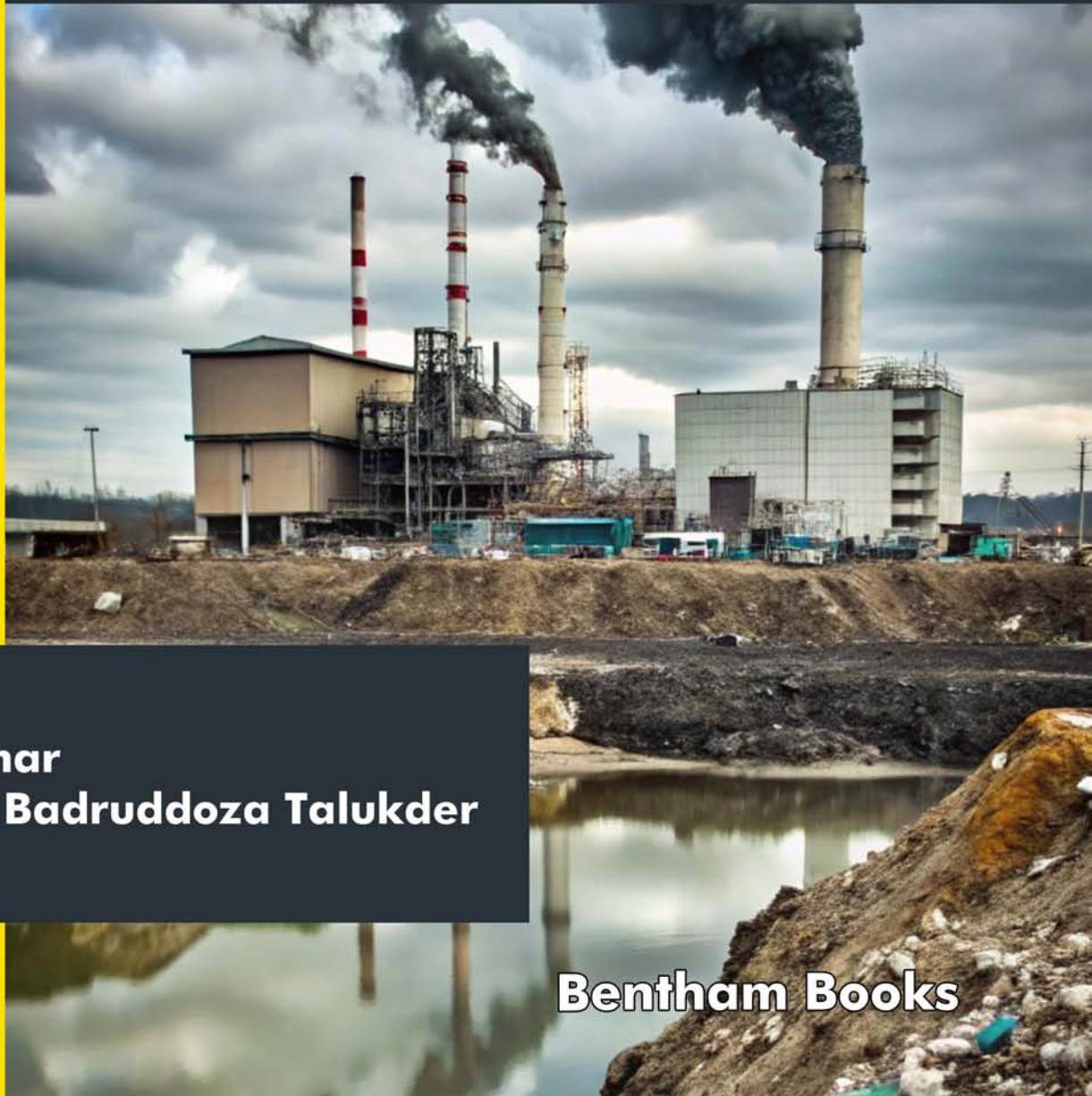


ENVIRONMENTAL POLLUTION CONTROL MEASURES, PREVENTION AND SAFETY MANAGEMENT



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FOREWORD

Environmental pollution control has become a global concern and is inseparable from the policy objectives of governments around the globe.

There is a practical need to analyze this pressing issue concerning the relationship between environmental pollution and public health, and to adopt reasonable strategies to prevent health hazards and to follow up on research topics in this very important area.

However, many conventional waste pollution monitoring methods can lead to significant environmental issues, such as diminishing valuable resources, and cause a significant negative impact on society. This research-oriented edited collection introduces pollution treatment methods that can be adopted at local and international levels and examines appropriate resource management strategies for environmentally related issues. Presenting the latest research topics and innovative ideas to educate future citizens about the sustainable development of our planet.

The book investigates the diverse effects of environmental pollution and emphasizes how urgent it is to resolve the ecological costs of waste contamination. Each chapter blends academic theory, field research, case illustrations, and policy analysis, enabling a holistic understanding of the subject matter along with meaningful and productive experimental findings in this multidisciplinary field by renowned research scientists to report hazard analysis and human health risk assessment. This volume also reports practical achievements in environmental safety, environmental pollution control, along with technology innovation methods for better managing continuous screening and monitoring of chemical residues in environment.

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PREFACE

Environmental pollution control is very complex and multidimensional, and managing it effectively requires a range of advanced technologies. Environmental pollution is a global concern that is closely linked to the policy objectives of governments worldwide. It is crucial to analyze the relationship between pollution and public health and adopt practical strategies to prevent health hazards. Continued research on this important topic is also necessary.

This book covers important research topics in environmental pollution control and offers the most recent practical solutions by considering key concepts, a study plan, additional literature, and case studies. The authors of each chapter discuss the limitations of the current measures, prevention, and safety management, and suggest complementary treatment methods.

This edited collection is creating an interdisciplinary platform for researchers and practitioners to present and discuss the most recent innovations, trends, and concerns, as well as the practical challenges encountered and solutions adopted in the field of environmental science. It brings to the fore the case studies and practical relevance of a framework for safety management and the future of sustainability in the ecosystem.

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CHAPTER 1

Impact of Environmental Pollution on Food Security

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Abstract: Environmental pollution is becoming a significant threat to global food security, with a profound impact on food availability, quality, and stability. This chapter aims to present how various types of pollution, including air, dust, water, biological, and climate change, impact food production systems. These pollutants affect the quality of food harvested from poisonous soil and water. Pollution also contaminates water, disrupts water-based food chains, and destroys crops due to air pollution. This theory acutely reveals the interconnection between nature, pollution, and food systems, highlighting how pollution at one point affects the entire food supply chain. The chapter also investigates the exact impacts of crop harvesting and shows how pollution contributes to reduced nutritional value, bringing theious economic consequences to the farming communities.

Furthermore, it highlights the differential impacts of pollution on food security across various socioeconomic backgrounds, underscoring the need for location-based strategies to address these challenges. Fisheries and cattle are mostly vulnerable to pollution that accumulates through the food chain. Moreover, both food availability and human health are also at risk. The chapter discusses moderation strategies and deliberates on sustainable agricultural practices that set pollution control policies and technological solutions to protect the human food system. Lack of harmonized international hard work and environmental fairness considerations, as pollution and its impacts on food security often excessively affect vulnerable populations. In conclusion, this chapter aims to integrate science-driven solutions to address future challenges, such as pollution and implementation, thereby enhancing food and food security in a changing world.

Keywords: Challenges, Climate, Environment, Food, Impact, Pollution, Security.

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INTRODUCTION

Pollution of the environment is a threat to global food security, as it affects the capacity of individuals, communities/and nations to access protective, nutritious, and adequate food at any given time. Pollution is also closely linked to and impacts the food system, particularly in relation to the development of sustainable agriculture and food systems, food security, and the health of ecosystems. (Bisht, Kamboj *et al.*, 2020). For example, water, land, and even the air become contaminated with heavy metals, pesticides, and microplastics, which reduce crop production rates and affect livestock health. In addition, pollution disrupts ecosystems, contributing to their degradation and ultimately compromising food systems.

As the global population increases, competition for resources intensifies, exacerbating the already growing threats from pollution. These are compounded by climate change, which is caused by GHG emissions, affecting weather patterns, increasing the incidence of extreme events, and hastening soil degradation (Ramanathan & Feng, 2009). For poor nations in the developing world, where dependence on food production from the agricultural sector is widespread, the impact is significantly more damaging, exacerbating the dangers posed by hunger, malnutrition, and the cycle of poverty.

Defining Environmental Pollution

The act of putting a deleterious substance or energy into an environment that is unsuitable for the specific purpose in a manner that results in a detrimental alteration of the nature of the entirety of the climate; a decrease in quality or deterioration of the features of an environment; negative effects on living species. Such contaminants can be grouped according to their source, phase state, or effects: chemical (industrial effluents, pesticides, metals), physical (plastics, noise, radiation), and biological (pathogens, alien species). Pollution can be either anthropogenic in origin, as observed in industrialization or deforestation, or natural, resulting from processes such as volcanic eruptions, basin desertification, or intensive and uncontrolled agricultural activities (Bisht, Kamboj *et al.*, 2020). Some of these pollute and alter major environmental features, including air, water, soil, and life forms, with knock-on effects on global systems such as weather and food production. Besides affecting the environment, pollution affects people's health both by causing and exacerbating respiratory disorders, waterborne diseases, and other illnesses resulting from exposure to toxins. It also exacerbates socioeconomic injustice because polluting activities affect individuals living in the vicinity of polluted sites or those who receive inadequate amounts of clean resources (Brehm & Pellow, 2022). Every problem of environmental pollution is

best solved through the use of science, policy, technology, and community involvement. To address these concerns, this paper presents a comprehensive view of the problem, an analysis of its impacts, and approaches to ecosystem rehabilitation and the advancement of sustainable development goals.

Overview of Food Security

Food security is defined as the affordable access by all people at any one time to the required amounts of the appropriate kinds of food (Pinstrup-Andersen, 2009). It is a multidimensional concept encompassing four key dimensions: availability, accessibility, use, and stability. Stocking establishes the qualitative and quantitative availability of food through production, trade, and distribution systems. Accessibility is defined as the economic and physical ability to gain access to food and individual and community resources. In this case, biological utilization of food products is promoted by focusing on nutrition, safe food intake, and healthcare to ensure the optimal conversion of food into energy and health. Stability refers to a country or geographical region having a steady food supply, access to food, and effective food utilization in the face of shocks such as conflicts, climate variations, and economic hardships (Pingali, Alinovi *et al.*, 2005). These dimensions point towards sustainable and equitable systems to achieve food security on a global level.

Linkages Between Pollution and Food Systems

Pollution affects agricultural and food production systems in the broadest sense, as well as the environment from which these production systems derive their sustainability. These are basic natural resources that support food production, and they include soil, water, and air, which are unproductive or damaged, making food production and resilient food systems almost impossible. The processes of chemicalization, mechanicalization, and industrialization have contaminated the soil with industrial waste, excessive pesticides, and heavy metals, resulting in diminished soil fertility, reduced agricultural yield, and compromised food quality (Rathod, Saras *et al.*, 2025). Contamination from agricultural effluent, chemical disposal, and raw sewage remains the primary threat to the quality of water used in supporting agricultural productivity, irrigation, and human consumption. Likewise, air pollution affects several factors, including the levels of greenhouse gases and particulates, as well as moderating factors such as temperature, moisture, and radiation, which impact crop production (Ramanathan & Feng, 2009). In particular, total BFRs can accumulate along the food chain, resulting in damaging consequences for consumers and compromising food safety. These disruptions demonstrate how closely linked the demands for food provision are

CHAPTER 2

Impact of Environmental Pollution on Food Security: Psychological Distress and Economic Resilience in Vulnerable Populations**Durgeshwary Kolhe¹ and Arshad Bhat^{2,*}**¹ *Department of Clinical Psychology, School of Vedic Sciences, MIT-ADT University, Pune, Maharashtra, India*² *Amity Institute of Liberal Arts, Amity University, Mumbai, Maharashtra, India*

Abstract: This chapter examines the complex interconnections between environmental pollution, food security, and psychological well-being in at-risk groups. This analysis examines the direct consequences of several pollution types-soil contamination, water pollution, and air pollutants- on agricultural output and food safety, leading to subsequent impacts on mental health and economic stability. The study emphasises the psychological discomfort exhibited as anxiety, sadness, and intergenerational trauma in communities experiencing chronic food insecurity resulting from environmental deterioration. The chapter examines the economic repercussions, such as diminished agricultural productivity, increased healthcare expenses, and involuntary relocation, while assessing diverse resilience strategies employed at both community and policy levels. The research highlights the efficacy of integrated strategies that combine environmental restoration, psychological support, and economic interventions, as demonstrated through the analysis of case studies and empirical evidence. The discourse concludes by pinpointing significant research gaps and suggesting prospective avenues for sustainable solutions, highlighting the pressing need for collaborative efforts among various stakeholders to tackle these interrelated challenges. It greatly enhances the existing literature on environmental health and food security, offering pragmatic insights for policymakers, researchers, and community leaders engaged in developing resilient agricultural systems and assisting those impacted.

Keywords: Agricultural Contamination, Economic Sustainability, Environmental Pollution, Food Security, Psychological Resilience.

INTRODUCTION

The complex connection between environmental pollution and food security constitutes a significant concern of the 21st century, with extensive implications

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for human well-being and societal stability (Varzakas & Smaoui, 2024). This intricate interaction influences both the physical dimensions of food production

and generates considerable psychological and economic repercussions for disadvantaged groups globally. Environmental contamination, in its various forms, poses an unprecedented risk to agricultural systems and food security. Industrial effluents, agricultural runoff, air pollutants, and heavy metal contamination have become significant issues in both developed and developing countries (Johnson & Williams, 2023). Recent studies have reported concerning levels of Persistent Organic Pollutants (POPs) in agricultural soils, with concentrations surpassing safety limits in numerous areas (Naeem *et al.*, 2023). These contaminants undermine soil fertility and permeate the food chain, eliciting significant concerns regarding food safety and the long-term health of ecosystems. The Food and Agriculture Organisation (FAO, 2023) defines food security as comprising four essential pillars: availability, access, utilization, and stability.

Utilisation entails the appropriate biological consumption of food, necessitating a sufficient diet, potable water, and healthcare. Stability guarantees the temporal consistency of the other three dimensions (FAO, 2023). Environmental contamination endangers each of these pillars in distinct and frequently exacerbating ways. Psychological discomfort in afflicted communities emerges through multiple means. Research conducted by Pourmotabbed *et al.*, (2020) has revealed heightened levels of anxiety, sadness, and hopelessness in populations experiencing chronic food insecurity as a result of environmental deterioration. This psychological strain is particularly evident in agricultural areas, where livelihoods are closely tied to environmental quality. The apprehensive worry linked to possible crop failures and prolonged food system instability engenders a chronic state of stress that can significantly affect mental health outcomes.

Economic resilience, defined as the ability to sustain steady income streams and adapt to environmental challenges, is crucial in mitigating the relationship between environmental degradation and food security. Recent economic assessments suggest that communities with diverse revenue sources and robust social support networks exhibit greater resilience to food security concerns (Anderson *et al.*, 2023). The capacity to cultivate and sustain resilience differs markedly among the socioeconomic groups. Marginalised groups, especially in low-income areas and emerging regions, disproportionately endure these issues. Studies demonstrate that these populations frequently face a “triple burden” comprising environmental exposure, limited economic resources, and inadequate access to support services (Bohle, 2010). This amalgamation of factors gives rise to a multifaceted array of difficulties, necessitating meticulous deliberation in policy formulation and intervention tactics. This chapter aims to provide a

comprehensive examination of the impact of environmental pollution on food security, taking into account both psychological and economic factors.

Understanding these relationships is essential for formulating effective interventions and policy responses that help vulnerable groups in enhancing resilience against these problems. The importance of understanding the connection between environmental degradation and food security has become increasingly evident through empirical studies across diverse global contexts. The World Health Organization's extensive report on environmental health consequences (WHO, 2022) indicates that about one-third of the global population experiences food insecurity, a condition directly associated with environmental deterioration. This issue is especially severe in underdeveloped countries, when regulatory systems for pollution management are insufficient. Recent research by the Food and Agriculture Organisation (FAO, 2023) indicates that industrial pollution affects over 40% of agricultural land in South Asia, with heavy metal contamination exceeding safety limits in key agricultural regions. The International Food Policy Research Institute's global evaluation (IFPRI, 2023) found that regions near industrial zones experience a 15-30% decline in crop yields due to air pollution and soil contamination, which adversely affects the local food supply and quality. The psychological health consequences of these environmental issues have been systematically documented in numerous seminal studies. The Lancet Commission on Global Mental Health (Patel *et al.*, 2022) established a notable association between food insecurity and elevated levels of anxiety and depression in impacted groups. Their research indicated that small-scale farmers suffering from crop failures attributed to environmental contamination were three times more likely to experience significant psychological distress than those in unaffected regions.

In rural areas, where livelihoods are closely tied to agricultural output, the World Bank's Rural Development Report (World Bank, 2023) indicated that households experiencing chronic food insecurity due to environmental degradation exhibited markedly elevated rates of stress-related health problems. This observation was especially evident among women and children from low-income households. This chapter seeks to accomplish two main objectives: It aims to study the intricate relationship between environmental pollution and food security, focusing specifically on their effects on mental health and economic resilience. Drawing on longitudinal research from the United Nations Development Programme (UNDP, 2023), we will examine the impact of various pollution types on multiple dimensions of food security across different geographical and socioeconomic situations. The chapter advocates for evidence-based multidisciplinary methods that combine economic resilience tactics with psychological support networks. These methodologies are based on effective intervention programs documented by

CHAPTER 3**Plastic Waste: The Environment, Human Health, and Safety****Manu Mehrotra^{1,*}, Manish Baboo Agarwal¹, Manish Kumar Panday², Pankaj Mittal², Santosh Kumar Bhardwaj³ and Seema Agarwal⁴**¹ *Sharda School of Basic Sciences and Research, Sharda University, Agra, Uttar Pradesh, India*² *Department of Applied Sciences, Anand Engineering College, Keetham, Agra, Uttar Pradesh, India*³ *Department of Mathematics and Computing, Madhav Institute of Technology & Science, Gwalior, Madhya Pradesh, India*⁴ *Department of Mathematics, SRM Institute of Science and Technology, Ghaziabad, Uttar Pradesh, India*

Abstract: Plastic waste has become a pervasive and critical issue affecting both the environment and human health. The sheer volume of plastic waste, exacerbated by inadequate disposal practices, contributes to significant environmental degradation. Plastic debris in oceans and waterways harms marine life, contaminates the food chain, and disrupts ecosystems. On land, plastic waste clogs drainage systems, pollutes soil, and affects biodiversity. Human health is also severely impacted by plastic waste. Microplastics and chemical additives from plastics can leach into food and water sources, leading to ingestion of harmful substances that can cause various health issues, including cancer, reproductive problems, and neurological disorders.

Additionally, the burning of plastic waste releases toxic fumes that contribute to air pollution and respiratory diseases. Ensuring safety in the context of plastic waste involves implementing stringent regulations on production and disposal. This includes promoting recycling, banning single-use plastics, and enforcing proper waste management practices. Public awareness campaigns are crucial in changing consumer behavior and encouraging sustainable practices.

Keywords: Environmental Degradation, Human Health, Plastic Pollution, Public Awareness, Safety Regulations, Waste Management.

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INTRODUCTION

Disposal of plastic waste has become one of the most critical issues, alongside greenhouse gas emissions and climate change. However, the excessive use of plastic has become a global problem. The global economy has been significantly impacted by the widespread use of plastic since the mid-20th century. The ease and variety of functions it provides make plastic a very useful consumer product, yet it also raises alarming concerns (Kumar *et al.*, 2021; Barrowclough *et al.*, 2022).

The damage done to the environment by plastic is both alarming and complex. Plastic in the oceans does more harm than good as sea animals suffocate and die due to its ingestion (Thushari *et al.*, 2020; Gregory, 2009). The effect becomes more damaging with the use of microplastics. We are increasingly switching to plastic as a substitute, which has particles with sizes less than 5 mm. This also affects the food and ecosystem (Marcharla *et al.*, 2024), (Ziani *et al.*, 2023), (Yuan *et al.*, 2022).

Apart from marine pollution, plastic waste also harms soil and agricultural landscapes. Microplastics have been detected in soils worldwide, raising concerns about their impact on soil health and plant growth. Such microplastics can alter the soil composition and its fertility, which can have adverse effects on agricultural productivity and food security (Sajjad *et al.*, 2022; Shi *et al.*, 2023; Sa'adu *et al.*, 2023). Furthermore, plastics are primarily dependent on fossil fuels, which account for a huge amount of greenhouse gas emissions and contribute to climate change. There are highly controversial implications of plastic waste for human health. Plastics contain thousands of chemicals, some of which have been proven to leach into food and drinks. Such chemicals are connected to a multitude of health complications that range from reproductive problems to cancer and neurological issues (Atiwesh *et al.*, 2021; Walker *et al.*, 2023). For instance, research has established that Bisphenol A (BPA) appears to act as an estrogen mimic within the human body. Therefore, hormonal imbalances can result in developmental problems or an increased risk of contracting certain types of cancers (Gao *et al.*, 2015; Saal *et al.*, 2020). Humans also consume other microplastics through the food chain and water supplies. While the health impacts are not entirely understood at present, researchers now believe that it can introduce poisonous elements into the human body (Emenike *et al.*, 2023).

Plastic waste poses safety risks to the environment and human health. Bad disposal processes for plastics can lead to fires in landfills or recycling facilities, releasing toxic smoke that causes respiratory diseases and other health issues. In regions where plastic waste is not properly managed, it can attract pests, including

rodents and mosquitoes, which cause diseases such as dengue fever and malaria. The financial burdens associated with the cleanup process require significant expenditure of funds and may divert resources from other essential community services (Kehinde *et al.*, 2020).

An overall, multifaceted approach must effectively counter this challenge. Plastic use needs to be reduced at its source. This can be done through policy-based reductions in single-use plastic use and the promotion of environmentally friendly alternatives, such as biodegradable bags and water bottles. Another methodology is to enhance waste collection infrastructure, which can be achieved by expanding recycling facilities and implementing proper disposal methods (Simantiris, 2024; Vanapalli *et al.*, 2020). This process can reduce the amount of plastic waste in landfills or oceans. Consumer education on proper recycling practices, eliminating single-use plastics, and the dangers of plastic pollution is also required by awareness campaigns. Policymakers need to enforce strict regulations regarding the production and disposal of plastic.

Emerging technologies hold promise in addressing this plastic waste problem. Biodegradable plastics are being researched for the development of products that break down biologically over time, making them an alternative to traditional plastics. Other innovations include converting waste plastic into energy or feedstock that can be reused in manufacturing operations (Williams *et al.*, 2022; Matavos-Aramyan, 2024). The problem of plastic waste is a complex issue, but it is certainly not one that cannot be resolved. In fact, such issues can be addressed if we work together to create more sustainable futures, in which the wide-ranging effects of plastic waste on the environment, human health, and safety are analyzed, and a proper strategy is adopted. This strategy could include reducing waste, improving waste disposal practices, raising awareness, and promoting innovation. Urgent action is necessary to protect the planet's ecosystems and ensure the well-being of both present and future generations.

IMPACT ON ENVIRONMENT

Plastic waste has a harmful and widespread effect on the Earth's ecosystems. There are many ways through which plastic waste impacts the environment, some of which are:

Marine Pollution

Plastic waste has become one of the most significant environmental issues facing the Earth. Large pieces of plastic, from bags and bottles to microbeads, cause entanglement or suffocation to aquatic creatures. For example, sea turtles often mistake a plastic bag for a jellyfish, their primary food source; thus, ingesting it

Innovative Remediation Techniques for Polluted Soils: Insights from Krishi Vigyan Kendra in India

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Abstract: The present chapter explores the types, causes, and current scenario of soil pollution in India. The role of public-sector agricultural extension and research agencies in preventing soil pollution in India has been discussed in this chapter. The public sector expenditure on agricultural extension in terms of soil and water conservation in India during the years 2009-10 to 2018-19 has been studied in the present chapter. The interventions of agricultural science centres commonly known as 'Krishi Vigyan Kendra' (KVKs) to mitigate soil pollution in the western region of Maharashtra have been studied as a case study. The study found that public-sector agricultural extension agencies like Krishi Vigyan Kendra are playing a crucial role in creating awareness among farmers about the adoption of location-specific and scientific farm practices. The adoption of such practices ensures the mitigation of soil pollution and erosion, which further stimulates agricultural sustainability.

Keywords: Agricultural extension, India, Krishi Vigyan Kendra, Soil health card, Soil pollution, Western Maharashtra.

INTRODUCTION

After independence, India emerged as an agrarian economy. The agriculture sector contributes in the form of the highest employment-generating sector in the context of the Indian economy. Being one of the crucial factors of production, soil holds paramount significance in the agricultural sector. It also serves as a

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foundation for the overall development of the country. Even in the history of mankind, most ancient civilizations emerged in the fertile soil along riverbanks. Hence, the interplay between soil health and agricultural production directly affects food security and the livelihoods of people. Soil contributes to the major ecosystem in various ways. Soil transforms organic materials into inorganic nutrients with the help of soil organisms. It helps in terms of providing water, nutrients, and physical support for plant growth and development in animal production. It regulates the CO₂, N₂O, and CH₄ emissions and supports carbon sequestration (FAO & ITPS, 2017). In recent years, soil pollution has emerged as a critical challenge in India. As the country strives towards the vision of ‘Viksit Bharat’, *i.e.*, a developed nation, it is important to address the issue of soil erosion and soil pollution in India. The increased industrial activities and urbanization in India have worsened the problem of soil pollution. Hence, there is an urgent need for the implementation of strict regulations to mitigate the problem. As the country has a strong network of public-sector extension agencies, the present chapter discusses the role of these agricultural extension agencies in the prevention of soil pollution.

MEANING, TYPES, AND SOURCES OF SOIL POLLUTION

Meaning and Definitions of Soil Pollution

Soil health has become a matter of global environmental issue in recent years as it impacts human health, the ecosystem, and agriculture. Being one of the parts and parcels of earth’s natural resources, as well as the base of plant life, soil plays a crucial role in sustaining food grain production and maintaining biodiversity. Soil has definitely played an important role in all the progress that humans have achieved so far. However, there is always a trade-off between development and the environment. Nowadays, soil is contaminated by numerous human activities, including the disposal of industrial waste, excessive pesticide use, and urbanization. There is an urgent need to understand the meaning, nature, and causes of soil pollution, which will help in designing effective strategies to mitigate its effects and promote a healthier environment for upcoming generations. The definitions of soil pollution given by several reports are:

“Soil pollution refers to the presence of a chemical or substance out of place and/or present at a higher-than-normal concentration that has adverse effects on any non-targeted organism” (Rodríguez Eugenio *et al.*, 2018). “Soil pollution is defined as contamination of soil at higher-than-normal concentrations by waste materials of human origin that have adverse effects on human and ecosystem health” (Münzel *et al.*, 2022).

Soil pollution and soil contamination are often used interchangeably. However, according to the Intergovernmental Technical Panel on Soils (ITPS) under the Global Soil Partnership (GSP), there is a difference between these two terms. According to this report, when a chemical or any material is present in the soil at a concentration greater than what would be found naturally, it is called 'soil contamination'. Soil contamination is not always harmful. On the other hand, soil pollution is the presence of chemicals or materials that are out of place and/or present at a greater than normal concentration that negatively affects any non-targeted organism. Both intentional and inadvertent actions can lead to soil pollution. The different types of soil pollution are given in the following section.

Types of Soil Pollution

Soil pollution can be caused by a specific event or a series of events within a particular area in which contaminants are released to the soil, and the source and identity of the pollution are easily identified. This type of pollution is known as point-source pollution. This type of soil pollution is very common in urban areas. On the other hand, in Fig. (1), it is mentioned that soil pollution, which spreads over very wide areas, accumulates in soil, and does not have a single or easily identified source, is called diffuse pollution. It involves the transport of pollutants via the air-soil-water system (Rodríguez Eugenio *et al.*, 2018).

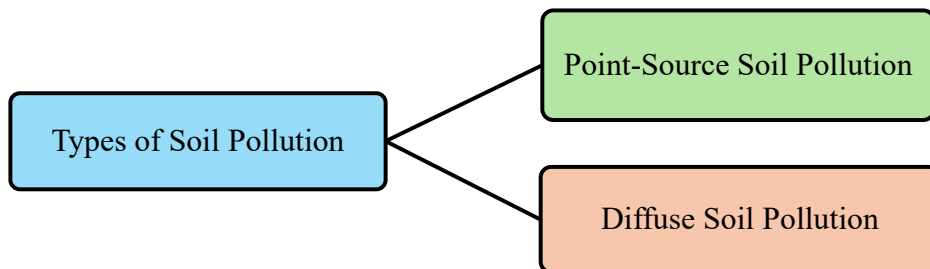


Fig. (1). Types of soil pollution. **Source:** Rodríguez Eugenio *et al.*, 2018.

Various Sources of Soil Pollution

Sources of soil pollution can be broadly classified into two types: natural (geogenic) sources and anthropogenic sources. Natural and geogenic sources of soil pollution stem from both environmental processes and geological formations. These sources include the weathering of rocks, which releases heavy metals and minerals into the soil, altering soil composition and fertility. For instance, volcanic eruptions can deposit ash and toxic substances, leading to elevated concentrations of heavy metals like lead, cadmium, and arsenic. Natural phenomena such as erosion and landslides can also expose and redistribute pollutants, while biogenic processes, such as the decomposition of organic matter,

The Impact of Environmental Pollution on Food Security and Sustainable Agriculture

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Abstract: Widespread environmental pollution today results in contamination of soil, water, air, and, consequently, food and feed produced. This poses a significant threat to food security, defined as a state where all household members have safe access to sufficient, nutritionally adequate, and culturally acceptable food at all times, enabling them to live an active and healthy life. In the era of a growing population and concerns about environmental degradation, land, and water scarcity, the economic and health implications of increased pollution on decreased agricultural productivity, land degradation, food availability, and increased poverty deserve more attention. A detailed review of the food security implications of different types of pollution is currently missing, a gap this paper aims to fill. Several alarming statistics and actual case scenarios substantiate the urgent need for undertaking such a review. It is estimated that pesticide poisoning severely affects the health of 3 million agricultural workers in the developing world. About 200,000 deaths are caused by acute pesticide poisoning annually, leading to the loss of roughly 20 million disability-adjusted life years. Both members of the human population involved in food production and biodiversity resources are endangered. Due to the hazards associated with pesticide use, alternative biological control methods are increasingly adopted, adding a new dimension to co-occurring hazards. Ecological systems and economic interests are all interconnected, and contamination and degradation of one implies subsequent degradation of the others. In many regions, the increasing pollution of shared resources, such as rivers, streams, and pastures, is attributed to the intensification of grazing and the use of fertilizers in fodder production, as presented in the chapter. In turn, this plays a significant role in reducing the diversity of pollinator species.

Keywords: Corporate Social Responsibility, Eco-friendly Technologies, Global Impact, Green Innovation, Sustainable Business Models, Sustainable Practice.

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INTRODUCTION

Environmental pollution refers to the contamination of materials or resources that can be directly or indirectly harmful to the environment. It is the most pressing concern for the world, resulting from human activities and products such as waste, burning fuels, and deforestation (Shafik, Tufail, Apong, *et al.*, 2024). Some of the major types of environmental pollution are air pollution, water pollution, noise pollution, soil pollution, thermal pollution, and radioactive pollution. These types of pollution have significant implications for their aggravating effects on agricultural systems (Nautiyal *et al.*, 2024). Together with agriculture, these pollutions are evolving globally and bearing consequences on environmental factors. Food security is a multifaceted concept that secures individuals, communities, and nations. It comprises three major components: the availability, accessibility, and utilization of food. Availability refers to the presence of an adequate supply of food at global, national, and household levels. Access to food means obtaining food in an appropriate manner, whether through markets, transportation, or at the homes of individuals (Sharma *et al.*, 2024).

Utilization of food is about the ability of individuals to obtain nutrients from the food they eat, enabling them to lead a vital and active life. The quantity and quality of food are necessary. Food security can be infringed upon at various levels and in numerous ways. There is no universally accepted measure of food security, making it hard to gauge exactly what the situation is like around the world. Worldwide, 950 million people are undernourished, one in every eight, and a child dies every five seconds from hunger or malnutrition-related diseases (Sandilya *et al.*, 2024). As a result of pollution, there has been a direct reduction in food production and food unavailability due to reduced quality and quantity. Thus, food security is compromised. There is degradation in the condition of flooded areas suitable for growing rice, resulting in soil erosion and nutrient depletion, which also contributes to food unavailability. Food scarcity ultimately leads to chronic illness. Approximately 2 billion people worldwide are affected. Social instability, illness, and a lack of hygiene are particularly precarious in cities, where people from different social groups, congestion, and a disposable society must coexist with the waste generated during household and industrial activities (Singh *et al.*, 2024).

Environmental pollution represents a great challenge to this generation's sustainable future. Pollution occurs in various forms, each affecting ecosystems and contributing to food supply security concerns. These include air pollution, water pollution, soil pollution, marine pollution, and noise pollution. Air pollution refers to the release of gaseous and particulate substances from natural and anthropogenic sources into the atmosphere, where these pollutants have

undesirable effects; this is particularly relevant in the context of agricultural sustainability (Quayson *et al.*, 2024).

Of particular concern are emissions from the combustion of oil, natural gas, petrol, and diesel. Water pollution refers to the entry of foreign matter into sources of water that are potable, thereby degrading their quality (Kalinaki *et al.*, 2023). This can be exemplified by the presence of toxic chemicals emitted through mining, industrial activities, sewage, and chemical spills into rivers, lakes, and dams. Soil pollution is a function of the presence of chemical contamination from foreign substances and alterations to the natural characteristics of the soil, resulting in changes to its physical, chemical, and biological properties (Shafik, 2024a). For instance, nitrogen, phosphate, potassium, and other minerals that form part of soil ecology are depleted, altered, and destroyed by fertilizers, animal waste, and municipal waste. These issues are exacerbated by toxic chemicals from the petrochemical industry and acid rain, among others. Overall, ecosystems and the environment are being compromised, and if pollution continues unabated, food security will be seriously threatened. Environmental degradation, such as pollution and other constraints, increases the risk that investments in agriculture may not yield the anticipated production (Moreno *et al.*, 2024). This would harm food security outcomes.

The concept of food security revolves around the continuous availability of enough food for a healthy and active lifestyle for all members of a household. The elements that make up this definition include food availability, *i.e.*, the consistent flow of food supplies onto the market, as well as physical and economic access to food by all, which is achieved through optimal land access and production, employment, and trade relations. Food must be properly produced, *i.e.*, it must be produced through sustainable agricultural practices, while the stability of all these essential elements ensures access to enough food to provide a complete and balanced diet on a day-to-day basis (Shafik, 2025a). Staple foods and their equitable distribution are crucial to achieving food security at the household level. Food security is one of the great socio-economic challenges of our time. Ending world hunger will not only promote human development but also enhance global security and social stability. By ensuring that all people have enough to eat, we not only increase the purchasing power of the world's poorest but also reduce deaths due to malnutrition, which disproportionately affects children in developing countries (Shafik & Kalinaki, 2024). Ensuring long-term food security ultimately requires the implementation of sustainable agricultural practices. Measuring the level of food security in a community is a complex process because it is not enough to know if people have food to eat. The symptoms of so-called hidden hunger can occur even when overall food intake in terms of calories is adequate (Adebunmi Okechukwu Adewusi *et al.*, 2024). Malnutrition affects each

Harnessing Innovation in Air Pollution Control and Prevention Technologies: Current Trends and Future Prospects

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Abstract: Air pollution is indeed one of the most significant environmental health issues today. It results from the combined contribution of effluent discharges from industries, vehicular exhausts, agricultural activities, and natural causes. With effective air pollution control technologies and preventive measures, environmental and public health impacts will be minimized. This chapter examines and discusses various technologies for managing and reducing air pollution, including their effectiveness, implementation modalities, and potential future improvements. This chapter examines the current trends and prospects in air pollution control, as well as the prevention technologies.

Keywords: Air Pollution Control, Emission Reduction, Filtration Technologies, Renewable Energy, Environmental Policy, Sustainable Urban Planning.

INTRODUCTION

Filtration systems, such as HEPA filters, baghouse filters, and activated carbon filters, are used to remove particulate matter and other harmful gases. Electrostatic precipitators (ESPs) utilize electrical charges to capture fine particles from industrial emissions. They are regarded as one of the most effective methods of treatment for high efficiency and low cost. Various scrubbers, including both wet and dry types, serve a significant function in removing harmful gases from the atmosphere, particularly sulphur dioxide (SO₂) and nitrogen oxides (NO_x). The primary function of catalytic converters is to reduce the emission of harmful particulates from vehicles by converting harmful gases into less toxic forms. Some examples of advanced emerging green technologies include photocatalytic

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oxidation, biofilters, and Carbon Capture and Storage (CCS), which can lead to improved long-term air quality control. Finally, there are eco-friendly alternatives to conventional fuel-based vehicles, like electric and hydrogen-powered vehicles. Policy interventions, including the Clean Air Act, European Union Air Quality Directives, and Emission Trading Systems (ETS), regulate emissions and promote the sustainable management of industries. That way, the reduced emissions will help the environment and public health in future generations. The technology and regulatory reduction model demonstrates dual effectiveness in addressing air pollution and protecting public health and environmental resources in the future.

Here is an excerpt describing the growing threats posed by air pollution to society, ecosystems, and the climate. Other kinds of environmental issues resulting from increasing pollutant levels in the atmosphere include global warming, acid rain, and respiratory diseases (Marco *et al.*, 2019). The various sources of air pollution include industrial waste, vehicle exhaust, agricultural activities, and natural phenomena such as wildfires and volcanic eruptions. This is why a strategy combining regulatory measures and technological innovations is needed to curb the health and environmental impacts of air pollution. Common air pollutants include Particulate Matter (PM), nitrogen oxides (NO_x), sulphur oxides (SO_x), Volatile Organic Compounds (VOCs), and greenhouse gases such as carbon dioxide (CO₂) and methane (CH₄) (Suh *et al.*, 2000). These pollutants arise from numerous anthropogenic and natural sources. Industrialisation emits significant amounts of NO_x and SO_x, which contribute to the formation of smog and acid rain. Transportation is another major source of VOCs and PM, and other sources contribute to the worsening air quality in cities (Fenger, 1999). The greenhouse gases CO₂ and CH₄ are sources of climate change, resulting in increased temperatures worldwide and extreme weather events (Montzka *et al.*, 2011).

Health issues from air pollution are extensive. Fine particulate matter (PM_{2.5}) is a cause of respiratory and cardiovascular diseases, lung cancer, and premature death (Neas, 2000). Children, the elderly, and those with pre-existing conditions are particularly at risk. Long-term exposure tends to inhibit children's lung development, leading to Chronic Obstructive Pulmonary Disease (COPD) in adults (Nadia *et al.*, 2015). The economic burden of such illnesses would also be significant, as they would increase spending on healthcare and reduce productivity in the workforce.

Governments and organizations have aimed to reduce emissions by setting regulatory frameworks to protect air quality. Policies such as the Clean Air Act in the United States, the Air Quality Directives of the European Union, and the Paris Agreement have established excellent standards for emission restrictions while promoting sustainable industrial practices (Kuklinska *et al.*, 2015). These

regulations facilitate the development and application of cleaner technologies, emission trading schemes, and stricter motor vehicle emission requirements.

Major technological developments play a role in reducing air pollution. High-tech filtration processes, such as HEPA filters and baghouse filters, do an excellent job of entrapping airborne particles in industrial applications. Electrostatic precipitators work on the principle of applying an electrical charge to the movement of fine particulates out of the emissions stream, thereby improving air quality in power generation facilities and industrial plants (Krigmont, 2023). The scrubbers, whether wet or dry, neutralize gases like SO₂ and NO_x, preventing the formation of acid rain. Owing to catalytic converters, which minimize noxious emissions by transforming toxic gases into less harmful compounds, vehicular emissions have been reduced (Ghulomjonovna, 2025).

Some emerging green technologies may provide sustainable solutions to air pollution prevention. Carbon capture and storage technology ensures that CO₂ emissions from industrial sources are captured and stored, rather than released into the atmosphere. The new generation of electric and hydrogen vehicles, which are free of tailpipe emissions, will combat urban air pollution (Sarfranz, 2021). Innovations in photocatalytic oxidation and biofilters are also being considered for industrial applications to degrade air pollutants.

In summary, air pollution poses an unprecedented challenge and requires a thoroughly orchestrated effort, ranging from policy measures to technological advancements. Emission reductions form the bedrock of regulatory frameworks designed to curb pollution in the real world, and thus, technology provides a means to these ends. There is a need for a global consensus on sustainable operations, the adoption of clean energy, and a comprehensive focus on research in pollution control technologies to improve air quality and safeguard public health for future generations.

Health and Environmental Impacts of Air Pollution

Air pollution is a worldwide concern, given its grave effects on human health and the environment. The resources causing air pollution include industrial emissions, transport, and agriculture, which release Particulate Matter (PM), Nitrogen Oxides (NO_x), sulphur oxides (SO_x), Volatile Organic Compounds (VOCs), and heavy metals into the atmosphere. These pollutants are responsible for a variety of health complications and environmental deterioration; thus, air pollution is a critical situation that requires immediate action.

CHAPTER 7

The Association between Carbon Emissions and the Human Capital Index in Emerging Nations

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Abstract: This study examined the empirical cointegration, long-term, and short-term relationships, as well as the causality nexus, between the Human Development Index and CO₂ emissions in Bangladesh from 1990 to 2019. It used the ARDL Bounds test and the Granger causality framework. The ARDL F-statistic bounds tests disclose long-run confirmation of cointegration. The human development index has time-invariant impacts on the growth of CO₂ emissions; *i.e.*, these effects are consistent in both the long and short term. However, there is no proof of a causal relationship between HDI and CO₂ emissions. The robustness of the results was tested using two alternative assessment methods: fully modified least squares and dynamic least squares. The Human Development Index is statistically significant. This paper provides recommendations for the government on CO₂ emission reduction measures and serves as a valuable decision-making tool for accelerating low-carbon development.

Keywords: CO₂ emissions, Energy Consumption, Granger causality test, Human Development Index, The ARDL bounds tests.

INTRODUCTION

Although developing nations are encouraged to join efforts to reduce CO₂ emissions and avert hazardous climate change, the impact of CO₂ reduction targets on the human development of developing nations remains a topic of debate. For a consensus to emerge in favor of low CO₂ stabilization objectives, developing nations must participate in global emission reduction efforts. To keep global temperatures from rising by more than 2°C, it has been argued, for example, that developing countries should achieve CO₂ reductions of more than 20% below business-as-usual levels. (Hossain and Chen, 2020; Banu *et al.*, 2018).

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Because developing nations are expected to rely heavily on fossil energy to meet their development needs, the potential consequences of such decreases on development criteria remain unknown. Developing countries have expressed concerns about whether development goals can be achieved in light of current technological advancements and population patterns (Hossain *et al.*, 2021b; Khan *et al.*, 2021; Wang *et al.*, 2018).

In several ways, this study advances our current understanding of the field.

As it is clear that all of these variables are interconnected, this research is, first and foremost, a first step in the ongoing effort to quantify the relationship between HDI and CO₂ emissions. Further research is needed in this area. However, it could be important to quantify the link between CO₂ emissions and HDI. The investigation of the relationship between HDI and CO₂ emissions is a novel and innovative piece of study in the area.

Second, when it comes to characterizing the human development process, this research is the first to apply the ARDL model and Granger causality in the context of a Bangladeshi setting. Bangladesh's current situation in terms of energy and human development is fragile, and the nation's energy issues are damaging both the economy and humanity as a whole. Bangladesh boasts a wealth of natural resources, and investors can capitalize on the use of renewable energy sources.

Third, policymakers must consider the environmental, economic, and social aspects of sustainable development. However, past studies have concentrated on how energy usage affects economic development rather than how it affects people's well-being. Investigating the link between the studied variables would provide policymakers with more data and a more comprehensive understanding.

Objective of the Study

1. To Examine the Relationship Between CO₂ Emissions and Human Development Index (HDI) in Bangladesh
2. To Explore the Role of Energy Consumption in Human Development and Environmental Degradation
3. To Provide Policy Recommendations for Sustainable Development
4. To Contribute to the Literature on CO₂ Emissions and HDI
5. To Evaluate Bangladesh's Progress in Human Development and Environmental Sustainability

Theoretical Overview

1. **Human Development Index (HDI) as a Measure of Development:** The HDI, introduced by the UNDP in 1990, serves as a comprehensive indicator of

human development, encompassing three key dimensions: access to knowledge (education), long and healthy lives (health), and decent living standards (income). Unlike GDP, which focuses solely on economic output, the HDI incorporates social and health metrics, providing a more holistic view of development. Recent adaptations of the HDI, such as the Planetary-adjusted HDI (PHDI), also consider environmental factors, including CO₂ emissions, reflecting the increasing importance of sustainability in development frameworks.

2. **CO₂ Emissions and Development:** CO₂ emissions are a critical driver of climate change, with developing nations like Bangladesh facing the dual challenge of reducing emissions while pursuing economic growth. Fossil fuel consumption remains a primary source of CO₂ emissions, and its reduction is essential to limit global temperature rise to below 2°C. However, developing nations often rely on fossil fuels to meet their energy needs, raising concerns about the trade-offs between emission reduction targets and human development goals.
3. **Energy Consumption and Human Development:** Energy consumption is a fundamental driver of both economic growth and human development. However, excessive reliance on non-renewable energy sources exacerbates environmental degradation, particularly through increased CO₂ emissions. Balancing energy consumption with sustainable practices is crucial for achieving long-term human development without compromising environmental health.
4. **Sustainable Development and Policy Implications:** Sustainable development requires integrating environmental, economic, and social dimensions. Policymakers must prioritize strategies that promote renewable energy, reduce CO₂ emissions, and enhance human welfare. The case of Bangladesh highlights the urgency of addressing energy consumption patterns and their impact on both human development and environmental sustainability.
5. **ARDL Framework and Granger Causality:** The ARDL (Autoregressive Distributed Lag) model is a robust statistical tool for analyzing long-term and short-term relationships between variables, particularly in time-series data. Granger causality analysis complements this by identifying causal relationships between variables, such as CO₂ emissions and HDI. These methodologies provide a rigorous basis for understanding the interplay between environmental and developmental factors.
6. **Bangladesh as a Case Study:** Significant increases in CO₂ emissions and energy consumption have accompanied Bangladesh's rapid economic growth. Despite improvements in HDI, the country faces challenges in reconciling development goals with environmental sustainability. This study highlights the

CHAPTER 8**An Overview of Pollution of Drinking Water Due to Unsafe Disposal of Industrial Waste in Raipur, Chhattisgarh****Ghanshyam Shakar^{1,*}, Srishti Shaifali Minz² and Shweta Dewangan³**¹ School of Engineering & IT, MATS University, Raipur, Chhattisgarh, India² Govt. Rajmohini Devi Girls P.G. College, Sarguja University, Ambikapur, Chhattisgarh, India³ Faculty of Commerce, ICFAI University, Raipur, Chhattisgarh, India

Abstract: Humanity depends on water, which is the most abundant element on Earth. Groundwater is the most crucial water source for meeting people's daily requirements. As a result, there is now greater dependence on groundwater, which contributes to its overexploitation. As far as groundwater is concerned, several cities in India have reached critically low levels. Due to increased demand and a lack of groundwater replenishment, the groundwater supply is declining. Despite overuse, people have even changed the natural recharge system in the name of development. The current waste management system is insufficient to handle residential and chemical waste. Industrial waste is generally discharged to the ground, alas, and rivers without treatment. This waste is mixed with groundwater, which pollutes it. The dependency on groundwater and the discharge of chemical waste are currently polluting the groundwater, which will become a significant issue in the future. The current study examines the detrimental effects of industrial waste in the Siltara industrial area of Raipur, the state capital of Chhattisgarh, and its surrounding localities. Thirty locations were selected for sampling water, and five samples were collected from each location within the study area of Siltara, which is polluted by industrial effluents. The writers examined the physical and chemical characteristics of the samples collected. After sample collection and analysis, it is determined that the water is highly contaminated and unsafe for human consumption, and several steps should be taken to purify it.

Keywords: Contamination, Groundwater, Industrial effluents, Over-exploitation, Recharge.

INTRODUCTION

The atmospheric environment is a physical and biotic habitat, which one can see, hear, touch, smell, and taste. The synergistic correlation between humans and the

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environment is essential; the balance between humans and the environment must be maintained at all costs (Agrawal & Singh, 2005). Regrettably, due to a range of human activities, the composition and character of the atmosphere have been severely altered.

Several activities, such as construction, industrialization, and transportation, are necessary for societal development. However, these activities contribute to the production of waste, which in turn pollutes our environment and causes groundwater pollution (Shrivastava, 1994).

Urban growth and industrial activities are making the situation worse because:

1. Natural assets are considered free products, but humanity damages this property.
2. The environment is considered a dumping ground where all byproducts are disposed of untreated. Also, it is impossible to dispose of waste material outside the planet (Singh *et al.*, 2004)

From the above two statements, it is clear that the time has come for us to use natural resources wisely, producing minimal waste. Intelligent management of natural resources and waste management techniques will help protect the Earth from pollution.

On the other hand, groundwater is the only source available below the Earth's surface that can meet human requirements (Mishra & Shrivastava, 2015). Groundwater is the water that occurs below the water table within the Earth. The occurrence of this water depends on the properties of rocks, such as porosity, permeability, transmissivity, and available storage (Mandal *et al.*, 2012). Additionally, it depends on the region's topography, yearly precipitation, and the area's need, use, and administration.

Industrial Effluents and Wastewater

The word 'effluent' originated from the word effluent, which means to flow out. In other words, effluent refers to the water flow in a river or channel. However, at present, the meaning of effluent has changed to the flow of waste to the land, air, or any other water body. Wastes such as liquids, smoke, and other waste are termed effluents. Effluent is broadly classified into two categories: industrial effluent and municipal effluent. Industrial effluent comes from a specific industry or factory.

The discharges from various companies are known as industrial effluents, and different organic contaminants have been discovered in diverse water resources.

Consequently, industrial effluent causes a significant environmental issue. When released into rivers and lakes, the water quality is affected. Similarly, Table 1 describes the general types of water pollutants found and their significance on aquatic wildlife, *etc.*

Table 1. General types of water pollutants and their significance.

Class of Pollutant	Significance
Heavy metals	Health, toxicity, aquatic biota
Organically bound metals and metalloids	Toxicity, aquatic biota
Inorganic species	Water quality, toxicity, aquatic biota
Trace organic pollutants	Toxicity
Polychlorinated biphenyls	Toxicity, aquatic biota, wildlife
Pesticides	Toxicity, aquatic biota, wildlife
Detergents	Toxicity, aquatic biota
Chemical carcinogens	Incidence of cancer

Raw industrial effluents can be categorized as organic or mineral, depending on the type of pollution that predominates. These effluents may have a high concentration of organic compounds because of a small number of significant pollutants or many molecules with very low concentrations. Table 2, therefore, describes the types of industrial waste found in water. It clearly shows the type of industrial wastewater, its characteristics, along with examples of the industries it comes from.

Table 2. Types of industrial waste water.

Type	Characteristics	Industry (example)
Organic	High organic pollution, readily biodegradable	Food industries
Organic	High organic pollution, not readily biodegradable	Refineries
		Petrochemical Industries
Organic	High organic pollution, non-biodegradable	Organic synthesis
Mineral	Low organic pollution Toxics	Steel industries, Electroplating industries, Extractive and mining-based industries
	High suspended solids	
Miscellaneous	Organic pollution (with major pollutants), high salinity	Chemical Industries
Miscellaneous	Organic pollution (mixture), salinity	Pulp and paper industries

Sustainable Urban Development: Managing Construction and Demolition Waste Methods in the Indian Context

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Abstract: The rapid growth of cities and towns, as well as infrastructure booms in India, has significantly escalated the future of Construction and Demolition waste, posing substantial environmental and public health challenges. Currently, the waste management practices are inadequate, resulting in improper disposal, resource wastage, and ecological degradation. This paper examines sustainable solutions for managing Construction and Demolition (C&D) waste in urban India, with a focus on waste minimization, recycling, policy enforcement, and the adoption of innovative technologies. The study examines the arrangement and volume of C&D waste and offers a critical evaluation of existing policies, including the 'Construction and Demolition Waste Management Rules, 2016'. The paper highlights successful case studies in global practices and their applicability in India. The challenges are identified and discussed with sustainable solutions. Technological innovations, including innovative crushers, automated sorting systems, and the integration of AI and IoT for efficient waste monitoring, are explored. The role of governance in enhancing compliance and policy, as well as incentivising private sector participation, is emphasised, explaining the importance of community engagement and public awareness campaigns. The paper concludes with the need for a coordinated effort from all stakeholders to implement sustainable Construction and Demolition (C&D) waste management practices that directly contribute to urban sustainability and resource conservation.

Keywords: Construction and Demolition, Ecological Degradation, Smart Waste Management Systems, Modular Construction, Waste Audits.

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INTRODUCTION

Overview of Urbanization Trends and Their Impact on ‘C&D Waste Generation in India

India has been experiencing unpredictable growth in urban areas. According to the UN, the urban population in India is projected to reach 600 million by 2030, accounting for approximately 40% of the total population. This rapid urbanisation is driven by natural population growth and migration from rural to urban areas in search of better employment opportunities and living conditions. The economic liberalization of the 1990s accelerated urban development, resulting in substantial investments in infrastructure projects, including housing, transportation, public utilities, and commercial complexes. This urban growth has led to extensive construction activities across the nation.

The ‘Smart Cities Mission’ was launched in 2015. Jain and Tiwari (2019) state that the aim is to promote sustainable and inclusive development by improving infrastructure and services in 100 selected cities. This initiative has encouraged construction activities like multiplexes, buildings, roads, and other urban infrastructure. The growing urban population has driven a high demand for housing and real estate. Government initiatives, such as the Housing for All by 2022 program, aim to construct affordable housing units for citizens who directly contribute to construction activities.

Construction and Demolition Waste Management Rules, 2016

Scope and Applicability

This rule applies to all waste generated from the construction, remodeling, repair, and demolition of any civil structure in urban and rural areas. This includes building materials, debris, and rubble resulting from the construction, remodelling, repair, and demolition of any civil structure of an individual, organisation, or authority that generates Construction and Demolition waste.

Responsibilities of ‘Waste Generators’

‘Waste generators’ are individuals, builders, and government bodies. They are responsible for:

- **Segregation:** Ensuring that C&D waste is segregated into recyclable and non-recyclable components before disposal.
- **Storage:** Waste is stored in accordance with the guidelines of local authorities.

- **Transportation:** Ensures safe transportation of waste to designated processing or disposal sites.
- **Disposal:** Disposing of C&D waste at only authorised collection, processing, or disposal sites.
- **Informing Authorities:** Provide information to the local authority regarding the production of Construction and Demolition (C&D) waste.

Duties of Service Providers and Contractors

The Service providers such as local municipal authorities, PWD, and contractors must perform these duties of Removal and Disposal, Record Keeping, and Compliance, which means removing C&D waste promptly and ensuring that it is disposed of at the designated place, maintaining records of C&D waste production, transportation, and disposal of and ensuring compliance with the norms and standards set by local authorities for managing waste.

Duties of Local Authorities

Local authorities are tasked with Authorization, Monitoring, Planning and Implementation, Infrastructure Development, and Public Awareness, which defines providing authorisation to C&D waste processing facilities, ensuring compliance with waste management rules by all stakeholders, developing waste management plans, establishing collection, transportation, and processing facilities, and conducting awareness programs for waste generators regarding proper waste management practices.

Duties of State Government

State governments are responsible for formulating policies and strategies for C&D waste management within their state, conducting training programs, and monitoring and supervising the implementation of these rules by local authorities and other stakeholders.

Duties of the Central Pollution Control Board (CPCB)

The CPCB is responsible for formulating guidelines for the environmentally sound management of Construction and Demolition (C&D) waste, promoting research and development (R&D) activities for the recycling and reuse of C&D waste, and coordinating with state pollution control boards for the implementation of these guidelines.

Tourism Informatics and Urban Foodscapes: Navigating Food Security Through the Coexistence of Fast-food and Traditional Cuisine

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Abstract: Metropolitan food environments consist of both fast food restaurants and traditional dining establishments operating side by side. This research examines the factors underlying the coexistence of these two food types and their impact on regional dining traditions, traditional food practices, and metropolitan expansion. The study drew its data from 50 participants to evaluate the changes in urban living that influence both fast food and conventional food restaurants. The analysis determines if these eateries play a unique role in cultural heritage preservation. Statistical analysis indicates that changing lifestyles directly contribute to the coexistence of these food businesses. This study demonstrates that traditional restaurants play a vital role in preserving cultural heritage, more so than fast food chains. The research findings have implications for urban planning and community health initiatives, suggesting we need a balanced food landscape that protects cultural traditions while accommodating modern urban lifestyles.

Keywords: Diversity, Food, Food chains, Heritage, Rural lifestyle, Urban centers.

INTRODUCTION

Modern metropolitan food scenes have undergone significant changes in recent periods, as traditional dining places have begun to coexist with fast food businesses. The societal transformations, including urbanisation and globalisation, together with changing consumer preferences, make up the symbolic meaning of these changes. The presence of both fast food chains and traditional restaurants raises important questions about what drives their growth and how they collectively influence culinary traditions, public health outcomes, and urban development.

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Laboratory changes and dietary preferences resulting from urbanization force people to prioritize efficiency and simplicity in their daily activities. The opportunity to serve busy customers has enabled fast food establishments to refine their business models. According to Lee J. and Martinez P. (2021), multinational fast food establishments have become widespread in cities due to their standardized menus and quick service methods. Traditional cuisine persists alongside fast food, with cultural heritage and community connections being the defining characteristics of many traditional restaurants. Traditional foods face competition from fast food in metropolitan areas, where modern life reveals intriguing connections between present and past preferences.

Factors Driving Coexistence

Changing Lifestyles and Consumer Preferences

The rapid and high-speed nature of metropolitan existence has stimulated the need for swift and easily accessible meals, harmonising with the fundamental characteristics of fast-food offerings. However, traditional gastronomy continues to entice individuals seeking a genuine and varied culinary experience. (Miller, T., & Williams, A., 2017) This implies that both sectors of the population are influencing cohabitation by selecting gastronomic choices that resonate with their individual preferences.

Globalization and Culinary Diversity

The occurrence of globalisation has greatly influenced the gastronomic scenery. Fast food restaurants often incorporate indigenous flavors into their menus to cater to local preferences, thereby blurring the boundaries between traditional and fast-service offerings. (Smith, G., & Brown, A., 2019) This tendency showcases the dynamic interplay between global food trends and regional culinary heritage, allowing customers to experience a blend of flavors within their urban surroundings.

Impact on Local Food Culture

Preservation and Evolution

Gastronomic landscapes have undergone noticeable changes due to globalization. Fast food chains incorporate local flavors into their menu selections to cater to regional customer tastes, thereby combining traditional cuisine with fast-service options. Global food preferences interact fruitfully with local gastronomy, as noted by Smith and Brown (2019), to provide urban customers with access to diverse taste combinations in their hometown.

Homogenization vs. Diversity

Rapid food coexisting with traditional cuisine resulted in either a broadening of the cultural kitchen or a decrease in variety. Metropolitan culinary diversity relies on striking a balance between conventional dining establishments and fast food venues to sustain a vibrant cultural food scene.

Implications for Public Health and Urban Development

Health Concerns and Lifestyle Diseases

The general health status of society worsens because the tradeoff between nutritional worth and standardized production standards exists in most quick-service food options. Clinical diseases linked to lifestyle increases in numbers when different food options operate side by side and cause obesity diseases like diabetes, combined with cardiovascular disease. Healthy fast food restaurant development combined with nutrition promotion represents essential measures for tackling such health challenges (Chen, S., & Patel, R., 2019).

Urban Aesthetics and Social Spaces

Both fast food locations and traditional dining sectors, together, create a stronger metropolitan visual appearance as well as social arrangements. Fast food establishments, which focus on quick service and uniform products, function differently from conventional restaurants that strive to preserve unique dining environments. According to Davis M. (2021), striking this balance between these eating methods transforms urban development zones by enhancing the city's appearance while developing diverse social opportunities for residents.

OBJECTIVE/ HYPOTHESIS

Objectives

1. To investigate the factors driving the coexistence of fast-food and traditional cuisine establishments in urban centers.
2. To analyze the impact of the coexistence on local food culture and the preservation of culinary traditions.
3. To evaluate Health and Urban Effects: Evaluate the implications of this coexistence on public health trends and the urban development of these areas.

Ecological Cost of Tourism: Addressing Plastic Pollution for a Sustainable Future

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Abstract: The purpose of this study is to investigate the ecological impacts of plastic pollution resulting from tourism and to identify innovative mitigation strategies that align with the Sustainable Development Goals (SDGs). This review examines the contribution of tourism to plastic waste generation and its ecological consequences, exploring mitigation strategies such as plastic bans, eco-friendly alternatives, public awareness campaigns, and industry regulations, while emphasizing the role of a circular economy. The purpose of this review is to examine the ecological consequences of plastic waste generated by tourism. The findings show that plastic pollution by the tourism sector significantly hampers the global ecosystem, creating a threat to biodiversity and long-term sustainability in tourism-dependent communities. The study found that due to the lack of significant initiatives, most plastic waste continues to accumulate in landfills and pollute water bodies. The study suggests immediate action through sustainable policies and practices to establish a “world of three zero” as recommended by Nobel laureate Dr. Muhammad Yunus. This study highlights the urgent need for collective action to mitigate plastic pollution in tourism destination zones. By integrating sustainable, eco-friendly practices and creating awareness, we can help save the global ecosystem.

Keywords: Biodiversity, Eco-friendly, Environment, Microplastic, Plastic, Pollution, Sustainable Tourism, Waste.

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INTRODUCTION

The rapid growth of the global tourism industry is a significant aspect of enhancing international economic development, but it also creates substantial environmental challenges. Among these environmental challenges, plastic pollution stands out as a critical issue, especially in tourism-dependent zones. Plastic pollution is less studied, and there has been limited focus on this issue in rural communities compared to urban areas. Plastic waste has recently become an environmental hazard due to its resistance to degradation and long-term persistence in the environment. This abnormal scenario is due to the mass production of plastic, which is increasing dramatically every year (Geyer *et al.*, 2017), coupled with inefficient disposal and recycling systems, resulting in an increasing amount of waste entering the global environment (Lebreton *et al.*, 2017; Jambeck *et al.*, 2015). The tourism industry is highly dependent on single-use plastics for packaging, hospitality services, and convenience items. In recent years, plastic pollution has garnered the attention of tourism stakeholders, social workers, governments, the media, and the public due to its detrimental impact on the environment and human well-being. Although plastic is an essential element of *et y, pr*, providing benefits such as comfort, hygiene, and safety, which contribute to the well-being of society, its single-use nature and improper disposal outweigh the benefits unless it is used and disposed of properly (Plastic Europe, 2019). Affordable plastic packaging materials are accessible to both urban and rural communities, as well as to remote villages worldwide (Godfrey, 2019). Plastic pollution affects a wide spectrum of natural and semi-natural habitats found in both urban and rural areas, including river, coastal, and island communities, threatening SDGs 14 (Life Below Water) and 15 (Life on Land).

In recent decades, an ecological threat created through plastic waste accumulation in the sea by humans has led to the ocean areas being polluted by various wastes like plastics, domestic waste, heavy metals, chemicals, etc., but 80–85% of this waste is plastic, which is an alarming sign (Deng *et al.*, 2021; Derraik, 2002). In addition, it is also intensified by the behavior of the community people and tourists who still often throw garbage into water areas (Saifi & Susanto, 2024). This plastic pollution has an impact on the accumulation of contamination in river fish and seafood species, and food contaminated with microplastics is not safe for human consumption (Hantoro & Widianarko, 2018). Oliveira *et al.* (2020) stated that successful measures at the local level, or those addressing a single product stream, are often undermined or offset by the emergence of new types of plastic, new exposure pathways, and new additives. Therefore, a more comprehensive approach is needed, namely one that considers various regulatory tools, education, awareness among local people and tourists, and encourages voluntary actions throughout the life cycle of plastic products and materials, which is more likely to

be successful. Therefore, strategic steps are needed, one of which is the adoption of the sustainable tourism concept, so that tourism activities do not further exacerbate pollution conditions in the tourist zone. Therefore, it is a time for transitioning to sustainable tourism practices from traditional ones, in order to safeguard global ecosystems and ensure the long-term viability of the tourism sector.

LITERATURE REVIEW

Sustainable tourism plays a crucial role in development, particularly in reducing the environmental impact of materials such as plastic and cane that are discarded in the tourist zone. In an economic and social context, sustainability involves minimizing plastic waste in ecosystems. Pollution in the tourism zone is often a result of irresponsible tourism activities, which can be a distinct experience (Paskova, 2024). The tourism industry, which began in the early 1950s, now generates nearly \$1,000 billion in total revenue and creates direct employment of more than 70 million people. However, the rapid growth of the global tourism industry is a significant aspect of enhancing global economic development, while also creating substantial environmental challenges. Plastic pollution stands out as a significant environmental challenge stemming from the tourism sector (Liu, 2022). In the production process, plastics are produced with the addition of several additives, such as dyes, fillers, or flame retardants. As a result, very few plastics can be recycled without loss in performance or aesthetics. Even the most recyclable plastic, PET or polyethylene terephthalate, is only recycled at a rate of 20-30%, with the remainder typically ending up in incinerators or landfills, where the carbon-rich material takes centuries to decompose (Christensen *et al.*, 2019). While demand for plastic had increased, local waste management systems developed at a much slower pace, resulting in consistent leakages into the environment (Yhdego, 1995). All activities can be linked to increased beach accumulation of plastic, which puts the development of the local tourism community at risk (Zhao *et al.*, 2015).

As of 2020, the global mass of produced plastic exceeds the biomass of all land and marine animals combined (Laville, 2020). A large amount of plastic waste enters the environment, causing problems throughout the ecosystem. For example, studies suggest that the bodies of 90% of seabirds contain plastic debris (Mathieu *et al.*, 2014). The amount of plastic waste produced increased during the COVID-19 pandemic due to increased demand for protective equipment and packaging materials (Shams *et al.*, 2021). The ever-increasing consumption of plastics was highlighted as a critical environmental issue. Global use is projected to reach 1.1 billion metric tons by 2050, up from approximately 2 million metric tons in the 1950s (Dottle, 2022). Several studies have revealed that Coastal tourism, a

CHAPTER 12

The Impact of Artificial Intelligence in Environmental Pollution—A Dwelling Aspect for a Better Sustainable Tomorrow

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Abstract: Because the transformative power of Artificial Intelligence (AI) continues to fuel innovation, concerns are growing about its negative impact on the environment. In this article, we examine the sustainability issues surrounding AI, focusing on related problems such as carbon emissions, digital waste, and environmental impacts. Through proactive actions and ethical practices, we must learn how civilization can effectively cope with these concerns and strive to build a sustainable world where AI and nature conservation coexist harmoniously. From an environmental perspective, AI presents both positive and negative possibilities. On the positive side, AI can aid in alleviating most of the major climate problems; on the other hand, it can also exacerbate the issue. By transferring in advance, we must continue to utilize this powerful gadget in the proper ways: reducing ocean pollution, aiding conservation efforts, and enhancing recycling techniques. However, we also want to find ways to power the machines with less environmental impact, and that can be accomplished without undue delay. AI is hailed as a game-changer, but under its transformative capability lies a pressing concern: its environmental impact. The improvement, protection, and use of AI generation technologies have a significant carbon footprint. In this chapter, we delved into the hidden environmental predicament surrounding AI and uncovered the urgent need for proactive measures. A sustainable future can be secured, and the dangers AI poses to our world community can be mitigated by being aware of the risks and acting responsibly.

Keywords: Artificial Intelligence, Environment, Safety Management, Sustainability, Pollution.

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INTRODUCTION TO ENVIRONMENT

Artificial intelligence extends far beyond high-profile chatbots; machine learning now powers a diverse array of ubiquitous technologies, from GPS navigation systems to the algorithms that curate social media feeds. But as AI's reputation continues to grow, more researchers and specialists are noting the environmental cost. Education and AI tool usage require a significant amount of computational power, and the consequent carbon dioxide emissions are just one of the ways AI impacts the climate. Its impact on the environment is much greater than its carbon footprint. Artificial intelligence (AI) can have a profound effect on the environment, both positive and negative. The advancement and use of AI have changed many aspects of our lives, as well as our relationship with the world. With its ability to analyze unprecedented volumes of facts, examine patterns, and make decisions in real-time, AI can be utilized to optimize energy efficiency, reduce waste, and enhance the aesthetic appeal of sustainable practices. But the negative environmental effect of AI is also a contributing factor to this scenario. Bhamidipati, R.T. (2025).

The significant environmental impact of AI is evident in several areas. A considerable advantage of AI is that it can optimize power consumption and reduce waste. For instance, machine-learning algorithms can review data from smart grids to optimize power consumption in real-time, reducing the need for fossil fuel-based overall strength generation. Such initiatives may reduce greenhouse gas emissions and curb the impact of climate change. Akbar, N.S. (2025).

AI can also expand and enforce environmentally sustainable practices in sectors like agriculture, forestry, and transportation. For instance, precision agriculture can help farmers reduce their use of fertilizers and pesticides, resulting in healthier crops and lower environmental pollution. Additionally, AI-driven forestry management can help ensure that forests are sustainably harvested with minimal impact on the surrounding environment. In transportation, AI can help optimize routes and reduce gasoline consumption, which results in fewer emissions and cleaner air. Naga, H., Bhaskar, V., & Mayil, V.V. (2025).

Environmental Pollution

M, A. In the 2025 step, researchers highlight that air pollutants continue to be a significant environmental and public health concern, and that particles are the primary contributors to air quality degradation. This study aims to investigate various methods for assessing perception and predicting air quality using statistical procedures, time series analysis, and system modeling strategies. Traditional fashion, including regression analysis, ARIMA, and time series

decomposition, was typically applied to the first class of air ratings. However, advances in Artificial Intelligence (AI) have introduced specialized predictive models and Support Vector Machines (SVM), Deep Convolutional Neural Networks (DCNN), and Long Short-Term Memory (LSTM) networks. Furthermore, we examine the effects of meteorological elements on the distribution of pollutants and the effectiveness of strategies for urban greening to reduce air pollutants. The results demonstrate that hybrid AI models, which combine deep learning and statistical methods, possess excellent predictive capabilities and offer promising techniques for real-world applications and informed decision-making. AI can be used to occupy new substances in unique homes. It also enhances the degree of reduction in strength or weight available for utilization during production, up to an aerospace level. The materials can be based on renewable assets that reduce reliance on fossil fuels and mitigate the environmental implications of production. These reforms will enable you to identify and address ecological problems more effectively. For instance, you use AI to visualize and project anticipations. This technology allows us to prepare for storm activities and minimize our social and environmental impact. Through AI, we analyze and publish ecological data, including air and water quality information, to identify areas for improvement and aim for solutions. A., Madhuri, J.V., Saravanan, D., Vijayakumar, T., Manimegalai, D.V. The development of AI algorithms takes a lot in terms of resources. The biggest fear is the power of electricity to train and run AI algorithms. Training AI models used in education can consume a massive amount of computer energy. This processing takes immense electricity. This intensity is often generated by fossil fuels, resulting in a surge of greenhouse gas emissions.

Another issue is the ability to compress AI to address environmental challenges. For instance, AI-boosted automation will result in high-speed recording and reduced waste in industries such as e-commerce, where quick and widespread delivery is made the norm. Similarly, AI-based agriculture is a green health initiative. Qin, Z., Wei, B., Gao, C., Chen, X., Zhang, H., Wong, C.U. (2025). The easiest way to run AI algorithms is to use the statistics on which they have been trained, and this data distortion can lead to biased decisions. For example, suppose the AI-generated rules are trained with statistics that prioritize monetary gains over environmental security. In that case, decisions can be made that prioritize long-term financial benefits over short-term ecological concerns. With the help of renewable energy assets from solar or wind power, this can contain and make the AI model work, Manoharan, G., Ashtikar, S. P., & Nivedha, M. (2024). Applying AI in a manner that encourages sustainable behavior and minimizes environmental footprint is another alternative. We can utilize AI as a model to maximize recycling technology and reduce food waste in delivery chains. The increasing need for branding with new and sophisticated AI technology has led to

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