BIODIVERSITY CONSERVATION AND LOCAL LIVELIHOODS: A STUDY ON SIMILIPAL BIOSPHERE RESERVE IN INDIA

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ABSTRACT

Over-exploitation of natural resources and changing climatic conditions due to global warming are responsible for rapid loss of biological diversity. Creation of protected areas (PAs) across the globe which forms a critical component in global biodiversity conservation efforts are primarily designed for preventing further loss of species by restricting human use of natural resources. The Similipal Biosphere Reserve (SBR) in the Indian State of Odisha is the sixth largest biosphere reserve in the country and forms a major part of the World Network of Biosphere Reserves. However, currently the reserve is under increasing pressure from growing human population that directly depends on the reserve for their livelihoods. The objectives of the present study are to develop a comprehensive understanding of the problems facing the SBR; and identify and analyse different factors that determine the extent of dependency of villages located in and around the reserve for extraction of non-timber forest products (NTFPs). The paper reviews the existing studies on the SBR by using the DPSIR framework for an in-depth understanding of interaction between local population and the biosphere reserve. Econometric techniques and descriptive statistics are applied to analyse the secondary data collected from 136 villages located in and around the reserve. The results show that economically poor villages and villages having more male members are likely to extract more NTFPs from the reserve. Villages located in transitional and buffer zones are likely to extract more NTFPs compared to villages that are in core zone. Designing appropriate and effective local institutions that would foster biodiversity conservation as well as livelihoods and structure the community behaviour are widely considered as the panacea for this problem.

Introduction

The basic human life-support systems of the biological environment have always been characterised by change - an inevitable consequence of all anthropogenic factors. In recent years, many scientific reports have pointed out that the loss of biodiversity in terms of extinction of species has increased dramatically, largely due to increasing human intervention in the natural environment (Vitousek et al., 1997; Pimm, 2001; Agarwal and Gibson, 1999) resulting in various social conflicts (Kothari, 1999) and ecological disruption.

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Forest dwelling communities and indigenous tribes have for centuries depended on forest resources for their livelihoods. There has been increasing interest in the contribution that natural forests make to local employment and income generating activities (Arnold and Towns, 1998; Chileshe, 2005). The people inhabited in and around the protected areas (PAs) live in a subsistence economy with little or no access to market, education, health and other sanitation services and try to improve their living standards by extracting more forest resources (Godoy et al., 1998; Cavendish, 2000; Fisher, 2004) that may result in serious implications on conservation of biodiversity and natural habitats. Nevertheless, the PAs are subjected to pressure from these human extractions/dependencies in terms of grazing, cutting trees for firewood and timber, extraction of non-timber forest products (NTFPs), hunting, etc (World Bank, 1995; Amacher et al., 1999; Heltberg et al., 2000; Linde-Rahr, 2003).

However, empirical studies show that human dependency is high for collection of NTFPs (Heltberg et al., 2000; Heltberg, 2001; Amacher et al., 1999; Linde-Rahr, 2003; Shah, 2007). There is a growing consensus among researchers that NTFPs contribute significantly for rural livelihoods (Cavendish, 2000; Cocks et al., 2008). But, there exists a two-way relationship between extraction of NTFPs, particularly fuelwood collection and deforestation. On one hand, the demand for fuelwood from village commons and forests is the prime cause of forest degradation and on the other hand, increasing fuelwood scarcity is the result of perpetuation of forest degradation as it is the main source of energy for local people (World Bank, 1995; Heltberg et al., 2000). This phenomenon operates in PAs and thereby PAs face tremendous pressure from human population. Studies find that excessive resource extraction for human livelihoods not only affect the tree species and their compositions but also have adverse impact on wildlife, invertebrates and the

environment (Shaanker et al., 2004; Shahabuddin and Kumar, 2007)[2].

However, the restrictions imposed both by the Central and local governments on PA forest resources lead to clashes and confrontation between local people and PA managers and many times result in acute human-wildlife conflicts. Hence, it has been argued that the local or indigenous people and their social, physical, and economic well-being should be realised from the perspective of a holistic conservation effort (Sanderson et al., 2002; Sanderson, 2005; Redford and Fearn, 2007). It is widely accepted that local support is a critical factor in successful management of PAs (Wade, 1988; Ostrom, 1990; Bromley, 1992; Baland and Platteau, 1996; Bashir, 2000). Local support or at least acceptance of conservation will be achieved if the attitude of the people can be changed by promoting non-farm activities, such as tourism, alternative employment opportunities, etc., i.e., making them a shareholder in net conservation benefits or at least involving them in low or no costs (Katrina, 2000; Sekhar, 2003; Sekhar, 2003; Nji, 2004; Macura et al., 2011). However, promotion of such policy requires deeper understanding of the interaction between the human population and the biosphere reserve. In other words, it is important to examine the basic social and economic characteristics of the villages that are located in and around the biosphere reserve and how these factors shape the use of resources from the biosphere reserve.

On the basis of above discussions, the present paper makes an attempt to examine these issues in the context of Similipal Biosphere Reserve (henceforth SBR) in the Indian State of Odisha. The aim of the study is to develop a comprehensive understanding of the complex relation between human population and the SBR using the DPSIR framework; and identify and analyse different factors that determine the extent of dependency of villages located in and around the SBR on the reserve for extraction of

NTFPs, using secondary data collected by Indian Institute of Forest Management (IIFM) in 2007-08.
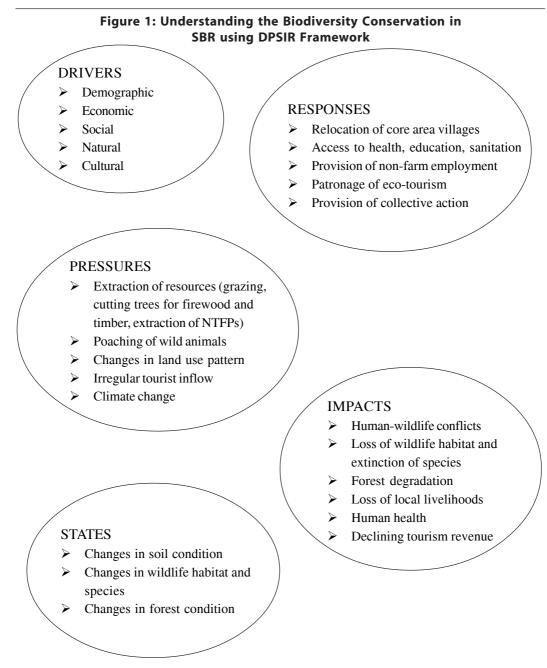
Study Area Description

The selection of SBR as the study region is justified on the following grounds. The SBR covers an area of 5569 km2 and is located in the northern part of the Eastern Ghats of the Indian State of Odisha (200 17'- 220 34' N and 850 40'-870 10 E'). It is the sixth largest biosphere reserve in the country, recognised as one of the first nine prime areas for tiger conservation programme. The forests of Similipal were once leased out during 1890. In 1907, 1152 sq. mile of forests was notified as reserve forests abandoning leasing of timber logging awarded to private companies (Senapati & Sahoo, 1967). The first systematic forest management was initiated through the working plan of JJ Hart in 1909. It was officially designated as a 'Tiger reserve' in 1956 and included under national conservation programme 'Project Tiger' in 1973. The Government of Odisha declared Similipal as a wildlife sanctuary in 1979 with a designated area of 2750 sq. kms. The sanctuary has a core area (845.70 sq. kms.) which has been accorded a national park status by the State Government, without a final notification though, by the Indian Government due to non-eviction of all villages from the core out of the designated park area. The Similipal Tiger Reserve (STR) along with a transitional area of 2250 sq. kms has been declared as a 'Biosphere Reserve' in 1994. UNESCO added the biosphere reserve to its list of biosphere reserves in May 2009. STR is one of such rare PAs to be declared as a biosphere reserve, sanctuary and designated national park having both 'Project Tiger' and Project Elephant', two flagship conservation programmes.

The reserve is dominated by sal (Sho-rea robusta) forests with semi-evergreen, moist and dry deciduous vegetation. The area is the abode of 1076 species of vascular plants representing 170 families of which 64 species are cultivated plants and 96 are orchids (Mishra, 2010). Among 41 species of medicinal plants of Odisha prioritised for conservation action (ibid), 30 are known to occur in Similipal. It is home to 42 species of mammals, 242 species of birds and 30 species of reptiles. As a major tiger habitat, it is estimated to have 99 Royal Bengal Tigers and 432 wild elephants (Census, 2007).

The SBR falls under one of the Schedule V areas (tribal sub-plan area) of the State as majority of inhabitants are tribals. There are 1265 villages inside the SBR with a total population of 4.62 lakhs of whom 73.44 per cent belong to scheduled tribes (Census, 2001). Out of 1265 villages, 65 villages are situated inside the Sanctuary area of which 61 villages are in the buffer area and remaining three villages are in core area. The total population of villages located in buffer and core area is 12000 and 449, respectively (ibid). In buffer area, the percentage of scheduled tribes is 87 while in core area it is 100 (ibid). However, the reserve is facing heavy dependence of local tribal population residing in and around the biosphere reserve for their daily livelihood, which is putting enormous pressure on the reserve.

Human-nature Interaction in the SBR: A Review of Literature Using the Driver-Pressure-State-Impact-Response (DPSIR) Framework

The present study uses the DPSIR[3] framework in order to understand the relation between the conservation of biodiversity and local livelihood implications in the SBR and identify and analyse important factors of Driver-Pressure-State-Impact-Response. For this the study takes the help of existing literature and secondary data on socio-economic and demographic factors from the region. The summary of the analysis of the DPSIR framework are presented in Figure 1.

Figure 1: Understanding the Biodiversity Conservation in SBR using DPSIR Framework

DRIVERS
➢ Demographic
➢ Economic
➢ Social
➢ Natural
➢ Cultural

RESPONSES
➢ Relocation of core area villages
➢ Access to health, education, sanitation
➢ Provision of non-farm employment
➢ Patronage of eco-tourism
➢ Provision of collective action

PRESSURES
➢ Extraction of resources (grazing, cutting trees for firewood and timber, extraction of NTFPs)
➢ Poaching of wild animals
➢ Changes in land use pattern
➢ Irregular tourist inflow
➢ Climate change

IMPACTS
➢ Human-wildlife conflicts
➢ Loss of wildlife habitat and extinction of species
➢ Forest degradation
➢ Loss of local livelihoods
➢ Human health
➢ Declining tourism revenue

STATES
➢ Changes in soil condition
➢ Changes in wildlife habitat and species
➢ Changes in forest condition

Driving Forces : One of the major driving factors putting pressure on the SBR is the tremendous increase in population in and around the SBR. The total population of the entire biosphere reserve is around 4.62 lakhs (Census 2001), which has increased by around two times compared to the previous census (Census, 1991). Besides, the tribal population constitutes around 74 per cent of the total population who depend largely on the reserve for daily subsistence

(Vasundhara, 2006; Mishra, 2010). A study conducted by Vasundhara (2006) exhibits that the forest produce constitutes more than 50 per cent of the local household income in Similipal. The sheer increased number of people and their growing need for subsistence affect biodiversity, both directly and indirectly. One of the direct consequences of increased population growth has been the expansion of agriculture activities in and around the SBR. Agriculture and animal husbandry alter the biological diversity by destroying or modifying the native biota (Rath and Sutar, 2004). Around 20 per cent of forest land within the biosphere reserve has been reported encroached by local people for agriculture activities since 1995 (ibid). Though grazing is prohibited in the core area of Similipal Sanctuary, around 50,000 livestock graze inside the reserve daily (Singh, 1999). Cattle from up to a distance of 5-7 km from the Reserve boundary also graze inside the reserve (ibid) which exert pressure on the SBR. The livestock population in the core area has also been increased around three times since 1991 (Rath and Sutar, 2004; Rout, 2008).

Poor infrastructure facilities, non-availability of basic amenities and conflicting interests between local people and the forest department officials, which often create space for naxal activities[4], have collectively put enormous pressure on the biosphere reserve. Moreover, the frequent forest fire by the NTFP collectors, smugglers, poachers and grazers, adversely affect the condition of SBR. Between the years 1991 to 2000, around 100 sq km of forest was burnt due to forest fire (Rath and Sutar, 2004). Poaching of wild animals as a cultural practice, locally known as Akhand Shikar,[5] add additional pressure to the SBR. Further, the local village level institutions (both formal and informal) functioning inside SBR fail to address these problems adequately (Vasundhara, 2006). Besides, the natural drivers, such as droughts[6], foster pressure on SBR.

Pressures : The major pressure that the SBR faces is because of the extraction of forest resources by local people. Fuelwood[7] is found to be the single most energy source for people living inside the reserve (Vasundhara, 2006). Livestock population in the SBR has increased substantially, which has led to over-grazing of forest pastures (Singh, 1998). Often the domestic cattle stray into the tiger habitat for grazing because of shortage of fodder in buffer zone resulting in cattle lifting and hence, economic loss to local people. Between the year 1990 and 2000 the total number of cattle killed in such cases was 219 (Rath and Sutar, 2004). Besides, encroachment of forest land area for cultivation by local people has changed the land use pattern. The Maoist attack in different parts of the SBR (specifically on the tourist guesthouses), affected the tourist inflow into the reserve during 2009-10. All these pressures adversely affect the state of environment of the biosphere reserve.

States : The above mentioned pressures have adversely affected the state of the environment of the SBR. The loss of forests and forest cover, and degradation of dense forest have reduced the wildlife habitat, specially the habitats of elephants, mammals and reptiles and many endangered species (CSE, 2002). Again the loss of forest cover and forest areas have its impact on the life of people who largely depended on forest products. As a result of massive degradation of forests and dwindling livelihood options, some people migrated to nearby urban areas for seeking jobs or working as labourers. Forest cover loss also affected the climate of the region in general and of the SBR in particular (World Bank, 2008). Besides, the natural and man-made forest fire especially during summer have reduced flora in mountain and forest areas bringing soil erosion, loss of soil and have threatened wild animals (Rath and Sutar, 2004). Finally, it is to be noted that pressures from human activities have changed and is also changing the biological, physical and chemical conditions of the SBR.

Impacts : The changing biological, physical and chemical conditions of the SBR have resulted in serous impacts on wildlife and human livelihoods. In fact, the altered state of the environment in the SBR has disturbed the human-wildlife ecological equilibrium. The forests of the reserve have been reduced by 30 per cent during the last 30-40 years causing a decline in wildlife population by 50 per cent (Rath and Sutar, 2004). Again, the percentage change in the dense forest area declined from -3.01 per cent in the year 1984-85 to -2.88 per cent in the year 2004-05. Forest degradation and deforestation also affected the social cohesion. Resource scarcity resulted in conflicts between forest department and local people and breaking down of local institutions. The SBR witnessed increasing trend of human-wildlife conflicts in and around the reserve. Though death due to wild animal attack [8] is less in number, the crop raiding by the elephants is a common event inside the reserve (ibid). The declining ecosystem services of the SBR owing to forest degradation and deforestation, dwindling agricultural products, non-availability of basic amenities and poor sanitation are the major cause of malnutrition in the SBR (Vasundhara, 2006). Repeated forest fire [9] severely damaged the flora and fauna in several parts of the SBR (CSE, 2002). Although population of leopards and other wild cats increased in Similipal, the population of tiger has not increased to such extent and the reason is attributed to the human interference in the tiger habitat (Rath and Sutar, 2004). Wild dogs have become rare and even hares are no more frequently met within the denuded area (ibid). Moreover, the declined tourist inflow into the reserve in 2009 due to Maoist violence adversely affected the revenue from eco-tourism which further affected the development projects in the region (Government of Odisha, 2008).

Responses : In response to the above problems, the biosphere authorities, in particular, and the government of Odisha, in general, have taken a few corrective measures. One of the important steps that the SBR authority has taken is the relocation [10] of core area villages where the density of wildlife population is high and the negotiations with other three villagers are on for relocations. Several other steps that are taken by the authority are the provision of better access to health, education and sanitation; provision of non-farm employment to local people in order to reduce the dependency on forest resources; patronage of eco-tourism inside the SBR which has huge potential to improve local livelihoods and formation of local institutions [11] for better conservation activities. Efforts are also being made towards providing wildlife education, spreading awareness, research and training for local people by different government organisations and NGOs (Rout, 2008). Though many development activities are being run by the government towards the livelihood improvement and biodiversity conservation, how effective these initiatives are in meeting the requirements needs further examination. However, the responses from both Central and the State governments to the threats of loss of biodiversity especially to the wildlife, have led to the completion of many projects for conservation of wildlife. 'Project Tiger', a major conservation initiative of the Government of India, was launched in 1973 to save the tiger from extinction. Similipal tiger reserve was one of the nine such reserves chosen in the country for launching the Project Tiger. Again, the 'Project Elephant' as a conservation strategy for elephant and its habitat was launched in 1992 and over 7000 sq.km of Similipal area was added to it. Besides, the Mugger Crocodile Project was introduced in Ramtirtha area of Similipal in order to provide protection to the endangered Crocodiles. However, the SBR requires more measures for the in-situ protection of forests, conservation of a number of endangered and medicinal plants and also towards the improvement of local livelihoods of the indigenous people living inside the reserve.

Although the DPSIR framework provides a complete and integrated analysis of factors

affecting biodiversity conservation, the present study primarily focuses on the link between the driving forces and the pressure exerted on the reserve and suggests some suitable responses/policy measures. In this context, we have made an attempt to identify and analyse the factors that influence the extent of extraction of NTFPs by villages located in and around the SBR using village level secondary data.

Understanding the Factors Affecting the Extraction of NTFPs by Villages in the SBR

As mentioned above, people living in and around the SBR are critically dependent on forests for their livelihood. It is found that 50 per cent of annual household income comes from forest, 20 per cent from agriculture and the remaining 30 per cent comes from wage labour (Vasundhara, 2006). Further, income from forests are largely derived by selling honey, Sal seed, Jhuna (Sal Latex), Paluo, Sal Leaf, Siali leaf, Siali fiber, etc[12].

The present study is the first attempt to understand the village characteristics of resources extraction in the SBR. Various factors may influence household utilisation of forest resources. What follows is a brief review of related literatures from different regions.

It is observed that households with larger size collect more forest products and clear more forest as compared to smaller size households primarily because these households have more workers and more mouths to feed (Almeida, 1992). Studies found that larger families have a greater demand for natural resources and more labour to fulfill this demand, leading to higher forest income (Almeida, 1992; Adhikari et al., 2004). However, it appears that household composition, gender and age structure are more important than the mere numbers (ibid). Having more number of female population in a household implies more dependency on forest produce as in a male dominated society females are engaged in the collection of NTFPs while males are involved in other income generating activities (Heltberg et al., 2000).

Studies found that education makes fuelwood collection increasingly unprofitable due to higher opportunity costs of labour as education creates opportunities for off-farm employment, self-employment and facilitate out-migration for better jobs that reduce dependence on forest resources (Godoy and Contrer, 2001; Adhikari et al., 2004). Better-educated households have more access to a wider range of income opportunities and thus lower forest income (Godoy and Contreras, 2001; Adhikari et al., 2004; Fisher, 2004).

The relationship between the landholding size of a household and dependency on NTFPs is an ambiguous one. Few empirical studies suggest that higher the landholding size, the more forest resources will be required to maintain fertility (Adhikari et al., 2004; Adhikari, 2005) whereas others opine that higher crop income from more land leads to lower relative forest income (Blaikie and Coppard, 1998) or the households with less land use forests more (Fisher, 2004). With regard to livestock holding, it is found that the more livestock may require more forest resources required as feed (Adhikari et al., 2004; Adhikari, 2005) and more collection of forest products during herding (Olsen and Larsen, 2003) whereas more livestock population constitute a major household asset endowment and thereby higher livestock income leads to lower relative forest income (Rayamajhi et al., 2012).

As a whole, higher total household income (and wealth) in the form of improved off-farm employment opportunities (Angelsen and Kaimowitz, 1999), access to credit and better agriculture production may reduce dependency on forest resources. As income rises, the importance of NTFPs in the household economy shrinks, as the economic importance of other income sources, such as agriculture, wage employment and self-employment would rise relative to the income from environmental resources (Godoy et al., 1998). On the other hand, better asset endowments allow households to

exploit more forest resources and thus higher income from NTFPs (Escobal and Aldana, 2003). So, the relationship is ambiguous in nature.

In addition to the internal factors discussed above, external factors, such as market access, influence household decisions towards the use of forest resources in a significant way. It is found that greater access to market may often accelerate forest extraction and induce people to earn more income by selling forest produce in the market (Angelsen and Kaimowitz, 1999). Whereas, others suggest that good market access imply lower forest income as alternative income opportunities are better (Ndoye and Kaimowitz, 2000). Hence, the relationship between market access and NTFPs income is assumed to be ambiguous.

Methods and Data : The data used in this study were extracted from a report [13] prepared by the Similipal Forest Department with the help of Indian Institute of Forest Management (IIFM), Bhopal. The report contains the data related to basic socio-economic characteristics and the market value of NTFP collection of 136 sampled villages located in and around the SBR. The data were collected during the year 2007-08 from three zones: core, buffer and transitional. The sampled villages were distributed across the three zones in the following way. From the core zone all the four (100 per cent sample) villages were selected. From the buffer zone out of 61 villages, 12 villages (20 per cent sample) were sampled using random sampling technique. In the case of transitional zone, out of 1200 villages, 120 villages (10 per cent sample) were sampled for data collection. Although data set has few limitations in terms of restricted number of variables, in this paper we have made an attempt to identify and analyse factors that are likely to affect the extent of extraction of NTFP collection by these villages for a better understanding of the relation between driving forces and pressure.

Variable Description and Hypotheses : In order to understand the level of dependency of local villages on the SBR we have used two dependent variables: (1) average income of the village from the collection of NTFPs and (2) total average income of the village. The idea is to identify and analyse the characteristics of villages that are more likely to depend on the SBR and derive policy implications for reducing pressure on the same. With regard to independent variables several socio-economic and geographical characteristics of sampled villages are considered and hypothesised as under. Average household size of the village is hypothesised to have a positive impact on NTFPs income as larger families demand more natural resources leading to higher income from NTFPs.

Number of females in a family is expected to have a positive effect on household's NTFP income as it is observed in studies that female members are involved more in collecting NTFPs from the forest compared to their male counterparts. This is because male members are usually involved more in agriculture, wage earning and in other non-farm employment activities (Heltberg et al., 2000). Following the dominant view in the literature, the total literacy rate in the sample village (as a proxy for education) is hypothesised to have a negative impact on the NTFPs income. As the members of a family become educated, the dependency on forest shrinks gradually because of higher opportunity costs involved as better employment opportunities can be had outside (Godoy and Contreras, 2001; Adhikari et al., 2004; Fisher, 2004).

Landholding size is another important factor hypothesised to influence household NTFPs income. Some are of the opinion that landholding size has a negative impact on forest dependency, while others find a negative relation between the two. Hence, the relationship between landholding size and NTFPs income is assumed to be ambiguous. Same relation is being observed with regard to livestock holding and NTFPs income (Adhikari et al., 2004; Adhikari, 2005; Rayamajhi et al., 2012). The

distance of the community to the nearest market is used as a proxy for market access, whose relation with the forest dependency is also ambiguous.

With regard to the understanding of share of NTFPs income in the total household income, which includes livestock, agriculture and non-farm activities, we have included, as mentioned above, the average total household income of the village as one of the dependent variables and regressed with a host of independent variables, including the average NTFP income. It is expected that in subsistence economy, such as in Mayurbhanj, the share of NTFP income in the total income would be a significantly positive one. Table 1 presents the description of variables included in the econometric analysis of determinants of average NTFPs income and average total income.

Table 1: Description of Variables Included in the Econometric Analysis of Determinants of Average NTFPs Income and Average Total Income

Variable	Definition	Expected Effect on Average NTFPs Income	Expected Effect on Average Total Income
Ln NTFPs Income	Log of average household income obtained from the selling of NTFPs in the prevailing market price (in rupees) per village	Dependent Variable	?
LN Total Income	Log of average household total income (sum total of average household agriculture income, livestock income, NTFPs income and others) in rupees per village	?	Dependent Variable
Ave. Fuelwood consumption	Average household consumption of fuelwood per week (in kg)		?
People involved in wage earning	Number of people involved in wage earning (either in government or in private jobs) per household		+
Female Population	Number of female members in a household		+
Total Literacy rate	Percentage number of people with the ability to read and write in a village	?	+
Ave. Landholding Size	Average household landholding in acre	?	+
Ave. Livestock population	Average number of livestock population per household	?	+
Distance to nearest Market	Distance to nearest market (in km)	?	+
Ave house hold Size	Average number of household population	+	?
D1	Dummy variable= 1, if the village is coming under transitional zone and 0, otherwise	?	
D2	Dummy variable= 1, if the village is coming under buffer zone and 0, otherwise	?	

The relationship between the dependent and the above mentioned independent variables can be estimated by using the ordinary least squares (OLS) regression. The basic OLS estimation for the determinants of average NTFPs income and the average total household income takes the form:

$$\log \text{NTFP Income} = \alpha + \beta_1 \text{aveHHsize} + \beta_2 \text{female HHpo p} + \beta_3 \text{total literacy} + \beta_4 \text{aveHH land size} + \beta_5 \text{aveHH livestock pop} + \beta_6 \log \text{total income} + \beta_7 \text{market distace} + \beta_8 D1 + \beta_9 D_2 + \varepsilon_1 \quad \ldots\ldots\ldots (1)$$

$$\log \text{total income} = \alpha + \beta_1 \text{total literacy} + \beta_2 \text{aveHH fuel wood cons} + \beta_3 \text{aveHH size} + \beta_4 \text{aveHH land size} + \beta_5 \text{aveHH livestock pop} + \beta_6 \text{wage earners HH} + \beta_7 \text{market distance} + \beta_8 \log \text{NTFP income} + \varepsilon_2 \quad \ldots\ldots\ldots (2)$$

Table 2 : Summary Statistics of the Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
Ave. Fuelwood consumption_HH	136	131.871	82.759	0.000	514.000
People involved in wage earning_HH	136	2.053	1.090	0.000	6.329
Ln NTFPs Income_Vilage	136	7.419	1.741	1.000	10.922
LN Total Income_Vilage	136	8.372	0.939	5.513	10.937
Female Population_HH	136	2.789	0.805	1.000	6.651
Total Literacy rate_Vilage	136	36.741	18.780	2.500	100.000
Ave. Landholding Size_HH	136	1.285	1.547	0.333	11.000
Ave. Livestock population_HH	136	10.831	7.982	2.000	57.000
Distance to nearest Market (km)	136	13.199	16.133	1.000	120.000
Ave HH Size	136	5.640	1.524	3.000	13.000

Descriptive statistics of the variables used in the models are provided in Table 2. As can be observed, the average household size of the sampled villages in and around the SBR is 5.64. Literacy rate in these villages are 36 percentage, which is significantly low compared to the district and State level. The average distance to market is found to be 13 kms, which suggest that villages are having no easy access to market.

Results and Discussion : Table 3 presents the results of OLS model of the determinants of the income from NTFPs collection in the SBR. Overall, model is found to be highly significant with an r-square of 78 per cent.

The number of women in household has a negative (contrary to the expected effect) and significant (at 10 per cent level) effect on NTFPs income, indicating that male members in the family are more likely to play role in the NTFPs collection, and thus the income. Average landholding size of the household has a significant negative (at the level of 5 per cent) on the NTFPs income, meaning that more the land, the less will be the dependency on forest produce. Because the household having more landholding may be getting better agriculture produce or involved in productive farm activity. The average livestock population per household is found to have a positive significant (at 10 per cent level) effect on forest produce, indicating that the local households are extracting more forest resource to feed and herd the livestock and thereby getting more income by selling animal products.

The total income per village has a positive effect on the income from NTFPs and the effect is highly significant at 5 per cent. This indicates that the increase in total income (including agriculture, livestock, wage earnings, etc.) does not reduce the village dependency on the forest produce and more forest extraction leads to higher NTFPs income. This may be because of the fact that collection of NTFP may not involve cost to the households, except opportunity cost of time, which may attract households' labour allocation to this activity. The two locational variables are found to be significant and have positive effect on forest dependency. The villages coming under the buffer and transitional zone are highly dependent on the forest produce and getting more income from NTFPs collection compared to the core zone villages. This may be due to the fact that the buffer and transitional area villages might have better market access as compared to the core areas villages.

Table 3: OLS Regression Results of Determinants of Average NTFPs Income

Variables	Coef.	Std. Err.	t	P>t
D1	3.942	0.898	4.39*	0.000
D2	3.363	0.754	4.46*	0.000
Female Population_HH	-0.360	0.211	-1.70**	0.091
Total Literacy rate_Vilage	0.001	0.004	0.24	0.809
Ave. Landholding Size_HH	-0.394	0.113	-3.50*	0.001
Ave. Livestock population_HH	0.018	0.011	1.63***	0.105
LN Total Income_Vilage	1.338	0.081	16.52*	0.000
Distance to nearest Market (km)	0.003	0.005	0.61	0.542
Ave HH Size	0.163	0.113	1.45	0.149
Constant	-7.245	1.234	-5.87*	0.000
Number of obs	136			
F(9, 126)	51.8*			
Prob > F	0.000			
R-squared	0.787			
Adj R-squared	0.772			
Root MSE	0.831			

Note: * 1% significance level; ** 5% significance level; *** 10% significance level.

Table 4 presents the OLS results of determinants of average total income of the villages in and around the SBR. The overall model is highly significant with an r-square of 69 per cent.

The coefficient of income from NTFPs has turned out to be positive and highly significant (at 1per cent level or less) indicating that the collection of NTFPs forms a significant part of household income. This means higher the income from NTFP higher is the total income of the village/household. The average household size has a significantly (at 10 per cent level) positive impact on the total income, meaning that the larger the household size, the more the average total income of the household. This is

because more people will be engaged in income generating activities (particularly in the collection of NTFPs) leading to higher total income. Average landholding size has a highly significant (at 1per cent level or less) positive impact on total income indicating that households having more lands are likely to have more average total income. This may also mean that the share of income from agriculture is likely to be more as the landholding size is more.The distance to nearest market place has a significant (10 percent level) negative effect on total income, indicating that the village households nearer to market places are likely to have more income in comparison to the far away village households. This is obvious because households closer to market can sell their products easily and hence have more income.

Table 4: OLS Results of Determinants of Average Total Income

Variable	Coef.	Robust Std.Err.	t	P>t
Total Literacy rate_Vilage	-0.001	0.003	-0.310	0.756
Ave. Fuelwood consumption_HH	0.001	0.001	1.210	0.230
Ave HH Size	0.058	0.030	1.960***	0.052
Ave. Landholding Size_HH	0.380	0.061	6.270*	0.000
Ave. Livestock population_HH	-0.001	0.007	-0.130	0.896
People involved in wage earning_HH	-0.021	0.047	-0.440	0.659
Distance to nearest Market (km)_Village	-0.006	0.003	-1.780***	0.077
Ln NTFPs Income_Vilage	0.478	0.054	8.790*	0.000
constant	4.087	0.413	9.890*	0.000
N	136			
F (8,127)	22.85*			
Prob>F	0.000			
R-square	0.689			
Root MSE	.54			

Note: * 1% significance level; ** 5% significance level; *** 10% significance level.

Conclusions

In this study we have made an attempt to understand the complex relationship between biodiversity conservation and promotion of local livelihoods in SBR using secondary literature and information. First, we have reviewed the existing empirical studies on the SBR systematically by using the DPSIR framework in order to have a comprehensive and clear understanding of the various interactions between biodiversity conservation and local livelihoods. Second, by using the secondary data of 136 villages located in and around the SBR, the study analyses various factors that influence the extraction of resources from the SBR with the help of econometric tools (OLS regression).The analysis of DPSIR framework provided a broader understanding of how the driving forces, such as changing population dynamics, increasing economic activities, rising social tensions, etc., have put enormous pressure on the SBR leading to change in the state of the environment which has resulted in various impacts, such as loss of habitats and wild species and loss of livelihoods and so on.

The empirical results suggest that villages located in and around the SBR are

dependent more on the reserve for their sustenance. More importantly, the results suggest that the villages having low landholding size are likely to extract more NTFPs from the reserve which indicates that poor villages are dependent more on the SBR. Because of low opportunity costs involved in collection of NTFP the share of NTFP income to the total income of the household increases as the total income rises. Interestingly, villages located in buffer and transitional zones extract more NTFPs compared to the villages located in core zone of the SBR. This can be attributed to the fact that villages located in transitional and buffer zones are having relatively easy access to market as compared to the core zone villages. Therefore, it is essential to take necessary measures in order to reduce anthropogenic pressure on the SBR.

In this context, the first set of measures should be adopted for reducing the direct household dependency on the SBR for livelihoods. The measures could be in the form of the provision of non-farm activities in tourism sector (Hvenegaard & Dearden, 1998; Bookbinder et al., 1998; Gossling, 1999; Sekhar, 2003), promotion of local handicrafts industries, engaging local people in various forest activities including patrolling and infrastructure development works, etc. In addition, access to education can also go long way in providing alternative livelihood opportunities to the local people. The second set of measures should be framed for promoting sustainable use and management of the SBR. In this context, attention must be focused in strengthening local level community and/or village institutions that can restrain excess use of resources from the reserve by framing rules and regulations (Ostrom, 1990; Heltberg, 2001; Adhikari, 2005; Behera, 2009). As indicated, a variety of local level community institutions (e.g., JFM, EDC, green gaurd) exists in and around the SBR but majority of them are often found to be not effective. Devolving sufficient property rights over forest resources to local communities may help secure their broad-based and active participation in decision making process, which may result in positive change in the attitude of local population towards conservation of biodiversity, as experienced in African countries where forest department and local communities are managing the wildlife jointly. In this regard, the role of NGOs and forest department is critical in evolving co-management system for wildlife and its habitats.

Notes

1   According to the World Bank (2002), more than 1.6 billion people throughout the world rely heavily on forests for their livelihoods and some 350 million people depend only on forests, both for their subsistence and income (Mahapatra et al., 2005; Howell et al., 2010). It is found that more than 65 per cent PAs are characterised by human settlements and resource use (World Bank, 1995) who use forest extensively (Godoy et al., 1998; Cavendish, 2000; Fisher, 2004).

2   For instance, over-grazing by cattle and removal of dead branches and dry leaves from the ground can alter the nutrient dynamics and constant movement of livestock and humans inside the PAs may disturb the normal life of the wild habitats (Sekhar, 1998).

3   The European Environmental Agency (EEA) introduced the DPSIR (Driving Forces- Pressures- State-Impacts- Responses), a conceptual framework describing the environmental problems and their relationships with the socio-economic indicators (See Figure 1). According to the DPSIR framework, social and economic developments (D) put Pressures (P) on the environment, leading to the physical, chemical or biological change in the State of the environment. This

leads to Impacts on ecosystems, human health, and society, which require a societal Response (R) based on Driving Forces, State or Impacts indicators through various mitigation, adaptation or curative actions (Gabrielsen and Bosch, 2003; Maxim, 2009).

4   The savage Maoist attack in the year 2009 has severely destroyed the reserve's infrastructure.

5   Akhand Shikar' is considered to be one singular custom that results in large-scale killing of wild animals.

6   According to Kanungo (2010), 2,460 villages in Mayurbhanj district in which the SBR falls are found to be highly affected by frequent occurrences of drought.

7   Almost 100 per cent households living in and around the SBR use fuelwood as major energy source (Vasundhara, 2006).

8   Most of the cases of tiger attack happened between 1973 and 1990 when more than six deaths were reported and, a few persons have been injured or killed by elephants attack (Singh, 1999).

9   Between the years 1991–2000, around 100 sq. km. of forest was burnt due to forest fire (Rout, 2008) and is a major cause of soil erosion and death of ground flora and fauna.

10   Out of four villages inside the core area, one has already been displaced to the transitional area in 2010.

11   The Government of Odisha, through its Joint Forest Management (JFM) Resolution (2008), adopted eco-development programme as a strategy for securing support from local communities in PA management. Eco-development Comm-ittees (EDCs) along the lines of Vana Surakhya Samiti (VSS) provide a strong linkage between conservation and development in order to meet the ecological demands, as well as to protect the SBR.

12   It is also observed that in Khadia and Mankidia villages 60 to 100 per cent of the annual income of the families comes from forest produces (Vasundhara, 2006).

13   A socio-economic study on Similipal Biosphere Reserve (IIFM, 2007).

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