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Biodiversity Crisis in India: Drivers, Impacts, and Policy Gaps

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ABSTRACT

India is one of the world's megadiverse countries, supporting roughly 7-8% of all known species although making up only 2.4% of the planet's land area. However, the nation's biodiversity loss has accelerated due to both environmental change and economic development. The IUCN has classified over 12% of assessed animal species as endangered, and about 90% of the land within India's four global biodiversity hotspots has already been degraded. Although earlier studies have examined specific threats to biodiversity in India, a comprehensive understanding of how these interconnected factors collectively drive biodiversity decline remains limited. This review comprehensively evaluates the major causes of biodiversity loss, including land-use change, mining, infrastructure expansion, pollution, climate change, overexploitation, invasive alien species, and habitat fragmentation. Emphasis is placed on forest diversion, ecosystem degradation, pollution-driven ecological stress, climate change induced habitat alterations, and the growing incidence of human-wildlife conflict. By integrating findings from scientific studies, conservation assessments, monitoring programmes, and policy records, the review provides a national-scale perspective on biodiversity decline in India and presents an evidence-based framework to support conservation planning, environmental governance, and sustainable development strategies.

KEYWORDS: Anthropogenic disturbance, Ecological fragmentation, Environmental governance, Habitat degradation, Species decline.

INTRODUCTION

Biodiversity, the variety of life on Earth that includes genetic, species, and ecosystem diversity, underpins ecosystem services that are essential for human well-being, such as pollination, water purification, and climate regulation. India is exceptionally rich in biodiversity, and despite occupying only about 2.4% of the world's land area, it harbours nearly 7 to 8% of the planet's recorded species (National Biodiversity, 2020). It is one of only 17 megadiverse countries globally, supporting an estimated 96,000 species of animals and 47,000 species of plants. Four global biodiversity hotspots fall wholly or partially within India, including the Himalaya and Indo-Burma region encompassing Northeast India, the Western Ghats, and Sundaland represented by the Andaman Islands. These regions are characterised by exceptionally high levels of endemism and many threatened species (National Biodiversity, 2020). Paradoxically, India's rich biological heritage is under severe pressure. Habitat loss from development, pollution, overexploitation, invasive species and climate change is driving sharp declines in many taxa (CSE, INDIA, 2021; Research Matters, 2025). India's biodiversity crisis is part of a broader global trend of biodiversity decline highlighted by recent international assessments. The inter-governmental Science Policy Platform on Biodiversity and Ecosystem Services (IPBES) has warned that up to one million species worldwide face extinction due to human activities, while the Convention on Biological Diversity's Kunming-Montreal Global Biodiversity Framework (2022) has

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established ambitious targets for halting biodiversity loss, restoring degraded ecosystems, and protecting at least 30% of terrestrial and marine areas by 2030 (IPBES, 2019; CBD, 2026). Evaluating India's biodiversity trajectory is therefore essential not only for national conservation planning but also for assessing progress toward global biodiversity commitments. Recent surveys report alarming trends, showing that more than half of the bird species for which long-term data exist are declining in population, and dozens of Indian species are already extinct or endangered (Eapen, 2020). The State of India's Birds Report 2020, analysing 867 bird species, found that 52% of 261 species with long-term data have declined since 2000, with 22% declining sharply. Alarmingly, among 146 species assessed for recent trends, nearly 80% are declining, and about 50% are in steep decline. In just five years, the number of Indian bird species at high risk of extinction rose from 82 to 101. Some species face near collapse, with the Finn's Weaver declining by up to 94% and fewer than 500 individuals remaining in India (Eapen, 2020). Conservation gaps extend well beyond avian species and reveal significant policy shortcomings. In India, 159 freshwater fish species are threatened with extinction, yet none are included under the protection. Habitat loss remains a central driver of biodiversity decline. Since 2015, approvals have been granted for the felling of nearly 11 million trees, and between 2019 and 2020, about 692 hectares of protected wildlife habitat were cleared for infrastructure projects. These trends mirror a broaden global crisis, with wildlife approximately 13 per cent are classified as facing a high risk of extinction. This includes 180 critically endangered species, many of which still lack adequate legal of the Wildlife Protection Act. More broadly, of the 8,664 species assessed in India by the International Union for Conservation of Nature (IUCN) Red List, populations have declined by 68 per cent since 1970, placing India among the countries at the highest risk of biodiversity collapse (Eapen, 2020)

An India-specific assessment is particularly important because the country simultaneously supports exceptional biological diversity, a large and growing human population, and one of the world's fastest-growing economies. The resulting pressures from infrastructure expansion, urbanisation, energy development, and resource extraction create unique conservation challenges that differ from those faced by many other megadiverse nations. Furthermore, India plays a critical role in achieving global biodiversity conservation goals, as the status of its ecosystems directly influences regional ecological stability, climate resilience, and the persistence of numerous endemic species. India has already lost around 90% of the area within its four global biodiversity hotspots, signalling an extreme erosion of its most species-rich landscapes. The Indo-Burma hotspot has suffered the greatest damage, with natural vegetation shrinking from 2,373,057 sq. km to just 118,653 sq. km a staggering 95% loss. Consequently, at least 25 species have gone extinct within these hotspots alone. According to the IUCN Red List, 1,212 animal species in India are monitored, and over 12% are endangered. Among the 148 endangered species, the crisis is particularly acute for vertebrates, including 69 mammals, 456 amphibians, and 23 reptiles, highlighting the disproportionate vulnerability of amphibians (CSEINDIA, 2021).

This paper reviews the causes and patterns of biodiversity loss in India, focusing on human-driven land-use change and ecological stressors. We stress that India's status as a megadiverse nation is under threat and outline the objectives of this review, which are to synthesise recent evidence on biodiversity decline, identify major anthropogenic pressures ranging from forest diversion and pollution to climate change, and examine policy and management responses. By surveying the literature and government data from the past decade, we aim to provide a thorough overview of how India's development trajectory is impacting its biological wealth and what measures could mitigate these trends.

Overview of Biodiversity in India

India is officially divided into ten biogeographic zones (Trans-Himalayan, Himalayan, Desert, Semi-Arid, Western Ghats, Deccan Peninsula, Gangetic Plains, North-East, Coasts, and Islands). Each zone encompasses distinct climates and ecosystems, ranging from the alpine and temperate forests of the Himalayas to the tropical rainforests and montane grasslands of the Western Ghats, and from the dry thorny scrub of the Thar Desert to the mangrove-rich coastal wetlands. These zones are further subdivided into 27 biogeographic provinces. For example, the Himalayan zone contains subtropical forests at lower elevations and coniferous and alpine ecosystems higher up, while the Western Ghats (a UNESCO World Heritage site) run along India's western coast and support lush tropical evergreen forests with exceptionally high endemism. The Gangetic Plains, Northeast India, and islands such as the Andaman and Nicobar Islands each support distinct and unique assemblages of species (Sharma, 2025). Two of India's zones, the Western Ghats and the Eastern Himalaya region, are internationally recognised biodiversity hotspots (among the 36 globally) due to their extraordinary endemism and extensive habitat loss. For example, the Western Ghats cover only ~4% of India's area but contain about 15,000 plant species, and nearly 4,000 of which are endemic to the region. The Eastern Himalaya (part of the larger Himalayan hotspot) also hosts hundreds of endemic plants and animals adapted to the montane environment. Aside from hotspots, many other habitats in India (e.g., central Indian forests, Gangetic wetlands, and coastal mangroves) are highly biodiverse (National Biodiversity, 2020; Sharma, 2025). Despite this richness, many Indian species are under threat. Of the roughly 1,212 Indian vertebrate species monitored by IUCN, over 12% are listed as threatened (endangered or critically endangered). In India's hotspot regions alone, at least 25 species have already gone extinct, and about one in eight of the assessed species is endangered (National Biodiversity, 2020). Iconic mammals like Bengal tigers, Asiatic lions, one-horned rhinoceros, Asian elephants, and snow leopards are threatened by habitat loss and poaching (Lai, 2024). Many amphibians and birds with restricted distributions, such as forest frogs and vultures, are also in decline. Overall, India's once-rich baseline biodiversity is being steadily eroded, as protected-area inventories and ecological surveys increasingly show that formerly common species are disappearing, becoming fragmented into small populations, or shifting their geographic ranges (WWF India, 2024).

Measuring Biodiversity Loss in India

Quantifying trends in biodiversity is challenging but crucial. India relies on multiple data sources, such as the IUCN Red List, which provides global threat assessments for some species, and it also produces a National Red List for plants and selected animal groups. The government's ENVIS (Environmental Information System) network and the Wildlife Institute of India compile biodiversity data, while the Forest Survey of India (FSI) publishes biennial Forest Cover reports that track changes in forest area and type. The latest report by the Ministry of Environment, Forest and Climate Change (MoEFCC) (2024) states that India's forest and tree cover combined is about 25.17% of the country's land. Although overall forest cover has shown slight net increases in recent decades (due in part to plantations and regrowth), this metric mask continuing loss of old-growth forests and wildlife habitat in many regions (Pandey, 2024a). According to the Universal Group of Institutions (2024), tree cover showed a significant increase of 1,289 sq. km, reflecting a sharp 0.5% growth in the last two years. In contrast, forest cover growth remains marginal, increasing by only 0.05% since 2021. Over the past two decades, the growth in tree cover has been driven primarily by plantations, whereas natural forest cover has shown little to no significant increase. Between 2021 and 2023, India lost 3,913 sq. km of dense forests, consistent with a 20-year trend of steady degradation. From 2003 to 2023, 24,651

sq. km of dense forests were destroyed, half the size of Punjab. Between 2014 and 2024, Mizoram experienced a substantial decline in forest resources, losing approximately 270 thousand hectares of forest cover over the ten-year period (Table 1). Although some losses were offset by plantations, natural dense forests are being replaced by monoculture plantations, raising ecological concerns. Reclassifying plantations as dense forests artificially boosts reported growth figures and obscures the true extent of forest degradation. While plantations help meet carbon targets faster, their frequent harvesting undermines long-term climate goals. Experts argue the report counts plantations, roadside trees, orchards, and urban patches as "forest cover". This inflates numbers and masks the decline of natural, biodiverse forests. Environmental lawyer Ritwick Dutta noted contradictions, explaining that roadside plantations are not considered forests under the Forest Conservation Act 1980 but are counted as forest cover in the India State of Forest Report (Aggarwal, 2022a; Pandey, 2024a). Between 2014 and 2024, India experienced a loss of 1.5 million hectares of tree cover, representing 4% of its tree cover recorded in 2000. This decline resulted in an estimated 830 million tonnes of carbon dioxide equivalent emissions (GFW, 2026) (Figure 1).

Rank	States/UTs	Forest cover Loss
1	Mizoram	270
2	Assam	200
3	Manipur	180
4	Meghalaya	170
5	Nagaland	160
6	Tripura	100
7	Odisha	89
8	Kerala	78
9	Arunachal Pradesh	67
10	Karnataka	32

Table 1: State wise tree cover loss in India in thousand hectares across selected states from 2014-2024. Source: https://www.globalforestwatch.org/

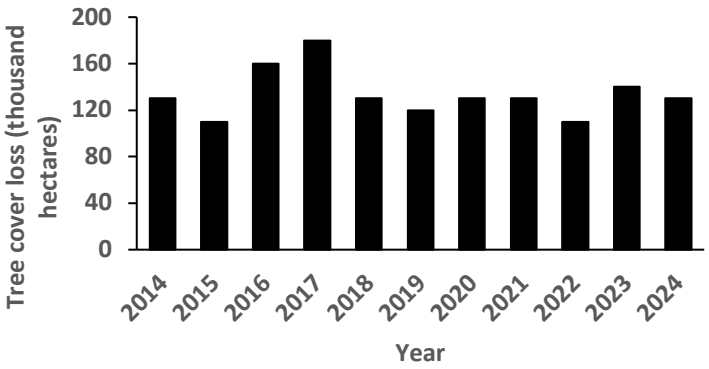

Figure 1**.** Annual tree cover loss in India from 2014 to 2024 expressed in thousand hectares showing year wise variation in forest decline. Source: https://www.globalforestwatch.org/

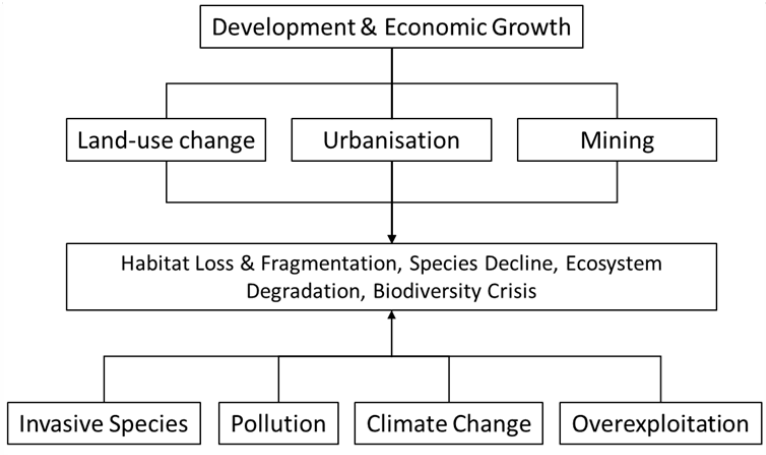

Figure 2. Conceptual framework illustrating the major anthropogenic drivers of biodiversity loss in India.

Citizen science initiatives and NGO-led research have helped bridge major data gaps in biodiversity monitoring. Analyses of bird population trends using eBird checklist data illustrate this clearly. The State of India's Birds (SoIB) 2023 evaluated 942 bird species and found long-term declines in 204 species, with 142 species showing ongoing declines (Viswanathan et al., 2025). Earlier, the SoIB 2020 reported that among 261 species with sufficient long-term data, 52% had declined since 2000, including 22% showing steep declines. This pattern has intensified, with SoIB 2023 indicating 60% of species in long-term decline and 40% in current decline (Bird Count India, 2023).

These results point to widespread deterioration, affecting even once-common birds, with species feeding on vertebrates or invertebrates declining most rapidly (Viswanathan et al., 2025). Comparable trends are emerging from targeted studies on plants, butterflies, and freshwater taxa, which report rapid local losses despite limited systematic monitoring. Nearly 23% of freshwater species remain data deficient, suggesting that actual extinction rates are likely underestimated (Sayer et al., 2025). Regional assessments further confirm a sharp decline in freshwater faunal diversity across India, with many species now facing a high risk of extinction (Dimri et al., 2025).

MAJOR DRIVERS AND IMPACTS OF BIODIVERSITY LOSS IN INDIA

Although biodiversity loss in India is driven by multiple interacting pressures, available evidence indicates that land-use change and habitat loss remain the dominant drivers, primarily through forest diversion, mining, infrastructure expansion, and urbanisation. These pressures are followed by pollution, climate change, overexploitation of biological resources, invasive alien species, and habitat fragmentation (Figure 2). Importantly, these drivers rarely operate in isolation. For example, road construction can simultaneously cause habitat loss, fragmentation, pollution, and facilitate the spread of invasive species.

Climate change further amplifies the impacts of existing stressors by reducing ecosystem resilience and accelerating species declines. Therefore, biodiversity loss in India should be viewed as the outcome of interacting and mutually reinforcing pressures rather than independent threats. Biodiversity loss in India is driven by a complex set of interacting pressures that are reshaping ecosystems across regions and taxa. The following sections examine the principal drivers of biodiversity loss in India and their ecological impacts.

1. Land-Use Change and Deforestation Driven by Development Projects

Land use change, particularly the conversion of natural forests to other uses, is the dominant

driver of habitat loss in India. This section examines the multiple ways in which development projects sanctioned by the government or carried out illegally lead to forest clearance and ecosystem degradation.

1.1 Government-Permitted Deforestation

Under the Indian Forest (Conservation) Act, 1980, now the Van (Sanrakshan Evam Samvardhan) Adhiniyam, any diversion of forest land for non-forest uses (mining, roads, reservoirs, etc.) requires central approval. Despite this, hundreds of thousands of hectares have been cleared. Government data show that 173,984.3 hectares of forest land were approved for diversion to "non-forestry" projects between 2014 and 2024 (DTE, 2025; Nandi, 2025). The largest categories of approved diversion in that decade were mining/quarrying (> 40,000 ha) and hydropower/irrigation projects (> 40,000 ha). Linear infrastructure is a major driver of forest diversion. Between 2014 and 2024, approvals covered approximately 30,606 ha for roads and about 17,233 ha for power transmission lines. Railway expansion, involving around 8,000 ha, and defence installations, covering nearly 14,968 ha, were also significant, alongside smaller allocations for industry and urban-related uses. Overall, forest clearances for infrastructure and industrial projects increased by more than 150% between 2014 and 2023 (The Assam Tribune, 2025). These figures indicate massive habitat fragmentation under official sanction. For example, new highways through central India have bisected corridors once used by tigers and elephants, and large dam projects have flooded valleys that hosted diverse forest communities. Urban projects expanding airports, rail networks, and "smart city" zones routinely involve forest land diversion (Variyar, 2021; SANDRP, 2025). Compensatory afforestation is meant to offset forest loss, but in practice it often falls short. States struggle to secure appropriate land, so plantations are frequently created far from the original sites, weakening their ecological value. While new trees may restore canopy cover, they cannot replicate the biodiversity and complexity of mature forests. Even where compensatory afforestation is mandated, it often results in monoculture plantations far from the lost habitat. Large land requirements also raise risks of community displacement, procedural bypasses, and land banking. Critics argue that the policy can end up legitimising forest diversion rather than preventing it. In Delhi, limited non-forest land has pushed authorities to consider planting in neighbouring states, a move widely criticised as ecologically ineffective and counterproductive (CUES, 2021; Hindustan Times, 2021). The cumulative effect is a piecemeal undermining of India's forest cover and connectivity under the guise of development.

1.2 Mining Expansion and Habitat Destruction

Mining represents one of the most consequential forms of approved land use change in India, as vast deposits of coal and metallic ores lie beneath forested regions in states such as Chhattisgarh, Odisha, Jharkhand, and Karnataka. Official data showing tens of thousands of hectares diverted for mining reflects its central role in deforestation. Although national reports often cite increasing forest cover, large tracts of dense forests have been cleared for extraction. Both legal and illegal operations, frequently enabled by weak oversight and political backing, have expanded across mineral-rich regions, including Madhya Pradesh and Maharashtra (WRM, 2019; Dhankhar, 2025). The Hasdeo Arand illustrates the conflict, where mining approvals proceeded despite ecological sensitivity, wildlife corridor value, and community resistance. Safeguards under the Forest Rights Act are often diluted, and funds meant for ecological restoration are diverted toward relocations rather than regeneration. The Aravalli Range across Rajasthan, Haryana, and Delhi faces similar degradation from illegal stone extraction. Vegetation loss, soil erosion, groundwater decline, and advancing desertification threaten livelihoods and biodiversity. Open-pit mines and associated infrastructure fragment habitats, disrupt wildlife corridors, and shrink common

lands, intensifying ecological stress and social conflict across forested landscapes (Dhankhar, 2025).

1.3 Absence of Meaningful Compensatory Afforestation

Indian law mandates that diversion of forest land for non-forest purposes be accompanied by compensatory afforestation on an equivalent or larger area, together with payment of net present value to account for the loss of ecosystem services. Under India's forest governance framework, these financial contributions are collected and managed through the Compensatory Afforestation Fund Act, 2016, which is intended to ensure ecological offsetting of forest diversion (National CAMPA online, 2026). While this framework is designed to balance development with conservation, its practical outcomes have been widely questioned. A Supreme Court–appointed committee and several audits, including assessments based on Comptroller and Auditor General findings, have revealed persistent implementation failures such as delays in land transfer, absence of actual plantations, use of community lands for afforestation, and completion of plantations on only a small fraction of the mandated area. Consequently, compensatory plantations have not matched the ecological functions of natural forests, leading to an overall decline in forest quality and extent despite formal compliance (Aggarwal, 2022b). Further analyses show that many CA initiatives prioritise fast-growing commercial species such as eucalyptus, acacia, and teak, often planted as monocultures on marginal lands. These plantations deplete groundwater, degrade soils, and support limited biodiversity, failing to restore original forest structure or wildlife habitat (Nitnaware, 2026). Concerns have intensified following recent policy changes that allow large commercial plantations to be classified as forestry, thereby exempting them from CA and NPV requirements. Conservationists argue that this shift effectively replaces natural forests with tree farms, weakening ecological safeguards and undermining genuine forest conservation (INSIGHTS IAS, 2026; NORTHEAST NOW, 2026; Rahul, 2023). Thus, the legal framework still links clearance to replanting, but implementation has often failed to preserve ecosystems.

2. Urbanisation and Infrastructure Development

Rapid and inadequately planned urbanisation has emerged as a dominant driver of environmental transformation in India's fragile ecosystems, particularly in the northwest Himalayas and the Western Ghats. In the Lesser Himalayas of Uttarakhand and Himachal Pradesh, urban expansion has intensified land use within ecologically sensitive landscapes. Remote sensing analysis from Nainital district shows an 11% decline in natural forest cover between 1991 and 2023, accompanied by a more than 100% increase in built-up area. Much of this growth has occurred over forests, agricultural land, spring sheds, floodplains, and steep slopes, leading to a 17% reduction in groundwater recharge, 35% depletion of natural springs, 11% loss of urban wetlands, and a 27% decline in biodiversity. Uttarakhand now ranks as the fastest urbanising Himalayan state, with over 30% of its population residing in urban areas compared to a regional average of 26%, while urban growth has encroached upon 11% of agricultural land and 9% of forests. Comparable land cover changes linked to urbanisation, timber extraction, and mining have also been documented in Kashmir, with projections indicating continued woodland decline in the Northwest Himalayas by 2030 (Pandey, 2024b). Across India, rapid urban population growth has driven cities to expand into surrounding natural habitats. Major metropolitan regions such as Delhi NCR, Mumbai, Bengaluru, and Hyderabad have experienced extensive sprawl, resulting in the large-scale loss of peri-urban ecosystems, including wetlands, lakes, and green corridors (Pandey, 2024b). In Delhi NCR, the disappearance of large numbers of wetlands has been associated with reduced groundwater recharge, increased flood risk, and intensifying urban heat island effects, as natural drainage

basins are replaced by impervious surfaces (Singh et al., 2023; Pandey, 2025; Yadav et al., 2025). Urban infrastructure development further fragments habitats by dissecting wildlife corridors through highways, ring roads, industrial zones, and residential projects. As forest patches become isolated, large mammals such as leopards and tigers are increasingly forced into human-dominated landscapes, resulting in rising wildlife sightings and escalating human-wildlife conflict, genetic bottlenecks, and ecological stress along urban fringes (Rajani, 2025; Singh et al., 2025a).

3. Pollution as a Driver of Biodiversity Loss

3.1 Air Pollution

Air pollution has emerged as a significant driver of biodiversity decline in India, causing direct physiological injury and disrupting ecological interactions, particularly in urban hotspots (Goud, 2024). Evidence from a four-year investigation by the National Centre for Biological Sciences highlights the severity of this threat.

The study analysed 1,820 wild giant Asian honeybees (*Apis dorsata*) across rural to highly polluted sites in Bengaluru and reported stark mortality differences. Average PM10 levels were 28.32 µg per m³ in rural areas but exceeded 100 µg per m³ at the most polluted sites, surpassing national standards at six of seven locations. In polluted environments, 80% of bees died within 24 hours and all perished within 1.5 days, whereas some rural bees survived up to four days. Exposed bees showed reduced foraging, irregular heart function, suppressed immunity, altered gene expression, and body surfaces coated with arsenic, lead, and tungsten. Laboratory-reared Drosophila melanogaster displayed comparable physiological disruptions under similar exposure conditions (Rao, 2020; Thimmegowda et al., 2020). Air pollutants further disrupt pollination by degrading floral scents and pheromonal signals. Ozone and nitrogen oxides can reduce flower visitation by up to 90% and pollination success by 31%, impairing insect communication and reproduction (Duque and Stefan Deventer, 2024; Kimbrough, 2022). Vegetation also experiences substantial injury. Ozone, sulphur dioxide, nitrogen oxides, and particulate matter impair photosynthesis, damage leaf tissues, disrupt nutrient uptake, and delay flowering, resulting in 5 to 10% crop yield losses and reduced carbon sequestration (González Medina et al., 2025; Singh et al., 2025b). Vertebrates face respiratory and systemic impacts from inhaling PM2.5, ozone, nitrogen oxides, and sulphur dioxide, leading to inflammation, cardiovascular strain, and organ damage (WHO, 2026). Globally, air pollution contributed to 6.7 million deaths in 2019 and poses comparable risks to wildlife, including reproductive decline in birds and developmental deformities in amphibians (WHO, 2024; Ghor ani Azam et al., 2016).

3.2 Water Pollution

Rivers and lakes in India are heavily contaminated by untreated sewage, agricultural runoff, and industrial effluents (from tanneries, textiles, mining, etc.). Recent reports from the Central Pollution Control Board (CPCB) and government sources confirm severe contamination in Indian rivers from untreated sewage, agricultural runoff, and industrial effluents (tanneries, textiles, and mining). Major rivers like the Ganga, Yamuna, and Sabarmati consistently fail water quality standards. Based on Biochemical Oxygen Demand (BOD), some river stretches were categorised under Priority 1 (BOD > 30 mg/L), indicating" NOT "Based on Biochemical Oxygen Demand (BOD), some river stretches were categorised under Priority 1 (BOD > 30 mg/L) based on Biochemical Oxygen Demand(BOD), indicating severe organic pollution (Vision IAS, 2025).

Eutrophication and toxic pollution devastate aquatic ecosystems, with fish and amphibians affected by oxygen depletion and heavy metal contamination, while even the rare Ganges River dolphin and Indus River dolphin face heightened risk from the loss of clean habitats and adequate prey (Sinha & Kannan, 2014). Polluted wetlands lose their aquatic plants and invertebrates, reducing food for migratory

birds. Contaminants undergo biomagnification, with pesticides from agricultural fields detected in river fish and even in human breast milk in urban areas, highlighting the profound risks posed to food webs and ecosystem health.

3.3 Soil Pollution and Agrochemicals

Intensive farming has introduced chemical stressors into India's landscapes. Insecticide and fertiliser runoff disrupt soil biota and non-target insects. For instance, neonicotinoid pesticides (widely used on cotton and vegetables) have been implicated in damaging pollinators such as bees and butterflies, though large-scale, India-specific studies are sparse (Chandrasekar et al., 2022). Imbalanced NPK (7.7:3.1:1 vs ideal 4:2:1) from intensive farming alters soil chemistry, reduces microbial diversity/populations, and depletes SOC. Overapplication of fertilisers alters soil chemistry, reducing microbial diversity and earthworm populations that are vital for soil fertility (Jat et al., 2021). Cumulatively, soil pollution reduces the carrying capacity of agricultural margins and woodlots for wildlife. There is growing evidence globally and some indications from India that heavy pesticide use contributes to the decline of beneficial insects (pollinators, predators) and the collapse of food chains (Spence et al., 2025). Landfilling of toxic waste and industrial slag, furthermore, destroys vegetation and alters local hydrology. Thus, agrochemical and waste pollution are subtle but pervasive drivers of habitat degradation in both rural and peri-urban India (Goswami & Basak, 2021).

4. Climate Change Intensified by Human Activity

The Himalayan region, which is geologically young and highly fragile, has undergone rapid warming during the 21st century. Temperature increases range from 0.15°C to 0.60°C per decade, a rate substantially higher than the global average of 0.74°C per century, affecting monsoon patterns and leading to more frequent extreme heat and drought. In the Himalayas, accelerated glacier melt threatens alpine ecosystems and river flow regimes downstream, altering freshwater habitats (Ahmed, 2025). Due to an increase in global temperature, terrestrial species are shifting their ranges. Case studies, such as the poleward expansion of the fall armyworm (*Spodoptera frugiperda*), phenological shifts in aphids, and increased bark beetle outbreaks in warming forests (Mehla et al., 2025). India's 7,500 km coastline is recognised as among the most vulnerable globally to sea-level rise, storms, and erosion, prompting the MoEFCC to map a national "hazard line" for climate-driven periodic bleaching events (Shohidullah Miah, 2015; MOEFCC, 2018).

Coastal and marine ecosystems are particularly at risk. India's long coastline is among the most vulnerable to climate impacts. Sea surface temperatures in the Indian Ocean have warmed by ~1°C since the 1950s, causing coral bleaching and habitat loss (Wenegrat et al., 2022). Given that reefs support many fish and invertebrates, this portends declines in marine biodiversity and fishery yields. Mangrove forests, another rich ecosystem (e.g., the Sundarbans), face rising sea levels and cyclonic storms. The Sundarbans' mangroves buffer India's largest mangrove delta, but saltwater inundation and severe cyclones (cyclone Amphan in 2020, for example) have degraded sections of it. Studies note that increased salinity stress and storm damage are hindering mangrove regeneration, which in turn jeopardises the myriad species (from Bengal tigers to estuarine fish) that depend on them (Chowdhury et al., 2023; ZCA, 2022). Marine species are also shifting due to climate change. Fish like hilsa are changing migratory patterns as ocean warming and river siltation alter breeding grounds (Shohidullah Miah, 2015). Phytoplankton productivity in the Indian Ocean is declining due to stratification from warming, which can ripple up the food chain (Dalpadado et al., 2021). Climate changes driven by human emissions are compounding biodiversity loss by altering habitats faster than many species can adapt. Many organisms in India are now facing a "double burden" of direct human impacts plus climate stress, pushing already-vulnerable species closer to extinction.

5. Overexploitation of Biological Resources

India's biodiversity is heavily exploited for food, fibre and commerce. Fishing pressure in India is intense, with both marine and inland waters heavily exploited, often beyond sustainable levels. Overfishing and destructive practices (trawling, dynamite) have led to steep declines in large fish stocks and incidental bycatch of turtles, dolphins and seabirds. Illegal, unreported fishing is a concern in the Indian Ocean region (Yadav, 2025). Approximately 56.3% of marine capture consists of bycatch, and such high rates threaten non-target species such as turtles and seabirds. Unregulated high-seas fishing in the Indian Ocean threatens marine life and food security, with squid catches increasing by up to 830% without effective regulation (WCS, 2023; Johnson, 2020). In forests and wildlands, demand for timber and non-timber products (firewood, medicinal plants, resin, bamboo, etc.) drives unsustainable harvests.

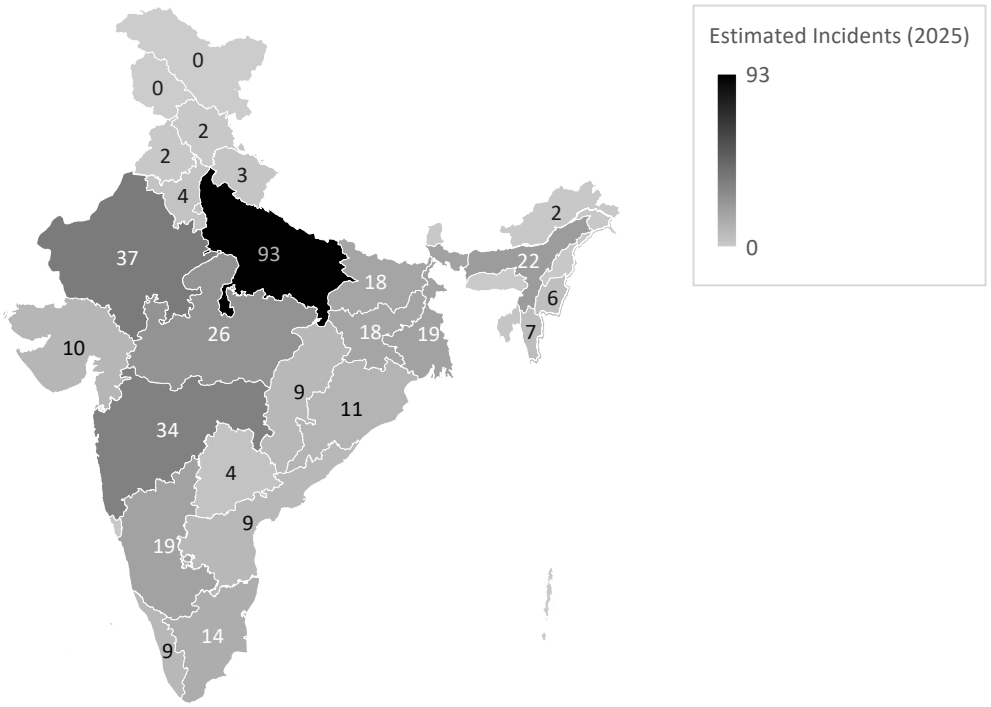

Figure 3. State wise distribution of estimated wildlife poaching and smuggling incidents in India for 2025. Source: https://indiadatamap.com/

Local communities rely on these, but commercial logging and charcoal production often exceed regeneration rates. This depletes forest biomass and alters structure, reducing habitat complexity (Forest Trends, 2020). Illegal wildlife trade is another facet of overexploitation. India's forests are source/transit points for poached animals and parts (tiger skins, bones, rhino horns, pangolin scales) going to international markets. Although India has stringent wildlife protection laws, persistent enforcement gaps allow poaching to continue, threatening tigers, leopards, rhinos, and numerous lesser-known species such as musk deer, orchids, and snake venom traded in illicit markets. The illegal pet trade in exotic birds and reptiles further intensifies pressure on already vulnerable populations. Collectively, these activities remove species at rates that exceed their natural capacity for recovery (Rana and Kumar 2023). In 2025, wildlife poaching and smuggling remain serious concerns across the country, with Uttar Pradesh reporting the highest number of recorded incidents (Figure 3).

6. Invasive Alien Species Introduced and Spread by Human Activity

Human altered habitats are highly susceptible to invasions by non-native species, which India has seen in abundance. *Lantana camara* (a shrub from the Americas) has invaded tens of thousands of hectares of Indian forests and grasslands, forming impenetrable thickets that exclude native undergrowth and seedlings. In fact, one study notes Lantana has spread into 40% of India's tiger habitat. Other invaders include Parthenium hysterophorus (a toxic weed that degrades pastureland), *Prosopis juliflora* (thorny mesquite, overtaking drylands in Rajasthan), *Eichhornia crassipes* (water hyacinth clogging lakes and canals), and *Saccharum spontaneous* (wild sugarcane that suppresses wetland flora) (Sekar, 2020). These species outcompete local plants for light, nutrients and water, often altering fire regimes and soil chemistry. The result is lower native plant diversity and less food for indigenous herbivores and pollinators. Some ornamental organisms (like *Poecillia reticulata* and *Pterygoplichthys disjunctivus*) also contribute locally. Overall, invasions act as a hidden driver of biodiversity loss. Once invasive species establish, they are costly to remove and often transform entire ecosystems irreversibly (Khambete, 2024).

7. Fragmentation, Isolation & Collapse of Ecosystem Connectivity

Habitat fragmentation is a defining consequence of India's accelerating development. Expanding roads, railways, canals, and mining projects divide once continuous landscapes into small, isolated patches, disrupting ecological connectivity. As habitats shrink and become increasingly separated, wildlife corridors collapse, restricting seasonal migration and limiting access to mates. Species dependent on large, undisturbed forests, such as hoolock gibbons and snow leopards, experience marked declines. Fragmented edges promote soil degradation, greater carbon release, and the spread of invasive plants, including *Lantana camara* and even commercial crops like coffee, into native forests. Sediment runoff from disturbed islands further damages marine ecosystems and coral habitats (Shankar 2024). Many tiger reserves remain tenuously linked by narrow forest strips intersected by highways and plantations. Grid fencing and rail infrastructure obstruct elephant and carnivore movement, while transmission lines hinder arboreal species (Jhala et al., 2021). Fragmentation also reduces gene flow, increasing inbreeding and extinction risk, with dams isolating fish populations (Mondol et al., 2013).

Way Forward — Policy and Management Recommendations

Given the scale of biodiversity loss, urgent policy action is needed. Key recommendations include the following:

i. Strengthen Environmental Regulations: Rather than diluting laws, India must uphold strict norms for forest and wildlife protection. Forest diversion should be minimised, with genuine ecological impact assessments. The recent FCA amendments that favour plantations over forests should be reversed (Saxena, 2024). Transparent EIA and Public Participation: All major projects should undergo rigorous, independent environmental impact assessments with public disclosure. Post-facto clearances should be banned. Citizens, scientists, and affected communities must have a real voice in decisions affecting forests, rivers, and wildlife (INSIGHTS IAS, 2025).

ii. Scientific Land-Use Planning: Use spatial data to identify and protect critical habitats (e.g., remaining old-growth forests, wetlands, mangroves). Zone land for development based on carrying capacity, rather than ad hoc approvals. Integrate biodiversity corridors into city and infrastructure planning (WWF, 2026).

iii. Protect Key Ecosystems: Special measures should be taken for exceptionally biodiverse regions, for example, by strictly safeguarding the Western Ghats, Eastern Himalaya, Northeastern forests, the Aravalli range, and coastal mangroves. Cancel ecologically harmful projects (like new mines or dams) in sensitive areas (Ghanekar, 2025).

iv. Urban Greening & Pollution Control: Cities should aggressively expand urban forests, protect remaining wetlands and regulate construction dust and emissions. Stringent air and water quality standards will benefit both people and biodiversity (Vajiram and Ravi, 2025).

v. Climate-Smart Conservation: Anticipate climate impacts by, for example, protecting altitudinal gradients to allow species migration, preserving genetic diversity (seed banks, gene banks), and restoring degraded forests to enhance carbon sequestration. In coastal zones, strengthen mangrove belts and coral rehabilitation efforts (Hussain et al., 2024).

vi. Community Engagement: Empower local and indigenous communities as conservation stewards. Co-manage protected areas, ensure fair benefit-sharing from ecosystem services, and uphold tribal land rights in forests (UNDP, 2023).

vii. Wildlife Corridors and Rescue: Legislatively secure identified wildlife corridors (e.g., elephant corridors) by preventing land conversion. Invest in wildlife crossings on highways and in anti-poaching patrols (WWF, 2026).

viii. Tackle Pollution and Invasives: Enforce stricter controls on effluent discharge to rivers and industrial emissions. Promote sustainable agriculture to reduce pesticide runoff. Implement invasive species management plans (e.g., remove water hyacinth from lakes and control Prosopis on grasslands) (Lele et al., 2025).

These and other measures require political will, inter-departmental coordination, and adequate funding. The judicial system (NGT, Supreme Court) and civil society have positive roles in oversight and accountability. International cooperation (e.g., migratory bird conservation, climate aid) will also be important. Ultimately, India must recognise that continued development without ecological limits will undermine long-term prosperity.

CONCLUSION

India stands at a crossroads. Its rapid economic and infrastructural development has lifted millions out of poverty, but it has

also come at a steep ecological cost. As this review shows, virtually every aspect of India's biodiversity, including forests, rivers, coasts, and species, is under mounting strain from human pressures. Land conversion for mining, roads, and urban expansion is fragmenting habitats, while pollution and invasive species are steadily degrading ecosystems, and climate change is further intensifying these pressures by adding another layer of ecological stress. The decline of biodiversity threatens not only wildlife but also India's future: forests and mangroves that buffer floods, insects that pollinate crops, and fisheries that feed coastal communities are all at risk. The solution lies in integrating ecological limits into development planning. This means abiding by environmental laws (not weakening them), conserving large, connected habitats, and investing in restoration. Economic growth and biodiversity conservation can be aligned through green infrastructure and sustainable land use. India's people, from farmers and urban residents to tribal communities, stand to benefit significantly from safeguarding the natural resources and ecosystem services that sustain livelihoods. India's extraordinary biodiversity is an asset and a responsibility. The coming decades will determine whether policiesand public will can reverse the current downward trends. Immediate, concerted action is required to ensure that development proceeds in harmony nature. Only by safeguarding forests, wildlife and water can India preserve the ecological foundations of its future well-being.

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CONFLICT OF INTEREST

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