

People and protected areas: some issues from India

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Abstract

People and protected areas: some issues from India. India is one of the 17 mega biodiverse countries, occupying only 2.5% of the world's geographical area and 1.8% of its forest area but supporting 16% of the world's human population and 17% of its livestock population. Biotic pressure on the country's protected areas is tremendous and managers of these areas face an uphill task in balancing divergent needs of different stakeholders of national parks and wildlife sanctuaries. The job of managing such areas is highly challenging because of the many difficult issues such as human–wildlife conflicts, encroachments, overgrazing, tourists' pressure (including pilgrimages into the forests), poaching, and an ever-increasing demand for diversion of protected areas for development purposes. In the present article we discuss some of these issues with reference to India and emphasise the danger of losing ecosystem services (mostly of an intangible or regulating kind of nature) emanating out of these protected areas.

Key words: Protected area, Biodiversity conservation, Ecosystem services, Human–wildlife conflict, Ecotourism, Tiger Reserve

Resumen

La población y las zonas protegidas: algunos problemas en la India. La India es uno de los 17 países con más biodiversidad, ocupa solo el 2,5% de la superficie del mundo y el 1,8% de la superficie forestal mundial, y alberga el 16% de la población humana y el 17% del número de cabezas de ganado del mundo. La presión biótica en las zonas protegidas del país es tremenda y los gestores de estas zonas se enfrentan a la tarea cada vez más ardua de encontrar un equilibrio entre las necesidades divergentes de las diferentes partes interesadas de los parques nacionales y las reservas naturales. Existen numerosos problemas, como los conflictos entre humanos y la fauna silvestre, las invasiones, el pastoreo excesivo, la presión turística (con inclusión de los peregrinajes a los bosques), el furtivismo o la creciente demanda de zonas protegidas con fines de desarrollo, que dificultan la labor de gestión de estas zonas. En el presente artículo, hemos analizado algunas de estas cuestiones con referencia a la India, a la vez que se hace más hincapié en el peligro que supone perder los servicios ecosistémicos (en su mayoría, de carácter intangible o regulador) que se derivan de estas zonas protegidas.

Palabras clave: Zona protegida, Conservación de la biodiversidad, Servicios ecosistémicos, Conflicto entre humanos y la fauna silvestre, Ecoturismo, Refugio del tigre

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Introduction

For existence and sustainability of life on mother earth, the foremost requirement is to conserve and maintain the equilibrium necessary for the environment, without which life on this planet will simply not be possible. Be it air, water, soil, forests, wetlands or the mountains, their collective values are undoubtedly of great significance to us. So too are the protected areas that play a vital role in the maintenance of life support systems. They are the cornerstones of biodiversity conservation and their importance can be understood in terms of their natural, ecological and cultural values.

India is one of the 17 mega biodiverse countries (Mittermeier and Mittermeier, 2005). The country occupies just 2.5% of the world's geographical area but it supports 16% of the world's human population and 17% of the livestock population (Mukerji, 2003; Singhal et al., 2003). India has more than 45,000 floral and 91,000 faunal species in a geographical area of 329 million ha (Reddy et al., 2016). Per capita availability of forest and productivity are among the lowest in the world, and the immense biotic pressure on the country's forests is therefore making biodiversity conservation a very challenging task. Protected areas in the form of national parks, wildlife sanctuaries, conservation reserves and community reserves in this thickly populated country are like an oasis in a desert. Managing protected areas in a democratic, large and densely populated country like India is nothing less than walking on a tight rope. The management of such areas faces constant challenges and difficulties due to issues such as human–wildlife conflicts, encroachments, overgrazing, tourists' pressure (including pilgrimages into the forests), poaching, running of vehicular and rail traffic through these areas, and the ever-rising demand for diversion of more land in protected areas for development purposes. We discuss some of the above issues in the present article with reference to India while giving greater emphasis to the dangers of losing ecosystem services, such as the impact on water quality and aquatic fauna emanating from these protected areas.

Present status

There are 769 protected areas in India spread over an area of 162072.49 km² and covering 4.93% of the country (table 1). These protected areas are national parks, wildlife sanctuaries, conservation reserves and community reserves.

In order to sustain the social, economic and cultural values of these areas, proper management is necessary. Though values are derived from these areas in many forms, it is also important to provide input in the form of proper funds. As for the budget (for 2018–2019), 2,350 million rupees (INR) have been allotted under the section 'Environment Protection, Management and Sustainable Development' (Ministry of Environment, Forests and Climate Change, 2018). Still, proper maintenance and evaluation of management will further help in this aspect. In India, a proper

framework is in place to evaluate the effectiveness of management of protected areas. On the basis of this framework, protected areas in the country are being awarded ratings. The people residing near or inside these areas also play an important role in conservation of biodiversity in protected areas.

The issue of 'relocation'

Conservation and displacement are closely related to each other. Conservation may also lead to displacement of local people. Tension lies between human presence in or near the protected areas and the success of conservation measures. Sometimes, management objectives translate into practices that ultimately result into displacement. Lack of evidence, which tells about the extent to which the rehabilitation practices have succeeded, exemplifies this tension. Displacement may involve use of force, and may also result in impoverishment, political and social cut off, and disempowerment. The protected area may become inaccessible to local people, and so basic amenities may not be available. Livestock, too, may become negatively affected as grazing is banned in a protected area. Since the main aim of displacement is conservation, it is very important to know to what extent the conservation targets were met after displacement. It is quite difficult to know the exact effect of displacement on conservation. The balance between human costs and conservation benefits is important to maintain. Displacement activities can solve a dual purpose: proper conservation of natural resources and better living conditions for people living in the forest (Agarwal and Redford, 2009).

In a study carried out in the Sariska Tiger Reserve of Rajasthan state, it was found in 2004 that the population of tigers was less than 10. It was suspected that poachers were responsible for this situation with some assistance from villagers, so the reserve was soon closed for further investigation. After the investigation and research were completed, the decision was made to relocate 11 villages situated in the reserve. The main aim was to create a 'people-free zone' in Sariska. By 2005 it was clear that a substantial proportion of Sariska had degraded to such a level that it was unable to support any mammalian prey or predator species. The connection between forest use and biodiversity decline was found to be highly complex. Most of the extractive pressure was due to the adjacent urban centres. However, no attempt was made to compare the effects caused by biomass extraction from the towns with the resident villages. Ecosystem dynamism and the human use issues are complex. In one rare case, human use has favoured biodiversity. For example, in the Kanha Tiger Reserve of Madhya Pradesh, it was found that the existence of villagers inside forests resulted in the formation of open grasslands. Thus, herbivores achieved an advantage due to the availability of forage. After the village was relocated, such formations were managed using fire and cutting techniques to sustain the biodiversity values. Thus, it shows that some form of human

Table 1. Protected Areas in India (as on January, 2018) (www.wiienviis.nic.in)*Tabla 1. Zonas protegidas en la India (en enero de 2018) (www.wiienviis.nic.in).*

	Number	Total area (km ²)	Coverage % of country
National parks	104	40,501.03	1.23
Wildlife sanctuaries	544	118,931.80	3.62
Conservation reserves	77	2,594.03	0.08
Community reserves	46	72.61	0.002
Protected areas (total)	771	162,099.47	4.93

interference may actually favour animal biodiversity. However, on the negative side, large scale biomass extraction will impact the biodiversity in a negative way. So, under controlled extraction conditions, socio-economic and institutional conditions can be created under which the non-destructive extraction of biological resources can be carried out. However, extraction must be sustainable in nature. Some years ago, the Baigas tribe of Kanha Tiger Reserve was displaced because this tribe was considered highly destructive to the regeneration of Sal trees due to slash and burn agriculture. However, they did not make any move to settled agriculture. Also, they could not become paid labourers. They were impoverished. Some time later, the village Supkhar was relocated from Kanha, in a well-coordinated relocation. In Gir, 500 families of buffalo-herding Maldharis tribe were moved out of the core area, leading to a decrease in the number of cows predated by lions. After this, displacement became an important objective for park managers. The case of Bhadra tiger reserve is quite different. Here, relocation helped in securing fertile agriculture land for the displaced people (Rangarajan and Shahabuddin, 2006). It was thus a success move both for the residents and the authorities. Failed displacement plans have something in common. The main cause for their failure is the lack of adequate provision of technical and financial input for successful agriculture livelihoods. In addition, a cooperative environment with collaborative and sincere efforts is necessary for success in these ventures.

Thus, the extent to which relocated people are satisfied with relocation is a point of concern. In one resettlement process carried out in Bhadra Wildlife Sanctuary and Tiger Reserve of Karnataka state relocation had mixed results. As a part of this study, a survey of 60% households was conducted in 2002. Later, in 2006, after the relocation of 11 villages, another survey was conducted, including 55% of households (Karanth, 2007). Prior to resettlement, people were facing challenges such as crop loss and livestock predation. Human-wildlife conflicts weren't infrequent. People also face difficulties such as shortages of drinking water, electricity supply, and medical care. The resettlement scenario arose in 1970s when people residing inside or near the forest

requested government help to relocate and resettle. Then, in 1974, a resettlement project was proposed by the Karnataka government. Funds were protected by the Project Tiger Steering committee between 1992 and 2002. In October 2001, 419 families were moved. Overall, the Bhadra resettlement process had a positive result. Households obtained access to electricity, drinking water, phones, solar lights, etc. A health care centre and nursery were also established. Later, people started earning from multiple sources (Karanth, 2007).

There were also some shortcomings. When people lived inside the forest they had an abundant supply of firewood, non-timber forest products and grazing land. However, after the resettlement there was limited access to these forest resources. Also, not all the people who were resettled were satisfied with the plots given to them. Some faced problem with the plot size, and some found the plots less fertile. People also reported problems of living with other residents in that area. From the conservation point of view, it was found that the forest area disturbed due to human activities recovered to some extent. More forage was available for wild animals after the resettlement. Poaching and fishing activities were drastically reduced. Thus, it can be seen that on one hand there were some people who were satisfied by the resettlement process, and on the other hand there were quite a few who were not completely satisfied. While people had access to new set of resources, they had to leave some natural resources like forage and fuel wood (Karanth, 2007).

The 'compensation' issue

People living in close proximity to protected areas face a major problem of conflict with wildlife. It becomes troublesome for them to protect themselves, their crop and their livestock from the wild animals. In order to cater for these losses, the government runs many compensation schemes for the people. The ground reality of people receiving the proper compensation may vary in different areas. Many studies have been carried out in different national parks across the country and brought different results. By and large, despite heavy losses for those living in and around protected

areas, few households apply for compensation in the true sense. General explanations for this type of attitude include inadequate remuneration, processing delays, corruption and red tape (Ogre and Badola, 2008). Only 31% households in five protected areas (PAs) located in Western Ghats of India received compensation (Karanth et al., 2013).

In a study carried out at Bhadra Tiger Reserve of South India by Madhusudan (2003), it was estimated that annually each household around the reserve lost 12% of their livestock to large felines and approximately 11% of their annual grain production to elephants. Compensation awarded to them covered less than 5% of livestock loss and 14% of crop loss. People were unhappy with the procedural delays for processing of claims. Similarly, in a survey conducted near Nanda Devi Biosphere Reserve of Indian Himalayas, it was found that 6 of 22 annual crops and all 4 horticultural crops on private farms were damaged by wildlife, but compensation by Reserve management for livestock killing by wildlife and compensation amounted to only 4–10% of the total assessed monetary value of killed livestock (Maikhuri et al., 2000).

A study carried out in the village Bhalalogpur (a pseudonym), located at the border of Rajaji National Park Uttarakhand, examined the experience of people with economic compensation for the losses due to human–wildlife conflict (Ogra, 2008). People living in the village had the problems of predation of livestock by leopards and tigers and crop loss by wild boars and elephants. They used techniques like wooden fencing, fire torches, home-made crackers, but these techniques did not bring effective results for them. There were very few instances when these techniques worked, but overall, villagers were at the receiving end. The compensation that was awarded after that fateful event varied widely in terms of the value, like from INR 500 to INR 100,000. The seasonal crop loss was estimated to be about 20–50% of the total crop loss. As a result of this the amount of food grain available for domestic use declined. When it came to compensation, the villagers had to face two major problems. One was the small amount of compensation and the other was the complex procedure of applying for compensation. The amount of compensation was not enough to compensate for the losses encountered by villagers. Also, there were many damages that were not covered under the compensation scheme of government. Also, there were transaction costs associated with the filing and preparation of cases, which were unavoidable. So these costs too became a burden for the villagers. Applying for compensation involved travelling and that was logistically a complicated process. Hence, many villagers did not apply for compensation. And if someone applied, the delay caused by the whole process nullified the value of compensation. Sometimes, errors were also reported in compensation. Thus, it became quite difficult for the villagers to sustain themselves in this whole process. Suggestions have been made to deal with such issues. One, the compensation should reflect market value for the losses encountered. Two, apart from compensation in the form of 'cash', it can also be paid

in the form of 'kind'. Participation of disadvantaged groups and local level can be effective in this whole process. On the other hand, these policies should not turn into people-centred policies. Also, it may occur that the provision of fair compensation may increase the chance of farmers becoming less cautious of the crop. So this is also a point of concern. A compensation process is necessary to provide compensation. If a proper process is not in place, then people may take unwanted advantage. But on the other hand, keeping in mind the state of poor and needy people residing in the forest area, it can be relaxed to some extent (Ogra, 2008).

Sometimes the approach followed for conservation (rehabilitation of people) may put the livelihoods of local communities dwelling inside the reserve in danger. Relocation may not always be fruitful for the people who depend on forest resources. In a study performed in 2007 in Sariska Tiger Reserve (Alwar, Rajasthan), it was found that the people who were resettled as part of the conservation project were affected in many ways (Torri, 2011). Their life was changed to a completely different world. In Sariska tiger reserve, a ban was imposed on the collection of forest resources, based on a conservation point of view. Wood cutting permits were limited and removal of dry wood for the construction purposes was also forbidden. These activities affected villagers. They needed forest resources for survival. Because of fear of getting caught by the forest staff, they used to cut the branches quickly rather than spending time looking for dry wood in the forest. Thus, they started paying less attention towards sustainable extraction in forest reserve. The practices of local communities and their demographic growth were said to be the main reason for impoverishment of biodiversity of the reserve. The villagers were not satisfied with the arrangements and in some cases, the villagers who were resettled went back to their former settlements. On the other hand, the displacement was considered vital for forest dwellers as they had no access to basic necessities like education, medical care, transportation, etc. According to forest staff, grazing and lopping seriously affected the appearance of forest in Sariska, especially in the buffer area. Adverse impacts on ecological and social development, land fertility and loss of biodiversity were noticed. From the villagers' perspective, displacement of people eliminated the traditional practices that were beneficial for the maintenance of forest biodiversity. Shepherds felt that their livestock could not be sustained outside the forest area, and that their loss would have an adverse impact on their livelihood. According to the villagers, they were not provided with compensation charges for constructing the houses, and so the people had to face severe consequences for this.

To achieve conservation as well as proper living standards for people, attitudes on both sides need to change. An interactive and collaborative approach in this regard can suit the process in a better way. Understanding the priorities of both sides is very important. A call for synthesis of the skills and insights of diverse communities may be helpful. Furthermore, a

more holistic and rigorous exercise that considers the ecological and sociological insights on displacement can also be beneficial in this regard.

A neutral course of action will involve steps taken to avoid involuntary displacement, keeping a track of whether the displacement-related grievances have been properly addressed or not, converting the involuntary displacements into voluntary ones, and designing such compensation packages that ensure the displaced people will not be negatively affected due to displacement. For this to happen, conservationists have to identify the interests of those who will be displaced, work with governments at local or national level or agencies to prepare suitable compensation packages, and involve local communities to determine the balance between compensation and concessions in relation to the strictness with which the conservation goals will be enforced. There is one more option, according to which conservationists may de-gazette some part of protected area so that its resources become available for development. Thus, better allocation of resources will be available, or better compensation packages can be formed out of this. Before finalizing a course of action, a balance must be sought between ethical appropriateness, monetary costs, and political feasibility (Agarwal and Redford, 2009).

The dynamics of geography in and around reserves

The people living in close proximity to protected areas use forest resources like fuel wood, herbs, fruits, etc. But, the people living in the core and on the periphery affect it in different manner. The way they utilise the natural resources is different.

In Tadoba Andhari Tiger Reserve (TATR) of Maharashtra state, it was determined how the resources of the park are impacted by people living inside or near the park area, and the different impacts caused by the park on different communities dependent on it. It was found that as the distance from villages present in the interior increases, both sapling species richness and sapling density increase. The main incursion of villages present at the periphery is on the richness of species and trees. They affect the vegetation mostly by felling of specific trees for timber, with minimum impact on sapling regeneration. Thus, the way of affecting the forest is different in the two cases. It was found that the villages in the interior of the forest affected the forest less than villages present at the periphery. Differences were also present in terms of land cover change. Here, the peripheral part of the park was worst affected. It was the most depleted area of forest cover with the lowest percentage of stable forest and the greatest percentage of non-stable forest. The villages present in the innermost part of the forest had the highest percentage of stable forest. Also, in the case of park fragmentation, the peripheral area suffered most. This region accounted for smaller sized patches and low shape index, located at far distances from each other. The areas surrounding the innermost villages were least fragmented (Nagendra et al., 2010).

Tourism in protected areas

Tourism in protected area comes with many implications and challenges. On one hand the local people get employment opportunities, and ways of income become diversified. Ultimately, this results in the betterment of people living in and around reserves. However, some shortcomings may also creep in. The traffic rises due to the increased frequency of vehicles. This affects the wildlife too. So care is required in this regard. Land is a scarce resource in developing countries, especially in a thickly populated country like India, where demand for land for various purposes remains always high. Therefore, protected areas are under increasing pressure to provide economic justification for their existence. Ecotourism from such areas provides a platform to generate substantial benefits for both governments and the local communities. The extent to which nature-based tourism or ecotourism offsets the costs of a PA has been examined in very few cases (Walpole et al., 2000).

Roads play an important role inside protected areas. There have been many instances when animals are killed by vehicles. Such damage to wildlife is difficult to control. In some cases, there are religious sites that attract a large number of visitors. So traffic increases and due to frequent passing of vehicles through the forest, the incidents of animals and insects getting killed also increases. This kind of problem cannot be solved completely. However, it can be mitigated to the maximum extent possible. In a study conducted across three habitats in Kalakad Mundanthurai Tiger Reserve, Tamil Nadu, from 2008–2009, the negative influence of the presence of roads on terrestrial and aquatic ecosystems was determined (Seshadri and Ganesh, 2011). It was found that millipedes, anurans, insects and reptiles dominated the list of mortalities, whereas the mammals avoided collisions. By knowing this impact, various strategies can be determined to tackle this issue of roads inside protected areas. The vehicular movement at night increased the mortality rate of nocturnal animals. During the festive season, large numbers of pilgrims in visit the religious enclaves located inside the protected areas, creating huge, sudden surges in traffic. Small animals are more likely to be killed by such disturbances than large animals, as these latter normally keep away from such traffic. Among the species recorded, the millipede was the most commonly killed species both before and after the festival season. Though they are active during dusk, in wet conditions and during the rainy season they were killed in the daytime too. Smaller invertebrates like ants, forest roaches and glow worms had a higher rate of mortality than larger invertebrates such as centipede sp. and scorpion spp. Mortalities increased by a whopping 299% during festivals. Not only diurnal but also nocturnal species were affected by this. Nocturnal species accounted for nearly 50% of the total mortalities recorded. Apart from crawling arthropods, many flying insects were also killed. The flying insects are attracted to the light beams of vehicles at night and get crushed by them. This, leads to a cascading effect as birds like owls and nightjars come to the road to feed

on the crushed insects. They, in turn, also get hit and killed by the vehicles. If this un-controlled movement of vehicles is not taken seriously, the situation will become worse and may lead to the local extinction of some species. The ecosystem is becoming affected. This could eventually cause a decline in the population of many species, and nocturnal species will be among the worst hit of all.

Serious steps should be taken to deal with this problem. Regulations in vehicular movement can solve this problem to some extent. Though complete banning of traffic inside the protected areas is not possible, some restriction on vehicular movement—especially at night time—could be an effective option. In addition to this, public transport such as buses should be encouraged instead of private cars. This would reduce the density of vehicles on the road to some extent. The speed of vehicles also plays some role in all this. Building speed breakers would have a barrier effect on large mammals, allowing them more response time and avoid collision (Seshadri & Ganesh, 2011).

It is estimated that for every rupee spent by tourists, the central and state governments in India receive 15 paise (1 rupee = 100 paise) as taxes (Seth, 1997). Furthermore, the tourism employment multiplier for India is about 1.8 and the tourism output multiplier is about 2.1 (Srivastava and Shukla, 2006), further demonstrating the high economic value of recreation services from these tiger reserves. The tourism recreational value for such spots is not truly reflected by gate fee revenue and researchers have estimated these values for some of the Tiger reserves using environmental economics methods like contingent valuation and travel cost approaches: e.g., 30 million Indian rupees (INR) per year for Corbett Tiger Reserve (Badola et al., 2010), 383.70 million INR per year for Kanha Tiger Reserve (Verma and Mishra, 2010) and 21.50 million INR per year for Kaziranga Tiger Reserve (Bharali and Mazumdar, 2012).

Due to tourism, land use patterns see a shift. Land prices rise in areas close to protected areas. New tourist facilities come up. Hence, proper planning and management is required so as to maintain the ecological integrity and functionality of the protected areas. The tourism is enhanced by many factors, such as good wildlife sightings, publicity by media, enhancement of the quality and quantity of resorts, improved accessibility to urban centres, bird-watching, economic growth and betterment of middle-class conditions. In the protected areas, many problems may occur, like poaching, fishing, electrocution, fuel wood collection, etc. But the readiness and promptness showed by forest department against these problems varies. The tourism revenue is in the hands of the forest department and managed by them alone. It could be shared between the forest department and the religious institutions, so as to make the pilgrimages a better host of eco-tourism activities. However, in the Periyar Tiger Reserve only 56% of the revenue was given to Periyar foundation to support eco-development and people's participation. Tourism can play a very important role for protected areas by earning revenues which can be used to support proper park management plans

and conservation efforts. If it is maintained in a proper manner, then more tourists will be attracted. In some protected areas geographical clustering of facilities is possible. This leads to better management of land use pattern than in other protected areas where facilities are spread out. Employment opportunities can be enhanced for local communities in the field of tourism. In order to sustain tourism, local communities and residents should be mixed and support should be enhanced among private enterprises for conservation initiatives (Karanth and DeFries, 2011).

Eco-tourism can be beneficial for the people living inside the protected areas. These people have limited resources for consumption. They are not financially sound. Thus, tourism brings in lot of earning opportunities. However, if the tourism is stopped for some reason, locals are badly affected. Their earning opportunities suffer. Tourism generates a substantial amount of revenue not only for local people but for the country too. Foreigners and nature lovers are attracted tonational parks and wildlife sanctuaries but too much human pressure in and around protected areas may prove harmful to animal populations. For example, in a research study conducted by the scientists of Wildlife Institute of India, tigers (both male and female) in the of Sariska Tiger Reserve in Rajasthan state were found to be in an extremely stressed condition due to the excessive production of hormones (glucocorticoids). The level of these hormones in the tigers in this reserve was twice that of tigers in other reserves. The reason was found to be excessive human interference in the reserve. There are 29 villages within the reserve and more than 400 villages around the reserve. Moreover, a large number of devotees visit a religious temple located in the core area. All these factors prevent the mating environment among tigers in the reserve. This conclusion was reached by a study in five tiger reserves of the country, namely Sariska, Panna, Bandhavgarh, Kanha and Ranthambore (Yadav, 2017).

In a study conducted in the Nanda Devi biosphere Reserve of Himalayan region, which sheds light on the history of expeditions and impact on local economy, the potential sites and expedition routes were identified and action plans for sustainable ecotourism were designed. After it was declared a National Park, all expeditions and trekking activities were banned, especially in the core area of the park. This had consequences on the local economy and environment. Thus, conflicts emerged between local people and authorities. This area was first approached in 1934 for trekking. After the independence of India, a huge increment in the number of mountaineers was observed. This ultimately led to adverse impacts. Both flora and fauna were seriously damaged. Entry only for the purpose of research was allowed. Stopping the flow of tourists had a negative impact on the earnings of local people. Most visitors came for trekking purposes and the people engaged as guides and porters were affected. The conservation policies affected many day-to-day activities of local inhabitants. Restrictions were placed on grazing, collection of non-timber forest products and removal of dead logs from van panchayats. Due to the presence of top-down structure, people were not involved

much in the action. Though some portion of a buffer area was opened for trekking, it did not result well as it was considered less adventurous than the core area for trekking. For promoting eco-tourism, many factors should be taken into account. Such actions should be identified as feasible from an ecological, socio-economic and cultural point of view. The primary focus should be the role of local people, the scope of expansion and the reduction of conflict. Local people must be made aware of their legal rights and their cooperation and joint efforts should be encouraged. Visitors should be made aware of the culture, tradition, climate and ecology of the place. Many opportunities for local people can be promoted, such as homestay tourism, growing of vegetables, and poultry and milk production. Small lodges and hotels too can also be established (Maikhuri et al., 2000)

The 'grazing' dilemma

The people living in and around the protected areas depend largely on livestock. Grazing by cattle also affects the forage present in the area. Many programmes have been implemented for conservation and better management of biodiversity in the Himalayas. The Natural Resource Management Plan is one such plan that exhibits the biodiversity conservation and management by creating protected areas in the form of sanctuaries, national parks and biosphere reserves. As a result, grazing was banned in some regions of the Nanda Devi Biosphere Reserve and Valley of Flowers National Park in the Himalayas for many years. This led to surprising results. The population of cattle started declining rapidly. Sheep and goat populations showed a drastic decline due to bans on grazing. The population of horses and mules was also affected. However, animal population loss was highest for yak. The domesticated yak population decreased almost to zero. Negative effects were also observed in terms of vegetation dynamics. Weeds and bushes/thorny bushes started growing as the ban was enforced. These weeds and bushes started expanding across many alpine pastures. Before the implementation of the National Resource Management Plan, cattle consumed these plants and thus controlled their growth. But after the implementation of the reserve, the rate of growth increased very rapidly, changing the vegetation dynamics and posing a threat to biodiversity. These species affected the richness of medicinal and aromatic plants. They replaced the habitat of valuable alpine pastures. This interruption of traditional land use led to landscape homogenization, and chances of fire hazard increased to a high level. The excessive growth of these unwanted species created an imbalance in the ecosystem (Nautiyal and Kaechele, 2007).

The Bharatpur Sanctuary was declared a National Park in 1981 and in 1982 a ban was enforced by the Government of Rajasthan. As a result of this ban, weeds took over in wetlands, reducing the fish population and also bird populations and nesting (Lewis, 2003). The excessive presence of weeds clogged

canals, filled marshes with weeds, and led to a series of wildfire incidents in the grasslands. Weedy plants like water hyacinth grew rapidly and had negative effects. It was then concluded to allow the primary consumers back for grazing so as to avoid decline in numbers and species of birds. And for the unmanageable fires in the open grasslands, it was decided to allow the villagers to collect fodder. Villagers had to pay a fee for a cutting license and were then allowed to cut grass from any dry section of the park. In this way, the situation returned to normal.

Human-wildlife conflict

For conservation practitioners, one of the most challenging issues is to address human-wildlife conflicts. Many ecological and social factors can be responsible for these conflicts. There is a need to develop preventive strategies so as to avoid these conflicts. In five important reserves in Karnataka's Western Ghats, a study was conducted to examine the patterns of loss due to conflicts and compensation awarded (Karanth et al., 2013). It was found that crop raiding incidents were experienced by villagers year round. From October to December, the frequency of such incidents was found to be slightly higher. There was high crop loss in the region. Crop loss was attributed to 19 species of wild animals, mainly wild pig, elephant and chital. Lower crop loss was associated with the distance from the reserve. Fifteen percent of households reported livestock loss. Predation incidents were in the range of 0 to 3 on an annual basis. People had their own mitigation measures, but these were ineffective. Individual measures such as night watch, guarding animals, and similar, were adopted. Like for the crop raiding pattern, the greater the distance from the reserve, the lower the livestock loss. Livestock loss was positively associated with animals grazing inside the reserve. Overall, the compensation process was a long process. Compensation payments for loss took more than one year to reach the affected people. People were inclined to report losses related to large animals like tigers and elephants.

The north east region of India is significant in terms of large wild animals like tigers, rhinoceros and elephants. Of these animals, elephants have become the focal point of conflict and conservation issues. More than 1,150 humans and 370 elephants were killed between 1980 and 2003 due to these conflicts (Choudhury, 2004). The burgeoning human population, the increasing needs for housing, agriculture, etc. were the main reasons for such conflicts. Due to the squeezing habitat, elephants usually come down to paddy fields and destroy crops. In 2001, angered residents in northeast India (Assam) selectively targeted their paddy fields with poison for crop-raiding elephants; a mutilated elephant carcass was subsequently discovered in the field with the words, 'Paddy Thief Bin Laden' scrawled upon its body (Sethi, 2003; Ogra, 2008).

In a household survey around the Kanha National Park of Central India, 17 species were identified as crop raiders, including 10 herbivores, 4 carnivores,

2 primates and peacocks (Karanth et al., 2012). The highest numbers of raiding incidents were reported from September to December, peaking in the month of October. Sixty-four percent of households reported experiencing more than five incidents per year, while 32% of households reported 2–5 incidents per year. Similarly, livestock losses to 10 carnivores were reported from April to July (dry season). Besides tiger and leopard, jackal and wolf were also found responsible. Some (34%) households reported more than 5 incidents/year, another 34% reported 2–5 incidents/year, and 31% reported one incident/year. Gir National Park in the Western state of India is famous for Asiatic lions. A study determined that on average, 14.8 attacks by lions and 2.2 lion-related deaths occurred annually from 1978 to 1991 (Saberwal et al., 1994). Most of these attacks (82%) occurred outside the protected area and during the drought season. The intensity of lion attacks also increased considerably. The researchers advocated reducing the lion population in the park by relocating or culling.

While some costs are visible, others are hidden and remain poorly addressed. Hidden impacts can be many, such as food insecurity, disruption of livelihoods, diminished psychosocial wellbeing, etc. The consequences people face due to conflicts with wildlife include loss of life, livestock predation, fear of wild animals, and crop damage by wildlife. The losses incurred by poor people who are dependent on forest resources affect their lives in an adverse manner. Crop damage caused by large animals, like elephants, is widespread. Depredation of livestock is yet another impact due to human–wildlife conflict. Such damage often leads to retaliatory killing of wildlife. Overall, the ecological consequences of such conflicts lead to drastic changes in wildlife populations with changes in genetic diversity. The causes of such conflict can be mobility, displacement and increment in human populations, loss and fragmentation of the existing habitat where people have been living, etc. Some costs cannot be compensated, such as decreased psychological well-being caused to fatality, or disruption of family and food insecurity caused by crop or livestock loss. Other ill effects include opportunity loss, poor health and nutritional status, and transactional costs incurred when pursuing compensation. The visible and hidden impacts are intermixed. The degree and severity of psychosocial effects cannot be overlooked. The aftermath effects include poverty, poor access to resources and social capital, and ethnic and political marginalization. The death of a provider, generally a male from the family, leads to catastrophic results for the family as a whole. The burden of responsibility falls on the shoulders of females and children. The relatives of victims of tiger and other carnivore attacks suffer from physical and mental trauma. In most cases they are unable to recover the body of the victim, which again results in mental trauma and stigma. Post-traumatic stress disorder is found in both male and female members (Barua et al., 2013).

Crop raiding by wild animals, especially elephants, can lead to the displacement of the family from that

area. Loss of livestock due to predation by carnivores can destroy the family's income and way of life. Livestock forms a substantial proportion of the socioeconomic capital of communities in many areas. Ultimately, people have to bear the consequences. They also have to guard their cattle at night. Thus, after a long tiring day they have to work at night too. This has a negative impact on their health (Barua et al., 2013).

Many recommendations can be made. Maps can be used by park and revenue authorities as well as the non-governmental organisations to target preventive actions in the most vulnerable conflict zones. Mitigation measures should be investigated, and this investigation should be scientifically based. Compensation must be in accordance with scales and should be observed and locally monitored (Karanth et al., 2013).

A suitable plan of action is required in this regard. A systematic assessment of the extent and scale of such hidden impacts is needed. Different scenarios of human–wildlife conflict should be considered for systematically assessing the extent and scale of hidden impacts. It should be determined how such conflict impact on the nutrition, physical and psychological well-being of the people. The risk of replicating other conservation conflicts must be avoided. A strong link between conservation, health and social sciences is required (Barua et al., 2013).

Road and rail kills

In India, a highway bisecting the protected areas is not a rare sight. In recent years it has been realized that highways have a severe impact on wildlife and their habitats (Vijayakumar et al., 2001; Das et al., 2007; Baskaran and Boominathan, 2010). Forest departments and non-governmental organizations in India are thus protesting against the construction of these so-called temples of development.

The 'hunting' bane

Hunting and poaching by local people has always been a serious threat to protected areas in India. In a survey conducted in the Kudramukha protected area in south India, it was found that at least 26 species of mammals were hunted, mostly with guns, at an estimated intensity of 216 hunter days/month/village (Madhusudan and Karanth, 2002). One study found that the population of tigers in Panna Tiger Reserve in Central India decreased from 2006–2010 due to poaching (Gopal et al., 2010). Tiger deaths related to poaching reached an all-time high in 2016. These figures represent only a fraction of the true mortality figures. Electrocution and poisoning of big cats have also been recorded across tiger habitats ('Save them from the trap' (July 29, 2017). *The Pioneer Daily News paper*, Chandigarh Edition). Snares are a problem not only in India but throughout Asia. Hundreds of thousands of deadly snares are removed by rangers from India's protected areas by forest officials annually but this is just the tip of the iceberg. Habitat degradation

and habitat loss also have a huge impact on tiger population. Not only human population around reserves but development projects, industries and roads in and around these protected areas are potential threats.

Enforcement of Wildlife Protection Act, 1972 (modified time to time), which prohibits hunting of most of the wild animals is a real challenge in India, especially in the north–east region of India. Local people in this portion of the country have a strong tradition of hunting (Hilaluddin et al., 2005; Mishra et al., 2006 and Datta et al., 2008). Eating wild birds/animals constitutes a significant part of their normal diet. Local hunters are often lured by international wildlife smugglers for derivatives from species such as tigers and elephants (Datta et al., 2008). Hunting, illegal fishing and trapping of wild fauna like tigers, barking deer, leaf deer, sambar, wild boar, bears, wildcat and a variety of birds by local inhabitants (Lisu, Chakma and Mishmi) for bush meat and hide is a severe concern for the management of Namdapha National Park of Arunachal Pradesh of this region (Arunachalam et al., 2004). During a camera trapping survey in the Namdapha National Park, no tiger was sighted even though this park is part of Project Tiger, a centrally sponsored scheme of the Government of India since more than a decade ago. The clouded leopard was the only large carnivore detected by camera trapping. Illegal hunting seemed to be the main cause behind the disappearance of tiger from the park (Datta et al., 2008).

The forests of North–East India are recognized as a global biodiversity hotspot and as an endemic bird area due to their richness in floral and faunal species. The landscape has high species diversity and endemism as it forms the transition zone between the Indian and Malayan eco–regions. North eastern states of India account for more than one fourth of overall forest and tree cover of the country. But today, the situation on this front is of concern. Unfortunately, due to increasing anthropogenic demands and technological development, the states in this region are no longer immune to large–scale land–use change (Bhuyan et al., 2003). Discussions with local people revealed that the availability of timber species, cane and bamboo in outer region of protected areas was reduced due to encroachments, forest fires, over exploitation, habitat destruction, lack of plantations and timely regeneration activities, and invasion of exotic and weed plant species like Lantana, Mikania, Eupatorium, Parthenium in the forest areas. Therefore, awareness must be raised among the indigenous communities, stressing the need to conserve rich biodiversity, especially plants of ethno–botanical importance and local wildlife. It was also noticed during talks with locals that villagers now have to travel larger distances in forests to hunt animals for religious ceremonial purposes than what they did a decade ago (Aiyadurai et al., 2010). The government agencies must support the conservation measures of biodiversity by the indigenous groups and must undertake vigorous awareness campaigns to protect local biodiversity and wildlife. State Biodiversity Boards, State Medicinal Plants Board, State Forest Research Institutes and Department of Environment and Forests have a major role to play in this direction.

Vitality of protected areas in terms of ecosystem services

Protected areas offer a range of ecosystem services that provide economic, social, cultural and spiritual benefits. They also help buffer climate change and contribute by storing and sequestering carbon. In India, Project Tiger was initiated in 1973, and nine national parks and sanctuaries were declared as tiger reserves. Today, there are 47 tiger reserves, covering over 2% of the country's geographical area. These tiger reserves are of tremendous value. They support human life by protecting fish nurseries and agricultural genetic material. Not only this, but they also provide cheap and clean drinking water, which can also be used for irrigation purposes. They provide immense stock and flow whose benefits are intangible, and thus often unaccounted for in market transactions. The National Tiger Conservation Authority (NTCA), Government of India, assigned a study to the Indian Institute of Forest Management (IIFM) Bhopal to estimate the quantum of significant ecosystem services, in terms of money, so that the real worth of these ecological assets may be known to the general public, policy makers, academicians and politicians. Many ecologists feel that the establishment of such reserves could be justified in terms of emanating ecosystem services alone (Badola et al., 2010). For instance, Periyar Tiger Reserve protects the watershed of Periyar Lake that irrigates more than 900 km² of agricultural land in neighbouring states (Shukla, 2011). A team of researchers under the leadership of Professor Madhu Verma of IIFM, Bhopal, completed the study in 2015. The study included six tiger reserves, located in different forest landscapes: (1) Corbett Tiger Reserve (Uttarakhand); (2) Kanha Tiger Reserve (Madhya Pradesh); (3) Kaziranga Tiger Reserve (Assam); (4) Periyar Tiger Reserve (Kerala); (5) Ranthambore Tiger Reserve (Rajasthan); (6) and Sunderbans Tiger Reserve (West Bengal).

The findings are an eye opener for all those concerned about life supporting systems and continuance of life on earth. We summarise these values in two of these reserves, the Corbett Tiger Reserve in North India, and the Periyar Tiger Reserve in South India. The Corbett Tiger Reserve is located in three districts in the State of Uttarakhand: Pauri Garhwal, Nainital and Almora, and it extends over an area of 1,288 km². Of this, 822 km² is core zone and 466 km² is buffer zone. Its total value of stock benefits was found to be INR 261.8 billion Indian rupees (INR) and for flow benefits, 14.7 billion INR per year (Verma et al., 2015; table 2). Periyar Tiger Reserve is in Western Ghats, in the state of Kerala. It is located in the Idukki district of Kerala state. It covers an area of 925 km², of which 881 km² is core zone and 44 km² is buffer zone. It also includes a 26 km² water spread area of Periyar Lake. Its total value of stock benefits is 316.5 billion INR and for flow benefits, and 17.6 billion INR per year (Verma et al., 2015; table 3).

Overall, the flow benefits from these selected six tiger reserves range from 50,000 INR/ha/year (US \$ 769) to 190,000 INR/ha/year (US \$ 2,923). The lower value corresponds to the tropical dry deciduous

Table 2. Few important ecosystem services emanating from Corbett Tiger Reserve

Tabla 2. Pocos servicios ecosistémicos importantes originados en la Reserva del tigre de Corbett.

Important ecosystem services	Economic Value (in INR)
Gene-pool protection	10.65 billion year ⁻¹
Water provision to downstream districts of Uttar Pradesh	1.61 billion year ⁻¹
Water purification services to New Delhi	550 million year ⁻¹
Generation of employment for local communities	82 million year ⁻¹
Provisioning of habitat and refugia for wildlife	274 million year ⁻¹
Sequestration of carbon	214 million year ⁻¹

Table 3. Few important ecosystem services emanating from Periyar Tiger Reserve

Tabla 3. Pocos servicios ecosistémicos importantes originados en la Reserva del tigre de Periyar.

Important ecosystem services	Economic Value (in INR)
Gene-pool protection	7.86 billion year ⁻¹
Water provision to districts of Tamil Nadu	4.05 billion year ⁻¹
Provisioning of habitat and refugia for wildlife	3.55 billion year ⁻¹
Generation of employment for local communities	25 million year ⁻¹
Water purification services to neighbouring towns and districts	483 million year ⁻¹
Recreation value	425 million year ⁻¹

forest region, where Ranthambore Tiger Reserve (Rajasthan) is located and the higher value corresponds to the tropical moist evergreen forest region where Periyar Tiger Reserve (Kerala) is located (Verma et al., 2017). Nearly 5% of India's geographical area consists of protected areas and they are responsible for providing ecosystem services or flow benefits worth 2,000 trillion INR per year by taking an average figure of INR 120,000/ha/year of flow benefits from the above study. This shows the huge significance of these areas in terms of ecological and social security of humans and other living systems in the country.

Conclusion

In the light of growing awareness of life-supporting functions of ecosystem services and advanced technology to make use of genetic diversity, the economic value of protected areas is likely to be appreciated in the near future (Verma et al., 2015). The protected areas of India support a wide range of economic

sectors, and investment in this natural capital will lead to maintaining ecological security and food security, thereby leading to overall sustainable development. These investments can be cost effective responses to the climate change crisis, creating jobs, supporting local economies, and maintaining ecosystem benefits on a long-term basis. An amicable and tactful handling of all contentious issues of protected areas can be a win-win situation for park managers, local communities and other stakeholders.

Reaching a higher GDP through infrastructure projects is important for the country but there is a need to take up such projects together with mitigation measures such as overpasses for the passage of tigers, elephants and other animals in and around reserves. Politicians, policy makers, planners, bureaucrats and common people need to understand that the future security of the national heritage of the country is at stake. A balanced view on the country's development, the conservation of biodiversity, and the hardships faced by people living in and around protected areas is the need of the hour.

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