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Analysis of Acid Rain: Adverse Effects on Environment

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Acid rain, caused by sulphur and nitrogen oxide emissions, is one of the few ecological challenges that has piqued the attention of scientists, politicians, legislators, industry, and the general public. The notion of acid rain first emerged in the literature over a century ago. In an 1872 book titled Air and Rain: The Beginnings of Chemical Climatology, an English scientist mentioned the acidic nature of rain water collected and examined.One of the few ecological concerns that has captivated the interest of scientists, lawmakers, legislators, industry, and the general public is acid rain, which is generated by sulphur and nitrogen oxide emissions. Almost a century ago, the concept of acid rain first appeared in the literature. An English scientist described the acidic composition of rain water collected and analysed in his 1872 book Air and Rain: The Beginnings of Chemical Climatology [1]–[3].

Since acid rain transcends geographical and political borders for example, state, national, and international, its natural, economic, political, and legal implications are highly complicated and sometimes perplexing. Acid rain is a common phrase for rain, snow, sleet, and hail that has become extremely acidic as a result of human activity, especially the combustion of fossil fuels. The emissions of gaseous sulphur oxides SO2 and nitrogen oxides NOx from the burning of coal, oil, and other organic materials, as well as smelting operations, generate acid rain. These main pollutants those produced directly from combustion engine smokestacks or tailpipes are oxidised and subsequently hydrolyzed in the atmosphere to generate secondary pollutants such as strong mineral acids, sulfuric H2SO4, and nitric oxide HNO3.

Pesticides may also have developmental, endocrine, and reproductive impacts. This has been observed for many decades; indeed, the title of Rachel Carsons seminal book, Silent Spring, was inspired by the loss of songbirds caused by DDT-induced eggshell thinning. Several animals have revealed comparable endocrine effects in recent research. Following contamination of the lake by organochlorine pesticides, dibromo chloropropane, and ethylene dibromide, research at Lake Apopka, Florida, has revealed significant changes in the alligator population, including decreased testosterone levels, smaller genitalia, and altered gender ratios in newborns, findings attributed to pesticide effects Guillette and others, 1996; Semenza and others, 1997. Similarly, recent results of remasculinization in atrazine-exposed frogs imply that triazine chemicals may have endocrine disruptive effects.

Two more pieces of law are also pertinent. The Pesticide Registration Improvement Act of 2003 PRIA establishes pesticide registration service fees for registration activities in three pesticide programme divisions: antimicrobials, biopesticides and pollution prevention, and registration EPA, 2005c. The Endangered Species Act ESA of 1973 forbids any activity that may have a negative impact on an endangered or vulnerable species or its habitat. In order to comply with this regulation, the EPA must guarantee that the pesticides it registers will not damage these species EPA, 2005c.

Box 20.4 covered pesticide labelling. Pesticide usage limitations are another significant part of pesticide control. Pesticides are offered in the United States and many other nations for either broad or limited usage. As previously stated, the greatest parallel for the distinction between these applications is the distinction between over-the-counter pharmaceuticals and those that need a prescription from a physician. Use in general Pesticides are less harmful, need minimal specific precautions other from basic safety precautions, and are offered in lower quantities. Use is restricted Pesticides are only sold to and used by qualified pesticide applicators. Certain substances are intended for general usage at low concentrations or formulations but are limited for use at greater concentrations. The registered pesticide applicator will have obtained enough training for the use of these chemicals and will have proved to the state regulatory agency adequate understanding for the products safe and effective usage. Most states require the applicator to be examined and certified, followed by continuous education and recertification. In most jurisdictions, commercial pest control may only be performed by a licenced applicator [4]–[6].

Sulfur oxides are produced naturally by volcanic activity and sea spray. In many regions of the globe, the principal source of SO2 in the atmosphere is the combustion of fossil fuels. In fact, it is believed that more than 90% of sulphur released into the atmosphere in the eastern United States is the consequence of human activities. In 1970, three-fourths of anthropogenically generated sulphur dioxides came from fuel burning, mostly from electric utilities in the midwestern United States, particularly the Ohio and Tennessee river basins. About one-fourth originated from industrial operations such as the chemical and petroleum sectors, but by 2002, the predominant source of SO2 was fuel combustion 85%, with industrial activities accounting for the remaining 9%. Recently, oxygen isotope fingerprinting identified anthropogenically generated SO4 pollutant in fine particulate from ship smoke, indicating that 4%-25% of yearly fine particulate may be caused by sulphate particles from ships burning 2.4% sulfur-containing bunker oil. 21 This kind of pollution is responsible for an estimated 60,000 cardiopulmonary and lung cancer deaths, particularly at ports in Europe and Asia. 22 California and the European Union have mandated that ships in their coastal waters use 0.1% sulphur marine distillate by 2012 and 2010, respectively.

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The registered pesticide applicator will have obtained enough training for the use of these chemicals and will have proved to the state regulatory agency adequate understanding for the products safe and effective usage. Most states require the applicator to be examined and certified, followed by continuous education and recertification. In most jurisdictions, commercial pest control may only be performed by a licenced applicator. Pesticide laws have mostly targeted two high-risk groups: children and workers. Pesticides are extremely dangerous to children. The Food Quality Protection Act FQPA of 1996 specified that contributions from all routes of exposure and all conceivable sources be taken into account when defining food tolerance limits for pesticides, with special consideration paid to the potential dangers to newborns and young children. After that, the EPA took various steps to safeguard children:

1. It established stricter requirements to protect babies and children from pesticide dangers, including an extra safety factor to compensate for developmental risks, inadequate data, and any specific sensitivity to pesticide chemicals that infants and children may have.

2. It limited certain pesticide usage; for example, in 1999, the EPA prohibited substantial uses of the organophosphate methyl parathion in children's food and imposed considerable limitations on the use of another organophosphate, azinphos methyl.
3. More pesticide research was necessary to clarify particular effects such as developmental neurotoxicity and acute and sub chronic neurotoxicity in children.
4. It created new diagnostics and risk assessment methodologies to target baby and child risk factors.
5. It boosted consumer education by, for example, distributing a consumer information leaflet to grocery shops nationwide and creating an interactive Web site for consumers.

Integrated Pest Management

IPM is a method of pest management that use a variety of control measures to keep insect populations at economically harmful levels while preserving environmental quality. The IPM idea was initially created for agricultural application in the 1960s in response to environmental and pest-resistance challenges induced by pesticide use Carson, 1962; Pedigo, 2002. IPM is described in agriculture as a holistic strategy to pest management that employs a combination of methods to decrease pest status to tolerated levels while preserving a quality environment. The IPM idea has been used in a variety of different environments since the 1960s, including turf and ornamental landscapes, houses, businesses, and buildings such as schools, malls, restaurants, and hospitals. Each of these applications has its own definition of IPM. IPM definitions for grass and ornamental landscapes, for example, concern preserving aesthetic quality. IPM criteria for buildings, houses, and schools often cover cleanliness, the preference for low-impact or reduced-risk chemicals, and the use of pesticides as a last option [7], [8]. Lastly, several states have adopted their own definitions of IPM and mandate its usage in specific contexts e.g., New Jersey Department of Environmental Protection, 2005; Pesticide Control Rules, 2005. Because of its intricacy, IPM is difficult for the general public to comprehend.

Monitoring

Monitoring is essential to any successful IPM programme. Monitoring offers information on pest populations, allowing for focused, data-driven management actions. The alternative to monitoring is to spray for pests whether they are there or not, which is unacceptable in todays culture. Monitoring may also disclose how well a programme is operating and highlight problem areas that need more attention. There are several species-specific monitoring techniques available, including traps baited with different attractants.

Cultural Management Techniques

Cultural management approaches alter the environment in order to make it unappealing to pests. Covering rubbish cans, for example, can remove a food supply that rats need to thrive. Dry food items, such as sugar and rice flour, may be kept in sealed containers to prevent insect contamination. Preventing the planting of plants near structures may help to limit the possibility of carpenter ants entering the structure. Remove or alter locations that may store water gutters, empty cans, tires, low parts in the landscape to eliminate possible mosquito breeding grounds. The adoption of cultural management strategies in the landscape may make plants more resistant to pest assault. Appropriate site selection, as well as correct fertilization and watering, decrease stress on plants, making them stronger and more resistant to assault. Pruning is another strategy. Pruning may eliminate sick or insect-infested plant sections while also preventing pests from spreading to healthy tissue or causing additional damage to the plant, providing management without the use of pesticides.

Control Measures

When pest-monitoring systems reveal a pest issue and preventative measures such as sanitation and cultural management are either unavailable or ineffective, the deployment of a control measure may be justified. Depending on the pest and the environment, physical and mechanical interventions, biological pesticides, or chemical pesticide treatments may be available. The best control measure is one that is kind on the environment and human health while yet offering effective control. The benefits and drawbacks of adopting DDT as a malaria control method are presented in Box 20.5, and the accompanying discussion includes general considerations in choosing among alternative control approaches.

DDT in Antimalarial Campaigns

Before the early twentieth century, malaria management depended on environmental methods such as drainage and landfills to decrease larval mosquito habitat, as well as biological controls such as larvivorous fish in ponds and larvicidal treatments of oil. These techniques were beneficial, particularly in North America and Europe, but malaria remained a problem in many impoverished countries. DDT, on the other hand, belongs to a class of chemicals known as persistent organic pollutants POPs; it may be found in the environment for years, is bioconcentrated as it goes up the food chain, and can affect animals and even people. Silent Spring by Rachel Carson warned the public that pesticides like DDT might have disastrous environmental impacts, killing not just insects but also birds and other animals. Moreover, although DDT has minimal acute toxicity in humans, there is some evidence that it may interfere with reproductive and endocrine functioning. As a result of these concerns, Sweden outlawed the use of DDT in 1970, the United States followed suit in 1972, and many other nations have since followed suit. The Stockholm Convention on Persistent Organic Pollutants, an international convention requiring the abolition of DDT and other POPs, was signed in 2001 and went into force in 2004, when the fifty-first country ratified it.

Biological control is using, manipulating, and conserving biological creatures that feed on insects and weeds to manage a problem. The biological pesticides natural enemies are defined as helpful creatures that build or restore a natural equilibrium in order to manage pests. While biological control is generally utilised in agriculture, when practicable, this strategy may offer effective control in an ecologically benign way in a variety of other circumstances. Nematodes, for example, are live creatures that target certain insects and may be used instead of pesticides to manage fungus gnats in home plant pots or white grubs in grass. Gambusia mosquito fish placed into ponds may suppress mosquito larvae under the correct circumstances. Employing biological control also entails avoiding management techniques that may be harmful to beneficial species. Natural enemy populations may be avoided by using ecologically friendly pesticides or other control strategies. Outdoors, some tactics might attract natural enemies and maintain them there once they arrive. Utilizing plant species that are appealing to beneficial creatures and offer alternative or additional food sources, such as nectar and pollen, can aid in pest management and minimise the need for pesticides.

double the amount of hydrogen ion, sulphate, nitrate, and chloride. The pH of precipitation is therefore determined by its entire ionic composition, which is determined by the sulphur and nitrogen content, as well as other compounds that are sent into the atmosphere, react, and eventually fall to the Earth's surface as precipitation. Several of these chemicals, in fact, play a vital role in neutralizing the acidity of rain. Reduced nitrogenous chemicals, such as ammonia and ammonium NH3 and NH4, which are produced by both combustion and agriculture, often combine with NO3 as NH4NO3 or sulphate as NH42SO4 and are transported over great distances. Base cations, or calcium, sodium, potassium, and magnesium in the atmosphere, are caused by sea spray, the attachment of dirt and dust particles, human emissions, and a number of other causes. They have the ability to neutralize the acidity of precipitation.

Chemical pesticides should only be used as a last option to manage pests; they should be used only when alternative methods are unavailable, impractical, or ineffective. Pesticide information is available from several state colleges and extension offices. These suggestions may be used to determine which pesticides are available and under what conditions to manage various pests. Where feasible, chemicals that are less damaging to the environment or the person should be utilised. The pesticide used should be effective enough that repeated sprays and the use of additional hemicals are not required. Lastly, all labelling instructions must be observed, and amounts used must never exceed the quantity specified on the label.

Sulfur and nitrogen oxides may travel large distances in the atmosphere as either primary or secondary pollutants. Increasing the height of chimneys and smokestacks to lower local, ground-level concentrations of particle air pollutants was an early response to local air pollution concerns in urban and industrialized regions The cure to pollution is dilution. As a consequence of this management strategy, air pollutants, especially gases, were injected into the atmosphere at a higher altitude and therefore carried farther downstream. Since around 1950, the average height of chimneys and exhaust fumes in the United States expanded dramatically: more than 400 smokestacks higher than 60 m were erected in the 1970s, and several were extended to more than 300 m in height. As a result, local pollution concerns were turned into regional air pollution challenges. This fact gave rise to one of the most divisive and politically charged parts of the acid deposition debate. That example, contaminants produced in one region may be deposited in another, with no remedy available to the beneficiaries. Also, it was impossible to quantify the specific sources of the contaminants.

Food Safety

The United States boasts one of the world's safest food supply. Despite this, millions of Americans fall sick each year as a result of tainted food, some with potentially deadly illnesses. Foodborne sickness is a serious public health concern, and foodborne disease prevention is a key responsibility of public health, environmental health, and agricultural organisations throughout the country. Food safety is an aspect of environmental safety that safeguards our food supply from farm to fork. Food safety programmes are often the result of collaboration between the food sector and regulatory organisations at the national, state, and municipal levels. These initiatives' overall purpose is to improve the safety of Americas food supply and minimise the incidence of foodborne illness.

Foodborne Illness

Foodborne illness is caused by ingesting food or drinks infested with pathogenic disease-causing bacteria, chemicals, or physical factors. Foodborne disease victims often have one or more of the following symptoms: nausea, vomiting, diarrhea, stomach discomfort, headache, fever, and dehydration. The pathogen in the food, the volume of contaminated food ingested, and the individual's health state at the time the infected food was eaten all impact the kind and severity of a person's symptoms**.** Foodborne infections often occur in outbreaks, with two or more individuals becoming unwell as a consequence of ingesting contaminated food. Victims of a foodborne illness epidemic may have consumed infected food concurrently during a meal, or they may have consumed contaminated food separately but from a common source, such as a cafe, supermarket, or factory.

Those who get unwell as a consequence of consuming contaminated food are considered cases of foodborne illness. The incidence of foodborne disease is the number of cases per population per unit of time, which includes outbreak cases as well as sporadic instances. For several reasons, foodborne illness is significantly underreported: victims frequently have mild symptoms and do not seek medical care; those who do seek medical care frequently have nonspecific symptoms that are not recognized as foodborne; definitive laboratory diagnoses of vomit, faeces, or blood are frequently not performed; and even when a diagnosis is made, physicians may not report cases to public health agencies.

Estimates of the number of instances of foodborne disease that occur each year vary widely, owing not just to underreporting, but also to the fact that many bacteria that cause foodborne illness may also be passed from person to person or via water, masking the role of foodborne transmission. The specific etiology of a foodborne disease is known in fewer than 20% of instances, according to the Centers for Disease Control and Prevention CDC. The United States Food and Drug Administration FDA projected an annual burden of 24 to 81 million instances of foodborne disease in 1993, resulting in an estimated 10,000 fatalities FDA, 1993.

The Council for Agricultural Science and Technology CAST estimated the yearly number of foodborne illnesses in 1994 to be between 6.5 and 33 million, with around 9,000 fatalities Feeding and Roberts, 1994. As part of its Emerging Infections Program, the CDC established the Foodborne Disease Active Surveillance Network Food Net in 1996 to more accurately monitor and quantify the incidence of foodborne disease. Food Net gathers data on 10 foodborne diseases in nine states and tracks changes in foodborne infections caused by microorganisms transferred via food. The CDC estimated in 1999 that there are 76 million instances of foodborne disease in the United States each year, resulting in around 325,000 hospitalizations and 5,000 fatalities based on data obtained from Food Net and other sources.

Food Net data from 2004 indicate some changes in the microorganisms known to cause foodborne disease. Between 1996 and 2003, cases of Cryptosporidium, E. coli O157:H7, Salmonella Typhi, Campylobacter, and Yersinia decreased dramatically, whereas cases of Listeria, Shigella, and Vibrio did not Shallow and others, 2004. Since active monitoring started in 1996, there has been regional and year-to-year fluctuation in the incidence of foodborne disease. Notwithstanding yearly and regional variations, decreases in the increased occurrence of foodborne disease reflect progress towards avoiding foodborne illness and safeguarding public health. While less well recorded, the impact of foodborne disease in underdeveloped nations, where hygiene and sanitation standards are often subpar, is likely substantially larger.

Behind all of these figures are actual individuals who have endured crippling, even deadly, ailments as a result of what most of us believe to be one of lifes less dangerous activities eating. Foodborne disease costs society billions of dollars each year in medical bills, lost productivity, punitive damages, lost sales for food firms, and greater monitoring by regulatory authorities, in addition to pain and suffering. Foodborne disease continues to be a serious public health issue in the United States and across the globe for at least three fundamental causes. Second, new pathogens are emerging. Listeria monocytogenes and Cyclospora cayetanensis are two new bacteria that have recently been discovered as potential sources of foodborne disease. Recent foodborne outbreaks connected to soft cheeses manufactured with poorly pasteurised milk, as well as contaminated hot dogs and luncheon meats, have been linked to Listeria bacterium. Cyclospora is a parasite which has been linked to contaminated farm fresh fruits and vegetables.

Finally, more individuals are living in vulnerable groups. Eating tainted food may make anybody sick. Most healthy individuals, on the other hand, remain asymptomatic or exhibit only minor flulike symptoms that pass in a few days. The same cannot be said for those in vulnerable groups, such as newborns and young children, the elderly, pregnant women & nursing mothers, and people with compromised immune systems as a result of HIV infection, cancer, diabetes, or certain drugs. The dangers of foodborne disease are much greater for those in vulnerable communities than they are for healthy persons. Those that are susceptible often get sick from lower doses of infections, and the signs and durations of their diseases may be significantly more severe, even fatal.

Raw foods may get contaminated in a variety of settings, including farms, ranches, and ships. Pathogens may be found in the intestines of healthy farm animals. Fresh fruits and vegetables may also be polluted if they are cleansed or irrigated with water contaminated with animal manure or human sewage, or if pesticides are applied close before harvest. Food contamination may also develop during manufacturing and delivery. Contact with minor quantities of faecal particles from the animals' intestines may taint meat and poultry carcasses during slaughter. Infected food handlers may also bring biological dangers, as can cross-contamination, which occurs when pathogens from raw animal meals beef, chicken, fish, and so on are transmitted to ready-to-eat foods through contaminated hands, equipment, and utensils. Metals and organic compounds, for example, may be introduced as chemical pollutants [2], [3], [9]. Foods consumed in the United States originate from all around the globe. Consuming food produced elsewhere in the globe entails relying on the land, water, and sanitary conditions in other locations, as well as how people in different areas of the world cultivate, harvest, process, or transport the goods. Due of the globalisation of our food supply, the health risks of one country may readily become those of another. As a result, steps to prevent and manage contamination must begin when food is gathered and continue until the food is eaten.

REFERENCES

[1] J. Li, C. Jia, Y. Lu, S. Tang, and H. Shim, Multivariate analysis of heavy metal leaching from urban soils following simulated acid rain, *Microchem. J.*, 2015, doi: 10.1016/j.microc.2015.04.015.

[2] Z. Liu, J. Yang, J. Zhang, H. Xiang, and H. Wei, A bibliometric analysis of research on acid rain, *Sustain.*, 2019, doi: 10.3390/su11113077.

[3] X. Zhang, H. Jiang, J. Jin, X. Xu, and Q. Zhang, Analysis of acid rain patterns in northeastern China using a decision tree method, *Atmos. Environ.*, 2012, doi: 10.1016/j.atmosenv.2011.03.004.

[4] X. Feng, Q. Liu, S. Wang, L. Cen, and H. Li, Arsenopyrite weathering in acid rain: Arsenic transfer and environmental implications, *J. Hazard. Mater.*, 2021, doi: 10.1016/j.jhazmat.2021.126612.

[5] B. F. SantAnna-Santos, L. C. Da Silva, A. A. Azevedo, and R. Aguiar, Effects of simulated acid rain on leaf anatomy and micromorphology of Genipa americana L. Rubiaceae, *Brazilian Arch. Biol. Technol.*, 2006, doi: 10.1590/S1516-89132006000300017.

[6] Z. Bakhshipour, A. Asadi, B. B. K. Huat, A. Sridharan, and S. Kawasaki, Effect of acid rain on geotechnical properties of residual soils, *Soils Found.*, 2016, doi: 10.1016/j.sandf.2016.11.006.

[7] R. Garaga, S. Chakraborty, H. Zhang, S. Gokhale, Q. Xue, and S. H. Kota, Influence of anthropogenic emissions on wet deposition of pollutants and rainwater acidity in Guwahati, a UNESCO heritage city in Northeast India, *Atmos. Res.*, 2020, doi: 10.1016/j.atmosres.2019.104683.

[8] D. P. Zhou, Y. Wang, Y. Bin Xie, X. Y. Wang, Y. F. Wang, and Y. Hong, Analysis on change of precipitation pH and chemical characteristics of acid rain in Liaoning province 2007-2018, *Revista de Chimie*. 2020. doi: 10.37358/RC.20.5.8161.

[9] J. Shah *et al.*, Integrated analysis for acid rain in Asia: Policy implications and results of RAINS-ASIA model, *Annu. Rev. Energy Environ.*, 2000, doi: 10.1146/annurev.energy.25.1.339.