Role of Protected Area in Conservation and Sustainable Management of Biodiversity: An Indian Perspective

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Abstract

Protected areas (PAs) are the terrestrial or marine regions that are preserved for conserving biodiversity and their habitats to serve a range of socioecological functions including scientific research and education, protection of wildlife, conservation of biodiversity, and securing a range of ecological goods and services. India has strong legislation for the protection and conservation of biodiversity through the protected area network (PAN) through government investment. In India being a developing country, PA management has a great challenge due to the rapidly growing human population and their higher dependency on natural forests for their sustenance needs and livelihood security, political and economic instability, and higher poverty. Local socioeconomic conditions, the long-term scientific ecological studies on biodiversity in buffer and transition zones, development of assessment and monitoring techniques, and evaluation of economic and ecological benefits are some of the key aspects that become more important to determine the success of PAs towards environmental and socioeconomic sustainability. Therefore, the present chapter focused on the scientific, environmental, socioeconomic, and cultural values of Indian PAs and their specific role in the conservation of biodiversity.

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Keywords

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13.1 Introduction

Biodiversity is the variety and variability among flora, fauna, and microorganisms that reflect the organization of organisms at different levels (NRC 1999). Biodiversity is considered an important resource as it provides a range of products and services including food security, health care, and industrial raw materials that have led to upgraded standards of life (Gadgil 2003). Besides, it holds ecological significance through pollutant recycling, nutrient cycling, and climate regulation and provides opportunities for recreation and scientific studies, aesthetic, and monetary benefits through tourism (Norton and Ulanowocz 1992). India has distinctive biodiversity exceeding 45,000 plant and 91,000 animal species (Reddy et al. 2016) due to its diverse physiographic, edaphic, and climatic conditions (Kumar and Saikia 2020). Globally there are 17 mega biodiversity nations; India ranks sixth among them (Mittermeier and Mittermeier 2005) and also has four biodiversity hotspots with high endemism and habitat loss (Saikia and Khan 2018). India occupies only 2.5% of the total land surface of the earth, but it contributes ~8% of overall biodiversity (Joshi 2019). It has ~21.67% forest cover (ISFR 2019) which compliments ~1.8% of the world's total forest area (Maan and Chaudhry 2019). Global changes, including human-induced climate change, environmental pollution, overexploitation of natural resources, destruction of natural habitats, deforestation, and invasive species are the main reasons for biodiversity loss worldwide (Mantri et al. 2020). Habitat change due to destruction and fragmentation by human development and modernization are the most direct reasons for overall biodiversity loss. Other significant causes include human disturbance and changes in ecosystem structure due to the invasion of invasive weeds and fauna (Kettunen and ten Brink 2006) that have adequately curtailed biodiversity conservation measures (Gillespie 1997). The changing climate is also responsible for the shift of distribution ranges of various species of plants and animals and for their local extinction in various regions of India (Gokhle 2015). Besides high population densities, population pressure, poverty, rapid economic growth, industrialization, urbanization, agricultural intensification, and the development of infrastructures including roads, power lines, railways, etc. are the most serious threats to biodiversity loss in the tropical regions (Bargali et al. 2019; Karanth and de Fries 2010). Developmental projects mainly mining and power plants in India predominantly in mineral-rich states such as Jharkhand, Odisha, and Chhattisgarh have posed serious risks to wildlife habitats over the past many decades resulting in biodiversity loss (Gokhle 2015). On the other hand, the Indian Himalayan forests are severely affected by landslides in the hilly regions and floods in the plains, earthquakes, cloudbursts, heavy rain falls, and different biotic interferences (Saikia et al. 2017). There is an enormous

anthropogenic pressure on the forests of India, and per capita forest availability and productivity of resources are very low among the world, making the conservation of biodiversity a very challenging task (Maan and Chaudhry 2019).

Protected areas (PAs) are well demarcated terrestrial and marine areas that are legally recognized for long term conservation of biodiversity and natural resources. These areas are preserved primarily for conserving biodiversity and geological features in their natural habitats (Dudley 2008). PAs serve as a major tool for the conservation and protection of biodiversity; they are considered vital cornerstones for sustainable development. They provide various environmental and economic benefits and generate opportunities for investment and employment. These PAs are an important storehouse of ecological and sociocultural capitals to support the livelihood security and human welfare of millions of forest-dependent communities of the world. PAs in most developing countries are considered as the regions with the highest biodiversity with legal protection (UNEP-WCMC, IUCN 2016) where human activities are restricted, and the exploitation of natural resources is within limits. An additional benefit of PAs includes climate regulation, pollution control, and guards against environmental disturbance (Secretariat of the CBD 2008). According to the record published by the World Database on PAs, there are 217,155 designated PAs globally from 244 countries of which 202,467 are terrestrial and 14,688 marine PAs (UNEP-WCMC, IUCN 2016). PAs can be categorized as follows.

13.1.1 Category Ia (Strict Nature Reserve, SNR)

SNR are the PAs established to conserve biodiversity and the different geomorphological attributes of the area where anthropogenic disturbances such as recreational visits and developmental projects are strictly prohibited and resource uses are strictly restricted to ensure the preservation and conservation of biodiversity. It serves as an essential recommended area for scientific monitoring, assessment, and research (IUCN 2008).

13.1.2 Category Ib (Wilderness Area)

These PAs are modified to some extent depending on the need. No human intervention and settlements are permitted within the area. They retain their natural characteristics and aim for long term environmental conservation goals without any significant human disturbances and keeping it free from infrastructural development, with a predominance of natural processes (IUCN 2008).

13.1.3 Category II (National Park)

These are large natural areas consisting of large-scale species diversity with characteristic ecosystems set aside for conservation of natural habitats, flora, and fauna within the geographical region**s.** Wildlife sanctuaries also fall into IUCN category II, limited use of resources is allowed in these PAs (IUCN 2008).

13.1.4 Category III (Natural Monument)

These PAs are recognized for the protection of specific natural features, their associated biodiversity, and habitats. These can be geomorphological or living elements with high visitor value such as rock forms, waterfalls, sacred groves, oldest living trees, etc. (IUCN 2008).

13.1.5 Category IV (Habitat/Species Management)

These PAs are mainly concerned to protect particular species or habitats. The main priority of these PA is conservation and restoration of species and habitats (IUCN 2008). Conservation of specific species helps in indirect protection of other indigenous species (Roberge and Angelstam 2004).

13.1.6 Category V (Protected Landscape/Seascape)

These PAs have distinct characteristics with significant ecological, sociocultural, and scenic value developed with time and human-nature interaction. These PAs are categorized to protect and conserve the environment through traditional management practices. It maintains the balance between humans and the natural world in terms of sustainable development (IUCN 2008).

13.1.7 Category VI (PA with Sustainable Use of Natural Resources)

These are large areas in their natural conditions. The main aims of these areas are natural resource management and nature conservation; simultaneously natural resources are utilized in sustainable ways for nonindustrial purposes by local communities. It promotes mutual benefits of conservation and sustainability and promotes economic security to local livelihoods (IUCN 2008).

Unfortunately, despite the significant ecological and economic significance of PAs, their importance is greatly undervalued that resulting in inadequate protection and management. PAs are facing tremendous challenges of effective management that result in biodiversity loss with increased human population and greater demand for natural resources (Kideghesho et al. 2013). Therefore, the present study focused

on the scientific, environmental, socio-economic, and ethnic values of Indian PA and their specific role in the conservation of biodiversity and future research perspectives.

13.2 Protected Area Network (PAN) of India and Its Present Status

Around 15% of the total global land area is under PAs, while India officially protects ~5% of its total geographic area covering almost all the ecoregions (Dinerstein et al. 2017). National park, wildlife sanctuary, conservation reserve, and community reserve are the four legal categories of PAN in India with a total of 981 (171,921 sq. km) PAs including 104 (43,716 sq. km) national parks, 566 (122,420 sq. km) wildlife sanctuaries, 97 (4483 sq. km) conservation reserves, and 214 (1302 sq. km) community reserves covering 5.03% of the total geographic areas of the country (WII 2021) (Table 13.1) as on 1 August 2021.

Greater than 70% of the community and conservation reserves are in three Indian states, and union territories of which 122 community reserves are in Meghalaya and Nagaland and 34 conservation reserves in Jammu and Kashmir. Besides, India has a total of 18 biosphere reserves (BRs) recognized under the Man and Biosphere (MAB) program of UNESCO to promote economic and ecological development in a sustainable manner by community efforts and proper scientific interventions (http://www.wiienvis.nic.in/Database/br_8225.aspx), 07 natural world heritage sites (http://www.wiienvis.nic.in/Database/whs_pas_8227.aspx) (Table 13.2), 46 Ramsar wetland sites for the protection from further degradation and sustainable utilization of wetland resources as notified by MoEFCC, GoI (WII 2021; Hindustan Times 2021), and 4 biodiversity hotspots, viz., Himalaya, Western Ghats and Sri Lanka, Indo-Burma, and Sundaland spread throughout the Indian subcontinent (Saikia and Khan 2018). The first BR in India is the Nilgiri Biosphere Reserve notified in 1986 which spreads among Tamil Nadu, Karnataka, and Kerala (source: www.wiienvis.nic.in), while Kachchh is the largest BR in India located in Gujarat, covering ~12,454 sq. km area notified in the year 2008 (Pardeshi et al. 2010).

However, pressures on the natural environment increase with the ever-growing human population, climate change, pollution, agricultural expansion, industrial growth, urbanization, development of dams, highways, and mining have led to

Table 13.1 PAs of India. (Source: www.wiienvis.nic.in)

PAs of India	No.	Total area (sq. km)	% of India's total geographical area
National parks (NPs)	104	43,716	1.33
Wildlife sanctuaries (WLSs)	566	122,420	3.72
Conservation reserves (CRs)	97	4483	0.14
Community reserves	214	1302	0.04
Protected areas (PAs)	**981**	**171,921**	**5.03**

Table 13.2 Biosphere reserves and natural world heritage sites in India. (Source: www.wiienvis.nic.in)

Biosphere reserves	Total area (sq. km)	Year of notification	Location (States)
Nilgiri	5520.00	1986	Tamil Nadu, Kerala, Karnataka
Nanda Devi	5860.69	1988	Uttarakhand
Nokrek	820.00	1988	Meghalaya
Great Nicobar	885.00	1989	Andaman and Nicobar Islands
Gulf of Mannar	10,500.00	1989	Tamil Nadu
Manas	2837.00	1989	Assam
Sunderbans	9630.00	1989	West Bengal
Simlipal	4374.00	1994	Odisha
Dibru-Saikhowa	765.00	1997	Assam
Dehang-Dibang	5111.50	1998	Arunachal Pradesh
Pachmarhi	4926.00	1999	Madhya Pradesh
Khangchendzonga	2619.92	2000	Sikkim
Agasthyamalai	1828.00	2001	Kerala
Achanakmar-Amarkantak	3835.51	2005	Madhya Pradesh, Chhattisgarh
Kachchh	12454.00	2008	Gujarat
Cold Desert	7770.00	2009	Himachal Pradesh
Seshachalam Hills	4755.997	2010	Andhra Pradesh
Panna	2998.98	2011	Madhya Pradesh
Natural World Heritage sites			
Great Himalayan National Park Conservation Area	905.40	2014	Himachal Pradesh
Western Ghats	7953.15	2012	Maharashtra, Goa, Kerala, Karnataka, Tamil Nadu
Nanda Devi and Valley of Flowers National Parks	630.00 87.50	1988	Uttarakhand
Sundarbans National Park	1330.10	1987	West Bengal
Kaziranga National Park	429.96	1985	Assam
Keoladeo National Park	28.73	1985	Rajasthan
Manas Wildlife Sanctuary	391.00	1985	Assam

habitat destruction, fragmentation, degradation, and overexploitation of natural resources (UNEP-WCMC, IUCN 2016; Joshi 2019; WWF 2020). Besides, unsustainable natural resource extraction and illegal wildlife trade have severely threatened much Indian flora and fauna (UNEP-WCMC, IUCN 2016). However, India's conservation challenges are different from other developed countries including the USA, Brazil, and China as in developed countries, the majority of PAs are situated in sparsely populated areas with relatively low biodiversity value (Pimm et al. 2014), while in India, millions of people live within a few km peripheries of PAs and perhaps 04 million reside within the PAs where the dependency on PAs for livelihood security is very high (Narain et al. 2005).

13.3 Roles of PAS in the Conservation of Biodiversity

PAs offer various ecosystem products and services including energy and nutrient cycling, ecosystem restoration, habitat for wildlife, decomposition of wastes, pollution mitigation, help in pollination and disease-pest management, carbon sink, soil stabilization, disaster control and mitigation, etc. (Secretariat of the CBD 2008) that ultimately provides economic, social, cultural, spiritual, and scientific benefits (Maan and Chaudhry 2019). The principal motive of the PAs is to protect, conserve, and improve natural habitats that help in reducing the rates of habitat loss, degradation, and fragmentation (UNEP-WCMC, IUCN 2016; Boucher et al. 2013). Besides, it plays a crucial role in mitigating the impacts of climate change by reducing greenhouse gas (GHG) emissions and ecosystem restoration that helps in switching from carbon sources to sinks (IUCN 2012; Shukla 2016). They act as cornerstones of different cultural and religious practices which bring pride in community, confidence, and scientific discovery (Secretariat of the CBD 2009).

Exploring PAs offers opportunities to understand nature, and healthy outdoor recreational activities through ecotourism, exercise, education, and research by educational institutions. It brings a sense of adventure, challenges, and new discoveries (Secretariat of the CBD 2008). PAs are a kind of global tourism industry that provide opportunities for livelihood earning to local communities and generate income for funds and development. Entry fees, souvenir concessions, and hospitality generate income that helps in running protected areas and their management (Boucher et al. 2013; Secretariat of the CBD 2008). Terrestrial PAs, especially forest communities, play an essential role in climate regulations through the large potential of carbon sequestration (Gibbs et al. 2007). It regulates water and energy cycles and soil conservation, protects from natural disasters, and increases resilience capacity (Avissar and Werth 2005). The drinking water supply in around one-third of the world's largest cities was directly fulfilled by the PAs (Secretariat of the CBD 2008; IUCN 2012; MacKinnon et al. 2019). PAs maintain essential ecosystem services through their genetic resources which can withstand climate change impacts by increasing resistance and resilience to the vulnerability of livelihoods (Secretariat of the CBD 2009). They are able to absorb excessive rainfall, control stream flows, accommodate floodwaters thereby minimizing their damaging potential, and control fires through effective fire-protection measures (Shukla 2016).

PAs have played an essential role in protecting various rare, endangered, threatened, and endemic flora and fauna from further loss and extinction (Karanth et al. 2010; Walston et al. 2016) as it can be used as supportive measures to attain sustainable use of biodiversity. Divyabhanusinh (1999) states that none of the fauna (birds and mammals) has been lost from India since the cheetah (*Acinonyx jubatus*) was extinct in 1952. More than 85% of the total global one-horned rhinos (*Rhinoceros unicornis*) and ca., 70% of the total global tigers live in India, mainly due to the efficient functioning and effective conservation of India's tiger reserves (Jhala et al. 2015; Walston et al. 2016). Besides, almost 97% of the total population decline of the three *Gyps* vulture species is due to the veterinary uses of the drug diclofenac which are now limited inside or near PAs (Prakash 1999). The conversion of

grasslands into agricultural farmlands, pasture, and plantation belts throughout India (Rahmani 2012; Arasumani et al. 2018) threatened a number of birds including the Great Indian bustard (*Ardeotis nigriceps*), which has less than 250 individuals throughout India (Rahmani 2012; Bird Life International 2021).

13.4 Problems in Protected Area Network (PAN) of India

Global climate change is causing threats to biodiversity at an individual level (Bellard et al. 2012) creating an accelerated pressure on each species, population, and community for migration and directional selection (Thomas et al. 2004; Parmesan 2006) leading to decreased resilience of the ecosystem and loss of genetic diversity (Meyers and Bull 2000; Botkin et al. 2007). Management of PAs in India is becoming challenging due to biotic and abiotic pressures such as population explosion, human-wildlife conflict, overgrazing, irresponsible tourists' attitudes and their negligence, encroachment in PAs, poaching, and developmental projects (railway lines, highway, high tension power transmission) within and around PAs (Maan and Chaudhry 2019). Human settlements within PAs are permitted without compromising the conservation goal, but sometimes, the local inhabitants exploit forest resources for their livelihood and other economic activities including traditional cropping, slash and burn agricultural practices, and assisting poachers resulting in decline in wildlife (Rangarajan and Shahabuddin 2006; Maan and Chaudhry 2019). These PAs need proper management for the sustenance of its socioeconomic, ecological, and cultural values.

The PAs of India are facing several challenges such as lack of legal protection, management plans, and their proper implementation to fulfill the requirements of the growing human population. Legal protection measures under the different government policies and local community level initiatives are unable to support in a large way to conserve biodiversity and promote local livelihoods. In Nokrek Biosphere Reserve, Meghalaya (Singh and Borthakur 2015) fund managers lack scientific understanding, limited knowledge of biodiversity, and also lack proper training to enhance the skill and capabilities of biodiversity conservation and protection. The main cause of failure is the lack of adequate provision of technical and financial input for successful agriculture-based livelihoods. Relocation of the human population is also a challenging task and displacement activities can solve proper conservation of natural resources and better living conditions for people living in the forest (Agrawal and Redford 2009). In addition, a cooperative environment with collaborative and sincere efforts is necessary for success in these ventures (Maan and Chaudhry 2019).

Human-wildlife conflict negatively affects communities and poses serious challenges to governments and organizations to align wildlife conservation with sustainable development. Different terrestrial and aquatic species move from core zone to buffer for easy access to food and a greater abundance of palatable grasses (IUCN 2020). The major basis of human-wildlife conflict is a reduction in the size and quality of available habitat due to encroachments, deforestation, denotification

of protected areas, and expansion of cultivation and habitation (Singh 2002). The northeast region of India is significant as a habitat for a large number of wild animals where Asiatic elephants are the major reason for human-wildlife conflict and almost 1150 humans and 370 Asiatic elephants died from 1980 to 2003 (Choudhury 2004). The burgeoning human population and the increasing needs for housing and agriculture are the main reasons for such conflicts. The annoyed inhabitants in Assam, NE India, have targeted crop-raiding elephants by selectively poisoning their paddy fields and inflicting violent elephant carcasses known as "Paddy Thief Bin Laden" (Gureja et al. 2002). The majority of Indian protected forests are suffering from the dwindling pressure of cattle grazing due to a lack of sufficient pasture and grazing lands (Singh and Borthakur 2015) which ultimately reduces the plant growth by removing newly grown saplings, affecting the natural regeneration process, and altering the overall ecological processes. Proper management and functioning of Indian PAs may be a problematic task due to the insufficient funds and facilities, lack of public awareness, trained staff, limited jurisdiction, and necessary information base (WII 2012). The inadequate remuneration, processing delays, and corruption in the process of compensation paid for livestock killed or crops damaged by wild animals (Maan and Chaudhry 2019) and the overall situation warrant action on multiple fronts, with due consideration of social realities.

13.5 Protected Area Management and Maintenance in India

Management of PAs in developing countries like India extends significant challenges due to the higher level of poverty, ever-increasing population growth, and higher dependency of people for livelihood security, along with lack of strong institutional mechanisms with the state forest departments towards protecting and safeguarding biodiversity. Conservation measures should never be imposed on the local inhabitants, and there must be involved from the local people in various levels of conservation efforts according to their knowledge base, interests, skills, self-reliance, and traditions (Panwar 1982). The management of PAs faces constant challenges and difficulties due to issues such as human-wildlife conflicts, habitat encroachments, overgrazing, pressure from tourism, illegal hunting, poaching, wildlife trade, running of vehicular and rail traffic through these areas, and the ever-rising demand for diversion of more land in PAs for developmental purposes (Maan and Chaudhry 2019). India has made significant achievements in enhancing the PAN, and it plays an important role in protecting biodiversity (Karanth et al. 2010; Walston et al. 2016). Almost 89% increase in the number of national parks, and 38% in wildlife sanctuaries established from 1988 to 2012 (WII 2012). The Government of India (GoI) and its ministry act as a guide with the policies and planning of wildlife management and conservation, while the state forest departments have the responsibility to implement national plans and policies. The GoI has implemented various types of acts, laws, and legislation to limit the growing damage to forest resources, wildlife, and biodiversity. The major acts related to conservation and sustainable management of biodiversity include the following.

13.5.1 Forest Act 1927

It is an act with a full set of documented laws related to forests, forest biodiversity, forest resources, and their transport and the duty liable on timber and other non-timber forest products. This act prohibits any clearing of forests, setting fires, trespassing of domestic livestock into reserve forests, felling of trees for timbers, stone quarrying, clearing of land for cropping and other agricultural practices, hunting, shooting, fishing, and poisoning of water or set of traps for wildlife. The accused of any crime should be punished with imprisonment or fine or both, in addition to compensation based on the type of crime and the verdict of the convicting court (source: www.indiacode.nic.in).

13.5.2 Wildlife (Protection) Act 1972 (WLPA) and Wildlife (Protection) Amendment Act 2006

It is an act to provide the protection to wildlife including animals, birds, and plants and for matters connected therewith to ensure the ecological security of the country. It safeguards all the wild animals other than vermin and specific plant species from killing, trapping, and selling animals and their young ones or eggs, animal products, meat, etc. which are considered an offense under this act. The act grants permits and recognition to zoos and central zoo authority, prohibition of harm to wildlife by killing and trading of live animals, penalties for the offense, etc. The act was amended in 2006 with the addition of two new chapters which are mainly concerned with the conservation of tiger and endangered species of flora and fauna (source: www.indiacode.nic.in).

13.5.3 Forest (Conservation) Act 1980

It is an act to provide conservation of forests and the matters connected therewith. It acts on the forest resources of all of the Indian states and territories and the act checks further deforestation and conservation of forest and forest resources. It limits the utilization of forest lands for non-forest activities like the cultivation of commercial crops like coffee, rubber, cocoa, spices, tea, etc. It promotes conservation, sustainable development, and management of forests and forest resources through the establishment of check-posts for forest security, fire lines, wireless communications, construction of fencing, bridges and underpass, check dams, territorial boundary marks, pipelines for water supply, etc. and impose a penalty for violation of the provisions of the act (source: www.indiacode.nic.in).

13.5.4 Environment Protection Act 1986

It provides protection and helps to improve the environment and the matters connected therewith. The act is comprehensive legislation to ensure the safety for the environment to all the Indian states and territories, which defines the power of the central government to take necessary measures and frame rules to protect and improve the environment, regulate environmental pollution, prevention, control, and its abatement and to also decide penalty and miscellaneous power. It provides different standards for controlling emissions and discharge of selective pollutants from particular industries and to establish, recognize, and operate environmental laboratories for inspection of any industrial plants, equipment, manufacturing units and processes, materials, or substances (source: www.indiacode.nic.in).

13.5.5 National Forest Policy 1988

It aims to maintain stable environmental conditions and ecological balance for the sustenance of all life forms. The major objective of this policy is to conserve the gene pool of flora and fauna within the remaining natural forests. It limits soil erosion, improves water conservation, and mitigates floods, droughts, and siltation. It also helps in increasing forest and green cover of the country through afforestation efforts and social forestry projects on degraded and unproductive lands. It helps to provide livelihood including fuelwood, fodder, minor forest products, and small timber to the rural tribal populations. It also promotes people's participation and women's empowerment to increase forest productivity to meet the essential needs of the country and minimize the growing pressure on the existing natural forests. Strategies to achieve its goals mainly include afforestation and forestry programs, wildlife conservation, promoting a synergistic relationship between the tribal community and forests for the conservation of forest and forest resources and sustainable development (source: www.indiacode.nic.in).

13.5.6 National Biodiversity Act 2002

It is an act to ensure the conservation of biodiversity, their sustainable use, and equitable sharing of the benefits of the use of biological resources. It safeguards traditional and historic knowledge prevents biopiracy, prohibits people's claims on patents without the governments' approval, etc. The act takes charge of assessment and approvals of biodiversity, national development plans, the harmful effects on the conservation of biodiversity, endangered and threatened species, and prohibiting their collection. It consists of 12 chapters with detailed explanations about various biodiversity boards, committees, and their functions with provisions for punishment and penalties for offenses under the act (source: www.indiacode.nic.in).

13.5.7 Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006

The act safeguards the rights of forest-dwelling scheduled tribes and other traditional forest dwellers living in forests for generations but whose rights could not be recorded. The act empowers the scheduled tribes and forest dwellers to traditionally use the forest areas for self-cultivation, basic needs, livelihood, habitation, and sociocultural perspectives. It protects the rights of forest dwellers from unlawful evictions with the provisions of basic facilities for the tribal community and forest dwellers to access development facilities like education, health, nutrition, and infrastructure, and their traditional knowledge helps to protect, conserve, and manage forests, biodiversity, wildlife, catchment areas, and water sources (source: tribal.nic.in; forestrights.nic.in).

13.6 Community Conservation Efforts Outside the Protected Area Network (PAN)

Biodiversity conservation in India has been practiced since the Vedic period (Kumar 2008), and it is continued today. Many tribal communities and forest dwelling societies residing outside PAN play a crucial role in biodiversity conservation through cultural concepts like sacred forests, grooves, corridors, and ethno-forestry (Berkes et al. 1998); these efforts are known as community conservation. Forests provide food, fuel, fodder, and income opportunities to tribal and forest dwellers. It plays an important role in their sustenance, sociocultural life, and economic support to the tribal population of India. Joint forest management (JFM) has become a comprehensive effort of forest conservation initiated by the GoI in 1990 in context with the National Forest Policy (1988). It aims to conserve forests, forest biodiversity, and sustainable development through the involvement of local communities with the forest departments in forest management activities (Murali et al. 2003) within the PAs and degraded forest regions (Damodaran and Engel 2003; Balooni and Inoue 2009) that have been originated in West Midnapur district of West Bengal in 1971 (Directorate of Forests, Govt. of WB 2016). In JFM certain rules are made by the forest department regarding the use of forest resources by the local communities which helps in their sustenance without any negative consequences on the forests and the forest department and government agencies have also developed an initiative to motivate, educate and train people to earn livelihoods to improve their economic status and standards of living.

JFM is a strategy to achieve multipurpose goals such as rural development, poverty alleviation, gender equality, women's participation, and empowerment (Maksimowski 2011) through providing opportunities and training to villagers in a sustainable way to prevent biodiversity loss and forest degradation. The Indian States of West Bengal, Odisha, Bihar, Gujarat, Haryana, Himachal Pradesh, Uttar Pradesh, Uttarakhand, Rajasthan, Karnataka, Madhya Pradesh, Maharashtra, Punjab, Rajasthan, Arunachal Pradesh, and Tripura have actively participated in

JFM (Damodaran and Engel 2003; Sundar 2002). In JFM, forests are managed through direct access to locals that help in obtaining their basic needs and benefits like fresh air, water supply, employment opportunities, etc. through increasing forest cover, forest fire control, prevention of poaching and hunting of wildlife, water recharge through adequate precipitation, regulating regional climate, improved pollination, and protecting wildlife habitat (MoEF, GoI n.d.). It also helps in conserving forests biodiversity; checking soil erosion, mitigating floods and droughts; increasing tree cover in degraded forests; fulfilling the basic needs of rural tribal populations with provisions of food, fuelwood, fodder, minor forest products, small timbers, medicines, source of income; and increasing the forest productivity to minimize the pressure on existing forests (MoEF, GoI n.d.; Directorate of Forests, Govt. of WB 2016).

Sacred groves (SGs) are other community-based forest management initiatives to protect forest patches traditionally by local communities due to the faith, belief, rituals, taboos, and various traditional and cultural values associated with these forests (Pandey 2010; Murtem and Chaudhry 2014) where hunting, gathering of forest products, and collection of fuelwood are strictly prohibited. SGs are ideal areas for the conservation of biodiversity as the majority of these forest patches are virgin forests with rich biodiversity (Khan et al. 2008). It is found throughout India mainly in tribal-dominated regions from the Western Ghats to Central and Northeastern India (Balasubramanyan and Induchoodan 1996; Burman 1992; Gadgil and Vartak 1976; Khumbongmayum et al. 2005; Rodgers 1994). There are almost 23,000 sacred groves located in 19 different tribal dominating Indian states covering ca. 68,633 ha forests area (Malhotra et al. 2007). SGs are considered as one the safe places for many rare, endangered, threatened, and endemic species of plants and animals, and they are conserved through sacredness, religious beliefs, and taboos. They provide a number of ecological services such as pollination, seed dispersal, habitat, minimizing erosion by water and wind, conserving soil, maintaining hydrological cycle, and availing water (Khan et al. 2008). SGs play a positive role in maintaining ecosystem health, habitat protection, and preserving cultural and ethical beliefs (Godbole et al. 1998; Godbole and Sarnaik 2004; Ramakrishnan and Ram 1988). SGs can be another effort for biodiversity conservation outside protected areas but at present; they are facing the challenge of losing their identity and importance due to anthropogenic activities, exploitation of resources for economic development by rural tribal populations and by the cultural change among young generations (Khan et al. 2008).

13.7 Land Degradation Neutrality

The concept of land degradation neutrality (LDN) has come up on 2011 at United Nations developed by the United Nations Convention to Combat Desertification (UNCCD) secretariat as a concept for maintaining the balance between "not yet degraded" and "already degraded" land to achieve sustainability (Gichenje et al. 2019). LDN is a state of net zero land degradation defined as "a state whereby the

amount and quality of land resources necessary to support ecosystem functions and services and enhance food security remain stable or increase within specified temporal and spatial scales and ecosystems" (UNCCD 2022). It aims to maintain and enhance ecosystem services on the basis of scientific approaches including planning, implementing, and monitoring of natural land resources (Cowie et al. 2018). It focuses on conservation of biosphere, society, and economic instability through promoting land restoration, multifunctional use of land, and raising awareness (Keesstra et al. 2018). LDN protects, restores, and promotes sustainable use of landscape; it is helpful in forest management, combats desertification, and prevents further land degradation and biodiversity loss (Solomun et al. 2018). It balances land degradation and reclamation by maintaining and improving land quality at on-site and off-site land restoration, thereby eventually helping in achieving healthy soils and stable terrestrial ecosystems (Barkemeyer et al. 2015). LDN can play an important role in minimizing global challenges such as food, water and energy security, poverty alleviation, human health, migration, conflicts, economic crises, and income inequality (Akhtar-Schuster et al. 2017).

PAs can be used as a cornerstone for LDN under the umbrella species concept and flagship conservation strategies for biodiversity conservation and environmental protection (Cantú-Salazar and Gaston 2010). Protected area networks can be used as effective tools to preserve biodiversity and prevent land degradation, in addition to regional and local climate change, anthropogenic disturbance, and other environmental drivers that can be maintained (Beatty et al. 2014). Building capacity alliances with conservationists, ecologists, foresters, land-use planners, bureaucrats, rural union leaders, and indigenous communities within PAs for regulating and conserving PAs will promote sustainable development strategies to support socioeconomic and cultural aspects of indigenous communities (Naughton-Treves et al. 2005). This action would help to achieve comprehensive conservation goals with limited funding, time for action, conservation efforts, and shortcuts for the maintenance of biodiversity (Roberge and Angelstam 2004). A total of 1,44,296 protected sites have been reported which accounts for 12.9% of the earth's surface is an achievement and new PAs are continuously established, thus more protected areas mean better conservation and hence less land degradation (Andrade and Rhodes 2012).

13.8 Future Research Prospects

There is interplay between biodiversity conservation and ecotourism. Further research may be able to examine the more complex interaction between environmental and socioeconomic concerns of terrestrial PAs worldwide that will enable us to estimate the achievements of socioeconomic upliftment and biodiversity conservation. The determination of species' adaptive capacity and sensitivity to climate change along with the impacts of anthropogenic disturbances in PAs will help in determining the actual reasons behind the population loss of much important wildlife. Formulation of long-term monitoring and assessment tools of economic and

ecological benefits are of particular importance to achieve sustainable development through ecotourism, timbering, and value addition of different forest products.

13.9 Conclusions

Conservation of biodiversity within their natural habitats is ensuring intragenerational and intergenerational equity. The Indian PAs are supporting a range of economic activities, providing industrial goods, and investment with proper maintenance of ecological services and livelihood security, to millions of forest dwellers around the globe. There is a need to take up various conservation projects together with mitigation measures including the corridors for tigers, elephants, and other animals in and around reserves. Planners, policymakers, and common people need to understand that the future security of the national heritage of the country is at stake. The major goals of the policymakers should be the development of proper monitoring and management plans for eco-sensitive zones around PAs and emphasis must be given to preserving the existing PAs, establishing new PAs, and also to enhance the area under the existing PAs to achieve environmental sustainability and limit the biodiversity loss. A balanced view of the country's development, the conservation of biodiversity, and the hardships faced by the local inhabitants residing in and around PAs are also needed to achieve sustainable development. India has strong legislation for the conservation of nature and also has government investments in the forms of more than 50 tiger reserves, government compensation schemes, etc. to facilitate local socioeconomic and livelihood supports, which are considered the good signs of future prospects for conservation.

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