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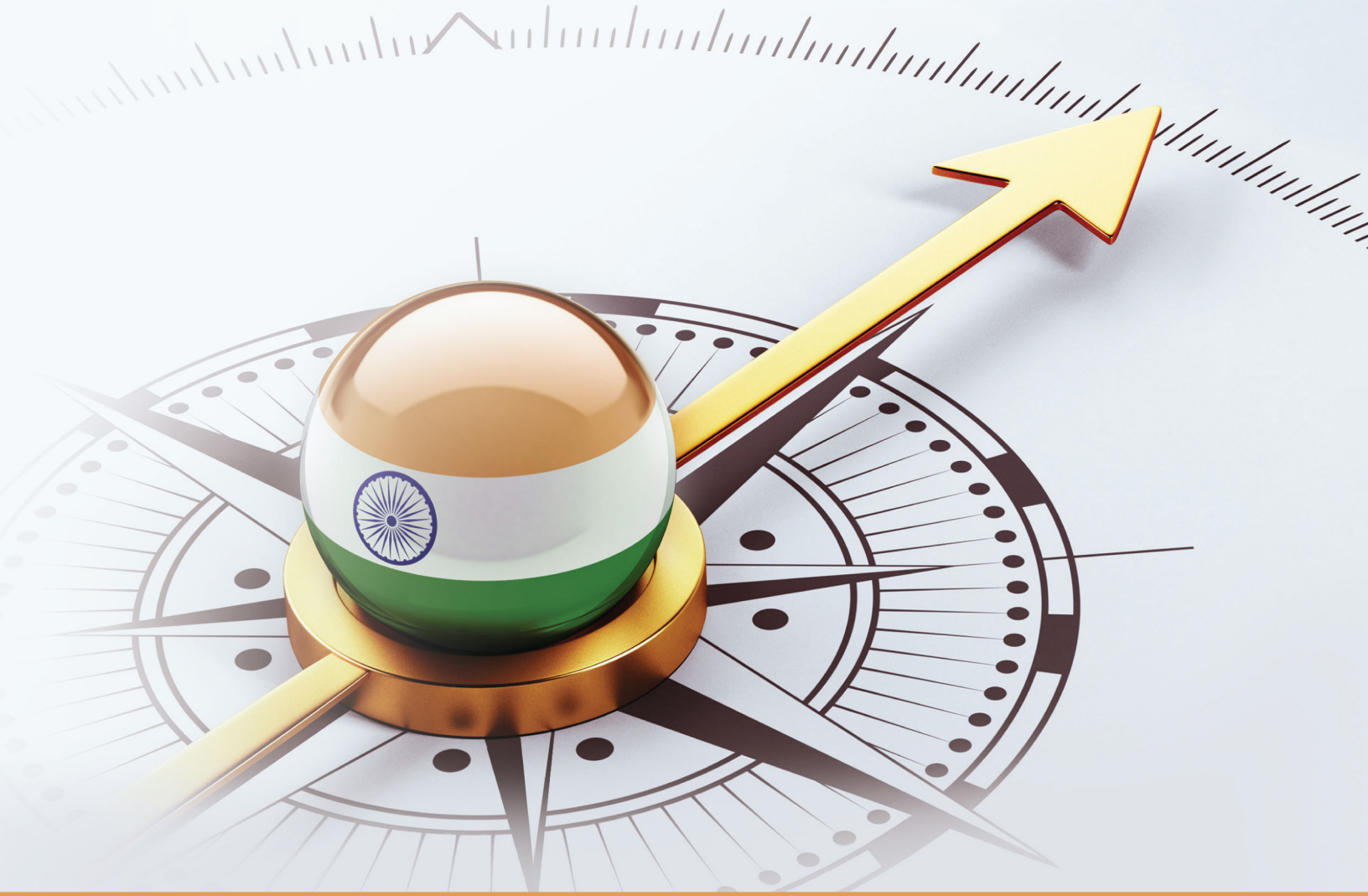


Huntington Program on Strengthening US-India Relations

7. India Environment

The Challenge of the Balance

Shreekant Gupta

INTRODUCTION

Population and economic growth continue to put pressure on India's environment, which is likely to increase in the future. In 2024, India ranked 176 out of 180 in Yale University's Environmental Performance Index.[1] According to a 2013 World Bank study, the total cost of environmental degradation in India was equivalent to 5.7 percent of GDP in 2009 (the reference year for most of the damage estimates).[2] In terms of air quality, India is the second-most polluted country in the world. The average life expectancy of Indians in 2025 was 3.5 years less (8.2 years less in the national capital, New Delhi) than it would be if it met the air pollution standards of the World Health Organization (WHO).[3] There is increasing concern regarding water scarcity, and climate change is disrupting weather patterns (especially the timing of the Indian monsoon), contributing to floods, landslides, droughts, and heat waves.[4] From the perspective of the global commons, India is the world's third-largest emitter of greenhouse gases (GHGs), which continue to increase (though its per capita emissions are very low and it is making significant efforts to promote renewables, especially solar energy). While there is pushback from civil society and a proactive judiciary, the overall picture is one of considerable deterioration and further threat in the future.

In this chapter, we review the current state of India's environment, focusing on recent developments across various sectors such as water, forests, biodiversity, pollution, and climate change. We situate this discussion within the context of ongoing economic and demographic changes in the country, which both influence and are influenced by the environment. Given the wide range of topics under the term *environment* and the limitations of space, our coverage is comprehensive but not exhaustive. It offers a snapshot of the state of India's environment.[5]

Whenever possible, we rely on data from official government sources, supplemented by information from scientific organizations and reputable international institutions, such as the United Nations, the World Bank, and the World Resources Institute, among others.

In 2023, India surpassed China to become the world's most populous country. Its population of 1.46 billion is four times that of the United States but is squeezed into a landmass one-third its size, making it one of the most densely populated

A Chapter from The Hoover Institution's Annual Survey of India 2026

countries in the world. Moreover, India's population is still growing (at approximately 0.88 percent per year) and will peak only by 2062, at around 1.7 billion.[6] In addition to its population, the Indian economy is also expanding (some would argue not fast enough) and has just surpassed Japan to become the world's fourth-largest economy at US$4.2 trillion. What is more, India aspires to become a "developed" economy by the year 2047 (the centenary year of independence). This will entail an economy at least five times as large as today, if not more.[7]

These statistics have a significant bearing on the current state of India's environment and on its future trajectory. Providing for a large population that is (rightfully) aspiring to higher living standards translates into greater demand for environmental resources and services, such as energy, water, food, raw materials, and land for cities. The environment, or nature more broadly, can be seen as both a source and a sink for the economy. It provides resources and ecosystem services for economic activity (namely, production, consumption, and investment) and receives residues of that activity (air, water pollution, solid waste, etc.). Just as we need to use nature for economic growth, it is equally important to invest in it to ensure that growth remains sustainable in the future.[8] While this is true for all countries, balancing these twin imperatives is especially vital for India. This push and pull between environment versus development determines what happens to the country's forests, biodiversity, land, air, and water.

To organize thoughts, we break down the gamut of environmental issues broadly into *green* and *brown* themes. The former comprises forests, biodiversity, coastal and mountain ecosystems, land, rivers, lakes, and other natural resources, whereas the latter is more urban centric and covers air and water pollution, municipal and hazardous waste, e-waste, and other related issues. Of course, there are overlaps and cross-cutting themes such as water and climate change, which are both green and brown issues.

The following section is a short overview of the legislative and institutional framework for environmental governance in India. The subsequent four sections provide an interpretative assessment of the current situation in four key environmental areas—namely, water, forests, biodiversity, and urban environmental issues (air pollution and waste disposal). The seventh section examines the impacts of climate change on India and its efforts to adapt to it. We also analyze the measures that India is implementing to reduce its GHG emissions, particularly through renewables, to fulfill its commitments under the Paris Agreement and achieve its goal of net-zero GHG emissions by 2070. The final section offers policy recommendations and perspectives on the future of India's environment.

INSTITUTIONAL AND LEGISLATIVE FRAMEWORK

India has a plethora of laws and policies to manage and regulate every aspect of the environment. Laws are in place for controlling water, air, noise pollution, hazardous waste, and e-waste. Similarly, there are laws to protect coastal areas, wildlife, forests, and more (see "Environment Legislation in India" box). It is another matter that these laws are weakly enforced. A multitude of legal and administrative bodies at the federal and state levels are tasked with implementing and enforcing these laws. Notably, the Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs) are statutory bodies created by acts of Parliament. The CPCB sets standards for air and water quality, offers recommendations on pollution control and prevention, and monitors the activities of state boards. The SPCBs enforce environmental laws and regulations at the state level. They grant consent for the establishment and operation of industries

ENVIRONMENT LEGISLATION IN INDIA (ACTS, RULES, NOTIFICATIONS, AND AMENDMENTS)*

General

- **Environment (Protection) Act, 1986:** A comprehensive umbrella act empowering the government to take steps to protect and improve the environment.
- **National Environment Policy (NEP), 2006:** A comprehensive strategy to guide environmental conservation through regulatory reform and project implementation

Pollution control

- **Water (Prevention and Control of Pollution) Act, 1974:** Aims to prevent and control water pollution and maintain water quality.
- **Air (Prevention and Control of Pollution) Act, 1981:** Focuses on preventing and controlling air pollution.
- **Hazardous Waste (Management and Handling) Rules, 1989:** Regulates the handling of hazardous waste.
- **Ozone Depleting Substances (Regulation and Control) Rules, 2000:** Guides the phasing out of ozone-depleting substances.

Forest and wildlife protection

- **Indian Forest Act, 1927:** An older act that remains in force for forest management.
- **National Forest Policy, 1952:** First comprehensive forest policy after independence, established the goal of 33 percent forest cover of the country's land area to maintain ecological balance.
- **Wildlife (Protection) Act, 1972:** Provides for the protection of wild animals, birds, and plants.
- **Forest (Conservation) Act, 1980:** Regulates the diversion of forest land for nonforest purposes.
- **National Forest Policy, 1988:** Shifted from purely government-managed forestry to a more participatory, community-based model, such as joint forest management or JFM.
- **Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006:** Recognizes the rights of forest-dwelling communities.
- **Forest (Conservation) Rules, 2022:** Streamlines the approval process for diverting forest land for nonforest purposes.
- **Forest (Conservation) Amendment Act, 2023:** Amends the original 1980 act. Allows for the diversion of forest land for certain activities, including ecotourism. Also includes provisions for projects of national importance.

*Environmental legislation is the overarching legal framework. It includes acts, which are laws passed by the Parliament or state legislatures. These acts give government agencies the power to create detailed rules to implement the laws. Notifications are official public announcements from the government that provide specific information or make changes, often to implement or clarify rules and acts. Amendments are changes made to existing acts and rules to update them over time.

(*continued*)

Biodiversity and ecosystem conservation

- **Biological Diversity Act, 2002:** Aims to conserve biodiversity and ensure equitable sharing of its benefits.
- **Wetlands (Conservation and Management) Rules, 2010, 2017:** Establishes a framework for the conservation and wise use of wetlands.
- **Coastal Regulation Zone Notifications, 2018:** Regulates activities in coastal areas.

Institutional and tribunal laws

- **National Environmental Tribunal Act, 1995:** Aims to create a tribunal for environmental cases.
- **National Environment Appellate Authority Act, 1997:** Established an appellate authority for environmental cases.
- **National Green Tribunal Act, 2010:** Provides for the establishment of the NGT to handle environmental cases.

and ensure they meet environmental standards by conducting inspections. Under the statutes, they also have the authority to impose fines, penalties, or even shut down noncompliant facilities. The National Green Tribunal (NGT), also a statutory body, was established under the NGT Act, 2010, to ensure the effective and swift disposal of cases related to environmental protection, forest conservation, and natural resources. It provides a specialized and rapid judicial forum for environmental dispute resolution, enforces legal rights concerning the environment, and offers relief and compensation for environmental damage.

Besides these statutory bodies, each state has departments of environment and forests staffed, among others, by an elite group of over three thousand officers from the Indian Forest Service (a modern version of its colonial predecessor, the Imperial Forest Service). Their duties include conserving forests and wildlife, maintaining ecological balance, managing national parks and wildlife sanctuaries, protecting against threats like poaching and forest fires, overseeing afforestation efforts, and collaborating with local communities. These officers supervise a large workforce of forest rangers, forest guards, and others. Other line departments, such as those responsible for water, also carry out the environmental agenda.

Given this elaborate structure of legislation, institutions, and personnel, India's low global rank and poor environmental outcomes may surprise the reader. The reasons, inter alia, are weak implementation of complex laws, understaffed and underfunded pollution boards, bureaucratic red tape, and competing interest groups. Two eminent legal scholar-practitioners have aptly described the overall situation as a "regulatory stew" of extensive legislation but patchy enforcement and ad hoc judicial intervention:

> On the surface, India's extensive environmental regulations comprise statutes that adopt command and control strategies backed by penal sanctions. What sets apart this legal regime from others is the distinctive and indeed, disproportionate role of judges and citizens in making the law work.

> For all the legislations and intricate rules, India's environmental laws are largely ineffective. The agencies responsible for implementing these laws have a feeble capacity to administer, a faint grasp of societal requirements and no resolve to match the performance of regulators elsewhere in the world. For over three decades, citizens have been compelled to petition the courts (and more recently, the NGT) to secure enforcement of black letter laws and push the state to adopt global best practices. As a result, we have in India a regulatory stew of ample legislation, patchy enforcement and ad hoc judicial directions.[9]

WATER

We begin with the most fundamental environmental challenge for India—namely, water. It is a multilayered, multifaceted cross-cutting green and brown environmental issue. In India, the environmental challenges related to water range from quantity (water scarcity) to quality (water pollution), from depletion of aquifers and deterioration of surface water bodies (rivers, lakes, ponds, and tanks) to riparian disputes between states and between India and its neighbors (Pakistan, China, Nepal, and Bangladesh), and more. Water is also at the center of the climate crisis.[10] To quote the UN, "Water and climate change are inextricably linked. Climate change affects the world's water in complex ways. From unpredictable rainfall patterns to shrinking ice sheets, rising sea levels, floods and droughts—*most impacts of climate change come down to water*." In India, climate change is exacerbating both water scarcity and water-related hazards (such as cyclones, floods, and droughts), as rising temperatures disrupt precipitation patterns and the entire water cycle. Here we focus on recent developments with regard to the quantity and quality of water, including river cleanup and the depletion and contamination of groundwater.

CURRENT TRENDS IN GROUNDWATER AND SURFACE WATER AVAILABILITY

India, with 18 percent of the world's population, contains only 4 percent of global freshwater resources. It also faces large growing and competing demands for water—for personal use by its nearly 1.5 billion people, for agriculture and industrial activity, and for generating power. According to government estimates, demand for water is projected to increase by 33 percent between 2025 and 2051. In terms of supply, India gets its water mainly from three sources: precipitation (predominantly the summer monsoon, from June to September, which accounts for nearly 80 percent of total rainfall); the surface (the mighty snow-fed rivers Indus, Ganga, and Brahmaputra originating in the Himalayas); and underground aquifers (groundwater). While the demand for water is increasing and the trade-offs between different uses are becoming increasingly difficult to manage, the supply from all three sources is declining or becoming more erratic. This demand and supply mismatch is worsened by a mismatch across space and time as well. Different parts of the year get too much or too little rain or river flow. The same is true for different parts of the country, which can experience droughts and floods simultaneously.

According to India's Central Water Commission (CWC), the country's utilizable water resources are approximately 1,139 billion cubic meters (BCM), comprising 690 BCM of surface water and 449 BCM of replenishable groundwater.[11] Agriculture alone consumes about 80 percent of total available water (mainly groundwater), and that, too, in an inefficient manner.[12] Only the remaining 20 percent is available for domestic and industrial purposes. It should, however, be noted that the use of water for agriculture is highly uneven across the country—while 60 percent of India's sown area is rain fed (and hence also vulnerable to drought), in other parts of the country there is extensive use of water, especially groundwater, for cultivating a

few water-hungry crops such as rice, sugarcane, wheat, and cotton.[13] On the whole, groundwater is a key source of water in irrigated agriculture, meeting approximately 60–65 percent of the water needs. In 2023, 87 percent of all groundwater extracted was used for irrigated agriculture.[14] Approximately 700 million rural Indians rely on groundwater for daily needs, with 85 percent of rural households dependent on it, compared to about 48–50 percent in cities.[15] India's cities are increasingly relying on groundwater due to an unreliable and inadequate municipal (piped) water supply. As the world's largest user of groundwater, the country extracts nearly 25 percent of the global groundwater supply—more than China and the United States combined.[16] It is also the most groundwater-dependent country in the world.

Today groundwater is a vanishing resource in several parts of the country.[17] Due to government support for the cultivation of water-intensive crops, including input subsidies and nearly free electricity to farmers, the pumping of groundwater in some parts of the country exceeds recharge.[18] This is coupled with the overextraction of groundwater in India's burgeoning cities to meet their ever-growing need.[19] According to the World Bank, almost two-thirds (63 percent) of India's districts are threatened by falling groundwater levels.[20] In many cases, this water is also becoming contaminated with arsenic, nitrates, and fluoride.

An assessment by the CWC in 2024 estimated India's average annual per capita water availability (per person per year) at 1,513 cubic meters. This is below the scarcity threshold of 1,700 cubic meters, indicating the country is experiencing water stress.[21] Availability is projected to decline further—to 1,367 cubic meters by 2031 and 1,228 cubic meters by 2051—well below the global water stress benchmark of 1,700 cubic meters. This is a result of both increasing demand from a growing population and decreasing supply from the three sources mentioned above. Pollution, encroachment on wetlands, and fragmented water infrastructure exacerbate the problem, particularly in urban areas where lakes and water bodies have declined sharply. In the city of Bengaluru, for example, the number of lakes declined from 262 in 1961 to just 81 today, with many of these heavily polluted or encroached upon.

GOVERNMENT PROJECTS AND SCHEMES

The Indian government is implementing a six-year (2020–25) groundwater conservation plan costing INR 60 billion (US$676 million), cofunded by the World Bank. The program, called Atal Bhujal Yojana (Atal Groundwater Plan), spans eighty districts across seven states: Gujarat, Haryana, Karnataka, Madhya Pradesh, Maharashtra, Rajasthan, and Uttar Pradesh. Its goal is to stop the decline in groundwater levels using a participatory, community-led approach for sustainable groundwater management.[22] With an annual budget of about US$113 million, this is a modest start that could be expanded if successful. The challenge of groundwater depletion is significant and urgent.

The Jal Jeevan Mission is a national program in India launched in 2019 to provide functional household tap water connections and safe drinking water to all rural households by 2024. It has a budget allocation of INR 670 billion (US$7.55 billion) for 2025–26. The total estimated cost of the mission, which extends until 2028, was initially set at INR 3,600 billion (US$40.56 billion). The mission is considered successful due to its significant progress in providing tap water connections to a large number of rural households, with over 157 million connections made as of August 2025, or 81.01 percent of all rural households. This has led to positive outcomes like saving women's time, improving health, and reducing waterborne diseases. However, ongoing challenges include ensuring the long-term sustainability of water supply and maintenance and addressing potential water-quality issues in some areas.

GANGA RIVER

Regarding surface water, India's snow-fed rivers are depleting, especially its most vital one, the Ganga, on which millions depend. For thousands of years, the river and its tributaries have supported one of the world's most densely populated regions. Considered the holiest river by Hindus, it extends 2,500 km from the Himalayas to the Bay of Bengal. The Ganga basin sustains nearly six hundred million people (40 percent of India's population), supplies about a quarter of India's freshwater, and underpins much of the country's food production and economy (50 percent of GDP). However, recent studies indicate that the river's decline is accelerating at an unprecedented rate in recorded history. A paper published as recently as September 2025 reconstructed stream flow records spanning the last thirteen hundred years. The study reveals that the drying of the river from 1991 to 2020 is the worst in the past millennium. Sections of the river that once supported year-round navigation are now impassable in summer, and irrigation canals are drying up weeks earlier than before. The river and its tributaries are unable to replenish themselves because water has been diverted into hundreds of irrigation canals, and groundwater has been pumped for agricultural and drinking needs, reducing recharge. Over a thousand dams and barrages on the Ganga and its tributaries have drastically altered the river. At its source high in the Himalayas, the Gangotri glacier has retreated nearly a kilometer in just twenty years. Urgent, coordinated action is necessary, and piecemeal solutions will not suffice. Experts agree it is time to reconsider how the river is managed. This will entail reducing the unsustainable extraction of groundwater so supplies can recharge. It will also mean environmental flow requirements to keep adequate water in the river for people and ecosystems.[23] Transboundary cooperation is also essential. India, Bangladesh, and Nepal have to do better at sharing data, managing dams, and planning for climate change.

The Ganga is also heavily polluted with untreated sewage and industrial effluents from numerous cities and towns along its course and that of its major tributary, the Yamuna (Delhi is located on its banks). The Indian government has been trying to clean the Ganga for the last four decades, starting with the Ganga Action Plan in 1985 and continuing through the National Ganga River Basin Project in 2008. The latest initiative is the Namami Gange Programme, launched in 2014. It is a flagship project of the current BJP-led government: Varanasi, the most holy city for Hindus, is located on the banks of the Ganga and is also the constituency of Prime Minister Modi. So far, the results have been mixed.[24]

CURRENT TRENDS IN WATER POLLUTION

India faces a severe water pollution crisis that endangers public health, ecosystems, and economic growth. An estimated 70 percent of surface water is currently unfit for consumption. In addition to pollution of the Ganga River mentioned earlier, more than half of India's 605 rivers are classified as heavily polluted, with a majority of urban and rural populations affected by unsafe water for drinking, bathing, and agricultural purposes. According to an assessment by the CPCB in 2025, 296 river stretches across 271 rivers are polluted. The state of Maharashtra continues to have the highest number of polluted river stretches at 54, along with other significantly affected important rivers including the Yamuna in Delhi and the Sabarmati in Ahmedabad, the Chambal in Madhya Pradesh, and the Tungabhadra in Karnataka. Groundwater contamination compounds the crisis. The Central Ground Water Board's 2024 report highlights nitrate, fluoride, arsenic, uranium, and iron as major pollutants often exceeding safe levels. Nitrate contamination alone affects over half of India's districts, driven by agricultural runoff and fertilizer overuse. Fluoride and arsenic issues also span hundreds of districts, posing chronic health risks due to long-term exposure.

FORESTS

India's forests span the Himalayas, the Western Ghats (a vast mountain range on the west coast and a UNESCO World Heritage Site), Central India, the northeast, and the mangroves of the Sundarbans. The country's forests underpin livelihoods, climate regulation, water security, and cultural identities while hosting globally significant biodiversity within a small share (2.4 percent) of the world's land area. Unlike in the Global North, where forests and wilderness are primarily used for adventure and recreation, India's forests are deeply intertwined with people's lives and livelihoods. Approximately three hundred million people in India (more than a fifth of its population) depend on forests for their livelihoods, primarily through the collection of nontimber forest products, fuelwood, and fodder.[25] A large portion of this population comprises tribal people (Advisasis, or "Original Inhabitants") and other traditional forest-dwelling communities that live in and around forest areas and rely on them for sustenance and cultural needs. These communities are often among the poorest and most vulnerable groups in India. Ironically, most of India's mineral deposits, including iron ore, bauxite, coal, and rare earth elements, are frequently found under its richest forests and tribal lands. It creates a dilemma of balancing the need for energy security and industry with the imperative to protect forests and the rights of tribal communities. As we discuss below, of late the scales are mostly tipped in favor of the former.

THE HISTORICAL CONTEXT

In the colonial period (during the British Raj), forests were mainly seen as a source of revenue and of timber, inter alia, for building an extensive rail network, rather than as a shared community resource. The Indian Forest Act of 1865, and its successors in 1878 and 1927, established state monopoly over forests, centralized control, prioritized timber extraction, and alienated local users.[26] After independence, the Indian government adopted the laws inherited from the British Raj, gaining control over forests. This was given a further impetus in 1980 with the enactment of the Forest (Conservation) Act to regulate the use of existing forest land and prevent further deforestation. The act did not create new protected areas; instead, it regulated the diversion of forest land for nonforest purposes or the leasing of forest land. In particular, state governments were required to obtain permission from the central (national) government to change the status of a forest from reserved (with restrictions on use) to nonreserved or to use a forest for a nonforest purpose such as growing plantation crops (tea, coffee), spices, and so on. Despite this, policy enforcement faced hurdles including illegal logging, forest land diversion, and conflicts between conservation and commercial interests. In the late 1990s and early 2000s, however, grassroots activism by India's tribal and forest-dwelling communities led to the enactment of two laws, the Panchayat (Extension to Scheduled Areas) Act of 1996 (PESA) and the Forest Rights Act of 2006 (FRA) which provided a significant boost to the rights of local forest users and communities.[27] The FRA, in particular, represented a paradigm shift, legally recognizing the rights of forest-dwelling communities over land and resources, and emphasizing participatory forest governance. These laws were complemented by the National Forest Policy of 1988, which laid the groundwork for joint forest management (JFM), a collaborative approach between forest departments and local forest-dependent communities to protect, conserve, and manage the forests.

RECENT DEVELOPMENTS

India's forests have witnessed incremental gains in area on paper. On the other hand, there has been an intensification of natural forest loss in key biomes, rapid policy shifts have loosened safeguards, and early-stage experiments with market-linked tree planting have remained contested on grounds of integrity and equity. The official source of data on India's forest resources is the biennial assessment

conducted by the Forest Survey of India, the *India State of Forests Report* (*ISFR*). Its eighteenth edition, ISFR 2023, was released on December 21, 2024. It reported 827,357 sq km of "forest-cum-tree" cover accounting for 25.17 percent of the country's geographic area, marginally up from 24.62 percent in the previous assessment, ISFR 2021, but well short of the goal of having 33 percent of the country under forest-cum-tree cover, as first articulated in the National Forest Policy of 1952. More problematically, these aggregates include plantations and urban trees, conflating canopy area with ecological quality.[28] ISFR 2023's net increase in area is small and skewed toward tree cover outside recorded forest areas while several states with natural forests—especially in the Northeast, Central India, and parts of the Western Ghats—saw declines, aligning with known pressures from mining, roads, power transmission lines, and hydel/irrigation projects.[29] Government data shows that nearly 1,740 sq km (an area half that of Goa or Rhode Island, the smallest states in India and the United States, respectively) of forests have been "diverted" (i.e., cut down) over the last ten years (2014–24) for infrastructure and industrial projects (table 7.1). This process gathered pace in the preceding year (2023–24), which alone accounted for 15 percent of the total loss. Two-thirds of the cumulative forest area diverted was in seven forest-dependent states in the Northeast, Central India, and parts of the Western Ghats (table 7.2).

Independent reporting on ISFR 2023 emphasized that the notional gains in forest area coincide with declines in several biodiversity-rich regions and shifts toward plantations and nonnotified areas, suggesting compositional change rather than an increase in the strength of natural forests. Critiques highlight that monoculture plantations—often comprising fast-growing or exotic species—cannot substitute for the old-growth complexity, leading to inflated figures for tree cover and obscured losses of dense natural forests and species-rich habitats.[30] Overreliance on canopy metrics, without accounting for native species richness, age structure, connectivity, and function, limits informed policy and masks biodiversity decline. Similar questions were raised about the seventeenth edition of the report, ISFR 2021, and those prior to it as well.[31]

Global Forest Watch data for 2024 indicate that India lost about 150,000 ha of natural forest in that single year, of which 18,200 ha was primary forest.[32] The data also shows that primary forest loss rose from 2023 to 2024, and that India's cumulative tree cover loss since 2002 is substantial, reinforcing that plantation-led gains cannot be equated with old-growth ecosystem function or biodiversity outcomes.[33] Together, these patterns suggest a growing quality-quantity split: expansion of managed or plantation tree cover versus attrition of high-integrity natural forests.

POLICY AND LEGAL SHIFTS

In March 2023, the government introduced the Forest (Conservation) Amendment Bill (2023 Amendment) in the Parliament, proposing changes that exclude certain types of forest from protection under the Forest (Conservation) Act of 1980. Inter alia, it expanded the list of activities allowed on forest land.[34] The bill was passed in both Houses of Parliament and came into force on December 1, 2023, despite concerns among environmentalists, experts, and citizens that the changes would make it easier for authorities to divert reserved forest areas for commercial and public infrastructure purposes.[35] The 2023 amendments also risk undermining the Forest Rights Act and PESA-aligned community governance by centralizing discretion and easing diversion pathways (the transfer of forest land for nonforest purposes).[36] The constitutional validity of the act has been challenged in the Supreme Court, and it is under litigation.[37] In the meantime, however, implementation of the act continued in 2024–25 via notification of rules and issuing a consolidated handbook, expanding permissible activities and narrowing the scope of lands requiring central government approval for nonforest use.

TABLE 7.1 FOREST CLEARANCES FOR INFRASTRUCTURE AND INDUSTRIAL PROJECTS BY CATEGORY OF USE

Category	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	Total (ha.)	Total (percent)
Hydel/ irrigation	2,369.1	2,282.3	3,637.9	4,170.1	5,488.2	7,447.6	2,135.5	2,007.3	2,486.4	8,114.0	40,138.3	**23.07**
Mining/ quarrying	5,839.5	3,940.4	1,762.5	4,127.1	5,485.3	3,420.5	2,396.2	3,939.5	3,574.0	5,611.2	40,096.2	**23.05**
Road	1,576.3	2,024.4	1,289.3	2,336.5	2,087.3	2,668.3	5,297.7	4,966.4	4,603.3	3,756.0	30,605.7	**17.59**
Power transmission line	2,429.7	1,193.9	293.9	817.0	974.0	1,484.7	2,281.8	2,731.4	3,072.0	1,954.4	17,232.7	**9.90**
Defence	1,231.0	180.0	1.0	3,636.8	4,159.1	187.4	2,601.1	421.9	261.3	2,288.5	14,968.1	**8.60**
Railway	653.1	383.0	76.2	1,832.0	236.8	612.9	1,049.8	1,169.5	1,700.6	284.8	7,998.7	**4.60**
Forest village conversion	0.0	966.2	0.0	929.0	285.7	0.0	210.0	298.3	394.8	166.0	3,250.0	**1.87**
Thermal power	395.9	2,037.6	0.0	114.4	10.7	46.5	38.1	0.0	0.0	1.0	2,644.0	**1.52**
Other uses	684.5	2,434.5	775.1	1,664.6	860.0	1,660.8	2,304.0	1,654.8	1,289.5	3,722.7	17,050.6	**9.80**
Total by year	**15,178.9**	**15,442.3**	**7,835.9**	**19,627.6**	**19,587.2**	**17,528.7**	**18,314.2**	**17,189.1**	**17,381.9**	**25,898.5**	**173,984.3**	**100.00**

Note: All figures in hectares. 1km^2=100 hectares.

Source: Ministry of Environment, Forest and Climate Change, "Forest Clearances for Infrastructure and Industrial Projects," Lok Sabha Unstarred Question No. 183, answered July 21, 2025, https://sansad.in/getFile/loksabhaquestions/annex/185/AU183_QnjVUU.pdf?source=pqals.

TABLE 7.2 FOREST CLEARANCES FOR INFRASTRUCTURE AND INDUSTRIAL PROJECTS BY STATE/UNION TERRITORY, 2014–24

State/Union Territory	Area (in hectares)	Percent
Madhya Pradesh	38,552.61	22.23
Odisha	24,458.89	14.11
Telangana	11,422.47	6.59
Gujarat	9,985.15	5.76
Arunachal Pradesh	9,495.98	5.48
Rajasthan	8,796.22	5.07
Maharashtra	8,498.35	4.90
Jharkhand	8,353.42	4.82
Chhattisgarh	7,925.79	4.57
Uttar Pradesh	7,059.23	4.07
Uttarakhand	6,471.89	3.73
Andhra Pradesh	5,455.99	3.15
Punjab	3,717.23	2.14
Himachal Pradesh	3,554.74	2.05
Haryana	3,526.41	2.03
Manipur	3,111.40	1.79
Karnataka	2,991.62	1.73
Bihar	2,780.64	1.60
Assam	1,720.17	0.99
Tripura	1,298.57	0.75
West Bengal	1,037.66	0.60
Tamil Nadu	703.79	0.41
Mizoram	627.64	0.36
Jammu and Kashmir	577.30	0.33
Goa	324.13	0.19
Sikkim	254.43	0.15
Meghalaya	176.92	0.10
Kerala	172.89	0.10
Andaman and Nicobar	123.20	0.07
Delhi	116.92	0.07
Dadra and Nagar Haveli and Daman and Diu	64.50	0.04
Chandigarh	40.72	0.02
Grand Total	**173,396.87**	100.00

Source: Ministry of Environment, Forest and Climate Change, "Diversion of Forest Land for Developmental Activities," Lok Sabha Starred Question No. 333, answered March 24, 2025, https://sansad.in/getFile/loksabhaquestions/annex/184/AS333_d9RAcZ.pdf?source=pqals.

A recent controversial aspect of forest policy in India is the notion of *compensatory afforestation*, planting trees elsewhere in lieu of forests that are being cut. This has been codified through legislation—namely, the Compensatory Afforestation Act of 2016 (CAMPA Act). A fund and implementing agencies have been set up under the act, including the National Compensatory Afforestation Fund Management and Planning Authority (National CAMPA) and corresponding State CAMPAs. Compensatory afforestation is being widely used, for instance, in diverting forest land for nonforest purposes and to compensate for this by planting trees elsewhere. Problems with the underlying premise of compensatory afforestation aside, its effectiveness has been questioned, including complaints regarding implementation and the existence of unused funds.[38]

FEDERAL PROGRAM ACTIVITY

The Ministry of Environment, Forest and Climate Change (MoEFCC) noted the continued sanctioning of forestry and wildlife projects in fiscal year (FY) 2024–25, including budget releases to states and Union Territories, implying administrative continuity. The Ministry's 2024–25 Annual Report highlighted programmatic strands—forest conservation, fire alerts, wetlands, and biodiversity management—that provide institutional scaffolding but do not resolve underlying tensions between diversion, restoration quality, and rights-based governance.

BIODIVERSITY

As mentioned earlier, India is a megadiverse country. With only 2.4 percent of the world's land area, it accounts for 7–8 percent of all recorded species, including over forty-five thousand species of plants and ninety-one thousand species of animals.[39] The country's varied physical features and climatic conditions have resulted in a wide variety of ecosystems such as forests, wetlands, grasslands, desert, and coastal and marine ecosystems that harbor and sustain high biodiversity. India accounts for four of thirty-six global biodiversity hot spots—the Himalayas, the Western Ghats, the states of the northeast and Andaman Islands (part of the Indo-Burma hot spot), and the Nicobar Islands (part of the Sundaland hot spot).[40] These regions are characterized by a high number of endemic species and, unfortunately, significant habitat loss. The Wildlife Protection Act (1972) created protected areas for endangered species. Despite recent headline achievements such as expanding protected areas and notable carnivore recoveries (tigers in particular), which are discussed below, the recent statutory and policy changes, forest loss in key biomes, and diversion of forest land for infrastructure, mining, and so on are key areas of concern.

One of the most significant recent threats to biodiversity, especially wildlife, is habitat loss and fragmentation caused by rapid population growth, urbanization, agricultural expansion, mining, and infrastructure development. Habitat fragmentation breaks up natural ecosystems into smaller, isolated patches of habitat for wildlife, disrupting water flow and ecological processes, particularly in sensitive regions like the Himalayas. While India increased its Ramsar sites to ninety-three in 2025 (up from eighty-nine in the previous year), acknowledging conservation efforts, the overall trend shows a decline in wetland extent and increased fragmentation.[41] India experienced significant wetland loss in 2024, as indicated by a reduced wetland area in the 2024 Wetlands Atlas compared to the 2022 Atlas, especially in lakes, riverine wetlands, and waterlogged areas.[42] Another study by Wetlands International South Asia found that India lost nearly one-third of its natural wetlands to urbanization, agricultural expansion, and pollution over four decades (1970–2014).[43] According to the International Union for Conservation of Nature Red List, 1,673 plant and animal species in India are threatened with extinction. This includes 99 mammals, 83 bird species, 106 reptiles, and 671 plant species.[44]

On the positive side, India now hosts the world's largest number of tigers, which is also the national animal of India. This is despite having just 18 percent of the global tiger habitat. Based on the last quadrennial tiger census in 2022, there were an estimated 3,682 tigers across fifty-eight tiger reserves, up from an all-time low of 1,411 in 2006. The increase in numbers, however, comes with challenges—namely, human-tiger conflict and habitat fragmentation.[45] Tiger populations are nearing the saturation point in that some areas cannot support more tigers, necessitating a focus on sustainable coexistence, habitat connectivity, and human-wildlife conflict management to ensure long-term success.

The news on another large mammal, elephants (designated as the national heritage animal of India in 2010) is not so favorable. The report of the last quinquennial elephant census conducted in 2022–23 by the Wildlife Institute of India was to be released in June 2024. It showed a steep decline of 20 percent in the elephant population from five years ago (from 19,825 in 2017 to 15,887), with Central India and Eastern Ghats (the mountain range on the east coast) recording an alarming decline of 41 percent compared to 2017. Besides recording the decline in the elephant numbers, the report identified "mushrooming developmental projects" such as "unmitigated mining and linear infrastructure (roads and railways) construction" as significant threats to the species.[46] The report, however, has been withheld by the government and has not been officially released.[47]

Mention must also be made of the widely discussed India's Cheetah Project. Launched with great fanfare on September 17, 2022, on Prime Minister Narendra Modi's birthday, it aims to reintroduce the cheetah, the fastest land animal and extinct in India for over seventy years, into Indian ecosystems. The project, which has now been conducted for three years, began with eight African cheetahs from Namibia being transported to Kuno National Park in Central India. Additional cheetahs have arrived from South Africa, marking the first intercontinental translocation of a major carnivore. As a prestige project of the central government, it seeks to establish a sustainable cheetah population.[48] In 2025, the population had grown to twenty-seven, including fifteen free-ranging in Kuno, with twenty-six cubs born and a cub survival rate of 61 percent, exceeding the global average of 40 percent. Overall, Kuno has presented a mixed outcome for the cheetahs. Many have survived, confirming the initial success of the project, but some have died under unusual circumstances.

Wildlife experts have criticized the project, questioning whether the African cheetahs will find India's habitats, especially Kuno National Park, ecologically suitable in terms of prey availability and terrain. Concerns also include predator conflicts, habitat fragmentation, and the ethics of introducing a foreign subspecies instead of focusing on native wildlife. Additional worries involve the stress of translocation, disease vulnerability, genetic health in unfamiliar environments, and the project's long-term sustainability. Some observers argue that the project may serve more as a political spectacle than a truly ecologically sound initiative.[49]

By 2025, many of these criticisms gained partial validation, though not universally. One major event highlighting ecological challenges is the recent death of a female cheetah after a territorial clash with a leopard at Kuno (where sixty to seventy leopards heavily outnumber around twenty-five cheetahs).[50] It illustrates the high-stakes nature of predator interactions in mixed habitats.[51] Additionally, some studies continue to debate the ecological and ethical issues surrounding the translocation of African cheetahs into Indian ecosystems, emphasizing that complete ecological equivalence or ethical justification remains uncertain. Nonetheless, the steady increase in cheetah numbers and reproduction rates challenges more pessimistic predictions. But only time will tell if the project has succeeded.

Achieving true success in India's cheetah reintroduction program will take at least fifteen to thirty years, if not longer.[52]

Broader conservation efforts to include other endangered species are urgently needed. The latest status report on India's birds shows that out of 1,358 recorded bird species, 942 are of high conservation priority, with a significant portion of those species experiencing a decline. Out of the 338 bird species for which long-term trends could be determined, 106 species (31 percent) have declined since 2000, and another 98 species (29 percent) have experienced "rapid decline."[53] Of particular concern is the near extinction of vultures, which serve as nature's cleanup crew by consuming dead animals, preventing the spread of harmful bacteria, reducing the transmission of zoonotic diseases like rabies, and even reducing GHG emissions from decaying carcasses.[54] Their scavenging also provides economic benefits by decreasing the need for costly carcass collection and transportation. Thus, while vultures provide essential ecosystem services the populations of three vulture species endemic to South Asia—namely, the white-rumped vulture, Indian vulture, and slender-billed vulture, have nearly completely disappeared from the wild. The latest nationwide vulture survey, conducted in 2022, reveals that compared to 2002, the populations of the three species have declined by 67, 48, and 89 percent, respectively.[55]

GREAT NICOBAR PROJECT

An issue currently attracting much attention is the Great Nicobar Project, a ₹720–810 billion (US$8.11–9.13 billion) mega-infrastructure project to be built on a pristine island, the Great Nicobar, situated in the Bay of Bengal/Andaman Sea.[56] It is part of one of the four global biodiversity hot spots of India. The island is also a UNESCO Biosphere Reserve recognized for its ecologically important ecosystems—namely, rainforests, mangroves, and coral reefs. As it turns out, the island is strategically situated forty nautical miles from the western entrance to the Malacca Strait, through which a third of global sea trade passes (and ninety nautical miles northwest of the Indonesian island of Sumatra). The project includes an International Container Transshipment Terminal and an international airport (both are envisaged as competitors to Singapore) accompanied by a 450 MVA gas-solar power plant and a large (166 km^2) township. The island has a natural deepwater harbor that needs minimal dredging. The project is meant to leverage the island's proximity to the Malacca Strait and position it as a strategic Indo-Pacific hub rivaling Singapore and Hong Kong. According to government estimates, the port alone will generate Rs 300 billion (US$3.38 billion) in annual revenue by 2040 while creating fifty thousand jobs.[57] Environment clearance was granted in November 2022 with multiple mitigation conditions, and monitoring committees were constituted subsequently to track compliance.

Objections around the project have centered, inter alia, on alleged violations of environmental and tribal protections and severe ecological risks in a high-seismic zone. Scientists have documented around twenty-five hundred species of plants, birds, animals, lizards, butterflies, and other creatures on the island, of which more than four hundred are endemic.[58] Off the shores of the island are rainbow coral reefs, seagrass beds, and undersea ridges sheltering hundreds of species of fish and dugongs and fifteen species of dolphins and whales. The island is home to the Shompen, an Indigenous people numbering between two hundred and four hundred who shun contact with outsiders and are among the last hunters, gatherers, and cultivators. They have been officially designated as a Particularly Vulnerable Tribal Group by India's Ministry of Tribal Affairs. The project will fell close to a million primeval rainforest trees in its initial phase alone and ultimately spread over 244 km^2—nearly a fifth of Great Nicobar. It will also likely wipe out the uncontacted Shompen.[59] The government intends to compensate for the loss of these old-growth trees (in fact, the loss of an entire ecosystem) with

the "world's largest curated animal safari park" (Aravalli Forest Safari Project), which is proposed to be established more than 3,000 km away on the Indian mainland in the state of Haryana. This is through compensatory afforestation under the CAMPA Act discussed earlier in this chapter.[60] Despite these concerns, the government is forging ahead with the project.[61] The Great Nicobar Project is a compelling example of the aforementioned development versus environment conundrum, with the scales tipped in favor of the former.[62]

URBAN ENVIRONMENTAL ISSUES

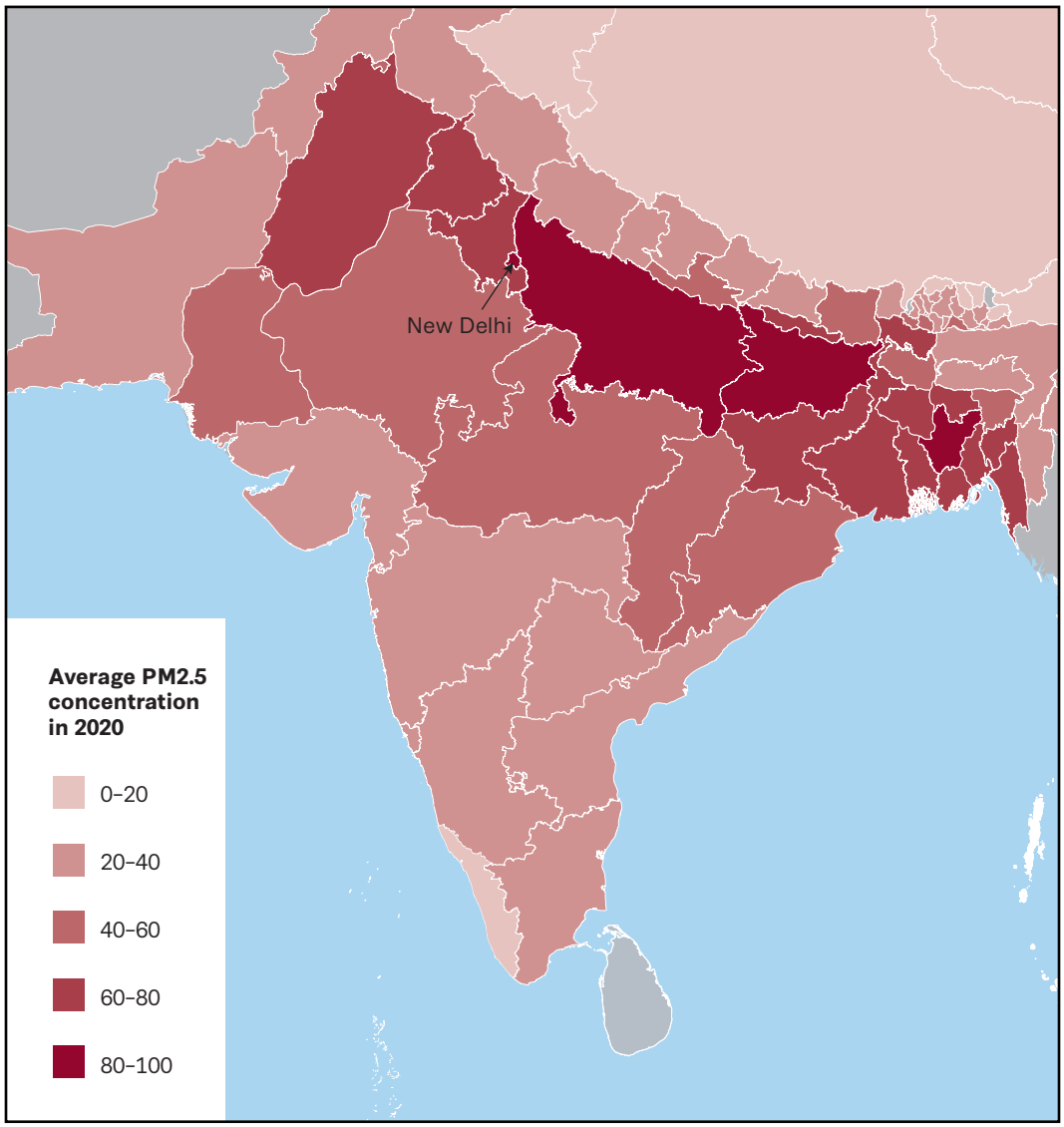
Accurate estimates of India's urban population are hampered by a lack of census data (the last one was conducted fourteen years ago in 2011). According to World Bank estimates, between 1960 and 2024 the urban population increased from 78 million to 535 million (that is, from 18 percent to 37 percent of the total). Despite the relatively slow pace of urbanization, the presence of more than half a billion people in dense urban settings puts severe pressure on the environment in terms of air and water pollution, sewage and waste disposal, and housing and transport.[63] What makes things worse is that India's urban growth is characterized by a lopsided top-heavy pattern, in which Class I cities (population 100,000 or more), including metropolitan areas, are expanding rapidly at the expense of smaller towns and surrounding areas. This skewed growth further concentrates urban population and intensifies environmental pressures.[64] In this section we limit our discussion to two of the most salient and visible problems: that of polluted air and of cities awash in mountains of solid waste.[65]

AIR POLLUTION

We first consider air pollution, which has an impact on all city residents, including the affluent. Unlike polluted water that can be treated with home filtration devices (such as the ubiquitous reverse osmosis systems found in middle- and upper-income urban households), there is no escape from polluted air. Staying indoors in an air-conditioned space offers only limited relief. Therefore, it is not surprising that air pollution receives considerable attention from policymakers, the media, civil society, and the judiciary. To be fair, air pollution is a serious health issue.[66] According to the annual 2025 update of the Air Quality Life Index, India ranks among the most polluted countries worldwide, ranking second out of 252, potentially losing a total of 4.9 billion life years due to high levels of air pollution. The average life expectancy of Indians is 3.5 years less (8.2 years less in the Delhi region) than it would be if the concentration of fine particulate matter (PM2.5) met the WHO annual average limit of 5 $\mu g/m^3$.[67] It is important to note that these are averages and conceal the fact that the years of life lost are higher for the urban poor.[68] While all of India lives in areas where the annual average particulate pollution level (PM2.5) exceeds the WHO limit, air quality is the worst in the northern Indo-Gangetic plain, exposing more than 540 million Indians to very high levels of air pollution (figure 7.1). Residents here lose, on average, 5 to 8 years of life expectancy. Even using the far less stringent Indian standard of 40 $\mu g/m^3$ for PM2.5, 46 percent of the population lives in areas that exceed this level.

Over the years, several attempts have been made to improve air quality, especially in the national capital region. The measures taken include converting public transport and taxis to natural gas; banning diesel vehicles older than ten years and petrol vehicles older than fifteen years; enforcing stringent tailpipe standards for all vehicles; expanding the metro rail network; and setting up a regional agency, the Commission for Air Quality Management, and a short-term emergency response measure, the Graded Response Action Plan (GRAP).[69] All of this has met with limited success. The very fact that GRAP must be invoked year after year, especially in the winter months, shows the failure of efforts to come up with a long-term solution. GRAP not only fails to address the root causes of air pollution but also creates other

FIGURE 7.1 Map of average PM2.5 air pollutant concentrations in South Asia



Note: Nepal and Bangladesh data is from 2018, the latest year with complete and available data.

Source: Air Quality Life Index.

problems like the disruption of economic activity, halting important public works like road repairs and affecting thousands of daily wage laborers, who lose income.[70] The fact that air pollution is a regional problem (figure 7.1) has prompted a rethink from focusing on city-specific measures to airshed management.[71] Efforts are also underway to curb the burning of paddy stubble on farms in Punjab and Haryana in October and November, which compounds the problem.[72]

Given the focus on outdoor (ambient) air pollution in the public discourse, it is crucial to remember that indoor (household) air pollution is just as serious a problem.[73] According to a *Lancet* study, in 2019 household air pollution caused by burning solid fuels for cooking, including traditional biomass like wood, crop residue, and dung, accounted for about one-third of all deaths linked to air pollution in India.[74] Indoor pollution is also a significant cause of child mortality, responsible

for half of all child deaths from acute respiratory infections, a leading cause of child deaths in India. The use of solid biomass for cooking is widespread in rural India, leading to a higher indoor air pollution burden compared to urban areas, where cleaner fuels like liquefied petroleum gas are more widely used. But India has made notable progress in improving household access to clean fuels over the past decade. The percentage of households using firewood as their primary cooking fuel decreased from three-fourths of all rural households in 2009–10 to half of all rural households by 2020–21. However, disparities across class, caste, and region in the use of clean fuel still exist.

WASTE DISPOSAL

Waste management spans municipal, hazardous, and e-waste streams and is marked by rapid growth in generation, persistent gaps in infrastructure and compliance, and systemic challenges in governance, data integrity, and the integration of informal sectors. Despite policy advancements and institutional frameworks, implementation remains uneven, exposing environmental and public health risks across urban and industrial landscapes. India generates approximately 170,000 metric tons of municipal solid waste per day, although estimates vary. Only about 75–80 percent of this waste is collected. Of that, less than 60 percent is processed, leaving over 40 percent either dumped or openly burned, contributing to air pollution and groundwater contamination. Legacy dumpsites, estimated at over 2,300 with about 250 million tons of accumulated waste, remain a critical liability and a source of serious environmental hazard (fires, contamination of groundwater, etc.). Those in Deonar, Mumbai, and in Ghazipur, Delhi, are taller than multistory buildings and monuments. The Municipal Solid Waste (Management and Handling) Rules of 2016 mandate source segregation, processing, and scientific landfilling, but compliance is poor across states and cities.[75] Per capita waste generation is rising and could be around 0.7 kg per person per day now.[76] While this is a relatively small figure compared to high-income countries, in absolute numbers it overwhelms the capacity to dispose of it safely or process it. Metropolitan cities and state capitals are the primary contributors, with just eight major cities (Delhi, Mumbai, Kolkata, Chennai, Bengaluru, Hyderabad, Pune, and Ahmedabad) generating over 44,000 tons per day in 2022–23.[77] The informal sector plays a crucial role in waste collection and recycling, particularly for dry waste, but lacks integration into formal systems, leading to health hazards and inefficiencies.

With regard to hazardous waste, India generated about 18.51 million tons in 2023–24, a significant increase of 18.2 percent from 2022 to 2023 (15.66 million tons). Of the 18.51 million tons generated, 38.5 percent was recycled and another 38 percent utilized in other ways (e.g., coprocessing in cement kilns), and the remaining 23.5 percent was either disposed of in landfills (19.2 percent) or incinerated (4.3 percent). Gujarat alone accounted for 47 percent of hazardous waste generated, primarily from shipbreaking at Alang, the world's biggest shipbreaking yard. It is the largest facility for dismantling decommissioned ships, handling the majority of the world's ship recycling.[78]

While there is a shift toward resource recovery, there is continued reliance on the disposal of hazardous waste.[79] The Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016, provide a regulatory framework, but enforcement is weak, with as many as 30 percent of units failing to submit annual returns in 2023–24.[80] Between 2018 and 2024, action was initiated against 283 defaulting units across eight states, and 127 contaminated sites were identified, with remediation underway at only 13, highlighting the slow pace of cleanup.[81]

The generation of electronic waste (e-waste) is also rising sharply, from 1.25 million tons in FY 2023–24 to 1.40 million tons in FY 2024–25, driven by increasing electronics consumption and short product lifecycles.[82] The E-Waste

(Management) Rules, 2022, introduced a robust Extended Producer Responsibility (EPR) framework, requiring producers to meet collection and recycling targets through certified recyclers.[83] As of 2024–25, over one thousand recyclers are registered, with significant growth in states like Maharashtra and Uttar Pradesh, but the informal sector still handles an estimated 90 percent of e-waste, posing environmental and health risks.[84] For instance, Seelampur in Delhi is India's largest e-waste dismantling market. It employs fifty thousand workers, including many children who work with their bare hands to extract valuable metals from circuit boards and other devices.[85] The CPCB has strengthened oversight through EPR certificate generation, mandatory registration, and technical guidelines, but verification and audit mechanisms remain underdeveloped.

On the whole, integration of the informal sector—critical for recycling and collection—remains a policy gap, with few initiatives providing formal recognition, safety equipment, or fair wages. Like most environmental issues, waste management in India reflects a paradox of policy ambition and implementation deficits. While regulatory frameworks have evolved, particularly in hazardous and e-waste, systemic issues in governance, data, and infrastructure persist. Closing the gap between policy and practice requires more vigorous enforcement, investment in processing and remediation, and formalization of the informal sector to build a circular economy.

CLIMATE CHANGE

The existential threat posed by a changing climate needs no recounting. There are two aspects to the issue. The first is reducing emissions of GHGs (mitigation), ideally to *net zero*, and the second is minimizing the harm from the warming that will inevitably occur (adaptation). The extent of harm, of course, depends on how much and how soon GHG emissions are reduced—the more rapid and deep the cuts, the less adaptation that will be required (in economic jargon, adaptation is *endogenous*). India's actions in reducing GHG emissions are not an environmental problem, per se, in the sense of other problems discussed so far. They do, however, offer win-win environmental outcomes. The most significant one is the synergy between improving local air quality and reducing GHG emissions, especially carbon dioxide (CO_2). A switch to renewables helps achieve both. So far, India has rightly maintained that its willingness and ability to move faster on mitigation depend on climate finance and technology from countries that occupy a disproportionate share of the carbon space. That said, India is on track to meet its commitments under the Paris Agreement, especially with regard to renewables. It has already achieved its Nationally Determined Contribution (NDC) of having 50 percent of its total installed electricity capacity from non–fossil fuel sources, five years ahead of the 2030 target. As of mid-2025, India's nonfossil electricity capacity had surpassed 250 GW.[86] It also claims to be making more than adequate progress toward reducing the GHG emissions intensity of its economy, but the data for this is not readily available.

India has committed to reducing its GHG emissions to net zero by 2070. This is a somewhat unambitious goal, especially given that other major economies are set to reach this target by 2060 or even 2050. More importantly, as per the UN Emissions Gap Report, India has to play a more proactive role if the world is to meet its climate target of limiting warming to 1.5°C (or at least 2°C).[87] But this can only happen if the requisite climate finance and technology are made available. What is more important from the perspective of this chapter are India's actions on adapting to current and future climate change. On this account, there is much to be desired.

Here it is important to remind ourselves that India is among the countries that are most vulnerable to climate change. Two-thirds of its population lives in rural areas and is economically dependent on climate-sensitive sectors such as agriculture, forestry,

animal husbandry, and fisheries. In addition, 68 percent of the cultivable land is drought prone, 12 percent is flood prone, and 8 percent is susceptible to cyclones.[88] Moreover, there is an increasing frequency of extreme weather events linked to climate change. Almost 250 million people live within 50 miles (80 km) of the coastline and are exposed to sea-level rise and coastal erosion.[89] The number of heavy rain events has tripled since 1950, and a single cyclone in 2020 cost India US$13 billion.[90]

Several studies have projected large losses of GDP and per capita GDP for India in the absence of ameliorative action.[91] Therefore, India needs to urgently "climate proof" its economy to the extent possible through adaptation. India's NDC submitted to the United Nations Framework Convention on Climate Change in October 2015 recognizes this fact:

> The adverse impacts of climate change on the developmental prospects of the country are amplified enormously by the existence of widespread poverty and dependence of a large proportion of the population on climate-sensitive sectors for livelihood. Hence for India adaptation is inevitable and an imperative for the development process. It is of immediate importance and requires action now (MoEFCC 2015, p. 19).[92]

Despite this, in 2020, for every Rs. 7 spent on mitigation, India spent Rs. 1 on adaptation, a surprising asymmetry.[93] What is more, for all these years India lacked a national adaptation plan (NAP).[94] Activities related to adaptation are subsumed under the now outdated National Action Plan for Climate Change launched in 2008. The action plan was implemented through eight separate National Missions, with different ministries of the central government responsible for their implementation. The now defunct Prime Minister's Council on Climate Change was the apex body to monitor and coordinate across these missions, which is no longer happening. India's initial adaptation communication was formally submitted to the UNFCCC only as recently as December 2023.[95] A NAP is now in the works, supported by a US$3 million grant from the Green Climate Fund.[96] India had planned to submit it to UNFCCC in November, around the time of COP30.[97] As of January 2026, the NAP remains unsubmitted, and no confirmed new timeline exists.

CONCLUDING THOUGHTS

The current state of India's environment is a cause for concern. Remedial actions are well-known—for example, better planning, greater interagency coordination, better functioning of agencies such as pollution control boards through adequate staffing and funds, and greater accountability. However, going beyond these obvious (though necessary) measures, the ongoing tension between economic development and environmental protection needs to be resolved through a proper ex ante cost-benefit analysis of projects, which includes the monetary value of ecosystems and other nonmarket goods and services. In effect, this is a sensible project appraisal that considers all costs and benefits ex ante to decide whether a project should be undertaken at all. The tools for doing so are available. This requires going beyond merely conducting an environmental impact assessment and trying to offset those impacts in some way, such as compensatory afforestation. Similarly, an ex ante regulatory impact analysis of executive actions is essential.[98]

NOTES

I would like to thank Anand Swamy for conversations that have helped shape my thinking on this subject. I would also like to thank Raghavan Srinivasan and Joseph Mathai for helpful comments. The sole responsibility for errors, omissions, and other shortcomings is mine.

1. The Environmental Performance Index (EPI) offers a data-driven overview of global sustainability. It uses fifty-eight performance indicators across eleven issue categories to rank 180 countries based on climate change, environmental health, and ecosystem vitality. The 2024 report is careful to note, "Despite the usefulness of synthesizing complex environmental data into single performance scores . . . many assumptions and subjective

methodological choices underlie the EPI results, so readers should treat the scores and rankings only as the starting point for deeper analyses and examination of disaggregated data." Factors contributing to India's low rank include weak biodiversity and habitat protection, high levels of air and water pollution, and emissions of heat-trapping greenhouse gases (GHGs). Sebastian Block, John W. Emerson, Daniel C. Esty, Alex de Sherbinin, and Zachary A. Wendling, *Environmental Performance Index 2024*, Yale Center for Environmental Law and Policy, 2024, https://epi.yale.edu. As expected, the EPI has been controversial in India. The Indian government has rejected it, claiming it is "based on unfounded assumptions." Several Indian environmental experts have also criticized it, though some see it as a wake-up call: Manish Kumar, "Environmental Performance Index: An Unscientific Study or an Opportunity to Reflect and Improve?," *Mongabay*, June 21, 2022, https://india.mongabay.com/2022/06/environmental-performance-index-an-unscientific-study-or-an-opportunity-to-reflect-and-improve.

2. World Bank, "India—Diagnostic Assessment of Select Environmental Challenges: An Analysis of Physical and Monetary Losses of Environmental Health and Natural Resources," vol. 1 of 3, June 5, 2013, accessed October 7, 2025, http://documents.worldbank.org/curated/en/220721468268504319.

3. Based on the Air Quality Life Index (AQLI) developed by the University of Chicago. The AQLI is a pollution index that converts concentrations of fine particulate matter (PM2.5) levels into their impact on life expectancy: https://aqli.epic.uchicago.edu; Sophiya Mathew, "Delhi Residents Could Live 8.2 Years Longer If Air Pollution Curbed: Chicago University Report," *Indian Express*, August 29, 2025, https://indianexpress.com/article/cities/delhi/delhi-life-expectancy-air-pollution-chicago-report-10217807.

4. India receives 80 percent of its annual rainfall during the summer monsoon months, between June and September. The monsoon rains have long been the lifeblood of India, providing the bulk of water for drinking and irrigation and for hydroelectric power generation. Press Information Bureau, Government of India, "The Indian Monsoon: Nature's Pulse and Nation's Lifeline," July 15, 2025, https://www.pib.gov.in/PressNoteDetails.aspx?id=154892&NoteId=154892&ModuleId=3. It has been reported that a 1 percent change in monsoon rainfall corresponds to a 0.34 percent variation in India's GDP. Christopher Bowden, Timothy Foster, and Ben Parkes, "Identifying Links Between Monsoon Variability and Rice Production in India Through Machine Learning," *Scientific Reports* 13, no. 2446 (2023), https://doi.org/10.1038/s41598-023-27752-8.

5. For a narrative of India's environmental journey over the last seventy-five years since Independence, see Swamy and Gupta (2025). It covers topics similar to those in this snapshot—namely, institutions, water, forests, pollution, waste disposal, and climate change and is a useful complement to this essay. Anand Swamy and Shreekant Gupta, "Environment and Development in Independent India," in *The Cambridge Economic History of Modern South Asia*, ed. Latika Chaudhary, Tirthankar Roy, and Anand V. Swamy (Cambridge University Press, forthcoming 2026).

6. Press Trust of India, "India's Population to Peak in Early 2060s to 1.7 Billion Before Declining: United Nations," *The Hindu*, July 12, 2024, https://www.thehindu.com/news/national/indias-population-to-peak-in-early-2060s-to-17-billion-before-declining-united-nations/article68395623.ece.

7. Interpreting the term *developed economy* to mean a high-income economy by World Bank definition implies a per capita gross national income of US$13,935. Since India will have at least 1.6 billion people by 2047, this implies an economy of US$22.3 trillion, which is 5.3 times the current size of US$4.2 trillion. Whether this comes to pass is, of course, moot. For a detailed discussion of India's past growth performance and prospects, respectively, see Nirvikar Singh, "India's Economy: An Assessment," in *The Hoover Institution's Survey of India*, ed. Šumit Ganguly and Dinsha Mistree (Hoover Institution Press, January 2025) and Nirvikar Singh, "India's Economy: Inside and Out" (this volume).

8. Put differently, the consumption of the environment for growing the economy can, if not managed properly, lead to environmental degradation, which can derail that growth itself. The economist Partha Dasgupta proposes measuring economic progress using *inclusive wealth* (accounting for natural, produced, and human capital) rather than just GDP. He argues that treating nature as separate from the economy leads to the erosion of natural capital. Also, by doing so, economic activities are pushing the biosphere beyond sustainable limits. For details, see Parth Dasgupta, *The Economics of Biodiversity: The Dasgupta Review* (HM Treasury, 2021), https://www.gov.uk/government/publications/final-report-the-economics-of-biodiversity-the-dasgupta-review.

9. Shyam Divan and Armin Rosencranz, *Environmental Law and Policy in India: Cases and Materials*, 3rd ed. (Oxford University Press, 2022), 2.

10. United Nations. "Water—at the Center of the Climate Crisis," accessed October 15, 2025, https://www.un.org/en/climatechange/science/climate-issues/water.

11. The CWC is the primary national agency for water resource management in India, responsible for collecting and monitoring water-related data. It is also responsible for initiating, coordinating, and furthering schemes for water conservation, control, and utilization in the country for purposes like flood control, irrigation, and hydropower. It publishes an informative report, *Water Sector at a Glance*. The most recent one is for 2023:

https://cwc.gov.in/sites/default/files/water-sector-glance-2023.pdf. The report for 2024 is not available yet. In addition, the "National Compilation of Dynamic Ground Water Resources of India" is an annual report published by the Central Ground Water Board under the Ministry of Jal Shakti, Government of India. The latest report, for 2024, is available at https://data.opencity.in/dataset/national-compilation-on-dynamic-ground-water-resources-of-india-2024.

12. A study by a government think-tank, NITI Aayog, notes that the country uses two to three times more water per ton of crop than developed nations. Ramesh Chand, "Improving Water Efficiency in Indian Agriculture," NITI Aayog, 2021.

13. These four crops consume nearly 700 BCM of water annually, about 60 percent of India's usable water resources. India's rice production for the 2023–24 agricultural year was estimated at 136.7 million metric tons (MMT). As a water-intensive crop, rice requires a significant amount of it; each kilogram of rice needs roughly 2,500 L of water. This translates to an estimated 341.75 BCM of water for annual rice production alone. Likewise, India's sugar production for 2023–24 was estimated at 34 MMT. Producing 1 kg of sugar requires between 1,500 (jaggery) to 3,000 (sugar) liters of water, translating to an estimated 51–102 BCM of water annually. Ram Ramprasad, "How India's Agriculture Can Save 200 Billion Cubic Meters of Water," India Water Portal, January 14, 2025, https://www.indiawaterportal.org/environment/sustainability/how-indias-agriculture-can-save-200-billion-cubic-meters-of-water.

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17. Vasudevan Mukunth, "Is India Plumbing the Depths of Groundwater?," *The Hindu*, June 27, 2025, https://www.thehindu.com/sci-tech/energy-and-environment/is-india-plumbing-the-depths-of-groundwater/article69541554.ece.

18. This is known as the food-energy-water nexus, a well-studied policy conundrum in India. See, for instance, Aditi Mukherji, "Sustainable Groundwater Management in India Needs a Water-Energy-Food Nexus Approach," *Applied Economic Perspectives and Policy* 44 (2022): 394–410.

19. Major metro cities—namely, Delhi, Bengaluru (India's Silicon Valley), Chennai, and Hyderabad—are heavily dependent on groundwater, with extraction rates well in excess of recharge, making aquifers drying up a certainty. Open City, "State of Groundwater Usage in Indian Cities in 2024," accessed October 16, 2025, https://opencity.in/state-of-groundwater-usage-in-indian-cities-in-2024.

20. John Roome, "India Seeks to Arrest Its Alarming Decline in Groundwater," *World Bank Blogs*, May 25, 2022, https://blogs.worldbank.org/en/endpovertyinsouthasia/india-seeks-arrest-its-alarming-decline-groundwater. This source also notes that poverty rates are 9–10 percent higher in districts where groundwater tables have fallen below eight meters, leaving small farmers particularly vulnerable. If current trends persist, at least 25 percent of India's agriculture will be at risk.

21. According to the international norms, a country is classified as *water stressed* when water availability is less than 1,700 m^3 per capita per year and *water scarce* if it is less than 1,000 m^3 per capita per year.

22. Press Information Bureau, Government of India, "Implementation of Atal Bhujal Yojana," Ministry of Jal Shakti, July 24, 2025, https://www.pib.gov.in/PressReleasePage.aspx?PRID=2147817.

23. Environmental flow (e-flow) requirements for the Ganga River are the minimum flows needed to sustain its ecosystem, which have been established through assessments and notifications. For the Ganga, the e-flow notification requires a minimum of 15–20 percent of the average lean season flow to be maintained continuously in the upper reaches until Unnao, Uttar Pradesh, to support the river's health, biodiversity, and water quality.

24. Monika Mandal, "After Spending Rs 33,000 Crore, Has the Indian Government Finally Managed to Clean the Ganga?," *Scroll*, October 3, 2023, https://scroll.in/article/1056887/after-spending-rs-33000-crore-has-the-indian-government-finally-managed-to-clean-the-ganga.

25. According to the last census conducted nearly fifteen years ago in 2011, there were about 650,000 villages in the country, out of which more than a quarter (nearly 170,000 villages) were located in the proximity of forest areas, often referred to as forest fringe villages. Moreover, as per the *India State of Forest Report 2019*, approximately three hundred million people are dependent on forests. Press Information Bureau, Government of India, "Involvement of Tribal Communities in Protection, Conservation, and Management of Forest Development," Ministry of Environment, Forest and Climate Change, December 18, 2023, https://www.pib.gov.in/PressReleseDetailm.aspx?PRID=1987759.

26. The 1865 act was the first major forest law, allowing the British to claim government forests. The 1878 act further expanded British authority, revoking communal forest rights and classifying forests into three categories: reserved, protected, and village, with the most commercially valuable areas falling under strict

state control and making traditional uses a privilege rather than a right. The 1927 act consolidated previous laws, making the existing regulations even stricter and affecting forest-dependent communities by consolidating the colonial government's control over forest resources.

27. The full name for the FRA is the Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act, 2006. While it was the government that passed these laws, they were the result of people's long-standing struggles for self-governance and recognition of their traditional rights. Though PESA and FRA are far from perfect and there is inadequate implementation (in many places rampant violation), "there were many examples where local communities compelled corporate houses to call off their projects." Kamal Nayan Choubey, "The State, Tribals and Law: The Politics Behind the Enactment of PESA and FRA," *Social Change* 46, no. 3: 355–70. A recent study in an influential journal found that increasing formal representation for Scheduled Tribes under PESA led to an average increase in tree canopy of 3 percent per year and a reduction in the rate of deforestation. In fact, the reduction was greater in villages near mines that had higher deforestation rates before implementing PESA. The authors conclude that organized protests against large-scale mining operations were the main channel of change. Saad Gulzar, Apoorva Lal, and Benjamin Pasquale, "Representation and Forest Conservation: Evidence from India's Scheduled Areas," *American Political Science Review* 118, no. 2 (2024): 764–83.

28. Jay Mazoomdaar, "The Case for Open, Verifiable Forest Cover Data," *Indian Express*, March 4, 2023, https://indianexpress.com/article/explained/explained-climate/india-forest-tree-cover-data-deforestation-explained-8474163.

29. The gain of 1,445 km^2 in absolute numbers between ISFR 2021 and ISFR 2023 comprises only a 156 km^2 increase in forest cover and a 1,289 km^2 increase in tree cover. The latter cannot be considered a forest in any meaningful sense. Official data defines *tree* cover as "all tree patches outside the forest area, which are less than one hectare in extent including all the scattered trees found in the rural and urban settings, and not captured under the forest cover assessment." Further, forest cover is defined as "all lands, more than or equal to one hectare in area, with a tree canopy of more than or equal to 10%, irrespective of ownership and legal status; and includes orchards, bamboo, and palm." Forest Survey of India, Ministry of Environment, Forest and Climate Change, Government of India, *India State of Forest Report 2023*, 1:xxix, xxv.

30. The ecologist Madhusudan argues that a natural forest is much more than a "tree-clad space." M. D. Madhusudan, "Forests Are More than Just Trees," *Deccan Herald*, August 15, 2022, https://www.deccanherald.com/science-and-environment/independence-day-india-at-75-forests-are-more-than-just-trees-1135457.html.

31. Athira Perinchery, "India's New 'State of Forest' Report Is Not Really About Forests," *The Wire*, January 16, 2022, https://science.thewire.in/politics/government/india-2021-state-of-forest-report-flawed-methods-unverifiable-data-climate-commitments. The article goes on to say, "Previous editions of the same report have elicited criticism from independent experts for their methods, and this time is no different."

32. Global Forest Watch (GFW), "India Deforestation Rates & Statistics," accessed October 16, 2025, https://www.globalforestwatch.org/dashboards/country/IND. According to GFW classification, natural forests possess many or most of the characteristics of a forest native to the given site, including species composition, structure, and ecological function. Primary forests are a subset of natural forests that have not been subject to major human impacts in recent history. Accountability Framework Initiative, "Natural Forest," accessed October 16, 2025, https://accountability-framework.org/the-accountability-framework/definitions/article/natural-forest.

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servants, primarily former Indian Forest Service officers. The case is still being heard, and some interim orders have been passed. C. R. Bijoy, "Will Forest Conservation Amendment Act of 2023 Sound the 'Death Knell' for India's Forests?," *Frontline*, March 21, 2024, https://frontline.thehindu.com/environment/forest-conservation-amendment-act-presents-great-conundrum-definition-supreme-court-ruling/article67938307.ece; C. R. Bijoy, "Commentary: Unravelling Forest Conservation," *Mongabay*, April 17, 2024, https://india.mongabay.com/2024/04/commentary-unravelling-forest-conservation-the-battle-over-the-forest; Citizens for Justice and Peace, "Forest Conservation Amendment Act, 2023: A Challenge to Adivasi Land Rights and Environmental Protections," February 10, 2025, https://cjp.org.in/forest-conservation-amendment-act-2023-a-challenge-to-adivasi-land-rights-and-environmental-protections; Krishnadas Rajagopal, "Do Not Reduce Forest Land for Linear Projects; If So, Return Same Area for Afforestation: SC to Centre, States," *The Hindu*, February 3, 2025, https://www.thehindu.com/news/national/do-not-reduce-forest-land-for-linear-projects-if-so-return-same-area-for-afforestation-sc-to-centre-states/article69176171.ece.

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41. A Ramsar site is a wetland site designated to be of international importance under the Ramsar Convention, named after the city in Iran where it was signed in 1971. Also known as the Convention on Wetlands, it is an intergovernmental environmental treaty under UNESCO that provides for national action and international cooperation regarding the conservation of wetlands. It identifies rare or unique wetland types or those important to conserving biological diversity, especially waterfowl habitat.

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65. The one in the Mumbai suburb of Deonar is India's oldest mountain of garbage. It was also the largest and tallest, standing at 36.5 meters (18 stories), but it has now been outdone by that in Ghazipur on the outskirts of Delhi, which is 65 meters tall (about the same height as Delhi's iconic medieval monument, the Qutub Minar). These and other landfills in Indian cities are major health hazards and regularly catch fire. Saumya Roy, "The Nightmare of India's Tallest Rubbish Mountain," BBC, October 17, 2021, https://www.bbc.com/news/world-asia-india-58866834; Shaunak Ghosh and Proma Chakraborty, "The Ghazipur Landfill: A Hill as High as Qutub Minar," *Newslaundry*, April 29, 2019, https://www.newslaundry.com/2019/04/29/delhi-ghazipur-landfill; Mubashir Naik and Poorvi Gupta, "New Delhi's Garbage Mountains Become Heat Bombs for India's Waste Pickers," *Al Jazeera*, August 14, 2025, https://www.aljazeera.com/features/2025/8/14/how-new

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