

Effects of environmental pollution on wildlife and human Health and novel mitigation strategies

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Abstract

Environment refers to the totality of all external factors and conditions that have an impact on a living thing's survival and growth. The effects of pollution on wildlife and human health are complex and affect many ecosystems and facets of civilization. Urbanization, industrialization, and the indiscriminate and improper use of chemicals, such as pesticides, have all accelerated environmental degradation and contamination, which has a negative impact on living things' health and created issues with residues in animal-derived foods. The impact of pollution on biotic components has been highlighted by recent developments in environmental-related toxicity in humans and animals as well as the rising frequency of chemical residue detection in food products. To solve the complex problems caused by environmental contamination, innovation and new mitigation techniques are essential. The creation and use of cutting-edge technology, such as diverse bioremediation methods, are included. In order to bring about change and promote successful mitigation methods, public participation and awareness are essential. Governments, businesses, communities, and people must work together to address the problems that environmental degradation has created. We can lessen pollution's harmful impacts on wildlife and human health, guaranteeing a healthier and more sustainable future for both the ecosystem and people, by implementing creative mitigation measures and giving sustainable practices priority.

Keywords: Pollution; Bioremediation; Phytoremediation; Wildlife; Environment; Humans; Pollutants

1 Introduction

The environment can be defined as a complicated system that comprises a variety of chemical or physical components and their interactions. The fundamental means for sustaining living things are provided by the natural environment's physical components, such as water, land, and air. The Living components and the environment will be in harmony if the reaction between these living organisms and the physical components is in equilibrium. Several environmental issues, including pollution, have arisen as a result of the dominance of humans over the environment breaking off the harmony between living things and the elements of the environment in recent decades [1]. Environmental pollution can be defined as the contamination of the natural environment with unfavorable compounds that may have unfavorable consequences on the health of living things and the habitat as a whole. Given that they are directly subjected to these pollutants through the air, water, and food they consume, wildlife and humans are particularly vulnerable to the consequences of pollution. World Health Organization [2].

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Environmental pollution poses a devastating effect on wildlife and human health. Diseases like cancer, neurological disorders, and respiratory disorders, have all been attributed to pollution. Similarly, reproductive and developmental problems as well as immune dysfunction have all been linked with pollution. World Health Organization [2]. The negative impacts of environmental pollution are not limited to human health alone, it can also present a deteriorating effect on wildlife populations. For instance, mass death in marine wildlife populations has been attributed to pollution from oil spills while reproductive problems and damage to internal organs in these organisms have been linked to pollutants in the air and water. World Health Organization [2].

The need to address the issue of environmental pollution cannot be overemphasized due to its negative impacts on wildlife and human health and the need to protect both wildlife and humans. This can be achieved through a variety of measures, including reducing emissions from industries, promoting the use of clean energy sources, and improving waste management practices. The National Wildlife Federation [3]. The review accentuates the heightening impacts of environmental pollution on wildlife and human health and suggests novel mitigation strategies.

1.1 Cases of Environmental Pollution in Developed and Developing Countries

Environmental pollution has become prevalent globally, though the rates of pollution differ in various locations across the world. Over the past ten years, there has been a noticeable decrease in air pollution in Europe, even though considerable volumes of air pollutants are still being released by industry, autos, power plants, and agricultural activities [4]. Europe's surface waters have become healthier thanks to the Urban Waste Water Treatment Directive, which ensures that wastewater is treated properly so that the environment is protected from the damaging effects of outflows from metropolitan and industrial wastewater [5]. According to the United States Environmental Protection Agency (USEPA), since 1980, national air quality has improved based on concentrations of common contaminants. [6]. While developing nations with expanding economies are not giving ongoing environmental challenges the required attention, industrialized nations have been able to recognize and regulate pollution thanks to the development of environmental legislation and the enforcement of regulations [7].

With the second-largest estimated population in the globe, Africa is the second biggest continent on the planet. Africa consists of five geographical regions: West Africa, Central Africa, Northern Africa, East Africa, and South Africa. The five regions of the African continent are home to a variety of mineral resources, including gold, phosphate ore, metal ore, coal, and oil [8]. The utilization of these natural resources has had a significant negative impact on Africa's ecosystem. By the year 2030, it is anticipated that 54% of African cities' populations will live in urban settings [9]. The rising industrialization, urbanization, and population growth of Africa are not without environmental impacts. It affects the region's air, soil, and water quality and creates a huge demand for key resources. Vehicular emissions, which are the main contributors to air pollution in the African region, have increased along with population expansion, industrialization, and urbanization [10]. However, due to laws governing vehicle emissions, emissions brought about by road transportation are declining in Europe [11]. Atlanta, Georgia, in the United States, saw significant drops in car emissions from the late 1990s to 2009, which greatly improved the city's air quality [12]. Houston, New York City, and In Los Angeles between 1990 and 2010, car emissions were lowered by *80–90% despite an increase in gasoline consumption [13].

Traffic and industry are the primary causes of air pollution in developed nations [14]. The consumption of solid cooking fuel also contributes significantly to air pollution on the African continent, along with emissions from traffic [15]; unpaved road dust that has been re-suspended [16]; burning of garbage and vegetation [17]; usage of insecticides to prevent malaria [18]; and West Africa's Sahara desert. The Sahel-Sahara desert is the world's largest producer of atmospheric particulate matter, with approximately 300 to 800 million metric tonnes of Saharan dust released each year [19]. When the Sahara desert is mobilized, transportable dust that has been transported by the atmosphere might cause surface water pollution. Despite the abundance of oceans, lakes, and rivers in various regions of Africa, boreholes and wells are the primary sources of drinking water across the majority of the continent [20]. However, these groundwater sources have very poor chemical and biological water quality because of their nearness to sources of contamination [21; 20]. African surface and ground waters have been contaminated by pollution brought on by industrial, agricultural, and bad hygienic habits [22; 23]. Nevertheless, water pollution is minimal in Africa when compared with other developed nations like China [24].

In Africa, anthropogenic activities including mining, farming, disposing of household and commercial garbage, and the car industries have all contributed to soil contamination. African farmers use farmyard manure and wastewater irrigation due to the scarcity and enormous expense of inorganic fertilizers; however, these methods may contain metals that enter the food chain and harm the soil [25]. Roadside soil contamination from automotive emissions is also pervasive in Africa due to a lack of laws or conformity with legislation [26]. Even though some African nations have

pollution reduction guidelines, it is not particularly helpful if the rules and laws are not upheld. The extensive contamination of the air, land, and water that Africans are constantly exposed to could have detrimental long-term repercussions on human health [27]. Both young and old people with respiratory illnesses have been linked to air pollution [28; 9]. According to recent estimates, waterborne illnesses cause roughly 1.5 million deaths annually in underdeveloped nations, mostly among children [29].

2 Environmental pollution and its effects on wildlife

Right now, pollution is hurting our planet really badly. More and more, the things we do as people are causing problems for the environment all over the world. This could mean that animals are losing their homes or their habitats are changing [30; 31] and could also mean that new species are coming in and causing trouble, or that diseases are spreading from one animal to another. There are also dangerous chemicals building up in the environment, and the climate is changing. All of these things are making it harder for plants and animals to survive [32; 33].

Due to interconnectedness of all living things, interactions between them are necessary for survival in order to preserve the natural world's equilibrium for all living organisms as well as the physical surroundings, which together make up the environment. The act of polluting the environment involves introducing potentially hazardous chemical or physical constituents into it. Polluting substances can significantly affect the metabolisms of specific species or drastically change the composition of an ecosystem, both of which are stable past conditions [34]. Due to various ways that humans have altered the environment and unbalanced nature, pollution has resulted. Humans have significantly altered the habitat of wildlife because of environmental pollutions. Previously, we underestimated the ecological effects of our actions and failed to consider the soil, water and air pollution that surrounds us as a source of waste. Because of this, wildlife must contend with a dizzying assortment of different forms of toxins that are either purposefully or accidentally introduced into the ecosystem. At worst, contamination of the air and water pollution can result in the demise of numerous creatures within a given ecosystem, including people [34].

For instance, when animal's homes get damaged or broken into smaller pieces, it can make it harder for them to find food and move around. Thereby reducing dietary intake and limiting gene flow, However, they can also make it more likely for contact between humans, both domesticated animals and wildlife [35] thereby accelerating the rates at which diseases are transmitted [36]. Contaminants can also have an adverse effect on reproductive conditions [37,38] gender ratios [39] and immunocompetence [40] all of which can have an indirect impact on the survival of sensitive species [41;42; 43]. In addition, pollutants can change habitat quality and lessen nutrient availability and promote blooms of toxic algae along coastlines [37; 38].

2.1 Aerial Air Pollution's Impacts on Wildlife

Air pollution can harm animals and their homes. Different animals can be affected differently because they interact with their environment in different ways. Air pollution can affect the habitat and food supply of animals [44].

2.1.1 *Effects of Air Pollution on Habitat.*

Animals have special homes called habitats that can be on land or in water. Sometimes, when it rains, the rain can change the soil and water in a way that can make it hard for animals to live and do what they need to do. This can also bring dangerous metals up from the ground that can hurt fish and other creatures. One metal called mercury can even travel far through the air before landing on the ground. There are different kinds of dirty air that can hurt the environment, like smog, tiny bits of dirt, and a type of gas close to the ground [44].

Animal's that interact with their environment include mammals, birds, fish, clams, worms, and insects. Consequently, each species being exposed to the impacts and susceptible to air pollution's effect in a unique way. Two basic routes exist for air pollution to impact wildlife. (i) It has an impact on how well their living space or environment is maintained (ii) It has an impact on the supply of food, both quantity and quality [44].

2.1.2 *How Environmental Toxins Impact Habitat*

Animals have their own homes called habitats, which can be on land or in water. When it rains, the rain can become harmful and change the dirt and water. This can be bad for the animals that live there because the water can become too dangerous for them and make them sick. Other types of pollution in the air, like smog and particles, can also hurt animals like they hurt people [44].

2.1.3 *How Air Pollution Harms Food Supply and Quality*

When harmful things like metals and chemicals get into the air, they can go into the food that animals eat. This can make the food not as good and can hurt the animals. When animals eat other animals, the harmful things can build up and become more dangerous. Big animals like bears and eagles can get hurt the most. So, people need to be careful about eating fish that might have too much of a harmful thing called mercury in them. We refer to this process as bioaccumulation [44].

2.2 **Examples of How Pollution Affect Various Species**

2.2.1 *Effects of Pollution on Amphibians*

Amphibians have declined dramatically in many areas of the world. These declines appear to have been exacerbated recently, and the amphibians are now more endangered in comparison with a wide range of vertebrates [45]. Approximate 41% of all vertebrate species are amphibians, making them the category of vertebrates with the greatest global threat as a result of human activity [46]. The introduction of foreign species, and the eradication of species that are indigenous and the contamination of aquatic and terrestrial habitats has been listed as significant threats [47].

Chemical contaminants in the environment can interfere with flora's ability to reproduce, grow, and survive by impairing the endocrine system's regular operation. These chemical pollutants have been classified as either naturally occurring or artificial substances, such as heavy metals, medicines, pesticides (including herbicides, insecticides, and fungicides), and so forth. Studies examining the effects of chemical pollution on amphibian species have multiplied since 2000 [48; 49].

2.2.2 *Effects of Pollution on Birds*

Birds have been used as lookout species otherwise termed as sentinel species to determine changes in the environment. Canaries birds were brought down into coal mines in the early 20th century were to detect toxic gas concentrations, such as carbon monoxide, which signals when levels have reached unsafe levels. This practice gave rise to the common expression "canary in the coal mine," which refers to early warning signs of impending danger. The 1962 publication of Rachel Carson's prize-winning book *Silent Spring* raised awareness of the broad effects of pesticide and insecticide use on songbirds. The usefulness of various bird species in the biomonitoring of metals has been evaluated [50]. The majority of researchers strongly advise that eaten plastic is likely to harm seabirds. Although some seabirds may eventually regurgitate plastic pellets with other indigestible debris, lessening negative consequences, there are still risks associated with ingesting plastic particles, such as blockage or internal injury [51].

2.2.3 *Sea Turtles Eat Plastic*

A Research conducted at the University of Nebraska–Lincoln by Stacey Safarik on the effects of pollution (plastic) on sea turtles and how to prevent them revealed that there is a significant amount of plastic in many oceanic regions, making it likely that it harms sea turtles. The study also revealed that the two main consistent themes were ingesting plastic and becoming entangled. The research's findings revealed that sea turtles frequently mistakenly ate plastic for food. Sea turtles were found injured or dead as a result of entanglement, it was also learned. Both of them can be fatal to sea turtles and their consumption can cause digestive problems, stomach perforations, and other serious health problems. Loss of limbs, limitations on movement to catch food, and drowning can all result from entanglements [52].

2.2.4 *Sea Lions and Bioaccumulation*

Sea lions are affected by persistent organic pollutants (POPs), various chemical attacks, including oil spills, just like the majority of marine mammals. Marine food webs are capable of bioaccumulating persistent organic contaminants, where upon they are bioamped up by trophic level predators like marine animals [53]. POPs have the potential to bioaccumulate in marine food systems throughout the coast and ocean, endangering the health and status of Galapagos sea lions [54]. Animals' capacity to resist disease and successfully reproduce is impacted by their immune and endocrine systems, this is crucial because mass death occurs and populations frequently near the verge of extinction during periods of nutritional stress and other types of stress in unpredictable environments (like El Nino occurrences) [55].

2.3 **Long Term Consequences of Pollution on Wildlife Population**

The plastic waste that is contaminating our oceans poses a threat to the lives of millions of marine creatures. Many marine creatures, including seals, whales, dolphins, seagulls, fish, and crabs, are perishing or becoming ill as a result of this terrible environmental problem. In 2014, the weight of the estimated 15 to 51 trillion microplastic particles floating in the waters worldwide ranged from 93,000 to 236,000 tonnes [56]. Marine creatures typically consume microplastics

because of their microscopic size. Furthermore, dangerous substances present in plastic have the ability to impair reproduction and increase the risk of illness. If they swallow microplastics, seals and other animals may suffer for months or years before they die [56]. The discovery that certain environmental pollutants can interfere with the hormone system and, as a result, may be to blame for the anomalies in reproduction observed in wildlife, has raised a great deal of alarm in recent years. Fish, reptiles, birds, and mammals have all shown aberrant reproductive development and lesions that may be signs of a hormonal imbalance [57].

3 Environmental pollution in relation to human health

Global health is being threatened by land, water, and air pollution. Currently, pollution is main leading global environmental cause of death and disease, according to the *Lancet*, a Commission on Pollution and Health. In 2015, pollution-related diseases were predicted to be the cause of 9 million premature deaths, which represented 16% of all fatalities worldwide and killed three times as many people than tuberculosis, malaria, and AIDS combined. As a result of pollution in 2015, 268 million disability-adjusted life years (DALYs) were lost, out of which 14 million years were lived with disability and 254 million were lost to premature death. We must take action to safeguard our environment for upcoming generations due to the tremendous harm it does to human health. Acting and controlling pollution is therefore now important. In the absence of such measures, the environment and human life will be harmed by the waste products from human activities such as heating, mining, agriculture, manufacturing, transportation, and others [58].

3.1 Effects of Water Pollution on Human Health

Water availability is Life-sustaining for human survival. In the last century, freshwater use has grown in double. Since the 1980s, the amount is increasing by about 1% per year, according to the 2021 Report of World Water Development published by UNESCO. Due to the increase in water use, its quality is significantly being impacted. As a result of, agricultural output, industrialization, and urban life, the environment has degraded and become contaminated. This has a deleterious influence on critical water sources (rivers and oceans), In turn, this has an impact on societal development and health in the long run. An estimate of about 80% of municipal together with industrial wastewater globally is discharged into the habitats untreated, causing harm to ecosystems and human health. This percentage is higher in LDCs, where wastewater treatment and sanitation facilities are in short supply [59].

Unsafe water has a serious influence on public health. Each year, approximately 300,000 children under the age of five die from diarrhea due by polluted drinking water, inadequate sanitation, and poor hand hygiene, according to the UNESCO 2021 World Water Development Report. According to Palestinian data, those who drink municipal water are more likely to have diarrhea than those who consume desalinated or home-filtered water [60]. In locations with poor access to clean water and sanitation, diseases such as cholera, trachoma, schistosomiasis, and helminthiasis are more frequent. Data from developing-country studies demonstrate a strong link between cholera and polluted water, and household water filtration and storage can significantly lower cholera incidence [61].

3.2 Effects of Air Pollution on Human Health

Air pollution simply means several toxins, such as SO_x, NO_x, and O₃ that have a negative influence on health. This contamination endangers public health by interfering with regular atmospheric cycles. High levels of pollution have been seen in major cities over the last 30 years. It is estimated that 1.3 billion people lived in extremely polluted cities prior to 1980. The main sources of air pollution are industrial facilities, automobile exhaust, and fuel consumption. Carbon emissions are expected to more than double by 2030. Pollution in rural areas has worsened as a result of increased urbanization and energy consumption [62].

The relative magnitudes of the short- and long-term harms have not been completely explained, according to a recent epidemiological research from the Harvard School of Public Health, due to varied epidemiological methodologies and exposure mistakes. New models are presented to enhance data evaluation on both short and long-term human exposures. New methods for properly analyzing data on both short and long-term human exposures are offered [63]. Short-term effects are transient and can range from minor irritations of the eyes, nose, skin, or throat to more serious ailments such as pneumonia, asthma, lung and heart issues, and bronchitis. Wheezing, coughing, chest tightness, and breathing difficulty are possible side effects. They can also induce chest tightness, wheezing, coughing, and breathing difficulties. Short-term air pollution exposure can also produce headaches, lightheadedness, and nausea. Chronic long-term consequences can be deadly, lasting years or a lifetime. A number of malignancies may develop over time as a result of the toxicity of various air contaminants [64].

3.3 Effects of Soil Pollution on Human Health

Soil pollution refers to the contamination of soil by waste products at higher-than-normal quantities, which has a negative impact on the environment and human well-being. Soil is essential to health in a variety of ways. Soil crops provide for almost 78% of worldwide per capita calorie consumption, with the remaining 20% coming from terrestrial food sources that rely on soil indirectly. Soil is a great source of nutrients and also serves as a natural filter of water. Pathogens, chemicals, and minerals in the soil can be ingested, absorbed through the skin, or absorbed through the skin [65]. Several indices have been established to evaluate the influence of contaminated soil on cancer risk via ingestion, inhalation, and skin exposure [66]. Dust particles are breathed as a result of dust being transported by the wind. Dust movement has been linked to diseases such as Asthma, pulmonary fibrosis, chronic obstructive pulmonary illness, and sarcoidosis. People with compromised immune systems, such as children, the elderly, and those who already have chronic cardiovascular disease, are particularly vulnerable [67].

3.4 Examples of the Effects of Pollution on Human Health in the Major Impacted Regions.

3.4.1 3.4.1 Africa

Significant contamination of Africa's water, air, and soil resources is common, and it could have long-term health consequences [27]. Air pollution's effects have been connected to respiratory disorders in old and young people [68; 69]. Every year, the estimated number of people largely children, die is over 1.5 million in developing countries as a result of water-borne infections [29].

3.4.2 Asia

Due to air pollution, both Asia's rising metropolis and its less developed rural areas have greater rates of disease and mortality. Air pollution levels routinely exceed allowable limits in several emerging Asian cities. The regional burden of respiratory disorders and cancer is developing as a result of noxious gas and particulate matter emissions from motor vehicles, industry, and other sources, as well as an increasing urban population exposed to them [70].

3.5 The Long-Term Consequences of Pollution on Human Health

According to the World Health Organization (WHO), Environmental pollution exposure over a long period of time is regarded to be the primary cause of 25 percent of the diseases that affect individuals today [71]. More than three times as many people died in 2015 from pollution-related premature mortality as from malaria, AIDS, and tuberculosis combined, according to estimates [72]. Being exposed to outdoor particle pollution for an extended period of time has been related to ill health and an earlier mortality, which is particularly concerning [73]. Air pollutants can concentrate in or flow through lung tissues depending on their size and chemical composition, despite the bronchopulmonary tract's many defenses such mucosal cilia and the air-blood barrier [74; 75]. Numerous respiratory conditions, such as lung cancer, chronic obstructive pulmonary disease (COPD), respiratory infections, and chronic obstructive pulmonary disease have been linked to air pollution [75]. The degree of harm that air pollutants can do is mostly determined by their chemical composition, which includes things like their oxidizing power, solubility, concentration, and the susceptibility of the affected person or item. The water solubility of SO₂ gases renders them dangerous to human skin and upper respiratory tracts. However, due to their reduced solubility, O₃ and NO₂ gases can enter the lungs more profoundly. CO is a colorless, odorless, highly soluble, and nonirritating gas. Since CO has a stronger affinity for hemoglobin than oxygen, it easily enters the bloodstream where it interacts with hemoglobin to produce carboxyhaemoglobin, which has adverse effects [76].

A study by [77], found that prolonged exposure to PM_{2.5} was linked to higher risks of stroke and stroke mortality. Long-term PM_{2.5} exposures were linked to a higher prevalence of autism spectrum disorder (ASD), according to another study [78]. Parkinson's disease, Alzheimer's disease, and dementia are all closely associated with PM_{2.5} exposure. Parkinson's disease and dementia were equal for second position in terms of risk, with Alzheimer's disease taking top place [79]. Developmental neurotoxins like arsenic, methylmercury and lead have long been identified [80; 81]. The blood lead levels of Children, particularly children below 10 g/dL, have a negative, nonlinear dose-response association with IQ, according to meta-analyses [82]. There is significant evidence from more than 20 studies, according to recent systematic analyses, showing prenatal exposure to organophosphate pesticides is associated with lower IQ scores and some other indicators of children's mental and motor growth [83]. Previously, it was discovered that chlorpyrifos was a recognized developmental neurotoxin [80], moreover, structural magnetic resonance imaging (MRI) has shown that exposure to the herbicide during pregnancy is linked to changes in brain shape [84; 81]. Environmental toxins can impede the development of the immune and respiratory systems, which can lead to a reduction in lung function, an increase in the chance of developing allergies, and a reduction in the body's capacity to fight illness [85].

Additionally, studies have been done on the long-term health impacts of air pollution through longitudinal studies. The development of COPD, chronic bronchitis (CB), asthma, and emphysema has been associated with long-term exposure to unsafe levels of air related pollution [86]. A growing body of evidence indicates that prolonged exposure to ambient air pollution is harmful to lung function [87]. The naturally occurring radioactive gas radon is chemically inert and results from the indirect decay of uranium [88]. Radon enters residential spaces either through the building materials or the foundation. There may be a lot of radiation in the spaces as a result. Additionally, radon can enter a home through cooking gas and tap water. The radionuclides of radon are responsible for more than half of the overall dose of radiation that an average human body receives from the environment's natural and artificial radionuclides, as radon is believed to contribute more than 50% to the formation of an average human dose [89]. It has been determined that lung cancer is caused by alpha-particle emissions from radon progeny that are inhaled [90]. Because of radon's radioactivity, there is a higher chance that someone will develop cancer from radiation exposure. Chromosome abnormalities in blood cells are more common among workers who were exposed to high levels of radon during uranium mining research. Numerous studies have shown a connection between chromosomal abnormalities' frequency and the chance of getting cancer [91; 88].

4 Remediation: an innovative strategy to lessen environmental pollution

Oftentimes, the phrase "remediation" is used to refer to the procedure of removing and/or cleaning up toxins from lands, but it may also be used to describe any situation that exists in a specific area, pollution exists. On the other hand, remediation can be seen as the way of reducing harmful substances that are continuously disposed in to the environment [92].

4.1 Various Remediation Techniques.

4.1.1 Bioremediation

The technique for eliminating pollutants from Land and aquatic environment is bioremediation [93]. Toxins, heavy metals, and other potentially harmful chemicals can be eliminated with this process. The practice of bioremediation is now used in a variety of sectors, including waste management, mining, oil and gas extraction, and agriculture. Both aerobic (oxygen-dependent) and anaerobic (oxygen-free) are the two most frequently used bioremediation techniques. In aerobic bioremediation, oxygen is used to break down contaminants whereas anaerobic procedures employ microbes devoid of oxygen to break The degree of hotness or coldness, The H-ion level, the presence of living matter in the water or land, coupled with the number of accessible nutrients for microbial growth are the major variables influencing this dialogue [94].

4.1.2 Mechanism of Bioremediation

It entails both the introduction of helpful microorganisms into the contaminated area and the removal process itself, i.e., the removal of these harmful substances through biological processes involving microorganisms capable of breaking down toxic substances into harmless by-products that can then be safely removed without causing any harm to people or animals living nearby the contaminated area [95]. The method can be applied in places where there is a large concentration of pollutants, such as landfills, wastewater treatment facilities, and locations with water and air pollution [95].

4.1.3 Phytoremediation

A developing method called phytoremediation can remove contaminants from contaminated water and soil [96]. Impurities are removed from soil and groundwater using plants. The majority of plants used in phytoremediation include characteristics including rapid growth, a large branch system, and a high metabolic rate. Grass rushes, and cattails are the plant species that are most commonly used. In contaminated soils, Lead and zinc can be absorbed by the roots of plants. [96]. Metals are gathered by the plant's root system and subsequently eliminated through leaching or precipitation. Heavy metals go through the body from the epidermis to the endodermis to the xylem sap.

4.1.4 Microbial Bioremediation

By employing the use of manipulated strains from microbes, bio-augmentation has developed as a remedy for the sluggish and ineffective breakdown of toxins and waste [97; 98]. The changes in these traits enable the modification of indigenous plants and animals to yield the needed outcomes. Genetically engineered organisms (GEMs) are microorganisms which have been engineered through in-vitro changes, including bacteria, fungi, and yeast. Utilizing microorganisms or their chemical substances to break and eradicate pollutants from the environment is a method known as bioremediation. In this process, GEMs might be used. The degradation of harmful pollutants in the

environments is essential, however, many microbes like bacteria cannot break down few out of these harmful and persistent substances which includes: pesticides, explosives, and strongly nitrated or halogenated aromatic compounds, due to their chemical inertness and inappropriate breakdown in natural environments [99].

4.1.5 Potential Effectiveness

The vision of turning discoveries into products is provided by ongoing investigations and their benefits. Synthetic organisms that resemble biological things can be created, and they can remove dangerous contaminants and heavy metals from the environment. Therefore, the widespread use of these organisms will be a step forward for the environment and enterprises. Even while remediation has the potential to help reduce pollution, not all chemicals are prone to thorough and quick deterioration. Particularly, it is frequently observed that bioremediation takes longer than other remediation methods. Remediation is expensive since it is such a specialized procedure, and biodegradation may release more lasting hazardous compounds into the environment than the ones already there.

5 Conclusion and Recommendation

Wildlife and human health are threatened in many ways by environmental pollution, which has far-reaching effects. The detrimental consequences go beyond the acute exposure and may have long-term repercussions on ecosystems and public health. It is difficult to comprehend and foresee the entire extent of the health effects of environmental pollution on wildlife and humans due to the complexity and interconnection of ecosystems. As a result, there is a global focus on finding innovative strategies to maintain and manage the environmental component due to rising demands on the air, water, and land resources as well as the occurrence of animal and human health issues caused by industrial pollution. To solve the complex problems caused by environmental contamination, innovation and novel mitigation techniques are essential. The creation and use of cutting-edge technology, such as diverse bioremediation methods, are included. In order to reduce environmental pollution, efforts should not just target its symptoms but also its underlying causes. This entails encouraging sustainable behaviors, modifying consumption habits, and switching to ethically acceptable circular industrial and agricultural processes. In order to bring about change and promote successful mitigation methods, public participation and awareness are essential. The public can become more aware of the effects of pollution, encourage behavioral changes, and have an impact on policy through advocacy, education campaigns, and community participation.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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