

HUMAN-INDUCED POLLUTION AND ITS IMPACT ON THE NATURAL ENVIRONMENT: A CRITICAL STUDY

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1. ABSTRACT

Human-induced pollution has emerged as one of the most serious threats to the natural environment and sustainable development. Rapid industrialization, urbanization, population growth, transportation, agricultural activities, mining, deforestation and improper waste disposal have significantly increased the level of pollution in air, water and soil. Unlike natural environmental changes, human-induced pollution is largely associated with human activities and has the potential to cause long-term and irreversible damage to ecosystems.

Air pollution contributes to respiratory and cardiovascular diseases, climate change and ecological degradation, while water pollution affects aquatic ecosystems, drinking-water quality and human health. Soil pollution caused by industrial waste, pesticides, plastics and hazardous chemicals reduces soil fertility and affects agricultural productivity. Marine pollution, particularly plastic and chemical pollution, further threatens aquatic biodiversity and food chains. The increasing generation of electronic waste and other forms of hazardous waste has added new dimensions to the environmental problem.

This study critically examines the major causes and forms of human-induced pollution and analyses their impact on the natural environment, biodiversity and human well-being. It also examines the legal and institutional measures adopted to control pollution and promote environmental protection. The study adopts a doctrinal and qualitative approach based primarily

on secondary sources, including environmental legislation, judicial decisions, government reports, international conventions, academic literature and reports of environmental organizations.

The study finds that although India has developed an extensive environmental legal framework, effective implementation remains a major challenge due to weak enforcement, inadequate monitoring, increasing industrial activity, poor waste management and limited public awareness. The study therefore emphasizes the need for stronger enforcement of environmental laws, sustainable industrial practices, effective waste management, renewable energy, environmental education and greater public participation. A coordinated approach involving government authorities, industries, local communities and individuals is essential to protect the natural environment for present and future generations.

Keywords: Human-induced pollution, Environmental degradation, Sustainable development, Pollution control, Environmental law.

2. INTRODUCTION

The natural environment is essential for the survival and well-being of all living organisms. Air, water, soil, forests, oceans and biodiversity provide the basic resources necessary for human life and economic development. However, increasing human activities have placed significant pressure on these natural systems. Industrialization, urbanization, population growth, transportation, intensive agriculture, mining, construction and excessive consumption of natural resources have contributed to increasing environmental pollution.

Pollution may be broadly understood as the introduction of harmful substances or forms of energy into the environment in quantities that adversely affect human beings, other living organisms and ecological systems. Human-induced pollution is particularly concerning because it is largely caused by human activities and can continue to accumulate over time.

Air pollution is one of the most visible forms of environmental pollution. Industrial emissions, vehicle exhaust, construction activities, burning of fossil fuels and open burning of waste release pollutants into the atmosphere. These pollutants can affect human health, reduce air quality and contribute to environmental problems such as climate change and acid deposition.

Water pollution is another major concern. Untreated industrial effluents, domestic sewage, agricultural chemicals, plastics and other waste materials enter rivers, lakes, groundwater and oceans. Water pollution affects aquatic biodiversity and may make water unsafe for human consumption. The contamination of water resources can also affect agriculture, fisheries and local communities.

Soil pollution is caused by the accumulation of hazardous chemicals, pesticides, industrial waste, plastics and other contaminants in the soil. It can reduce soil fertility, affect agricultural production and allow harmful substances to enter the food chain. Similarly, improper disposal of solid waste and plastic waste has become a serious environmental problem in urban and rural areas.

The consequences of human-induced pollution are not limited to the environment. Pollution also creates significant social, economic and public-health consequences. Vulnerable communities, children, elderly persons and people living near industrial or heavily polluted areas may experience greater exposure to environmental risks.

India has enacted several laws and established institutions for environmental protection, including the Environment (Protection) Act, 1986, the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981. Indian courts have also developed important environmental principles such as sustainable development, the precautionary principle and the polluter pays principle.

Therefore, human-induced pollution must be examined not only as an environmental issue but also as a legal, social, economic and governance challenge. This study critically analyses the causes and impacts of human-induced pollution and evaluates the effectiveness of existing environmental protection mechanisms.

3. REVIEW OF LITERATURE

Existing literature demonstrates that human activities are among the major drivers of environmental degradation and pollution. Environmental studies have extensively examined the relationship between industrial development, urbanization, consumption patterns and environmental pollution.

The World Health Organization (WHO) has highlighted the significant health consequences associated with air pollution and other environmental risks. Its reports indicate that air pollution is an important environmental risk factor contributing to premature deaths and various diseases.¹

The United Nations Environment Program (UNEP) has examined global environmental challenges including pollution, waste generation, plastic pollution and ecosystem degradation. UNEP literature emphasizes the need for pollution prevention, sustainable consumption and stronger environmental governance.²

The Intergovernmental Panel on Climate Change (IPCC) has extensively examined the relationship between human activities, greenhouse gas emissions and climate change. Its assessments demonstrate that human activities, particularly the burning of fossil fuels and land-use changes, have significantly contributed to global warming.

Indian environmental literature has focused on the development of environmental jurisprudence and the role of the judiciary in protecting environmental rights. Judicial decisions have recognized principles such as sustainable development, precautionary principle and polluter pays principle as important components of environmental governance.

Scholars have also examined the effectiveness of India's environmental legislation. Although India has a comprehensive framework of environmental laws, several studies identify difficulties relating to implementation, institutional capacity, monitoring, environmental compliance and public participation.

The literature therefore establishes that pollution is a multidimensional problem requiring cooperation between law, science, public policy, industry and society. However, there remains a continuing need to examine the effectiveness of environmental protection measures in addressing

¹ World Health Organization, 'Ambient (Outdoor) Air Pollution' (WHO 2024)
<[https://www.who.int/news-room/fact-sheets/detail/ambient-\(outdoor\)-air-quality-and-health](https://www.who.int/news-room/fact-sheets/detail/ambient-(outdoor)-air-quality-and-health)> accessed 28 August 2026.

² United Nations Environment Programme, 'Making Peace with Nature: A Scientific Blueprint to Tackle the Climate, Biodiversity and Pollution Emergencies' (UNEP 2021)
<<https://www.unep.org/resources/making-peace-nature>> accessed 28 August 2026.

rapidly changing forms of pollution, including plastic pollution, electronic waste, chemical pollution and pollution associated with expanding urbanization and industrialization.

4. OBJECTIVES

The primary objective of this study is to critically examine the nature, causes and consequences of human-induced pollution and its impact on the natural environment. The study aims to identify the major human activities responsible for air, water, soil, marine and other forms of pollution and to analyze their effects on ecosystems, biodiversity and human health. It further seeks to examine the impact of industrialization, urbanization, transportation, agriculture, mining, plastic consumption and improper waste management on environmental quality. The study also aims to analyze the existing legal and institutional framework for pollution control in India and to examine the role of environmental authorities and courts in protecting the environment. In addition, the study seeks to identify the major challenges in implementing environmental laws and policies and to examine the effectiveness of existing pollution-control mechanisms. Finally, the study aims to suggest sustainable, legal, technological and policy-based measures for reducing human-induced pollution and protecting the natural environment for present and future generations.

5. METHODOLOGY AND DATABASE USED

This study adopts a doctrinal and qualitative research methodology to critically examine human-induced pollution and its impact on the natural environment. The research is primarily based on secondary sources of information and focuses on the analysis of environmental laws, judicial decisions, government policies, international environmental instruments, academic publications and reports of recognized environmental organizations.

The primary legal sources include the Constitution of India, the Environment (Protection) Act, 1986, the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the National Green Tribunal Act, 2010 and other relevant environmental

regulations. Important judicial decisions of the Supreme Court and National Green Tribunal are also examined to understand the development of environmental jurisprudence in India.³

Secondary data is collected from books, academic journals, research articles, government publications, reports of the Ministry of Environment, Forest and Climate Change, Central Pollution Control Board reports, State Pollution Control Board materials, WHO reports, UNEP publications and IPCC assessments.

The study also uses official environmental databases and reports to understand pollution trends and environmental challenges. The collected information is analyzed through a qualitative and critical approach to identify the major causes of pollution, its environmental and social consequences, existing regulatory mechanisms and implementation challenges.

The research does not rely primarily on field surveys or interviews. Instead, it evaluates existing legal and environmental information to determine whether current laws, policies and institutional mechanisms are sufficient to address the growing problem of human-induced pollution.

6. RESEARCH ANALYSIS

6.1 Major Causes of Human-Induced Pollution

Human-induced pollution results from various economic, industrial and social activities. Rapid industrialization is one of the major sources of environmental pollution. Factories and industries may release harmful gases, chemicals, untreated wastewater and solid waste into the environment.

Urbanization has also increased pollution because of growing population density, construction activities, traffic congestion and increasing waste generation. The expansion of cities without adequate waste-management infrastructure can place significant pressure on natural resources.

Transportation is another important source of air pollution. Vehicles using petrol and diesel release pollutants and greenhouse gases. The increasing number of private vehicles in urban areas contributes to poor air quality.

³ Shyam Divan and Armin Rosencranz, *Environmental Law and Policy in India* (2nd edn, Oxford University Press 2002).

Agricultural activities can also contribute to pollution through excessive use of chemical fertilizers, pesticides and other agricultural inputs. These substances can enter water bodies and soil and affect biodiversity.

Mining and extraction of natural resources can cause land degradation, deforestation, soil erosion and contamination of water resources. Improper disposal of industrial and domestic waste further increases environmental pollution.

India's position in global air quality rankings underscores the severity of the pollution challenge. According to the IQAir World Air Quality Report 2024, India ranked as the fifth most polluted country globally, recording an average annual PM_{2.5} concentration of 50.6 micrograms per cubic metre, a level approximately ten times higher than the World Health Organisation's recommended safe limit of 5 micrograms per cubic metre.⁴ Thirteen of the world's twenty most polluted cities were located in India in 2024, with cities across the Indo-Gangetic Plain, including Byrnihat, Delhi, Hajipur and Ghaziabad, recording persistently poor air quality throughout the year, reflecting the cumulative effect of rapid industrialisation, urbanisation and transportation growth.

6.2 Air Pollution

Air pollution occurs when harmful gases, particles and other pollutants are released into the atmosphere. Major human sources include industries, transportation, fossil-fuel combustion, construction and open burning of waste.

Air pollution affects both human health and ecosystems. Prolonged exposure to polluted air can contribute to respiratory and cardiovascular problems. Air pollution can also affect vegetation, reduce visibility and contribute to climate-related environmental changes.

The public health consequences of air pollution in India are particularly severe. A study published in The Lancet Planetary Health in December 2024, drawing on nationwide data, estimated that approximately 1.5 million deaths occur annually in India due to long-term exposure to PM_{2.5} concentrations above the World Health Organisation's recommended guideline of 5 micrograms

⁴ IQAir, 'World Air Quality Report 2024' (IQAir 2025) <<https://www.iqair.com/world-most-polluted-countries>> accessed 28 August 2026.

per cubic metre.⁵ Vehicular emissions, which contribute an estimated 20 to 30 percent of PM_{2.5} at the breathing level in urban areas, represent a significant and growing source of air pollution in Indian cities, where unplanned and rapid urbanisation has resulted in sharp growth in the number of private vehicles on congested roads.

6.3 Water Pollution

Water pollution occurs when harmful substances enter rivers, lakes, groundwater, seas and other water bodies. Industrial effluents, domestic sewage, agricultural runoff, plastics and chemical waste are major sources.

Water pollution can destroy aquatic habitats and reduce biodiversity. Polluted water may also spread waterborne diseases and affect communities that depend on rivers, lakes and groundwater for drinking, agriculture and livelihood.⁶

The scale of water pollution in India is reflected in monitoring data published by the Central Pollution Control Board. According to the CPCB's 2023 assessment of river water quality, which covered 4,736 monitoring locations across rivers, lakes and other water bodies, a total of 296 polluted river stretches were identified across 271 rivers in 32 states and Union Territories, with Maharashtra reporting the highest number of polluted river stretches at 54.⁷ Only 62 percent of monitored river sites met the permissible biochemical oxygen demand limit of less than 3 milligrams per litre, indicating that a substantial proportion of India's river monitoring network fails basic water quality standards and pointing to a persistent gap between regulatory requirements and actual environmental conditions.

6.4 Soil Pollution

⁵ Suganthi Jaganathan and others, 'Estimating the Effect of Annual PM_{2.5} Exposure on Mortality in India: A Difference-in-Differences Approach' (2024) 8 *Lancet Planetary Health* e1028 doi:10.1016/S2542-5196(24)00248-1.

⁶ Central Pollution Control Board, 'Status of River Water Quality in India 2022–23' (Ministry of Environment, Forest and Climate Change 2023) <<https://cpcb.nic.in>> accessed 28 August 2026; United Nations Environment Programme, 'Freshwater Pollution' (UNEP 2022) <<https://www.unep.org/explore-topics/water-oceans/what-we-do/addressing-freshwater-pollution>> accessed 28 August 2026.

⁷ Central Pollution Control Board, 'Status of River Water Quality in India 2022–23' (Ministry of Environment, Forest and Climate Change 2023) <<https://cpcb.nic.in>> accessed 28 August 2026.

Soil pollution results from the accumulation of chemicals, pesticides, industrial waste, plastics and hazardous substances in the soil. Excessive use of pesticides and fertilizers may affect soil quality and biodiversity.

Contaminated soil can reduce agricultural productivity and allow toxic substances to enter plants and ultimately the human food chain. Soil pollution is particularly difficult to reverse because some contaminants remain in the environment for long periods.

Research on agricultural soil quality in India has identified geographically widespread contamination linked to intensive industrial and farming practices. A study published in the journal *Science* in April 2025, which analysed over 1,000 regional datasets, identified northern and central India as significant hotspots for cadmium contamination in agricultural soils, attributing this partly to the long history of intensive cultivation in these regions.⁸ Reports drawing on CPCB data have indicated that approximately 31 percent of agricultural land in India is affected by soil degradation, while pesticide residues have been detected in a large proportion of vegetable samples from Indian cities, pointing to the extent to which soil contamination translates into food chain risks for the wider population.

6.5 Plastic and Marine Pollution

Plastic pollution has become a major environmental challenge. Large quantities of plastic waste enter rivers and oceans through improper disposal and inadequate waste-management systems.

Marine animals may consume plastic or become trapped in plastic materials. Microplastics can enter aquatic food chains and create long-term ecological concerns.

India's contribution to global plastic waste mismanagement has attracted international concern. A 2024 report by Swiss environmental organisation EA Earth Action identified India as one of twelve countries responsible for 60 percent of the world's mismanaged plastic waste, with India's expected

⁸ Deyi Hou and others, 'Global Soil Pollution by Toxic Metals Threatens Agricultural and Human Health' (2025) 388 *Science* 1038; CPCB Annual Report 2022–23, as cited in 'Soil Pollution in India: Areas and Remedial Measures' (Dalvoy 2026) <<https://www.dalvoy.com/en/upsc/mains/previous-years/2017/geography-paper-ii/soil-pollution-india-areas-remedial-measures>> accessed 28 August 2026.

volume of mismanaged plastic waste for 2024 estimated at 7.4 million tonnes.⁹ Data further indicates that India's plastic overshoot day, the point at which domestic plastic waste generation exceeds the country's management capacity, fell on 6 January 2023, meaning that for the large majority of the year India's plastic waste significantly outpaced its management infrastructure, underscoring the urgency of improved waste governance.

6.6 Industrial Pollution and Environmental Law

India has enacted several laws to regulate pollution and protect the environment. The Water (Prevention and Control of Pollution) Act, 1974 focuses on preventing and controlling water pollution. The Air (Prevention and Control of Pollution) Act, 1981 addresses air pollution. The Environment (Protection) Act, 1986 provides a broader framework for environmental protection.

The Central Pollution Control Board and State Pollution Control Boards play important roles in monitoring pollution and enforcing environmental standards.

Electronic waste has emerged as a rapidly growing and environmentally significant category of pollution in India. Data placed before Parliament in December 2024 revealed that India's electronic waste generation increased by approximately 73 percent over five years, rising from 1.01 million metric tonnes in 2019-20 to 1.751 million metric tonnes in 2023-24, making India the third-largest generator of electronic waste in the world after China and the United States.¹⁰ The informal sector, which handles a disproportionately large share of e-waste through unsafe extraction methods, poses serious risks of soil and groundwater contamination through the leaching of toxic substances

⁹ EA Earth Action, 'Plastic Overshoot Day Report 2024', as reported in 'India Among 12 Nations Responsible for 60% of Mismanaged Plastic Waste' Business Standard (12 April 2024) <https://www.business-standard.com/india-news/india-among-12-nations-responsible-for-60-of-mismanaged-plastic-waste-124041200709_1.html> accessed 28 August 2026; Down to Earth, 'India Among the 12 Countries Responsible for 52% of the World's Mismanaged Plastic Waste: Report' (1 August 2023) <<https://www.downtoearth.org.in/waste/india-among-the-12-countries-responsible-for-52-of-the-world-s-mismanaged-plastic-waste-report-90927>> accessed 28 August 2026.

¹⁰ Rajat Ghai, 'India's E-Waste Generation Soars by 73% in Five Years, Raising Environmental Concerns' Down to Earth (17 December 2024) <<https://www.downtoearth.org.in/waste/indias-e-waste-surges-by-73-in-5-years>> accessed 28 August 2026.

including lead, mercury and cadmium, highlighting the need for stronger implementation of extended producer responsibility frameworks.

However, legal provisions alone cannot ensure effective environmental protection. Enforcement depends on monitoring capacity, institutional coordination, availability of scientific expertise and compliance by industries.

6.7 Role of the Judiciary

Indian courts have played a significant role in developing environmental jurisprudence. Courts have recognized environmental protection as an important component of the constitutional framework.

The National Green Tribunal, established in 2010 as India's dedicated environmental adjudicatory body, has played a measurable role in translating environmental law into ground-level enforcement. Since its establishment, the Tribunal has instituted over 52,000 cases and disposed of approximately 47,000 matters, and between July 2018 and July 2023 alone disposed of 16,042 cases against 15,132 freshly filed applications.¹¹ The Tribunal has additionally exercised suo motu jurisdiction across a wide range of environmental concerns and has facilitated the collection of environmental compensation exceeding Rs 400 crore by the Central Pollution Control Board, directed towards bioremediation and restoration of polluted areas, reflecting the institutional contribution of the Tribunal to pollution abatement.

In *M.C. Mehta v. Union of India*, the Supreme Court developed important principles relating to environmental protection and industrial liability. In *Vellore Citizens' Welfare Forum v. Union of India*, the Supreme Court recognized the precautionary principle and polluter pays principle as essential features of environmental law.¹²

The judiciary has therefore contributed significantly to the development of environmental rights and principles in India.

¹¹ 'National Green Tribunal' StudyIQ (7 July 2023) <<https://www.studyiq.com/articles/national-green-tribunal/>> accessed 28 August 2026.

¹² *MC Mehta v Union of India* (1987) 1 SCC 395; *Vellore Citizens Welfare Forum v Union of India* (1996) 5 SCC 647.

6.8 Sustainable Development

Economic development and environmental protection must be balanced. Sustainable development seeks to meet present needs without compromising the ability of future generations to meet their own needs.

Uncontrolled industrialization may generate short-term economic benefits but can create long-term environmental costs. Therefore, environmental impact assessment, pollution-control measures, renewable energy and sustainable production practices are essential.¹³

6.9. Critical Analysis

The research indicates that the problem of human-induced pollution is not primarily due to the complete absence of environmental laws. India has developed a substantial legal framework. The greater challenge lies in implementation and enforcement.

Weak monitoring, inadequate infrastructure, insufficient public awareness, lack of coordination between authorities and economic pressure on industries can reduce the effectiveness of environmental regulations.

Therefore, environmental governance should move from a reactive approach, where action is taken after pollution occurs, towards a preventive approach based on pollution reduction, sustainable production and environmental risk assessment.

7. SUGGESTIONS

Based on the findings of the study, the following recommendations are suggested:

7.1. Strengthening Environmental Law Enforcement:

Existing environmental laws should be effectively implemented through regular inspections, scientific monitoring and strict action against serious violations.

7.2. Stronger Pollution Monitoring:

¹³ World Commission on Environment and Development, Our Common Future (Oxford University Press 1987) ('the Brundtland Report').

Modern technologies such as real-time monitoring systems, satellite technology and data-based environmental monitoring should be used to identify pollution sources.

7.3. Sustainable Industrial Development:

Industries should adopt cleaner production methods, energy-efficient technologies and effective pollution-control systems.

7.4. Improvement of Waste Management:

Municipal authorities should strengthen systems for segregation, collection, recycling, treatment and safe disposal of solid and hazardous waste.

7.5. Reduction of Plastic Pollution:

Plastic consumption should be reduced through alternatives, recycling systems, extended producer responsibility and stronger implementation of plastic-waste regulations.

8. CONCLUSION

Human-induced pollution is one of the most serious environmental challenges facing modern society. Rapid industrialization, urbanization, transportation, intensive agriculture, mining, excessive consumption and improper waste disposal have significantly affected air, water, soil, forests and marine ecosystems.

The study demonstrates that pollution has consequences beyond environmental degradation. It affects human health, biodiversity, food security, economic development and the quality of life of present and future generations. Air pollution contributes to serious health problems, water pollution affects drinking water and aquatic ecosystems, while soil and plastic pollution threaten agricultural productivity and biodiversity.

India has developed a comprehensive environmental legal framework through legislation such as the Water (Prevention and Control of Pollution) Act, 1974, the Air (Prevention and Control of Pollution) Act, 1981, the Environment (Protection) Act, 1986 and the National Green Tribunal Act,

2010. The judiciary has also strengthened environmental protection through principles such as sustainable development, precautionary principle and polluter pays principle.

However, the existence of laws alone is not sufficient. Effective enforcement, institutional capacity, scientific monitoring, public awareness and responsible industrial practices are essential for achieving meaningful environmental protection.

The study therefore concludes that human-induced pollution must be addressed through a combination of legal, technological, economic and social measures. Development should not be understood merely in terms of economic growth but should include environmental sustainability and social well-being.

Protection of the natural environment is a shared responsibility. Governments must enforce environmental laws, industries must adopt sustainable practices, communities must participate in environmental protection and individuals must make responsible choices. A preventive and sustainable approach is essential to ensure that natural resources remain available for future generations.

Ultimately, effective control of human-induced pollution requires a shift from pollution management to pollution prevention, from unsustainable development to sustainable development, and from individual responsibility to collective environmental responsibility.

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