Chapter

Deforestation in India: Consequences and Sustainable Solutions

Rima Kumari, Ayan Banerjee, Rahul Kumar, Amit Kumar, Purabi Saikia and Mohammed Latif Khan

Abstract

Deforestation is one of the most pressing environmental issues that the world is facing currently. It is the conversion of forested land to non-forested land by humans. Deforestation occurs when a land dominated by naturally occurring trees is converted to provide certain services in response to the human demand. The indiscriminate felling of trees has resulted in a reduction of 3.16% in the global forest cover from 1990 to 2015. Although India has seen an increment in the total forest cover of ca. 1%, still there are certain regions in the country that have sought a decrease in the forest cover. The main reasons attributed to the reduction in forest cover are shifting cultivation, rotational felling, other biotic pressures, diversion of forest lands for developmental activities, etc. Continuous illicit cutting of trees has impacted the microclimatic conditions, hydrological cycle, soil quality, biodiversity, etc. of the country, thereby making the country more vulnerable for any uneventful happening. Sustainable forest management practices, alternatives for shifting cultivation, promotion of plantation outside the forest and the usage of certified forest products, etc. are some of the measures that can be adopted to curb the rate of deforestation.

Keywords: deforestation, forest cover, sustainable solutions

1. Background

Forest is a conditional renewable resource which can be regenerated but needs a certain period of time to maintain its sustainable functioning. In India, the forest resources have been found to be depleting at a pace which is much high [1]. Rapid industrialization, urbanization and over-exploitation have resulted not only in decline but also in permanent loss of forest cover to an alarming rate [2]. The major driver behind all these factors is the uncontrolled population growth of humans which leads to the dramatic increase in the demand for wood and forest products. The over-exploitation of forest resources has taken place beyond the sustained yields to fulfil the needs of humans, thus bringing a change in the net forest cover [2, 3]. With the current rate of population explosion, the world population could be expected to increase from 7.6 billion to about 10 billion in the next 30 to 35 years [4]. The growing demand for food can be expected to rise by 50% in the given period, and it is a matter of serious concern. Rational utilization and proper management of

the forest resources are the most viable ways to prevent mass destruction of forests and large-scale species extinction. It is necessary to find the links between the growing demands and meeting the demands in a sustainable manner. The scope of future studies must focus on the solution to establish this link by incorporating the principles of forestry, restoration ecology and natural resource economics.

Deforestation occurs when a land initially dominated by naturally occurring tree species is converted to provide certain services in response to the human demand. The UN Food and Agricultural Organization (FAO) has defined deforestation as *the conversion of forest to another land use or the long-term reduction of tree canopy cover below the 10% threshold*. Forest areas around the world are majorly cleared for agriculture, logging, mining and large-scale developmental projects. The Food and Agricultural Organization [5] coordinated the Global Forest Resources Assessment (FRA) which reported a 3.16% decline in the global forest cover from 1990 to 2015, and the total forest cover stands at about 30.6% in the present time compared to 31.6% in 1990. The rate at which the forest cover is declining poses a direct threat in the near future if not checked. With an estimated annual loss of 18.7 million acres, it is evident that future demands on forest resources would certainly lead to immense competition among nations [6]. Recently, in 2016, a study from the Maryland University reported that 73.4 million acres of the global tree cover were lost. Such a destruction of this essential and self-sustaining resource puts the implementation of the principle of sustainable development as mentioned in the Brundtland Report and Sustainable Development Goals of the 1992 of Rio Earth Summit in the state of question. And, it is an urgency to conserve the forests of which a vital part is already lost.

The value of forest is simple to understand but sometimes tough to quantify. The various values of the forest have been shown in **Figure 1**. Forest has a major contribution on the global economy and supports livelihood of the majority of rural populations in the world [7]. The direct uses of forest are most easy to quantify as it is directly related to economic returns. The indirect use and option value although play a major role in defining the valuation of the forest resources are seldom quantified and are being intangible in nature [8]. There is also a no-use value of the forest

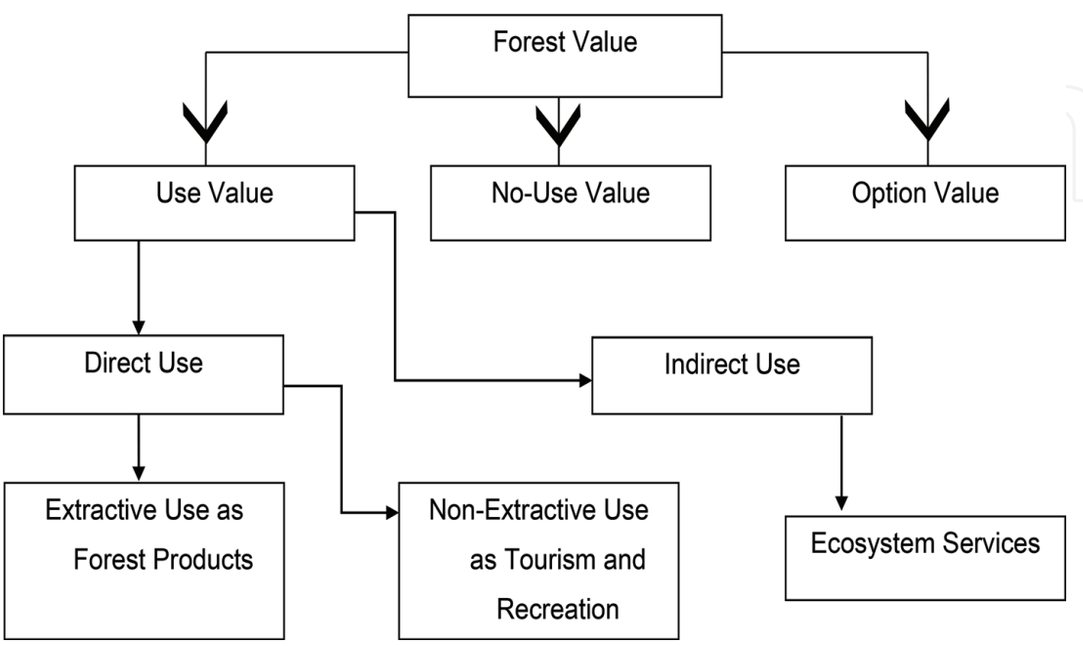

Figure 1.
Different values of forests ecosystems

resources which considers leaving the current forest intact as a heritage for the future generation and for satisfaction and happiness of the current population. But, these eco-centric views alone cannot suffice the support for a change in policy and land use pattern. There are some other important values of forests that are difficult to quantify. One of the major roles that forests play is that it acts as a major carbon sink [9–11]. Plants utilize carbon dioxide in the process of photosynthesis and store it in the form of carbohydrates, and these carbohydrates reach the soil as dead organic matter and contribute to soil carbon sink. When forests are cleared, less CO_2 is absorbed by plants, and atmospheric CO_2 concentration increases with the passage of time due to unavailable sink. Also, there is a marked reduction in soil organic carbon with the loss of vegetation cover, thereby affecting the productivity of the ecosystem. Productivity is believed to be an indicator of carbon assimilation capacity, and hence the more productive the forests are, the more carbon it stores [12–14]. The tropical forests are among the most productive as well as the most threatened ecosystem in present time with the maximum rate of deforestation. Thus, it is imperative to control the rate of deforestation in order to avoid the adversities associated with it.

2. Impacts of deforestation

The value and functions of forests are immense and diverse. Similarly, the impacts of deforestation are global and commune the whole forest community. One of the major constraints in understanding the true impact of desertification on forests is the inadequacy and imprecise form of data.

2.1 Impacts on global climate

The effect of large-scale deforestation is global, but it is necessary to assess its impacts on microclimate, regional climate and global climate to form a holistic understanding of mechanism [15]. The association of deforestation with the increased CO_2 concentration in the atmosphere and changes in the mass balances and surface energy can result in climate change at the local and global level [16]. The change in land use pattern especially the clearing of forest cover affects both hydrometeorological and global CO_2 concentrations leading to more warming as CO_2 readily absorbs infrared radiation [17]. Clearing tree cover and vegetation leads to increase in albedo of the region as bare soil reflects more solar radiation than vegetation, which again is a factor for altering regional radiation flux [15, 18]. One of the noticeable changes in regional climates occurs when the cloud formation shifts to higher elevations from lowland plains as a result of deforestation in the later area [19]. In a global scale, deforestation leads to warmer and drier weather due to the synergistic effect of reduced evapotranspiration, increased albedo and CO_2 concentration that triggers desertification, loss in biodiversity and melting of polar ice caps, ultimately leading to food insecurity. All these effects are successors of extremes in climate variation that are produced by the large-scale reduction in forest cover [20]. The estimated quantity of CO_2 added to the atmosphere due to deforestation in the tropics is roughly two billion tonnes [21]. It is interesting to note that the CO_2 emissions due to clearing of forest will almost be equivalent to 25% of what is added to the atmosphere due to anthropogenic emissions [22]. The shift in climate is somehow correlated to reducing forest cover. Further researches can clearly define the mechanisms and pathways by which these shifts are progressing and how they can be mitigated.

2.2 Impact on hydrology and soil quality

The global water cycle depends on the amount and distribution of precipitation for which one of the influencing factors is evapotranspiration [23]. There is a direct effect on drinking water on the basis of quality and quantity, fisheries and aquatic habitats, occurrence of flood and drought, life of dams on account of increase siltation and agriculture due to poor quality irrigation and crop yield [24, 25]. It must be recognized that the protective role of forests is operative and has a major impact on urban water resources [26]. Forests play an important role in maintaining the watersheds [27]. The degraded or degrading watersheds can be recovered by forestation, but once the forest or vegetation cover is lost, the watershed becomes vulnerable to erosion. This erosion leads to siltation in the downstream areas and consequently reduces the depth of river bed increasing the chances of flood. There are two main effects of deforestation that increase the chances of flooding. One is by reducing the tree fountain effect, i.e. interception and moisture uptake by the trees would cease after deforestation reducing the moisture holding capacity of soil that leads to greater runoff and erosion. And other is by the process of soil compaction and poor soil structure that will lead to reduced organic matter content of soil devoid of vegetation cover [28]. There are severe long-term effects on soil as a cause of deforestation. During slash-and-burn or shifting cultivation, an area of forests clears and exposes the bare soil to weather extremes of high solar insolation and heavy rainfall [29]. In the absence of the forest cover and organic matter, soil could not accommodate heavy precipitation, and the fertile layers of soil used to be easily washed away ultimately reduces the long-term productivity. The effect on soil is dependent on the interrelation and synergistic effect of evapotranspiration and infiltration that are directly altered due to loss in vegetation cover [23].

Deforestation directly increases erosion and siltation rates. There is an increased risk of flooding in Yangtze River basin in China and the major river basins in East Asia and the Amazonian basin [23, 30]. The slopes and terrains are more vulnerable to such situations. There are formations of shallow gullies which may be accounted for the concentrated flow of runoff that prevails due to long-term erosion. Cultivation and ploughing along the slopes cause rapid erosion in the areas with less vegetation cover [31]. In the Loess Plateau, the slopes of steepness greater than 15° showed shallow gully erosion as a result of cultivation activities [32]. The availability of dead vegetation can reduce the surface runoff from the early season rain and check soil erosion [33]. It is necessary to sustain the forest and vegetation cover to maintain the soil productivity and water quality of both the surface and underground sources.

2.3 Impact on biological diversity

Forests are very rich in biodiversity and store a vast gene pool, and the majority of species occur in the tropical forests. It consists of two-thirds of all known species and 65% of 10,000 species that are recognized as endangered by the International Union for Conservation of Nature (IUCN) [34]. The biodiversity could be regarded as an important asset that is necessary to conserve for future utilization. The World Health Organization states that the traditional people, almost 80% of them, rely on the local biodiversity for traditional medicines. A loss in the biodiversity may directly affect their health care and well-being [35]. Another most noticeable impact of deforestation is the increasing human-wildlife conflict. The decreasing forest cover is limiting the habitats of many species due to which is forcing them to intrude with human welfare [36]. There are increasing instances of invasion and animal killing. The northern margin of West Bengal, India, forms a significant

portion of the Himalaya Biodiversity Hotspot. The area has observed heavy fragmentation in the last decade, and as a result, there was a huge loss in the agricultural crop and both human and elephant life due to conflicts. There are reports of mortality of 20 elephants and 50 persons annually from this area [37]. It is also estimated that if deforestation in the Himalayas continue at the current rate, the dense forest cover (>40% canopy cover) will be restricted to 10% of land area in the Indian Himalayas by 2100. This may lead to a significant loss of 366 endemic plants and 35 endemic vertebrates [38]. The loss in biodiversity is of global concern irrespective of regional and local importance. Conserving the forest and an increase in forest cover certainly find a positive correlation with the increase and sustenance of biodiversity. Conversion of forest land to agricultural fields and other land use could be a threat to major loss in biological diversity in the near future.

2.4 Impact on economic and social welfare

Forests contribute to the world economy in terms of timber production and other forest produces. There are different contributions of forest as a means of direct employment in forestry services and other value-added contributions as recreation and aesthetics. The loss of tropical forest cover annually may account for about 45 billion US dollars [39]. The destruction of forest eliminates the sources of economic gain directly obtained and also eliminates the potential gain from the resources that the forest sustains as biodiversity, soil and water. Also, the destruction of forest increases the negative externalities in the form of increasing CO_2 concentration, risk of flood and human-wildlife conflict [40]. The proximity of settlements to protected areas further intensifies the chances of human-wildlife conflict (HWC). It is reported that settled households face high risk of HWC due to their close proximity of the Kanha National Park in Central India [41]. Deforestation has its social influence in the form of long-term effect. Development is a serious concern for indigenous community as it certainly leads to a change or shift of their culture and tradition. The cultural and religious aspects of the community are seldom preserved amid infrastructural advancement that leads to land and social conflict [42]. In a study of household survey from rural areas of Madhya Pradesh and Chhattisgarh state of India, it was found that the poorest of the local community gained about 30% of their living from forest produce which was claimed to be even higher than the returns from agriculture. Also, forest provides an option as safety net during the period of crisis in rural areas [43]. Various ecological services provided by the forests have been lost due to deforestation which in turn has immediate effects on the local communities dependent on these services for their daily needs. The inclusive approach for the sustainable management of forest resource is a vital consideration that considers economy as a subset of the society which in itself is a subset of the environment. Such considerations can help sustaining the constantly declining forest cover and its long-term impacts.

3. Forest cover status in India

The forest cover was found to be increased by ca. 1% for the year 2017 which is 21.54% of the total geographic area when compared to that of forest cover status in 2015 which is a positive sign towards the constant efforts that are being put in to protect the forest (**Figure 2**). This positive change in the forest cover is mainly attributed to the conservation and management practices that include afforestation activities, participation of local peoples for better protection

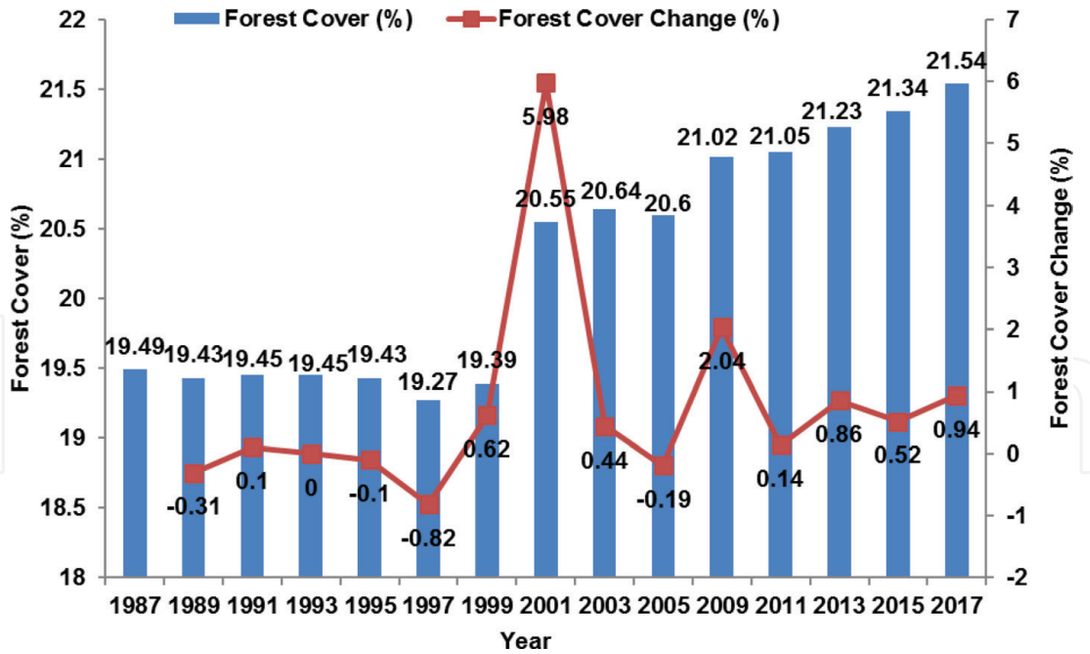

Figure 2.
Forest cover status in India for the last 30 years (1987 to 2017).

measures in plantation areas and traditional forest areas, expansion of trees outside forest, etc. Also, with this increase in the forest cover, the country has procured 8th position among the top 10 countries reporting the greatest annual forest area gain. Although there has been an increase in the total forest cover in India, still there are certain regions within the country that has sought a reduction in the same (**Figure 3**). The main reasons attributed for this reduction are

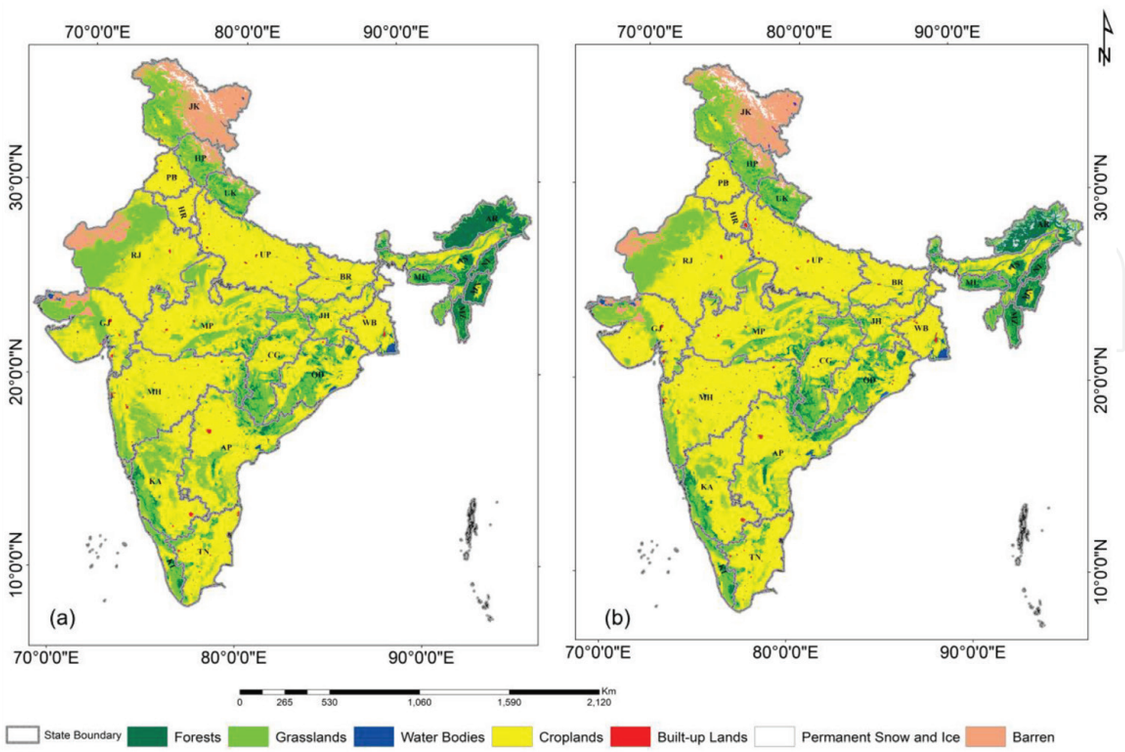

Figure 3.
MODIS-based land use/land cover map of India for the year (a) 2001 and (b) 2017.

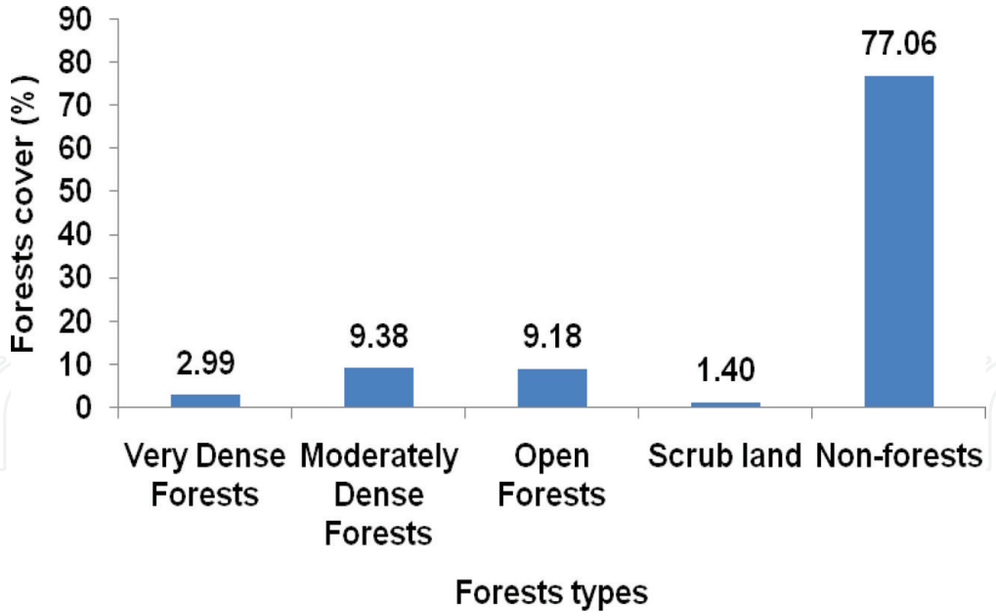

Figure 4.
Forest cover (%) of India for the year 2017 (Source: [44]).

shifting cultivation, rotational felling, other biotic pressures, diversion of forest lands for developmental activities, etc. [44]. A transition in the various forest cover classes has also occurred over the past. The present status of forest cover (%) of India belonging to various forest cover classes has been shown in **Figure 4**. It has been found that there is a reduction in the moderately dense forest and an increment in the open forest depicting degradation of forest cover to some extent. Changes within the forest cover classes result in decrease in the production capacity, thereby leading to forest degradation [45]. Control and regular check of these activities can help in strengthening the conservatory efforts of forest protection. This is the necessity of the present time to conserve the forests in order to sustain the vital ecosystems and the major carbon sink to combat the effects of global climate change and ultimately maintain the environmental balance.

4. Case studies of forest disturbances from different parts of India

Forests are an invaluable resource that is being subjected to so many threats. In order to protect our forests, it is very much necessary to understand the reasons behind their destruction. Differentiating the agents and causes of deforestation will enable in understanding the same [36]. Several disturbances within the forest directly or indirectly contribute in destruction of the forest. This can be interpreted from the results obtained while surveying in different forest patches in India.

4.1 Disturbances in the forests of Arunachal Pradesh

Arunachal Pradesh is one of the states that has more than 75% forest cover and has the maximum very dense forest cover type [44]. The state is highly diverse in terms of climate as well as forest cover with tropical, sub-tropical, temperate and alpine forests having higher NDVI (≥7.0) [46]. However, the pressure on forest resources is consistently increasing with the rise in population, development

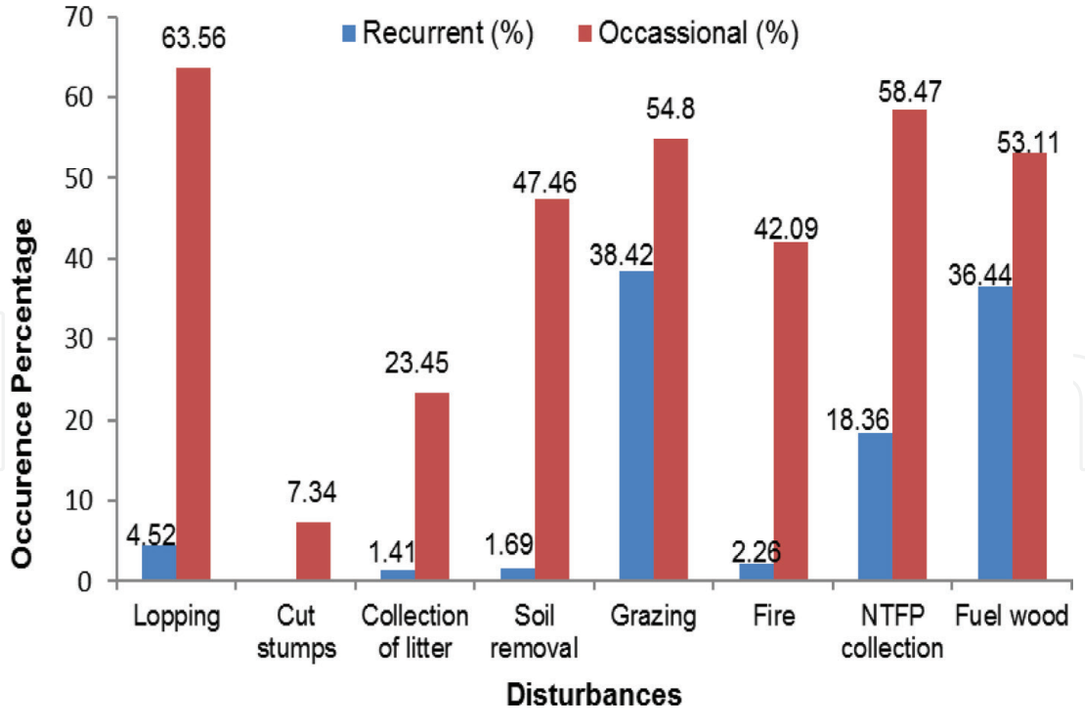

Figure 5.
Major disturbances in the forests of Arunachal Pradesh.

activities, large number of wood-based industries and unsustainable land use practices resulting in their degradation [47]. This has also resulted in decrease in the forest cover of the state [44]. Several disturbances were being observed during the field survey in the forests of Arunachal Pradesh during 2007 to 2010. The major disturbances that were found include lopping, cut stumps, litter collection, soil removal, grazing, fire, NTFP collection and fuelwood collection (**Figure 5**). Of these, fuelwood collection was found to be the most recurrent activity followed by grazing. Generally, fuelwood collection has not been considered as the major cause of deforestation but leads to the same in certain regions with reduced forest area such as in the Philippines, Thailand and parts of Central America [36]. Forest fire has also been observed as an occasional event in certain parts of Arunachal Pradesh. Fires are generally used as a tool in clearing the forest for shifting cultivation which is one of the major agricultural practices performed in the state. Fires when used responsibly act as a valuable tool in managing forest and agriculture, but when abused, it can lead to deforestation [48, 49]. Other disturbances that can be an indicator of deforestation include NTFP collection and presence of cut stumps in certain forests. Forests of the state are highly diverse in endemic as well as nonendemic species, which need intensive monitoring and management to conserve the species-rich ecosystems from ever increasing anthropogenic pressure and changing climatic conditions [50].

4.2 Disturbances in the forests of Madhya Pradesh

Madhya Pradesh is among one of the states of India which is endowed with rich and diverse forests and comprises the largest forest cover in the country [44]. This is mainly because of the efforts that the state has put in to conserve and harness this invaluable resource through innovative measures like community participation and decentralization (MP) [51]. Even after these continuous efforts, there are certain regions within the state where the occurrence of several types of disturbances in the forest has been found. The common disturbances that were being observed

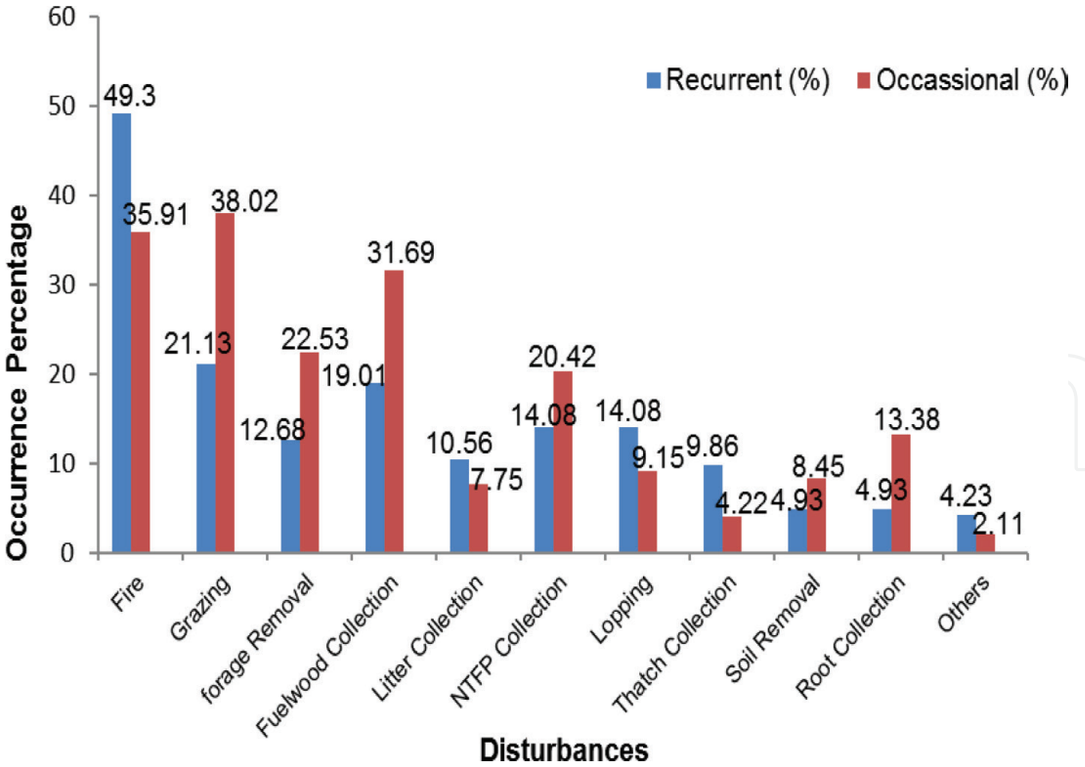

Figure 6.
Major disturbances in the forests of Madhya Pradesh.

during the field survey (2017–2019) include fire, grazing, fuelwood collection, forage removal, litter collection, NTFP collection, lopping, thatch collection, root collection, soil removal, etc. (**Figure 6**). Among all these fire has been found as the major recurrent type of disturbance in the forests of Madhya Pradesh. Other major disturbances were grazing followed by fuelwood collection. Since every type of deforestation is not intentional but some which are the results of amalgamation of anthropogenic and natural factors like wildfires and subsequent overgrazing can prevent the growth of young trees [52] and thus eventually degrade the quality and productivity of the forest.

4.3 Disturbances in the forests of Jharkhand

The name of the state 'Jharkhand' itself connotes 'area of land covered with forests' and has been exhibiting a unique relation with forests since time immemorial [53]. During the forest cover assessment [44], a net increase of 29 sq. km in the forest cover has been observed in the state which is mainly because of the plantation and conservation efforts within recorded forest areas. Although, there was an increment of 314 sq. km in the forest cover within the recorded forest areas, because of the felling of trees outside the forests area, its effect on forest cover has been offset. Also, several types of disturbances can be seen within the forest areas during the field survey (2016–2018), and the major disturbances were fuelwood collection, grazing, forage removal, lopping, cut stumps, thatch collection, root collection, soil removal, litter collection and NTFPs collection (**Figure 7**). Most of these disturbances were occasional in nature. Although these disturbances are not that recurrent, a regular check is necessary in order to prevent the forests from degrading and in achieving a sustainable forest cover. The forest management strategies should focus on the increasing demands of different timber and non-timber forest produce to conserve the plant diversity of the natural forests of the state [54].

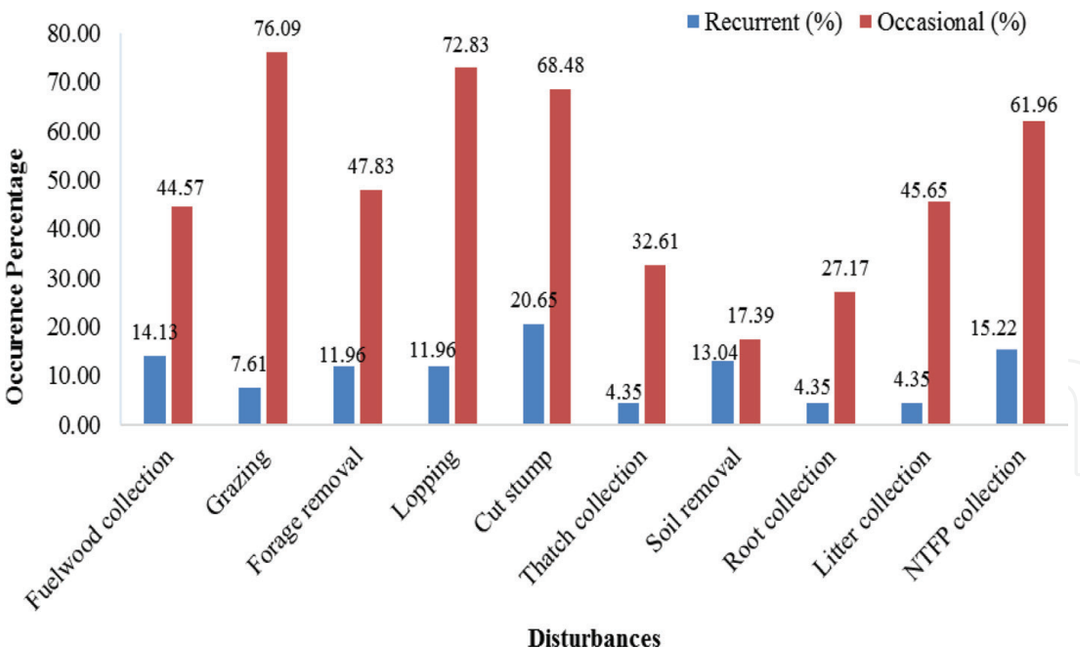

Figure 7.
Major disturbances in the forests of Jharkhand.

5. Joint Forest Management in India: a case study

Forest management and protection by the local communities is an age-old practice in India which can be traced back to the protective nature of the Bishnoi Community of Rajasthan towards the local forest and animals as the black buck. The idea of community-based forest management emerged in an administrative level in the 1970s and 1980s. The declaration of the Government of India in June 1990 marked the establishment of Joint Forest Communities in different India states as per the National Forest Policy of 1988. The Earth Summit of 1992 provided with a clear objective of Sustainable Forest Management to which India responded in a positive way. From an increase in the forest cover, non-timber forest product (NTFP) to conservation of native flora and fauna, a whole new realm of forest management strategy by the collaboration of forest departments and local communities aided in decelerating the degradation of natural forest in India [55]. The Participatory Forest Management (PFM) is equivalent to an informal contract in which the local communities are allowed to consume a portion of harvest and NTFP if they protect and conserve it for 5–10 years. In India there is no legal authority of the local community on the forest resource where as in other countries as in Nepal the Community Forest User Groups (CFUG) are registered under their Forest Act, 1993 [56]. It is the positive effort of the local communities of India that the area under Joint Forest Management increased from 22,017,583 ha to 2,144,000 ha in March 2006 with 106,482 recognized Joint Forest Management committees countrywide [57].

6. Mitigation measures to curb deforestation

Deforestation is a major environmental challenge which has been persistent from the past, and the situation is more worsened at present. Therefore, there is an urgent need to focus on the mitigative measures in order to prevent the distressing effects of deforestation in the near future. In order to alleviate the problem of deforestation, the strategies should be based on the underlying causes of the

same. Also, the strategies for mitigating the problem of deforestation require its effective implementation that needs the recognition of the roles of national, state and municipal governments along with the pro-active role of the civil society and private society [36]. The continuous increase in the human population especially in the developing countries has resulted in enhanced pressure on the forests for human settlements and other land use practices. A reduction in the growth rate of human population plays a crucial role in reducing the practice of deforestation [36]. Alternatives to slash-and-burn agriculture can be adopted as a strategy to mitigate the deforestation by boosting the agricultural and forestry productions for the shifting cultivators ([58, 59]). The sustainable alternatives for slash-and-burn cultivation will assist the poor farmers in leading a better life without destroying additional forests [60]. Public policies and laws with greater security, accessibility to the minimal inputs required to maintain or enhance food production and an opportunity to the cultivators to market their products will aid in the sustainability of shifting cultivation systems [61].

Another strategy that can be applied to control the rate of deforestation is through the adoption of sustainable agroforestry, sustainable logging, agro-pastoral production systems, etc. [62]. The sustainable forest management practices can be promoted only if it is ecologically, economically and socially sustainable [36]. Agroforestry has been considered as one of the methods to curb deforestation which in turn aid in reduction of CO_2 emissions and mitigation of climate change effect [63, 64]. The adoption of agroforestry practices has resulted in an increase in the income of agroforestry adopters as compared to that of non-agroforestry adopters and has also contributed towards improving soil fertility, reducing deforestation and conserving soil and water [65]. The provision of protected areas is one of the key steps towards an attempt to reduce deforestation which is generally motivated through biodiversity conservation [34]. Also, the global endeavours to reduce tropical deforestation are dependent heavily on the establishment of protected areas. It has been found that protection reduced deforestation as approximately 10% of the protected forests would have been deforested if they would have not been protected [66]. Tropical protected areas reduced deforestation which was liable for around one-tenth of total anthropogenic carbon emissions, thus playing a significant role in mitigating the effects of climate change and protecting biodiversity and ecosystem services [67]. Similarly, a total loss of 15.4% in the unprotected mangrove cover was compensated by the 15.7% rise in the protected mangrove cover (protected by government as per Ramsar Convention) which resulted in a net increase of 13.3% in mangrove cover across India in the last 25 years [68]. Implementation of forest certification can be among one of the strategies to control deforestation around the world. Forest certification is a process through which the producers identify their products in the marketplace and receive greater market accessibility and higher prices for their products by fulfilling certain stringent sustainable forestry standards [69]. Certification has played an important role in protecting Penten forests from 1986 to 2007, and the certified forests experience 20 times less deforestation than non-certified areas [70]. Thus, certification of forest can play a major role in controlling deforestation since the timber certification was found to be negatively related with deforestation, i.e. the increase in the certification process has resulted in a declination in the deforestation rate [71].

7. Role of Indian government in forest conservation

The Government of India has been continuously putting significant efforts in terms of conserving the forest resources. They have not only taken measures to

conserve the present forest cover but also have initiated several measures to increase the forests and tree cover of the country. Both the national and state governments are jointly responsible for the sustainable management of the forest resources in India. Various steps, rules and laws have been brought and implemented in order to conserve the forest cover of India. Some of these rules and laws are [72]:

- The Indian Forest Act, 1927: The act is an amalgamation of laws relating to forests, the transit of forest produce and the duty leviable on timber and other forest produces. It defines the procedures for declaring an area of a reserved forest, a protected forest or a village forest by the state government. With the amendment in the Act in 2012, it also prohibited the fresh clearances in forests and setting fire in a reserved forest.

- Forest Conservation Act, 1980 (with an amendment in 1988): The main purpose of the proposition of this act was to conserve the forests and to look into the matters connected therewith or ancillary or incidental thereto. With the implementation of this act, a prior approval of the Central Government is required for any sort of diversion of forest areas for the non-forestry purposes.

- [73]: The establishment of the National Forest Policy was also among one of the steps taken by the Government of India in order to ensure compensatory afforestation, essential environmental safeguards, sustainable utilization, maintenance, restoration and enhancement of forest areas.

- Wildlife Protection Act, 1972: The wildlife protection act was enacted basically to protect wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with a view to ensure the ecological and environmental security of the country.

- The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006: The act was framed with the purpose to recognize and vest the forest rights and occupation in forest land in forest dwelling scheduled tribes and other traditional forest dwellers who have been residing in such forests for generations but whose rights could not be recorded. These recognized rights of the forest dwelling scheduled tribes and other traditional forest dwellers include the responsibilities and authority for sustainable use, conservation of biodiversity and maintenance of ecological balance which in turn aid in strengthening the conservation regime of the forests while ensuring livelihood and food security of the forest dwellings scheduled tribes and other traditional forest dwellers.

Apart from these laws, the Government of India has also established Forest Survey of India (FSI), an organization under the Ministry of Environment, Forest and Climate Change, whose primary work is to gather and evaluate the country's forest wealth through a nationwide survey to measure forest areas [74]. This in turn aids in determining the factors and drivers behind the loss or gain in forest cover of any particular region in India. Another council, i.e. the Compensatory Afforestation Fund Management and Planning Authority (CAMPA), was established by the Government of India in 2009 as a National Advisory Council under the chairmanship of the Union Minister of Environment, Forest and Climate Change for the monitoring, technical assistance and evaluation of compensatory afforestation activities. This was particularly meant to promote afforestation and regeneration activities as a way of compensating for forest land diverted to non-forest uses [75].

Certain scheme such as Integrated Forest Protection Scheme (IFPS) was being formulated by the government to save the forests from fire. The scheme was designed by combining the forest fire protection and management technique along with forest conservation. Various other missions and programmes such as the National Mission for a Green India (NMGI) and National Afforestation Programme (NAP) were also being launched by the Government of India where the main aim of NMGI was to improve the quality of five million hectares of degraded forests and to bring another five million hectares of non-forest areas under forest cover through social and farm forestry. On the other hand, the NAP was launched with the objective to develop the forest resources with people's participation, with a focus on improving the livelihood of the forest-fringe communities, especially the poor [75].

The Ministry of Environment, Forest and Climate Change has been optimistic in strengthening the role of women in conservation of forest at local community levels since long. The National Forest Policy [73], for the first time, acknowledged the necessity of including woman members in forestry schemes. The Joint Forest Management Policy of 1990 mandated woman representatives not less than 40% in general body and 50% in executive body of the local forestry institutions like the JFM committee. Later in 2002, the Biodiversity Authority of India reframing the local biodiversity management committee structure mandated the reservation of one-third of its members as women. Thus, this understanding of the role of women in the local-level conservation measures and implementation of related rules has aided in improving the management of forest in rural regions of the country [76].

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