Sustainability and Biodiversity Conservation

Biodiversity loss due to forest diversion

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Abstract

Forests, constituting 31% of Earth's surface, are crucial ecosystems vital for regulating ecosystem functions. Despite their ecological sensitivity and diverse contributions, such as food and water supply, biodiversity habitats, and climate regulation, global forests face escalating threats from industrialisation, urbanisation, and population growth. Development activities like urban expansion, transport, and hydroelectricity generation exacerbate the loss of ecological diversity, resulting in forest disappearance, habitat fragmentation, and altered land use. Forest diversion, involving clearing for agriculture and non-forestry purposes, poses a significant menace, with 80.30% of such diversions concentrated in Telangana, Rajasthan, Madhya Pradesh, Maharashtra, and Odisha. In 2017 alone, 11,596.18 hectares of forest land were approved for non-forestry use. These diversions have far-reaching negative impacts on biodiversity, habitat loss, species extinction, invasive species, forest employment, wildlife corridors, food chains, and human-animal conflicts.
Keywords: Biodiversity loss, forest diversion, fragmentation, non-forestry, habitat loss

Introduction

Forests are complex ecosystems with a wide array of attributes that interact with one another at various geographical scales. They occupy 31% of the surface of the planet. Forests are the biosphere's most prolific, environmentally sensitive, and incredibly diversified ecosystems. Because they provide a range of services and functions essential to maintaining livelihoods, forest ecosystems require sustainable management. Worldwide, forest ecosystems play a vital role in the economic growth of numerous communities. They are essential for controlling ecosystem services and functions, such as the supply of food and freshwater, habitats for biodiversity, air purification, and temperature management. However, the demand on forest ecosystems worldwide has increased as a result of the rapid industrialisation and urbanisation

that have coincided with a growing population. As a result, forests have been extensively destroyed, severely diminishing their quality and health. Large tracts of varied forest ecosystems disappeared annually, having a profound effect on biological diversity worldwide. The primary factors contributing to the decline of forest ecosystems are deforestation, invasive species, fragmentation, and climate change. (Dar et al, 2022). One of the key elements of the Earth's ecosystem is the diversity of forests. The primary anthropogenic activities causing biodiversity loss include the dependence of livestock on the forest for a living, which results from factors like overgrazing, unemployment, poverty, and the destruction of forest land for other uses. Ecological diversity is also severely lost as a result of other development activities as urbanisation, transportation, communication, hydroelectricity production, and tourism. Over time, these actions lead to the loss of ecosystem sustainability, the fragmentation of natural habitats, the removal of forests, modifications to land use, changes to vegetation dynamics, and changes in the species composition (Himshikha et al, 2022). Forest diversion is the process of removing forest land for the production of spices, coffee, tea, oil-bearing plants, palms, rubber, medicinal plants or horticultural crops. It also includes any use of forest land for purposes other than reforestation projects, such as irrigation, mining, industries, infrastructure, etc.

Forest Diversion

The process of converting a forest area to a non-forest use is known as "forest diversion." A significant portion of the Earth's surface was once covered by forest land, but today, every country is experiencing a shift in the use of forest land for various purposes, including roads, housing, railways, industries, agriculture, and many other civil and developmental works. As a result, the amount of land under forest cover is rapidly declining, making it impossible to maintain the 33 per cent forest area as stated in the National Forest Policy of 1952. On the other hand, forestlands are disappearing, deteriorating, and being used for other types of development. The severe detrimental effects of these forest diversions are still being felt in the surrounding climate, agriculture, soil, temperature, employment opportunities derived from the forest, wildlife corridor movement, fertility, soil erosion, food chain and conflicts between humans and animals, among other ecological elements. (Dudhapachare, 2013). Biodiversity loss due to forest divergence is the negative impact on the variety and abundance of plant and animal species within a particular ecosystem when forests are converted or degraded for various reasons. The loss to biodiversity is primarily due to habitat destruction, over-harvesting, pollution, inappropriate as well as indiscriminate development and overexploitation of natural resources. Forest divergence, often in the form of deforestation or habitat

fragmentation, disrupts the intricate balance of ecosystems and has significant consequences for biodiversity. (Prakash, 2017; Kumar and Verma, 2017). The primary threat to forests is still land being diverted for agriculture and other uses. Man-animal conflicts and biodiversity loss result from the conversion of forests for farming and other purposes, which disturbs the natural equilibrium.

Forest Diversion in India (2017)

The Forest (Conservation) Act, 1980, governs the process of diverting forest land in India for non-forestry uses, in accordance with the report on Analysis of Forest Diversion in India, 2017, the MOEF&CC approved 686 projects, resulting in the diversion of 11596.18 hectares of forest land for non-forestry uses. According to statistics on forest land diverted by the state, 80.30% of all forest land diverted for non-forestry purposes in 2017 was in five states: Telangana, Rajasthan, Madhya Pradesh, Maharashtra, and Odisha.

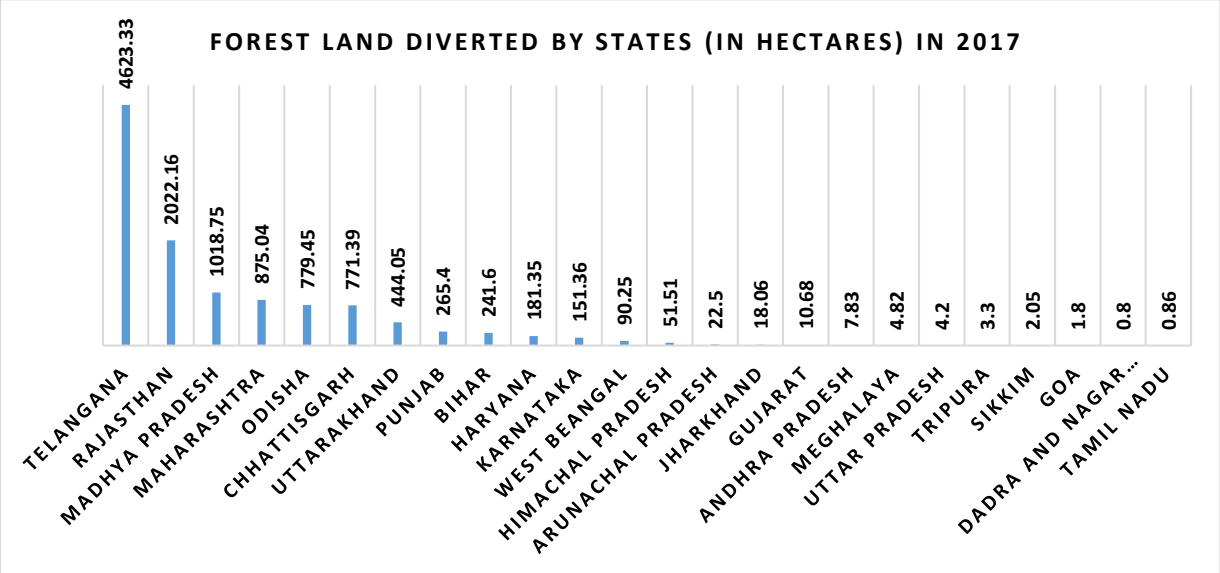

Figure 1. Forest land diverted by states (in Hectares) in 2017

Forest Land (in hectares) diverted for different projects in 2017

A proportion of different non-forestry uses out of the total amount of forest land that was suggested for diversion in 2017. 5,176.53 hectares of the 11,596.18 hectares of forest land that were converted for diversion in 2017 were used for irrigation projects. In 2017, 44.64% of the total forest land diverted was used for irrigation. Mining and quarrying were the next largest category after irrigation. 3,170.08 hectares, i.e., 27.34% of the total forest land diverted in 2017, was used for mining and quarrying. After that, 1,378.51 hectares of forest land were diverted for linear initiatives (such as highways, railroads, transmission lines, and pipelines). Of the

total forest land diverted in 2017, 11.89% was accounted for by linear proposals. Following Linear, "Others" was the second largest non-forestry use for which forest land was diverted in 2017. Proposals for infrastructure facilities, defence, ash disposal units, zoo/rescue centre construction for ex-situ conservation, and other additional purposes like building retail stores, approach access for gas pumps, and waste and sewage management facilities are included in this category. 904.08 hectares of forest land were diverted for "Others." When combined, projects including mining, irrigation, and linear proposals make up 83.86% of all the forest land that was diverted in 2017.

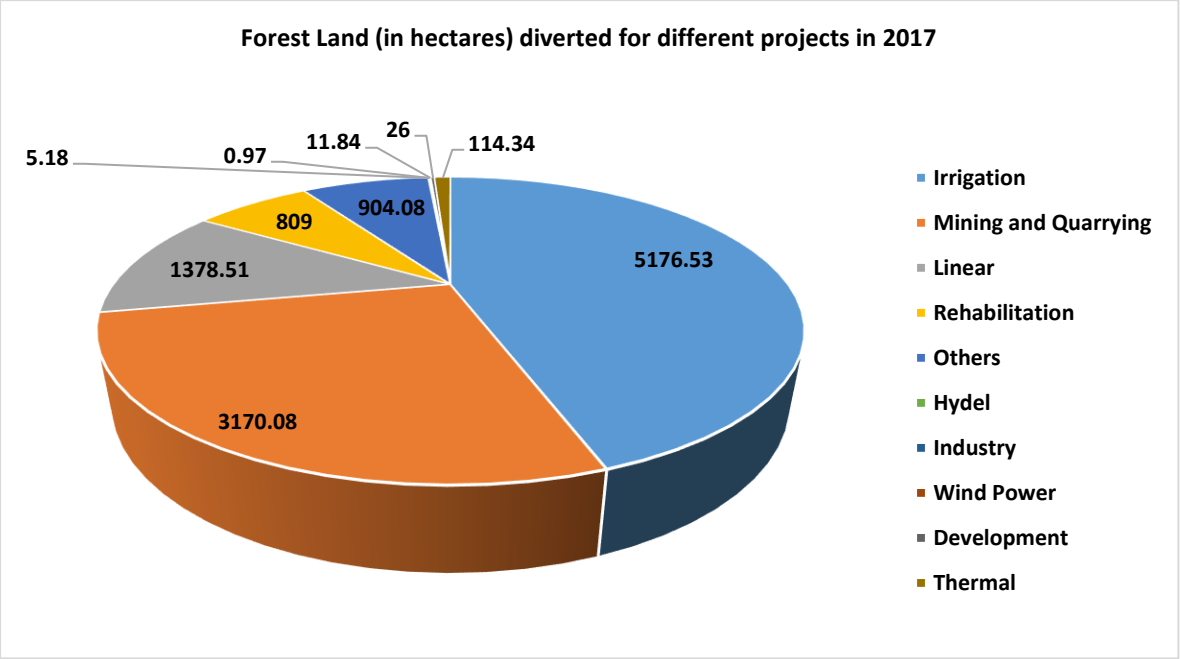

Figure 2. Forest land diverted for different projects in 2017

An article published in Mint on August 12, 2016, stated that based on information from the Union Environment Ministry, mining, irrigation, and hydroelectric projects have become the three main industries causing India's forest area to be diverted since the Forest Conservation Act (FC Act) was passed in 1980. Together, these three sectors make up about 900,000 hectares, or one-third of the total forest area that has been diverted. The FC Act permits the repurposing of Indian forest land for uses other than forestry. According to data from MoEFCC, a noteworthy 897,698.40 hectares of forest area were diverted for non-forestry operations like power projects, mining, roads and other industrial endeavours between October 1980 and July 2016. Notably, a total of 325,594 hectares, or over 36%, of the forest area diverted is due to irrigation (106,509 hectares), mining (132,464 hectares) and hydel projects (86,620 hectares). The combined impact of these five sectors becomes significant when one takes into account

the forest area diverted for defence (43,492 hectares) and the road sector (43,590 hectares), together accounting for over 46% (412,676 hectares) of the total forest area diverted in India. Madhya Pradesh is the state that has diverted the most amount of forest land, 245,978 hectares among the others. With 84,475 hectares, Chhattisgarh is in second position, closely followed by Gujarat (63,964 hectares), Punjab (63,371 hectares), and Maharashtra (60,001 hectares). More than 57% (517,789 hectares) of the total forest land diverted since the Forest Conservation Act's enactment in 1980 has come from these top five states combined.

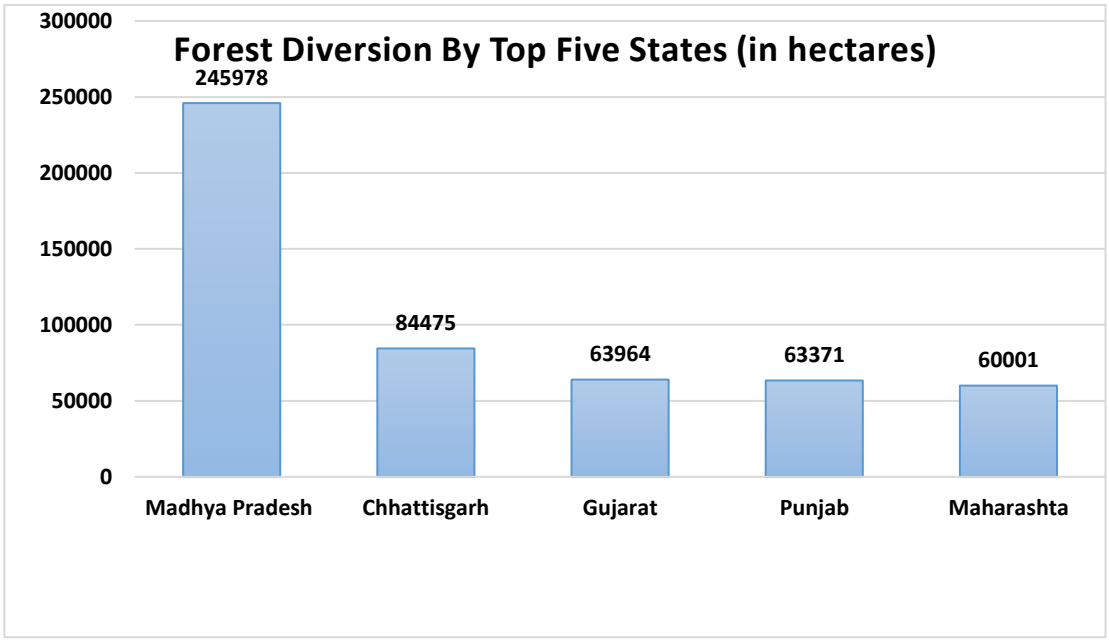

Figure 3. Forest Diversion by Top Five States (in hectares)

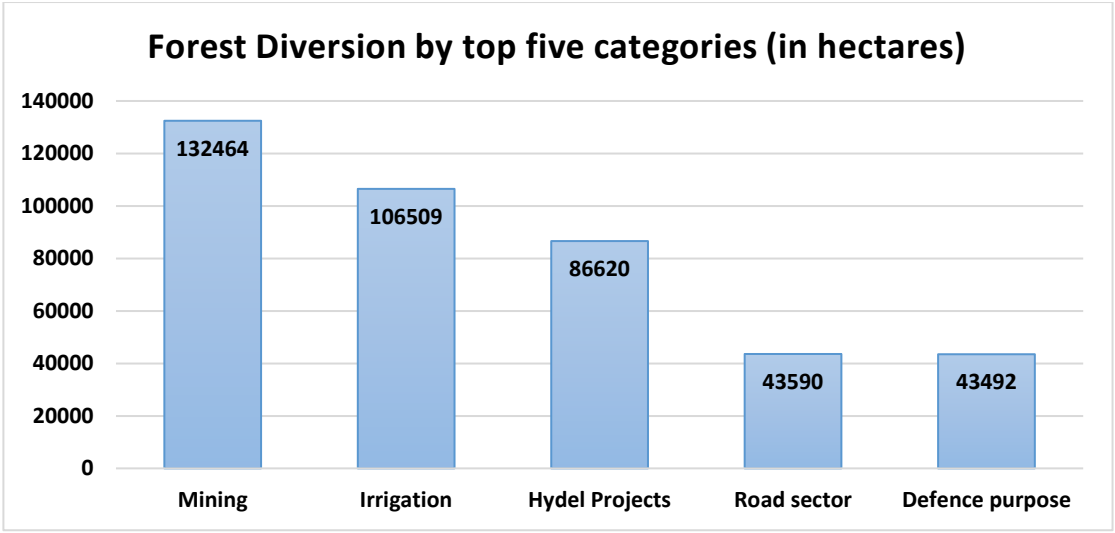

Figure 4. Forest Diversion by top five categories (in hectares)

Forest Diversion in Maharashtra

According to a January 2018 Hindustan Times article, Thane and Mumbai have recorded the largest number of forest encroachment cases in Maharashtra, with 49,463 and 33,850 cases, respectively, encompassing 973 and 6,170 hectares. With 670 sq. km. of its total 61,579 sq. km. of forest area encroached upon, Maharashtra ranks fifth nationally in terms of forest land loss to encroachers. 23% of the nation's total forest cover, or 13,612 sq. km, has been overrun by encroachment. The development of religious constructions, the diversion of land for agriculture, and urbanisation in the vicinity of Tier I and II cities are the primary challenges. Increased agricultural practices by tribal populations, religious structures, and urbanisation are responsible for the encroachments in Maharashtra, which have an effect on biodiversity and lead to conflicts between humans and animals. The biggest threat to forests is still land being diverted for agriculture and other uses. Man-animal conflicts and biodiversity loss result from the conversion of forests for farming and other purposes, which disturbs the natural equilibrium. The forest corridors that animals use to go from one forest region to another are severed by encroachments. Wildlife habitats and protected areas are rapidly disappearing. The flow of rivers will be impacted by encroachments for many years.

Forest Diversion in Odisha 2019-20

a) Section 2 of the Forest (Conservation) Act, 1980 allows for the diversion of forest land for non-forestry activities in Odisha. The MoEF&CC, Government of India, has approved this diversion of forest land. About 56,382.89 ha of forest land had been diverted under the aforementioned Act as of March 31, 2020, for various developmental projects; the specifics of this diversion are listed below.

Table 1. Forest diversion for various developmental projects in Odisha 2019-20

Sr. No	Sector	No. of Proposals	Forest Land Diverted (Ha)
1	Irrigation	84	10652.06
2	Industry	29	4404.63
3	Mining	186	28409.53
4	Energy	06	116.45
5	Road and Bridges	44	705.02
6	Railways	20	2433.48
7	Defence	04	3865.25
8	Human Habitation	04	361.53
9	Transmission	70	4338.81
10	Others	50	1096.13
	Total	497	56382.89

b) Permission granted for exploratory drilling following the 1980 Forest (Conservation) Act. Under section 2 of the Forest (Conservation) Act, 1980, the MoEF&CC of the Government of India has granted authorisation for the exploratory drilling of minerals on forest territory. As of March 31, 2020, authorisation has been granted by 14 project proponents for exploratory drilling of various minerals on 101.08 hectares of forest property.

c) The Forest Rights Act, 2006, Section 3(2), lists 13 categories in which the Ministry of Environment, Forests & Climate Change, Government of India, has authorized Divisional Forest Officers to grant permission for the diversion of forest land up to 1.0 hectares in each instance if it involves cutting no more than 75 trees per hectare for government departments small-scale public utility projects. 2006. Approximately 845.852 acres of forest land had been diverted as of March 31, 2020.

Table 2. Forest diversion for government departments in Odisha 2019-20

Sr. No.	**Sector**	**No. of Proposals**	**Diverted Forest Land (Ha)**
1	Anganwadi	14	0.761
2	Electric Line	598	305.685
3	Water Harvesting Structure	37	9.850
4	Tank and other minor water bodies	24	9.373
5	Drinking water supply and water pipelines	63	20.936
6	Irrigation	41	11.893
7	Road	534	369.946
8	School	110	60.751
9	Community canter	69	20.408
10	Vocational Training Centre	25	16.201
11	Hospital	14	4.216
12	Telephone line	13	2.113
13	Non-Conventional Energy Source	02	1.980
14	Others	20	11.739
	TOTAL	**1564**	**845.852**

d) to create critical public utility infrastructure by government departments, the State Government has received general approval under Section 2 of the Forest (Conservation) Act, 1980 from (MOEF), Government of India. This approval involves felling trees in districts affected by Left Wing Extremism (LWE) in 15 categories, not to exceed 50 trees per hectare. As of March 31, 2020, around 80.776 hectares of forest land have been redirected under the

aforementioned Act for a total of 19 distinct development projects. The specifics of these diversion projects are listed below.

Table 3. Forest diversion for various developmental projects in Odisha 2019-20

Sr. No.	Sector	No. of Proposals	Diverted Forest Land (Ha)
1	Stone Quarry	01	2.992
2	Drinking Water Supply	03	4.218
3	Road	07	53.540
4	Police Establishment	04	3.972
5	Irrigation	01	4.800
6	Power Sub Station	01	2.833
7	School	01	4.160
8	Transmission Line	01	4.261
	TOTAL	**19**	**80.776**

Impact of Forest Diversion on Biodiversity

The most serious danger to forests is still the diversion of land for farming and other uses. The equilibrium of nature gets disturbed when forests are converted to farms and other purposes, which results in a loss of biodiversity and conflicts between humans and animals.

Habitat Loss

Habitat loss is a serious threat to biodiversity and a crucial indicator of the extinction of species. This is a serious problem that affects both people and wildlife. Wildlife and habitat are causally linked. The three main types of habitat loss are habitat fragmentation, degradation, and annihilation. When a species' natural habitat is severely destroyed, it can no longer support both the species and its native ecosystems. This is known as habitat destruction. In the end, this leads to the extinction of species or the loss of biodiversity. Examples of habitat degradation include clearing forests to make way for fields for agriculture, filling marshes and mowing fields to make way for homes or businesses, harvesting fossil fuels, etc. The main causes of habitat degradation are the development of agricultural techniques, decreased availability of resources, including food, water, air quality, mining, pollution, logging, disastrous fishing operations, urbanisation-related activities, and disruption of ecosystem processes. Both humans and the species that live there are impacted by habitat deterioration. The deteriorated land continues to disappear due to erosion, desertification, and nutrient depletion (Singh et al, 2021). When a specific area is transformed from usable to unusable habitat, habitat loss occurs. The primary sources of habitat loss include mining, deforestation, aquaculture, industrial activity, and water extraction. (Verma, 2020). Urbanisation, agricultural conversion, and resource

extraction all result in habitat loss, which is the main cause of biodiversity loss. Another major threat to biodiversity is habitat fragmentation, or the loss of vast habitat units. Worldwide, animal and plant biodiversity are declining as a result of human activity. Preserving natural habitat is crucial for maintaining biodiversity on land and in water. (Arya, 2021; Chakraborty et al., 2021). While coral reefs are disappearing as a result of increased pollution and overexploitation, tropical forests are mostly threatened by land conversion for other purposes. According to some research, up to half of all animal and bird species could become extinct in the next 200–300 years. Loss of habitat lowers species richness and causes population declines. (Butchart et al., 2010).

Habitat Fragmentation

The fragmentation of tropical forests is causing habitat loss and eroding biodiversity. (Pimm, 1998; Laurance, 1999). The loss of tropical biodiversity at the local and regional levels has been the subject of numerous studies in recent years. It is recognised that fragmentation is a major worldwide concern. One of the most significant factors contributing to the decline in biodiversity in forest environments is fragmentation. (Fahrig, 2003). Due to habitat fragmentation, it is anticipated that several species will be highly vulnerable (Bustamante et al., 2003). In order to address the quantitative measurements of fragmentation, habitat fragmentation leads to an increase in the number of patches, a decrease in patch sizes, and an increase in patch isolation. A low core habitat and microclimatic changes in the edges are caused by the ongoing fragmentation, which also makes it easier for invasive alien species to establish themselves interior of the forest fragments. (Bustamante et al., 2003). (Reddy et al, 2013) revealed that patches with an area of less than 1 km^2 make up more than 90% of all forest fragments in all biogeographic zones. The decline and fragmentation of forests offer glaring illustrations of the connections between ecological pattern and process. Declines in species richness and variety, increased within-patch extinction rates, and the eventual extinction of area-sensitive species are all caused by reductions in forest area. Loss of forest also leads to decreased rates of immigration within patches, greater isolation of remnants, and less "rescue" from neighbouring populations. (Kupfer.et.al, 2009). The rapid disappearance of biodiversity in all its forms and at all scales is a cause for concern on a global scale. The primary reason for the decline in biodiversity is habitat destruction. The complete disappearance of a habitat or its degradation and/or fragmentation have a negative impact on species and ecological processes. Species introductions and changed rates of disturbances could encourage greater local diversity regionally, while habitat loss or modification, outbreaks of native or introduced species, and management of exploitable systems typically result in a decrease in species richness and

heterogeneity. (Lubchenco et al. 1991; Raghubanshi et al, 2009). In parallel, there is a growing fragmentation of forests, which has an impact on the distributions of flora and fauna, variety, and associated ecosystem services. However, most researchers believe that habitat fragmentation, either directly or indirectly, might lower species diversity by diminishing the core area or creating habitat isolation. The expansion of human land use is causing habitats to become more fragmented and under pressure, which is leading to a loss of habitat in terms of both quantity and quality. (Yin et al., 2019). By changing the spatial arrangement and community composition, fragmentation decreases habitat connectivity and may raise the risk of extinction. (Kong et al, 2021).

Loss of Biodiversity Hotspots

Biodiversity hotspots are areas of exceptionally rich biodiversity that are seriously threatened by human activity. These regions are distinguished by a high degree of endemism, and the fact that many species are unique to these locations and cannot be found anywhere else in the world.36 biodiversity hotspots hold the majority of Earth's biodiversity, although fewer than 10% of naturally occurring intact vegetation currently remains. 50% of vascular plants, 42% of endemic terrestrial vertebrate species, and 75% of the planet's endangered terrestrial vertebrate species are found in these hotspots. The loss of habitat poses a greater risk to hotspots and their biodiversity than climate change. Hotspots face the greatest threats in tropical Africa and some regions of Asia due to population pressure and increased demand for agricultural land. (Habel et al, 2019). Global biodiversity is being lost as a result of land being converted from natural areas to agricultural and populated areas. In global biodiversity hotspots, encroaching urban areas and agricultural land occupation accounted for roughly 90% and 10% of habitat loss, respectively. The developing countries' hotspots saw significant habitat loss due to agricultural land use, while the hotspots also showed greater threats to biodiversity from urban expansion. (Habel et al, 2019).

Invasive species

Invasive species have been brought about mostly by human activity, sometimes on purpose and other times accidentally. Notably, in this regard, the United Nations' Global Assessment Report on Biodiversity and Ecosystem Services recently identified that the main factor for the loss of biodiversity is invasive alien species (IPBES, 2019). An ever-widening spectrum of Invasive Alien Species are being dispersed by human-mediated travel, migration, and commerce over formerly resilient environmental barriers, including mountain ranges, hostile temperature zones, and fresh- and marine-aquatic habitats (Rai, 2015; Kueffer, 2017; Rai et al, 2020)**.** The introduction of invasive species poses the greatest threat to the biodiversity crisis.

Non-native species are called invasive species, and humans are the main force behind their introduction into the new ecosystem, where they start to pullulate. These species are harmful because they have a greater impact on the ecosystem than any other species. While a few newly introduced species become invasive and negatively impact the ecosystem, the majority of them do not become invasive. Numerous factors cause invasive species to disturb the natural ecology, including altering the habitat, introducing pathogens, being herbivorous on plants in native ecosystems, decreasing genetic diversity through hybridisation, and directly competing with native species for resources. Since preventing the loss of biodiversity is crucial for development, communities must continue to show their unwavering dedication to and reaction to this issue (Singh et al, 2021; Kilpatrick et al, 2017).

Species Extinction

Over the last fifty years, there has been a rapid rise in the global population, development, and urbanisation of the planet, resulting in the deforestation of hundreds of millions of acres of forests worldwide. Because of this, animals are losing more and more food sources and habitats every day. A 2020 study indicates that the sixth mass extinction of wildlife on Earth is escalating, with over 500 species of land animals at risk of going extinct and most certainly going extinct in the next 20 years (Mandowara, 2023). Additionally, it is predicted that by 2100, the dense forest cover (>40% canopy cover) in the Indian Himalayas will only make up 10% of the region's total land area if deforestation in the Himalayas continues at its current rate. 35 endemic vertebrates and 366 endemic plants could be significantly lost as a result of this. (Kumari et al, 2019). Many animal, bird, and insect species that live in forests have disappeared as a result of the reduction in forest cover, and numerous plant species have also vanished. Since the rainforest still harbours more than 80% of all species on Earth. Additionally, it is estimated that between 50 and 100 animal species disappear every day, resulting in the degradation of their natural habitats. Therefore, the only species that will probably survive in the future are those whose habitats are heavily protected. It is well known that fewer species may be supported by smaller land areas than by bigger land areas (Kumar, 2020)

Human Wildlife Conflict

As human activities continue to alter natural habitats, large predators find themselves compelled to inhabit and share space with humans in multifunctional landscapes. This coexistence frequently results in conflicts between humans and carnivores, presenting a significant obstacle to biodiversity conservation. The ongoing challenges in coexisting stem from the expenses incurred due to repeated damage caused by predator attacks, leading to

retaliatory killings and the potential local extinction of large carnivores. This jeopardizes the overall biodiversity of ecosystems in shared landscapes (Ripple et al, 2014; Naha et al, 2021). Human-wildlife conflict (HWC) is the term used to describe conflicts that occur when the behaviour or presence of wildlife poses real or perceived direct, ongoing risks to human needs or interests. These conflicts frequently result in conflict between groups of people and have detrimental effects on both people and wildlife. Numerous anthropogenic and ecological factors put pressure on areas where people and wildlife coexist, which leads to HWC. The potential for HWC is increased by anthropogenic factors such as habitat loss, changes in land use, livestock management, expansion of agricultural activities, resource exploitation, infrastructural development, and urbanisation. HWC is typically driven by an increase in the area of land and sea that is shared by humans and wildlife, which is typically brought about by a decrease in the amount of space available for animals to survive free from human disturbance. (Gross et al, 2021). Many species are forced to encroach on human welfare because their habitats are being limited by the declining level of forest cover. Instances of encroachment and the killing of animals are on the rise. A significant portion of the Himalaya Biodiversity Hotspot is located along the northern border of West Bengal, India. Over the past ten years, there has been significant fragmentation in the area, leading to significant losses in agricultural yield and human and elephant deaths as a result of conflicts. Each year, 20 elephants and 50 people are reported to have died in this region (Kumari et al., 2019). As reported by Planet Custodian, India frequently experiences human-wildlife conflicts due to the proximity of many people to forests. Ministry data covering the period from 2014-15 to 2018-19 reveals that 333 elephants died from electrocution, 71 from poaching, and 29 from poisoning, while train accidents claimed the lives of others. According to the Minister of MOEF&CC, between 2018-19 and 2020-21, 222 elephants succumbed to electrocution, 45 to train accidents, 29 to poaching, and 11 to poisoning nationwide. The data also indicates that, among tigers, 29 fell victim to poaching from 2019 to 2021, with 197 tiger deaths currently under investigation. (The Indian Express, July 26, 2022)

Conclusion

Forest diversion poses a serious danger to biodiversity, leading to the irreversible extinction of many plant and animal species as well as the intricate ecosystems they depend on. The fragmentation and destruction of vital habitats are caused by human activities such as logging, agriculture, and infrastructure development, which accelerate the loss of biodiversity on a global scale. Diverted forests result in habitat loss and degradation for rare and specialised

species, driving many of them dangerously close to extinction. Disruptions to the intricate web of ecological linkages and interdependence result in imbalances that have an impact on entire ecosystems. Urgent and coordinated action is needed to protect and restore forest ecosystems in order to address the alarming reduction in biodiversity.

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