also an important tool to raise awareness and convey the importance of ecosystems and biodiversity to policy makers. Therefore, it invites the actions of demonstrating and capturing the values of forest ESS so as to bring to the notice of policy makers about the inherent and often significant intangible values of forests. Thus, such demonstrated values will make a strong case for conservation of forests.

It is a well-known fact that the forests are being threatened over the years in developing countries. It has reached a dangerous level which is unacceptable (World Bank, 2006) and Assam is no exception. Various state of forest reports (FSI, 1999, 2011, 2016) reported that the rich forest cover of Assam to have been abused extensively and hence dwindling. The reason being the diverse forms of anthropogenic pressures on the forests which are substantiated by the data produced by Forest Survey of India (FSI) in its various reports. The glaring need, therefore, is to capture and demonstrate the value of the provisioning and other ecosystem services of forests. Such quantification can be expected to put an urgent intervention by the forest managers and other stakeholders for conservation of our precious and rich forest covers.

Fikir *et al.* (2016) emphasized in conducting empirical research on each and every forest area though the forests across places are facing almost similar problems. He said, "While the existing studies from different forest areas have widened our knowledge on various aspects of forest-people interaction, there are still many other forest areas where empirical researches on forest-people interface have been lagging". Against these backdrop two forest areas of Assam namely Laokhowa and Burhachapori Wildlife Sanctuaries have been undertaken for in depth study. The study aimed at demonstrating its actual value to the stakeholders so that it does not go unnoticed while making policy (conservation) decisions. Studies across countries show that the provisioning services (food, fresh water, wood and fibre, fuel, etc.), which the peripheral people harvest from the sanctuaries, not

only supplement their subsistence livelihood but also have tremendous use value and the current study aims at quantifying such values in monetary term. This paper focuses, therefore, on quantifying the use value of ecosystems services of Laokhowa and Burhachapori Wildlife Sanctuaries (LBWLSs) using the market price method.

The aim of this empirical study is to figure out the forest-people interface in the periphery of Laokhowa and Burhachapori WLSs and quantify the value (in monetary terms) of provisioning services extracted by the peripheral people. Thus, the present study has the following broad objectives:

- I. Quantify the value of the provisioning services of LBWLSs and
- II. Calculate per hectare value of LBWLSs.

Materials and Methods

Study area

The study has been carried out in the fringe villages of Laokhowa and Burhachapori Wildlife Sanctuaries (LBWLSs).

Brief background of Laokhowa and Burhachapori Wildlife Sanctuaries

The Laokhowa and Burhachapori Wildlife Sanctuaries located in Central Assam districts of Nagaon and Sonitpur of North East India covers an area of 114 km² in the flood plain of the mighty river Brahmaputra. Laokhowa was originally a game sanctuary while Burhachapori was a professional grazing reserve and were declared wildlife Sanctuaries in the year 1979 and 1996 respectively. Both the sanctuaries are ideal habitat for various key species of plants, reptiles and birds, endangered mammals like Rhino, Wild Pig, Buffalo, Royal Bengal Tiger, Elephants, and Bengal Florican, etc. The natural and perennial wetlands here have been functioning as breeding ground for various fish species that attract large number of avifauna (both endemic and migratory) to the sanctuaries and is one of the prime attractions to the tourists. Though LBWLSs are very strategically located between Kaziranga (towards East) and Orang (towards North West) National Parks, the sanctuaries are highly degraded despite its protected area status. The degradation of the forest ecosystem of the sanctuaries started during the early part of the eighties in the 20th century (Sivakumar *et al.*, 2013). The world famous one horned rhinos met its unfortunate fate of local extinction in LBWLSs due to poaching of 35 rhinos in 1983 by the vandalistic gunners which compelled other rhinos to flee. It heralded an ominous beginning of exertion of huge anthropogenic pressures in the form of relentless and ruthless cutting of trees, illegal collection of fuel wood and other NTFPs, such as construction materials, fish, simul cotton pods, etc. Massive unregulated domestic (non-inoculated) cattle grazing, destructive fishing, trapping of birds for

consumption, etc. by the resource poor peripheral people are pervasive. Consequently, it led to wanton destruction and depletion of the floral and faunal diversity from once rich forest ecosystems of LBWLSs. As a result, the bio-diverse sanctuaries have been metamorphosed into beleaguered scrubs languishing for survival. Hence, capturing and demonstrating and valuing the important ecosystem services of these once bio-diverse forests are of utmost need so as to restore its past glory.

Justification for selecting Laokhowa and Burhachapori Wildlife Sanctuaries

State of Environment Assam (2004) reported that Laokhowa and Burhachapori wildlife sanctuaries were the most disturbed and degraded sanctuaries which can be gauged from the fact that the one horned Rhinoceros and Bengal Florican, two critically endangered species, once abundant in the sanctuaries, have been completely wiped out from here. Though degraded the sanctuaries are of vital importance for the overall environment since the sanctuaries are the floodplain forests of Assam (Choudhury, 1998; Bora, 2004; Phukan and Sarma, 2004). The floodplain forests are unique and endangered ecosystem in the sense that these forests are biologically more productive and diverse. Despite having many stresses such forests consist of diverse species and thus the most species rich forests among all other types of forests. During past few years growing objections have been raised to the destruction of floodplain forests (Junk and Welcomme, 1990). Moreover, both the sanctuaries are part of the Kaziranga-Orang riverine landscape, which has been identified as a major gateway for straying animals within the protected areas of Central Assam. The sanctuaries are of vital importance since they act as a migratory corridor for the wild animals between Kaziranga and Orang National Park (Borthakur, 2011; Ojah, 2016).

Sampling technique

A two stage sampling technique is followed for this study. In the first stage, villages are selected on the basis of communities living, population pressures, proximity to the forest and socio-economic conditions of the people. Thus, on the basis of above parameters, nine villages (four from Burhachapori and five from Laokhowa sanctuary) have been selected comprising 20 per cent of the fringe villages located in a radius of 2 km from the forest boundary.

In the second stage, the census data are consulted for selecting the number of households to be studied. Since the villages are heavily populated and households are mostly homogenous in characters only 10 per cent of the total households of each village have been taken for detailed survey. Thus, a total of 302 households from nine villages have been selected randomly for in depth investigation. To make the study

representative due care has been taken to include the households of all the communities residing in the villages. An effort has also been made to incorporate heterogeneity in distances of the households across the sample villages from the forest boundary.

Methods

In order to obtain the required information regarding extraction of various provisioning services a semi-structured questionnaire is administered in the selected villages. Data regarding household characteristics along with their livelihood activities and various information of their extraction of provisioning services from LBWLSs have been elicited from the sample households through door to door survey.

Following Godoy *et al.* (1993); Chopra (1993); Gunatilake *et al.* (1993); Shackleton and Shackleton (2004); Brander *et al.* (2010); Wunder (2001) and Angelsen *et al.* (2014), the present study administers a Market Price method to value the flow benefits of the provisioning services of LBWLSs.

The socio-economic and demographic characteristics, the demand and supply of the provisioning services, quantification and valuation of these services, etc. are analysed from the data collected through household survey. Market price method, as mentioned above, is administered to estimate the value of the provisioning services extracted from the forest and fodder consumed by the livestock of the peripheral people. In order to calculate the fodder requirement for an average cattle and thus to find out total fodder requirement for all grazing animals, a concept cattle 'called unit' (CU) has been applied. The conversion of the livestock into a standard 'cattle unit' is done in the current study by using the conversion measures suggested by Ghule *et al.* (2012) and Patel *et al.* (1983). Moreover, a survey is carried out in the forest gate markets to obtain the prices of these services harvested and transacted in the market. The average price of each category of the product is then used to calculate the total value of the provisioning services harvested by the sample households.

Thus, the value of the forest products harvested by the peripheral people can be measured with the help of the following equation:

$$F_v = \sum_{i=0}^n Q_i * P_i$$

Where,

F_v = Value of forest

Q_i = is the quantity of provisioning services extracted,

P_i = is the forest gate prices of the provisioning services,

i = is the set of provisioning services.

The main advantage of using Market Price method is that it uses data from actual markets, and thus reflects actual preferences or costs to individuals. Moreover,

such data – i.e. prices and quantities are relatively easy to obtain. The method is not free from flaws which arise basically out of missing market and distorted market due to existence of tax or subsidy (Brander *et al.*, 2010). Fortunately, both these limitations are absent in case of the present study.

Results and Discussion

Results

The field survey has been conducted in two phases during May – October 2016. Two forest gate markets have also been surveyed for eliciting the forest gate price for the products collected from the sanctuaries. The data are analysed and the results have been presented below:

Empirical values of LBWLSs calculated using

Market Price Method: Millions of people throughout the world make extensive use of the forest provisioning services. These are harvested for both subsistence and commercial use either regularly or as a fall back during times of need. They add to people's livelihood security, especially for rural dwellers (Murthy *et al.*, 2005). The value of different provisioning services harvested by the sample households of the fringe villages of LBWLSs is presented in Table 1.

These services are fuel wood, fodder, wild edibles, wild fruits, leafy vegetables, fish, simul cotton pods and construction materials (*Imperata* and *Vetiveria*). The units of measurement are different for each of these services. For example, fuel wood, wild edibles, wild fruits, simul cotton pods and fish are measured in terms of kg/year while fodder, leafy vegetables and the construction materials are measured in terms of 'bundle' (a unit used by the local fringe dwellers). The monetary valuation of these services, which also indicates the income of the farming household, is carried out for all the sample households by using the market price method. Market survey has been carried out to determine the average prices of the collected products. There are variations in the estimated value realised by each of the villages. The value of green fodder consumed by the domestic cattle of the sample households is also calculated for the year by using a concept called cattle unit (CU). The total value of all these provisioning services of LBWLSs, as mentioned earlier, thus, is estimated to be a whopping ` 87, 61,584. The value of the provisioning services extracted by each sample household is found to be ` 33,314.

The table further indicates that the fuel wood has a predominant role followed by fish in the make-up of the incomes from various forest products. It is by far the most important forest product harvested by the villagers of almost all the sample villages. This finding is in the same line with the findings of the Poverty

Environment Network (PEN) studies where fuel wood emerges invariably as the single most important forest product across a series of cases from throughout the tropics, contributing over 35 per cent of forest income on an average (Angelsen *et al.*, 2014; Belcher, 2015).

Wild edibles are basically collected by the tribal households living in the *taungya*¹ villages in the sanctuaries. The edibles are plant and animal origin and only the tribal people have the expertise to identify these forest products. Such products have high nutritional values and are harvested absolutely for domestic consumption purpose. Similarly, both wild fruits and leafy vegetables are also collected in large quantity by the sample household lion's share of which are sold while keeping a smaller amount for domestic consumption. The table shows that *imperata* and *vetiveria* are two most important forest products extracted for construction purpose. While most of the studies didn't focus on fish as an item of ESS, present study finds fish to be one of the most important items of provisioning services listed after fuel wood.

Village-wise extraction benefit of the provisioning

services: 68.5 per cent of sample households investigated extract different provisioning services from the sanctuaries. The total value of the services harvested is estimated to be ` 51, 28,143 (Table 1). The relative share of the values of provisioning services appropriated by each village has been presented in Fig.1.

It is apparent from Fig. 1 that the sample households of eight out of nine villages extract different kinds and amount of provisioning services from LBWLSs. The total value of the provisioning services, thus, harvested is estimated to be ` 51,28,143. It is quite sizeable and significant in the face of historical negligence of the NTFPs *vis-à-vis* the timber resources of the forests (Adepoju and Salau, 2007). The value of fodder consumed by the domestic cattle is estimated to be a massive ` 36,33,441. Thus, the total value of the provisioning services harvested including the value of grazing is estimated to be worth ` 87,61,584. It is, thus, evident that the fringe people of LBWLSs depend on forests primarily for grazing, fuel wood and fish. It is further seen from the figure that the highest benefits *i.e.*, 41 per cent of the value of provisioning services are being appropriated by the sample households of Pub Futaljar village followed by the households of Chitalmari Pathar (39 per cent).

Value of Grazing: The respondent households of all the nine villages keep large stock of cattle population. The average cattle population (cattle unit) is found to be 7.62 the highest being 176.2 cattle unit. These animals are not inoculated and freely graze in both LBWLSs. It is worth noting here that India State of

¹'*Taungya*', a Burmese word meaning Hill cultivation, was introduced in India by Dr Brandis in 1980. It consists of land preparation for tree plantation, growing agricultural crops for 1 to 3 years after the tree plantation and moving on to another area to repeat the cycle (www.agriinfo.in). The '*Taungya*' system is a complex combination of both artificial regeneration and shifting cultivation. '*Taungya*' became an integral feature of Assam forests when acute labour scarcity became an obstacle for the expansion of the Simul plantation.

Table 1: Details of the Provisioning services extracted and their aggregate value

Types of provisioning services	Total collection	Value (in `)
Fuel wood	554290@	2771450
Fodder	5680*	5680
Wild edibles	453.5@	9070
Wild fruits	2573@	25730
Leafy vegetables	78915*	15783
Simul cotton pods	9713@	582780
Fish	15395@	1539500
Thatch (Imperata)	19170*	95850
Nal- khagori- birina (<i>Vetiveria</i>)	8230*	82300
Value of provisioning services extracted by the sample households		5128143
Value of grazing		3633441
Total value of provisioning services (including grazing)		8761584
Average value per household		33314

Source: Primary survey, 2016

Note: @kg, *bundle.

Forest Report (FSI, 2011) states that about 40 per cent of the livestock graze openly in the forests in India. Likewise the current study finds the domestic stock to graze the sanctuaries freely for about seven months in a year. Besides, a few of the sample households collect palatable tree leaves during extreme monsoon conditions.

Since the livestock are composed of different types of animals and age group they are converted into standardized animal units using the conversion measures suggested by Ghule *et al.* (2012) and Patel *et al.* (1983). Conversion into a standard cattle unit is required since the livestock of different age and of different breed consume different amount of food. The concept of cattle unit is used for various purposes though it has been used in the context of the present research only to find out the amount of daily forage consumption by the domestic stock. Thus, the total fodder consumption by the domestic stock can easily be calculated from the average requirement of each cattle unit. Similarly, we can estimate the total value of the fodder by multiplying the total amount of fodder consumed by the market price.

It is to be mentioned here that the daily forage intake of livestock depends primarily on body weight, forage quality and stage of production. Daily intake of a full grown cow is around 2 per cent of her body weight and thus an average cow eats around 10 kg of an average quality feed (www.beef.unl.edu). Considering this, the total daily forage requirement of the livestock population of the sample households is 17,537 kg. Thus, the total fodder consumed by the cattle population in a year (for about seven months) becomes 36,33,441 kg. Considering ` 1 as the price of per kg fodder, the total value of the fodder consumed from Laokhowa and Burhachapori WLSs is ` 36,33,441.

The lion's share of grazing benefit is derived by the households of Dhania due to large cattle population owned by them. It is distinct from figure 2 that 33 per cent of the grazing value is being realised by the sample households of Dhania whereas the households of Pub Futaljar appropriate 28 per cent followed by the households of Chitalmari Pathar with 22 per cent of grazing benefit. The shares of other villages are very nominal as is evident from Fig. 2.

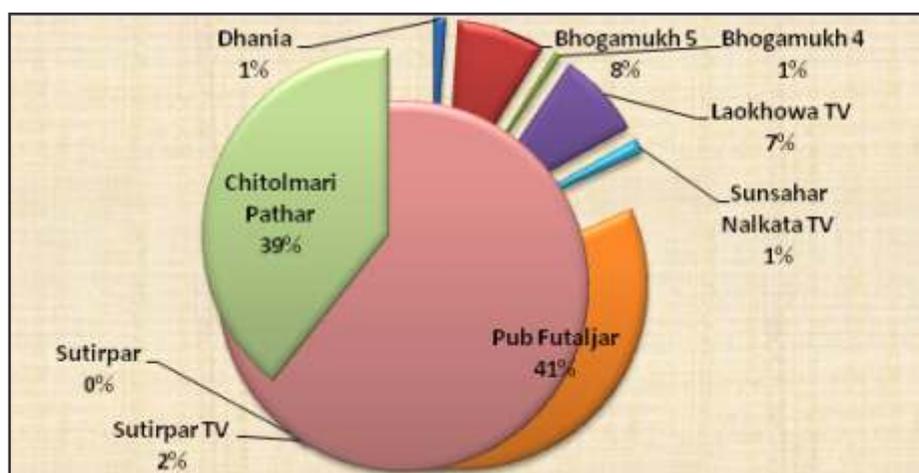


Fig. 1: Village-wise distribution of the values of provisioning services.

Source: Primary survey, 2016.

Table 2: Estimated value per hectare of Laokhowa and Burhachapori WLSs.

Assumed catchment area as % of the total area of Laokhowa and Burhachapori WLSs	Forest income (in `)	Forest income (including grazing) `
10	4498.3	7685.6
25	1799.3	3074.2
50	899.6	1537.1
US \$ per hectare per year (@ 72.48 = \$1 on 11-11-2018)		
10	62.0	106.0
25	24.8	42.4
50	12.4	21.2

Source: Author's estimation based on the primary survey, 2016.

Estimation of per hectare value of Laokhowa and Burhachapori WLSs: In order to estimate the economic value of the provisioning services or NTFPs per hectare of LBWLSs the values obtained from the household survey has been used to convert to per hectare value term. The estimation of per hectare value helps comparing the present study with other such studies. The value of the annual flow of provisional services accruing from a hectare of LBWLSs is shown in Table 2.

Per hectare value estimation of any forest has the constraint of determining the catchment area used by the forest goods collectors. The problem becomes more intense when the fringe villages are spread across the forest boundary. Keeping in mind this limitation, a range of values is estimated based on alternative assumptions, following Ninan (2007), such as 10, 25 and 50 per cent of the forest areas to be the catchment area from where the people access and harvest the provisioning services. The value of such services for the study area is expressed in terms of rupees and US dollars per hectare per year and presented in Table 2. The table shows that per hectare values of LBWLSs for the provisioning services is estimated to be ` 7685.6 if the collectors are assumed to collect the provisioning services from 10 per cent of

the forest area. Likewise, per hectare value becomes ` 3074.2 and ` 1537.1 respectively if the catchment area is assumed to increase to 25 and 50 per cent of the sanctuaries.

Per hectare forest value calculation as per the opportunity cost method: Market price may not be a good approximation of the true economic value if market or policy failure occurs. Therefore, Chopra (1993) talks of various methods of valuation of the use values of the forests, e.g., the provisional services. Opportunity cost of labour time in collection is one of the important methods she uses in her valuation of Indian deciduous forests to value fuel wood and other NTFPs. For calculation of the value of forest extraction by using labour collection time 'locally paid wage' instead of 'national minimum wage', that serves as 'shadow value of labour', has been administered in the present study as suggested by Chopra (1993) and Wunder *et al.* (2011). The value of the provisioning services per hectare of LBWLSs by using this method for 10, 25 and 50 per cent (Ninan, 2007) of the forest area is presented in the Table 3.

Thus, it is evident that a change in the methodology in estimating per hectare value changes the value of the forest. Taking 10 per cent of the total area of the sanctuaries per hectare value becomes ` 7685.6 when

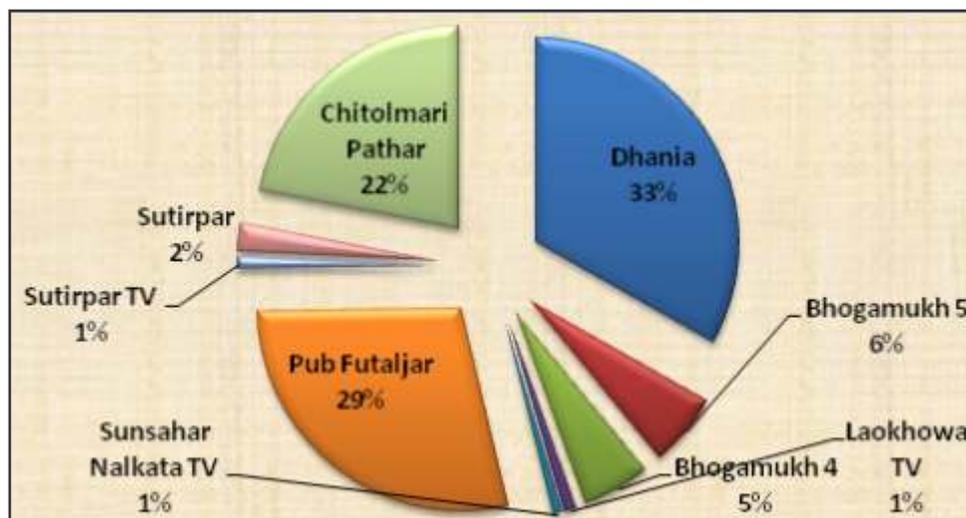


Fig. 2: Village wise grazing benefit appropriated by the sample households.

Source: Primary survey, 2016.

Table 3: Per hectare value of forest using cost of labour time in collection.

Types of provisioning services	Per hectare value of NTFPs		
	10% of Laokhowa and Burhachapori WLSs	25% of Laokhowa and Burhachapori WLSs	50% of Laokhowa and Burhachapori WLSs
Fuel wood	1484	593.68	296.84
Fodder	31.8	12.72	6.36
Wild Edible	17.8	7.15	3.75
Wild Fruit	34.6	13.8	6.39
Leafy vegetables	102.9	41.18	20.59
Simul Cotton	89.0	35.61	17.80
Fish	704.2	281.69	107.00
Thatch	73.58	29.43	14.71
Construction materials	49.6	19.86	9.93
Grazing	3187.2	1274.89	637.44
Total	5775.31 (\$88.60)	2310.12 (\$35.44)	1155.06 (\$17.72)

Source: Author's estimation based on the primary survey, 2016.

the market price method is applied (Table 2). The same reduces to ` 5775.31 (Table 3) when the cost of 'labour time in collection' is used.

Discussion

It appears obvious now that the fringe villagers harvest a wide range of forest products from LBWLSs. Fuel wood is the dominant category followed by fish which accounts for 32 and 18 per cent of the forest income and 8.9 and 4.9 per cent of the household income respectively. Though the leafy vegetables, wild edibles, fruits, etc. contribute only a tiny part of the household and forest income but all these items are important source of protein ensuring households' nutritional security to a great extent. The simul cotton pods and household construction materials (*Imperata cylindrica* and *Vetiveria zizanoides*) have a share of about 10 per cent to the forest income and 2.5 per cent of the household income of the people in the studied villages.

It is worth noting here that only the tribal people (Bodo and Tiwa community) residing in the forest and taungya villages of LBWLSs have the traditional knowledge and expertise in identifying and collecting the wild edibles from the forest. The harvested floras (about fifty different varieties) and faunas (about ten different species) are absolutely for domestic consumption purpose and never get transacted in the local markets. The tribal people also catch fish, but, unlike the immigrants, use only the traditional fishing gears instead of the destructive fishing equipment.

However, the highest share of the forest and total household income of the people comes from grazing. The sample households keep large stock of cattle and set them free into the sanctuaries. A few of the sample households collect palatable tree leaves from inside the forest during monsoon when the sanctuaries remain inundated (by flood water) and inaccessible for about four-five months. However, household survey and focus group discussion confirm that the cattle are low milking and non-inoculated and thus bear the possibility of transmitting various diseases to the wild

animals. There is also possibility of the cattle trampling over the eggs hampering the breeding cycle of the already dwindling grassland birds such as the famous Bengal Florican, which was once found in abundance in both these sanctuaries. Apart from that open grazing also squeezes the feeding areas for the wild herbivores culminating into dwindling (wild) herbivorous population. This further affects the predator population in the forest affecting adversely the entire forest ecosystem.

Household survey confirms that the collected items are destined to direct consumption and some are, of course, sold in market to supplement the meagre income of the collectors. Fish is an important provisioning service with 63 per cent of the total collection being sold in forest gate markets and fetch a very high price owing to its towering demand. On the other hand, 80 per cent of the leafy vegetables, 71 per cent of the simul cotton and about 50 per cent of the wild fruits are sold to generate subsistence income. However though, fuel wood is the most important provisioning service but only 12 per cent of the collected fuel wood is transacted in the markets. Counting physical quantities of products does not tell us much about their contribution to well-being rather the value will do. Thus, the findings of the present study highlight the crucial role of the forest provisioning services to its fringe dwellers. This estimated value is very important for policy makers to underpin the conservation decision.

It is, thus, evident that the LBWLSs possess tremendous values in terms of its provisioning services. The estimated value of all types of provisioning services harvested by the sample households is ` 8.76 million. This value of the provisioning services of the sanctuaries is enough to call for a restoration programme. The present study also estimates per hectare value of LBWLSs on account of the provisioning services to be in between \$106 and \$21. If extrapolated to the entire population living within two kilometre periphery the corresponding value goes up to \$1387 and \$277 per hectare. This can be compared with the findings of other studies. A

review of 24 studies worldwide suggests the value to reach only about \$50 per hectare (Godoy *et al.*, 1993) while Chopra (1993) and Appasamy (1993) estimate it to be \$130 and \$80 respectively for the deciduous forests of India and the forests of Tamil Nadu. On the other hand, Gunatilake *et al.* (1993) estimate the yearly value per hectare of the Knuckles area of Sri Lanka to be \$92.

Conclusion and Policy suggestion

Forest ecosystems are being degraded and lost because of rapid population growth. It seems, of late, that forest conversion is becoming more profitable than forest conservation. However, many positive externalities of ecosystems are lost or strongly reduced due to land use conversion and therefore better accounting of such ecosystems is crucial to improve decision making for biodiversity conservation and sustainable ecosystem management. But, the basic understanding we need to inculcate, as advocated by Pearce (2001) is that all ecological functions of forests are also the economic functions. Nevertheless, the irony is that these important forest functions don't have a market and hence no apparent economic value. It, therefore, may justify the conversion of forests for other purposes. Thus, estimation of forest ecosystem services has the potential to change radically the way we look at all forests.

The monetary value of the ecosystem services estimated in this study expresses the crucial role the LBWLSs play in social and economic well-being of its fringe dwellers. The current study takes into account only the monetary value of the provisioning services of LBWLSs. But, apart from the provisioning services it also provides other environmental services such as watershed protection, pollution control, carbon sequestration, flood mitigation and protection from landslide and soil erosion. It can be anticipated that per hectare value of LBWLSs would be much higher if the entire ecosystem services *i.e.*, regulating, supporting and cultural services, in addition to the provisioning services, are taken into account. It may be concluded, therefore, that large scale extraction of forest products though may increase the income of the poor and destitute fringe dwellers, would degrade the sanctuaries and shall have enormous long term negative implications for both the fringe people and the environment as well. Ecosystem degradation and the loss of biodiversity undermine ecosystem functioning and resilience and thus threaten the ability of ecosystems to continuously supply the flow of ecosystem services for present and future generations (Groot *et al.*, 2012). Therefore, a great deal of interest needs to be directed towards sustainable management and restoration of biodiversity and the past glory of both the Sanctuaries. The following suggestion may put forward for restoration and arrest further degradation of LBWLSs:

Switching upward in the energy ladder

Switching upward towards using LPG is the need of the hour looking into the massive dependency of the fringe dwellers on the sanctuaries. Awareness regarding use of clean energy, subsidised connection of LPG for the households living below poverty line along with guaranteed monthly supply of the refilled LPG cylinders is to be ensured. There are varied challenges to effective provision of domestic LPG and they are: ensuring reliable supply and accessibility, increasing affordability, appropriate pricing, etc. Moreover, renewable solar energy can be promoted to fill the gap created by erratic power supply. Provisions of all these will help ease the pressure on the forest in the long run.

Employment generation

It would be important to provide the peripheral people with gainful employment opportunities so as to increase their income since there is a negative association of income with the forest collection. Provision of skill development training in activities such as dairy will serve dual purpose of generating income and reducing pressure on the sanctuaries as well.

वनों का आर्थिक महत्व : असम, भारत के लावोखोवा और बुरहाचापोरी वन्यजीव अभयारण्यों की व्यवस्थापन सेवाओं का एक विश्लेषण

कुलीन चन्द्रा दास और मृणाल कान्ति दत्ता

सारांश

आर्थिक मूल्यांकन पारितंत्र की गैर अनुमान्य सामाजिक एवं पर्यावरणीय सेवाओं के लिए आर्थिक मानों को मानने की एक प्रक्रिया है। मूल्यांकन की आवश्यकता तब उठती है जब पर्यावरणीय निर्णय लेते समय एक पारितंत्र की अप्रत्यक्ष सेवाओं को ध्यान में नहीं रखा जाता है, जिसके द्वारा बाजार का विलोपन और अतन्तमत्वा इनका विदोहन और क्षति होती है। इस शोधपत्र में उत्तर पूर्व भारत में असम के लावोखोवा और बुरहाचापोरी अभयारण्यों के वन पारितंत्र की व्यवस्थापन सेवाओं के मूल्यों का आकलन किया गया है। किसी समय वनस्पति एवं प्राणिजात विविधता के अच्छे भण्डार वाले अभयारण्यों को गत शताब्दी के अस्सी के दशक में भारी क्षति का सामना करना पड़ा है और वर्तमान में भारी मानवोद्भव दबावों के कारण उत्तरजीविता के लिए संघर्षरत हैं। 302 सीमावर्ती परिवारों से प्राथमिक आँकड़ों का उपयोग करके अध्ययन ने सीमावर्ती लोगों द्वारा लाभ उठाए जा रहे नौ महत्वपूर्ण व्यवस्थापन सेवाओं की पहचान की है। पोषणिक सुरक्षा उपलब्ध कराने के अलावा ये सेवाएं संग्रहकर्ताओं की कभी कभी नकदी कमी को पूरा करती हैं। बाजार कीमत विधि का उपयोग करके यह शोधपत्र इकट्ठा दोनों अभयारण्यों की व्यवस्थापन सेवाओं का मूल्य रुपये 8.7 मिलियन निर्धारित करता है। शोधपत्र में आगे चलाई सहित व्यवस्थापन सेवाओं के कारण अभयारण्यों के प्रति हैक्टेयर मूल्य का आकलन करने का प्रयास किया गया और यह रुपये 7685.6 (\$ 106) पाया गया।

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